Predictive Ecosystem Mapping
Report 2000

FRBC 712553-3075

Prepared for

Larry Henry, RPF
Nicola-Similkameen Innovative Forestry Society
Merritt, B.C.

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J.S. Thrower & Associates Ltd. *Consulting Foresters*
Vancouver – Kamloops, B.C.

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1. INTRODUCTION

1.1 BACKGROUND

In July 1997 five major licensees; Weyerhaeuser Company Ltd., Tolko Industries Ltd., Aspen Planers Ltd., Ardew Wood Products Ltd., and Riverside Forest Products Ltd.; the Nicola Tribal Association (NTA), the Upper Similkameen Indian Band, and the Merritt Forest District Small Business Forest Enterprise Program (SBFEP) presented a written proposal to the Forest Minister requesting Innovative Forestry Practices Agreements (IFPAs) for the Merritt TSA. Their proposal was approved in November 1998. IFPAs encourage holders to practice innovative forest management in return for corresponding gains in Allowable Annual Cut (AAC) as outlined in Section 59.1 (7) of the Forest Act.

To facilitate the implementation of the approved IFPAs, the five licensees, the NTA, the Upper Similkameen Indian Band, and the Merritt SBFEP formed the Nicola-Similkameen Innovative Forestry Society (NSIFS). The NSIFS is responsible for implementing this innovative forestry program for the Merritt TSA.

Forestry Plan #1 for the Merritt IFPAs was submitted to the Ministry of Forests (MOF) in July 2000 and approved by the Regional Manager in January 2001. In Forestry Plan #1, the NSIFS committed to a co-operative approach with the MOF to develop a Predictive Ecosystem Mapping (PEM) approach to ecological mapping to reduce costs and time periods associated with traditional Terrestrial Ecosystem Mapping (TEM) mapping.

The ecosystem is the fundamental unit of resource management in B.C. Ecosystem maps are integrated planning tools that provide the location and distribution of ecosystems within a management unit. Predictive Ecosystem Mapping (PEM) is a cost-effective alternative to the original TEM, and is a method of predicting ecosystem occurrence on the landscape given basic inventory information and expert knowledge. Details on the history of the PEM project for the Merritt TSA are outlined in "Predictive Ecosystem Mapping (PEM) in the Merritt Forest District".[1]

1.2 PROJECT OBJECTIVE

This report outlines and summarizes the activities that occurred in fiscal year 2000 PEM processing contract. The objective of this project was to work with the NSIFS ecological consultant (Oikos Ecological Services Ltd.) to complete the production of 43 (1:20,000 BCGS) PEM Maps in the Merritt Timber Supply Area (TSA). The consultant ecologist was responsible for the production of the ecological knowledge bases (KBs) whereas J.S. Thrower & Associates Ltd. (JST) was responsible for the GIS processing used in the PEM modeling process. For

[1] Keystone Wildlife Research. 2000. Predictive Ecosystem Mapping in the Merritt Forest District Documentation Report. Unpublished. November 2000.

further details regarding the PEM process refer to documentation prepared by Keystone Wildlife Research for the NSIFS.[1]

1.3 STANDARDS

Over the past two years standards for PEM have evolved. Standards documents were still being written when the Merritt PEM project started. This contract (712553-3075), between the NSIFS and JST states explicitly what the deliverables for the 2000 fiscal year will be:

1. 43 - GIS PEM resultant coverages (on a compact disc)
2. 43 - GIS PEM thematic hard copy maps

It should be noted that Standards Agreements for the Merritt IFPA PEM project had not been received prior to March 19, 2001 when the final GIS processing was undertaken to meet the final contract deliverables.

1.4 AGENCY LIAISON

In order to meet the NSIFS objective of a co-operative approach to develop the Merritt PEM two workshops were held at critical junctions along the PEM process:

1. February 12, 2000 Workshop
2. November 2, 2000 Workshop

These workshops were provided as a venue for JST, Oikos, Keystone, and both agencies (MOF and MOELP) review the project and confirm the next steps. This included processes, data handling, PEM attribute legend development, and the production of the final products.

