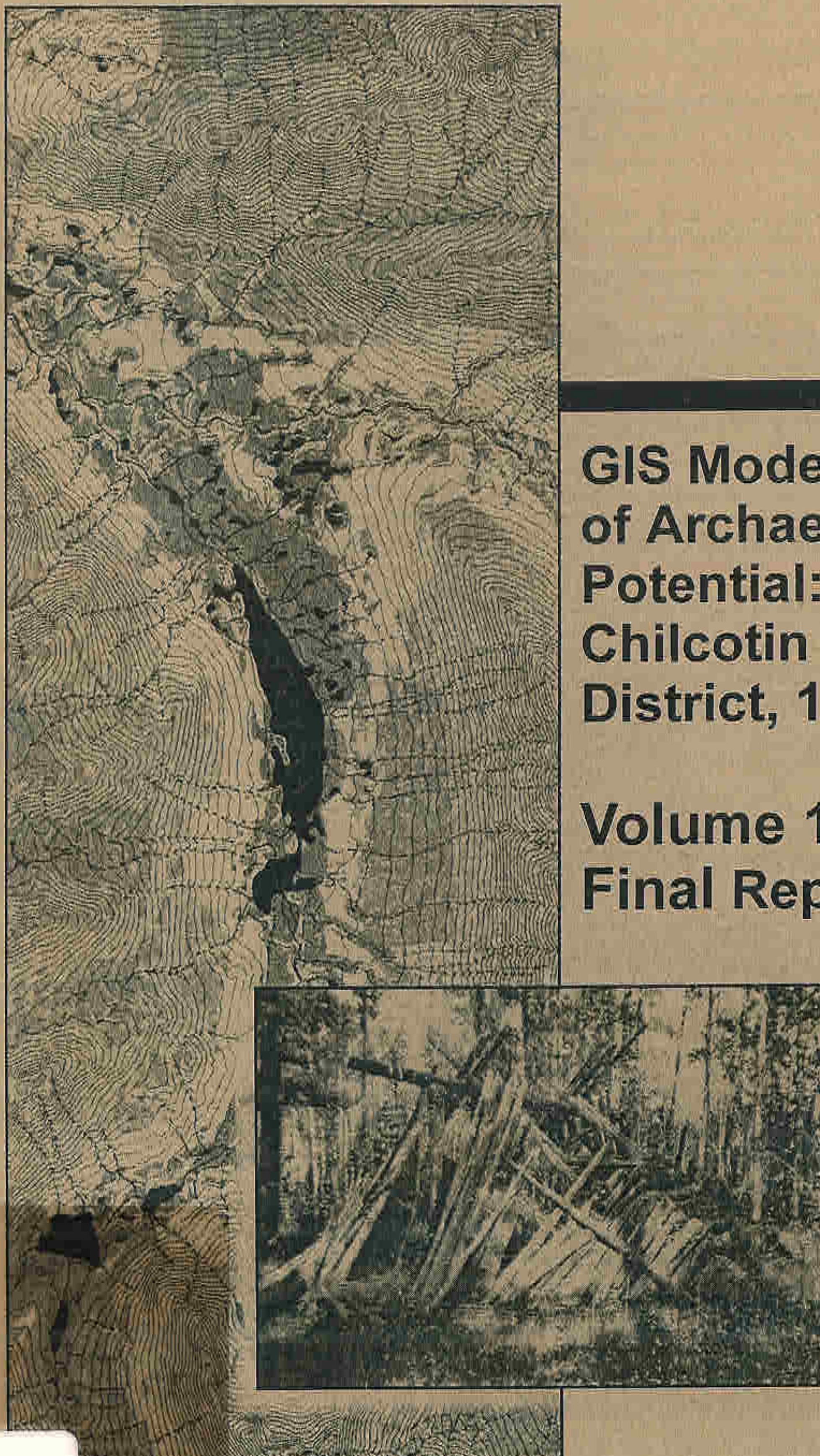

GIS Modelling of Archaeological Potential: Chilcotin Forest District, 1998

Volume 1: Final Report

ARCAS
CONSULTING
ARCHEOLOGISTS
LIMITED

GIS MODELLING OF ARCHAEOLOGICAL POTENTIAL: CHILCOTIN FOREST DISTRICT, 1998

Volume 1
FINAL REPORT

Prepared for:
Ministry of Forests
Cariboo Forest Region
Williams Lake, B.C.

Prepared by:
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July, 1998

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Cover Illustration: detail of modelled mapsheet 92O.004
Cover Photo: remains of a traditional Tsilhqot'in winter house near Puntzi Lake, 1951 (R. Lane photo)

ACKNOWLEDGEMENTS

A project of this scope requires the assistance and support of a large number of people. Many individuals helped with this AOA, and all deserve credit. The AOA benefitted greatly from the experience and knowledge of a diverse group of people representing First Nations, government, and industry interests. Cooperatively, we were able to work through many contentious issues, and hopefully we've come up with a final product we can all live with. In particular, Arcas would like to thank the following individuals for providing input and direction, reviewing draft results, taking the time to attend various meetings, and having patience.

Tsilhqot'in National Government: Chief Ervin Charleyboy, Deputy National Chief Ray Hance, Don Wise, Lars Jensen, Stan Stump Sr., Joe Alphonse, Gene Cooper, and Paul Grinder

Tsilhqotin Nation communities: Chief Roger William, Chief Leslie Stump, Ray Alphonse, Wesley Alphonse, Patrick Charleyboy, Hector Cooper, Frank Joe, Alex Lulua, William Myers, David Setah, Gilbert Solomon, Fanny Stump, and the other Elders and community members who attended various meetings.

Ulkatcho First Nation: Laurie Vaughn, Hugh Middleton, and the archaeology crew.

Carrier Chilcotin Tribal Council: Cameron Beck, Claire Longe, Bert Groenenberg

Ministry of Forests - Cariboo Forest Region: Kate Ashman, Mark Hamm

Chilcotin Forest District: Kelly Brecknock-Feldinger

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Cariboo Lumber Manufacturers Association: Duncan Barnett

Archaeology Branch: Heather Moon, Doug Glaum

I.R. Wilson Consulting: Bruce Dahlstrom, Kevin Twohig, Farid Rahemtulla

Millennia Research: Peter Dady, Morley Eldridge, Colin Moyer, Kat Roberts

This project was funded by Forest Renewal British Columbia, with the Ministry of Forests - Cariboo Forest Region acting as contract administrator.

SUMMARY

In 1997-98, Arcas Consulting Archeologists Ltd., with the technical assistance of Range and Bearing Environmental Mapping Corporation, and with the support of the Tsilhqot'in National Government, undertook an Archaeological Overview Assessment (AOA) of the Chilcotin Forest District at the request of the Ministry of Forests and funded by Forest Renewal British Columbia. This report presents an overview of the objectives, approach, methodology, and results of the AOA. It is intended to accompany digital (on CD-ROM) and paper maps provided to the MoF.

The purpose of this AOA was to assess and map the archaeological potential (sensitivity) within the Chilcotin Forest District (CFD). All lands within the CFD are included in the study, including parks, private lands, leased lands, and Indian reserves. The CFD covers about 2.8 million hectares and falls within the traditional territories of the Tsilhqot'in Nation and its member communities; the Southern Carrier people, notably the Ulgatcho First Nation; the Esketemc (Alkali Lake) First Nation; and the Homalthco, Kwakiutl and Nuxalk First Nations in the western part of the CFD.

This AOA is concerned with archaeological sites. An archaeological site is a geographical place which contains physical evidence of past human activities which can be best studied using archaeological methods of investigation. Different kinds of physical evidence (also known as archaeological remains or resources) can be present in various combinations at archaeological sites. Examples of archaeological resources are cooking pits, storage pits, artifact scatters, trails, underground houses (pithouses), human burials, fish traps, rock art, and bark-stripped trees. Although an archaeological site is restricted to the location containing physical evidence, it is related to the traditional use of the area around a site which often is important for understanding why a site is present and the purpose of the site.

A traditional use site is a geographical place where aboriginal people undertook one or more traditional activities. Some traditional use sites contain physical evidence of those activities, and are considered to be archaeological sites as well as traditional use sites. However, some traditional activities such as berry picking, medicine collecting and spiritual practices leave little or no physical evidence. Traditional use studies, which rely on interviews and archival research, are intended to investigate traditional use sites which do not contain archaeological evidence.

The AOA is concerned only with the *archaeological (physical)* evidence for past human activity, and does not address traditional use activities or other concerns. The AOA is based on current knowledge and assumptions, and there could be aboriginal land use patterns in the past that are not presently known. The AOA should be subject to ongoing updating and revisions as our knowledge about the location of archaeological sites in the CFD increases. It was not the intent of this AOA to document First Nations interests in the land, and the study was conducted without prejudice to aboriginal rights or title. The participation of First Nations in this AOA does not necessarily mean that these First Nations endorse or agree with the process or results of this AOA.

Objectives and Methods

The objectives of this AOA were to:

- classify the lands of the CFD into classes of different archeological potential, and
- provide recommendations for each class of potential for the archaeological management of proposed forestry developments, and
- provide accurate digital GIS data (see below) showing the location of recorded archaeological sites, aboriginal and historic trail routes, and forestry areas previously examined archaeologically.

A computer model created in a geographic information system (GIS) was used in the AOA to assess the potential for archaeological remains throughout the CFD. Broadly defined, a GIS is a computer-based system

used to store and manipulate digital geographic information. A *model* can be defined as a simplified description of a more complex system, which can be used to make predictions about that system. In this case, the system under examination is the past aboriginal use of the landscape which resulted in the formation of archaeological sites, which can then be used to predict archaeological potential.

The modelling approach used here is based on the relationship between the various kinds of traditional activities reported for the study area and the characteristics of the natural environment (biophysical variables). This type of modelling relies heavily on ethnographic, historic, and community sources of information. Past changes to the natural environment also were considered. Modelling involved identifying: (1) the traditional activities which resulted in physical evidence; (2) the types of archaeological sites resulting from these activities; (3) the associated archaeological evidence associated with the site types; and (4) the locations for each of these site types, along with the mappable biophysical variables associated with these locations.

Given this approach, the AOA did not attempt to create a model that predicts the specific locations of archaeological sites. Rather, the AOA model predicts the capability of the landscape to support the types of traditional aboriginal activities which resulted in physical evidence, thereby forming archaeological sites, with each type of activity resulted in one or more specific kinds of archaeological sites.

At the request of the Tsilhqot'in National Government, the analysis of the interaction between environmental variables in the model is based on the idea of biophysical constraints. From this perspective, variation in archaeological potential can be seen as a result of the number and degree of biophysical constraints which inhibit traditional use of an area, and conversely, the number of favourable biophysical variables which enhance traditional use. The challenge in developing such a model of archaeological potential is identifying these constraints and variables, and how the presence or absence of constraints and favourable variables affect overall archaeological potential.

The modelling also recognized the importance of the aboriginal trail network to understanding past use of land and resources away from rivers and lakes. Trails are archaeological sites and are excellent predictors of the presence of other types of archaeological sites. The trail network in the CFD is not well documented at this time, but both archival and community research identifying trails was undertaken as part of this AOA. Trail routes were mapped, digitized, and included in the AOA.

GIS modelling requires mapped data in digital (electronic) format. Relevant biophysical data such as stream locations, wetland locations, forest cover, topography, landforms and wildlife habitat areas were obtained in digital format, as were relevant cultural data such as trail and wagon road routes and known archaeological site locations. Most of these data were obtained at a scale of 1:20,000. This digital information then was entered into the computer and stored as layers of data (coverages). Before applying the model, each coverage was divided into a 10 m grid, creating millions of map "cells" across the study area. Then the GIS examined the content of each cell for each coverage, created a database record for each cell, applied the model to each database record, and lastly predicted the potential for different kinds of traditional activities (and the various kinds of archaeological sites associated with them) of each cell. The highest score for each cell was then placed in a new database. Paper maps showing archaeological potential were made from this database. Digital maps on computer disks also were made from this database. As the database record for each cell is linked directly to a point on the digital maps, any point on the digital maps can be queried to obtain the biophysical and cultural data and the archaeological potential scores for that location.

Access to Information

The results of the AOA are available in two formats:

- digital maps showing archaeological potential, known archaeological site locations, and trail locations, with attached database
- paper maps at a scale of 1:50,000 showing archaeological site potential

Complete digital data (maps and attached database) have been provided to the Ministry of Forests, the Tsilhqot'in National Government, and the Archaeology Branch of the Ministry of Small Business, Tourism and Culture. First Nation communities with traditional territory in the CFD may request digital data sets from the Archaeology Branch. To limit access to sensitive information, another version of the digital data without known archaeological site locations or trails has been made, and is available to forestry licensees and regulatory agencies from the Archaeology Branch.

Results

The GIS model classified the entire CFD into four classes of archaeological potential: High Potential (Low constraint) (Class 4), Moderate-High Potential (Moderate-Low constraint) (Class 3), Moderate Potential (Moderate constraint) (Class 2), and Low Potential (High constraint) (Class 1). The total area of each class of potential varied by biogeoclimatic zone.

The four classes of archaeological potential do not predict the specific locations of archaeological sites. Rather, these classes predict the potential of the landscape to be favourable to the traditional land use activities resulting in the formation of archaeological sites. In other words, high potential areas are the most favourable for activities which result in archaeological sites, and therefore the highest probability of finding an archaeological site will occur in these areas. Although the highest overall density of archaeological sites will be found in Class 4 areas, it is important to keep in mind that sites are not necessarily present at all points within all high potential areas. Conversely, low potential (Class 1) areas have the lowest probability of containing archaeological sites and the lowest overall site density. It is important to remember that low potential areas do not have "zero" potential, and therefore an archaeological site may be present at any location within Class 1 lands.

Archaeological Management Recommendations

For lands in each of the four classes of archaeological potential, a different level of archaeological work is recommended before a proposed development (forestry or otherwise) occurs. Table 14 (Section 4.0) summarizes the **minimum** archaeological management actions and methodologies recommended for the four classes of archaeological potential.

We recognize that the archaeological potential maps produced by this AOA are only one tool for predicting the geographic distribution of archaeological sites in the study area. Another source of information is the First Nations of the CFD. Studies in the Cariboo Forest Region have shown First Nations to be a good source of information for certain types of sites, including trails, rock art sites, and isolated burial places whose locations are very difficult to predict. Also, First Nations bring their own perspective to past aboriginal land use and archaeological site potential. Therefore, for all proposed developments, we strongly recommend consultation on archaeological concerns with the relevant First Nations, regardless of the class of archaeological potential predicted by this AOA for the proposed development property.

No specific management recommendations are offered for particular types of archaeological sites. In our view, the actions recommended in Table 14 of this report should be sufficient to address potential impacts to sites, regardless of type of site, as predicted by this AOA as long as First Nation consultation is meaningful and the field work methodologies used are current, tailored to specific concerns and circumstances, and carried out to the highest professional standards.

Lastly, we recognize that the archaeological potential maps produced by this AOA are based on current knowledge and assumptions. As new information becomes available the model used to predict potential as well as the maps themselves should be revised. Therefore, we recommend that the Ministry of Forests and the Archaeology Branch jointly establish a detailed schedule and process for reviewing and revising the archaeological potential model and maps of this AOA.

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GIS MODELLING OF ARCHAEOLOGICAL POTENTIAL: CHILCOTIN FOREST DISTRICT, 1998

Volume 1
FINAL REPORT

1.0 INTRODUCTION

In 1997-1998, Arcas Consulting Archeologists Ltd. (Arcas), with the technical assistance of Range and Bearing Environmental Resource Mapping Corporation, conducted an Archaeological Overview Assessment (AOA) of the Chilcotin Forest District (Figure 1). This project was undertaken at the request of the Ministry of Forests (Cariboo Forest Region), with funding by Forest Renewal British Columbia. This project was conducted with the assistance and direction of the Ministry of Forests (MoF) and the Tsilhqot'in National Government (TNG).

The primary goal of this AOA was to provide the MoF and First Nations with a set of maps and recommendations which would assist with the effective protection and management of archaeological resources within the Chilcotin Forest District (CFD). This AOA used a model created in a computer-based Geographic Information System (GIS) to predict the relative archaeological potential (sensitivity) of the landscape within the CFD. Four classes of archaeological potential were identified, and digital and paper maps showing these classes were generated using the GIS. Specific archaeological management actions are recommended for each class of archaeological potential shown on these maps.

This report presents an overview of the objectives, approach, methodology, and results of the AOA. It is intended to accompany digital (on CD-ROM) and paper maps provided to the MoF. All management decisions based on these maps should be made in reference to the recommendations found in this report. A number of Technical Appendices to this Final Report are presented as a separate volume, and these appendices provide additional technical details regarding the methodology, results, and recommendations of the study.

1.1 Scope and Limitations

This AOA is concerned with archaeological sites. An archaeological site is a geographical place which contains physical evidence of past human activities which can be best studied using archaeological methods of investigation. Different kinds of physical evidence (also known as archaeological remains or resources) can be present in various combinations at archaeological sites. Examples of archaeological resources are cooking pits, storage pits, artifact scatters, trails, underground houses (pithouses), human burials, fish traps, rock art, and bark-stripped trees. Although an archaeological site is restricted to the location containing physical evidence, it is related to the traditional use of the area around a site, and this use often is important for understanding why a site is present and the purpose of the site.

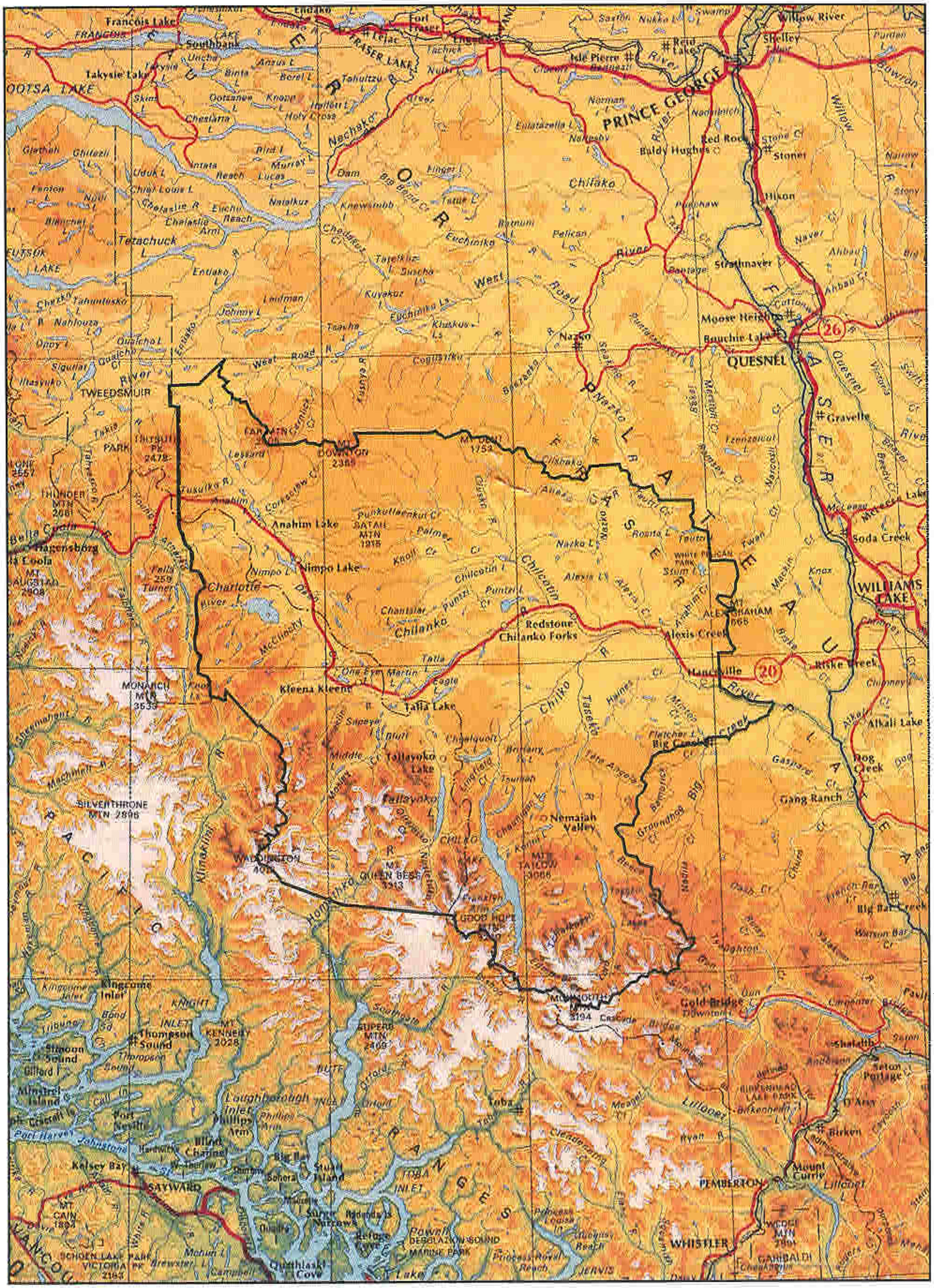


Figure 1. Location of Chilcotin Forest District (1;2,000,000; British Columbia Relief Map).

A traditional use site is a geographical place where aboriginal people undertook one or more traditional activities. Some traditional use sites contain physical evidence of those activities, and are considered to be archaeological sites as well as traditional use sites. However, some traditional activities such as berry picking, medicine collecting and spiritual practices leave little or no physical evidence. Traditional use studies, which rely on interviews and archival research, are intended to investigate traditional use sites which do not contain archaeological evidence.

The AOA is concerned only with the *archaeological (physical) evidence* for past human activity, and does not address traditional use activities or other concerns. It was not the intent of this AOA to document First Nations interests in the land, and the modelling of archaeological potential was conducted without prejudice to aboriginal rights or title. First Nation consultation is recommended as part of all archaeological management decisions. The model of archaeological potential used in this study is based on current knowledge and assumptions, and should be subject to ongoing revision as additional information becomes available.

The Tsilhqot'in National Government (TNG), TNG member communities, the Carrier-Chilcotin Tribal Council (CCTC), and Ulkatcho First Nation (UFN) participated in or were consulted as part of this study. The involvement of First Nations in this AOA does not necessarily mean that these First Nations endorse or agree with the process or results of this AOA.

