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VIRGIN ISLANDS LAND USE SURVEY

Final Project Report

Prepared for:

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CHAPTER 1

INTRODUCTION

On March 8, 1989, the Governor of the Virgin Islands signed contract number PC-P&NR - 203-89 between the Department of Planning and Natural Resources (DPNR) and Island Resources Foundation (IRF). The contract called for Island Resources Foundation to conduct a land use survey for the U.S. Virgin Islands.

A major work product of the land use survey project is a series of maps that depict the existing land uses in the Virgin Islands. This report, to which the maps are appended, provides a description of the land use mapping process utilized by the project as well as limited analysis and recommendations extracted from data generated during the project. The report also conveys the other work products of the project, which are:

- a description of the land use classification intensity scale system;
- a description of a geo-referencing system;
- a description of a land use database (including an expanded land use classification system);
- a summary of a seminar on geographic information systems (presented to DPNR on April 17,1989); and
- a bibliography.

The land use maps are a key work product which can stand alone, but this report contains important supplementary information on the land use classification system and the mapping process. Further, we note in passing some very serious project constraints, such as the eight-week time frame (foreshortened from six months), incomplete information, missing DPNR baseline maps and inventory data, and map-scale issues all provided a difficult context for the project which is important to understand. IRF believes that the information, analysis, and maps produced by this project are a substantial step towards the development of a suitable land use information system for the Virgin Islands.

It is impossible in an eight-week project to do more than provide the basis upon which DPNR can build an appropriate land use and natural resources management database. IRF is confident that the material conveyed in this report provides DPNR with a more accurate picture of the Territory's current land use regime than it has had at any time in the past twenty-five years. In addition, the project has provided the tools to construct a sophisticated land use database system.

CHAPTER 2

THE MAPPING PROCESS

This chapter describes the process used by IRF to map the land uses of the Virgin Islands. A discussion of map scale and air photograph interpretation is provided to enable a better understanding of the map products. In addition each of the land use categories is described in detail.

Many of the parameters that applied to the map work in this project were dictated by the terms of IRF's contract with DPNR. The most significant of these were:

1. A map scale of 1:24,000 for island-wide land use maps;
2. A map scale of 1:12,000 for the "urbanizing" areas of St. Thomas and St. Croix; and
3. The use of 1988 black and white air photographs as the primary data source.

As discussed earlier, the time constraints of the project allowed a maximum of four weeks to complete all air photo interpretation.

The mapping process followed a ten step procedure as follows:

1. Devise a land use classification system;
2. Utilize 1988 air-photographs to identify each land use;
3. Outline each land use onto a mylar over lay at the appropriate scale;
4. Note on the mylar overlay those areas where there is uncertainty and field checking is required.
5. Field check as necessary;
6. Correct lines on mylar overlay to reflect field checked information;
7. Ink lines on mylar overlay;
8. Run inked mylar overlay together with mylar base map to produce a draft land map;
9. Further refine draft maps;
10. Produce final maps.

IRF's contract with DPNR required that the island-wide land use maps be produced at a scale of 1:24,000 (one unit on the map equals 24,000 units on the ground; one inch on the map equals two thousand feet on the ground). The contract, as clarified, specified a scale of 1:12,000 for the "urbanizing" areas of St.Thomas and St. Croix. DPNR requested that the following urbanizing areas be mapped:

East End and Tutu Planning Districts, St.Thomas; and

Sion Farm and Southwest Planning Districts, St.Croix.

IRF's contract also specified that the land use mapping be based on interpretation of the 1988 series of air photographs flown for the U.S. Army Corps of Engineers.

The series were flown on various days of March, 1988, at a flight level of 4,800 feet. The scale of the photographs is as follows:

at sea level, 1 inch equals 833 feet;

at 200 feet above sea level, 1 inch equals 800 feet; and

at 400 feet above sea level, 1 inch equals 767 feet.

The focal length of the camera lens was 152.6 mm.

A transparent grid was ruled to show the size of one acre on the air photographs. This was used to determine the density of structures. This density information combined with locally obtained information facilitated the photo interpretation process. The U.S. Geological Survey topographical maps were used as the base maps for the island-wide mapping. These maps had been photo-revised in 1982, (based on photos from before 1978) and indicated recent developments in magenta. The base map for the urbanizing areas was the CH2M Hill, 1:12,000 series.

A considerable amount of field verification was required to ensure map accuracy. Field verification involved a simple but time consuming process of "windshield surveying" those areas where the land use could not be gleaned from the air-photograph. The actual land use would be mapped directly onto the air photograph with a grease pencil and the information transferred to a map at a later date.

It is important to make several observations regarding map scale. The scale selected (1;24,000) is one typically used for planning purposes and is appropriate to indicate island-wide land use patterns. It is not the scale of choice for future more detailed mapping. For the purposes of this project the map scale is adequate to provide a general sense of the location, size and pattern of the basic land uses in the Virgin Islands. It is not adequate to allow for detailed management, planning or engineering. When the Virgin Islands decides to pursue a geographic information system or other more detailed land use mapping program, attention must be paid to the selection of appropriate map scale.

THE LAND USE CLASSIFICATION SYSTEM USED FOR MAPPING

There are four main considerations that went into the development of the land use classification system and intensity scale. These are:

1. The scope of the project (limits of available time and budget);

2. The quality, quantity and availability of land and water use data;

3. The purpose for which the classification system and map products will be used; and,

4. Compatibility with prior land use mapping efforts in the Virgin Islands.

Project time constraints require that the land use system always be a balanced compromise between the ideal and the practical. For instance, Teytaud, 1981, developed a classification system which has seven level-1 (general) land use types, 36 level-2 (detailed) types and some 100 level-3 (very precise) types. Other land use inventory systems that were examined include Zube's 1968 land use survey (12 categories), a 1962 land use classification manual (O'Harrow, 1962), and the Virgin Islands Planning Office's 1977 Land Use and Housing Element (12 categories). In addition, the Virgin Islands Zoning Law (Title 29, Chapter 21, V.I.Code) and the Virgin Islands Coastal Zone Management Act and Coastal Land and Water Use Plan (Title 12, Chapter 21, V.I.) were consulted.

As noted, it is possible to devise a very fine land use classification system that identifies up to several hundred land uses. For instance agricultural land can be mapped simply as "agricultural land" or can be broken down into use types such as crop production, silviculture, animal pasture, and aqua-culture or hydroponic farms. Each of these can, in turn, be further characterized; for instance, crop land can be identified as bananas, pineapple, or sugar cane, if the mapper has sufficient time and adequate data.

An underlying objective of this land use survey is to provide a sufficient level of detail within the time and budget limits of the project. The land use maps that are the final product of this project are expected to be used principally as a planning tool. The level of detail is adequate for planning purposes. The maps displaying this classification system indicate patterns of development, areas that can be expected to develop in the future, and areas that are in need of protection or intensive management.

The primary data source for conducting the land use inventory is the set of air-photographs of the Virgin Islands flown by the Army Corps of Engineers in March, 1988. There are numerous secondary sources including field surveys, 1989 air-photos, and current land use data from the Virgin Islands Government.

