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**Before the**
**FEDERAL COMMUNICATIONS COMMISSION**
**Washington, D.C. 20554**

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| In the Matter of | ) | |
| | ) | |
| Satellite Delivery of Network Signals to Unserved Households for Purposes of the Satellite Home Viewer Act | ) | CS Docket No. 98-201 |
| | ) | RM No. 9335, 9345 |
| Part 73 Definition and Measurement of Signals of Grade B Intensity | ) | |

## REPLY OF DIRECTV, INC.

DIRECTV, Inc. ("DIRECTV") hereby replies to the oppositions filed by the National Association of Broadcasters ("NAB")[1] and the ABC, CBS and Fox network affiliate associations (collectively, "Affiliates")[2] to DIRECTV's petition for reconsideration of the Commission's Order[3] in the above-captioned proceeding.

In the SHVA Order, the Commission recommended the use of an adjusted propagation model for predicting signal strength at individual households, known as the Individual Location Longley-Rice ("ILLR") model. One component that the Commission has agreed should be

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1 NAB, Opposition to Echostar and DIRECTV Petitions for Reconsideration (filed April 16, 1999) ("NAB Opposition").

2 ABC Television Affiliates Ass'n, CBS Television Affiliates Ass'n, Fox Television Affiliates Ass'n, Opposition to Petitions for Reconsideration and/or Clarification (filed April 16, 1999) ("Affiliate Opposition").

3 In the Matter of Satellite Delivery of Network Signals to Unserved Households for Purposes of the Satellite Home Viewer Act, Part 73 Definition and Measurement of Signals of Grade B Intensity, CS Docket No. 98-201, RM No. 9335, RM No. 9345, Report and Order (rel. Feb. 2, 1999) ("SHVA Order").

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included in the ILLR model is the use of land use and land cover ("LULC") data, which reflects the presence of signal propagation impediments such as vegetation and buildings. The Commission has acknowledged that these impediments "affect signal intensity at individual locations" and should be accounted for in the ILLR, but stated that it is "not aware of a standard means of including such information in the ILLR that has been accepted by the technical and scientific community."[4] Thus, the Commission stated that LULC data "shall be included" in the ILLR model "when an accurate method for doing so is developed."[5]

In its petition for reconsideration, DIRECTV urged the Commission to reconsider this position to the extent that satellite providers should be permitted to incorporate LULC data into the ILLR model as soon as possible, without the need for further regulatory approval. The SHVA Order itself acknowledges that "credible and useful" LULC data are available in the Global Land Information System ("GLIS") database maintained by the United States Geological Survey ("USGS").[6] The Commission's failure to sanction satellite providers' utilization of GLIS LULC data in connection with the ILLR methodology without first pursuing additional regulatory proceedings severely diminishes the ILLR model's utility in predicting, with as much accuracy as possible, whether signals of Grade B intensity can be received at discrete locations.

Predictably, the broadcast industry has continued to fight the development of a more accurate predictive model, as it has at every turn. Notably, however, in opposing DIRECTV's petition for reconsideration, the broadcasters do *not* dispute, because they cannot, the

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4 *Id.* at ¶ 83.

5 *Id.* at ¶ 71.

6 *Id.*

Commission's findings that an adjustment based on LULC data is a refinement that should be incorporated into the ILLR model, or that "credible and useful" data can be gathered from the U.S. government's GLIS database.[7] Instead, the primary objection of the NAB and the Affiliates is that the satellite industry has failed to proffer a "specific software package" that these parties assert must be separately evaluated by the Commission before the LULC data can be incorporated into the ILLR model.[8]

DIRECTV agrees with the broadcasters that the Commission must be satisfied with the ability of the satellite industry to incorporate the LULC component into the ILLR methodology. To that end, as described in the attached Engineering Statement, DIRECTV and the engineering firm of Hatfield & Dawson are actively in the process of developing an LULC loss algorithm implementation that can be "readily achieved using the USGS database."[9] The Hatfield & Dawson statement explains the details of this implementation, first describing the USGS LULC

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7 The Affiliates maintain that incorporating GLIS data into the ILLR model will engender some measure of "double counting" because, the Affiliates claim, the ILLR methodology already incorporates such data to some limited, unspecified extent. *See* Affiliate Opposition at 6 & n.20. The Affiliates themselves note, however, that the Commission expressly considered and rejected this argument in the SHVA Order, *see id.;* SHVA Order at ¶ 82, and the Affiliates have not sought reconsideration on this point. The Affiliates' "double counting" argument also is speculative and wholly unsupported. The record reflects that the standard Longley-Rice model, although it considers terrain, "is severely flawed in that it does not consider the effects of vegetation and building clutter." Comments of Communications Engineering Associates, Exhibit A, "Overview of Radiowave Propagation Prediction Modeling and Comparison of Performance of Models," at 13. The FCC's conclusion that LULC data must be incorporated to increase the ILLR's predictive accuracy is correct.