1.2 Objectives, Application, and Products

The AOA will benefit all groups with an interest in the protection and appropriate management of archaeological resources in the study area, including First Nations, the MoF, and the Archaeology Branch. The digital and paper maps produced by this study can be used to assess the archaeological sensitivity of the landscape. This assessment will assist in determining the appropriate management actions to be taken in order to avoid conflicts with archaeological sites. The AOA process provides all interested parties with the information necessary for planning and monitoring archaeological resource management activities in the Chilcotin Forest District.

Primary objectives:

- to classify the lands of the Chilcotin Forest District into classes of relative archaeological potential;
- to provide the Ministry of Forests (MoF) with recommendations for each class of potential which ensure appropriate archaeological management in forestry planning, and;
- to provide accurate digital GIS data showing the locations of recorded sites, aboriginal and historic trail routes, and forestry areas which have been examined archaeologically.

Applications and Benefits:

- identifying areas of highest archaeological sensitivity and concern

- assisting users in making appropriate land use decisions
- allowing for efficient and effective archaeological management in forestry planning
- standardizing appropriate levels of archaeological work in forestry developments
- identifying recorded archaeological sites so that impacts can be avoided
- providing the information necessary to monitor archaeological management actions
- identifying priority areas for future inventory studies

Products:

- digital (1:20,000 base scale) and paper maps (1:50,000 scale) of the study area showing the extent of the different classes of archaeological potential
- digital maps showing the location of all recorded archaeological sites in the study area (as of December 1997)
- a digital database listing recorded archaeological sites and site types
- digital maps showing the routes of aboriginal and historic trails
- digital maps and a digital database of all forestry-related archaeological impact assessments (1994 through 1996)
- recommendations for addressing archaeological and digital data gaps and model limitations
- recommended management actions for each class of archaeological potential

The MoF, First Nations, and the Archaeology Branch have full access to the digital maps produced by this overview. These maps provide users with the ability to query digital databases for information on archaeological site locations and types, previous forestry AIA results, the presence of biophysical features, the site types expected in each area of archaeological potential, and the overall archaeological site potential for any given location. Full access to digital maps and features are not available to other users. However, other users may have access to digital maps (without database information) and paper maps showing the four classes of archaeological potential, which can be used as overlays to assess development plans or inventory planning. Other users should contact the MoF-Cariboo Forest Region for more information on these maps.

1.3 GIS and Modelling Innovations

This study incorporated a number of advanced GIS techniques using an ARC/INFO-based software package (ArcPot) developed by Range and Bearing, and innovative modelling approaches developed by Arcas in consultation with First Nations. This has resulted in substantial improvements over previous GIS overviews undertaken in the Chilcotin Forest District and elsewhere in B.C. The final digital product also includes improved data and features which greatly enhance the usefulness of the overview.

Advances in GIS:

- extremely high slope resolution on a 10 m grid extrapolated from digital map elevations

- a sophisticated stream gradient analysis used to classify salmon and fish potential based on Forest Practices Code standards

- incorporation of a full suite of digital biophysical variables, including forest cover, biogeoclimatic zones, and ungulate habitat

- grid (raster)-based modelling, which allows more efficient and more sophisticated analysis of multilayer digital coverages, and can be more easily modified and reapplied, than vector-based modelling

- digital maps which can be viewed in ArcExplorer (freeware), ArcView, or GeoMedia software, and available in both raster and vector format

- digital maps which can be queried to produce tables which list the features which produced the model results, and the site types which can be expected, for any point on the map

Innovative Modelling Approaches:

- a deductive approach which emphasizes traditional activities as opposed to recorded site distribution

- an emphasis on biophysical constraints mitigating against archaeological potential, as opposed to an additive approach using favourable variables

- modelling for each site type using *logical statements* which identify specific combinations of variables and constraints

- extensive use of biogeoclimatic zones and subzones to modify relative potential

- incorporation of high resolution slope data to target small landforms

Enhanced Data and Features:

- improved recorded archaeological site locations, including areal extent of sites greater than 100 m in size

- comprehensive aboriginal and historic trail coverage, with aboriginal origin and level of route confidence data

- incorporation of local community knowledge of archaeological sites
- conformity with regional AOA standards for digital data and site typology
- point and click access on digital map to a table listing the biophysical variables, potential for each site type, and overall site potential present for all locations

1.4 Study Area

The study area for this AOA encompasses the entire Chilcotin Forest District (CFD), including parks, protected areas, and private lands (Figure 1). The CFD is located in the Interior of B.C. between the Coast Mountains and the Fraser River, and covers an area of approximately 2.8 million hectares. The Chilcotin Plateau forms the majority of the study area, with the Chilcotin Ranges bounding the study area on the west and south. The study area includes most of the Chilcotin River watershed, as well as the upper reaches of the Nazko, Dean, Klinaklini, and Homathko drainages.

The study area falls within the traditional territory of the Tsilhqot'in Nation and the Southern Carrier people. Resident First Nations include the communities of Tl'etinqox-t'in (Anaham), Tsi Del Del (Alexis Creek), Xeni Gwet'in (Nemiah Valley), and Yunesitin (Stone), which are affiliated with the Tsilhqot'in National Government, and the Ulkatcho First Nation, affiliated with the Carrier-Chilcotin Tribal Council. Additional native communities with an interest in the study area include Nazko and Esketemc (Alkali Lake) First Nations, as well as the Homalco, Kwakiutl, and Nuxalk First Nations in the western part of the CFD.

1.5 Definitions

A number of technical terms are used throughout this report and the Technical Appendices (Volume 2). Some of the more important of these terms are defined below. Additional terms are defined in the text.

- *Archaeology* is the study of past cultures through the examination of material remains and physical evidence of past activities.
- *Ethnography* is the description of the culture of particular social groups, based on aboriginal testimony, participant observation, and written records.
- *History* is the study of the human past through the examination of written and oral records.
- *Traditional activities* are those which were practised by aboriginal people at the time of contact with European culture, and which may still be practised today.
- *Traditional use sites* are places where traditional aboriginal activities took place. Not all traditional use sites are represented by archaeological remains, as some activities did not result in physical evidence.

- *Archaeological sites* are areas which contain physical evidence of past traditional activities, such as cultural features and cultural materials.

- *Cultural features* and *cultural materials* are the physical remains found at archaeological sites. Cultural features are archaeological remains which are not portable and cannot be removed from the site context without damaging them, such as hearths, depressions, modified trees, rock art, and structures. Cultural materials are archaeological remains which can be removed from the site context without damaging them, such as stone artifacts and flakes, bone, and fire altered rock.

- *Archaeological site potential* is the relative potential of the landscape to be favourable to the traditional land use activities resulting in the formation of archaeological sites. For example, high potential areas are the most favourable for activities which result in archaeological remains, and therefore the highest probability of finding an archaeological site will occur in these areas.

- *Digital data* is information which is stored electronically in a computer system.

- *GIS (Geographical Information System)* is a computer-based system used to store and manipulate digital geographic information.

- *Model* refers to a simplified description of a more complex system, which in turn can be used to make predictions about that system

1.6 Study Team

Arcas Consulting Archeologists Ltd. was lead proponent for this AOA, but a number of other individuals and firms assisted with various aspects of this project. The roles and responsibilities of each are briefly described below.

- *Arcas Consulting Archeologists Ltd.* was responsible for project management, liaison, First Nation consultation, background research, developing the model, reviewing application of the model, recommendations, and reporting.

- *Range and Bearing Environmental Resource Mapping Corporation* was responsible for acquiring, translating, and classifying all digital data, applying the model, and producing all digital and paper outputs.

- *Tsilhqot'in National Government* organized steering committee meetings, gave input on overall project direction, provided access to community and traditional knowledge, liaised with communities, and reviewed the model and results. *Stan Stump Sr.* of the Tsilhqot'in Nation conducted community research in Tsilhqot'in Nation communities and assisted with anecdotal site ground-truthing.

- *Archaeo Research* was responsible for trail research and reviewing the model background.
- *Pierre Friele* of Baumann Engineering was responsible for palaeoenvironmental, glacial landform, and geomorphological research.

2.0 GIS AND MODELLING

A *Geographic Information System* (GIS) was used in this study to describe and analyze the landscape of the Chilcotin Forest District. Broadly defined, a GIS is a computer-based system used to store and manipulate digital geographic information. This study used a GIS to implement a model the archaeological potential of the study area. A *model* is defined as a simplified description of a more complex system, which in turn can be used to make predictions about that system. For this project, the system we are attempting to model is the past aboriginal use of the landscape which resulted in the formation of archaeological sites, which in turn can be used to predict archaeological site potential.

2.1 GIS Mapping and Digital Data

The GIS used in this study is based on landscape and biophysical attributes commonly associated with past human activity. Geographical information on these attributes, derived from the GIS, was used to develop a model of archaeological potential for the study area. This study, therefore, is spatially based, using elements of the landscape that can be described with geographical shapes -- points, lines, and areas. These variables are predominately biophysical in character, which is typical of most overview assessment studies dedicated to modelling past land use.

A GIS requires landscape and biophysical data in a digital format. Most major biophysical attributes available from paper maps, such as streams and forest cover, are also available in digital form. Most existing paper maps have been turned into digital maps by a process known as *digitizing*. In other cases, biophysical attributes, such as digital elevations, have been produced directly in digital form. However, not all biophysical attributes are currently available in digital form. Wherever possible, the digital information used in this study was derived from existing sources, although some map data was digitized specifically for this project.

The digital information entered into the computer is stored as separate *layers* of data, sometimes referred to as *coverages* or *themes*. These coverages can be stored as raster data or vector data. In a raster system, geographic information is represented as a grid made up of *grid cells*, where each cell is a pre-determined size and contains the information present at that point in the grid. Raster systems are best suited for complex modelling and analysis, as they require less storage space and provide faster data access. In a vector system, the geographic locations of objects are summarised as points (x- and y- coordinates), lines (points linked in sequence), or *polygons* (enclosed areal shapes), which are better suited for portraying mapped data where mapping accuracy is required. In both raster and vector systems, complex manipulation of data is possible. Coverages can be displayed separately or brought together in new combinations. Questions can be asked about the relations between data within and between coverages, and a series of *analysis functions* are possible. These analysis functions progress from basic *descriptive* activities such as new map displays, to more *interpretive* actions, where the data is presented in new combinations, and lastly, to *prescriptive* activities, like spatial modelling, which produce new spatial information.

2.2 Analysis and Modelling Capabilities of a GIS

Although map-based input forms the foundation of a GIS, map displays and analysis are the true strengths of this system. The five basic analysis functions of GIS are display, classification, overlay, distance (connectivity), and neighbourhood analyses. Displays of individual variables at various scales and in combination with other elements within the system provide useful views of how well the data capture process has worked. Data in its raw form can also be *classified* to produce new displays. For example, slope values can be grouped according to specified ranges. The relationship between variables can be explored, using *overlay* operations, where two separate coverages are allowed to intersect to provide new information. Water coverage showing streams can be matched to slope coverage to determine stream sections too steep to have fish potential, for example. Various *distance* and *connectivity* measurements can also be made, and *adjacency* or *neighbourhood* analyses can be undertaken to describe the relationships of various mapped features to each other. In this study, a neighbourhood analysis was used to measure site locations to other landscape features in order to assess spatial relationships between sites and features.

Often these four operations - classification, overlay, distance, and neighbourhood analyses - represent the entire function of a GIS and are certainly the core of its analytic capabilities. However, the data also can be updated and re-examined using more complex spatial modelling operations. For example, new boundaries of a specific width can be added around points, lines, and polygons using *buffering* operations, creating new polygons. Likewise, numeric values or unique codes can be attached to points, lines, and polygons following specific rules. When various points and polygons intersect, their numeric values can then be added together to produce a score, or they can analyzed using logical statements. A logical statement is a set of computer instructions which asks the GIS to look for the presence or absence of certain codes at a particular place on the map, and a new code is produced based on the specific combination of codes present at that spot. The final score or the outcome of logical statements can then be used to produce a new coverage which represents the relationship of various features to each other - in this case, archaeological potential. In this way, GIS provides a final modelled landscape that becomes an effective decision-making tool.

2.3 GIS Specifications

The GIS software used in this AOA was ESRI's ARC/INFO along with their raster conversion package ARC GRID 7.1.2. The base mapping was derived from digital 1:20,000 scale Terrain Resource Information Management (TRIM) maps. All input and output data was formatted to the following specifications:

Projection: BC Albers
Datum: NAD83
Spheroid: GRS80

All vector digital input was converted to a 10 m grid in ARC GRID. Modelling was undertaken using ARC/INFO-based archaeological potential software (ArcPot) developed by Range and Bearing. ESRI's ArcView 3.0 software was used for the review and analysis of draft and test outputs.

All final modelled data (potential maps) was outputted onto CD in the following formats: ESRI Shape (vector), ARC/INFO Image, ARC/INFO GRID. Archaeological site and trail coverages were outputted to CD in ESRI shape format.

2.4 Previous Models of Archaeological Potential for the Chilcotin FD

A GIS-based model of archaeological potential has not been developed previously for the Chilcotin Forest District. However, several conventional map-based models of archaeological potential have been developed for all or part of the forest district in a number of earlier studies.

In the Dean River valley (Eldridge and Eldridge 1980), the results of a 775 ha random sample archaeological inventory was used to predict site densities for the entire Dean River valley below 4000 feet in elevation from Anahim Lake to the north boundary of the CFD. The study area was divided into five classes of relative potential. Each class was described in terms of the degree of limitations on the potential for containing archaeological sites, as well as overall expected site density. Distance from water was considered the greatest limitation on site potential, and all lands greater than 250 m from major water sources were identified as having moderately severe (Class 4) to severe (Class 5) limitations. Classes 1, 2, and 3 were defined on the basis of specific fluvio-glacial terrain features, as well fish distribution and productivity. Classes 1, 2, and 3 contained 8.2% of the land, but were estimated to contain 75% of all. Although further archaeological work was not recommended for Class 4 and 5 lands, it was estimated that at least 25% of all sites would be found in these zones. This model was limited in scope, and was specific to the conditions of the Dean River valley. The landscape features used were generalized and did not allow fine resolution predictions, and archaeological potential in association with minor aquatic and terrain features was underestimated. Consequently, the model could not identify the areas containing 25% of all sites. Furthermore, the specific environmental factors used to assess potential are not clearly described, making it difficult to use or adapt the model to predict archaeological potential in other areas or environmental zones.

An archaeological overview of the Cariboo Forest Region (Bussey and Alexander 1992) was commissioned for the Committee on Resources and the Environment (CORE). A model of archaeological potential was developed for the study area, which was divided into a number of broad environmental zones at a scale of 1:250,000. On the basis of ethnographic information and known archaeological site distribution, expected site types and site densities were predicted for each environmental zone. Due to the mapping scale, this overview was inadequate for operational level planning. The very generalized environmental zones employed in the study also were problematic in predicting sites associated with specific small-scale landforms and minor aquatic features. Lastly, the emphasis on known site distribution had a tendency to underestimate site densities and distribution in areas where little previous archaeological survey had taken place, such as forested zones.

Models of archaeological potential were also developed for the archaeological review of the five-year consolidated development plan of the Chilcotin Forest District (Klassen and Stryd 1996; Hewer 1996). The models employed in these studies attempted to avoid the problems associated with earlier models, which were based on broad environmental zones, by focussing on the relationship of specific aquatic features to site distribution. High and moderate potential zones or buffers of differing sizes were assigned to various classes of aquatic features, and the relative potential of these zones was then modified by slope. These models required a cumbersome analysis to determine the relative potential of a specific area, as the buffers and slope values were not mapped and had to be determined manually for each development area. Due to the almost exclusive emphasis on aquatic features and slope, these models were relatively unsophisticated and did not consider the influence of other biophysical variables. Slope resolution was also poor, and was applied indiscriminantly across the study area regardless of setting or potential site type. Moreover, these models did not take into account the influence of broad environmental zones, which led to overemphasized potential in some areas and underemphasized potential in others. Lastly, the models relied fairly extensively on known site distribution despite the limited and unrepresentative nature of archaeological survey in the area, which decreased their accuracy in areas of poor survey coverage.

2.5 Modelling Approach Used in this Study

The model used in this study has attempted to incorporate the best features of previous models, while also utilizing innovative approaches and enhanced data to improve accuracy and resolution. For example, the model has retained an emphasis on buffered aquatic features, but the size and relative potential of these buffers is modified by broad environmental zones. Slope has also been retained as a variable which decreases potential, but the resolution of this variable is greatly improved and has been applied differently in different settings. The model has also been applied at a base scale of 1:20,000 (and the entire study area has been mapped at a scale of 1:50,000), making the final product more appropriate for operational planning. Most importantly, the present model employed a GIS, allowing for complex analysis of multiple variables as well as high resolution mapping.

Using GIS, the model used in this study incorporates a sophisticated analysis of the interaction between environmental variables, and an increased emphasis on the idea of biophysical constraints. The idea of emphasizing constraints in this model is a direct result of consultation with the Tsilhqot'in National Government. The TNG challenged Arcas to develop a model starting from the basic underlying assumption that all of the Chilcotin Forest District has archaeological potential. The TNG recognized that different areas have higher or lower potential for archaeological sites, but it was incumbent upon the model to show why some areas have lower potential than others. From this perspective, variation in relative archaeological potential can be seen as a result of the number and degree of biophysical constraints which inhibit traditional aboriginal land use activities resulting in archaeological remains, and conversely, the number of favourable biophysical variables which enhance or support these activities. The challenge in developing a model of archaeological potential is identifying these constraints and variables, and how the presence or absence of constraints and favourable variables affect overall archaeological potential.

From a GIS modelling perspective, it is necessary to identify biophysical constraints and variables from digital landscape *coverages* or map layers. However, not all biophysical variables affecting archaeological potential are available in digital (or even paper) form. Biophysical variables can be classified into *macro-features* and *micro-features* (Table 1). Macro-features are those which are large enough that they are easily mappable; in other words, they are readily visible or identifiable on digital or paper maps. Micro-features are small features which are not readily identifiable on maps, and available mapping generally does not have the resolution to pick up the presence or absence of these features. Micro-features are usually only identifiable from field inspection or aerial photos. The presence or absence of micro-features modifies the level of constraints produced by macro-features.

Table 1: Comparison of Selected Macro-features and Micro-features

Macro-features	Examples	Micro-features	Examples
generalized slope	slope averaged or classified across a large area (i.e., contours or slope classes)	specific slope	the actual slope of a small area (i.e., spot measurements in degrees)
major aquatic features	lakes, major streams, wetlands	specific aquatic characteristics	boggy, poorly drained areas; indefinite streams
major landforms	eskers, large glacial channels, major terraces	minor topographic features	knolls, small terraces, rocky or hummocky terrain
macro-climate	rainfall, temperature	micro-climates	sheltered, exposed areas
broad vegetation zones	biogeoclimatic zones and subzones	vegetation communities	balsamroot fields, berry patches
generalized forest composition	stand composition, overall age class	specific forest composition	minor species, old-growth veterans
generalized wildlife habitats	ungulate winter range	specific wildlife habitats	game trails, migration corridors

A GIS-based model of archaeological potential, by its very nature, is largely restricted to the use of macro-features. This is because the existing accuracy and resolution of digital mapping does not permit the identification of micro-features using a GIS. In a GIS model, therefore, we can only identify the specific macro-feature biophysical variables which are associated with each traditional activity resulting in archaeological remains, and hence with each archaeological site type. In other words, the macro-features which act as constraints or as favourable variables can be identified. Where few favourable variables are present and many constraints exist at a particular point on the landscape, the potential for that site type is low. Conversely, where fewer constraints exist and more favourable variables are present at a particular point, the potential for that site type becomes higher. However, a GIS-based model cannot account for unmapped micro-features. These micro-features may increase or decrease the level of constraints in a given area, thereby decreasing or increasing the archaeological potential determined from macro-features.

Lastly, this study relied on a modelling approach which emphasizes traditional activities as opposed to known site distribution. Most GIS-based models of archaeological potential rely heavily on the known distribution of recorded sites. In these models, a spatial analysis of site distribution is used to determine the relationships between sites and various environmental variables. This type of *inductive* modelling presents two problems. First, it assumes that we have a representational and statistically unbiased sample of recorded sites. Most areas of the province have very poor archaeological survey data. This is particularly true in the Chilcotin, where only a tiny fraction of the land area has been surveyed. This site survey has been largely nonrepresentational, and only 816 sites are known from an area covering more than 2.8 million hectares. Any model developed solely from this information for the entire forest district would be statistically and theoretically weak. Secondly, a model based only on known site distribution relies on circular reasoning, and this type of model would only predict archaeological potential for the types of settings where sites are already known to exist. In other words, it is self-confirming, and not readily testable. It would rarely predict sites in the types of settings which have not been adequately surveyed.

In response to the above limitations, this study uses a *deductive* modelling approach which does not rely exclusively on known site distribution. Theoretically, using a deductive model, you do not need to know the location of a single site in order to predict their locations. Instead, the modelling approach used here is based on traditional aboriginal land use activities rather than site distribution, and relies heavily on ethnographic, historic, and community sources. This model involves identifying: 1) the traditional activities which resulted in physical archaeological evidence; 2) the types of sites resulting from these activities along with the associated archaeological remains, and; 3) the locations for each of these site types, along with the mappable biophysical variables associated with these locations. As such, this project did not attempt to create a model that predicts the specific locations of archaeological sites. Rather, this study uses a model that predicts the potential capability of the landscape to support the types of traditional aboriginal land use activities which resulted in physical evidence, thereby forming archaeological sites. Each type of activity could resuld in one or more specific archaeological site types at any given location. In this way, the model produced in this AOA relied heavily on ethnographic, hstorical, and community sources, although the two approaches are complementary and mutually reinforcing. The modelling also recognized the importance of the aboriginal trail network to understanding past use of land and resources away from rivers and lakes. Trails are archaeological sites and are excellent predictors of the presence of other types of archaeological sites.