Our research has indicated that there has not been a survey of the major land uses of the Virgin Islands since the 1977, Land Use and Housing Element. The Land Use and Housing Element was funded by the U.S. Department of Housing and Urban Development and conducted by the Virgin Islands Planning Office in 1976 and 1977. An original intent of this project was to replicate some important aspects of the Land Use and Housing Element, such as the land use classifications and database. Unfortunately, as a result of the limited scope and time frame of this land use survey project, it is not practical to replicate the 1977 land use classifications. In addition, the land use categories are not defined in sufficient detail to be replicated in this project. Since the data generated by the 1977 land use study is based on inadequately defined criteria, it is not possible to generate meaningful statistical land use change information, based on the 1977 data.

The land use classification system developed for this project is intended to be replicable. The land use categories that have been selected for inclusion are the most significant land uses in the Virgin Islands and are of the type that are typically used for planning purposes. Further, the categories roughly correlate to the existing classification of the Virgin Islands Zoning Law (low-density residential, agricultural, commercial, etc.). The classification system also will lend itself to further refinement and possible use as a base for a computerized geographic information system (GIS) [See Chapter 4].

A final consideration that entered into the selection of the land use categories was the extent to which each use could be identified from the 1988, black and white air-photographs and how such information would be transferred onto maps. A preliminary land use classification system was developed on March 15, 1989, and reviewed by the staff of the Department of Planning and Natural Resources. The system was tested and revised the following week. The system described in this report has been tested and found to be workable for the presentation of the major land and water uses of the Virgin Islands. The system also provides a level of detail that is appropriate for the two map scales that are being used in this project, i.e., 1:24,000 and 1:12,000.

Following is a description of the land use classification system, by land use type, as used in the Virgin Islands Land Use Inventory Project. The intensity scale for each use, as appropriate, is also provided. The classification system is intended to reflect the actual, not potential, uses of land and water. Thus, undeveloped land that is zoned for medium-density residential development will be mapped as undeveloped land. In those cases where a mix of land uses are noted and determined not to be separately identifiable, the predominate land use has been mapped. For example, if a single family home is identified within a farm, the area will be mapped as agricultural land. The minimum mapping unit for this project ranges from one acre for residential uses to 5 acres for retail/commercial uses.

LAND USE CLASSIFICATION SYSTEM

1. AGRICULTURAL: All land dedicated to agriculture falls into this category. This is a broad category, intended to capture the variety of agricultural use in the Virgin Islands. Dairy farming, cattle grazing, crop production, tree farming, and agricultural experiment and field stations are examples of this classification.

2. RESORT/HOTEL: In an economy where tourism is one of the largest sectors, such as the Virgin Islands, it makes sense to identify resort and hotel uses. All resorts and hotels that have been listed by the Virgin Islands Department of Economic Development have been mapped. Hotels and resorts are facilities that: are used primarily by visitors to the islands; rent on a daily or weekly basis; often include ancillary uses

such as swimming pools and restaurants; and usually are owned or managed by a single corporation.

We have distinguished hotels and resorts from non-resort condominiums. While increasingly, condominiums are being used for the same purpose as hotels, they are closer to being a residential land use and generally are mapped as a medium- or high-density land use. In those cases where the distinction is blurred, such as hotels where rooms are owned by individuals, a judgment has been made based on the primary use of the facility.

3. RETAIL/COMMERCIAL: This category is intended to include a wide variety of uses and activities. It is typical to find these uses clustered together in small shopping centers or as strip development along the major roads. Examples of uses included in this classification are gas stations, convenience stores, fast food establishments, small and large shopping centers, restaurants, auto dealerships-auto-servicing centers, and office buildings.

4. INDUSTRIAL/MANUFACTURING: Industrial uses of land in the Virgin Islands range from watch assembly and other light manufacturing to oil refining, electrical generation and water desalination. Other uses included in this category are mining/quarrying, auto-graveyards, warehouses, and non-marine storage and distribution centers. Intensity of use will be indicated by the actual size (as mapped) of the industrial/manufacturing facility.

5. PUBLIC FACILITIES/ PUBLIC INSTITUTIONS: This classification recognizes there are a broad range of uses that are either publicly owned or publicly used, but which do not fit neatly into a single land use category. Examples are airports, schools, fire stations, churches, sewage treatment plants, sanitary land fills, and certain public buildings such as museums, libraries, post offices, universities, and prisons. Intensity of the uses in this category are indicated by their actual land coverage as mapped. To the extent possible the major public facilities are identified by name, e.g., Fort Christian. Other facilities in this category such as schools and churches are identified by a symbol on the maps.

6. RESIDENTIAL: A significant portion of the land of the Virgin Islands is devoted to residential uses. As one would expect, the residential districts in the Zoning Law, when taken together, comprise the largest zoning category. Over sixty per cent of the land area of St.Croix, over eighty per cent of St.Thomas, and over ninety per cent of the non-federal land on St.John is zoned for residential uses. The Zoning Law (Title 29, Chapter 3, Virgin Islands Code) has set the pattern for residential development since its passage in 1973.

Because residential uses of the land of the Virgin Islands are of such importance, they have been divided into three subcategories: low, medium, and high density.

a. LOW DENSITY RESIDENTIAL: This category reflects the fact that low-density residential development is one of the most significant (in terms of land coverage) uses in the Virgin Islands. The pattern of development and density has been guided by the zoning law which defines low density as one or two structures per acre. The R-1 low-density residential zoning district allows one structure (which may contain two dwelling units) per half-acre. For the purposes of this inventory the low-density residential category is defined as having one or two residential structures per acre. In addition, such structures should have no more than two dwelling units and be no more than two stories high. It should be noted that this category is intended to capture, as a mapping unit, those areas that are actually utilized for low-density residential development - not those areas that are zoned for but not yet developed as low-density residential.

b. MEDIUM DENSITY RESIDENTIAL: This is an intermediate class of development that does not correspond directly to the zoning law's classifications. It is based, however, on actual land use development patterns in the Virgin Islands. In reality it is easier to identify those areas that are clearly being used for low-density or high-density residential uses. This category has been created to capture those areas that, in the Virgin Islands' context, fall somewhere between low and high density residential development. Thus a range of 3-6 residential structures (one or two dwelling units per structure) per acre is considered medium density residential development. Development in areas zoned R-2 (low-density residential) is medium density in this survey because generally one finds four structures per acre in this zone. Multi-family dwellings that have 6-10 dwelling units per structure also fall within this category provided that there are a maximum of two structures per acre). Such multi-family structures generally are "low rise" (2-3 stories).

c. HIGH DENSITY RESIDENTIAL: This category includes "high rise" (6-8 stories) residential structures as well as various apartment buildings and condominiums that meet the threshold requirements of the category. Therefore any residential development that is either over 6 structures per acre or over 20 dwelling units per acre is high density. This category includes most public housing, various apartment buildings and certain condominiums. As noted earlier, the differences between condominiums and hotels, from a use perspective, is becoming blurred. However, it is possible to identify those condominiums where the majority of use is by the month or year and thus can be considered "residential." Major high density residential uses are identified by name either on the map or in a key code.

7. URBAN: These are areas of the Virgin Islands that are characterized by highly mixed land use activities, very dense development, and a high concentration of population. These areas are, in fact, very difficult to map adequately by simply using air photographs. Therefore, for the purposes of this survey, urban areas will be identified as a single land use category. A determination has been made that the urban boundaries shall be as follows: Charlotte Amalie, census tract boundaries; Christiansted, census tract boundaries; and Frederiksted, census tract boundaries.

