

A Proposed Biophysical Approach to Visual Absorption Capability (VAC)¹

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Abstract: In British Columbia, visual analysis is in its formative stages and has only recently been accepted by Government as a resource component, notably within the Resource Analysis Branch, Ministry of Environment. Visual absorption capability (VAC), is an integral factor in visual resource assessment. VAC is examined by the author in the degree to which it relates to interdisciplinary biophysical assessments presently carried out by the Branch. Such assessments encompass the disciplines of soils, surficial geology, aquatics, vegetation, wildlife, outdoor recreation and climate. A conceptual framework for developing a proposed system of applying these data to an overall mapping system for visual absorption capability in the Province is set forth and a sample case study selected for pilot study purposes.

INTRODUCTION

This paper concerns itself with the development of a proposed methodology for developing visual absorption capability assessments, using the biophysical land classification system as presently carried out within the Resource Analysis Branch in British Columbia. Current biophysical terminology is briefly examined, followed by VAC terminology and design factors. Relationships existing between the two are then explored. A proposed system of application, using an interdisciplinary team approach in relating biophysical ratings to the VAC assessment, is set forth. A case study is

then hypothesized. This is followed by a summary of how the system could be applied in British Columbia as the Province moves towards a greater recognition of the visual resource as needful of evaluation, not only in the preliminary mapping stages, but the degree to which it must be considered at any final environmental impact level.

BIOPHYSICAL LAND CLASSIFICATION AND THE RESOURCE ANALYSIS BRANCH

The biophysical classification program is a building block process that encourages the integration of physical and biological data (landforms, surficial materials, soils, climate, vegetation and organisms) to form "ecologically significant" units of the landscape. The process involves the delineation of various terrain, aquatics and climatic phenomena, each of which is an end point for the appropriate discipline, but, when combined, provides the basis of the biophysical map unit (Smith 1969).

^{1/}Submitted to the National Conference on Applied Techniques for Analysis and Management of the Visual Resource, Incline Village, Nevada, April 23-25, 1979.

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Biophysical mapping is initially based on air-photo interpretation where visually different units of land are identified and differentiated. These landscapes, due to differences in landform and vegetation pattern (texture, in visual terms) are the basis for depicting biophysical units. As such, biophysical units are also significant to visual management, since visually significant features and biophysically significant characteristics are often similar.

Biophysical inventories within the Branch are generally conducted at a reconnaissance level (1:50 000 base) with more detailed inventories carried out only where high values for more than one resource prevail or when intensive management is justified. This scale appears to be suitable for most VAC assessments as well.

The analysis of biophysical data can be complex or simple; it can range from manual overlay mapping, to sophisticated computer technology. Similarly, visual absorption capability data can be evaluated at any degree of simplification or complexity (Benson 1978). Basic to the system are the following components - all represented within the Branch:

Subject Areas of Biophysical Base Maps

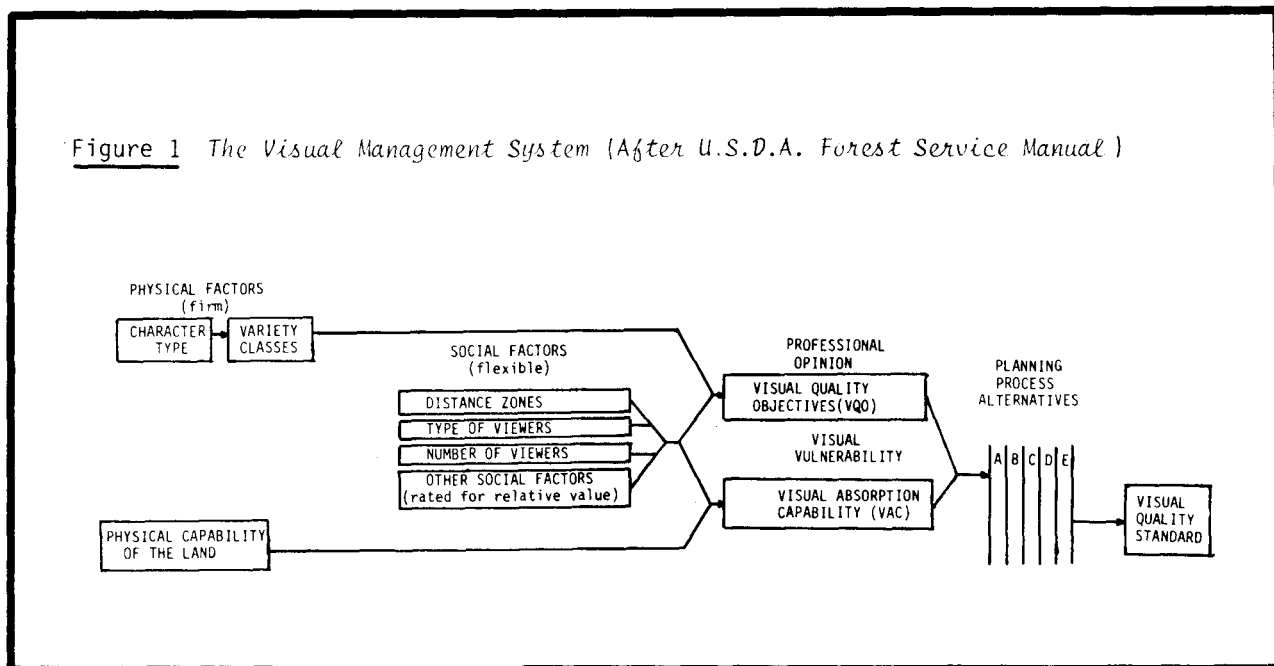
- | | |
|-----------------------|-------------------|
| 1. Climate | 5. Vegetation and |
| 2. Terrain | Forest Cover |
| 3. Soils & Topography | 6. Wildlife |
| 4. Aquatics | |

Within the above categories, numbers 2, 3, and 5 are most applicable to VAC assessments, although selected data may be drawn from climate, aquatics and wildlife as well. This will be demonstrated in the proposed classification system outlined later in this paper.

VISUAL ABSORPTION CAPABILITY

Visual absorption may be defined as the physical capacity of a landscape to absorb proposed development or management activities and still maintain its inherent visual character and quality. Two of the most important factors affecting the absorption capability of a landscape are: 1) the degree of visual penetration, i.e., the distance into the landscape you can see from a vantage point and 2) the complexity of the landscape. The degree of visual penetration is affected both by vegetation and topography (Anderson et al. 1977). Landscape complexity refers to topographic extremes, vegetative diversity, climatic variations and heterogeneous regional characteristics - all prevalent in British Columbia. The capability to accommodate management impacts (development, logging, roads, transmission lines, etc.) and still maintain visual quality standards depends largely on biophysical factors. Social and economic parameters enter the scene at more subjective levels and involve management decision highly dependent upon inherent physical (biophysical) capacities of

Figure 1 The Visual Management System (After U.S.D.A. Forest Service Manual)



the land for the resolution of visual quality objectives.

VAC Principles

Basic principles governing VAC analysis can be summarized as follows:

1. All lands vary in their ability to absorb modifications.
2. Areas near landscape focal points have lower capabilities to absorb modification.
3. The higher the complexity/diversity of the landscape, the higher its visual absorption capability.
4. Landscape edges, i.e., breaks between forest and meadow, lakeshore etc., have high VAC due to their diversity of background, but low VAC due to their propensity to become focal points.
5. Ridgetops are most likely to have low VAC due to consequent scrutiny as focal points, e.g., observer position^{3/} is generally "inferior" or lower. Lands visible from a greater number of observation positions will have lower VAC.
6. Lands with the highest soil color contrast have the lowest VAC since development may expose soils by side casting, stockpiling, etc.
7. VAC ratings should consider regional topographic, geomorphic and climatic parameters on a relative basis, i.e., VAC ratings will vary between regions and sub-regions.
8. Lands with geologic stability and good growing conditions may have moderate to low VAC if vegetation is lacking or monotonous and uniform, but high VAC in the long run due to good regeneration rates and stable soil conditions.
9. Uniformly tall, dense stands of trees have high VAC due to screening ability, i.e., high VAC when in foreground but lower VAC when in background.

