14

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The Forestry Corp.

Slope Delineation of the Foothills Forest

Proposal submitted to: The Foothills Forest
Hinton, Alberta

August 12, 1994

Table of Contents

Slope Class Delineation of the Foothills Forest

1. Introduction

The Foothills Forest has recently completed a preliminary inventory of environmentally significant areas within its 1.2 million hectare landbase. In order to refine this classification, additional detail regarding slope classes is desired.

This proposal will describe an approach to analyze the existing digital elevation data to produce an Arc/Info coverage representing percent slope in classes predetermined by the Foothills Forest.

Several alternatives for ensuring the slope data is compatible with other features are presented. Options for cost saving by the Foothills Forest are identified by:

- doing much of the work using the Foothills Forest GIS Lab equipment and software, and
- by using the Foothills Forest plotter for producing the required hardcopy maps.

These cost saving options are presented as alternatives only. Additional cost for having the work performed totally off-site are included should you feel these alternatives are not desirable.

2. Digital Terrain Representation

The earth's surface can be represented electronically by collecting location information in 3 dimensions: X, Y and Z. The X and Y locations, commonly used in planimetric mapping, are represented by one of several geographic or coordinate systems such as latitude/longitude or UTM. The Z location is the elevation above mean sea level.

The Foothills Forest already has elevation data in digital form. X and Y locations are stored as UTM , zone 11 coordinates. The elevation (Z value) is in meters above mean sea level. This data was processed and conditioned by the Resource Information Division of Lands and Forest Services. The points generated as part of that process are at 50 meter intervals; suitable for analysis and mapping at relatively large scales (up to 1:15,000). Breaklines (streams and ridges) are included in this point data. This data is currently stored as point coordinates in ASCII files.

2.1 Type of Surface Representation

To create slope classes, the data must be converted to one of two formats that Arc/Info uses for terrain analysis: a lattice or a TIN (triangulated irregular network). The advantages and disadvantages to each are detailed in Table 1. For the purposes of this project, we recommend creating a TIN for the following reasons:

1. the original data (control points, streams, ridges, etc.) are retained as true points in the terrain representation,
2. additional known points can be added during other data collection programs (by using GPS) to enhance the resolution of the surface representation where more detail is needed (detailed block design, surface water flow assessment, etc.).,
3. a TIN can always be converted to a lattice where the lattice grid structure is desired for analytical purposes.

2.2 Breaklines and Lake Features

The resulting surface should account for all elevation breaklines such as streams, ridges and lakes. The existing DEM data already accounts for streams and ridgeline features. However, it is unknown if lake boundaries are specifically included as breaklines. Lake boundaries are important to include to ensure that the slope class for a lake is zero percent. If lake boundaries are included, we still need to ascertain if they are included as 'hard' features. This is important to know because interpolation of elevation will occur over 'soft' features (like the grid point data), but will not occur over 'hard' features. If the lake boundaries are not included as hard features, they will need to be recoded as such in the TIN generation.

Additionally, The Foothills Forest must determine which set of lake boundaries should be included in the analysis. Some lake surfaces will be represented adequately with the existing DEM points. Likely, these will be the same lake boundaries included in the ***a_gb*** layer of the 1:20,000 base data. However, for

analytical purposes, The Foothills Forest may wish that lake boundaries be compatible with the lakes identified in the various vegetation inventories which cover the project area. This can be done by extracting the lakes from the various forest cover layers (Weldwood Inventory, AVI and Phase 3), determining their elevation by examining the annotation from the existing 1:20000 base data, then coding them has 'hard' features and rebuilding the TIN using these new lake boundaries.

The options for handling lakes will be discussed in the Methodology section and separate costs for each option are itemized in section 5.

One assumption made in this proposal is that if lakes are to be extracted from the forest cover information, they are coded appropriately for easy extraction.

2.3 Minimum Polygon Size

Map products are requested at a scale of 1:50,000. Traditional mapping conventions would call for a minimum polygon size of approximately 25 hectares. However we recommend that no minimum polygon size be set for a number of reasons:

- traditional restrictions on polygon size were based on limitations for paper mapping, but in this case the data will likely be used in digital form where scale is not fixed,
- the data will likely be used in conjunction with other digital sources of data which were collected at larger scales (1:20,000), resulting in smaller polygons,
- the data will likely be used analytically at scales much larger than the mapping scale, and in fact for uses such as determining operability constraints, scales of 1:10,000 would not be uncommon.

Notwithstanding this recommendation, our approach will examine sliver or extraordinarily small polygons to determine if they are relevant or simply an artifact of the analysis.