8. WATERFRONT/MARINE: As small remote islands, waterfront and marine uses are of vital importance to the Virgin Islands. This category includes those uses that depend on a location on the shoreline or in the coastal waters. Examples of uses within this category include cruise ship docks, cargo and container ports, oil terminals, marinas, boatyards, and mooring areas. Intensity of the various uses is indicated by their relative size as mapped. To the extent possible, waterfront and marine uses are identified by name and function.

9. PARKS/ DEDICATED OPEN-SPACE/ RECREATION: This category depicts those uses of land and water that are dedicated to recreational activities or land conservation, or in some instances a combination of the two. Uses in this category include recreational areas such as basketball courts, tennis courts, and baseball fields, beaches, and land and water within the Territorial and National Park system. Other land and water that is dedicated to open space such as land owned by the Nature Conservancy and other non-profit organizations is also indicated.

10. UNDEVELOPED: After mapping all of the other land uses in the classification system, any remaining land is classified "undeveloped." Since this is a survey of land uses, not land characteristics, the undeveloped land will not be labeled as "woodland" or "dry scrub vegetation" or "steep slopes." In addition, the identification of land as "undeveloped" will provide an indication of the remaining amount of land that potentially can be developed.

CHAPTER 3

GEOGRAPHIC REFERENCE SYSTEMS AND GEOPOSITIONING

INTRODUCTION

In a discussion of information management needs for the Virgin Islands Biosphere Reserve, Potter, Green and Goodwin (1988) stressed the crucial role of a standard geographic reference system. Their major points, which apply equally well to the needs of DPNR, are briefly summarized in this introductory section. The second section discusses mapped grid systems used in the Virgin Islands, and the third section presents recommendations for developing a standardized geographic reference system. Appendix 1 provides some concrete examples of the use of map grids in geopositioning and gives methods of converting between different coordinate systems.

A geographic reference is defined as a definite, unambiguous point, line, or enclosed two- or three-dimensional space which is related to some specified spatial coordinate system. A review of prior studies on land use, biology, and environmental monitoring carried out for the V.I. Biosphere Reserve found that much of the data had no reliable geographic references. There were two main factors which contributed to this problem:

(a) A lack of standardization and consistency in notation made it difficult to correlate the results of different studies. Geographic references ranged from geographic coordinates in the "degrees, minutes and seconds" of latitude and longitude, to imprecise "metes and bounds" legal property descriptions, to naming of general areas based on the use of the old Danish system of estates and quarters.

(b) Even when a standardized measure such as latitude and longitude was used, in many cases the coordinates given were either incorrect or too imprecise to permit relocation of the exact same spot by future workers.

These same kinds of deficiencies are probably just as common in DPNR's data, since the Department does not currently employ a standardized system of geographic referencing. However, because the Virgin Islands are characterized by small size, critical resource constraints, and intensive human use, resource managers and planners have a correspondingly greater need for precise and unambiguous geopositioning information. Potter, Green and Goodwin stated that:

> The promulgation and enforcement of a geographic reference standard for the information resources ... is the single most significant step that can be taken to improve the long-term effectiveness of [any] information management strategy. Among other advantages, the consistent, universal application of a single geographic reference system will greatly reduce the costs of implementation and data entry for any subsequent Geographic Information System.

single geographic reference system will greatly reduce the costs of implementation and data entry for any subsequent Geographic Information System.

MAPPED GRID SYSTEMS IN THE VIRGIN ISLANDS

Three different coordinate systems appear on the maps and charts commonly used in the Virgin Islands: the Puerto Rican Coordinate System, Virgin Islands Extension ("PR/VI Coordinate System"); the Universal Transverse Mercator (UTM) System; and the latitude and longitude system. Some of these maps display their coordinate system as a rectangular grid of lines as an aid to accurate geopositioning.

Nautical Charts

Nautical charts displaying a latitude and longitude grid are available, at a variety of scales, for all coastal and marine areas in the Territory. Nautical charts do not normally show the other coordinate systems.

USGS "Quads" and "V.I.P.O. 1963"

There are two primary map sources in the Virgin Islands which provide grid systems for terrestrial areas. These are the U. S. Geological Survey's (USGS) standard 7.5-minute topographic quadrangle maps (latest edition 1982, but based on data from before 1978; scale 1:24,000 or 1" = 2,000') and the V.I. Planning Office's (V.I.P.O.) large-scale topographic maps produced by Aero Service Corporation (1963; scale 1:2,400 or 1" = 200'). Many other maps in common use by the local planning and permitting agencies are based on enlargements or reductions of these maps with various details added.

The 1963 V.I.P.O. maps display a 1,000-foot grid based on the PR/VI Coordinate System. Each sheet of this map covers an area corresponding to one minute of latitude and one minute of longitude. At the latitude of the Virgin Islands, this means that each V.I.P.O. grid cell has an area of approximately 22.96 acres or 9.18 hectares. Coordinates of latitude and longitude are shown at the corners of each map sheet.

The 1982 USGS 7.5-minute quadrangles display the Universal Transverse Mercator (UTM) 1,000-meter grid, with each cell covering an area equal to 100 hectares or 247 acres. Cells can be subdivided into 100 subcells; each would then cover 1 hectare or 2.471 acres. The USGS maps also provide tick marks along their margins for latitude/longitude (every 2 minutes 30 seconds of arc) and the PR/VI Coordinate System (every 10,000 feet), thereby facilitating conversions among all three coordinate systems.

It should be noted that while the latitude/longitude grid and the PR/VI Coordinate grid are aligned to true north, the UTM grid has a declination, so that it appears slightly skewed in relation to these. This can be seen by inspection of the USGS map; the amount of the UTM grid declination at the center of each quadrangle map is shown (in both degrees and minutes and in mils) in a diagram at the bottom of each sheet. When measuring angles relative to true north using the USGS map, it is important to measure from the sides of the map, which correspond to meridians of longitude, rather than from the UTM grid lines.

Water Resource Maps (CH2M Hill)

The 1:12,000 or 1" = 1,000' scale series of "Water Resources Maps" (1976) and "Sediment Reduction Program Maps" (1979) produced for DPNR by BC&E/CH2M Hill have no actual grid, but carry tick marks for the PR/VI Coordinate System, spaced 10,000 feet apart and 20,000 feet apart, respectively. These maps also show tick marks for latitude and longitude along their margins.

WAPA

The Virgin Islands Water and Power Authority (VIWAPA) has a computer system running AutoCad software on which it maintains digitized 1" = 200' scale planimetric maps, showing buildings and infrastructure interpreted from 1986 aerial photography. The margins of these maps carry tick marks which are labeled "an approximation of the Puerto Rican Coordinate System." There is a Sheet Index Map for each island which shows sheet numbers for the 1" = 200' maps and which also displays a grid; however, comparison with the USGS map shows that this grid is actually the UTM 1,000-meter grid, not the PR/VI Coordinate System.