2. METHODS

The production of PEM is a complicated procedure involving a series of analytical methods ranging from preprocessing GIS maps, to KB creation, running EcoNGen, and to post-processing maps (Appendix I). The mapsheets completed represent every subzone but one[2] found in the Merritt TSA. The primary focus of the project was on the forested subzones as they were deemed to be of primary importance for forestry and wildlife interpretations of the PEM. Therefore, the KBs for the forested subzones were revised several times. Because of project scheduling and budgets the ecologists had less opportunity to revise the KBs for the non-forested subzones. The PEM processing completed during this contract included the following activities (Appendix I)[1]:

- GIS dataset preparation

[2] The Atp(TP) did not occur on the completed mapsheets.

- Ecological KB formatting
- PEM Attribute Legend
- EcoNGen processing
- PEM resultant database creation
- Final PEM entity themed maps

2.1 GIS DATASET PRODUCTION

Several GIS datasets were available to be used in the PEM production. These included:

- Forest cover (Source MOF)
- TRIM (Source MOELP)
- Bio-terrain (Source NSIFS)

It was determined in the PEM workshops (Section 1.4) that the bio-terrain data set provided the best base for PEM. This data is tied to the TRIM base so that features would not be duplicated during the mapping process. Attribute data from TRIM (i.e. slope, aspect, and elevation classes), and forest cover (i.e. open range and species information) were used to improve the ecologists ability to predict PEM entities (site series or TEM ecosystem units) (Appendix II). In order to add these attributes and lines to the bio-terrain, GIS processing routines were used. The results of this GIS analysis was a dataset that was unloaded from the GIS and fed into EcoNGen (see Section 2.3).

2.2 ECOLOGICAL KNOWLEDGE BASE FORMATTING

Once the KBs were received from the project ecologists, they had to be prepared for EcoNGen. JST consolidated each of the 25 KBs into a single access database. Consistency and error checking was conducted during this process to ensure that the KBs used in the model run produced the expected results. JST worked closely with Oikos to ensure the quality and consistency of the KBs used in this project. The KBs used included:

- CWHms1
- ESSFdc2
- ESSFww
- ESSFxc
- IDFdk1
- IDFdk2
- IDFxh1
- IDFxh2
- MHmm2
- MSdm2
- Msunk
- MSxk
- ATp(cm)
- ATp(tp)
- ESSFdcp
- ESSFmwp
- ESSFxcp
- BGxh1
- BGxw1
- IDFdk1a
- IDFdk1b
- IDFxh1a
- IDFxh1b
- IDFxh2a
- PPxh2

2.3 PEM ATTRIBUTE LEGEND

At the November PEM workshop work began on the development of the PEM attribute legend. This legend content was outlined at the workshop by all parties and completed by Oikos and JST (Appendix II).

2.4 ECONGEN PROCESSING

EcoNGen is part of the PEM application software created by the B.C. MOF. Utilizing KBs developed by ecologists and various types of GIS inventory data EcoNGen produces ecological predictions. The EcoNGen modeling software uses as inputs the GIS resultant attribute database produced in Section 2.1 and the ecological KBs in Section 2.2. The result of this model processing was a ecological prediction for each polygon processed. Initially the MOF were to run this program but due to budget constraints the MOF provided JST a copy of the software for use on this project.

2.5 PEM RESULTANT DATABASE CREATION

EcoNGen attribute predictions for each polygon had to be post-processed in order to be re-attached to the original GIS resultant data set. Once this step was completed, a final GIS post-processing routine was run to hard code polygons based on a number of forest cover attribute codes. As a final step to aid in the creation of wildlife themed maps, the PEM resultant database was intersected with the structural stage database. The structural stage attributes were created in a separate project completed in 2000 by EcoConcepts (Carol Thompson)[3].

2.6 FINAL PEM THEMED MAPS

The final PEM resultant polygons were dissolved based on 'site series' and categorized based on moisture regimes to allow for more efficient production of a useable hardcopy map product. The resultant database was dissolved on the PEM entity attribute to reduce the number of polygons to be mapped.