^{3/}Observer Position: a term employed to describe observer's relationship to this visual objective within the landscape. Three terms are used: observer inferior (viewer below object), observer normal (viewer on level with object), and observer superior (viewer above object).

Relationship Between Biophysical and VAC

Relationships existing between biophysical land classification outlined earlier and VAC become apparent when physical factors leading to VAC evaluations are specified. Essentially these are:

Slope, vegetative pattern, color and diversity, vegetative screening ability, site recoverability, soil color contrast, landscape diversity, land stability, waterform diversity and soil erodibility.

This paper will confine its objectives to an analysis of biophysical factors, rather than discussing social and economic factors relative to visual absorption capability. There are several good reasons for this. First, biophysical factors are relatively more constant over time than social and economic considerations and thus lend themselves more readily to inventory and analysis; and secondly, visual analysis is often carried out in areas where social factors arising out of proposed new developments are in a state of flux - political or otherwise - and thus more difficult to assess in the context of VAC. Public preferences for landscape types may also change over time.

The most generally accepted physical VAC factor is slope, for as the slope of a seen area increases, VAC decreases (Anderson et al. 1977). Vegetation composition, screening ability, color diversity and regeneration rates are also extremely important, for as they increase or become viable, VAC increases. These determinants are readily available from Resource Analysis Branch biophysical maps.

Soil erodibility, soil color and soil stability - data readily obtainable from most soil reports - are also important factors relative to VAC, since exposed cut banks, overburden, side casting (man induced) and naturally unstable or eroding slope faces may contrast sharply in color and texture with the surrounding natural landscape.

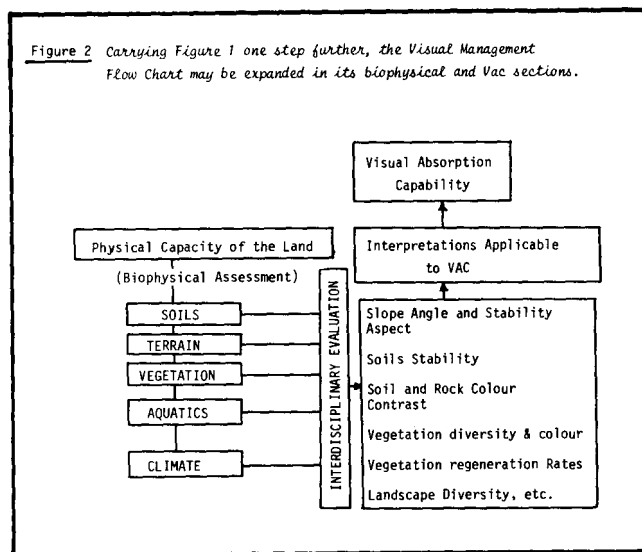
The Mapping Process

Let us now examine (1) relationships existing between VAC and biophysical mapping and (2) possible methods of incorporating VAC evaluations with other disciplines in the

mapping process.

In addition to biophysical mapping as outlined, the Resource Analysis Branch now conducts recreation carrying capacity studies (Block 1976) based principally on vegetation, soil, and surficial geology characteristics and limitations. Of specific interest to VAC are the identifications of major limiting factors to recreation use based upon soil texture, soil depth, drainage, flooding, vegetation density, vegetation diversity and sensitivity to development. Man-made constraints are also categorized in the landscape. In fact, the recreation carrying capacity classification is the most appropriate system utilized within the Branch for "expanding" into VAC ratings and has been selected for demonstration purposes as shown in the hypothetical mapping example (fig. 5).