Virgin Islands Real Estate Atlas

There is one other "grid system" in the Virgin Islands which is important, although it is not in itself intended to provide accurate geopositioning. This is the grid system employed on the Virgin Islands Real Estate Atlas, Map and Ownership Volume published by Real Estate Data, Inc. The grid, with numbered cells, is displayed on a set of small "Index Maps" (no scale shown) found in the front of the Real Estate Atlases. The lines of this grid correspond to the edges of each sheet of the 1963 V.I.P.O. topographic map, and the numbers in the grid's cells correspond to the sheet numbers of the V.I.P.O. map. Each map sheet also contains a grid reference to sectors within that map. Parcels are numbered as a sub-feature of the map-and-grid numbers.

The importance of the V.I.P.O. Index Map grid is mainly that it allows one to correlate the proper sheet of the V.I.P.O. maps with the V.I. Tax Assessor's Plot Maps. When a particular location can be identified on the V.I.P.O. map, it is then possible to find the correct Tax Assessor's Plot Map in the Real Estate Atlas by utilizing the Index Map grid along with a system of subgrids. This leads via a plot code to land ownership information in the records of the Tax Assessor's Office.

RECOMMENDATIONS

DPNR should adopt a standard geographic reference system according to the following specifications (based on Potter, Green and Goodwin, 1988):

(1) The Virgin Islands Extension of the Puerto Rican grid ("PR/VI Coordinate System"), expressed in feet (i.e., 10,000's), should be adopted as the geographic reference standard for DPNR and all other resource management and planning agencies in the Virgin Islands. Most land survey work for planning, land use mapping, project feasibility studies, permitting and development is

based on either the Puerto Rican Coordinate System/ Virgin Islands Extension or the Universal Transverse Mercator (UTM) system rather than latitude and longitude. All terrestrial mapping work should henceforth use the PR/VI coordinate system as the reference standard for geopositioning.

(2) The geographic references for coastal and marine mapping may also employ the system of latitude and longitude coordinates but each map should show at least three geographic reference coordinates for the PR/VI Coordinate System.

Latitude and longitude is an important secondary coordinate system for the Virgin Islands because of the area's general maritime orientation, the critical importance of its marine and coastal resources and the many recent surveys which establish easily verified "ground truth" points along the coastlines. Precise location of virtually all marine resources or sampling sites in the Territory can be established by triangulation and interpolation from known coastal and offshore features and US Geological Survey benchmarks. In addition, the latitude/longitude coordinate system is the only one which is displayed in common among all the important maps and charts used in the Territory.

(3) It should be DPNR's policy to require and enforce the inclusion of PR/VI Coordinate System marks on all maps which the Department accepts for environmental assessment reports, site plans, biological monitoring studies, etc. One way to enforce this is to require all map submissions to DPNR to use map bases purchased from the Department, at the appropriate scale. In addition, on each map at least one pair of geographic references should be labeled with latitude and longitude and UTM coordinates, to facilitate conversions to the other coordinate systems.

(4) DPNR should maintain geographically referenced data in some type of computerized database (not necessarily a full GIS). Geographic references should be entered exclusively in terms of the PR/VI Coordinate System. Conversion of coordinates to other coordinate systems can be done automatically by a small, stand-alone computer program; software to accomplish such conversions is readily available.

DPNR may permit applicants to provide geographic references in the other two coordinate systems, but for purposes of quality control references should be checked by DPNR's computer before storage in the database. Existing geographic references for important previous studies and mapped information in DPNR's files should be recalibrated to the PR/VI coordinate system as a necessary long-term revision in the Department's information resources.

(5) DPNR should maintain a large-scale display map (1" = 1,000') with detailed overlay grids calibrated to the PR/VI Coordinate System, and with tick marks for latitude and longitude and the UTM system. This should be used to assist staff and permit applicants to estimate geographic reference coordinates.

(6) Reference coordinates for mapped features should follow accepted mapping standards. In general, lines should be identified by the midpoint on the line, and polygons should be identified by a centroid, within the polygon.

(7) When reporting positions that have been determined by standard surveying methods, the precision of the geographic references should be keyed to the size of the unit being reported, with smaller units requiring more precise references. When making imprecise position estimates (e.g., measurements made with a ruler on a map), the reported precision of the geographic references should be consistent with the errors inherent in the scale of the map and the method of measurement.

(8) There are existing Federal cartographic standards for map accuracy which should be adopted by DPNR for all mapping projects, e.g., the National Bureau of Standards (US Dept. of Commerce) FIPS Publication #70, or the standards emerging from the Federal Interagency Coordinating Committee for Digital Cartography (FICCDC).

APPENDIX TO CHAPTER 3:

EXAMPLES OF GEOPOSITIONING AND CONVERTING BETWEEN COORDINATE SYSTEMS

PROBLEM A: Using the most recent USGS map of St. Croix, find the WIVI radio tower at Fort Louise Augusta, northeast of Christiansted, and designate it as a geographic reference point, giving coordinates in the UTM, PR/VI and latitude/longitude systems.

METHOD: Looking at the top margin of the map, notice that the vertical UTM grid lines are labeled 3 10 000 E, 3 11, etc., and that they increase in 1,000-meter increments from west to east. Locate the nearest vertical UTM grid line to the west of the radio tower, this is the one labeled 3 20. The grid line 1,000 meters to the east of this is labeled 3 21, and the tower lies between these. Using a magnifying glass and the finest (60 divisions/inch) scale on a triangular architect's rule, count the number of divisions between these two vertical grid lines; you should get 99. Then measure from the 3 20 line east to the radio tower; you should get 39 divisions.

Now you have to set up a proportion to calculate the number of meters east of the 3 20 grid line that the tower is located. Since the 99 divisions on the ruler represent 1000 meters on the map, the number of meters that the tower lies east of the grid line is given by 39/99 x 1000 meters, or about 394 meters. 20,000 meters plus 394 meters equals 20,394 meters; therefore the vertical grid coordinate of the tower is 3 20 394 E.

Now look at the right side of the map and find the nearest horizontal grid line to the south of the station; this is the 19 63 N (unlabeled in this instance). The tower lies between this line and the next one to the north, the 19 64 line. Measure from the 19 63 line to the radio tower; you should get about 98 units. By setting up a similar proportion, 98/99 x 1000 meters, we can calculate that this represents about 990 meters. 63,000 meters plus 990 meters equals 63,990 meters, hence the horizontal grid coordinate is 19 63 990 N.

Now look at the left-hand bottom margin and right-hand top margin of the map, and find the tick marks on the outside of the margins labeled 1 070 000 FEET and 1 110 000 FEET, respectively. There are also ticks on the outside of the top right-hand margin and bottom left-hand margin, respectively labeled 90 000 FEET and 50 000 FEET. These ticks represent the coordinates of the Puerto Rican Coordinate System, Puerto Rico, St. Croix zone (or Puerto Rican Coordinate System, Virgin Islands extension for St. Thomas and St. John). The coordinates increase from west to east and south to north in increments of 10,000 feet.

Using the 60-scale rule, count the number of divisions between the 70,000 feet and the 80,000 feet tick marks on the right-hand map margin; you should get 301 units. Using a long ruler, draw in a line between the 70,000 feet marks on each side of the map. Now measure perpendicularly from this line north to the radio tower; you should get 148 units. Setting up a proportion, 148/301 x 10,000 feet equals 4917 feet. Then 70,000 feet plus 4,917 feet equals 74, 917 feet, which is the horizontal grid coordinate.