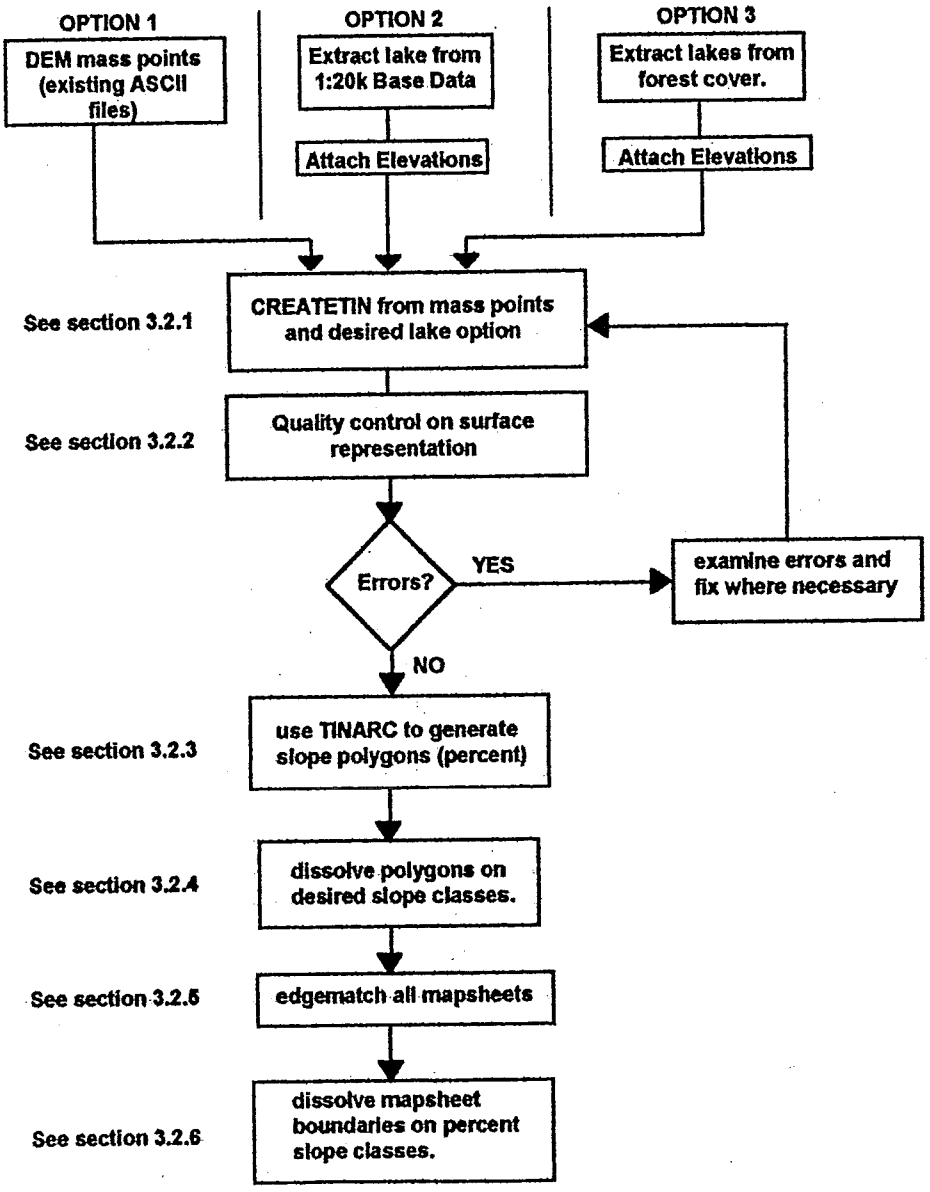
Table 1: Comparison of Lattice and TIN Structures

	LATTICE	TIN
Advantages	• can be used interchangeably with GRIDs • smaller data storage • faster processing	• original data can be maintained in the model • lines and points can be precisely represented (i.e. can use their true values, not an interpolation) • model can readily adapt to a complexity of terrain (can put in more points in rugged terrain and fewer in less variable surfaces)
Disadvantages	• grid structure of points doesn't always represent the true surface • original data not maintained with interpolation to a regular grid • linear features cannot be represented sufficiently for large scale applications	• expensive to build • more time consuming to process • TIN model not directly interchangeable with other Arc/Info structures; must do a conversion first before any analytical processing can occur with other features.

3. Methodology

3.1 Overview

The flowchart below shows the flow of events necessary to create the desired slope polygon coverage. The three options for including lake features are described in more detail in section 3.2.1. Each subsequent process of error checking and slope creation are detailed in sections 3.2.2 through 3.2.6.