A consistent themed map product was created to allow for the display of PEM entity groups for all subzones and mapsheets completed. These maps grouped ecosystems into the following categories (Appendix III)[4]:

- Very Dry
- Dry
- Slightly Dry
- Fresh

[3] Structural Stage Algorithm for the Merritt TSA, by Eco-Concepts Ecological Services Ltd., January 2, 2001.

- Moist
- Wet
- Wetlands
- Grasslands
- Alpine
- Rock
- Gravelbar/gravel pit/cultivated/claybank/urban/hayfield/meadow
- Lakes/rivers

Each category was represented by a unique colour on a map. Forty-three (1:20,000 BCGS) hardcopy maps were produced covering all 25 subzones in the Merritt TSA.

3. DELIVERABLES

The deliverables submitted at the conclusion of this project include:

1) GIS PEM resultant database coverage.
2) PEM entity hardcopy map.
3) Overview composite map.

Each deliverable was produced for each of the 43 mapsheets listed below:

- 092H027
- 092H028
- 092H036
- 092H040
- 092H045
- 092H046
- 092H048
- 092H049
- 092H050
- 092H056
- 092H057
- 092H059
- 092H060
- 092H065
- 092H066
- 092H067
- 092H068
- 092H069
- 092H070
- 092H075
- 092H076
- 092H077
- 092H078
- 092H079
- 092H080
- 092H086
- 092H087
- 092H088
- 092H089
- 092H090
- 092H096
- 092H097
- 092H098
- 092H099
- 092H100
- 092I014
- 092I015
- 092I017
- 092I018
- 092I034
- 092I035
- 092E041
- 092E051

4. CONCLUSION

With the delivery of fiscal year 2000 final products, a successful PEM program was concluded for a significant portion of the Merritt TSA. Forty-three mapsheets covering nearly half of the Merritt TSA landbase (approximately 600,000 ha) have been completed.

[4] Personal contact with representatives from both Keystone Wildlife Research and Oikos Ecological Services to help construct the PEM thematic map (March 2000).

Due to the dynamic nature of the PEM product, value can continually be added to both the GIS resultant database and the ecological KBs as new techniques and data become available. With this in mind, PEM will be a continually improving product. With PEM improvements will come the increased validity and reliability of the various interpretations of PEM.

APPENDIX I – PEM DATA FLOW DIAGRAM

APPENDIX II – PEM ATTIBUTE LEGEND

Merritt IFPA PEM attributes are based upon PEM attributes submitted by Keystone Wildlife Research and modified to reflect the attributes that were used for the Merritt PEM project. Note that all the attributes are available, but this legend reflects only those that were used during the project. This legend has been evolving as the project progresses under the guidance of the ecologists.

A. BIOTERRAIN ATTRIBUTES

(1) TERRAIN SYMBOLS

Simple Terrain Units: e.g., texture ----> gFt - J <---- process
surficial material ____/ ____ surface expression

Note: Two or three letters may be used to describe any characteristic other than surficial material, or letters may be omitted if information is lacking.

Composite Units: Two or three groups of letters are used to indicate that two or three kinds of terrain are present within a map unit. The decile, a superscript, immediately preceeds the component described.

e.g., ^{5}Mb^{5}Rh· indicates that "Mb" and "Rh" each occupy about 50% of the terrain unit area

^{6}Mb^{3}Rh^{1}Cv indicates that the unit consists of 60% Mb, 30% rock, and 10% colluvium

Stratigraphic Units: Groups of letters are arranged one above the other where one or more kinds of surficial material overlie a different material or bedrock:

e.g., Mv indicates that "Mv" overlies "Rr".
Rr

Symbols for the following characteristics are placed beside or below the terrain symbols.