8 NAB Opposition at 4; *see* Affiliate Opposition at 7.

9 Hatfield & Dawson, Engineering Statement, "Technical Issues and Definitions Relative to the Satellite Home Viewer Act: Implementation of the Land Use and Land Cover Loss Algorithm Within the ILLR Program" (April 1999) ("Hatfield & Dawson"), attached as Exhibit 1.

database, next describing the adaptation of the LULC database categories for the enhanced ILLR program (building upon work that is being performed by the Telecommuni-cations Industry Association ("TIA")), and then explaining the manner in which LULC data will be implemented within the ILLR program.[10] As Hatfield & Dawson conclude, there is no reason that LULC data cannot be incorporated "now as an element in the ILLR program so that it is as accurate and useful as possible in predicting which satellite subscribers can receive a signal of Grade B intensity."[11]

In this regard, the focus of the NAB and the Affiliates on gaining an opportunity to pick apart a specific software solution by demanding that it be submitted to the Commission for public comment is simply another delaying tactic. It should not be tolerated.

The Commission has concluded that "land use and land cover affect signal intensity," and has stated that the model "shall" include it.[12] The only doubt that the Commission has expressed is whether "technically and scientifically accepted methods" have been developed to do so.[13] DIRECTV has shown that, in fact, such "technically accepted" methods exist and are being actively pursued by the satellite industry. The Commission does not need not wait for specific vendor applications to be fully introduced to understand how the LULC loss algorithm is being developed. The Commission has the evidence and testimony before it to validate that such an implementation is well understood, straightforward conceptually, and based on a "long history" of "techniques of combining digitized topographic data with digitized land use/land for use with

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10 *See id.*

11 *Id.* at 2.

12 SHVA Order at ¶ 83.

13 *Id.*

appropriate propagation calculation."[14] Both the Declaration of Robert H. Plummer[15] and the Hatfield & Dawson Engineering Statement confirm that applications with the ability to combine commercially-available mapping software with USGS LULC data are readily achieved and in fact are already in process. Furthermore, Hatfield and Dawson have explained in detail how the LULC loss algorithm is being developed.[16]

Accordingly, there is no reason for the Commission to impede the immediate use of LULC data as a component in the ILLR methodology. The efforts of the NAB and the Affiliates to hinder accurate predictive measurements of Grade B signal intensity at the home should be rejected.

## III. CONCLUSION

The Commission should explicitly allow for the incorporation of LULC data into its ILLR model without requiring DIRECTV and other satellite providers to wait for further regulatory action. The USGS GLIS database is a credible and well-recognized source in the technical community for obtaining such information, and the integration of that database with the ILLR model should be permitted to proceed. DIRECTV thus urges the Commission (i) to withdraw the qualifying language in the SHVA Order to permit the immediate usage of the

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14 Hatfield & Dawson at ¶ 5.

15 *See* DIRECTV Petition for Reconsideration, Declaration of Robert H. Plummer at ¶ 6.

16 The Affiliates also question the usefulness of incorporating the GLIS LULC database because the resolution is different from the terrain databases used in the ILLR. Affiliate Opposition at 7. This argument is specious, however, and presents no reason to delay in incorporating LULC data into the ILLR model. Adjusting for LULC obstructions based on the planimetric grid utilized by the GLIS database is far superior to making no LULC adjustment at all. The Affiliates have not even attempted to show otherwise.

LULC data as a component of the ILLR, and (ii) to rule that integration of data from the USGS GLIS database into the ILLR model satisfies the LULC component.

Respectfully submitted,

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# ENGINEERING STATEMENT

## Technical Issues and Definitions Relative to The Satellite Home Viewer Act

## Implementation of the Land Use and Land Cover Loss Algorithm within the ILLR Program

**Prepared for**
**DirecTV**

**4/99**

# Technical Issues and Definitions Relative to the Satellite Home Viewer Act: Implementation of the Land Use and Land Cover Loss Algorithm within the ILLR Program

## 1. Introduction

The Satellite Home Viewer Act describes a distinction between served and unserved households to allow determination of eligibility for direct satellite provided network television service. In order to perform the test described by the Act, the FCC has adopted the "Individual Location Longley-Rice" (ILLR) prediction program. This program predicts the strength of a signal from a terrestrial television broadcast station at an individual household.

Television signal propagation is affected in varying degrees by land use and land cover (LULC). LULC is also known as land clutter or morphology. It is made up of vegetation or foliage, and man-made structures. The recent SHVA R&O (CS Docket No. 98-201) calls for the inclusion of LULC losses in the ILLR program:

> "1. We conclude that land use and land cover affect signal intensity at individual locations and should be used in the ILLR when an appropriate application develops. The United States Geological Survey maintains a Global Land Information System ("GLIS")1 database on land use and land cover indicating features such as vegetation and man-made structures. We believe that this information is both credible and useful. We acknowledge that larger buildings are usually found in urban areas and Congress expected that the SHVA would primarily benefit rural consumers, but the definition of "unserved" is not explicitly limited to those consumers. The statute does not impose a mileage limitation or distinguish between urban and rural households. While we expect the model to include land use and land cover, we are not aware of a standard means of including such information in the ILLR that has been accepted by the technical and scientific community. When an appropriate application has been developed and accepted, this information will be included in the ILLR. We challenge interested parties to develop such an application that more accurately reflects the signal intensity at an individual location."