3.2 Approach

The Forestry Corp. proposes to do much of the analytical work on the Cardinal workstation located in the GIS Training Lab at the Forest Technology School. This would save the Foothills Forest the cost of using equipment owned by the Forestry Corp. and would make good use of the under-utilized system in the GIS Lab. If this is not a desirable arrangement, then the Forestry Corp. will do the work off-site, but will then add the cost of the workstation to the proposed budget.

The Foothills Forest has already invested in an electrostatic plotter for creating hardcopy output. We propose to provide the Foothills Forest with digital map files which can be directly plotted using the Foothills Forest plotter. One day of manpower is allotted to produce the maps using Foothills Forest equipment and media. Again, should this not be a desirable arrangement, the Forestry Corp. will provide hardcopy maps at the costs indicated in section 5.

3.2.1 Create the Tin

Data for TIN generation will come from two sources: the DEM points and the lake boundaries. Three processing alternatives are presented, covering the options discussed in section 2.2 regarding lake boundaries:

Lake Option 1: D.E.M. mass points: These points describe the terrain surface (including streams and ridgelines). Lake boundaries are included in this set, but may not be 'hard' features, meaning that the lake boundary could be fuzzy (i.e.: it may not match the exact boundary as digitized in the 1:20,000 base data.

Lake Option 2: Use mass points in Option 1, plus lake boundaries from the 1:20,000 base data. The lake boundaries will be coded with their elevation and added to the DEM data as a 'hard' feature, ensuring that any points within the lake are replaced with the lake surface.

Lake Option 3: Use mass points in Option 1, plus lake boundaries from the various vegetation layers. The lake boundaries will be extracted from the AVI and Phase 3 data, coded with their elevation (obtained from the 1:20,000 base data or NTS mapsheets) and added to the DEM data as a 'hard' feature, ensuring that any points within the lake are replaced with the lake surface.

The choice of which option to choose depends on how the data will be used.

Option 1 would be appropriate if it is not important that lake shorelines be perfectly represented in the digital elevation model. Remember that it will take some exploratory analysis to determine if the mass points are appropriate for representing lake boundaries. The data is still appropriate for summarizing area by slope class, and where mapping or analysis would not occur at scales

larger than 1:50,000. For higher level area summaries (township, compartment or higher administrative units), the error in matching boundaries would likely not be significant.

Option 2 is appropriate if the current base map lakes are not 'hard' features in the DEM and the Foothills Forest wants the slope coverage to be compatible with the base map lakes.

If the slope data is to be used for operational and larger scale (1:15,000 - 1:20,000) issues, the best product will result from implementing Option 3. At these larger scales, discrepancies between the lake boundaries identified in the DEM, and lake boundaries in the forest cover layer will be quite evident.

3.2.2 Quality Control

The TIN must be examined for several problems which may indicate data anomalies:

- sinks, or holes in the TIN (usually a data error),
- sudden peaks (usually a data error),
- flat triangles (may be errors, or may be plateaus or lakes), and,
- long, narrow sliver polygons (may be valid or may occur along an artificial boundary such as a mapsheet border).

Problem areas can be identified by visually examining draft line drawings showing the surface and related hydrologic features. In addition, the Arc/Info TINERRORS procedure will be used to find any flat triangles. Other Arc/Info procedures such as TINLINES and TINSHADES (for example) will also be used to visually identify potential problem areas. When problem areas have been identified, they will be visually checked against existing data (hydrologic layers, NTS maps, etc.) to determine if corrections are necessary to the TIN data. All errors will be fixed and the TIN regenerated. Potential errors noted along mapsheet borders will be deferred until the mapsheets are edgematched. While some edge polygons may appear to be errors when viewed independently, they may be reconciled once the adjoining mapsheet is completed. Further error examination will occur in step 3.2.4.

3.2.3 Generate Slope Polygons

The Arc/Info command TINARC will be used to convert the TIN to polygons. The resulting coverage will contain attributes describing the slope, aspect and surface area of the triangle in square meters. The surface area is the equivalent 3-dimensional area, which will be equal to or larger than the 2-dimensional area of the triangle.