Count the number of divisions between the 1 100 000 FEET tick and the 1 100 000 FEET tick on the upper margin; you should get 299. Then draw in a line between the 1 100 000 feet ticks at the top and bottom margins. Measure from the 1 100 000 feet line east to the radio tower; you should get 155 units. Then 155/299 x 10,000 feet equals 5184 feet, and 1,100,000 feet plus 5184 feet equals 1,105,184 feet, which is the vertical grid coordinate.

Now look at the top and bottom right-hand corners of the same map, respectively labeled 17 degrees 48 minutes and 17 degrees 40 minutes 30 seconds in the latitude/longitude system. These coordinates represent a difference of 7.5 minutes of north latitude between the top and bottom edges of the map. Tick marks are shown every 2'30" of latitude, on the inside of the right-hand margin. Thus the next latitude mark up from the bottom of the map is the 43' tick just inland from the southern coastline, and the one after that is the 45'30" tick just inland from the northern coastline. Similarly, there is a 7.5 minute difference in west longitude between the right and left map margins, respectively labeled 64 degrees 40 minutes 30 seconds and 64 degrees 48 minutes.

Using the 60 divisions/inch scale, count the number of divisions between the 17 degrees 43 minutes and the 17 degrees 45 minutes 30 seconds latitude ticks; you should get 455. Now using a long ruler, draw in the latitude line across the map between the 43" ticks on each side. Measure from this 43' line to the radio tower; you should get 435. Because there are 60 seconds in every minute of latitude, 2'30" equals 150 seconds. Since the 455 ruler divisions represent 150 seconds of latitude on the map, the tower lies 435/455 x 150 or about 143 seconds north of the 43' line. Converting back to minutes and seconds, this gives 2'23". The latitude of the tower is therefore 17 degrees 45 minutes 23 seconds N, which can be expressed in minutes and decimals as 17 degrees 45.4 minutes N.

Now count the number of divisions between the right-hand margin of the map (64 degrees 40 minutes 30 seconds) and the 64 degrees 43 minutes tick; you should get 434. Measure from the right-hand margin to the radio tower, you should get 197. Since 434 divisions represent the 150 seconds of longitude, the tower lies 197/434 x 150 or about 68 seconds west of the 40'30" line. Converting back to minutes and seconds, this gives 1'08". The longitude of the tower is 64 degrees 41 minutes 38 seconds W, or 64 degrees 41.6 minutes W in minutes and decimals.

SOLUTION: Since the convention is to name the horizontal coordinate first, the geographic reference of the tower is: 19 63 990 N, 3 20 394 E in the UTM system; 74 917 FEET, 1 105 184 FEET in the PR/VI Coordinate System; and 17 degrees 45.4 minutes N, 64 degrees 41.6 minutes W in the latitude/longitude system. Because we are measuring to the nearest 1/60th of an inch, and 1 inch equals 2000 feet (606.1 meters, or 19.7 seconds of latitude) on the map, this means that the error in our measurements is plus or minus about 33 feet, or ten meters, or 0.3 seconds of latitude.

PROBLEM B: Using the same USGS map as above, designate the point where UTM grid line 3 21 intersects the shoreline of Beauregard Bay to the east of the WIVI radio tower as a geographic reference. Then transfer this geographic reference point to the V.I.P.O. 1" = 200' scale map, which has no UTM grid, and give its coordinates in the latitude/longitude system.

METHOD: Since both maps have the latitude/longitude and PR/VI coordinate systems, the geographic reference could be transferred by computing its coordinates in either of these systems on the USGS map using the methods of Problem A, and then repeating the process on the V.I.P.O. map. However, there are other methods which depend on the fact that there is a nearby point whose coordinates are known and which is common to both maps, namely the WIVI radio tower. We can use this common geographic reference to fix the position of other points on the V.I.P.O. map.

Since the scale of the two maps is different, we must first compute a scale factor which we can use to convert measurements from one map to the other. In this case we know that one inch on the USGS map equals 2,000 feet on the ground, while one inch on the V.I.P.O. map equals 200 feet. Therefore the scale of the V.I.P.O. map is ten times as large as that of the USGS map, and the scale factor is 10. If we didn't already know the map scales, or if we wanted to check on their accuracy, we could compute the scale factor by taking measurements between two identical points on each map and dividing the larger measurement by the smaller.

Draw a line on the USGS map from the WIVI tower to the intersection point of UTM grid line 3 21 with the shoreline of Beauregard Bay. Use the 60 scale on an architect's rule to accurately measure the length of the line between the radio tower and the point on the shoreline; you should get 59 divisions.

Convert the length of the line between the radio tower and the shoreline point (on the USGS map) to the scale of the V.I.P.O. map by multiplying by the scale factor; therefore we have a length of 59 x 10 = 590 divisions on the 60 scale rule. Find the radio tower on the V.I.P.O. map and set the zero mark of the rule on it. Then, holding the zero mark on the tower, mark the point at which the 590th division intersects the shoreline to the east of the tower. This is the location of UTM grid line 3 21, our geographic reference.

SOLUTION: Once the point is located, we can easily figure out its latitude/longitude coordinates by the methods of Problem A. They are approximately: 17 degrees 45.4 minutes N, 64 degrees 41.3 minutes W.

[Note that in this last example the geographic reference point was easy to transfer because it was chosen as the intersection of the shoreline and the UTM grid line. It would not be so simple if the geographic reference point were, say, a house which was shown on the USGS map but not on the other map. Then it would be necessary to establish bearings to the house from two or three other points common to the two maps. The bearings could be found on the USGS map by using a protractor to measure the angles between true north (indicated by the longitude meridian at the margin of the map) and the lines drawn from the common points. Then lines with the identical bearings can be laid off from the same points on the other map. If this is done accurately the lines should intersect at a point or form a small triangle which represents the location of the house. Yachtsmen may also be familiar with a third method of solving this problem, using a three arm protractor.

[Another, less accurate, method can be used if only a single point is common to both maps. Draw a line between the point and the house on the USGS map, then measure the bearing of this line as well as the distance between the common point and the house. Lay off the same bearing line on the V.I.P.O. map and then measure off the appropriate scaled-up distance along the line to determine the location of the house.]

CHAPTER 4

LAND USE CATEGORIES

The land use classification scheme developed in this section has been designed to provide the Department with a more elaborate classification matrix than can be supported by the simple use of aerial photo interpretation and occasional ground truth checking. The detailed land use classifications presented in this chapter would be derived from a variety of records available to DPNR, either as part of the permit application process or as other publicly available or readily observable behavior.

This classification scheme, or any reasonable modification of it, can be easily implemented in a land use database system, such as that proposed in Chapter 5, below.

Decision Rules

Early in the process of defining detailed land use classifications and intensities, a series of rules were developed to help guide the discussions. These rules were presented for the Department's approval, along with the original proposed land use classes. They are:

1. Use existing Ten Classes.

   That is, the detailed classifications should be a refinement and a detailing of the mapped classifications, rather than an altogether different set of criteria.

2. Sub-categories must be mutually exclusive and exhaustive.

   By definition, each set of sub-categories must add up to 100% of each major category.