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1*See* USGS Web page at < http://edcwww.cr.usgs.gov/Webglis/glisbin/glismain.pl >.

The predominant effect of LULC on television signals is to attenuate the strength of the signal as it travels near the earth's surface. LULC attenuation adds to the signal losses caused by terrain obstructions and reflections.

The accuracy of the ILLR prediction program will be increased when this program is enhanced to account for the additional television signal losses caused by LULC. Thus land use and land cover must be incorporated now as an element in the ILLR program so that it is as accurate and useful as possible in predicting which satellite subscribers can receive a signal of Grade B intensity.

H&D is presently working with DirecTV engineers to implement an LULC loss algorithm within the DirecTV subscriber eligibility ILLR-type program. We believe that the implementation can be readily achieved with the USGS database.

The remainder of this statement provides details of the DirecTV LULC loss algorithm implementation.

## 2. Description of the USGS LULC Database

The USGS offers to the public a LULC database which can be used in conjunction with an enhanced ILLR program to determine additional losses due to foliage and other land use conditions which exist in the vicinity of the receiving location (i.e., a household).

The LULC database files are available in two formats. The first describes the boundaries of LULC regions as vectors. This line-based format is the more compact of the two, but it requires a sophisticated access algorithm to determine the LULC characteristics in the vicinity of a geographic point.

The second format is known as Composite Theme Grid (CTG). This format assigns LULC characteristics to a square grid of points spaced at 200 meter intervals.

The CTG format is recommended for use with the ILLR program even though it takes considerably more storage space than the vector format. LULC information can be retrieved from CTG files by use of a simple algorithm that selects the grid point nearest to a given household or other geographic point of interest.

The first step towards implementing the LULC enhancement to the ILLR program, is to obtain the USGS LULC files in CTG format for the entire US. General instructions on how to obtain the files, and the details of the file formats are given in [1] and Appendix 2.

## 3. Adapting the LULC Database Categories for the Enhanced ILLR Program

The next step is to write a stand-alone program that reads, processes, and reduces the various USGS files into a manageable format. As explained below, much of the data contained in the LULC database is not required by the ILLR program. Thus an initial, "one-time" processing of the raw LULC database will greatly reduce the amount of data the ILLR program must consider, and this will in turn increase the speed of the program.

Most of the 37 LULC categories either have no relevance, or are too detailed for television signal prediction algorithms. In recognition of this fact, the Telecommunications Industry Council ("TIA", a standards-setting organization whose recommendations are frequently followed by the Commission) has reduced and reclassified the original USGS LULC categories so that only those that are relevant to signal propagation remain.

Table 1 was excerpted from a recent unpublished TIA committee working draft [2]. This table shows the 10 reclassified categories.

**Note:** The TIA draft has yet to be released to the public. After ratification by members of the formulating group, and possible revisions, it will be published as Technical Standards Bulletin TSB-88A. Until the document has been ratified and published, the information contained in the draft must be considered as tentative.

The Telecommunications Industry Association holds the copyright for the TIA committee working draft [2]; Tables 1 and 2 are reproduced here with the permission of TIA.

**Table 1. Re-Classification of USGS LULC Categories**

| USGS Classification Number | USGS Classification Description | New Classification Number | New Classification Description |
|---|---|---|---|
| 11 | Residential | 7 | Residential |
| 12 | Commercial and services | 9 | Commercial/industrial |
| 13 | Industrial | 9 | Commercial/industrial |
| 14 | Transportation, communications, & utilities | 1 | Open land |
| 15 | Industrial and commercial complexes | 9 | Commercial/industrial |
| 16 | Mixed urban and built-up lands | 8 | Mixed urban/buildings |
| 17 | Other urban and built-up land | 8 | Mixed urban/buildings |
| 21 | Cropland and pasture | 2 | Agricultural |
| 22 | Orchards, groves, vineyards, nurseries, and horticultural | 2 | Agricultural |
| 23 | Confined feeding operations | 2 | Agricultural |
| 24 | Other agricultural land | 2 | Agricultural |
| 31 | Herbaceous rangeland | 3 | Rangeland |
| 32 | Shrub and brush rangeland | 3 | Rangeland |
| 33 | Mixed rangeland | 3 | Rangeland |
| 41 | Deciduous forest land | 5 | Forest land |
| 42 | Evergreen forest land | 5 | Forest land |
| 43 | Mixed forest land | 5 | Forest land |
| 51 | Streams and canals | 4 | Water |
| 52 | Lakes | 4 | Water |
| 53 | Reservoirs | 4 | Water |
| 54 | Bays and estuaries | 4 | Water |
| 61 | Forested wetland | 5 | Forest land |
| 62 | Non-forest wetland | 6 | Wetland |
| 71 | Dry salt flats | 1 | Open land |