3.2.4 Reclassify Slope

Slope percents generated from step 3.2.3 will be reclassified into the desired classes. An additional attribute, FF_SLOPE will be added to the *.pat* file and coded according to the table below:

FF_SLOPE	Percent Slope
2	slope <= 2%
5	2 < slope <= 5%
9	5 < slope <= 9%
15	9 < slope <= 15%
30	15 < slope <= 30%
45	30 < slope <= 45%
60	45 < slope <= 60%
999	slope > 60%

At the end of this step, the resulting slope coverage will have the following Arc/Info data fields:

Field Name	Input Width	Output Width	Type	No. Decimals	Units
AREA (2-dimensional)	4	12	F	3	sq. m.
PERIMETER	4	12	F	3	m
SLOPE#	4	5	B		-
SLOPE-ID	4	5	B		-
PERCENT_SLOPE	4	12	F	3	percent
ASPECT	4	12	F	3	azimuth degrees
SURFACE_AREA (3-D)	4	12	F	3	sq. m.
FF_SLOPE	4	5	B		max percent

3.2.5 Edgematch Slope Coverages

After all the mapsheets have a corresponding slope polygon coverage, they will be joined into one large coverage for the Foothills Forest. Edgematching involves joining neighbouring maps and ensuring compatibility of both the spatial features (lines and nodes matching) and the attributes (slope percent classes). Edgematching may assist in reconciling some of the very small sliver polygons that were created during the polygon creation. If not, they will be examined here for their validity and decisions made on a case by case basis with consultation with the Foothills Forest representative.

3.2.6 Dissolve Boundaries on Full Coverage

The mapsheet boundaries will be dissolved on the percent slope criteria, resulting in a single coverage of slope polygons for the extent of the Foothills Forest. As a final activity, the slope coverage can be clipped exactly to the Foothills Forest boundary if desired. Alternatively, the Foothills Forest boundary can be unioned (added to) the slope coverage along with an additional attribute added to the polygon attribute table to indicate if the polygon is inside or outside the Foothills Forest. The data outside the Foothills Forest boundary is still important for analytical purposes (particularly for hydrologic work), so it would be adviseable to retain as much slope information as possible.

4. Deliverables

4.1 Digital Products

All digital files will be provided in ***tar*** format on 8mm tapes:

4.1.1. digital files of the TINs produced in Arc/Info TIN format

4.1.2. digital coverage of the resulting polygon layer of slope percents classified to the criteria described in the Request for Proposals and in section 3.2.4. The polygon coverage *.pat* file will contain the items listed in section 3.2.4.

4.1.3. digital map files in Calcomp 68436 format ready for plotting on the Foothills Forest electrostatic plotter. The geographic extent of each map will be determined by mutual agreement at the time of map production.

4.1.4. digital map file in Calcomp 68436 format ready for plotting on the Foothills Forest electrostatic plotter. This single map will display the slope polygons for the entire Foothills Forest in one large map file. The electrostatic plotter will plot the image in a series of 36x24 sheets which can be pieced together to produce a large wall map.

4.2 Hardcopy Products

Hardcopy maps can be delivered from the digital map files described in section 4.1. However, some of the expense of plotting the maps can be saved by producing them on the Foothills Forest plotter. A separate cost for producing hardcopy products is indicated in section 5 and covers the following products:

4.2.1 approximately 11 maps at 1:50,000 on 48x36 inch paper. These would be based on UTM mapsheet boundaries (9 mapsheets per map).

5. Work Requirements and Cost

As described in section 3.2, our approach is to use the Foothills Forest GIS Lab equipment and software to reduce the cost to the Foothills Forest. The additional costs for The Forestry Corp. to do the work in-house is indicated in the tables below. Separate costs are also shown for providing hard copy maps if the Foothills Forest prefers to have these produced by the Forestry Corp.

There are 74 full UTM mapsheets in the Foothills Forest, and 15 partial mapsheets. For purposes of costing, we used the equivalent of 80 full mapsheet equivalents.

The summary table below indicates the total cost of producing digital and hardcopy products as requested by the Foothills Forest using the processes described in this proposal. Supporting tables itemizing individual tasks are included on the following pages.

As the hardcopy products are presented as options, a final, *total* cost is not presented. Costs for each of the hardcopy options are shown individually.

Total the summary for digital products (depending on the Lake Option), plus the in-house processing costs if the work cannot be done at the Foothills Forest, with the desired hardcopy option to approximate the total cost for all desired products.

	Lakes Option 1	Lakes Option 2	Lakes Option 3
Generate Slope Polygons (see Table 5.1)	9,500.	17,260.	20,260.
Assemble final coverage (see Table 5.2)	3,850.	3,850.	3,850.
TOTAL DIGITAL PRODUCTS	**$ 13,350.**	**$ 21,110.**	**$ 24,110.**
IN-HOUSE PROCESSING (from both Tables 5.1 and 5.2)	**$ 3,000.**	**$ 5,400.**	**$ 6,300.**

HARDCOPY OPTIONS:	**Plotted externally by Forestry Corp.**	**Plotted by Forestry Corp. using Foothills Forest equipment**
48"x36" 1:50,000, wall size format (approximately 11 sheets)	715.00	400.00

Note that all costs are GST exclusive.