Soil Drainage: e.gs., w w-m w,i

Slope Steepness: e.gs., 3 3-5

Aspect: e.gs., h w-k

(2) MATERIALS

(Kb = Sm GIS = Surfm_1,Surfm_2,Surfm_3)

A	Anthropogenic materials	Artificial materials, and materials modified by human actions such that their original physical appearance and properties have been drastically altered.
C	Colluvium	Products of gravitational slope movements; materials derived from local bedrock and major deposits derived from drift; includes talus and landslide deposits.
D	Weathered bedrock	Bedrock modified *in situ* by mechanical and chemical weathering.
E	Eolian sediments	Sand and silt transported and deposited by wind; includes loess.
F	Fluvial materials	Sands and gravels transported and deposited by streams and rivers ; floodplains, terraces and alluvial fans.
FA	"Active" fluvial materials	Active deposition zone on modern floodplains and fans; active channel zone.
FG	Glaciofluvial materials	Sands and gravels transported and deposited by meltwater streams; includes kames, eskers and outwash plains.
I	Ice	Permanent snow and ice; glaciers.
L	Lacustrine sediments	Fine sand, silt and clay deposited in lakes, and beach gravels and sand.
L1	Alkali lake beds	Dried-up or partly dry lakes where white efflorescence is visible on air photos.
LG	Glaciolacustrine sediments	Fine sand, silt and clay deposited in ice-dammed lakes, and beach gravels and sand.
M	Till	Material deposited by glaciers without modification by flowing water. Typically consists of a mixture of pebbles, cobbles and boulders in a matrix of sand, silt and clay. Chiefly basal till, but may include small areas of ablation till.
M1	Ablation till	Material melted out on top of glacier ice. Contains less silt and clay and less dense than basal till.
O	Organic materials	Material resulting from the accumulation of decaying vegetative matter; includes peat and organic soils.
R	Bedrock	Outcrops, and bedrock within a few centimetres of the surface.
U	Undifferentiated materials	Different surficial materials in such close proximity that they cannot be separated at the scale of the mapping.
V	Volcanic materials	Unconsolidated pyroclastic sediments.
N	No surficial materials	Generally Non-productive types (eg. Lakes, rivers, Rock.

(3) SURFACE EXPRESSION

(Kb = Se, Se2 GIS = SURF_1A, SURF_2A, SURF_3A, SURF_E1B, SURF_E2B, SURF_E3B)

a	moderate slope(s)	Predominantly planar slopes; 15-26^{O} (27-49%).
b	Blanket	material >1-2m thick with topography derived from underlying bedrock (which may not be mapped) or surficial material.
c	Cone	a fan-shaped surface that is a sector of a cone; slopes 15^{O} (27%) and steeper.
d	Depression	enclosed depressions.
f	Fan	a fan-shaped surface that is a sector of a cone; slopes 3-15^{O} (5-27%).
h	hummocky	steep-sided hillocks and hollows; many slopes >15^{O} (27%).
j	gentle slope(s)	predominantly planar slopes; 3-15^{O} (5-27%).
k	moderately steep slope	predominantly planar slopes; 26-35^{O} (49-70%).
m	rolling topography	linear rises and depressions; <15^{O} (27%).
p	Plain	0-3^{O} (0-5%).
r	Ridges	linear rises and depressions with many slopes >15^{O} (27%)r.
s	steep slope(s)	slopes steeper than 35^{O} (70%).
t	terrace(s)	stepped topography and benchlands.
u	undulating topography	hillocks and hollows; slopes predominantly <15^{O} (27%).
v	Veneer	material <1-2m thick with topography derived from underlying bedrock (may not be mapped) or surficial material; may include outcrops of underlying material.
w	mantle of variable thickness	material of variable thickness infilling depressions in an irregular substrate (rock or surficial material).
x	thin veneer	a thin veneer, where material is predominantly 10-25 centimeters thick.

(4) GEOLOGICAL PROCESSES AND MASS MOVEMENT SUB-CLASSES

(Kb = Gp GIS = Geop_1, Geop_2, Geop_3)