Prior to setting forth a proposed system of VAC mapping based on biophysical factors, I have developed an expansion of figure 1 as follows:



A PROPOSED SYSTEM OF VAC ASSESSMENT BASED ON BIOPHYSICAL MAPPING CAPABILITIES

Having briefly examined the biophysical approach as utilized by the Resource Analysis Branch and its implications to VAC, the following basic structure is proposed as a beginning framework leading to VAC classification. The system will, of course, require considerable field testing, modification and refinement, but the ingredients to its application are readily available. Three major

phases would be involved:

1. assessment of the macro area by satellite photo examination (and 1:250 000 mapping if available) and 80 chain photos to determine basic physiographic (regional) characteristics,
2. development of guidelines for visual assessment of each project on a regional or sub-regional level based upon homogeneity within the characteristic landscape,
3. a collation, or "drawing from present or past biophysical mapping carried out by individual disciplines, thus leading to a VAC rating system which could then be checked by further air photo analysis and field review.

Basic Assumptions

Although social and economic factors do not come under detailed examination in this paper, some evaluation of viewer response is essential in the preliminary mapping phase. Among the more significant of these are the following assumptions.

At all times, the VAC biophysical ratings should relate to and be conditioned by the following:

1. that the mapped area is under constant or periodic viewer involvement or will come into view subsequent to a proposed development impact (corridor alignment, roads, hydro lines, mining, townsite development, outdoor recreation use, etc.).
2. That, if not seen at present (much of British Columbia), the following baseline concept should govern mapping priorities: river basins or valley corridor benchlands are more likely to be utilized for access and development than adjacent uplands, ridgetops or areas of rugged topography.
3. that visual impact of management activities usually increases as viewing distance decreases and vice versa and that areas seen from destination points are generally of more concern than those seen from access routes.

When development is actually proposed, viewer position (superior, inferior or normal) will be assessed prior to final VAC evaluation. It is also important to point out that VAC assessments prior to development can lead to a more realistic route, corridor or develop-

ment alternative, and are preferable to "after the fact" assessments.

Governing Factors

Five primary factors govern VAC bio-physical ratings: (1) slope, (2) vegetation regeneration potential, (3) landscape diversity, (4) soils erosion potential and (5) soils and rock color contrast potential (Vold 1979). These are defined as follows:

1. Slope
 - slope stability
 - slope: angle of repose
 - slope as viewed from superior, inferior, and normal viewer positions
2. Soils
 - erosion potential (leading to exposure)
3. Vegetation
 - regeneration potential - soil fertility and macro climatic factors

4. Soil and Rock Color Contrasts
 - low to high contrast with characteristic landscape cover

5. Landscape Diversity
 - vegetation density, diversity, pattern and screening potential: successional characteristics
 - landform/land use diversity (slopes, valleys, ridges, urban and rural areas, etc.)
 - waterform interest and diversity
 - visual features of interest and/or significance

Utilizing the above five factors, the following rating system would govern all VAC evaluations, i.e. $VAC = S \times (E+R+C+D)$ where S = Slope, E = Soil Erosion, R = Vegetation Regeneration Potential, C = Soil and Rock Color Contrast Potential, and D = Landscape Diversity.

A rating system would then be established as follows (Table 1), where the higher number carries the highest VAC.

Table 1

<u>Factor</u>	<u>Conditions</u>	<u>Rating</u>
1. (S) Slope (dominant and determining factor) (This is a complex factor i.e. a long slope on a mountainside has a more cumulative impact than short, steep slopes in rolling topography)	0 - 5 percent slope	5
	6 - 15 percent slope	4
	16 - 30 percent slope	3
	31 - 60 percent slope	2
	> 60 percent slope	1
2. (E) Soil Erosion Potential	Low Erosion Potential	3
	Moderate Erosion Potential	2
	High Erosion Potential	1
3. (R) Vegetation Regeneration Potential	High Regeneration (generally CLI Forest Capability ^{4/} Class 1-3)	3
	Moderate Regeneration Potential (generally CLI Forest Capability Class 3-4)	2
	Low Regeneration Potential (generally CLI Forest Capability Class 5-7)	1

^{4/} CLI - Canada Land Inventory, 1965-70. In forest biomes, vegetation potential is generally related to forest productivity (capability).