Table 5.1 Generate Slope Polygons by UTM Mapsheet

Lake Option 1	No. hours	$/hour	Total Cost ($)
Extract Lakes	0	50.00	0.00
Attach Elevations	0	25.00	0.00
Generate TIN	0.50	50.00	25.00
Quality Control	1.00	62.50	62.50
Generate/Classify Polygons	0.50	62.50	31.25
Total per mapsheet	2.00		$ 118.75
TOTAL @80 full map equivalents			**$ 9,500.00**
In-house processing (80 sheets @ 1.75 hr/map)	140.00	15.00	$2,100.00

Lake Option 2	No. hours	$/hour	Total Cost ($)
Extract Lakes	0	50.00	0.00
Attach Elevations	1.00	25.00	25.00
Generate TIN	1.00	50.00	50.00
Quality Control	1.50	62.50	93.75
Generate/Classify Polygons	0.75	62.50	47.00
Total per mapsheet	4.25		$ 215.75
TOTAL @80 full map equivalents			**$ 17,260.00**
In-house processing (80 sheets @ 3.75 hr/map)	300.00	15.00	$4,500.00

Lake Option 3	No. hours	$/hour	Total Cost ($)
Extract Lakes	0.50	50.00	25.00
Attach Elevations	1.00	25.00	25.00
Generate TIN	1.25	50.00	62.50
Quality Control	1.50	62.50	93.75
Generate/Classify Polygons	0.75	62.50	47.00
Total per mapsheet	5.00		$ 253.25
TOTAL @80 full map equivalents			**$ 20,260.00**
In-house processing (80 sheets @ 4.5 hr/map)	360.00	15.00	$5,400.00

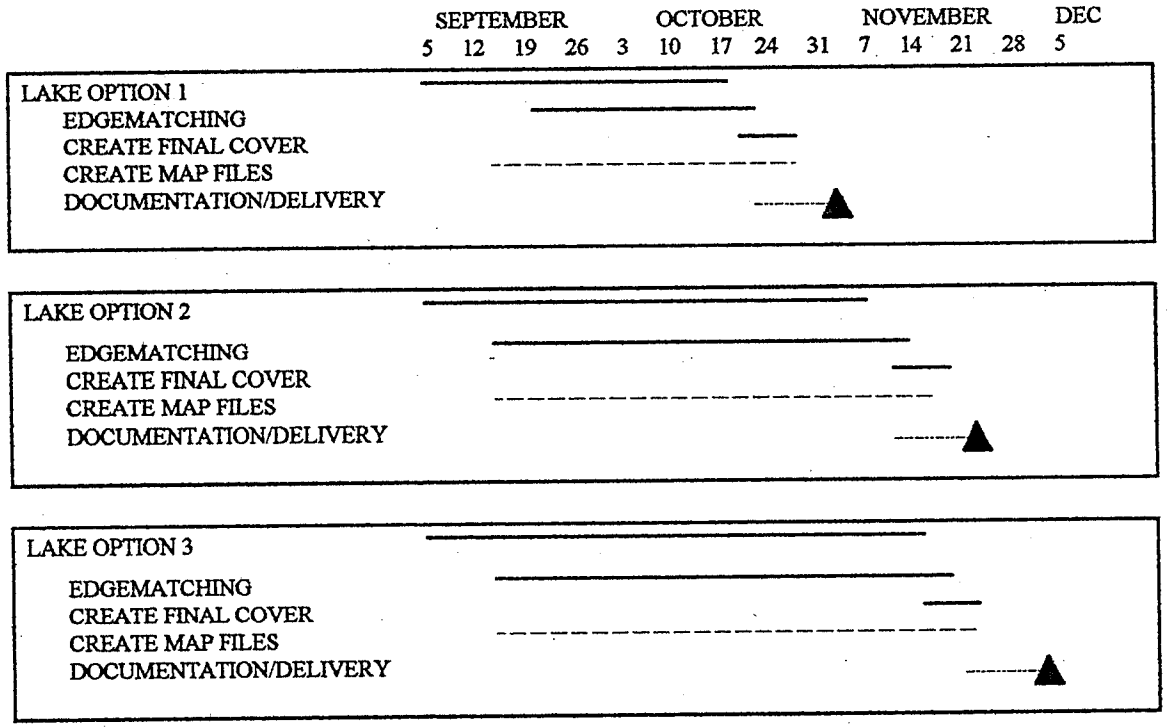
Table 5.2 Assemble Final Slope Coverage

Task	No. days	$/day	Cost	Total Cost
Edgematch all sheets	5.0	400.	$ 2000.	
	1.0	500.	500.	$ 2,500.
Dissolve mapsheet borders	0.5	400.	200.	200.
Create digital map files	1.0	500.	500.	
	0.5	400	200.	700.
Media Delivery &	0.5	500.	250.	
Documentation	0.5	400.	200.	450.
Total for all 80 Maps				**$ 3,850.**
In house processing cost	7.5	120		900.