3. Prefer Zoning-based sub-categories for decision-making relevance.

   Stated as a preference, rather than an imperative, this rule emphasizes the desire to focus the classification system on relevant decisions.

4. Prefer categories based on existing government record systems, such as business licenses or hotel certificates.

   The Land Use Classification system cannot undertake to reform all of the data systems of Government, nor can it propose to unilaterally impose new standards (such as new hotel/guest house categories) on the well-established practices of other agencies.

5. Prefer photogrammetrically verifiable characteristics.

In addition, indicators of intensity should be factors which are generally easily observable, or available from public records (such as permit or tax abatement applications).

6. Within each Class, identify the relative intensity of use of each sub-category.

The intention of this exercise is to provide a rough yardstick or red flag mechanism to alert planners and permit givers to proposed uses which might have especially adverse effects.

7. For management purposes, prefer to keep total number of categories to less than 100.

As currently defined, this list contains 109 detailed land use classifications.

CLASS
Sub-category

Class / Sub-category	LO	MED	HI
1. Agriculture			
1A Pasture	X		
1B Garden Crops			X
1C Tree Crops		X	
1D Livestock		X	
1E Aquaculture	X		
1F Animal Husbandry			X
1D Other Agriculture		X	

Comment: Intensity based predominantly on negative environmental impacts, especially water and chemical usage. Positive environmental effects can be experienced from well-managed pasture and aquaculture projects.

Class / Sub-category	LO	MED	HI
2. Resort/Hotel			
2A Hotels			X
2B Smaller Hotels		X	
2C Condos and Apartments		X	
2D Guest House and Other	X		

Comment: Categories based on resort and hotel registrations with the Department of Economic Development and Agriculture.

Other includes villas, cottages and campsites.

Intensity based on energy use, employment, and gross revenues per square foot of structure (available from IDC). Generation of sewage, solid waste, and vehicular traffic are additional negative factors contributing to high intensity use. [Murphy's Law Factor: On-site power generation, fresh water production, sewage treatment and solid waste disposal technologies should be evaluated in the context of a high propensity for mechanical systems to break.]

Class / Sub-category	LO	MED	HI
3. Retail/Commercial			
3A Retail Sales and Restaurants		X	
3B Offices		X	
3C Movie Theaters and Drive-ins	X		
3D Gas Stations			X
3E Mixed Use Shopping/Commercial Parks		X	
3F Other Commercial		X	

Comment: Intensity based on economic turnover, energy use -- especially for air conditioning -- and pollution potential. Most significant polluting activities include generation of sewage, solid waste, and vehicular traffic.

CLASS

Sub-category	Intensity LO	MED	HI
4. Industrial/Manufacturing			
4A Light Manufacturing			
4Aa Watch Manufacturing	X		
4Ab Rum Refining		X	
4Ac Textile Processing	X		
4Ad Other Light Manufacturing		X	
4B Heavy Manufacturing			
4Ba Oil Refining			X
4Bb Other Basic Industries			X
4Bc Other Heavy Manufacturing		X	
4C Wholesale and Warehousing		X	
4D Mixed Use Industrial Parks	X		
4E Other Industrial Use		X	

Comment: Intensity based on capital and energy intensity of the enterprise, and pollution potential, especially for shorelines and irreplaceable resources such as groundwater. For example, if an oil refinery uses ten times more energy in the oil refining process than all other energy consumers in the territory combined, it should be recognized as a high intensity land use. Then add in the costs of a spill from one of the tankers which bring oil from Valdez.

5. Public Facilities

Sub-category	LO	MED	HI
5A Schools			
5Aa Private Elementary & 2ndary		X	
5Ab Public Elementary & 2ndary		X	
5Ac Private Post-Secondary School		X	
5Ad Public Post-Secondary School			X
5Ae Other School		X	
5B Airports			X
5C Post Offices		X	
5D Churches	X		
5E Fire & Police Stations	X		
5F Military or Auxiliary Facility		X	
5G Museums & Libraries	X		
5H Landfills			X
5I Other Federal Public Facility		X	
5J Other Non-Federal Public Facilities		X	

Comment: Intensity based on extent of land alteration, pollution potential, stimulus to vehicular traffic and economic impact of use.

CLASS Sub-category	Intensity LO	MED	HI
6. Residential			
6A Low Density Residential			
6Aa Low Density Single Family	X		
6Ab Low Density Two-Family	X		

Comment: Based on one or two dwelling units per structure, and less than three structures per acre.

6B Medium Density			
6Ba Medium Density Single Family	X		
6Bb Medium Density Two Family	X		
6Bc Medium Density Multi-Family		X	

Comment: Assumes three to six single family structures (containing one or two dwelling units) per acre; and multi-family structures containing six to ten dwelling units per structure and not more than two structures per acre.

6C High Density			
6Ca High Density Single Family		X	
6Cb High Density Two Family		X	
6Cc High Density Multi-Family			X

Comment: Assumes more than six single or three duplex family structures per acre; or more than 20 dwelling units in multi-family structures.

Comment: Residential intensities are directly proportional to the number of inhabitants supported per land area unit.

7. Urban			
7A Urban Resort			
7Aa Urban Resort Hotel			X
7Ab Urban Resort Small Hotel		X	
7Ac Urban Resort Condo & Apts.	X		
7Ad Urban Resort Other	X		
7B Urban Retail/Commercial			
7Ba Urban Retail and Restaurants		X	
7Bb Urban Office Structures		X	
7Bc Urban Mixed Commercial Use		X	
7Bd Urban Gas Stations & Parking Lots			X

CLASS Sub-category		Intensity LO	MED	HI
7C Urban Industrial/Manufacturing				
7Ca	Urban Light Industry		X	
7Cb	Urban Wholesale & Warehouse		X	
7Cc	Urban Other Industry			X
7D Urban Public Facilities				
7Da	Urban Schools		X	
7Db	Urban Airports			X
7Dc	Urban Post Offices		X	
7Dd	Urban Churches	X		
7De	Urban Fire & Police Stations	X		
7Df	Urban Military Facility		X	
7Dg	Urban Museums & Libraries	X		
7Dh	Urban Landfills			X
7Di	Urban Other Federal Facilities		X	
7Dj	Urban Other Non-Federal Facilities		X	
7E Urban Residential				
7Ea	Urban Low Density Residential	X		
7Eb	Urban Medium Density Res.	X		
7Ec	Urban High Density Residential		X	
7F Urban Waterfront/Marine				
7Fa	Urban Waterfront Industrial			X
7Fb	Urban Waterfront Pleasure		X	
7G Urban Parks, Open Space, & Recreation		X		
7H Urban Undeveloped		X		
7I Other Urban Use			X	
8. Waterfront/Marine				
8A Waterfront				
8Aa	Cruiseship Piers & Docks			X
8Ab	Cargo Piers & Docks			X
8Ac	Marinas		X	
8Ad	Marine Craft Sales/Service			X
8Ae	Waterfront Recreation	X		
8Af	Non-Commercial Waterfront Use		X	
8Ag	Other Waterfront Uses		X	

Comment: Intensity based on scale of shoreline alteration for the structure, and the potential for chronic or catastrophic pollution incidents.