4. Soil and Rock Color Contrast	Low Contrast (e.g.. 2.5 or less hue on Munsell Colour Chart)	3
	Moderate Contrast (e.g., 5 hue change)	2
	High Contrast (e.g., greater than 5 hue change)	1
5. Land Use/Landscape Diversity	High Diversity of vegetation types; diverse and interesting topography and attractive water bodies	3
	Moderate diversity (little variety in vegetation or topography present)	2
	Low Diversity (no significant change in vegetation pattern or topography present)	1

It becomes apparent that, since VAC values can vary from a low of $1 \times (1+1+1+1) = 4$ to a high of $5 \times (3+3+3+3) = 60$, VAC ratings can be assigned as follows:

Very Low VAC= 4-15	Complexed to "low"
Low VAC = 16 - 27	VAC: allows subjective variation and room for value judgements relative to specific projects.
Moderate VAC= 28-40	"Moderate": no change
High VAC = 41 - 50	Complexed to "high"
Very High VAC=51-60	VAC: allows subjective variation and room for value judgements, as above

Example

A landscape area or unit on 16 - 30 pct. slopes with a low erosion potential due to coarse textured, but stable materials with low regeneration potential due to soil droughtiness, low color contrast due to limited soil leaching and high landscape diversity due to open, parkland conditions, would carry a rating as follows: $VAC = 3 \times (3+1+3+3) = 30$, or a moderate VAC rating.

A Proposed System of Classifications

Carrying the VAC assessment into a proposed class system incorporating the previously stated assumptions and with assigned biophysical ratings, I would propose

the following class definitions:

Class I (VAC biophysical rating of 51 - 60)

Areas which are gentle to moderate in elevation, with diverse vegetation and stable soil conditions, and capable of supporting management activities with a minimum negative affect on the visual quality of the landscape: low foreground, middle ground, background impacts.

Class II (VAC biophysical rating of 41 - 50)

Areas of rolling to ridgeline topography with open to semi-open mixed and diverse evergreen/deciduous vegetation capable of supporting management activities with a minimum amount of landscape alteration (screening, site design, etc.) and having stable soils and landform characteristics.

Class III (VAC biophysical rating of 28 - 40)

Areas of moderately interesting and regionally typical landscape character, interest and diversity with varied topography restricted to slopes less than 15 percent supporting diverse vegetation. However, the topography and vegetative cover are reasonably difficult to manipulate in the interest of the visual resource.

Class IV (VAC biophysical rating of 16 - 27)

Areas of pronounced topographic eminence but lacking in diversity with slopes ranging to 30 percent and vegetation characterized by open deciduous, evergreen or shrub complexes. Management activities would be seen regard-

Summary of Proposed Biophysical System of VAC Assessment

Figure 4 The proposed five class system as outlined would be conditioned (and clarified) by the following which would indicate what VAC problems existed and at times where and whether more mapping, design and analysis might be needed.

1) LANDFORM		5) WATER FEATURES	
Slopes in excess of 15%	S ¹	Flooding potential	W ¹
High Foreground Profile	S ²	Cutbank (stream) erosion	W ²
High Middle-ground Profile	S ³	Lack of edge diversity (Lake)	W ³
High Background Profile	S ⁴	Limited by scale related to surrounding landscape	W ⁴
2) LANDSCAPE DIVERSITY		6) MAN-MADE	
Uniform, lacking in variety, (vividness)	L ¹	Urban features	M ¹
Lacking in Intactness ⁷	L ²	Road, railway, Hydro line right-of-way	M ²
Lacking in unity ⁸	L ³	Surface Mining extractions	M ³
3) VEGETATION		Other	M ⁴
Uniform: Lack of diversity	V ¹		
High Veg. Sensitivity	V ²		
Low Regeneration Rate	V ³		
Fall & Spring Colour or other plant material deficiency	V ⁴		
4) SOILS			
Erosion/Slope Failure	C ¹		
Excessive Rock & Soil Colour Contrast with Surroundings	C ²		
Poor drainage	C ³		
Excessive compaction	C ⁴		