Overall, the emphasis on deductive modelling, biophysical constraints, traditional land use patterns, and aboriginal trail networks fits well with aboriginal conceptions of archaeological site potential favoured by the TNG. Moreover, this modelling approach is theoretically stronger and more defensible from an archaeological perspective. In summary, the modelling approach used in this study relied on the following assumptions:

- the existing level of archaeological survey in the study area is limited and unrepresentative of actual archaeological site distribution, and therefore site distribution is unreliable for predicting archaeological site potential

- ethnographic, historic, and contemporary sources documenting traditional aboriginal land use activities in the recent past are relatively comprehensive, and broadly applicable to the last several thousand years

- traditional activities resulting in physical archaeological evidence took place across the entire landscape, and thus the entire landscape has archaeological site potential

- various biophysical constraints decrease the diversity, intensity and frequency of traditional activities, thereby reducing archaeological site potential, while other favourable variables enhanced traditional use, thereby increasing archaeological site potential

- major biophysical constraints and favourable variables can be identified using a GIS, while minor constraints and variables can only be identified through fieldwork or review of other sources (such as aerial photos or community consultation)

- certain combinations of constraints and favourable variables are associated with specific traditional activities and archaeological site types

2.6 Classes of Archaeological Potential

In a model of archaeological potential, the landscape is classified into different levels which reflect the landscape's relative potential for supporting the presence of archaeological sites. The specific number of classes of potential is determined in accordance with the objectives of the study. For this study, the landscape was classified into four classes of relative archaeological site potential. Each of these classes has been defined by determining the relationship of different combinations of constraints and variables (both macro-features and micro-features) to traditional activities (and the corresponding archaeological sites). From this information, the expected relative diversity and density of site types associated with each class can be estimated. The highest density of sites and the greatest diversity of site types is expected in the highest potential areas (where constraints are lowest), while the lowest density of sites and least diversity of site types is expected in the lowest potential areas (where constraints are greatest). Each class is also intended to correspond to one of four standard archaeological impact management options currently used in B.C.: archaeological impact assessment (AIA); preliminary field reconnaissance (PFR); archaeological overview assessment (AOA), and no further action. As such, a different archaeological resource management action may be appropriate for each class of potential. Table 2 summarizes the characteristics of each class of potential, and the corresponding archaeological management action.

Table 2: Summary of Classes of Archaeological Potential

Relative Potential	**Description**	**Possible Management Action**
High	• this level has few or no constraints presented by macro-features, and is not expected to have any micro-features which would increase the level of constraints (i.e., decrease potential) • the highest density of sites, and greatest range in site types, is expected for this class	• complete, intensive AIA
Moderate-high	• this level has some constraints presented by macro-features, but is expected to have areas where micro-features increase/decrease the level of constraint (i.e., increase/decrease potential) • a moderate-high density of sites, and a range of site types, is expected	• judgemental AIA or PFR to identify the presence or absence of micro-features and assess their effect
Moderate	• this level has significant constraints presented by macro-features, and is expected to have few micro-features which decrease the level of constraint (i.e., increase potential); if these micro-features are present, most should be identifiable on air photos, large-scale maps • a low-moderate density of sites, and several site types, is expected	• AOA using maps, air photos, and further research to identify micro-features (may lead to an PFR or AIA)
Low	• this level has a high degree of constraints resulting from macro-features, and is not expected to have micro-features which decrease the level of constraints (i.e., increase potential) • a low density and only a few types of sites is expected (but NOT zero potential)	• consultation to identify known sites, unmodelled site types

3.0 METHODOLOGY

3.1 Consultation

Consultation with First Nations

Consultation with First Nations was considered essential to ensure the success and credibility of this project. Although consultation with First Nations was limited by time and financial constraints, efforts were made to (1) contact all First Nations with an interest in the study area, (2) meet with representatives of resident First Nations to discuss objectives and methodology, and (3) establish protocols for ensuring the meaningful participation of resident First Nations in developing and reviewing the model. Arcas was committed to working closely with First Nations, and wherever possible incorporated First Nations input in developing and reviewing the model.

The study area falls within the traditional territory of the Tsilhqot'in Nation and the Southern Carrier people. Resident communities affiliated with the Tsilhqot'in National Government are the Tl'etinqox-t'in (Anaham), Tsi Del Del (Alexis Creek), Xeni Gwet'in (Nemiah Valley), and Yunesitin (Stone) First Nations. The Ulkatcho First Nation, affiliated with the Carrier-Chilcotin Tribal Council, is also a resident community. Additional native communities with an interest in the study area include the Nazko and Esketemc (Alkali Lake) First Nations, as well as the coastal Homalco, Kwakiutl, and Nuxalk First Nations.

Specifically, First Nation consultation for this AOA included the following steps:

- all First Nations with an interest in the study area were notified by mail at the initiation of the AOA
- work on this project did not commence until a "Terms of a Working Relationship" agreement was signed with the TNG on May 15, 1997 which spelled out conditions for TNG participation and consultation in the AOA
- the TNG and Ulkatcho First Nation were informed of the progress of the AOA by phone, fax, and mail on a regular basis
- periodic meetings were held with representatives of the TNG and/or member communities to discuss the progress of the AOA and to review methodology and results
- a meeting was held with representatives of Ulkatcho First Nation to discuss the objectives and methodology of the AOA
- several meetings were held with a steering committee established by the TNG
- the CCTC attended several MoF steering committee meetings
- at the request of the TNG, a member of the Tsilhqot'in Nation was hired to conduct

community research to identify and record locally known archaeological sites (see Section 3.2)

- a number of interim and final deliverables (digital coverages, overview maps, digital potential maps) were provided to the TNG and Ulkatcho First Nation

- meetings were held with representatives of the TNG and the CCTC to review the interim deliverables and the first draft of the modelled test areas

- follow-up meetings were planned with Ulkatcho First Nation and the TNG after completion of the project

Additional details concerning First Nation consultation is provided in the Technical Appendices (Volume 2). The participation of Ulkatcho First Nation in this project was limited in scope, primarily due to the lack of financial support available. During consultation, the Tsilhqot'in National Government voiced concerns over the objectives and methodology of the project. These concerns were addressed to the best of our ability through consultation before and during the project. In particular, the TNG closely monitored the project and provided substantial direction and as part of their steering committee process. Participation by the TNG and Ulkatcho First Nation in this AOA in no way implies that these groups endorse or agree with the process and results of the AOA. Recommendations for improving First Nation consultation is provided elsewhere in this report.

Consultation with Archaeologists

The contract for this AOA required consultation with other archaeologists familiar with the area. A number of informal discussions were held with Arcas employees, employees of other archaeological firms, academics, and government archaeologists. In these discussions, archaeological site distribution, modelling approaches, and appropriate archaeological management actions were reviewed.

At the request of the MoF and the TNG, Arcas consulted extensively with two archaeological firms (I.R. Wilson Consulting and Millennia Research) also conducting GIS-based AOAs in the Cariboo Forest Region. The purpose of this consultation was to share information on archaeological site distribution, discuss methodological approaches, ensure that consistent baseline data, terminology, and digital formats were employed, and review modelling results and recommendations. In addition, several shared test area mapsheets were selected and compared during initial modelling stages. Liaison consisted of frequent contact by phone, and four meetings were held with representatives of I.R. Wilson and Millennia. Heather Moon (on behalf of the Archaeology Branch) and representatives of the various GIS subcontractors participated in several of these meetings.

MoF Steering Committee

A steering committee for this project was organized by the MoF with representatives of all stakeholders invited to attend. The purpose of this committee was to give direction on methodological, logistical, and scheduling issues, and to review the progress of the AOA. A steering committee meeting was held during Phases 2 through 6 of the study. Representatives of the following groups attended one or more of these meetings: Cariboo Forest Region, Chilcotin Forest District, Archaeology Branch, Quesnel Forest District, and forestry licensees. The TNG, CCTC, and Ulkatcho First Nation were also invited to attend steering committee meetings. Representatives of the TNG attended the first meeting, but chose not to attend future meetings due to jurisdictional issues. Representatives of the CCTC attended most meetings. Representatives of the Ulkatcho First Nation were unable to attend these meetings, in part due to budgetary considerations.

3.2 Background Research

Before developing a model of archaeological potential, it is essential to have an understanding of the natural setting and cultural context of the study area and its archaeological resources. The background research component of this AOA involved a thorough review of ethnographic, archaeological, historical, archival trail, biophysical, and palaeoenvironmental sources.

Ethnographic Research

This research was used to determine the types of traditional activities that would have resulted in the formation of archaeological sites, and where these activities took place within the study area. Although not exhaustive, ethnographic research included a review of relevant ethnographic and historical sources which document the traditional culture of the Tsilhqot'in and Southern Carrier peoples. These sources included written documents recording (1) observations of early Euro-Canadian visitors to the region, (2) descriptions of aboriginal culture by anthropologists and other researchers, and (3) the oral histories and traditions of aboriginal people. These sources are important for understanding the traditional way of life of aboriginal groups in the study area, and they help to place the archaeological resources into a cultural and historical context. In particular, these sources were used to identify traditional land use activities and build the model of archaeological potential.

The following types of sources were consulted in the ethnographic research:

- early post-contact period (late 18th and 19th century) historical documents and journals
- post-contact (late 18th and early 20th century) ethnographic and historic observations
- published oral traditions and contemporary traditional knowledge supplied by local aboriginal informants
- recent (mid- to late-20th century) anthropological studies and doctoral dissertations

A critical review of the ethnographic and historical sources consulted in this study, and a summary of traditional land use activities, are provided in the Technical Appendices (Volume 2). A relatively thorough ethnographic overview for the study area can be found in Bussey and Alexander (1992).

Archaeological Research

A comprehensive review of previous archaeological research in the study area was conducted. The main objective of this review was to identify the number and types of sites known from the study area, evaluate site distribution and survey coverage, and determine the extent of archaeological survey data gaps. This research consisted of the following components: (1) a review of regional archaeological history, (2) a review of recorded site information, and (3) a review of previous archaeological work in the study area, with an emphasis on forestry-related archaeological impact assessments (AIAs). In addition, a pilot community-based archaeological research program was initiated in cooperation with the TNG. Highlights of the archaeological and community-based research are summarized below.

Regional Archaeological History

- the regional archaeological history of the study area was reviewed in order to identify trends in settlement and subsistence patterns over time; a recent summary of regional archaeology and archaeological history can be found in Bussey and Alexander (1992)

Recorded Sites

- site forms and maps for all recorded archaeological sites in the study area were obtained from the Archaeology Branch

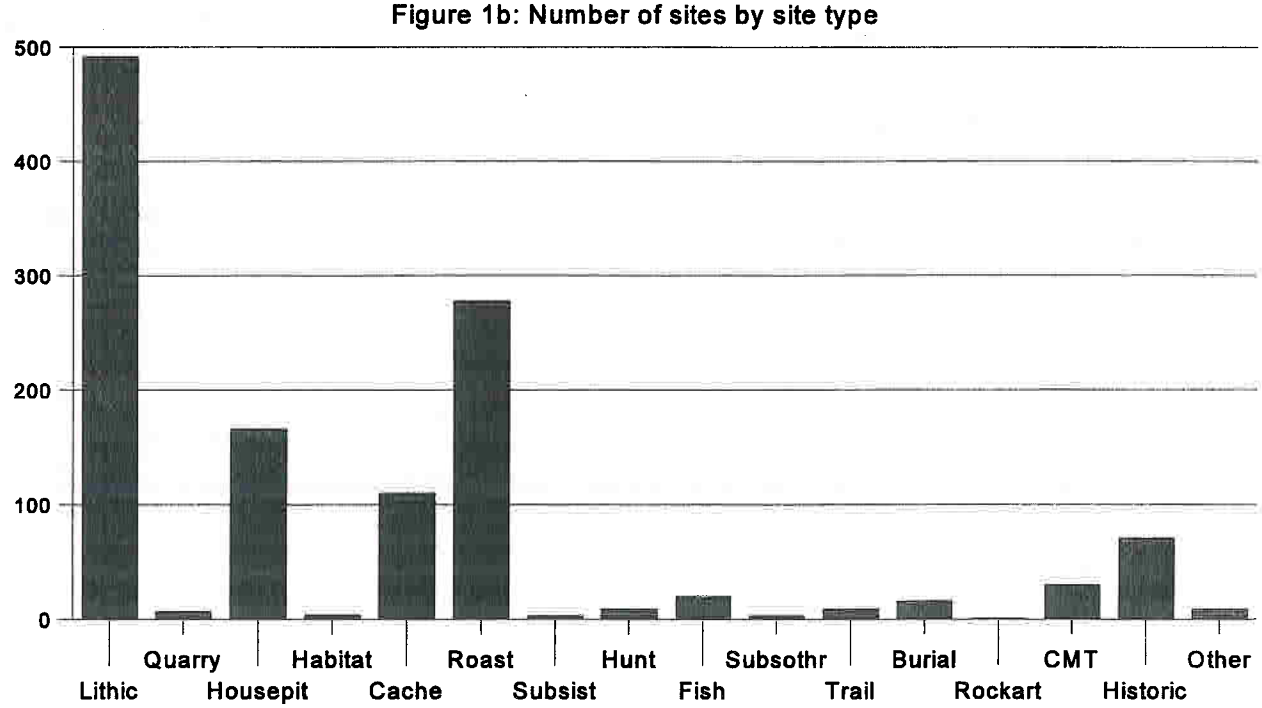
- a database containing site numbers and site types was created; as of December 1997, 811 archaeological sites were registered in the CFD (Figure 1b)

- all recorded sites were classified using a simplified site typology jointly developed for the Cariboo Forest Region AOAs (Table 3); each site may be represented by more than one site type (e.g., 166 sites contain housepits, but many of these also contain caches or artifacts)

- all recorded sites were plotted on 1:20,000 scale maps and digitized as a GIS coverage, using location information obtained from Archaeology Branch site form records and original site maps; all sites were plotted as points, while sites greater than 100 m in any direction were also plotted as polygons (Figure 2)

- digital site locations were used to assess the relationships of sites to slope and aquatic features (see Section 3.0)

Figure 1b: Number of sites by site type



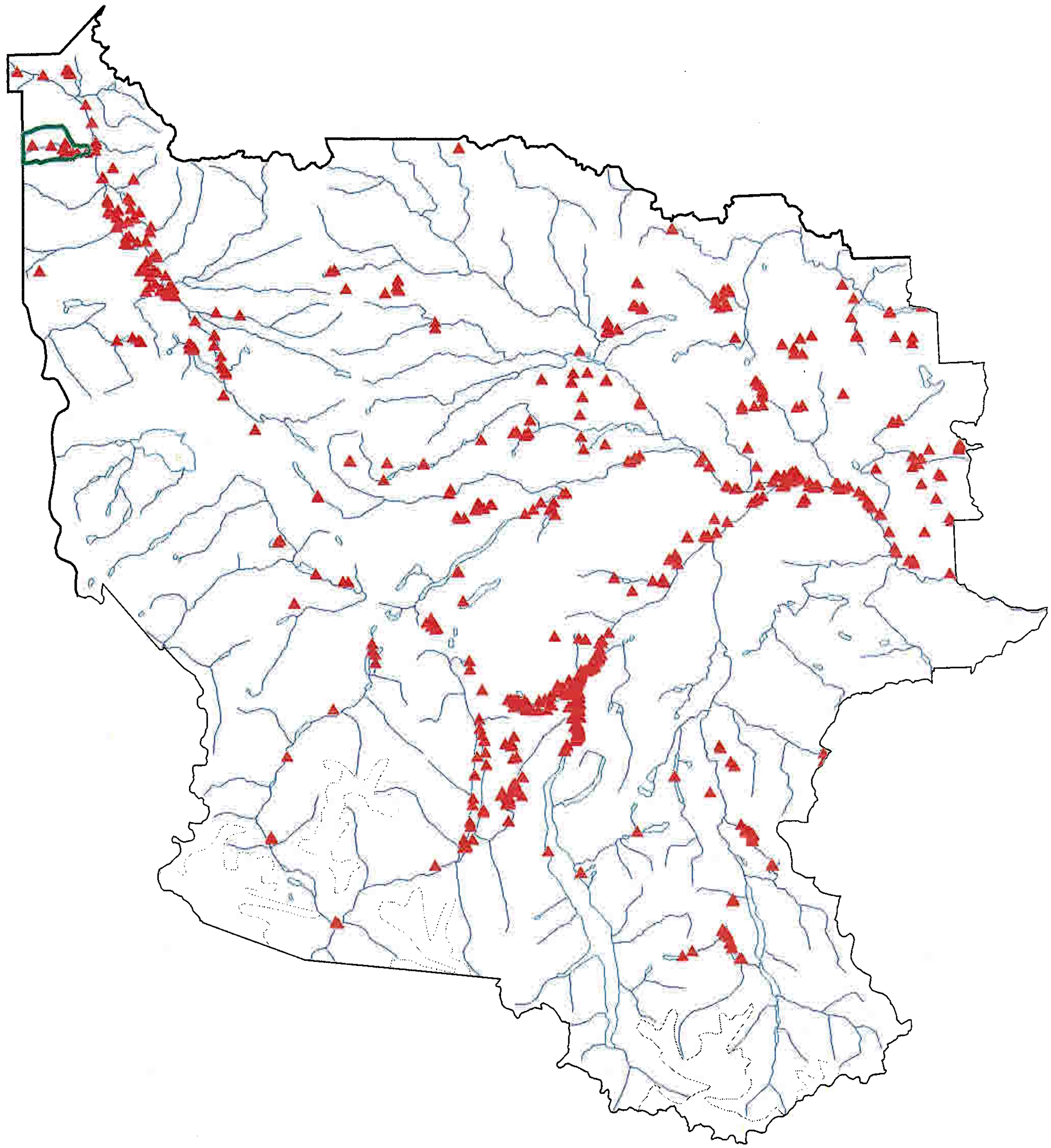


Figure 2: Location of recorded archaeological sites and lithic procurement zone (green polygon) in the Chilcotin Forest District (1:1.25 million)

Table 3: Simplified Archaeological Site Typology, Cariboo Forest Region

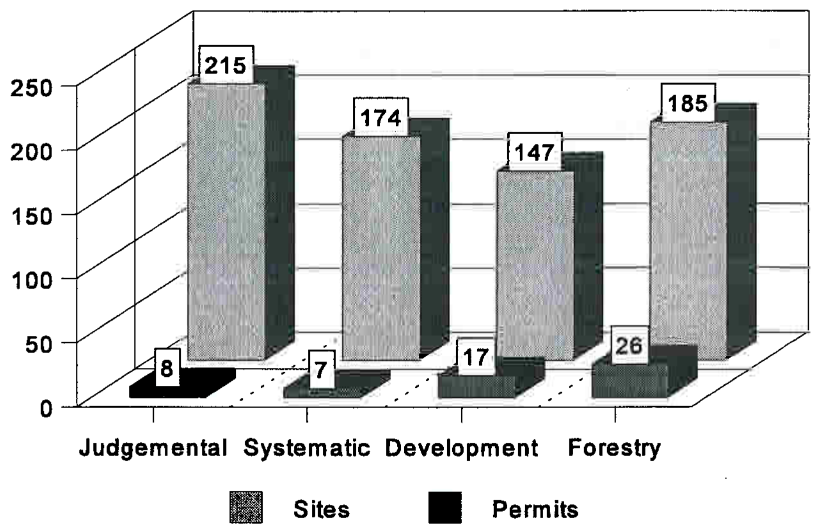
Code	Description	Corresponding Archaeology Branch typology
lithic	artifacts on or below surface	cultural material, surface/subsurface/isolated, lithic/bone/fire altered rock
quarry	quarries for obtaining stone used for making artifacts	cultural material, surface/subsurface, lithic, quarry
housepit	housepits and depressions	habitation, depression, [circular/rectangular], [housepit]
cave	caves or rock overhangs used as shelters	habitation, rock shelter/cave
habitat	other habitation features (non-historic), i.e., wood frames, platforms	habitation, other
cache	pits for storing food (fish, plant, animal)	subsistence feature, depression, cache
roast	food processing/cooking pits (plant and animal)	subsistence feature, depression, roasting/cooking pit, etc.
subsist	other pits of unknown function relating to food resources	subsistence feature, depression, [other]
hunt	all cultural features directly relating to hunting activities	subsistence feature, land mammal, pitfall/deadfall, blind/drivelane/fence, etc;petroform, rock alignment/cairn (relating to hunting)
fish	all cultural features directly relating to fishing activities	subsistence feature, fish, [trap/weir/drying rack/fishing station, etc.]
subsothr	other cultural features directly relating to resource activities	subsistence feature, other (also trapping)
trail	aboriginal or pre-1846 origin	trail; earthwork, trail
burial	human remains and associated cultural features	human remains, [burial/mound/box, etc.], (including historic)
rockart	rock paintings and rock carvings	pictograph; petroglyph
cmt	culturally modified trees	cultural material, surface, culturally modified tree; subsistence feature, culturally modified tree
historic	all sites with a "historic" component	historic, [...(various subcategories)...]
other	all cultural materials and features not covered in preceding categories	i.e., ceremonial

Previous Archaeological Survey

A comprehensive review of previous archaeological survey projects in the CFD was undertaken in order to evaluate the extent of survey coverage in the district. For this review, archaeological projects were grouped into four categories: (1) judgemental research projects, (2) systematic research projects, (3) development AIAs, and (4) forestry AIAs. The four categories were defined on the basis of the objectives of the different types of studies and the survey strategies employed. Excavation reports were not considered, unless they also incorporated a survey component. Refer to the Technical Appendices (Volume 2) for more details.

- all archaeological survey projects in the forest district were identified from a thorough review of reports and archaeological permits issued by the Archaeology Branch

Figure 3: Number of permits and sites by survey type



- as of December 1997, at least 58 permitted archaeological projects have been undertaken in the CFD: 8 judgemental research surveys (including one FRBC project), 7 systematic research inventories (including one FRBC project), 17 small-scale development AIAs, and 26 forestry-related AIAs (Figure 3); at least 721 of the 811 sites in the study area were identified in these projects (Figure 3)

- data on the total area surveyed in the judgemental research surveys could not be accurately determined, but 215 sites were identified in these projects

- 2372 ha were surveyed in the systematic research inventories, and 174 sites were identified and recorded

- data on the total area surveyed in development AIA projects could not be accurately determined, but the area appears to be relatively low; complete data on the number of sites identified is unavailable, but at least 147 sites were recorded

- as of December 1996, more than 30,000 ha had been surveyed in forestry-related AIAs, and 165 sites had been identified (at least 20 additional sites were identified in 1997 but complete forestry AIA data and total ha surveyed were unavailable)

- a database of all forestry-related AIAs was produced which can be linked to digital forest development plans; this database includes identification numbers of all previously surveyed developments, the permit number and archaeological firm, the intensity of survey, and identified sites

- on the basis of this review, gaps in archaeological data and survey coverage were identified (see Technical Appendices in Volume 2)

The review of past archaeological surveys in the Chilcotin Forest District indicates that forestry related projects have had a major impact on the archaeological database for the study area. Nearly 50% of all archaeological projects (including FRBC funded inventories) are forestry related, and 237 sites have been identified in these projects (nearly 30% of all recorded sites). The total land area surveyed in these studies also vastly exceeds the area covered in other types of projects, although much of the area received low intensity survey coverage. The density of sites identified in forestry related projects is lower than in other types of projects, but this is largely because most of the area surveyed in forestry projects are generally lower in potential than the areas surveyed in other projects. For example, judgemental surveys generally focus on only the highest potential areas along major rivers and lakes, while most cutblocks are set back from major water features. Forestry related surveys were useful for this AOA study in that they help indicate where sites are not found as well as where they are found.