A	Avalanches	Slopes modified by frequent snow avalanches.
Af	Avalanches: major tracks	In zones of coniferous forest: broad avalanche track(s) occupied by predominantly shrubby, deciduous vegetation.
Am	Avalanches: minor tracks	Similar to above, but generally narrower than the height of adjacent trees.
Aw	Avalanches: mixed	Includes both major and minor avalanche tracks.
Ao	Avalanches: old tracks	Clearly visible on air photos, but less well defined than active tracks because they are partly or completely occupied by young conifers.
B	Braiding channel	Channel zone with many diverging and rejoining channels; channels are laterally unstable.
C	Cryoturbation	Heaving and churning of soil and surficial materials due to frost action.
D	Deflation	Removal of sand and silt particles by wind action.
E	Glacial meltwater channels	Areas crossed by meltwater channels that are too small or too numerous to map individually.
F	Failing	Slope experiencing slow mass movement, such as sliding or slumping.
H	Kettled	Area includes numerous small depressions and/or ìakes where buried blocks of ice melted.
I	Irregularly sinuous channel	Channel displays irregular turns and bends.
J	Anastamosing channel	Channels diverge and converge around semi-permanent islands.
K	Karst processes	Solution of carbonates (limestone, dolomite) resulting in development of collapse and subsidence features.
L	Surface seepage	Abundant seepage.
M	Meandering channel	Channel characterized by regular turns and bends.
N	Nivation	Surface modified by hollows developed around semi-permanent snowbanks.
P	Piping	Subsurface erosion of silty sediments by flowing water resulting in the formation of underground conduits.
R	Rapid mass movement	Slope affected by processes such as debris flows, debris slides, and rockfall.
S	Solifluction	Slope modified by slow downslope movement of seasonally frozen regolith.
U	Inundated	Areas submerged in standing water from a seasonally high watertable.
U1	Inundated due to beaver activity	Inundation or partial inundation resulting from the presence of beaver dams.

V	Gullying	Slope affected by gully erosion.
W	Washing	Winnowing of fines by flowing water resulting in development of lag deposits.
X	Permafrost processes	Processes related to the presence of permafrost and permafrost aggradation or degradation.
Z	Periglacial processes	Solifluction, nivation and cryoturbation occurring together in a single terrain polygon.

(5) SOIL DRAINAGE CLASSES

(Kb = D_1 or D_2 GIS = Drain_1 or Drain_2)

x	very rapidly drained	water is removed from the soil very rapidly in relation to supply
r	rapidly drained	water is removed from the soil rapidly in relation to supply
w	well drained	water is removed from the soil readily but not rapidly
m	moderately well drained	water is removed from the soil somewhat slowly in relation to supply
i	imperfectly drained	water is removed from the soil sufficiently slowly in relation to supply to keep the soil wet for a significant part of the growing season
p	poorly drained	water is removed so slowly in relation to supply that the soil remains wet for a comparatively large part of the time the soil is not frozen
v	very poorly drained	water is removed from the soil so slowly that the water table remains at or on the surface for the greater part of the time the soil is not frozen

Where two drainage classes are shown:
if the symbols are separated by a comma, e.g., “w,i”, then no intermediate state is present;
if the symbols are separated by a dash, e.g., "w-i", then all intermediate classes are present.

(6) SLOPE CLASSES

(Kb = S GIS = S)

Class	Slope %
1	0-10%
2	11-25%
3	26-45%
4	46-70%
5	>70%

(7) ASPECT CLASSES

(Kb = As GIS = AS)

Class	Description	Aspect Definition
k	Cold	285° to 60° (slope class is >2)
c	Cool	60° to 135° (slope class is >2)
h	Hot	135° to 240° (slope class is >2)
w	Warm	240° to 285° (slope class is >2)
n	Neutral	All aspects with slope class <3)

(8) CODES AND DESCRIPTIONS OF ECOLOGICAL SOIL GROUPS (ECOSOIL)

(KB = ECOSOIL GIS = ECOSOIL_1, ECOSOIL_2, ECOSOIL_3)