6. Project Schedule

Three project schedules are shown below, indicating different time-lines for the option chosen for processing lake boundaries.

Delivery of final products can be achieved by October 31 for Option 1, November 14 for Option 2 and November 28 for Option 3.



7. Project Team

The Project Leader will be Brian Maier. Within The Forestry Corp., Brian is responsible for the development and implementation of information systems with an emphasis on geographic information systems. While employed at Weldwood of Canada, Brian was responsible for acquisition and processing of the existing digital elevation data being used by the Foothills Forest.

Brian has used this DEM to perform perspective view analyses in two separate projects for Weldwood of Canada. Views of the proposed McLeod 8 compartment harvest plan were produced for the Operations Group in late 1993. Recently, the DEM data was used to produce perspective views of selected cutblocks in Berland 4.

Assisting Brian will be Robert Held. Bob has a strong quantitative background and acquired GIS experience while employed at the Land and Forest Services, Forest Management Division. Any required data coding will done in-house by Elisha Cahoon, our Forest Technologist. Elisha is a recent Forest Technology School graduate and has solid experience in all aspects of mapping.

Detailed resumes of The Forestry Corp. and the project team members follow.

The Forestry Corp.

Company Capability

Capability

The Forestry Corp. is a forestry consulting company offering a variety of forest management services to industrial and government resource management agencies. Although the company is newly established, the company's consultants have a strong consulting background.

The company's senior consultants have extensive experience in quantitative forest management, including inventory design, forest inventory, timber supply analysis and growth and yield program development. The consultants also have experience developing and preparing management plans having prepared plans for several companies including Weyerhaeuser Canada Ltd. and Sunpine Forest Products. Additionally, the consultants have helped develop and implement pre-harvest site assessment programs for silvicultural planning for several clients. The Forestry Corp. can provide clients with complete forest inventory and GIS services. Inventory design, analysis, photo-interpretation, digital loading and geographic information system application development is conducted by Forestry Corp. staff. Competitively priced field services can be offered through association with other consultants.

The senior consultants presently with The Forestry Corp. have extensive experience in quantitative forestry, ecology, inventory and other aspects of forest management.

Neil Stevens has worked in forestry consulting for over seven years, including three years as the manager of W.R. Dempster & Associates. He has been responsible for management on a wide variety of projects, including multi-year projects involving AVI and GIS work. Neil has conducted timber supply and yield analyses for many of the industrial forest companies in Alberta including Daishowa-Marubeni International Ltd., Canadian Forest Products Ltd, Weyerhaeuser Canada Ltd. and Weldwood of Canada Ltd. He has extensive experience providing liaison between industrial clients and provincial resource management agencies.

As a consultant with W.R. Dempster & Associates, Olenka Bakowsky was responsible for coordination and implementation of studies in forest ecology and growth and yield. Olenka's strong background in ecology and forest mensuration is an unique and valuable asset to inventory and pre-harvest site assessment projects. Prior to becoming a forestry consultant she worked for Timber Management, Research and Reforestation Branches of the Forest Service. Her varied work history has provided the opportunity to work extensively with provincial government staff.

Dean Patterson is a highly qualified and respected photo-interpreter. He has over 12 years of experience in remote sensing having worked for Alberta Forestry, Lands and Wildlife, Forestry Canada and for several consultants. Dean has been responsible for project coordination and quality control on several large Alberta

Vegetation Inventory projects. He is experienced with many remote sensing applications including the use of satellite imagery as well as aerial photography.

Brian Maier is responsible for the development and implementation of information systems with an emphasis on geographic information systems. Brian was previously with Weldwood of Canada Limited where he was responsible for management of the GIS system, development of relational data models and ARC/INFO GIS applications. His expertise in the GIS field is complemented by a very strong background in quantitative forest management, inventory, and growth and yield. Prior to joining Weldwood Brian was with the Timber Management and Research Branches of Land and Forest Services.

