APPENDIX B. QKAREA--AN APPLICATIONS PROGRAM

The routine QKAREA (Quick Area) is a main program designed to illustrate one way to use the Longley-Rice model in the area prediction mode. Written under the constraints of 1966 ANSI Fortran, it is meant to be used in a batch environment. It reads cards to define parameters and prints out tables showing estimated quantiles of basic transmission loss versus distance for a set of confidence levels. In addition to the system and environmental parameters, the user may choose from among four different modes of variability analysis and the specific quantiles, both of reliability and of confidence, for which computations will be made.

Input.

Input is through a sequence of cards of ten different "types." Each type introduces a particular set of parameters or directs the program to perform a particular operation. The cards may appear in any number and in almost any order and as many output pages for as many different systems as desired may be produced. The concept is that the information on any one card will change values for the indicated parameters while leaving all other values as they were previously defined. When all desired changes have been made, the user requests an execution run, whereupon computations are made and a page of output produced. At the very beginning all parameters are assigned default values which are therefore the values used unless the user explicitly changes them. Furthermore, most of the parameters by their nature must have strictly positive values; if they are given zero or negative values on the input cards, the program will simply ignore those values and therefore retain those previously given. In particular, since Fortran interprets a blank field as a zero value, such a blank field may be used to indicate that the corresponding parameter is not to be changed.

The cards are read in 10-column fields, the first of which is a sequence of digits and the remaining seven floating point numbers read with an F10.0 format. Column 1 is always an "execute" indicator: if it is any non-zero digit, then as soon as the card is processed the program makes its computations using parameter values as are then defined. The digit in column 2 indicates the card type and defines how the remaining digits in the first ten columns and how the floating point numbers in the remaining fields are to be interpreted. In outline, the ten types can be described as follows:

	Col. 123	11, ...
Stop	XØ	(or a blank card)
Title	X1	(a 60 column title on the next card)
Distance	X2	$d_o, d_1, d_{s1}, d_2, d_{s2}$
Reliability	X3V	q_T, q_L
Confidence	X4	$q_{C1}, q_{C2}, \ldots$
Environment	X5C	$\Delta h, N_o, Z_s, \varepsilon, \sigma$
System	X6NPSS	f_{MHz}, h_{g1}, h_{g2}
(Alternate)	X7NPSS	$f_{MHz}, h_{g1}, h_{g2}, \Delta h, N_s, \varepsilon, \sigma$
Execute	X8	
Reset	X9	

In this table we have begun the representation of a card with the execute digit X in column 1 and the card type digit in column 2. Following this there may be single upper case letters indicating particular parameters with single digit values and then there comes a sequence of variables. These latter are to be replaced by floating point values in successive 10-column fields beginning at column 11. The card types and definitions of the variables are described in detail below.

Card Type 0. Stop. When this card is read the program has finished the job run. If the execute digit is set, a page of output is produced first. This card, which can be entirely blank should be the last card of the input deck. On many computers, however, it is unnecessary. This is true if, upon reading an end of file marker, the computer either leaves the input variables unchanged or zeroes them out.

Card Type 1. Title. If desired the user may supply a short title which will appear at the top of the output pages. This title will consist of the first 60 columns on the card that immediately follows a card of type 1. The default title reads "Area predictions from the Longley-Rice model, version 1.2.1."

Card Type 2. Distances. This card defines the distances at which quantities of basic transmission loss will be computed and displayed. There are three intended formats: (i) d_o alone with the remaining variables omitted--only the single distance d_o; (ii) d_o, d_1, d_{s1} alone--distances from d_o to d_1 in steps of d_{s1}; and (iii) all five variables--after stepping through to d_1 as above, distances continue on to

d_2 in steps of d_{s2}. All distances are measured in kilometers. If d_o and d_1 are nonpositive, the card is ignored; otherwise the entire schema of distances is changed irrespective of what was previously defined. If some of the variables such as the step sizes are undefined, the program will use its own algorithms to define them. In particular, if d_o is nonpositive, it will be replaced by d_{s1}. In the original default condition, distances go from 10 to 150 km in steps of 10 km and then on to 500 km in steps of 50 km.

Card Type 3. Reliability. This card defines the mode of variability and if needed, the quantiles of required reliability. The mode is given in terms of the service intended by the system under study and is defined by the digit V with values

V = 0, single-message service
1, individual service
2, mobile service
3, broadcast service.

Since V can have the value 0, it must always be explicitly given whenever this card type is used. If V=0, there is no meaning to reliability and any quantiles given on the card are ignored. If V is 1 or 2 the quantile in the first field, measured as a percentage, will be used as the required reliability; that in the second field will be ignored. If V is 3, then q_T is the required percent of time and q_L the required percent of locations. If a quantile needed by the variability mode is missing or nonpositive, it will be replaced by the value of 50 percent; thus, if this card is used, all indicated data should probably be explicitly defined. The original default condition assumes the broadcast service (V=3) with both q_T and q_L equal to 50 percent.

Card Type 4. Confidence. This card defines a sequence of confidence levels which will be used as the second independent variable (the first being distance) for which quantiles of basic transmission loss will be computed. There may be from one to seven of these quantiles, all measured as percentages. Each of the listed quantiles will be used in the order given to head a column in the output table. Each use of the card redefines the entire list of confidence levels. If none are specified, the program defaults to a single level equal to 50 percent. The original default condition uses three levels equal to 50, 90, and 10 percent, in that order.