CODE	GROUP DESCRIPTIONS	Sm + Se
NOSOIL	very thin to non-soil	Ru, Rk, Rs, Rh, Rr, Rm Rw, Ra, Rj
VTCSOIL	very thin (<20cm) coarse soils	Dx, Cx
VTMFSOIL	very thin (<20cm) medium/fine soils	Mx
MDCSOIL	moderately deep (20-100cm), coarse soils	Cv, FGv, Dv,Fv
MDMSOIL	moderately deep (20-100cm), medium soils	Mv, Mw
MDFSOIL	moderately deep (20-100cm), fine soils	Lv,Ev, LGv
DCSOIL	deep (>100cm) coarse soils	Ch, Cf, Cu, Cb, Cj, Ca, Ck, Cc, Cs, Cw, FGp, FGr, FGt, FGk, FGa, FGu, FGs, FGw, FGf, FGj, FGm, Fj, Ft, Fu, Ua, Us, Uk
DCSSOIL	deep (>100cm), coarse soils with subsurface seepage	FAf, FAp, Fp, Ff
DMSOIL	deep (>100cm), medium soils	Mb, Mm, Mp, Mu, Mw, Ma, Mr, Mt, Mk, Mj, Ms
DFSOIL	deep (>100cm), finesoils	Lp, Eu, LGp, LGu
MDOSOIL	moderaely deep (20-100cm), organic soils	Ov
DOSOIL	deep (>100cm), organic soils	Op, Ob

1. Coarse Soils -S, LS; Medium soils - SL, L, SiL; Fine soils - Si and finer
2. Slope Se is not included
3. k table category is ECOSOILS
4. N = lake and water features and A = Urban road type features

(9) ELEVATION CLASSES

(Kb = E1 GIS = E1)

Elevation Class	Elevation (m)
1	< 1300
2	> 1299

(Kb = E2 GIS = E2)

Elevation Class	Elevation (m)
1	< 1600
2	> 1599

(Kb = E3 GIS = E3)

Elevation Class	Elevation (m)
1	< 1450
2	> 1449

(10) RIPARIAN AREAS
(Kb = CB and GIS = CB)

CB	**1**	Where a resultant polygon contains a portion of a 20 meter buffer along a single line stream and where the slope is less than 30 percent.

(11) ADJACENCY
The four types of adjacent polygons used in this project were derived from the Ministry of Forests EcoPrep Arc/Info .amls.

(Kb = ADJ1, ADJ2, ADJ3, ADJ4 and GIS = ADJ1, ADJ2, ADJ3, ADJ4)

Title	Description
ADJ1	**NP polygon adjacent to a (double line) stream**
ADJ2	**NP polygon adjacent to a wetland**
ADJ3	**NP polygon adjacent to a rock outcrop**
ADJ4	**NP polygon adjacent to an alpine polygon**

B. FOREST COVER ATTRIBUTES

(12) TREE SPECIES
(Kb = SP_S,SP_PL,SP_PY,SP_AC,SP_AT,SP_FD,SP_BL,SP_CW,SP_HW,SP_EP
GIS = SP_S,SP_PL,SP_PY,SP_AC,SP_AT,SP_FD,SP_BL,SP_CW,SP_HW,SP_EP)

If the area of the polygon is greater than or equal to 20 percent of the original bioterrain/slope/aspect resultant polygon where the species one, two or three are greater than 30 percent volume in the stand it is considered present (indicated by a 'Y'.

(13) TREE AGE CLASS

Age Class	Age (years)
1	1 – 20
2	21 – 40
3	41 – 60
4	61 – 80
5	81 – 100
6	101 – 120
7	121 – 140
8	141 – 250
9	251+

(Kb = AGEGRP GIS = AGEGRP

Age Group	Age Class
MAT = 1	5-9

(14) TREE HEIGHT CLASS

Height Class	Height (m)
1	0.1 to 10.4
2	10.5 to 19.4
3	19.5 to 28.4
4	28.5 to 37.4
5	37.5 to 46.4
6	46.5 to 55.4
7	55.5 to 64.4
8	64.5 +

(Kb = HTGRP GIS = HTGRP)

Height Group	Height Class
s = 1	1-2

(15) TREE CROWN CLOSURE CLASS

Crown Closure Class	Crown Closure Percent
0	0-5%
1	6-15%
2	16-25%
3	26-35%
4	36-45%
5	46-55%
6	56-65%
7	66-75%
8	76-85%
9	86-95%
10	96-100%

(Kb = CCGRP GIS = CCGRP)