Robert Held has recently joined The Forestry Corp. He was previously employed by the Land and Forest Services, Forest Management Division where he was responsible for collection of mensurational data, analysis and development of volume and yield relationships. He has over 14 years of experience with the Forest Services at various field and management levels.

Typical Projects

The Forestry Corp. has conducted work on a variety of projects during 1993 and 1994 as indicated in the following summary.

1993	Prepared a Preliminary Management Plan for Sunpine Forest Products Ltd. The plan which addressed both timber and non-timber resource values was largely written and prepared by The Forestry Corp. Liaison with provincial officials as part of the approval process was also conducted by The Forestry Corp. staff.
1993	Prepared the current Detailed Management Plan for Weyerhaeuser Canada Ltd. (Slave Lake).
1993	Developed a strategy for forecasting the growth and yield of regenerated stands for the Land and Forest Services. The strategy addressed both inventory and modelling issues in the short and long term. An approach for integrating regeneration survey data with individual tree models was proposed.
1993	Analysed pre-harvest site assessment data for Canadian Forest Products Ltd. and developed silvicultural prescriptions based on the ecological classification.
1993	Conducted AVI for various clients including Sunpine Forest Products Ltd. and the Province of Alberta.
1993/94	As part of an ongoing project, a program to facilitate field data entry of PSP data on hand held data recorders is being developed. The project includes facilities for data verification, editing and upload/download from PCs.
1993/94	Conducted a vegetation and productivity assessment for potential industrial development in the Eastern Slopes. The project involved volume sampling, as well as stem analysis. AVI was conducted on the area and was digitally loaded.
1993	Compiled operational cruise data for Sunpine Forest Products Ltd. and developed tree and log profiles based on the inventory data.
1993/94	Evaluated regeneration survey data for Canadian Forest Products Ltd. in terms of its' bearing on regenerated yield. Summaries of the data were produced and potential relationship to treatment were examined.
1993	Developed a PSP data entry program for Weldwood of Canada Limited.
1993	Interpreted and classified coniferous understorey as a participant in a research project initiated by the Canadian Forest Service.

1993	Based on Land and Forest Service management plans and AFORISM data, the incidental volume not explicitly accounted for in AAC calculations was estimated.
1993/94	As an ongoing project, GIS maintenance services are being provided to Weldwood of Canada Limited.
1994	Developed a GIS application for land disposition management for Weldwood of Canada Limited.
1994	Developed a detailed data model for the Foothills Model Forest.

Staff of The Forestry Corp. have conducted work on numerous other projects some of which are described in individual staff resumes contained in Appendix 1.

Current Clients

Canadian Forest Products Ltd.

Weyerhaeuser Canada Ltd., Drayton Valley and Slave Lake

Weldwood of Canada Limited., Hinton Division

Sunpine Forest Products Ltd.

Cardinal River Coals Ltd.

Land and Forest Services, Alberta Environmental Protection.

Daishowa-Marubeni International Ltd.

Canadian Forest Service

Foothills Model Forest

1986 to 1988	**Forester, Forest Measurement Section, Alberta Forest Service** Coordinated all programs related to forest mensuration including permanent sample plot program, stem analysis program and detailed cruise analysis as well as ad hoc projects. Designed and maintained PSP database and PC-based cruise compilation program. Designed forest inventory specifications for the White Area Inventory, which provided the framework for the current Alberta Vegetation Inventory.
1986	**Forester, W. R. Dempster & Associates.** Developed and implemented a harvest scheduling tool using yield projection curves and area volume check procedures. Designed and implemented PC based cruise compilation system and several forest sampling procedures. Developed log profile analysis programs to determine log distribution form cruise-based data. Completed a research project on regeneration performance on disturbed lands to provide the basis for setting standards.
1984-1986	**Research Assistant, University of Alberta** Responsible for statistical analysis of several research projects and coordinated the start of the forest industry/government/university group now known as WESBOGY.
1983-1984	**Forester, Forest Measurement Section, Alberta Forest Service** Conducted statistical analysis of forest measurement data for Phase 3 Forest Inventory Cover Type Volume Tables. Contributed to the National Biomass Inventory.

Typical Recent Projects

1994	Developed a GIS application for land disposition management for Weldwood of Canada Limited.
1994	Developed a detailed data model for the Foothills Model Forest.
1992	Designed, developed and implemented a GIS based operational harvest plan application
1991	Supervised development of Alberta version of Stand Projection System, a managed stand yield table projection program from the US.
1988	Developed PC-based cruise compilation system for the Alberta Forest Service.
1988	Designed forest inventory specifications for the White Area Inventory (precursor to the present Alberta Vegetation Inventory).