Community-based Archaeological Research

The community-based research program was initiated at the request of the TNG. The community research was intended to acknowledge and utilize the extensive knowledge about archaeological sites which resides with Tsilhqot'in community members. The TNG expressed concern that community members were aware of archaeological sites that may not be accounted for in the model of archaeological potential developed by Arcas. Thus, this research was intended to ensure that all site types in all settings were considered in the model. Although the community-based research was less extensive than originally planned, the interviews provided useful cultural information about traditional activities resulting in archaeological remains, and ground-truthing of reported sites revealed 100% accuracy of community site location knowledge.

The highly successful results of this program indicate the value of this research and support its continued inclusion in the AOA process. The research undertaken in this AOA should be considered a pilot project which can be used as a model for future community-based archaeological research. A summary of the community-based archaeological research is provided below. For more details, please refer to the Technical Appendices (Volume 2).

Community research program was conducted by a member of the Tsilhqot'in Nation with the assistance of Arcas personnel. The research involved (1) interviews with Tsilhqot'in community members to identfy locations of unrecorded archaeological sites, and (2) ground-truthing of reported sites.

- a list of potential informants from Tsilhqot'in communities was produced, and informants were interviewed by the Tsilhqot'in researcher

- six reported archaeological site locations were ground-truthed by the Tsilhqot'in researcher and an Arcas employee, accompanied in some cases by Tsilhqot'in elders or community informants

- in total, 12 archaeological sites were identified and recorded to provincial standards; sites included housepits, caches, surface artifact scatters, and a quarry site

- cultural information pertaining to many of the sites was obtained from the community members

- the site types and settings were evaluated and considered in the model building

Trail Research

A comprehensive trail research program was undertaken by Archeo Research and Arcas in order to identify the routes of (1) aboriginal trails, (2) non-aboriginal trails in use prior to 1846, and (3) trails of historical significance. This research focussed on map, archival, and historical sources pre-dating 1945. Except where evidence to the contrary was found, all trails in existence in the 19th century were assumed to be of confirmed pre-1846 aboriginal origin. Many trails and wagon roads in existence before 1945 were assumed to follow the routes of pre-1846 trails, and are considered to be of unconfirmed but probable aboriginal origin. No trails of strictly non-aboriginal origin pre-dating 1846 were identified.A few of the identified trails and wagon roads were considered to be of non-aboriginal origin, but are of historical significance. A complete table of trails, listing the name, source, route confidence, and origin, is provided in the Technical Appendices (Volume 2).

- major sources consulted include 19th century archival maps, early 20th century surveyor's maps, and Edition 1 (pre-1945) National Topographic Series maps (1:250,000 scale)

- trails known to local First Nations informants or recorded as archaeological sites were also identified

- more than 100 trails were identified in the study area (Figure 4) and entered into a database; some trails have sections which overlap portions of other trails identified from other sources

- trails were divided into sections according to route confidence (high, moderate, low); trail sections and route confidence are identified in the GIS database

- trails were also classified by origin (probable aboriginal, possible aboriginal, and probable non-aboriginal/historic); trail origin is listed in the Technical Appendices (Volume 2)

- to provide more accurate routes, most trails were plotted on 1:20,000 scale maps, and digitized as a digital map coverage; due to their relative accuracy, trails identified from 1:250,000 scale NTS maps were digitized directly from the original map, in order to minimize the plotting and digitizing required

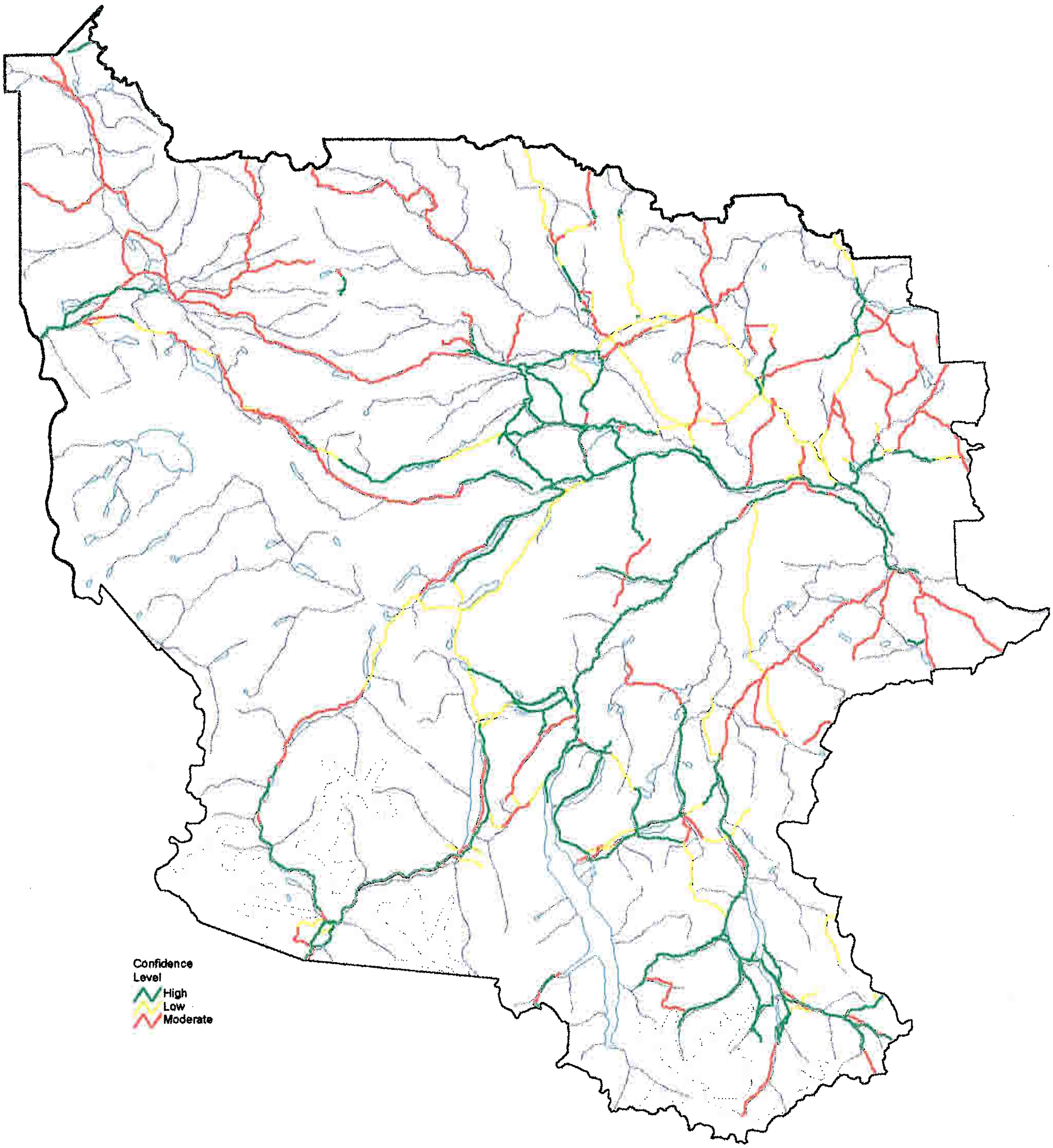


Figure 4: Distribution of aboriginal and historic trails in the Chilcotin Forest District (1:1.25 million)

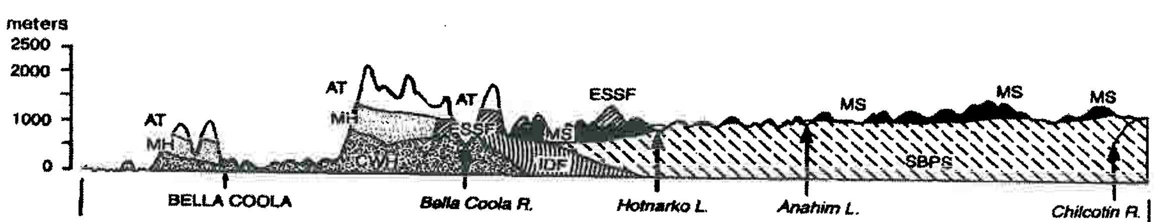
Biophysical Research

Biophysical research involved a review of the biological and physical context of the study area. This research was important for understanding the general biophysical constraints which affected past human use of the landscape, and to highlight the specific relationship of resources to settlement and subsistence patterns. More specifically, this research was necessary to identify the biophysical features which had a relationship to archaeological potential and could be incorporated into the GIS coverages of the study area. The research included a review of (1) the general biophysical classification of the study area, (2) slope stability and classification, (3) the types and distribution of landforms and aquatic features in the CFD, and (4) the distribution and abundance of specific flora and fauna which were important subsistence resources. Complete information on sources for the biophysical research are provided in the Technical Appendices (Volume 2).

Two major province-wide systems have been used to classify the biophysical environment of the study area: (1) biogeoclimatic zones, and (2) ecosections.

Biogeoclimatic zones are large-scale zones based on topographic and climatic variables and characterized by specific plant communities. Each biogeoclimatic zone is named after the dominant climax plant species found in that zone. Minor climatic variations within each zone are identified by subzones and variants. Climatic conditions in each biogeoclimatic subzone and variant interact with elevation, latitude, and topography to create an environment suitable for a specific vegetation community.A cross-section of the landscape from Bella Coola to the Chilcotin River shown in Figure 5 illustrates the influence of elevation and topography on the vertical and horizontal distribution of biogeoclimatic zones. Eight biogeoclimatic zones and a total of fourteen subzones are represented in the Chilcotin Forest District (Table 4), with the Sub-Boreal Pine-Spruce (SBPS) and Montane Spruce (MS) zones covering the largest areas (Figure 6).

Figure 5. Biogeoclimatic zone X-section of the Chilcotin Forest District.



Ecosections are the smallest units of an ecoregion classification system developed to provide a systematic method for showing the small-scale ecological relationships in British Columbia. The ecoregion classification system is based on macroclimate and large scale physiography. Each ecosection represents an area with minor physiographic and macroclimatic variation, creating an area of broad ecological uniformity. Seven ecosections are present in the Chilcotin Forest District (Table 5), with the Chilcotin Plateau ecosection forming the largest portion of the study area (Figure 7). Ecosections provide an alternate method for classifying the landscape.

Table 4: Biogeoclimatic zones in the Chilcotin Forest District

Biogeoclimatic Zone	Code	Area (ha)	%	Model Code (zone)	Model Code (subzone)
Alpine Tundra	AT p	486,708	17.2	1	1
Bunch Grass very dry warm, Alkali variant	BGxw2	1629	<0.1	2	2
Coastal Western Hemlock dry submaritime, southern variant/unclassified	CWHds1 CWHunc	23,068	0.8	3	3
Interior Douglas-fir very dry mild	IDFxm	59,604	2.1	4	4
Interior Douglas-fir dry cool, Chilcotin variant	IDFdk4	288,208	10.2	4	5
Interior Douglas-fir unclassified	IDFunc	101,013	3.6	4	6
Englemann Spruce-Subalpine Fir very dry very cold	ESSFxv	272,055	9.6	6	13
Mountain Hemlock moist maritime, leeward variant	MHmm2	11,610	0.4	7	14
Montane Spruce very dry very cold	MSxv	462,335	16.3	8	15
Montane Spruce unclassified	MSunc	80,285	2.8	8	16
Sub-Boreal Pine Spruce dry cold	SBPSdc	63,286	2.2	9	17
Sub-Boreal Pine Spruce moist cold	SBPSmc	40,658	1.4	9	18
Sub-Boreal Pine Spruce moist cool	SBPSmk	494	<0.1	9	19
Sub-Boreal Pine Spruce very dry cold	SBPSxc	946,705	33.4	9	20
TOTAL		2,837,658	100		

Table 5: Ecosections in the CFD

Ecosection	Code	Model Code (eco)
Central Chilcotin Ranges	CCR	5
Chilcotin Plateau	CHP	6
Fraser River Basin	FRB	7
Nazko Upland	NAU	8
Northern Pacific Ranges	NPR	9
Western Chilcotin Ranges	WCR	12
Western Chilcotin Uplands	WCU	13

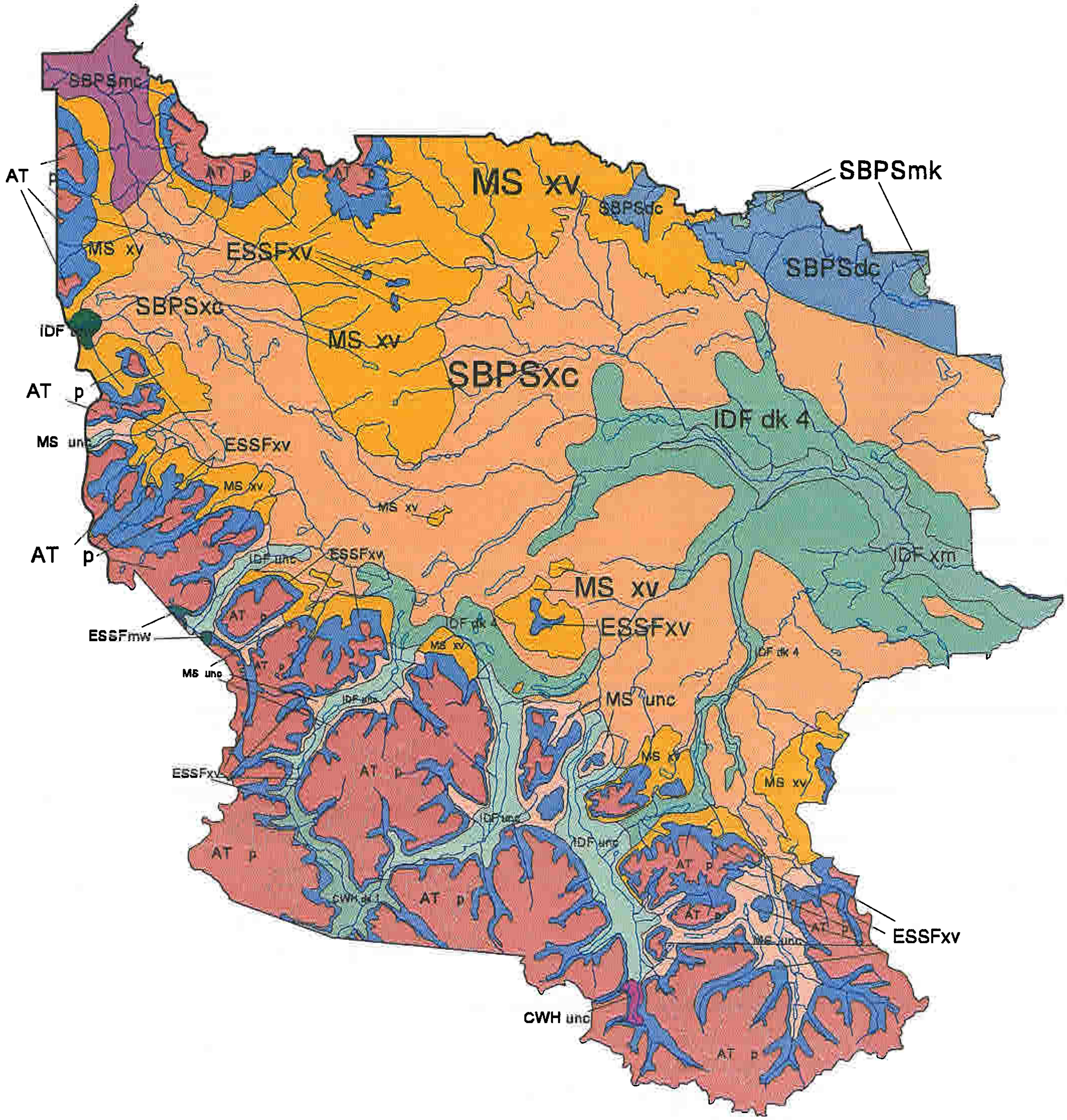


Figure 6: Biogeoclimatic zones in the Chilcotin Forest District (1:1.25 million)

Prepared by Arcas Consulting Archeologists

Figure 7 : Ecosections in the Chilcotin Forest District (1:1.25 million)

Prepared by Arcas Consulting Archaeologists

Slope is an important factor in modelling archaeological site potential. In this AOA, slope is expressed in percent, such that a 100% slope (i.e., 100 m rise over 100 m run) is equivalent to 45 degrees. In general, gentle slopes are more favourable for human use and more stable than steep slope. As a result, slope has a strong influence on archaeological site distribution and preservation. In order to utilize slope in modelling, this variable needs to be classified in a way which reflects its relationship to both human use of the landscape and to slope stability. The distribution of archaeological sites by slope was analyzed in the GIS, in order to highlight the relationship of site distribution to percent slope. In addition, two systems for classifying slope were reviewed: (1) a geomorphological system based on slope stability, and (2) the provincial INCOSADA standard for slope class.

Landforms of interest to archaeological potential modelling include those formed by glacial, fluvial (river), lacustrine (lake), colluvial (gravitational), and aeolian (wind) processes. All of these geomorphic processes deposit the sedimentary materials which have helped shape the landscape. Some of these landscape features, such as well-drained terraces, are favourable for human use and also are conducive to archaeological site preservation. Others, such as active flood channels, are less suitable for human use and result in relatively poor archaeological site preservation. Other landforms are the result of organic processes and include bog and wetland deposits which are relatively unfavourable for human use. Lastly, certain volcanic landforms include deposits of vitreous (glassy) basalt and obsidian which provide sources for the materials for making stone tools.

The evolution and distribution of landforms in the study area, and their significance for archaeological potential, were investigated in this AOA (see Technical Appendices [Volume 2]). However, most information on the classification and distribution of landforms is currently available only from maps. The following sources were reviewed:

- *glacial landforms* have been mapped and described by the Geological Survey of Canada; landforms identified included large meltwater channels (forming terraces adjacent to streams and waterbodies), small meltwater channels (forming ravines), and glacial lake deposits

- *fluvial, lacustrine, colluvial, and aeolian landforms and deposits* are mapped and described on provincial soils and surficial geology maps for a portion of the study area

- *volcanic deposits* have been mapped and described for a portion of the study area by the Geological Survey of Canada; however, the specific identification of vitreous basalt and obsidian deposits is not possible at the low resolution of this mapping

- *vitreous basalt and obsidian deposits* were identified through a review of archaeological reports, site forms, geological reports, and anecdotal information

Aquatic features include all lakes, streams, and wetlands (swamps, marshes, fens, and bogs). Although a number of systems for classifying these aquatic features exist, two major systems were reviewed for this project: (1) B.C. Forest Practices Code operating guidelines and (2) the B.C. Watershed Atlas program. Specifically,

- the Forest Practices Code system classifies (1) *streams* according to (a) the presence or absence of fish (or fish potential), and (b) average stream width, and (2) *lakes and wetlands* on the basis of (a) area, and (b) which biogeoclimatic unit they are found in.

- the Watershed Atlas program classifies streams on the basis of order and magnitude, where (a) order refers to the placement of a stream reach within the watershed based on the number of feeder streams, and (b) magnitude refers to the estimated volume of water flowing within a stream reach based on the number and length of feeder streams.

Flora and fauna reviewed for this AOA focussed on those plant and animal species which were important subsistence resources. Wherever possible, the historic range of these species was considered. This review focussed on:

- the distribution of anadromous salmon and other fish species; this information was available from federal and provincial inventory data as well as specific research reports and species accounts

- the distribution of ungulate species and ungulate capability, with an emphasis on mule deer and caribou; this information was obtained from provincial inventory and capability studies, research reports, and species accounts

- the distribution and abundance of root and berry crops by biogeoclimatic zone, with a particular emphasis on mountain potatoes, balsamroot sunflower, and huckleberries; information was obtained from biogeoclimatic zone reports and species accounts

- the distribution of tree species which formed an important part of subsistence activities and raw material procurement, including lodgepole pine, whitebark pine, and western redcedar; this data was available from provincial inventory data, forest cover maps, and species accounts

Palaeoenvironmental Research

A thorough review of palaeoenvironmental data for the study area was conducted for this AOA by Pierre Friele. The objective of this research was to assess environmental change over time, in order to determine the potential effects of this change on archaeological potential. This research focussed on Holocene vegetation and climate trends, as well as possible shifts in biogeoclimatic zones, which should be considered in building the model of archaeological potential. The complete results of the palaeoenvironmental research are included in the Technical Appendices (Volume 2). Highlights of this research are summarized below.

- very few palaeoecological studies are available for the study area, and only two pollen cores with radio-carbon dates have been studied; palaeoecological reconstruction for the study area has to rely primarily on inference from similar zones in adjacent areas

- the modern biogeoclimatic zone distribution probably extends back 4500 years before present (BP), with small ecotonal shifts and readjustments corresponding to Neoglacial climatic oscillations

- warmer, drier climates existed in the Mesothermic (4500 to 7000 years BP) and Xeothermic (7000 to 9000 years BP); alpine timberlines were higher, grasslands occupied the modern IDF and dry SBPS zones, and the modern SBS, ICH, CWH, and MS zones were occupied by IDF and SBPS analogues

- before 9000 years ago, forested communities had no modern counterparts, and consisted of open forest scrub dominated by lodgepole pine

This research suggests that the use of current biogeoclimatic zones in the model would be valid for the period from 4500 years ago until the present. This period probably accounts for the majority of archaeological sites in the study area, as relatively few sites older than 4500 years BP are expected. Currently, the oldest radio-carbon dated site on the Chilcotin Plateau dates to 2220 years BP, and few sites have been dated on the basis of artifacts to be older than 3500 years BP. The relationship of palaeoenvironment to archaeological potential in the period before 4500 BP is difficult to ascertain. The warmer, drier climate in the period before 4500 years BP may have resulted in more extensive areas which were favourable for human occupation, although the distribution of important water features and aquatic resources (such as salmon) was probably reduced. At present, palaeoenvironmental data is insufficient for mapping out past vegetation communities, and the relationship of these communities to early site distribution in the study area is not known. Without further palaeoecological studies and archaeological surveys focussing on early sites, it is difficult to evaluate the effect of early palaeoenvironments (more than 4500 years BP) to archaeological potential.