| USGS Classification Number | USGS Classification Description | New Classification Number | New Classification Description |
|---|---|---|---|
| 72 | Beaches | 1 | Open land |
| 73 | Sandy areas other than beaches | 1 | Open land |
| 74 | Bare exposed rock | 1 | Open land |
| 75 | Strip mines, quarries, and gravel pits | 1 | Open land |
| 76 | Transitional areas | 1 | Open land |
| 77 | Mixed barren land | 1 | Open land |
| 81 | Shrub and brush tundra | 1 | Open land |
| 82 | Herbaceous tundra | 1 | Open land |
| 83 | Bare ground | 1 | Open land |
| 84 | Wet tundra | 1 | Open land |
| 85 | Mixed tundra | 1 | Open land |
| 91 | Perennial snowfields | 10 | Snow & ice |
| 92 | Glaciers | 10 | Snow & ice |

We endorse the TIA method of reducing and reclassifying the original 37 LULC categories into 10 categories relevant to signal propagation. This reduction results in a nearly four-fold simplification of the raw LULC data.

H&D and DirecTV personnel are now writing a stand-alone, pre-processing program that reduces the various LULC files for the US into a single compact binary file. The pre-processing program need only be run once for each version or update of the USGS database. The output file of the pre-processing program becomes an input file for the new ILLR program.

The enhanced ILLR program will be able to read this binary file to quickly retrieve the LULC category that is most appropriate for the household location under consideration. Further details of the retrieval process are described in the next section.

## 4. Implementation of the LULC Algorithm within the ILLR Program

With this topic we begin discussion of enhancements to the existing ILLR program. Specifically, *the ILLR program must be enhanced by the addition of one or more subroutines that determine* ***additional losses*** *to the predicted television signal strength at a given household based on the frequency of the signal and the revised LULC category applicable to the location of that household.*

The LULC subroutines will be written in the FORTRAN programming language. The existing Longley-Rice (L-R) algorithm, which is the main component of the ILLR program, is also written in FORTRAN. Thus the new LULC subroutines will be written in FORTRAN.

The function of the LULC subroutines can best be described in terms of the flow of the enhanced ILLR program. The enhanced ILLR program flowchart is shown in Appendix 3. The following describes the flow of the program as it analyzes a single propagation path from one television station to a single household:

1) ILLR accepts as inputs the geographic coordinates and height (20' or 30') of the household receiving antenna.
2) ILLR accepts as inputs the frequency and Effective Radiated Power (ERP) of the TV station transmitting antenna.
3) ILLR accesses the USGS 3" terrain database and extracts terrain elevations at 0.1 km increments along the propagation path.
4) The L-R algorithm within ILLR determines the initial signal loss based on free-space loss and terrain-related losses.
5) ILLR calls the first LULC subroutine that reads the binary LULC database, and determines the revised LULC category based on the geographic coordinates of the household.

6) ILLR calls the second LULC subroutine to determine additional signal loss based on the TV signal frequency, the height of the household receiving antenna, and the revised LULC category found in 5).
7) ILLR adds the L-R loss from 4) and the LULC loss from 6) to come up with a total propagation loss for the propagation path.
8) ILLR calculates the signal strength at the household based on the total path loss determined in 7).
9) ILLR outputs an eligibility decision based on a comparison of the signal strength calculated in 8) to the Grade B threshold level for the given TV signal frequency.

Tasks 5, 6 and 7 are enhancements; remaining tasks are performed by the existing ILLR program.

The simplified flow is presented to illustrate how the new LULC subroutines will fit into the existing ILLR program. A typical subscriber eligibility run will be more complicated: Tasks 2 through 8 are repeated for each network station in the market, and for each interfering TV station. Then a more comprehensive task 9 determines eligibility based on the strengths of both the in-market and interfering television signals.

The first LULC subroutine called in task 5 determines the appropriate revised LULC category by finding the single LULC data point that is both nearest to the household, and close to the propagation path. Data points are arranged in order of latitude and longitude within the binary LULC file, so the search for the appropriate data point takes very little time.

The second LULC subroutine called in task 6 determines the additional signal loss based on the TV signal frequency, the height of the household receiving antenna, and the revised LULC category found in Task 5. This determination is made by reference to a simple table of values, as described in the next section.

## 4. Relating the Revised LULC Categories to Additional Propagation Loss

Production of the LULC loss subroutines is just one part of the ILLR enhancement process. The other part is the definition of the additional loss values for each revised LULC category and for each television band. The same TIA document described in Section 3 offers both a starting point and a framework for the determination of additional loss values for television signals.

The use of digitized LULC data for evaluation of VHF and UHF signals at "real" receiving locations is an established engineering practice. Recently, a specific set of loss factors, using the revised LULC categories as a basis, has been recommended by the TIA for land mobile radio applications. It is but a modest extension of the TIA procedure to make it directly applicable to television applications with slightly higher receiving antenna locations. All that is required is the collection of a group of samples adequate to allow statistically meaningful loss values to be calculated. The sole difference arises because of the somewhat lower mobile antenna heights and modest differences between television and land mobile frequencies. We present the TIA recommendation here as an illustration of the look-up table format that will be incorporated into the Task 6 LULC subroutine.