CC Group	CC Class
1	1-2
2	3-4
3	5-6
4	7-10

(16) NON-PRODUCTIVE FOREST CODES
(Kb = NPDESC GIS = NPDESC)

FC-NP-Code	NPFDESC Used	Description
2	A	alpine
3	R	rock
6	G	gravel pit
10	Treated as normal	alpine forest with species
11	NPBR	non-productive brush
12	NP (without species) NP with species treated normally	non-productive forest (with or without species)
13	NPBU	non-productive burn
42	C	clearing
50	U	roads
54	U	urban
60	H	hayfield
62	M	meadow
63	OR	open range
35	SWAMP	swamp

Attributes Available in Bioterrain/Slope/Aspect Resultant Coverage

This is a full list of attributes from the bioterrain/slope/aspect resultant coverage. As the Knowledge Bases are being developed it is possible for more attributes to be used. This list will be periodically updated. Note the attributes currently being used are italicized.

Bioterrain Decile 1
TDEC_1 PRTFLG_1 TTEX_1A TTEX_1B TTEX_1C *SURFM_1* SURFM_Q1 SURFM_ST1 *SURF_E1A* *SURF_E1B* SURF_E1C BEDROCK_1 STTEX_1A STTEX_1B STTEX_1C SSM_1 SSURFM_Q1 SSURFM_ST1 SSURF_E1A SSURF_E1B SSURF_E1C

Bioterrain Decile 2
TDEC_2 PRTFLG_2 TTEX_2A TTEX_2B TTEX_2C *SURFM_2* SURFM_Q2 SURFM_ST2 *SURF_E2A* *SURF_E2B* SURF_E2C BEDROCK_2 STTEX_2A STTEX_2B STTEX_2C SSM_2 SSURFM_Q2 SSURFM_ST2 SSURF_E2A SSURF_E2B SSURF_E2C

Bioterrain Decile 3
TDEC_3 PRTFLG_3 TTEX_3A TTEX_3B TTEX_3C *SURFM_3* SURFM_Q3 SURFM_ST3 SURF_E3A *SURF_E3B* SURF_E3C BEDROCK_3 STTEX_3A STTEX_3B STTEX_3C SSM_3 SSURFM_Q3 SSURFM_ST3 *SURF_E3A* SSURF_E3B SSURF_E3C

Bioterrain *Geophysical Attributes*
GEOP_1 GEOP_Q1 GEOP_ST1 GEOP_SCM1A GEOP_SCM1B GEOP_SCM1C *GEOP_2* GEOP_Q2 GEOP_ST2 GEOP_SCM2A GEOP_SCM2B GEOP_SCM2C *GEOP_3* GEOP_Q3 GEOP_ST3 GEOP_SCM3A GEOP_SCM3B GEOP_SCM3C DRAIN_1 DRAIN_SEP1 *DRAIN_2* DRAIN_SEP2 DRAIN_3

Bioterrain Aspect/Slope Attributes
MEAN_ASP LOWREL_FLG POLY_COM ASP_CLS1 ASP_SEP1 ASP_CLS2 ASP_SEP2 ASP_CLS3 SLPC_1 SLPC_REL1 SLPC_2 SLPC_REL2 SLPC_3 RELIABILIT

Grouped Ecosoil Attributes
ECOSOIL_1 *ECOSOIL_2* *ECOSOIL_3*

BEC Zone Attributes
QBEC_TAG BECLABEL REF_NO *BGC* ZONE_SUBZONE

TRIM Aspect/Slope Attributes
SLOPE-CODE ASPECT-CODE *S* *AS*

Forest Cover Attributes
AGEGRP AGE_AREA *CCGRP* CC_AREA HTGRP HT_AREA *NPDESC* *SP_PY* *SP_S* *SP_AT* *SP_AC* *SP_PL* *SP_FD* *SP_BL* *SP_CW* *SP_HW* *SP_EP*

TRIM Elevation Attributes
ELEVATION *E1* *E2* *E3*

EcoPrep Adjacency Attributes
ADJ1 ADJ2 ADJ3 ADJ4

Creek Buffer Attributes
INSIDE *CB*

APPENDIX III – PEM ENTITY GROUPING LEGEND