CLASS Sub-category		Intensity LO	Intensity MED	Intensity HI
8B Marine Uses				
8Ba	Mooring Areas (permitted)		X	
8Bb	Anchoring Areas (not permitted)		X	
8Bc	Channels (buoyed and not)		X	
8Bd	Non-Commercial Transportation		X	
8Be	Fishing and Trapping	X		
8Bf	Other Marine Uses	X		
9. Parks/Open Space/Recreation				
9A Active Recreation Areas				
9Aa	Baseball Diamonds		X	
9Ab	Tennis Courts		X	
9Ac	Football/Soccer/Rugby Fields		X	
9Ad	Cricket Pitches	X		
9Ae	Other Racket Courts		X	
9Af	Track and Field Play Areas	X		
9Ag	Multipurpose Playing Fields	X		
9Ah	Other Active Recreation Areas		X	
9B	Stadiums & Racetracks			X
9C	National Parks		X	
9C	Territorial Parks		X	
9D	Recreational Beaches		X	
9E	Protected Natural Areas	X		
9F	Other Parks and Open Spaces		X	

Comment: Intensity based on environmental impact of the use (e.g., tennis courts are more defacing of the landscape than cricket pitches) and its ancillary facilities, such as parking lots, high intensity lighting, etc..

10. Undeveloped		LO	MED	HI
10A	Mangroves, Salt Ponds & Wetlands		X	
10B	Barren Land & Rocky Shorelines		X	
10C	Scrub and Grasslands		X	
10D	Other Undeveloped Land		X	

CHAPTER 5

LAND USE DATABASE DESIGN

This discussion of a database design for land use records for the Virgin Islands Department of Planning and Natural Resources includes four elements: (1) a brief survey of existing record systems; (2) a proposal for a land use database; (3) file and record descriptions for that proposed system in dBASE III Plus; and (4) a new copy of a dBASE III Plus work-alike (dBXL, by WordTech Systems), assuring that DPNR can run the proposed system on any computer without infringing on copyright and use licenses.

[When DPNR begins to develop regular reporting systems based on the land use database, we suggest the Department acquire one of the stand-alone report writers, rather than relying on the cumbersome report writing functions of dBASE and its clones. Island Resources Foundation has been using R&R Relational Report Writer with success in recent months, but there are a number of similar systems on the market at prices around $150.]

Existing Land Use Record Systems

There are three major sources of parcel-based land use information in the Virgin Islands. The first is the Department of Planning and Natural Resources, which has land use information at both the area, and the parcel level. At the area level, the Department has a land use map (not referenced to parcels) which illustrates general patterns of land use in 1978. This project is producing an update of the earlier map -- at somewhat greater standards of accuracy, but not referenced to parcels -- for land uses seen in 1988-89.

DPNR Parcel Record Systems

Offices generating and tracking land use information in the Department of Planning and Natural Resources are widely dispersed in function and geographic location. Multiple, non-compatible, and non-integrated record systems are maintained independently by DPNR agencies with such diverse mandates as:

- the Virgin Islands' Cadastre Office;
- permitting functions for land development and coastal zone alteration;
- comprehensive territory-wide planning functions; and,
- the issuance and policing of all fishing and hunting licenses.

Except for the Cadastre Office, DPNR offices make no attempt to establish or maintain a comprehensive (i.e., involving all parcels) database of all Virgin Island land units or owners. In general, each office tracks only those units which are licensed or which apply for permits from that office. In addition, it is unclear, for example, whether a property which receives a special land use permit from the Coastal Zone Commission is perpetually subject to monitoring, and whether the record of that permit and its attendant use conditions are actively maintained by DPNR.

[This section could be expanded, depending on information from permit applications and enforcement forms and records used by the Department. But this information was not available.]

Recorder of Deeds

A second major source of definitive land use information is the Recorder of Deeds in the Office of the Lieutenant Governor.

Records in the Office of the Recorder of Deeds are manual -- most record entries are handwritten. The unique property numbering system used by the Recorder of Deeds is based on the historic Estate and Quarter system of the Virgin Islands. This system is referred to as the "legal description" of the property. The cross reference with the unique "map and grid" parcel number used by the Tax Assessor's Office seems to be maintained by the Tax Assessor -- not the Recorder of Deeds.

Tax Assessor's Office

The Office of the Tax Assessor is also part of the Office of the Lieutenant Governor. The St. Thomas Office of the Tax Assessor has recently been moved to the Nisky Center office complex, and will be close to many of the planning, permitting and executive offices of the Department of Planning and Natural Resources.

The Tax Assessor maintains a computerized record for every parcel (and condominium) in the Virgin Islands. The record system is well established and must be considered among the most reliable in the Virgin Islands, since it is used to generate the annual real estate tax bills. Any serious attempt by the DPNR to build a comprehensive parcel and land use record system should start from, and develop update procedures with, the Tax Assessor's system. The current Tax Assessor system is operated as a unit record file, processed in batch mode on the central computer system of the Department of Finance. Modifying and transferring this system to an on-line, networked database accessible to both the Tax Assessor's Office and DPNR should generate substantial benefits for both agencies.

The map and grid system which is used by the Tax Assessor to assign unique parcel numbers is based on large scale maps (apparently larger than 1:1000) provided to the Tax Assessor (specifically, in St. Thomas, Mr. Martin) by the Cadastre Office of DPNR. The exact scale and accuracy standards of these maps are not known.

Other Agencies

Other important sources of information about land use which need to be considered and eventually incorporated into a comprehensive DPNR land use database include:

Detailed farm plans maintained by the delegate agency of the USDA Soil Conservation Service.

Business licenses issued by the Department of Licensing and Consumer Affairs.

Tax incentives awarded by the Industrial Development Commission and other programs of the Department of Economic Development and Agriculture.

National Park use and management plans for park land on St. John, Buck Island and Hassel Island, as well as administrative properties in St. Thomas and St. Croix.

Power and Water networks serviced by WAPA.

Various responsibilities and programs of the Department of Public Works, including highways and planned highways, earth change permits, water well permits, and septic tank and leach bed permits.

Hazardous materials use based on reports filed with the Fire Service or VITEMA.

Housing projects and infrastructure maintained by the Virgin Islands Housing Authority.

Facilities and activities of both the marine and air divisions of the Virgin Islands Port Authority.

Hydrology, including flood zones, erosion zones, and aquifer recharge zones, from the Water Resources Office of the Caribbean Research Institute.

Monumentation -- that is, the construction, recording and maintenance of specific geodetic reference points -- by the USGS, the National Oceanic and Atmospheric Administration, the Federal Aviation Authority, the Army Corps of Engineers, and the Department of the Navy.

Other information relevant to land use, but not necessarily the specific responsibility of any one Virgin Islands government office includes: geology; soil classifications; seismic conditions; and topography.

Database Design

A detailed needs analysis of the Department of Planning and Natural Resources was not conducted for this database design. Furthermore, no effort was made to seek detailed verification of data and other resources potentially available to the Department (e.g., data in the Tax Assessor's files was not analyzed). This design is based on accepted land use database designs used in a variety of local government settings, extensively modified to reflect specific Virgin Islands opportunities, constraints and resources.

As a generic model this proposed system is comprehensive to a fault. That is, it might require converting and updating many variables which are not critical to the decision making needs of the Department.