3.3 Digital Data

GIS-based models of archaeological potential must rely extensively on mapped biophysical and landscape features. A major objective of the background research was to identify the biophysical variables which have an application in modelling archaeological potential. The next step in the AOA methodology was obtaining relevant biophysical data mapped in a digital format. Using this digital data, map layers or coverages can be built for each set of biophysical features which are inputted into the GIS.

Six main steps were involved in building the digital coverages for the study area (Figure 8): (1) acquisition of existing digital data, (2) digitizing of additional coverages, (3) translation and review of data coverages, (4) classification of features, (5) analysis and review of associations between sites and features, and (6) buffering features.

Steps 1 through 3: Data Acquisition,Digitizing,and Translation

The types of biophysical features identified as having significance for archaeological potential included: slope, biogeoclimatic zones, ecosections, aquatic features, glacial and other landforms, wildlife values, and specific forest stands. Most of the biophysical data required for the model were available from existing digital sources (Table 6). However, in a number of cases it was necessary to manually digitize specific features or data from existing paper maps or from information plotted onto maps. In addition to biophysical data, archaeological sites and trails were manually plotted and digitized as separate coverages (see Section 3.2).

Some biophysical features identified in the background research could not be acquired digitally. For example, fluvial, colluvial, and aeolian landforms are available from 1:50,000 scale soils and surficial geology maps, but only 50% of the CFD (mostly the eastern portion) is covered by these maps. As a result, complete digital coverage of these landforms could not be acquired. Other available coverages were not used if they were considered inappropriate. For example, wildlife capability mapping available for most species was too generalized to be of use. In the end, only core caribou habitat and critical mule deer winter ranges were selected for use as wildlife value coverages. Although other wildlife data was consulted during model building, it was not directly used as a GIS coverage. Likewise, Watershed Atlas digital data was not used, as it was less accurate than data available from Terrain Resource Information Management (TRIM) mapping.

The digital coverages were obtained from their sources in a variety of GIS formats and map projections. After digital data coverages had been acquired, they were translated using the GIS into compatible formats which allowed all the different coverages to be used together. To evaluate the suitability and accuracy of the various coverages, overview maps of the entire district (or selected mapsheets within the district) were plotted (printed) and reviewed. Data gaps and problems with resolution were identified and wherever possible rectified.

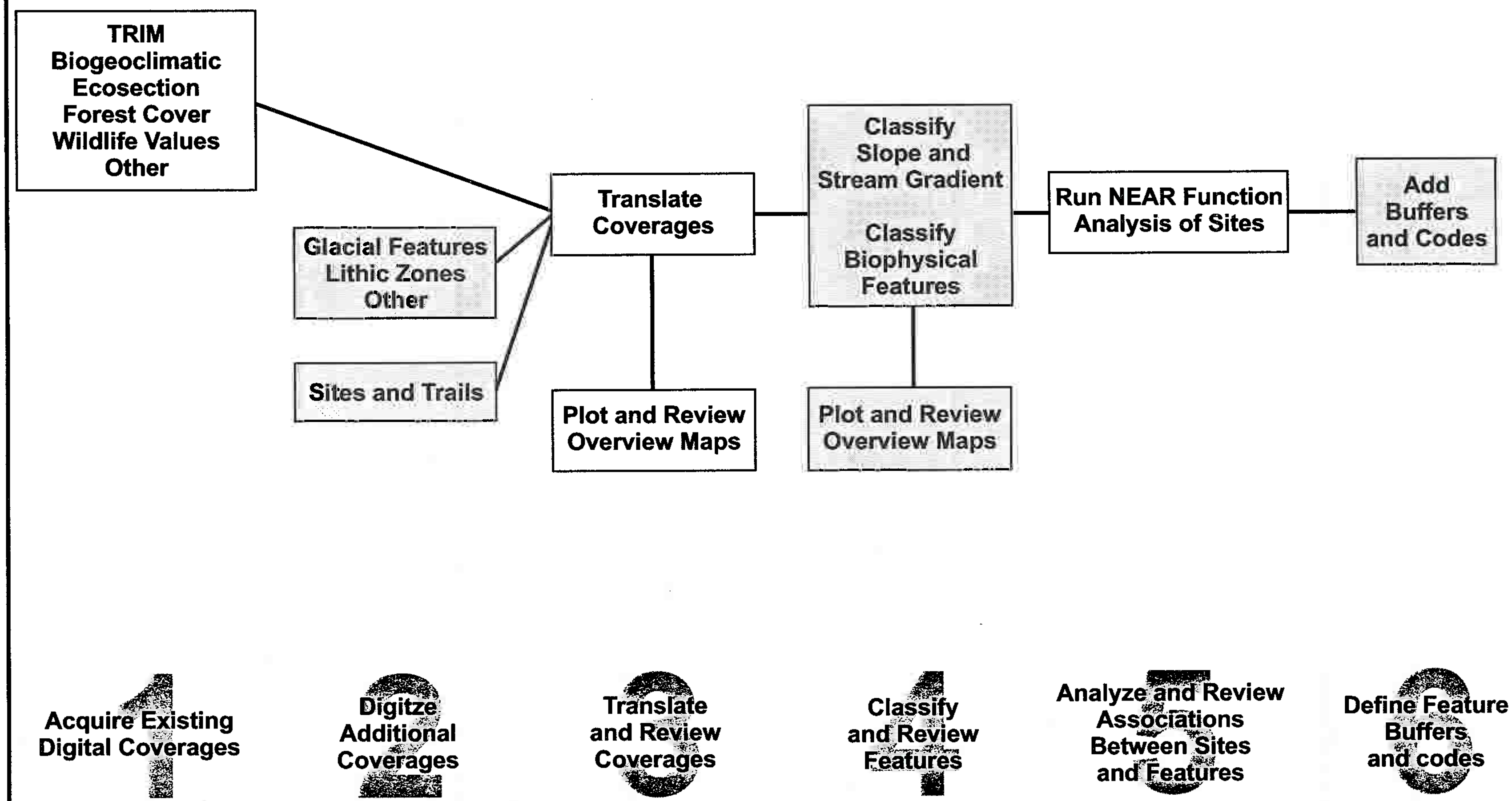


Figure 8: Schematic diagram of digital data acquisition and classification

Table 6: Digital Coverage Sources for Biophysical Features Used in the GIS		
Feature	**Digital Source**	**Comments**
Slope	Digital Elevation Model (DEM) from TRIM	1:20,000 scale digital map system
Biogeoclimatic Zone and Ecosections	digital maps, Ministry of Environment, Lands and Parks (MoE)	1:250,000 scale (NTS base)
Streams, lakes, and wetlands	TRIM	1:20,000 scale
Glacial landforms	manually digitized from GSC maps available for the entire CFD	large meltwater channels, small meltwater channels, glacial lake deposits (Figure 9); 1:250,000 scale
Other landforms	TRIM	eskers, cliffs, waterfalls, and rapids
Lithic procurement areas	possible lithic areas identified from archaeological and geological sources plotted and manually digitized	vitreous basalt and obsidian sources could not be identified from bedrock geology maps; 1:20,000 scale
Wildlife values	digital wildlife capability and critical range mapping produced by the MoE	caribou range, mule deer habitat; 1:250,000 scale (NTS)
Vegetation	digital Forest Cover mapping available from the MoF	lodgepole pine, whitebark pine, western redcedar, open range (1:50,000 scale)

Step 4: Feature Classification

Once all digital coverages were assembled, various modelling features were selected and classified using the GIS. Table 7 includes a list of all features used in the model and a brief description of their classification criteria. The specific features and classification criteria were identified on the basis of the background research and the review of plotted coverages. Classification of features focussed on using criteria which are directly related to past traditional land use activities, with an emphasis on subsistence resource potential. For example, streams were classified according to their fish values, which was considered to be more relevant to past land use than stream size. Pre-existing systems for the classification of features were used wherever possible. In particular, classification criteria were kept consistent with the Forest Practices Code.

- *Slope* was classified into 15% increments (i.e., 0-15, 15-30, 30-45, 45-60, 60+) on a 10 m grid (Figure 10), based on an analysis of site distribution by slope, slope stability classes, and provincial slope classification standards (INCOSADA).

- *Biogeoclimatic zones/subzones* and *ecosections* were classified on the basis of existing MoE designations.

- *Streams* were classified according to their salmon and fish potential, primarily using stream gradient, following Forest Practices Code operating guidelines. Salmon potential was

Table 7: Feature Classification Criteria		
Feature Class	**Feature**	**Classification Criteria**
Slope	slope	15% increments, using DEM slope (quintic) from TRIM
Biogeoclimatic zone / subzone	all zones and subzones (see Table 4)	biogeoclimatic zone and subzone designations from MoE
Ecosections	all ecosections (Table 5)	ecosection designations from MoE
Streams (fish values, based on FP Code guidelines)	High salmon potential	TRIM double and single line streams, 0-8% grade, with salmon potential (checked against FISS)
	High fish potential (excluding salmon)	TRIM double and single line streams, 0-12% grade, excluding salmon stream network
	Low/No fish potential	TRIM double and single line streams, >12%, plus all TRIM intermittent/indefinite streams, all grades
Lakes (excludes indefinite / intermittent lakes, reservoirs)	Large	TRIM lakes >1000 ha (= L1 lakes >1000 ha)
	Medium	TRIM lakes 100 - 1000 ha (= L1 lakes)
	Small	TRIM lakes 5 - 100 ha (= L1 lakes)
	Very Small	TRIM lakes <5 ha (= L2, L3, L4 lakes)
Wetlands (& indefinite lakes)	Large wetlands & complexes	TRIM wetlands >5 ha (including complexes, if linked in TRIM; = W1, W5 wetlands)
	Small wetlands	TRIM wetlands <5 ha (= W2, W3, W4 wetlands)
Landforms (glacial and other)	Eskers	TRIM eskers
	Large Glacial	major meltwater channels (terracing) from GSC maps
	Small Glacial	minor meltwater channels (ravines) from GSC maps
	Glacial Lakes	glacial lakes from GSC maps
	Scarps	TRIM scarps and cliffs
	Waterfalls	TRIM falls and cascades
	Rapids	TRIM rapids
	Lithic Zone	plotted area based on quarries, bedrock, and drainage
Wildlife	caribou core range	moderate and high capability habitat from MoE
	mule deer winter range	all mule deer critical winter range from MoE
Vegetation	old growth lodgepole pine	lodgepole pine stands of age class ≥8 from MoF Forest Cover mapping
	old growth cedar	cedar stands of age class ≥8 from Forest Cover
	whitebark pine	all stands with whitebark pine present from Forest Cover
	open range	all open range polygons from Forest Cover

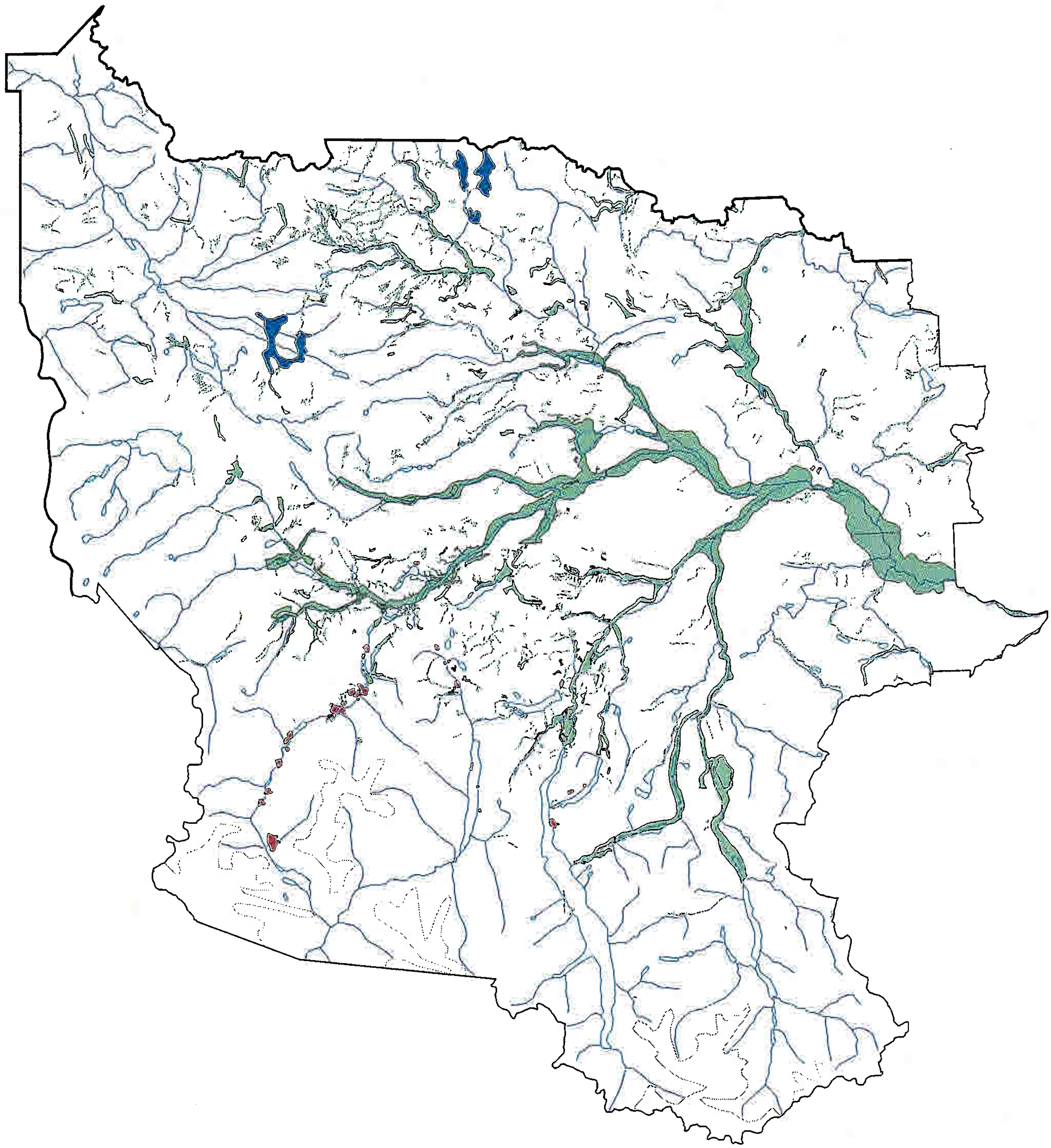


Figure 9: Distribution of glacial landforms in the Chilcotin Forest District (1:1.25 million)

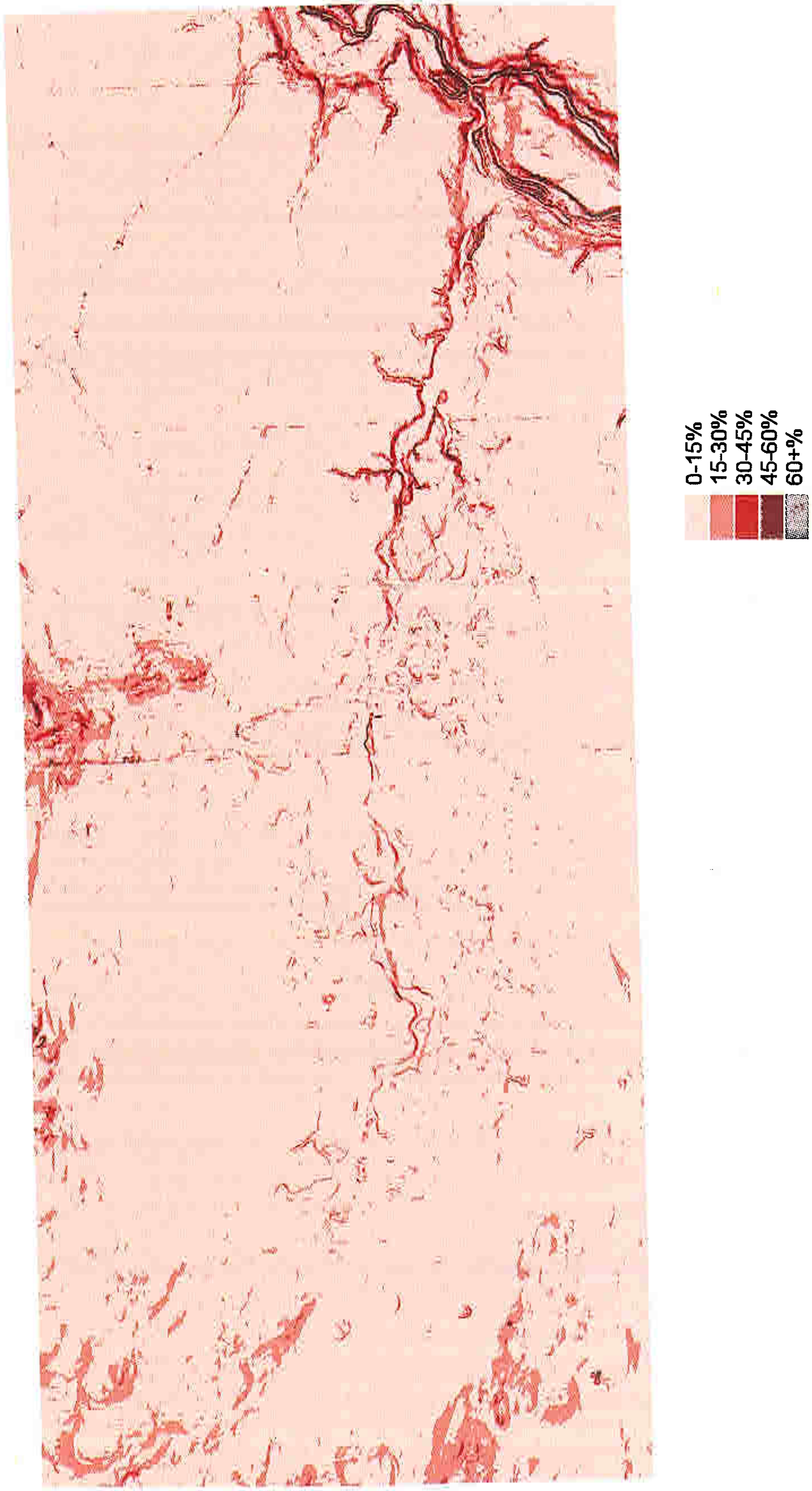


Figure 10: Example of slope classification (1:125,000; TRIM sheets 92N.100/92O.091)

checked against Fisheries Information Summary System (FISS) inventory data (produced by Fisheries and Oceans Canada and MoE), resulting in a network of streams with salmon potential (Figure 11).

- *Lakes* were classified according to their size, primarily following Forest Practices Code operating guidelines; however, L1 lakes less than 1000 ha in size were divided into two size classes, while all L2, L3, and L4 lakes were grouped into a single class, to better reflect resource availability.

- *Wetlands* were classified according to their size, primarily following Forest Practices Code operating guidelines; however, W2, W3, and W4 wetlands were grouped into a single class due to their small size.

- *Landforms* were classified according to their identification on TRIM and GSC maps.

- A single *lithic procurement zone* was identified on the basis of a known obsidian source area near Anahim Peak (Figure 2); this zone was classified using bedrock geology and recorded quarry sites within a watershed drainage.

- *Wildlife* variables (core caribou habitat and critical mule deer winter ranges) were classified using information obtained from the MoE (Figure 12).

- *Vegetation* variables used in the model (old growth lodgepole pine stands, old growth cedar stands, whitebark pine stands, and open range grasslands), were selected and classified using Forest Cover information (Figure 13).

After all features were classified, the GIS was used to plot the features as district overview maps or on selected test mapsheets (1:20,000 scale) so that they could be reviewed. For example, the salmon stream network was plotted for the entire study area and checked against other maps and data for accuracy. The distribution of other features, such as glacial landforms, forest cover stands, and wildlife ranges were also reviewed in this way. On the other hand, the classification of slope and streams was plotted on selected mapsheets and reviewed in detail. This review allowed for classification errors to be identified and corrected.