Resume

Brian Maier

Senior Consultant

Academic and Professional Qualifications

Bachelor of Science in Forestry, 1983, University of Alberta
Member of the Alberta Registered Professional Foresters Association.

Employment

1993 to Date — **Senior Consultant, The Forestry Corp.**
Concentrating in database design, implementation and application development with a focus on geographic information systems.

1991 to 1993 — **Resource Information Coordinator, Weldwood of Canada Limited.**
Coordinated, developed and implemented information systems for forest management with an emphasis on geographic information systems. Developed and implemented a strategic plan for implementing GIS at the desk-top level. Responsibilities included development and maintenance of a relational data model for forestry information needs (Oracle and RBase) and design and maintenance of user-friendly GIS applications (Arc/Info). Duties also included management of UNIX based workstations and X terminals.

1988 to 1991 — **Manager, Forest Growth and Yield, Research Branch, Alberta Forest Service.**
Worked with Timber Management and Reforestation Branches to develop a strategy for meeting growth and yield needs of the Forest Service. Managed the Stand Dynamics research program which assessed regenerated stand performance. Supervised development of Alberta version of the Stand Projection System, a managed stand yield table projection program from US. Northwest.

1989 to 1991 — **Acting Director, Research Branch, Alberta Forest Service**
Responsible for management of the Research Branch including supervision of professional staff. Determined and documented forestry research priorities for the province, under the auspices of the Alberta Forest Research Advisory Committee. Managed the Alberta Forest Development Trust Fund, including review of proposals, forwarding recommendations of the Trust Fund Committee to the Minister and producing an annual report.

The Forestry Corp

Resume

Robert J. Held

Senior Consultant

Academic and Professional Qualifications

Bachelor of Science in Forestry. 1991 University of Alberta

Forest Technology Diploma. 1982 Northern Alberta Institute of Technology

Employment

1994 to Date:	Senior Consultant, The Forestry Corp.
	Responsible for timber supply analysis, quantitative analysis,
1991 - 1994	Forester, Resource Analysis and Forest Measurements Sections, Land and Forest Services
	Development of localized volume tables and yield tables for Phase 3 and AVI inventories, timber supply analysis. Coordination of volume sampling programs under contract and inhouse. Management and compilation of temporary and permanent sample plot data in mainframe and personal computer environments. Coordination of specialized personal computer based software for data input, editting, compilation and reporting. Coordination of computer hardware and software aquisition.
1988 - 1991	Enrolled in B.Sc. For. program. Employed as a Sector Boss for supervision of firefighting crews.
1986 - 1988	Forest Officer II Fox Creek Ranger District Whitecourt Forest
	Review and approval of Annual Operation Plans, inspection of forest harvesting operations, overseeing scarification and planting contracts, supervisor of Initial Attack and fire fighting crews, supervision of recreation crew. Inspection of oil and gas related activities.
1982 - 1986	Forest Officer I and Forestry Aide, Timber Management, Whitecourt Forest
	Planning, layout of cruise and regeneration survey programs, supervision of crews, and completion of final costs and reports. Supervison of scarification projects and assist in planting contract checks.

Typical Recent Projects

1993/94	Layout design, and coordination of volume sampling program, within 5 forest management units in the Grande Prairie Area.
1992/93	Development of localized volume tables and yield tables in the High Level, High Prairie and Slave Lake areas.
1992/93	Oversaw development of a cruise compilation program to be used by LFS field staff, in completion of cruise reports and appraisal summaries.
1991	Development of PC based cruise compilation program to create covertype/strata level volume tables.

Resume

Elisha Cahoon

Forest Technologist

Academic and Professional Qualifications

Diploma in Forest Technology. 1994 Northern Alberta Institute of Technology

Two years in Science 1989-1991 University of Calgary

Employment

1994 to Date:	**Forest Technologist, The Forestry Corp.** Plot allocation, AVI stratification, field sampling, transferring polygon boundaries, drafting, sketch mapping.
1993:	**Aerial Observer, Alberta Environmental Protection, Edson** Relief towerperson, drafting, fire costing, photo mosaics, data entry.

Typical Recent Projects

1994	Fire origin mapping using 1:60,000 photography for approximately 60 townships in the Rocky Mountain Forest region.
1994	Plot allocation and setup for Regenerated Yield Surveys onto various scales of photography.
1994	Volume plot allocation onto Phase 3 maps.
1994	Initial stratification and fieldwork for AVI interpretation.
1993	Acquisition of 35mm for the construction of photo mosaics for the Urban Wildlife Interface project.
1993	Construction and final drafting of the 35mm photo mosaics for the Urban Wildlife Interface project.