Table 2 shows the value of additional signal loss ( $A_{clutter}$ ) to be used for each of the revised categories as a function of frequency [2]. We believe that these loss values represent the highest values likely to be found for television applications. That is because the values shown in Table 2 are based on mobile antenna heights of approximately 6 feet above ground. As the receiving antenna is raised up to the 20 or 30 foot level for television reception, the losses tend to decrease.

**Table 2. Additional Loss Values in dB as a Function of Frequency and Revised LULC Classification for Mobile Applications**

| | Frequency (MHz) | | | | | |
|---|---|---|---|---|---|---|
| **Classification** | **30-50** | **136-174** | **220-222** | **380-512** | **746-941** | **Reclassified Number** |
| **Open land** | 1 | 3 | 3 | 3 | 5 | 1 |
| **Agricultural** | 2 | 3 | 3 | 4 | 18[1] | 2 |
| **Rangeland** | 1 | 9[1] | 9 | 10[1] | 10 | 3 |
| **Water** | 0 | 0 | 0 | 0 | 0 | 4 |
| **Forest land** | 3 | 8[1] | 9 | 12 | 25[1] | 5 |
| **Wetland** | 1 | 3 | 3 | 3 | 3 | 6 |
| **Residential** | 3 | 14[1] | 15 | 16[1] | 20[1] | 7 |
| **Mixed urban/ buildings** | 4 | 15[1] | 16 | 17[1] | 20[1] | 8 |
| **Commercial/ industrial** | 4 | 14[1] | 14 | 15[1] | 20[1] | 9 |
| **Snow & Ice** | 0 | 0 | 0 | 0 | 0 | 10 |

**Notes:**

1. Taken from Rubinstein [3]; based on the author's measurements of 162, 460 and 860 MHz signals. Non-superscripted values are derived from "industry sources" according to the TIA Committee Draft [2].

2. Values for urban settings may be heavily influenced by the density of foliage in a particular urban environment. Heavily forested urban environments may exhibit clutter losses in excess of those shown in this table [2].

## 5. Conclusion

We believe that the LULC enhancements to the ILLR program should be implemented at once.

The techniques of combining digitized topographic data with digitized land use/land cover data for use with appropriate propagation calculation methods have a long history. Virtually all modern propagation software provided to the PCS and cellular industry incorporates these techniques, and various descriptions of suggested methods have been published in the technical literature for at least the last 20 years, some of them directly applicable to the broadcast VHF/UHF circumstance.

Loss values can be determined and added to the LULC subroutines at any point during the development of the enhanced ILLR program. Thus the task of defining the loss values can be carried out in parallel with the production of the LULC subroutines, and other modifications to the existing ILLR program.

H&D and DirecTV are actively researching this subject, and we have already begun implementing an enhanced ILLR program for the DirecTV subscriber eligibility system.

April 14, 1999

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## APPENDICES

1. Bibliography

2. Description of LULC Database from the USGS

3. Enhanced ILLR Program Flowchart

**BIBLIOGRAPHY** **APPENDIX 1**


[1] *Land Use and Land Cover Digital Data from 1:250,000 and 1:100,000-Scale Maps: Data Users Guide 4*, National Mapping Program, U.S. Geological Survey, Reston, Virginia, 1990

[2] *Wireless Communications Systems, Performance in Noise- and Interference-Limited Situations, Recommended Methods for Technology-Independent Modeling, Simulation, and Verification*, Unpublished Committee Working Draft, PN-4193, Telecommunications Industry Association, January 1999 [This document will become TSB-88A upon publication]

[3] Rubinstein, Thomas N., "Clutter losses and environmental noise characteristics associated with various LULC categories", *IEEE Trans Broadcasting*, vol. 44, No. 3, September 1998, pp. 286-293

M. A. Weissberger, "An Initial Critical Summary of Models for Predicting The Attenuation of Radio Waves By Trees" ,*ESD-TR-81-101,* DOD, Electromagnetic Compatibility Center, Annapolis, September 1982

C. Welch, C. Lemak and L. Corrington, "A Model for Estimating Electromagnetic Wave Attenuation In a Forest (EWAF) Environment", The Applied Computational Electromagnetics Society, 1995 Conference

H. T. Head, "The Influence of Trees on Television Field Strengths at Ultra-High Frequencies", FCC docket proceeding, Association of Maximum Service Telecasters, late 1950s

B. Asp, "Vegetation Influence on Wave Propagation", *Nordic Radio Symposium, Conference Proceedings,* April 15-17, 1986, pp. 31-40

W. R. Vincent and G. H. Hagn, "Comments on The Performance of VHF Vehicular Radio Sets in Tropical Forests", *IEEE Trans. on Veh. Technol., vol. VT-18, pp. 61-65, Aug. 1969*