Steps 5 and 6: Near Analysis and Feature Buffers

In a GIS, all area within a specified distance of a feature, called a buffer, can be identified, creating a new polygon which can be used in map displays or analysis. In this AOA, buffers of varying widths were assigned to most classified features (Table 8). These buffers contain the areas adjacent to features where certain traditional activities took place, and therefore where archaeological sites might be found. Each feature was assigned one or more buffers, with each successive buffer intended to reflect greater constraints (lower potential) for traditional activities. The assumption behind the use of buffers is that activities associated with a specific feature occur most frequently closer to the feature, while these activities decrease in frequency at greater distances from the feature. For example, most base camps associated with salmon fishing occur immediately adjacent to salmon

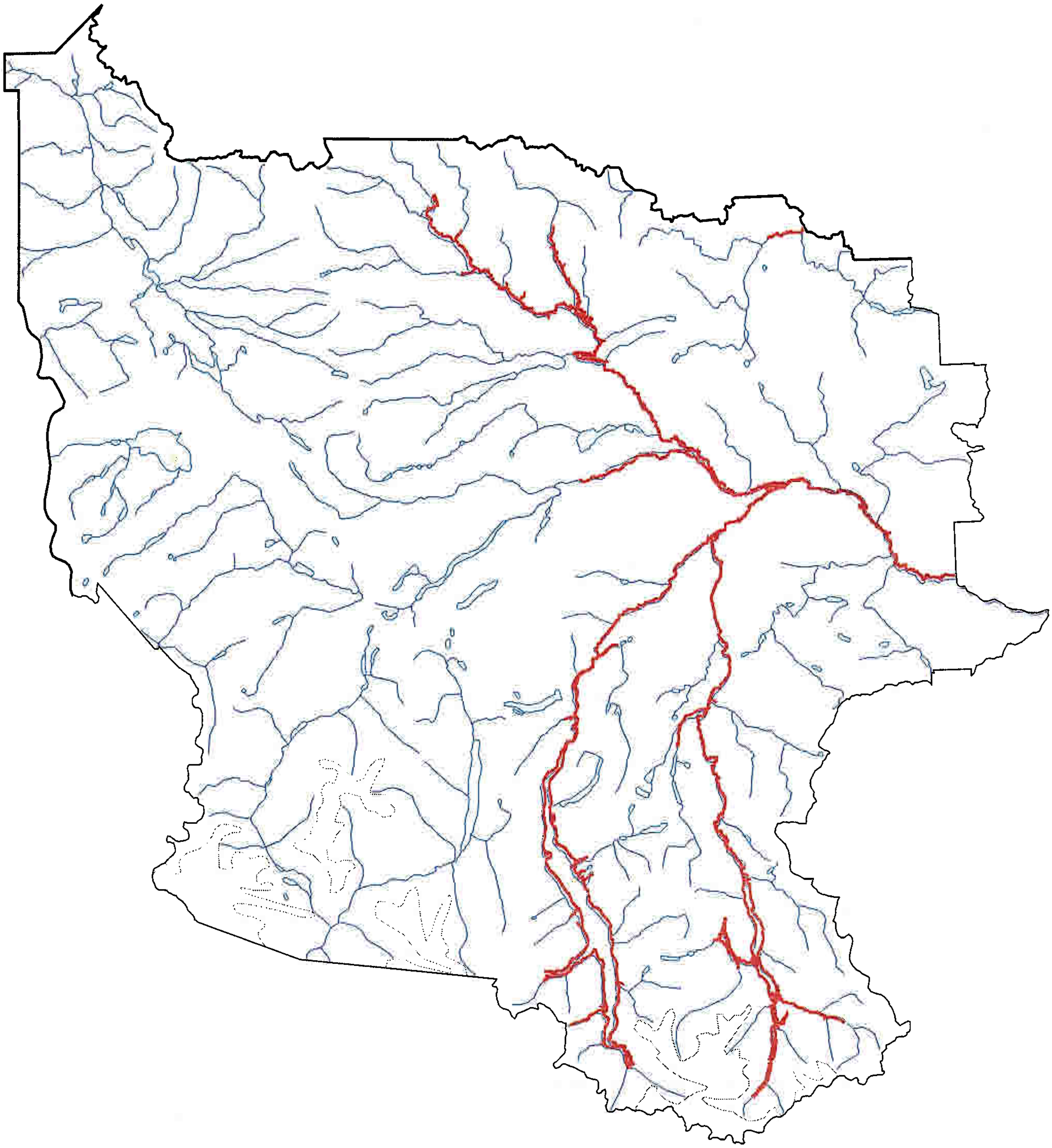


Figure 11: Distribution of streams with salmon potential in the Chilcotin Forest District (1:1.25 million)

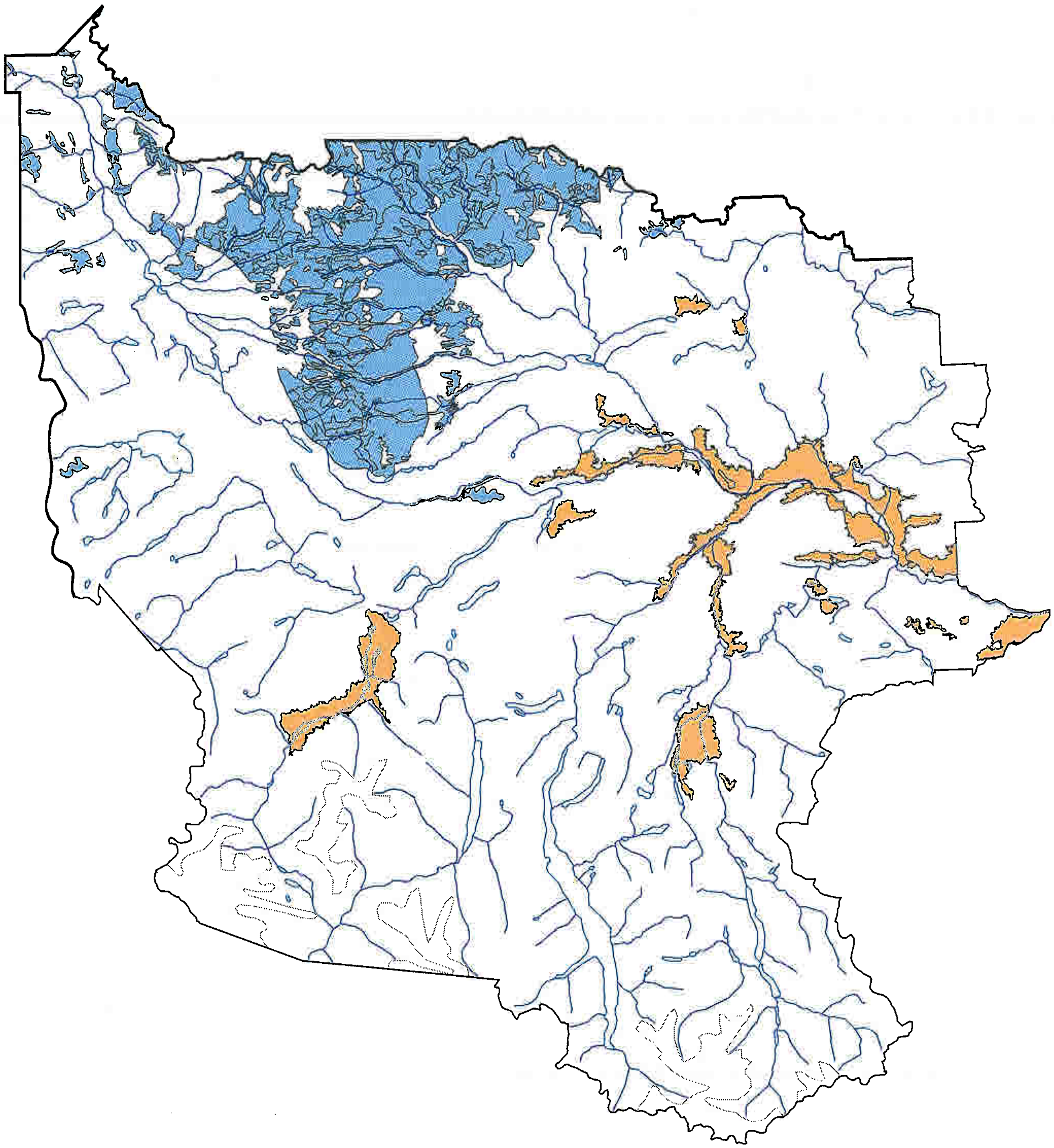


Figure 12: Moderate and high caribou capability (blue) and mule deer winter ranges (orange) in the Chilcotin Forest District, derived from MoE mapping (1:1.25 million)

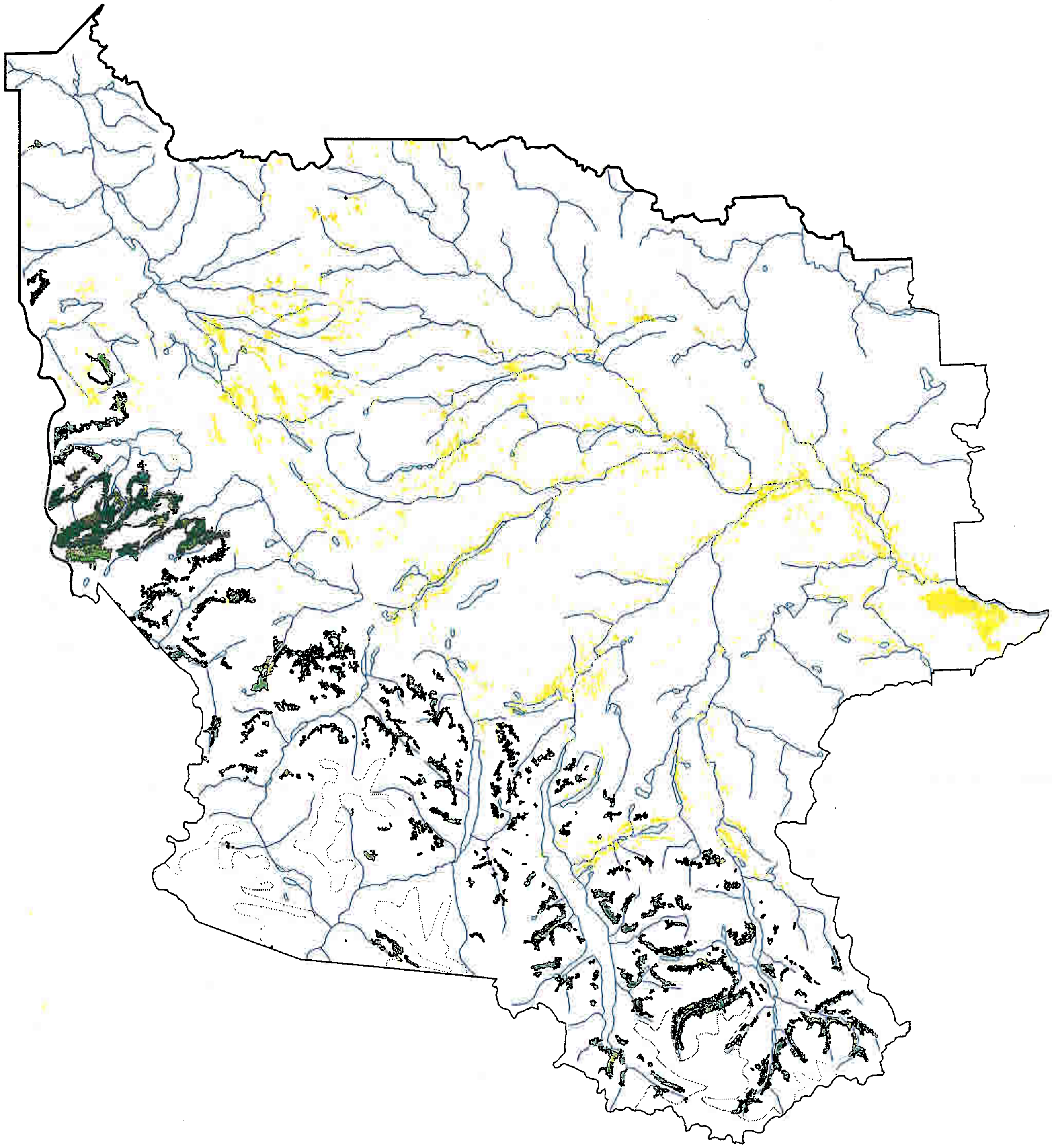


Figure 13: Distribution of Whitebark pine stands (green) and Open Range (yellow) in the Chilcotin Forest District, derived from Forest Cover data (1:1.25 million)

Table 8: Feature Buffers, Polygons and Codes

Feature Class	Model Code	Polygon Code	Buffer Codes and Widths (m)			
			1	2	3	4
Salmon streams	streamsalm	-	0-50	50-300	300-1000	1000-2500
Fish streams	streamfish	-	0-50	50-200	200-500	500-700
Other streams	streamothr	-	0-50	50-300		
Large lakes	lakelarge	-	0-50	50-200	200-500	500-700
Medium lakes	lakemed	-	0-50	50-100	100-300	300-500
Small lakes	lakesmall	-	0-50	50-300		
Very small lakes	lakevs	-	0-50			
Large wetlands	wetlarge	-	0-50	50-300		
Small wetlands	wetsmall	-	0-50	50-300		
Eskers	eskers	-	0-50			
Large Glacial	meltlarge	1	-			
Small Glacial	meltsmall	-	0-200			
Glacial Lakes	glacialake	1	0-100			
Scarps/cliffs	cliffs	-	0-100			
Waterfalls	falls	-	0-100			
Rapids	rapids	-	0-100			
Lithic Zone	lithiczone	1	-			
Caribou range	ungulate	1	-			
Mule deer range	ungulate	2	-			
Old growth pine	oldgrowth	1	-			
Old growth cedar	oldgrowth	2	-			
Whitebark pine	whitebark	1	0-300			
Open range	openrange	1	0-200			
Sites <100 m	sitepnt	-	0-100	100-250		
Sites >100 m	sitepoly	1	0-100	100-250		
Trail, high conf	trailgood	-	0-200			
Trail, moderate conf	trailmod	-	0-350			
Trail, low conf	trailpoor	-	0-350			

streams, while fewer base camps would be situated at greater distances from the streams. In turn, the model can use a series of buffers to predict differing levels of archaeological potential at varying distances from different features.

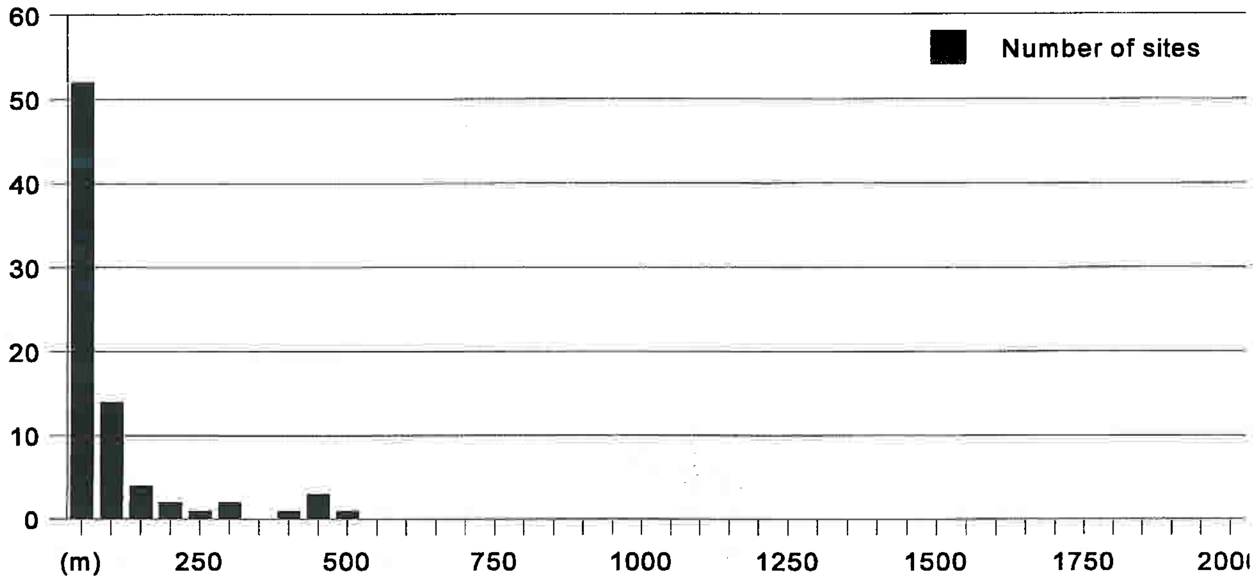
Determining the number and widths of buffers for each feature was a difficult task. In most cases, the first buffer on a feature is intended to capture those activities which occur immediately adjacent to that feature. For example, salmon fishing stations and waterfowl hunting blinds occur immediately adjacent to specific aquatic features. However, ethnographic and historic records do not provide explicit information about the distances that most traditional activities, and associated sites, occur in relation to specific features. For example, research has shown that caches are associated with salmon rivers, but the average and maximum distances that caches are found from these rivers is unknown.

In order to provide guidance on buffer sizes, a "near analysis" was conducted using the GIS. This analysis measured the distance from each major feature to each recorded archaeological site within 2000 m of the feature. Sites which were closer to other selected features are excluded from this analysis. These distances were then plotted in a bar graph producing a generalized visual representation of the distribution of archaeological sites in relation to that feature. For example, Figure 14 shows the distribution of all recorded sites within 2000 m of medium-sized lakes (where these sites were closer to the lake than other aquatic features). In this example, 80 sites were found within 2000 m of medium-sized lakes. Of these, 52 sites (65%) were found within 50 m, 66 sites (83%) were found within 100 m, 71 sites (89%) were found within 300 m, and 100% of sites were found within 500 m of medium-sized lakes. Based on the results of this analysis, buffer widths for medium-sized lakes were set at 50 m, 100 m, 300 m, and 500 m from the lake shore (Table 8).

Caution was used when interpreting the results of the near analysis, due to the low number of recorded sites associated with each feature class, and the nonrepresentative nature of archaeological site distribution in the CFD. For example, no sites have been identified more than 500 m away from medium-sized lakes which may reflect the lack of survey at distances greater than 500 m from these lakes. Additional archaeological inventories are required to establish better site distribution data and test the validity of feature buffers. Nonetheless, the near analysis provided some guidance on buffer widths. Where applicable, ethnographic data and field experience also were used to adjust the buffer widths.

Most polygon features (including biogeoclimatic zones, ungulate ranges, and forest cover stands) did not receive a buffer. In these cases, it is the area enclosed by the polygon, and not the area around it, that is of significance to the model. In order to be recognized by the GIS during modelling, the area contained by all polygon features was assigned a numerical code (Table 8).

Figure 14: Near Analysis of recorded sites to medium-sized lakes



3.4 Model Building

The theoretical framework for the model used in this study is provided in Section 2.0. Based on this modelling approach, six steps were required to build the model (Figure 15). For detailed information on the relationships between site types and environmental settings used in building the model, oplease refer to the Technical Appendices (Volume 2).

Step 1: Identify Traditional Activities

- using ethnographic, historic, and community knowledge sources, traditional land use activities which potentially resulted in physical evidence were identified

In total, 33 traditional activities were identified, ranging from salmon fishing to mortuary practises (Table 9). The order of traditional activities presented in Table 9 is arbitrary and is not intended to reflect their relative importance or significance.

Step 2: Identify Associated Archaeological Site Types

- using ethnographic and archaeological sources, the generalized archaeological site types associated with each traditional activity were identified (Table 9)

The main archaeological site types include: fishing stations; caches; base camps; kill/butcher sites; game overlooks; hunting blinds; processing/cooking sites; culturally modified trees; pithouses; mat lodges/plank houses; rock shelters; trails/wagon roads; transit camps; quarries; lithic workshops; rock carvings/paintings; and various ceremonial sites. A site type code was assigned to each site type associated with each traditional activity. Sixty-eight individual site types were identified (TYP1 through TYP67 in Table 9; note TYP 24a and TYP 24b).

Step 3: Identify Associated Archaeological Evidence

- using archaeological sources, the potential archaeological remains (cultural materials and features) associated with each of the sixty-eight site types were identified (Table 9)

The archaeological remains were coded using a typology of cultural materials and features developed for the archaeological overviews in the Cariboo Forest Region. The archaeological typology includes the following codes: housepit; lithic; hunt; fish; cache; roast; CMT; burial; rockart; trail; quarry; other (see Table 9).

Step 4: Identify Location of Activity/Site

- using ethnographic, historic, and other sources, the types of landscape settings where each traditional activity took place, and the types of environmental features associated with site types, were identified

Particular attention was placed on identifying those environmental features available on the digital coverages, such as aquatic features, major landforms, and slope. The relationships of the activities to other mapped features, such as ungulate habitats, forest cover, and biogeoclimatic zones were also identified.

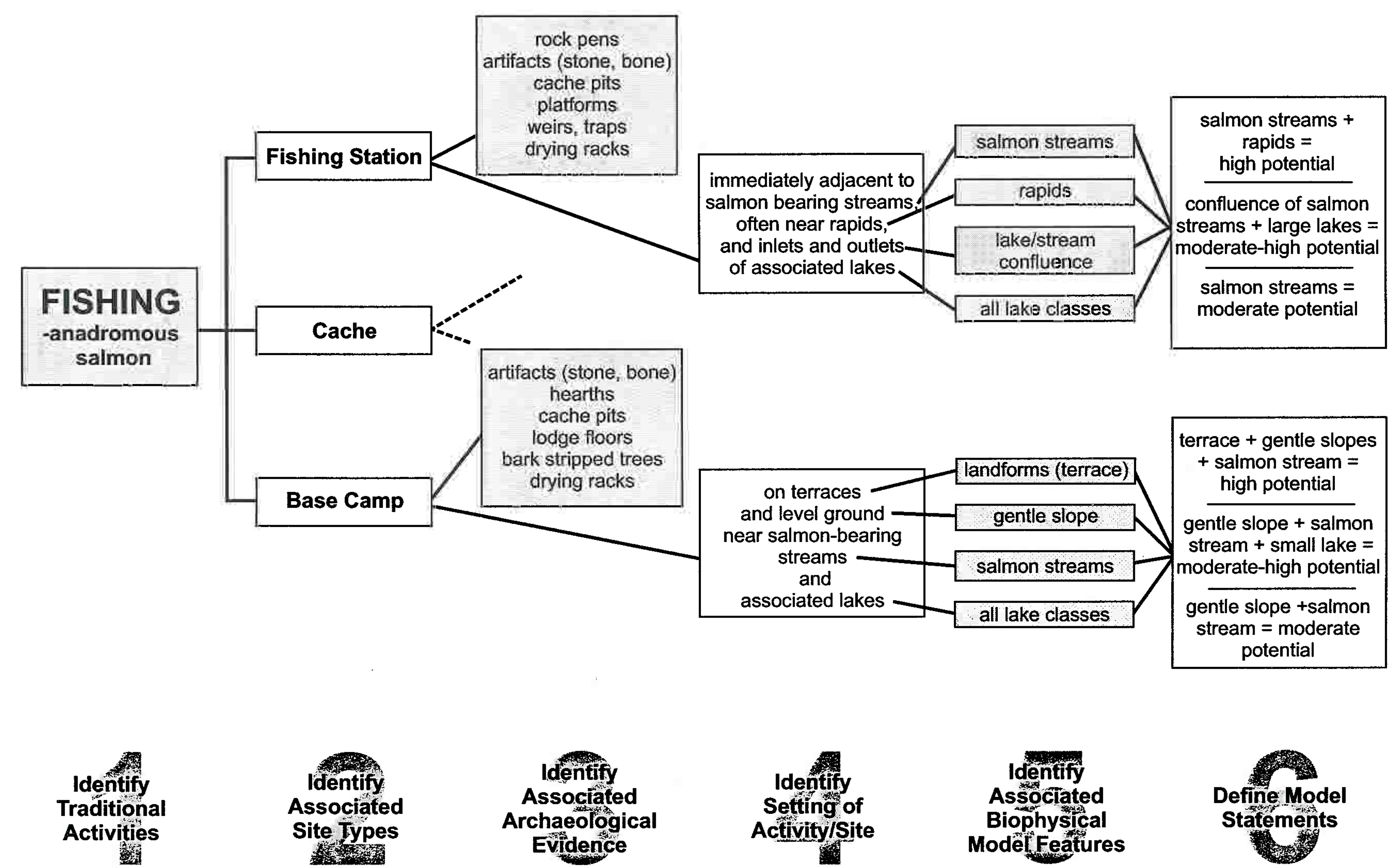


Figure 15: Schematic diagram of model building

Table 9: Traditional Activities/SitesModelling Summary for the Chilcotin Forest District