HYPOTHETICAL EXAMPLE

S¹
3 V^{1,3}
M²

A class three VAC area (unit) with variable topography and uniform vegetation having low regeneration rate through which a Hydro line is passing and is readily observed.

Step one: Determine mapping priorities i.e., where are VAC assessments needed relative to impact proposals?

Step two: Conduct preliminary air satellite and stereo pair examinations in determination of landscape units (Tetlow and Sheppard 1977).

Step three: Review basic assumptions and predict viewer response.

Step four: Map slope, vegetation soil and rock color contrasts and landscape diversity. Assign appropriate ratings from 1 to 5 (slope) and 1 to 3 (all others).

Step five: Apply the formula $VAC = S \times (E+R+C+D)$ and pre-map ratings on terrain unit complexed polygons as noted in figure 4.

Step six: Field check ratings wherever possible at a team level where soils, vegetation and aquatic specialists can verify findings.

Step seven: Draft final mapping on appropriate base followed by technical edit check by all disciplines involved.

less of any mitigation measures adopted during or following development.

Class V (VAC biophysical rating of 4 - 15)

Areas of extreme topographic variation with uniform vegetation cover, or devoid of such, offering little opportunity for matching management activities with the characteristic landscape; readily observed from access routes and perhaps elsewhere; slopes in excess of 35 percent, actively failing slopes and/or very sensitive vegetation (Figure 3*).

Under the proposed system, team effort with specialists in biophysical mapping components is essential, since some degree of training in the direction of visual analysis would enable them to view visual absorption factors, both in the field and throughout the mapping and interpretive phases. The "VAC" overlay would have its own nomenclature, or system of classes, either as a separate interpretation for the visual analyst, or as a component of the total biophysical package.

*See color illustration on page 389.

BIOPHYSICAL VAC ASSESSMENT: ITS OPERABILITY AND POTENTIAL

The biophysical approach to VAC as outlined in this paper would be an applied methodology to all land areas rather than theoretical, preceded ideally by methodology development in the broader field of visual analysis. It is difficult to determine costs of a project but they should be relatively low in comparison to benefits gained, being largely a matter of staff orientation and some added field travel and interpretation time.

The technology could be of great assistance to British Columbia and elsewhere in conducting visual corridor analysis, urban suitability studies, joint research with other agencies, forest harvesting, environmental impact assessments, and highway, hydro electric and other alignment studies before visual impact takes place. The extent of transferability should be virtually 100% since it could be applied to a common land base anywhere, providing of course, that an

data collected by disciplines on an interactive basis, within one administrative complex and "under one roof" This is supportive - in fact essential - to the system of VAC mapping proposed in this paper. Access to photos, air satellite photography, instrumentation, (stereoscopes, slides, projectors, digitizers, computers, etc.) and mapping and report production facilities is commonly shared by Branch professionals. A great deal of inter-action also prevails in seminars, workshops, and at the level of informal dialogue.

Our task, in British Columbia at least, is to develop a visual mapping methodology that could be utilized by all resource management agencies, consultants and the academic community in conducting or communicating visual resource assessments. Some exploratory work has already been done in this area, notably within the N.E. Coal Study area (Tetlow, Sheppard 1975) where a detailed Landscape Unit Analysis involving visual vulnerability evolved. Later work by Horner (1979) takes a more pragmatic look at terrain and vegetation in biophysical terms as they reveal VAC factors in the landscape.