P. L. Rice, "Some Effects of Buildings and Vegetation on VHF/UHF Propagation", ITS, Office of Telecommunications, Boulder, Colorado

S. A. Torrico, H. L. Bertoni and R. H. Lang, "Modeling Tree Effects on Path Loss in a Residential Environment", *IEEE Trans. on Antennas & Propagation, vol. 46, No. 6, pp. 872-880, June 1998*

J. C. Wyss, W. J. Anson and R. D. Orr, "NTIS Building Penetration Project", September 1984

"Attenuation in Vegetation", ITU-R PN.833-1, *Vol. 1997, P Series-Part 1*

J.A. Saxton and J.A. Lane, "VHF and UHF Reception-effects of Trees and Other Obstacles", Wireless World, vol. 61, pp. 229-232, 1955

A.H. LaGrone, "Height-gain Measurements at VHF and UHF Behind a Grove of Trees", IEEE Trans. BC-9, 37, 1953

A.H. LaGrone and C.W. Chapman, "Some Propagation Characteristics of VHF Signals in the Immediate Vicinity of Trees", IRE Trans. AP-9, 487, 1961

J.W. Herbstreit and W.Q. Crichlow, "Measurement of the Attenuation of Radio Signals by Jungles", J Research NBS (Radio Science), 68D, pp. 903-906, 1964

B. Josephson and A. Blomquist, IRE Trans, on Antennas and Propagation 6, pp.169, 1958

H.T. Head, Proc. of IRE 48, pp.1016, 1960

J.S. McPetrie and L.H. Ford, Proc. IEE vol. 93, No. 1-4, (pt. 3-A), pp. 531, 1946

Jansky and Baily Research and Engineering Dept., Atlantic Research corp.,Alexandria, VA., Semi-annual Report, 1965

G.H. Hagn, G.E. Barker, H.W. Parker, J.D. Hice and W.A. Ray, " Preliminary Resultrs of Full-scale Pattern Measurements of Simple VHF Antennas in a Eucalyptus Grove", Stanford Research Institute, Special Tech, Report

A.O Longley and P.L. Rice, "Prediction of Tropospheric Radio Transmission Loss Over Irregular Terrain, A Computer Method", ESSA Tech. Report, ERL 79-ITS-67

A. Kinase, "Influence of Terrain Irregularities and Environmental Clutter Surroundings on the Propagation of Broadcasting Waves in the UHF and VHF Bands", NHK Technical Momograph 14, 1969

E. Sofaer and C.B. Bell, "Factors Affecting the Propagation and Reception of Broadcasting Signals in the UHF Bands", Proc. IEE vol.113, 7

CCIR, Documents of the XIth Plenary Assembly, Oslo, 1966, Doc. V/2 (USA), published by the International Telecommunication Union, Geneva, Switzerland

CCIR, Documents of the XIth Plenary Assembly, Oslo, 1966, Doc. V/9 (United Kingdom), published by the International Telecommunication Union, Geneva, Switzerland

CCIR, Documents of the XIth Plenary Assembly, Oslo, 1966, Doc. V/99 (Italy), published by the International Telecommunication Union, Geneva, Switzerland

CCIR, Documents of the XIth Plenary Assembly, Oslo, 1966, Doc. V/43 (Federal Republic of Germany), published by the International Telecommunication Union, Geneva, Switzerland

CCIR, Documents of the XIth Plenary Assembly, Oslo, 1966, Doc. V/19 (United Kingdom), published by the International Telecommunication Union, Geneva, Switzerland

CCIR, Documents of the XIIth Plenary Assembly, New Delhi, 1970, Doc. V/103 (Federal Republic of Germany), published by the International Telecommunication Union, Geneva, Switzerland

CCIR, Documents of the XIth Plenary Assembly, Oslo, 1966, Doc. V/31 (Sweden), published by the International Telecommunication Union, Geneva, Switzerland
M.F. Ibrahim and J.D. Parsons, "Signal Strength Prediction in Built-up Areas, Part 1: Median Signal Strength", Proc. IEE Part F, 130 (5), pp. 377-384, 1983

J.D. Parsons and M.F.Ibrahim, "Signal Strength Prediction in Built-up Areas, Part 2: Signal Variability", Proc. IEE Part F, 130 (5), pp. 385-391, 1983

The following descriptive information was taken from the USGS Web page:

**Background**
The Land Use and Land Cover (LULC) data files describe the vegetation, water, natural surface, and cultural features on the land surface. The United States Geological Survey (USGS) provides these data sets and associated maps as a part of its National Mapping Program. The LULC mapping program is designed so that standard topographic maps of a scale of 1:250,000 can be used for compilation and organization of the land use and land cover data. In some cases, such as Hawaii, 1:100,000 scale maps are also used.

**Extent of Coverage**
Land Use and Land Cover (LULC) data are available for most of the contiguous United States and Hawaii. This is the only ground cover database that has nearly complete coverage of the United States.