Traditional Activity	Site Type Code	Site Types	Archaeological Code(s) Used in Model
Fishing: sockeye, chinook, steelhead	TYP 1	fishing station	Fish, Lithic, Cache
	TYP 2	cache	Cache
	TYP 3	base camp	Lithic, Cache, Fish, CMT
Fishing: trout, suckers	TYP 4	fishing station	Fish
	TYP 5	base camp	Lithic, Cache, Fish, CMT
	TYP 6	cache	Cache
Fishing: kokanee	TYP 7	fishing station	Fish
	TYP 8	base camp	Lithic, Cache, Fish
	TYP 9	cache	Cache
Fishing: whitefish	TYP 10	fishing station	Lithic, Fish
	TYP 11	base camp	Lithic, Fish, Cache
	TYP 12	cache	Cache
Hunting: mule deer	TYP 13	base camp	Lithic, Cache
	TYP 14	kill / butcher	Lithic
	TYP 15	game overlook	Lithic
	TYP 16	hunting blind, drive	Hunt, Lithic
Hunting: caribou	TYP 17	base camp	Lithic, Cache, Hunt
	TYP 18	hunting blind, drive	Hunt
	TYP 19	kill / butcher	Lithic, Hunt
	TYP 20	cache	Cache
Hunting: elk (moose)	TYP 21	base camp	Lithic, Cache, Hunt
	TYP 22	kill / butcher	Lithic
	TYP 23	game overlook	Lithic
Hunting: mountain sheep, goats	TYP 24a	base camp	Lithic, Cache, Hunt
	TYP 24b	hunting blind	Hunt
	TYP 25	kill/butcher	Lithic, Cache
Hunting: bears	TYP 26	base camp	Lithic, Cache, Hunt
	TYP 27	kill / butcher	Lithic
Hunting / Trapping: marmots	TYP 28	kill / butcher	Lithic, Hunt
Hunting / Trapping: beaver, muskrat, otter	TYP 29	kill / butcher	Lithic
Hunting / Trapping: snowshoe hare	TYP 30	kill / butcher	Lithic
Trapping: fisher, marten, lynx, fox, coyote	TYP 31	kill / butcher	Lithic
Hunting: grouse	TYP 32	kill / butcher	Lithic
Hunting: waterfowl	TYP 33	base camp	Lithic, CMT, Cache
	TYP 34	kill/butcher	Lithic
	TYP 35	hunting blind	Lithic, Hunt

Traditional Activity	Site Type Code	Site Types	Archaeological Code(s) Used in Model
Plant Gathering: spring beauty, avalanche lily	TYP 36	base camp	Lithic, Roast, Cache
	TYP 37	processing / cooking	Roast, Cache
	TYP 38	cache	Cache
Plant Gathering: balsamroot, nodding onion, silverweed, fern bulb, red lily bulb	TYP 39	base camp	Lithic, Roast, Cache
	TYP 40	processing / cooking	Roast
	TYP 41	cache	Cache
Plant Gathering: huckleberries	TYP 42	processing / cooking	Roast, Lithic
Plant Gathering: saskatoons / soap-berries / blueberries	TYP 43	processing / cooking	Roast
Plant Gathering: kinnikinnick berries	TYP 44	processing / cooking	Roast
Plant Gathering: tree lichen	TYP 45	cooking	Roast, Cache
Plant Gathering: whitebark pine nuts	TYP 46	processing / cooking	Roast
	TYP 47	cache	Cache
Plant Gathering: lodgepole pine cambium, pitch	TYP 48	culturally modified tree	CMT
	TYP 49	processing / cooking	Roast
Plant Gathering: trees	TYP 50	culturally modified tree	CMT, Lithic
Plant Gathering: tree bark	TYP 51	culturally modified tree	CMT
Habitation: winter village	TYP 52	pithouse, mat lodge / plank house	Housepit, Lithic, Cache, Roast, Burial, Fish, Hunt
Habitation: seasonal / temporary	TYP 53	mat lodge / plank house	Lithic, Cache, CMT
	TYP 54	base camp / temporary habitation structure	Lithic, Cache, CMT
	TYP 55	rock shelter	Cave, Lithic, Rockart
Travel / Trade	TYP 56	trail, wagon road	Trail, CMT, Lithic
	TYP 57	transit camp	Lithic, CMT, Cache
Rock Quarrying	TYP 58	quarry	Quarry, Lithic
	TYP 59	lithic workshop	Lithic
	TYP 60	base camp	Lithic
Ceremonial	TYP 61	rock carving / painting	Rockart
	TYP 62	tree carving	Other
	TYP 63	sacred	Other
	TYP 64	sweat	Other
Mortuary Practices	TYP 65	burial	Burial
	TYP 66	cremation	Burial
Warfare	TYP 67	defense	Other

Step 5: Identify Associated Biophysical Model Features

- on the basis of the location/setting information, the specific biophysical model features associated with each site type were identified

For example, the specific classes of lakes and streams associated with salmon fishing stations were identified, as were the specific biogeoclimatic zones and forest cover stands associated with avalanche lily collecting and cooking sites.

Step 6: Define Model Statements

- a series of modelling or logical statements were defined for each site type; these statements form the instructions to the GIS for modelling the landscape

The model statements identify the specific combinations of biophysical features associated with each site type. For each site type, the most favourable setting was identified first and classified as high potential, and then settings with progressively greater constraints (i.e., steeper slope, greater distance from water) for the same site type were identified, and classified as moderate-high, moderate, and low potential.

Defining the model statements was the most complex part of building the model. On the basis of a thorough review of various sources, the biophysical features forming the most favourable setting for each site type were identified. For example, it was established that the most favourable setting for a salmon fishing station is immediately adjacent to rapids on salmon streams. However, where greater constraints and fewer favourable features are present, the potential for fishing stations being present is lower. As an example, research determined that a moderately favourable location for a salmon fishing station occurs at the confluence of salmon streams and large lakes, while less favourable locations are found along the banks of salmon streams away from confluences and rapids. In terms of biophysical model features, these settings would involve the following classified features and buffers: "rapids=1" (100 m buffer around rapids), "streamsalm=1" (50 m buffer on salmon streams), and "lakelarge=1" (200 m buffer on lakes >1000 ha in size). These features would be used in the model statements, which are constructed by combining the codes and values for the features and buffers into a logical form. Table 10 presents some simplified examples of model statements.

Table 10: Simplified Examples of Model Statements
If rapids=1 and streamsalm=1 then potential for salmon fishing stations=high
If streamsalm=1 and largelake=1 then potential for salmon fishing stations=moderate-high
If streamsalm=1 then potential for salmon fishing stations=moderate

Wherever the buffers for the specified features intersect in the GIS, the potential for site TYP1 (salmon fishing station) ranges from high to moderate, according to the specific combination of features present at that point. Similar model statements were defined for each of the sixty-eight site types used in the model. In this AOA, more than 100 model statements were defined, with each statement representing a unique combination of features which result in a specific level of potential for a particular site type or set of site types. In each case, the most favourable setting or combination of features received the highest potential rating for that site, and for each setting with greater constraints or fewer favourable features, the potential rating was reduced. With these statements, the GIS can analyze the various digital coverages and identify the areas of high, moderate-high, moderate, and low potential for each site type throughout the study area. Examples of the actual model statements used in this AOA are found in the Technical Appendices (Volume 2).

3.5 Model Application

Before applying the model to the study area, each digital coverage (GIS map layer) was divided into a 10 m by 10 m grid, creating millions of map squares, called "cells", across the study area. The GIS can then determine the presence or absence of the features and codes in each cell in each coverage, and using this information, the GIS can create a database containing the codes for all the features present for each cell in all of the digital coverages used in the model. The model statements can then be applied to each database record, which produces a final potential value for each cell. The results of this process can then used to create a new map display showing the different classes of archaeological potential.

This model application process involved five main steps. Figure 16 presents a generalized example of these steps applied to a set of imaginary coverages. These steps are explained below.

Step 1: Identify Features Present for each Map Cell on each Coverage

- the GIS searches each cell on each coverage to determine what features, if any, are present

In Figure 16, a slope class is present for cell #99999 on the slope coverage, a stream buffer is present for cell #99999 on the stream coverage, a lake buffer is present for cell #99999 on the lake coverage, and a landform is present for cell #99999 on the landform coverage. In this example, no features are present on the remaining coverages (e.g., ungulate coverage).

Step 2: Identify the Code for each Feature in each Cell

- the code of each feature present on each coverage is identified

In Figure 16, the feature codes for cell #99999 are: slope=1 (i.e., cell is found in slope class 1 which represents a slope of less that 15%); stream=2 (i.e., cell is found in stream buffer 2 which is from 100 m to 300 m from stream); lake=1 (i.e., cell is found in lake buffer 1 which is 0 to 200 m from the lake), and; landform=1 (i.e., cell is found in landform polygon 1 which represents a terrace). This process is repeated for all of the cells in the study area.

Step 3: Create a Database Record for each Cell

- the feature codes for each cell are outputted to a database, with a single record for each cell

For cell #99999 in Figure 16, the database record would include the codes for slope, stream, lake and landform. For all coverages which did not contain a feature in cell #99999, the entries in the database record would be "0".

Step 4: Apply Model Statements to each Database Record

- all of the model statements are applied to each database record, resulting in a potential score for each site type for that particular cell

In the example in Figure 16, the model statement "If slope=1 and stream=1 or 2 and lake=1 or 2, and landform=1, then potential for TYP3=4" was applied to the database record for cell #99999. By

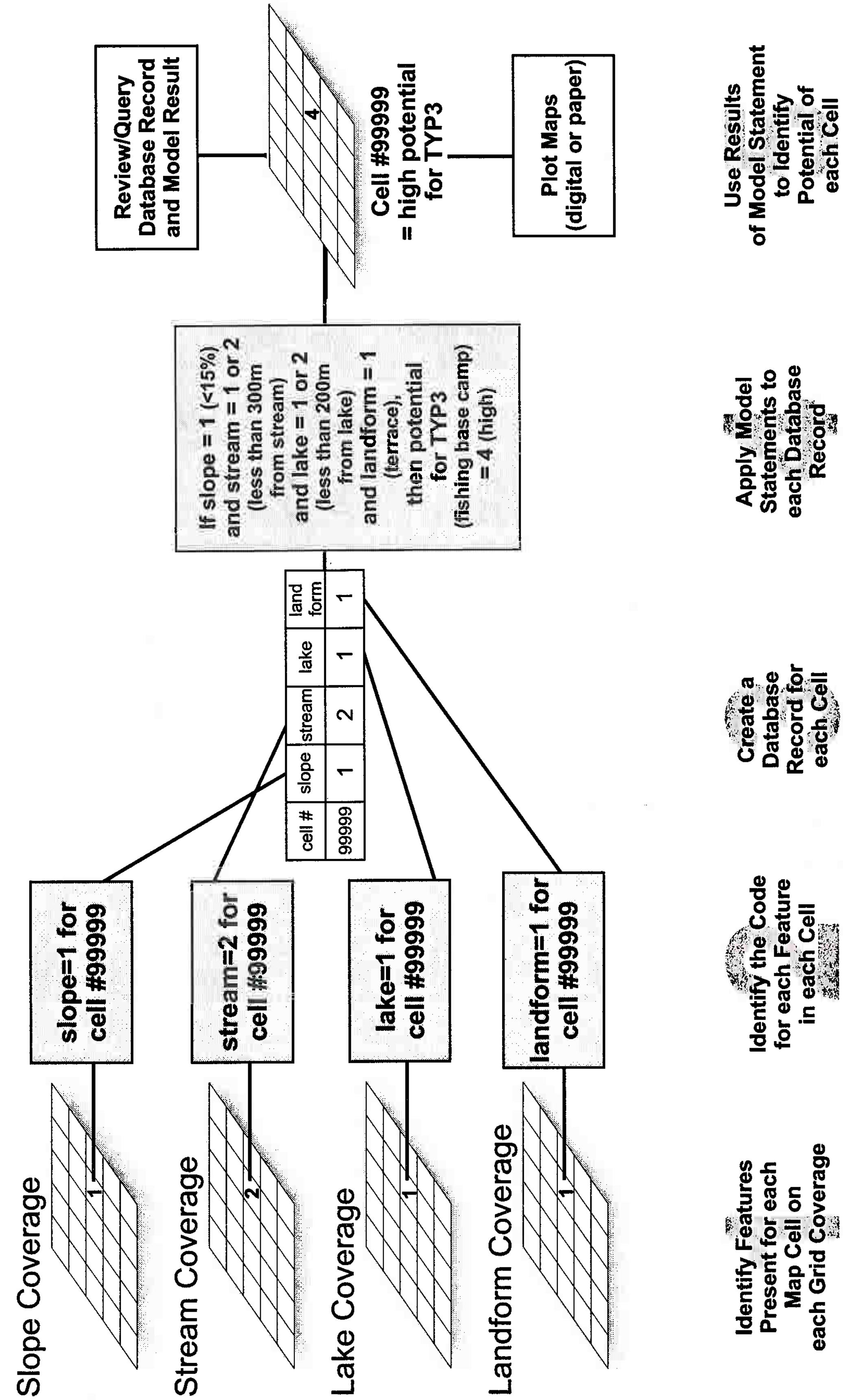


Figure 16: Schematic diagram of model application

applying the model statement to the record, a "high potential" score (4) for site type 3 (salmon fishing base camps) resulted for cell #99999. During the modelling process, all model statements for other site types are also applied to this database record. The application of other model statements may result in the same or lower potential score for cell #99999.

Step 5: Use Results of Model Statements to Identify Potential of each Cell

- the results of the model statements are used to classify the potential of each cell, and this information can be used to create new maps displaying potential

After the potential for each site type has been determined for each cell, the highest score for each cell is outputted to a new database field at the end of the record. The highest scores for each cell is then used to plot (print) maps of potential for the study area, with each class of potential a different colour on the map. For example, all cells with a score of "4" are coloured red, while all cells with a score of "1" are coloured light green (Figure 17). As the database record for each cell is linked directly to a point on the digital maps, any point on the digital maps can be queried to obtain the feature codes and potential scores.

Model Testing and Review

Before the modelling the entire study area, the model was applied to a single mapsheet to ensure the process functioned properly, and on this basis a number of technical problems were corrected. Next, six representative test areas from the study area were modelled and reviewed to establish whether the model was working correctly. The test areas were chosen from different parts of the CFD, each consisting of two adjacent TRIM maps (Figure 18). An effort was made to select test areas from as many different biogeoclimatic zones and ecosections as possible, in order to make them representative of the entire study area. Test areas were also selected from within the traditional territories of all the resident First Nations in the study area (Table 11). Three of the test areas were also selected from areas which overlap with other AOAs which were undertaken concurrently with this study in the Cariboo Forest Region.

The model was applied to the test areas on two separate occasions and the results were carefully reviewed. The test area review consisted of the following steps:

- each test area was scrutinized to ensure that the GIS coverages were accurate, the model was applied correctly, and the modelling results met expectations

- the locations of all recorded archaeological sites in each of the test areas were checked against the predicted potential to ensure that buffer sizes were adequate and the correct site types were predicted

- the predicted archaeological potential of the test areas was reviewed by archaeologists, representatives of First Nations, and MoF personnel familiar with the area

- the modelled test areas in overlap areas were compared with the test areas produced in AOAs conducted by other firms to identify any inconsistencies

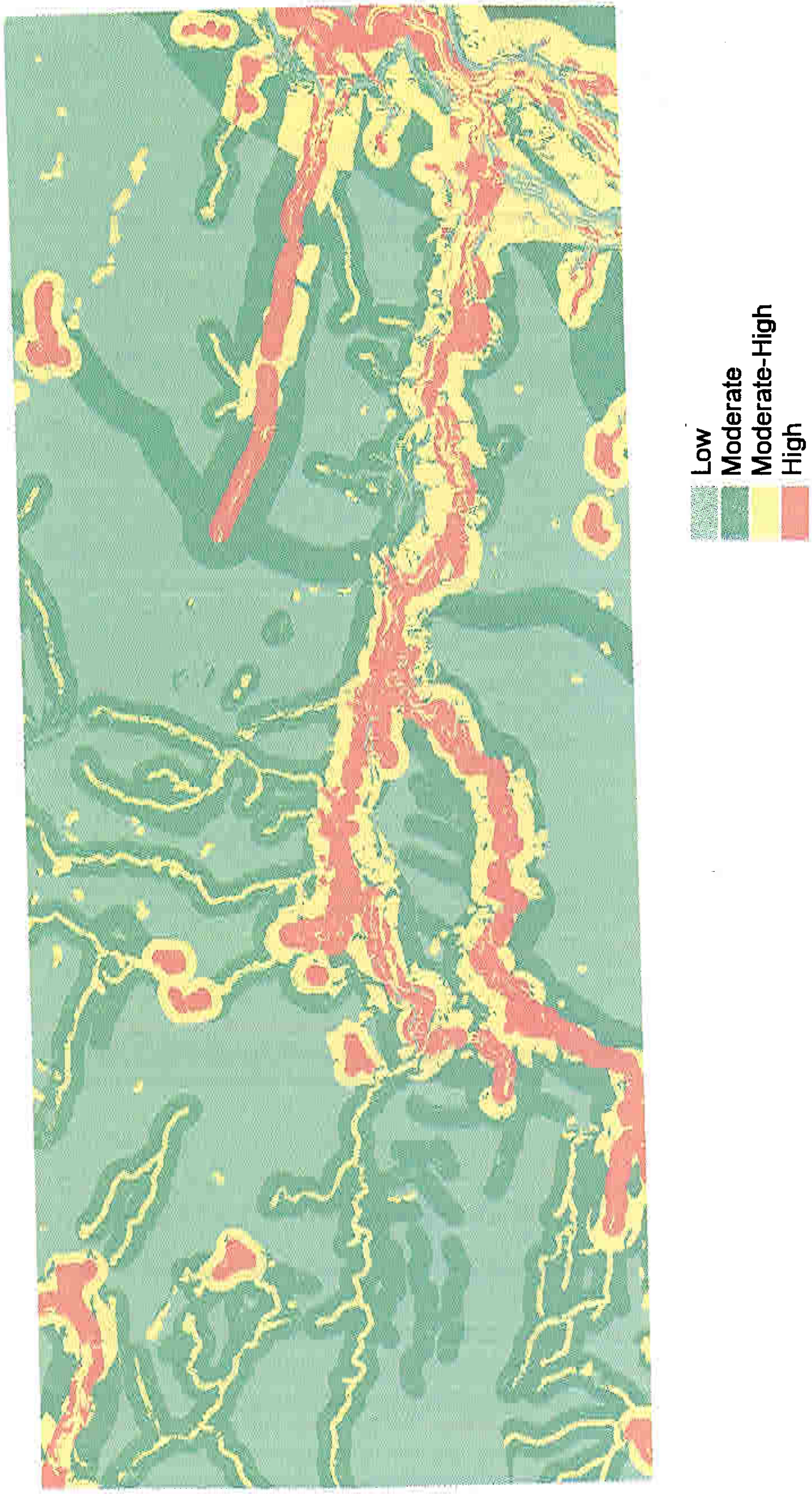


Figure 17: Example of modelled maps showing classified potential (1:125,000; TRIM sheets 92N.100/92O.091)

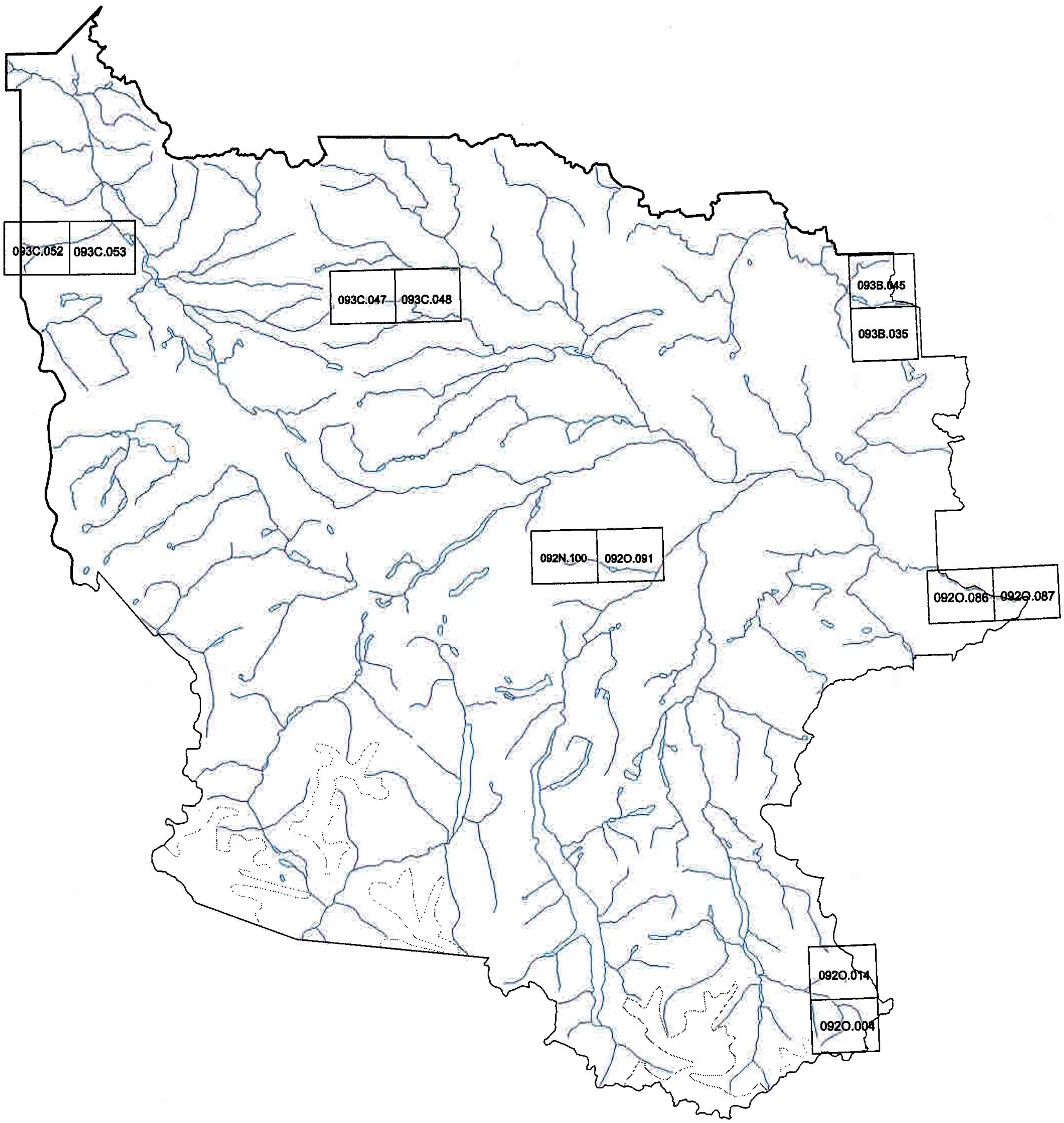


Figure 18: Location of Test Areas selected in the Chilcotin Forest District (1:1.25 million)

Table 11: Test Areas in the Chilcotin Forest District

Mapsheet Nos.	First Nation Territory	Biogeoclimatic Zone	Ecosection	AOA Overlap
092N.100 092O.091	Xeni Gwet'in Tsi Del Del	IDFdk4 SBPSxc	Chilcotin Plateau	
092O.004 092O.014	Xeni Gwet'in	AT ESSFxv	Central Chilcotin Ranges	Williams Lake FD
092O.086 092O.087	Stone	IDFxm IDFdk4	Fraser River Basin, Chilcotin Plateau	Cariboo Tribal Council, Williams Lake FD
093B.035 093B.045	Anaham	SBPSdc SBPSmk	Nazko Upland, Chilcotin Plateau	Cariboo Tribal Council, Williams Lake FD
093C.047 093C.048	Tsi Del Del	MSxv ESSFxv	Western Chilcotin Upland	
093C.052 093C.053	Ulkatcho	ESSFxv MSxv SBPSxc	Western Chilcotin Upland	

On the basis of the initial test area review, a number of problems in the GIS coverage and model statements were identified and corrected. The comments of archaeologists, First Nations, and MoF were noted, and where possible steps were taken to address their concerns. Differences in modelling results for the overlap test areas were also discussed and analyzed in cooperation with other firms conducting AOAs. To ensure as much consistency between modelled test areas as possible, several changes were made to the Chilcotin model. Once all revisions were made, the model was applied a second time to the test areas. These final test areas were reviewed again by Arcas, input and comments from First Nations was sought, and additional corrections and revisions were made. Once all corrections and adjustments were made, the model was applied to the entire CFD.