Card Type 5. Environmental parameters. With this card one can specify parameters relating to the terrain, the atmosphere, and the ground. The digit C defines the radio climate according to the coded values:

C = 1, equatorial
2, continental subtropical
3, maritime subtropical
4, desert
5, continental temperate
6, maritime temperate overland
7, maritime temperate oversea.

If the digit is 0 or blank it is ignored, and the climate code used will be the one previously defined. The terrain irregularity parameter Δh is measured in meters; since zero is a legitimate value, when this card is used one must always be sure to define this parameter explicitly. (If a strictly negative value is used, however, the program will employ the previously defined value.) The parameter N_o, measured in N-units, is the surface refractivity of the atmosphere as reduced to sea level, while Z_s, measured in meters, is the average elevation of the ground surface for which the actual surface refractivity N_s will be computed. If the indicated value of N_o is positive, then the value of Z_s must also be supplied; but note that if one wants instead to introduce directly the value of N_s, then one should merely set Z_s to zero or leave that field blank. The dielectric constant ε of the ground and the conductivity σ measured in siemens per meter are in the last two fields. These are treated as a pair; if the value of ε is positive, then the value of σ must also be supplied; if the value of ε is nonpositive, both fields will be ignored. The default values use a continental temperate climate (C=5), an average terrain irregularity with Δh=90 m, a four-thirds earth with N_s=301 N-units, and an average ground with ε=15 and σ=0.005 S/m.

Card Type 6. System parameters. On this card one can specify the parameters that define the system under study and how that system is to be deployed. The digit P defines the polarization: 0 for horizontal and 1 for vertical polarization. The two digits S give the siting criterion codes, first for terminal 1 and then for terminal 2; values: 0 for random siting, 1 for careful siting, and 2 for very careful siting. Since these three digits can have the value 0, they must always be explicitly defined. Some relief, however, is offered by the "no read" digit N. If N=1 then none of the three digits PSS will be read. In any other case all three will be read and used. The frequency f_{MHz} is measured in megahertz and is the value of the carrier frequency. And the heights h_{g1}, h_{g2}, measured in meters, are the heights above ground of the antennas at the two corresponding terminals. If there is a question, it is the so-called center of radiation of the antenna that should be used. The default values use vertical polarization (P=1), random siting (S=0) at both terminals, a frequency of 100 MHz, and antenna heights of 3 m at both terminals.

The latter, of course, are not meant to be useful but only to assure that there is no such thing as an undefined parameter.

Card Type 7. An alternative to card types 5 and 6. This card may be used to introduce most system and environmental parameters at once. The variables have the same meaning and the same input conventions described above. Note that it is the actual surface refractivity N_s that is used here; and recall that Δh should always be defined and that if the digit N is not 1 then all three digits PSS should be defined.

Card Type 8. Execute. When this card is read, the program immediately makes its computations using the data that have been previously defined. This is an alternative to setting the execute digit on the preceding card.

Card Type 9. Reset. When this card is read, the program will reset all parameters to their default values. Any following input cards may proceed on the assumption that they are effectively the first cards in the job run.

Installation.

The program is written in Fortran and conforms to the 1966 ANSI standards. We think it is also compatible with the 1977 ANSI standards. Thus on most modern computers it should be operable with very few modifications. The few changes that might be necessary are listed below.

(1) Some compilers require a PROGRAM card as the first card of the main program. When this is so, a suitable version of such a card should replace the first comment card which now reads "PROGRAM QKAREA."

(2) The input and output files are identified through the two variables KIN and KOT. These in turn are assigned fixed values in a DATA statement near the beginning of the main program. Presently, the values are 5 and 6, respectively. When other values are necessary or desired, one should replace that DATA statement with a suitable alternative.

(3) The only use of Hollerith characters, aside from Hollerith constants within FORMAT statements, is in the reading and writing of the title cards. Presently, this is done with a 15A4 format which will work adequately on many computers. When it is necessary or desirable to make adjustments here, one should change the FORMAT statements 1001 and 2011 and also the length of the array ITL where the title card is stored.

(4) The only non-trivial use of the printer control character is for positioning the printer page at the beginning of a page of output. When it is necessary to delete this use, one should replace FORMAT statement 2001 with a suitable alternative.

(5) With one exception the output lines never exceed 65 characters. The exception is the actual table of computed quantiles of basic transmission loss. The lines there can, if completely filled, occupy as many as 77 characters. When this is too long, one should merely refrain from requesting the full seven different quantiles.

We should also mention the common block /SAVE/. A few of the subprograms are entered several times and expect some of their local variables to have retained the values previously defined. The use of the common block to store such values will, since the block is also present in the main program, assure that the values are retained. Many Fortran processors, however, do always retain the values of local variables. When this is so, the common block /SAVE/ may be deleted wherever it appears without affecting any results. In 1977 ANSI Fortran a suitably phrased SAVE directive would be preferable.

The Longley-Rice model has been successfully installed on fairly small mini-computers. For such computers that do not use the full Standard Fortran, however, the present implementation will probably require considerable modification. The areas where it violates the Standard Basic Fortran, and therefore where one might encounter difficulties, include the following: (i) symbolic names of six characters, (ii) logical variables and logical IF statements, (iii) complex variables and some complex arithmetic, (iv) FUNCTION subprograms that redefine entities in common, (v) array declarators in COMMON statements, (vi) labeled common blocks, (vii) DATA statements, and (viii) the "A" format descriptor.

In general, the program should be operable and results satisfactorily accurate on any computer with floating point numbers having at least six significant decimal figures and a range at least as large as $10^{\pm 35}$.