**Data Source**
Manual interpretation of aerial photographs acquired from NASA high-altitude missions and other sources were first used to compile the land use land cover maps. Secondary sources from earlier land use maps and field surveys were also incorporated into the LULC maps as needed. At a later time, the LULC maps were digitized to create a national digital LULC database. The evolution of this process resulted in the creation of the Geographic Information Retrieval Analysis System (GIRAS).

Initial source preparation involves the transfer of field survey information, photo classification detail and associated line work to a base map for digitization. This may be done through stereo compilation or monoscopic transfer techniques. Adjacent maps are also checked to ensure continuity. The maps are digitized and the appropriate classification codes are assigned for processing through GIRAS and checked for accuracy. All LULC data conform to the Universal Transverse Mercator (UTM) projection.

**Data Characteristics**
All LULC features are delineated by curved or straight lines that depict the actual boundary of an area, commonly referred to as a polygon. These polygons have a minimum size of 10 acres or 4 hectares. Each polygon represents a homogeneous element in the mapping scheme that is labeled with an integer or attribute code. The arcs and nodes of the polygon are further defined by an X,Y point or string of points that provide direction and location for the polygon. This relationship may be defined by the labeled area within the polygon or outside of it. Such positional data can be manipulated to meet a variety of user needs by reprojecting the data or re-scaling them.

## DESCRIPTION OF LULC DATABASE FROM THE USGS, p. 2

### Spatial Resolution

The minimum area representing the man made features of the LULC polygons are 10 acres (4 hectares) that have a minimum width of 660 feet (200 meters). This minimum width precludes the existence of very narrow or long tracts of data classification. Non-urban and non-man made features may be mapped with polygons with a minimal area of 40 acres (16 hectares) that have a minimum width of 1320 feet (400 meters).

### Data Organization

The LULC data are available in two different formats. The first format was developed as a part of the Geographic Information Retrieval and Analysis System (GIRAS). This data structure evolved as the USGS developed the LULC program in the late 70's. The other format is the Composite Theme Grid (CTG) format. This format is grid cell oriented instead of polygonal.

### Record Descriptions

Geographic Information Retrieval and Analysis System (GIRAS)
The GIRAS format involves a standard character fixed length record (usually ASCII-coded, 80 character card images). Each record may consist of 1 to 16 data-element fields. Each data-element field may be one of three different types: 1) 16 bit binary integer ; 2) 32 bit binary integer or 3) a string of text characters. The GIRAS file structure is comprised of a map header, section header, arc records subfile, coordinate subfile, polygon records subfile, file of arcs by polygon (FAP) subfile, text subfile and an associated data subfile.

### Composite Theme Grid (CTG)

The CTG files are sequential and consist of fixed length records (except for header files) with one grid cell for each logical record. The grid cells are actually a regular point sample of the quad where the center point of each cell is 200 meters apart from other center points in adjacent cells. The cells are mapped to the UTM projection, oriented in the north-south, east-west directions and sequenced by row from north to south, within each row, by column east to west.

### Data Availability

The LULC data are available (at no cost) through an Internet anonymous File Transfer Protocol (FTP) account at the EDC. The data are also available (at cost of reproduction) on magnetic tape from the U.S. Geological Survey's Earth Science Information Centers (ESICs).

### Procedures for Obtaining Data

FTP Instructions
To access the account:

FTP to edcftp.cr.usgs.gov

Enter "anonymous" at the Name prompt.

Enter your complete e-mail address at the Password prompt.

**DESCRIPTION OF LULC DATABASE FROM THE USGS, p. 3**

Change (cd) to the "pub/data/LULC/250K" subdirectory to access 1:250,000-scale LULC data, or cd to the "pub/data/LULC/100K" subdirectory to access 1:100,000-scale data.

Set the file transfer mode to binary by typing the word "binary".
Use the "get" and "mget" commands to download the 00README or data files.

The 00README file located under "/pub/data/LULC/250K" and "/pub/data/LULC/100K" contains an explanation of the directory structure and instructions for uncompressing data files.

The FTP files are also available sorted by state by southeast latitude and longitude of the 1:250,000-scale map:
1:250,000-scale sorted by state
1:100,000-scale sorted by state

**Classification Codes**
Classification Codes-first and second level categories:

1 Urban or Built-Up Land
- 11 Residential
- 12 Commercial Services
- 13 Industrial
- 14 Transportation, Communications
- 15 Industrial and Commercial
- 16 Mixed Urban or Built-Up Land
- 17 Other Urban or Built-Up Land

2 Agricultural Land
- 21 Cropland and Pasture
- 22 Orchards, Groves, Vineyards, Nurseries
- 23 Confined Feeding Operations
- 24 Other Agricultural Land