Ground-truthing of the modelled test areas was also planned as part of evaluating the model. The ground-truthing was to be carried out with the participation of First Nations. The purpose of the ground-truthing was twofold: (1) to check the accuracy of the biophysical features mapped in the GIS, with an emphasis on slope and stream classification, and (2) to assess the accuracy of the predicted potential based on field reconnaissance observations, local knowledge, and professional judgement. Unfortunately, ground-truthing of the test areas was not undertaken due to scheduling difficulties. It is recommended that ground-truthing of the test areas be undertaken as part of the proposed model review (see Section 4.0).

Another important step in evaluating the success of the model involves a *site capture analysis*. This analysis is used to determine the percentage of sites which were found in each class of potential. If the model worked correctly, it was expected that the highest percentage of sites would be found in the high potential class, and fewer sites would be found in each of the successively lower potential classes. The site capture analysis was to be conducted after the entire study area was modelled, and was not conducted in time to be incorporated into this report. When this data becomes available, the results of the site capture analysis will be provided to the MoF, First Nations, and the Archaeology Branch under separate cover. Although the site capture analysis was not intended to revise the current version of the model, the results should be evaluated as part of the future model review.

3.6 Data Gaps and Limitations

During the course of this study, a number of data gaps and limitations were identified which in turn resulted in certain limitations to the model of archaeological potential.

Consultation and Community-based Knowledge

- inadequate opportunities for review of preliminary model and test areas by First Nations
- inadequate participation of First Nations in steering committees due to financial and time constraints
- limited access by AOA team to existing traditional use studies and trail research
- limited access by AOA team to community knowledge concerning archaeological site locations and trail routes (partially due to reduced scope of community-based archaeological research component)

Ethnography and Archaeology

- limited ethnographic and historic land use information in existence
- low number and non-representative distribution of recorded archaeological sites in CFD
- poor information on early period (prior to 4500 years Before Present) archaeological site settings and distribution
- limited data on relationship of site distribution to slope and aspect
- poor information on intensity and extent of forestry AIA survey coverage
- lack of research-oriented archaeological inventory studies in certain biogeoclimatic zones

Biophysical

- limited information on historic and current salmon and fish distribution
- insufficient distinctions between stream classes
- lack of accurate wildlife data, primarily concerning ungulate core ranges and migration corridors
- limited information on past wildlife and vegetation distributions and abundance

Digital Data

- poor mapping of indefinite/intermittent streams

- variable accuracy of site plotting
- variable accuracy of trail plotting
- insufficient mapping of soils and surficial geology
- low resolution of glacial landforms mapping
- low resolution of existing wildlife and vegetation data

Modelling Limitations

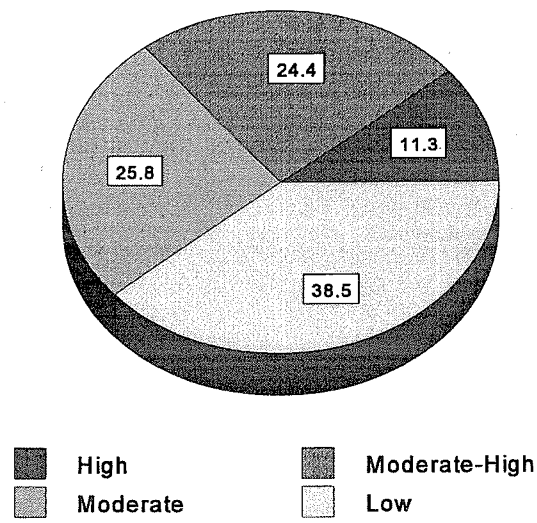
- biophysical features used in the model (i.e., streams) were not ground-truthed in test areas
- accuracy of slope classification was not field-checked
- some features which may affect potential were not used due to a lack of data or GIS limitations, including aspect and slope breaks
- insufficient palaeoenvironmental information is avaliable for modelling environmental change over time
- insufficient site distribution data to confidently determine width of feature buffers
- accuracy of recorded site plotting insufficient to allow confident assessment of site/slope associations
- the reliance on limited ethnographic and historic sources for modelling land use may not accurately reflect all precontact land use activities

4.0 RESULTS AND RECOMMENDATIONS

4.1 Modelling Results

The GIS model used in this Archaeological Overview Assessment classified the entire study area into four classes of archaeological potential: High (Class 4), Moderate-High (Class 3), Moderate (Class 2), and Low (Class 1). The percentage of the CFD land base in each class of potential is presented in Figure 19. Overall, 11.3% of the study area was modelled as having high potential (low constraints), 24.4% was modelled as having moderate-high potential (low-moderate constraints), 25.8% was modelled as having moderate potential (moderate-high constraints), and 38.5% was modelled as having low archaeological potential (high constraints). In terms of the proportions of the potential classes, the results of the modelling in this AOA conform to expectations, and are comparable to the results of other GIS-based models in the region. Specifically, it was expected that Class 4 (High) would contain the smallest area and Class 1 (Low) would contain the largest landscape areas, with Classes 2 and 3 containing approximately half of the area (Table 12). The total area of each class of potential varies by biogeoclimatic zone. This reflects the relative favourability of certain zones for human use and habitation, based on climate, topography, and resources.

Figure 19: Potential classes in percent



Please note that the four classes of archaeological potential do not predict the specific locations of archaeological sites. Rather, these classes predict the relative potential of the landscape to be favourable to the traditional land use activities which result in the formation of archaeological sites.

Table 12: Area of Potential Classes in CFD

Potential Class	Area (ha)	%
4 (High)	302,703.86	11.3
3 (Moderate-High)	650,608.31	24.4
2 (Moderate)	686,490.20	25.8
1 (Low)*	1,025,314.15	38.5
TOTAL**	2,665,116.52	100.0

* includes snowfields
** excludes area covered by lakes, wetlands, and double-line streams (TRIM data)

In other words, high potential areas are the most favourable for activities which result in archaeological sites, and therefore the highest probability of finding an archaeological site will occur in these areas. Although the highest overall density of archaeological sites will be found in Class 4 areas, it is important to keep in mind that sites are not necessarily present at all points within all high potential areas. Conversely, low potential (Class 1) areas have the lowest probability of containing archaeological sites and the lowest overall site density. However, it is also important to keep in mind that low potential areas do not have "zero" potential, and therefore an archaeological site may be present at any location within Class 1 lands.

Overall, the highest density and greatest frequency of recorded sites should be found in areas of high potential, while the lowest density and frequency of recorded sites should be found in low potential areas. However, significant gaps exist in archaeological data for the Chilcotin Forest District, and the distribution of currently recorded archaeological sites is not representative of the study area as a whole.

4.2 Application of Model Results

This AOA was initiated and designed specifically for archaeological management in forestry planning. However, the results of this overview are equally applicable to management planning for all land-altering developments in the study area. In addition, the overview results have application for archaeological research and inventory planning. We recommend that the model results be applied during development planning by all government ministries, government agencies, and industries responsible for overseeing or initiating land-altering activities, including:

- Ministry of Forests
- Ministry of Environment, Lands, and Parks
- Ministry of Transportation and Highways
- Archaeology Branch
- BC Lands
- BC Parks
- Municipalities
- Regional Districts
- Forestry Licensees
- Mining Companies
- Tourism Operators

The model results, in the form of archaeological potential mapping, are available in four formats for the entire Chilcotin Forest District:

- complete GIS vector data for each 1:20,000 scale TRIM mapsheet (ESRI shape format)
- GIS image data for each 1:20,000 scale TRIM mapsheet (ARC/INFO image format)
- digital plot files at a scale of 1:50,000 (TRIM base)
- paper maps at a scale of 1:50,000 (TRIM base)

Complete GIS data for the study area, in ARC/INFO vector format, is *only available to the MoF*, the TNG (and member communities), and the Archaeology Branch. The vector GIS data can be queried for modelling information at any point on the map, including which biophysical features are present, the relative potential for each site type at that location, and number and type of archaeological sites and trails present. The dissolved GIS data and digital plot files cannot be manipulated or altered and have been stripped of archaeological site and trail information. Dissolved GIS data can be used as a digital overlay on development plans or other data, while digital plot files can be used to produce acetate or paper copies of the maps. Access to GIS image data, digital plot files, and paper maps by forestry licensees must be negotiated with the MoF.

Application of Model Results in Forestry Planning

Overseeing the application of the AOA and model results in forestry planning is primarily the responsibility of the MoF. It is recognized that the management of archaeological resources in forestry contexts is ultimately at the discretion of the statutory decision-maker, and the AOA is a decision-making tool . However, it is recommended that the MoF, in consultation with the Archaeology Branch, develop a formal process for ensuring the consistent application of the model and the AOA recommendations in all aspects of MoF and licensee planning. Recommended guidelines for applying the model results in forestry planning are indicated in Table 13. These steps are appropriate for both licensee planning and MoF Small Business Incentive programs. Consultation with First Nations is recommended during all aspects of archaeological managment planning.

Table 13: Steps for Applying Model Results in Forestry Planning

Step	Task	Primary Responsibility
1	• identify the mapsheets for areas where proposed forestry developments (roads, gravel pits, cutblocks, silviculture areas, etc.) are located	licensee
2	• obtain the appropriate digital files and/or paper maps from MoF-Cariboo Region	licensee
3	• using the digital or paper archaeological maps as an overlay on the development plan, determine the archaeological potential of the area affected by the proposed developments	licensee
4	• in consultation with District Manager, determine the recommended archaeological management action(s) for each development area or portion thereof	licensee in consultation with the MoF
5	• where required, engage an archaeologist or qualified individual to conduct further research (i.e, development-specific AOA) • where required, engage an archaeologist to conduct a field assessment under permit (AIA)	licensee or archaeologist archaeologist
6	• report results of all archaeological fieldwork or research to the MoF, the Archaeology Branch, and First Nations (so that they can be incorporated into model revisions)	archaeologist and licensee
7	• determine the appropriate management actions for archaeological sites identified during fieldwork	licensee in consultation with the Archaeology Branch

Application of Model Results in Other Development Planning

The use of the AOA by the various development proponents and land management agencies listed at the beginning of this section should be encouraged by the Archaeology Branch. It is recommended that government ministries and agencies (other than the MoF), and development proponents (other than forestry licensees) contact the Archaeology Branch and/or MoF for guidance on the appropriate application of the overview results.

Application of Model Results in Archaeological Research and Traditional Use Studies

It is recommended that the research design of archaeological research and inventory studies

studies should contribute to the testing and review of the model of archaeological potential. First Nations and archaeologists undertaking these studies should contact the MoF and the Archaeology Branch for guidance on how this can be accomplished.

4.3 Archaeological Management Recommendations

This overview study classified the entire Chilcotin Forest District into four classes of archaeological potential. For lands in each of these four classes, a different level of archaeological work is recommended before proposed land-altering development activities proceed. We also recommend First Nation consultation for all four classes of archaeological potential. Moreover, survey areas containing all four classes of potential should be included in future archaeological inventory studies.

It is recognized that the archaeological potential maps produced by this AOA are only one tool for predicting the geographic distribution of archaeological sites in the study area. Another source of information is the First Nations of the CFD. Studies in the Cariboo Forest Region have shown that First Nations can provide important information for certain types of sites whose locations are very difficult to predict, including trails, rock art sites, and isolated burial places. Also, First Nations bring their own perspective to past aboriginal land use and archaeological site potential. Therefore, for all proposed developments, we strongly recommend consultation on archaeological concerns with the relevant First Nations, regardless of the class of archaeological potential predicted by this AOA for the proposed development property.

Table 14 summarizes the **minimum** archaeological management actions and methodologies recommended for each of the four classes of archaeological potential. No specific management recommendations are offered for particular types of archaeological sites. In our view, the actions recommended in Table 14 of this report should be sufficient to address potential impacts to sites, regardless of type of site, as predicted by this AOA as long as First Nation consultation is meaningful and the fieldwork methodologies used are current, tailored to specific concerns and circumstances, and carried out to the highest professional standards. Please note that the official archaeological management actions accepted by the MoF may differ from the recommendations outlined below. To obtain the formal recommendations, contact the District Manager of the CFD.

Specifically, the following archaeological management actions are recommended:

High (Class 4) potential land includes the areas which contain the fewest constraints and the most favourable landscape for one or more archaeological site types. Although not all high potential land will have archaeological sites, all land within this class has potential for containing sites. The area within 100 m of the site boundary of all recorded archaeological sites has also been classified as high potential. An intensive archaeological impact assessment (AIA) conducted under an Archaeology Branch heritage Inspection Permit is recommended for this class. It is also recommended that First Nation permits, if appropriate, are obtained for fieldwork. The intensive AIA should involve closely-spaced survey traverses and subsurface testing. All developments locations containing any area of high potential should be assessed, but the intensive AIA should be restricted to the area indicated as having high potential by the model. The Archaeology Branch also recommends that provision be made in permits to terminate work if field inspection indicates an area is misclassified by model.

Moderate-High (Class 3) potential land includes areas which contain some constraints for one or more site types, but also may contain some favourable landscape features. Although fewer archaeological sites are expected for Class 3 land, lands within this class have reasonable potential for containing sites. The area from 100 to 250 m around all recorded archaeological sites, and a 200 m buffer on each side of aboriginal trails with a high confidence level, have also been classified as having moderate-high potential. A judgemental AIA under an Archaeology Branch permit and, where appropriate, First Nation permits is recommended for this class. This judgemental AIA is intended to carefully assess the archaeological potential of the landscape by identifing the presence or absence of micro-features which may increase or decrease site potential. The AIA should also be used to ground-truth the locations of reported sites and trails. This AIA should include judgemental surface inspection and subsurface testing to confirm the assessments of potential. If the results of the AIA indicate high potential exists for some or all of the Class 3 land inspected, or if sites or trails are identified, the archaeological management action should be upgraded to an intensive AIA for the affected area. All developments with any amount of moderate-high potential should be inspected, but the judgemental AIA should be restricted to the area indicated as having moderate-high potential by the model. The Archaeology Branch also recommends that provision be made in permits to terminate work if field inspection indicates an area is misclassified by model.

Moderate (Class 2) potential land includes those areas with considerable constraints for all site types, and few favourable micro-features are expected. An area of 350 m on each side of trails with moderate or low route confidence are also included as having Class 2 potential. Class 2 land should be treated as a "caution" zone, and further research may help identify the presence of favourable micro-features or establish better confidence of trail routes. A development-specific in-office archaeological overview assessment (AOA) is recommended for Class 2 land. This development-specific AOA should begin with a review of the model features and site types predicted for the area, using information obtained from the digital GIS data. Based on this information, further research may be warranted, including (1) a review of aerial photos and large-scale maps, (2) archaeological or historical research, or (3) consultation with local informants. This development-specific AOA may also include an preliminary field reconnaissance (PFR) for all or part of the Class 2 lands in question. The development-specific AOA should be conducted by an archaeologist or individual familiar with the region and who meets qualifications identified by the MoF.

Low (Class 1) potential land has the greatest constraints for all site types, and few favourable features are expected in this class. However, it should be emphasized that low potential is <u>not</u> the same as "zero" potential, and some potential for a number of site types exists in this class. First Nation consultation is particularly important for this class, as AIAs and AFRs are not normally anticipated for these lands, and consultation may help to identify potential conflicts with unmodelled or site-specific archaeological concerns. Wherever possible, all forestry field staff should be advised of potential site types present in this class and the consequences of impacts to sites. If an archaeological site is encountered or impacted during forestry activities, all work must cease immediately and the MoF must be contacted. As with all classes, future archaeological inventory studies should include a representative sample of Class 1 lands in order to test modelling assumptions.

Table 14: Minimum Recommended Archaeological Management Actions

Potential Class	Minimum Recommended Actions	Recommended Methodology
High (Class 4)	• *intensive impact assessment (AIA)* • *First Nation consultation*	• AIA conducted by a qualified archaeologist under appropriate permits • intensive and/or systematic surface inspection at closely spaced intervals and intensive subsurface testing • provision in permits to terminate work if area mis-classified by model
Moderate-High (Class 3)	• *judgemental AIA* • *First Nation consultation*	• AIA conducted by a qualified archaeologist under appropriate permits • judgemental surface inspection of a representative sample of Class 3 lands, and judgemental subsurface testing where appropriate • if results of judgemental AIA indicate higher potential, fieldwork should be upgraded to an intensive AIA • provision in permits to terminate work if area mis-classified by model
Moderate (Class 2)	• *development-specific overview (AOA)* • *First Nation consultation*	• AOA conducted by an archaeologist or other individual with appropriate training • involves review of specific biophysical criteria and site types used in the assessment of potential, following guidelines available from MoF • on the basis of the review, additional in-office research (i.e., aerial photo interpretation, literature review, consultation) or a preliminary field reconnaissance (PFR) may be recommended • if a PFR indicates higher potential, fieldwork should be upgraded to a judgemental or intensive AIA • if no PFR required, then all forestry field staff should be advised of potential site types present
Low (Class 1)	• *First Nation consultation* • *forestry field staff advised of potential sites*	• First Nation consultation to identify potential conflicts with unmodelled or site-specific concerns • all archaeological inventory studies should include Class 1 lands in order to test modelling assumptions • all forestry field staff should be advised of potential site types present and consequences of impacts to sites • if an archaeological site is encountered or impacted, all work must cease immediately and the MoF must be contacted

4.4 Addressing Data Gaps and Model Review

A variety of data gaps and limitations were identified and described in an earlier section. Addressing these data gaps will help improve the accuracy and reliability of the model used in this overview study. For more information on data gaps and recommendations, please refer to the Technical Appendices (Volume 2). Some steps which may help address data gaps are summarized below.

- additional consultation with First Nations to review model and its application
- additional community-based archaeological research and ground-truthing of reported archaeological sites
- review accuracy and completeness of trail network, with expanded input from First Nations
- ground-truth biophysical features used in model, emphasizing slope and stream classification
- investigate use of additional model features, including aspect, slope breaks, soils and surficial geology, improved wildlife and vegetation data
- conduct archaeological inventory studies for high priority areas where the most significant archaeological data gaps exist (see Technical Appendices in Volume 2 for recommended priorities)
- incorporate results of all future archaeological overviews, field reconnaissances, and impact assessments into the model
- re-evaluate slope classifications and feature buffers as better site distribution data becomes available
- investigate palaeoenvironmental change and early precontact land use/site distribution

This overview study represents the first attempt at a GIS-based archaeological potential assessment of the Chilcotin Forest District. The results of the overview are limited by the availability, comprehensiveness, and quality of community-based, archaeological, biophysical, and digital data.

- *As new information becomes available and data gaps are addressed, it is important that the model of archaeological potential is revised and improved.*

It is anticipated that the model will be reviewed periodically, and that a future revised model will be used to generate new maps of archaeological potential for the study area. The most important steps necessary for reviewing and revising the model include increased input from First Nations, and the incorporation of new archaeological data from both archaeological inventory studies and forestry-related archaeological impact assessments. The MoF should institute a formal system for incorporating forestry-related PFR and AIA data into the model review which should be used by all archaeologists working in the study area. As new and better digital information becomes available, this data should also be incorporated into the model. Lastly, further research which may address some of the limitations identified in this study should be conducted.

We recommend that the MoF establish a detailed schedule and process for reviewing and revising the model. Although the exact timeline will depend upon the availability of new data and funding, a sequence of review steps and proposed schedule is presented in Table 15.

Table 15: Recommended Timeline and Steps for Review Process

Timeline	Review Step	Participants
Summer/Fall 1998	• conduct training workshops for MoF personnel • conduct field reconnaissance of test areas to ground-truth accuracy of biophysical features used as model input (e.g., confirm accuracy of slope classification • establish a formal system for incorporating AIA and AFR data in model review • plan and initiate priority archaeological inventory studies (AIS), including community-based site research (ground-truthing)	• MoF/archaeologists • MoF/First Nations/archaeologists • MoF/Archaeology Branch • MoF/First Nations/Archaeology Branch/archaeologists
Summer/Fall 1999	• conduct additional priority AIS, including community-based site research	• MoF/First Nations/archaeologists • MoF/First Nations/archaeologists
Year 2000	• initiate formal review of model • compile and review: AIS and AIA data, community research, trail research • review the availability of new digital data and the application of new GIS techniques • review palaeoenvironmental and early precontact data	• MoF/Archaeology Branch • MoF/archaeologists • MoF/Archaeology Branch • archaeologists

5.0 REFERENCES

Note: For a complete list of references used in the AOA, please refer to the Technical Appendices (Volume 2).

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TECHNICAL APPENDICES: see Volume 2