The framework is here: biophysical mapping carried out at a team level. What is now needed is refinement of the mapping concepts, initiating pilot study assignments and continuing to solicit technical criticism as the process evolves.

LITERATURE CITED

Anderson, L., S. Galliano, B. Neville, J. Carlisle, R. Bennetts, D. Holcomb and G. Chandler. 1977. Visual absorption capability for forest landscape. U.S.D.A., Forest Service, California Region (Reg. 5), Klamath National Forest, Yreka, CA. 25 p., unpublished.

Benson, W.A. 1978. The role of biophysical inventory and analysis in the integrated management of resources in British Columbia. In Proc., Conference on Integrated Management of Resources in British Columbia. (Centre for Continuing Education, University of British Columbia. Nov. 1978) 16 p. In press.

Block John 1976. Outdoor recreation inventory. In Proc., Natural Resource Inventory: Methodology, Availability, Interpretation. (U.B.C. Centre for Continuing Education. Oct. 14, 15, 1976). p. 151-156.

Colorado Department of Highways 1979. 1-70 in a mountain environment, Vail Pass, 97 p.

Horner, Roger 1979. Visual resources of the northeast coal study area, 1977-78. Prepared for ELUC Subcommittee on Northeast Coal Development by the Resource Analysis Branch, Ministry of Environment (In final draft stage).

Jones and Jones 1975. Upper Susitna river, Alaska, an inventory and evaluation of the environmental, aesthetic and recreation resources Alaska District, Corps of Engineers, Anchorage, March 1975. 218 p.

Smith, D.A. 1969. Conceptual bases, philosophical foundations and administrative procedures for multiple use management of natural resources. (Unpublished M.S. thesis, Faculty of Forestry, University of B.C., Vancouver, B.C.)

Tetlow, R. and Sheppard, S.R.J. 1977. Visual resources of the northeast coal study area, 1976-77. Prepared for ELUC Subcommittee on Northeast Coal Development by Resource Analysis Branch, Ministry of Environment, British Columbia. 102 p.

U.S.D.A. Forest Service 1973. Smith river highway visual analysis. Contract #39-4402. 139 p.

Vold, Terje 1979. Bullmoose biophysical folio, N.E. Coal Study Area. Resource Analysis Branch. 30 p.

RECOMMENDED REFERENCES TO BIOPHYSICAL LAND CLASSIFICATION

Demarchi, D.A., and Chamberlin, T.W. 1977. The Canadian experience: an approach toward biophysical interpretation. In Proc. Nat'l Symposium on Classification, Inventory and Analysis of Fish and Wildlife Habitat (Phoenix, Ariz. Jan. 24-27, 1977) p. 145-164.

ELUC Secretariat, Ministry of Environment, British Columbia 1977. Guidelines to linear development. 32 p.

Environment Canada

1976. A review of environmental management service biophysical and related surveys. (EMS Director's Meeting, Jan. 1976) 8 p.

Lacate, D.S.

1969. Guidelines for biophysical land classification. Department of Fisheries and Forestry, Canadian Forestry Services publication #1264. Ottawa, Ont. 61 p.

Resource Analysis Branch, Ministry of Environment, British Columbia

1977. Aquatic system inventory and analysis. 39 p.

1977. Biophysical land classification techniques: a brief description of the objectives, components and applications. 30 p.

1976. Terrain classification system. 56 p.

1976. Inventory of recreation capability: outdoor recreation features and carrying capacity. 64 p.

1978. Adams River - a resource analysis.

W.C. Yeomans, Project Co-ordinator, 83 p.

Walmsley, M.E.

1976. Biophysical land classification in British Columbia: the philosophy, techniques and application. In Proc., First Meeting, Canada Committee on Ecological (Biophysical) Land Classification (Petawawa, Ont. May 25-26, 1976) p. 3-26.

Yeomans, W.C.

1978. Spallumcheen; the visual environment. British Columbia Land Commission. 75 p.