3 Rangeland
- 31 Herbaceous Rangeland
- 32 Shrub and Brush Rangeland
- 33 Mixed Rangeland

4 Forest Land
- 41 Deciduous Forest Land
- 42 Evergreen Forest Land
- 43 Mixed Forest Land

5 Water
- 51 Streams and Canals
- 52 Lakes
- 53 Reservoirs
- 54 Bays and Estuaries

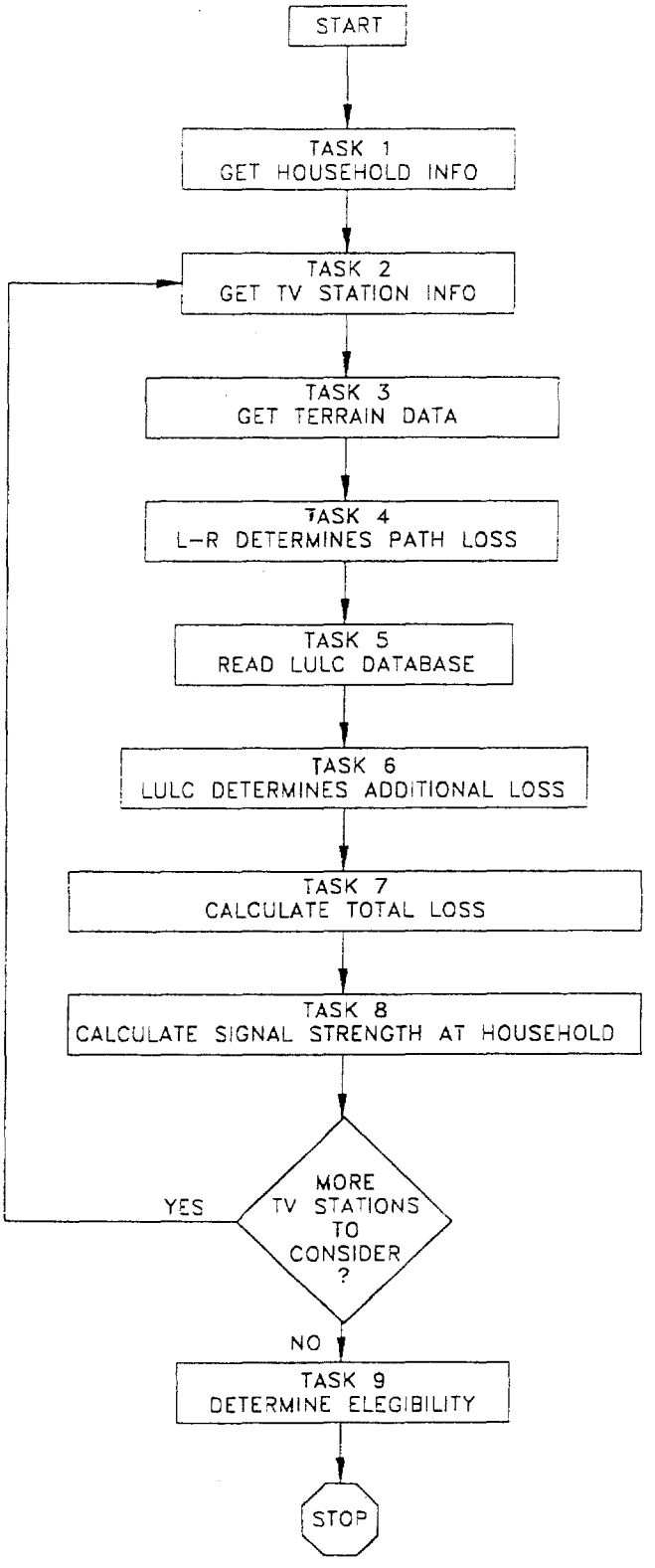
6 Wetland
- 61 Forested Wetlands

**DESCRIPTION OF LULC DATABASE FROM THE USGS, p. 4**

7 Barren Land
- 71 Dry Salt Flats
- 72 Beaches
- 73 Sandy Areas Other than Beaches
- 74 Bare Exposed Rock
- 75 Strip Mines, Quarries, and Gravel Pits
- 76 Transitional Areas
- 77 Mixed Barren Land

8 Tundra
- 81 Shrub and Brush Tundra
- 82 Herbaceous Tundra
- 83 Bare Ground
- 84 Wet Tundra
- 85 Mixed Tundra

9 Perennial Snow and Ice
- 91 Perennial Snowfields
- 92 Glaciers


START
TASK 1
GET HOUSEHOLD INFO
TASK 2
GET TV STATION INFO
TASK 3
GET TERRAIN DATA
TASK 4
L-R DETERMINES PATH LOSS
TASK 5
READ LULC DATABASE
TASK 6
LULC DETERMINES ADDITIONAL LOSS
TASK 7
CALCULATE TOTAL LOSS
TASK 8
CALCULATE SIGNAL STRENGTH AT HOUSEHOLD
MORE TV STATIONS TO CONSIDER ?
YES
NO
TASK 9
DETERMINE ELEGIBILITY
STOP

## CERTIFICATE OF SERVICE

I certify that on this 26th day of April, 1999, a copy of the foregoing filing was caused to be delivered via first-class mail, postage prepaid, to the following parties:

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