As submitted, this system design could be made operational within two or three days. (The only task remaining is that of assigning specific codes to variables in the database -- e.g., developing a series of reasonable three digit codes for Virgin Islands soil types.) This approach is not recommended. Instead, we advise conducting an in-house DPNR needs analysis, hewing closely to the specification of information critical to the actual decision making processes of the Department. When this self-examination is complete, the design submitted with this report should be studied rigorously to assure the need for each data item proposed. This two-stage adoption of the proposed database design should permit the Department to eliminate many variables from the submitted design, saving considerable money in both initial system construction and routine database maintenance.

We are confident the current staff and leadership of the Department are well qualified to carry out such a study.

Land Record User Matrix

As a preliminary step in the process of gauging user needs -- both inside and outside the Department -- we offer the tables presented on the two pages following. First is a blank matrix of potential Virgin Islands land record users and major information sources with geographic references.

The second table is a very preliminary attempt to fill in such a matrix. Given the very quick process of development, and the absence of any substantial feedback or reality testing, this second table should not be assumed to be authoritative -- for now, it simply serves as an interesting, if somewhat speculative, illustration of the kinds of information which a user needs study should begin to consider.

It will be noted that the table groups DPNR users and generators of land record information in the upper left corner of the matrix. The filled-in example demonstrates two important facts, related to the future of planning DPNR land record and geographic information systems:

1.) DPNR accounts for a large portion of the total users and generators of map and land record information. This implies that even without the active financial participation of other agencies, DPNR should be able to develop persuasive cost-effectiveness measures for many land record automation procedures.

2.) There are a large number of important users of land record information generated by DPNR. This implies that political and financial support (e.g., by user fees) should not be too difficult to develop.

LAND RECORD USERS MATRIX

[Blank Form for Data Collection]

/015 DPNR Activity Ctrs (OMB #'s)	Exec	TRev	Enfo	RevC	Insp	Cada	CapP	ComP	FAPl	LRPl	Muse	LSCA	EnvP	Other Government Agencies:												Utilities and O								
Land Use Record: -------	4911	4912	4913	4924	4934	4935	4942	4951	4952	4953	4963	4966	4981	LtGv	Fire	VTMA	Elec	L&CA	BIR	Polc	Ed	Hlth	DPW	Park	EcDv	WAPA	VIPA	VTLC	Real	Dev	VINP	SCS	AgEx
Parcel ID and Location																																		
Property Ownership																																		
Land Use																																		
Zoning																																		
Natural Resources																																		
Mineral Resources																																		
Land Surveys																																		
Coastal Zone Impact																																		
Other Environmental Impact																																		
Historic Preservation																																		
Flood Plains																																		
Building Code Violations																																		
Well Information																																		
Topography/Geology																																		
Air Quality Monitoring																																		
Water Quality Monitoring																																		
Groundwater Monitoring																																		
Recreation																																		
Archeology																																		
Other Parcel Characteristics																																		
Earth Change Permits																																		
Forest Cover																																		
Water Transport																																		
Roads																																		
Sewage Plants and Mains																																		
Water Mains																																		
Phone & Cable TV Lines																																		
Ghuts, Culverts & Bridges																																		
Public Facilities																																		
Air and Other Transport																																		
Boat Registration																																		
Fish Catch Data																																		
Fish Licenses																																		
Hunting Data																																		
Flood Plains																																		
Deeds, Liens and Easements																																		
Assessment Data																																		
Soils																																		
Farm Planning																																		
Property Sales																																		
Buildings & Improvements																																		
Epidemeology																																		
Voting Districts																																		
School Districts																																		
Monument Locations																																		
Census Data																																		
Crimes																																		
Fires																																		
Ambulance Calls																																		

G = Generator of Data
U = User of Data
B = Both
? = Question/To Be Determined

VI LAND RECORD USERS

Preliminary Assessment -- April, 1989

DNR Activity Ctrs (OMB #'s)	Exec	TRev	Enfo	RevC	Insp	Cada	CapP	ComP	FAPl	LRPl	Muse	LSCA	EnvP	Other Government Agencies: LtGv	Fire	VTMA	Elec	L&CA	BIR	Polc	Ed	Hlth	DPW	Park	EcDv	Utilities and O WAPA	VIPA	VTLC	Real	Dev	VINP	SCS	AgEx
Land Use Record: -------	4911	4912	4913	4924	4934	4935	4942	4951	4952	4953	4963	4966	4981																				
Parcel ID and Location	..	U	U	U	U	G	..	U	U	U	..	..	U	B	U	U	..	U	U	U	..	..	U	..	..	U	..	U	U	U	..	..	..
Property Ownership	..	U	U	..	U	B	..	U	U	..	..	..	..	G	..	U	U	U	U	..	U	..	..	..	..	..	..	..	U	U	..	..	..
Land Use	U	B	U	..	B	U	U	U	U	U	..	..	B	B	..	..	..	B	..	..	..	U	B	U	U	..	..	..	U	B	B	B	B
Zoning	B	B	U	..	U	U	..	U	U	U	..	..	U	..	..	U	..	U	B	..	..	..	U	..	U	U	..	..	U	U	..	..	..
Natural Resources	U	B	..	..	..	..	..	U	U	U	..	..	B	..	..	..	..	..	..	..	..	..	..	U	B	..	..	..	U	..	..	U	B
Mineral Resources	..	..	..	..	..	..	..	U	U	U	..	..	..	..	..	..	..	..	..	..	..	..	?	U	B	..	..	..	..	U	..	..	..
Land Surveys	..	..	..	..	..	B	..	..	..	..	..	..	..	U	..	..	..	..	..	..	..	..	B	..	..	..	..	..	U	B	..	..	..
Coastal Zone Impact	U	B	B	..	B	..	U	B	B	U	?	..	B	..	..	U	..	..	..	..	..	..	..	U	B	..	U	..	..	G	B	..	..
Other Environmental Impact	U	G	B	U	B	..	..	B	B	B	G	..	B	..	..	U	..	..	..	..	..	U	..	U	B	..	..	..	..	B	B	B	B
Historic Preservation	B	B	U	..	U	..	..	U	U	U	U	U	..	..	..	..	..	U	..	..	..	..	U	U	U	..	..	..	U	U	U	..	..
Flood Plains	U	U	..	..	..	..	U	..	..	U	..	..	..	..	..	B	..	..	..	..	..	..	B	..	..	..	..	..	..	..	..	..	..
Building Code Violations	..	U	?	..	?	?	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	U	B	..	..	U	..	..	..	..	..	..	..
Well Information	..	?	U	..	U	..	..	..	U	U	..	..	B	..	?	?	..	?	..	..	..	U	B	..	U	B	..	..	..	..	..	B	B
Topography/Geology	U	B	..	..	..	..	U	U	B	U	G	..	B	..	..	U	..	..	..	..	..	U	B	U	..	..	..	..	U	U	B	U	U
Air Quality Monitoring	U	U	B	..	?	..	..	U	..	U	..	..	B	..	..	..	..	..	..	..	..	..	U	..	..	U	..	..	..	U	..	..	..
Water Quality Monitoring	U	U	B	..	?	..	..	U	..	U	..	..	B	..	..	..	..	..	..	..	..	U	..	..	..	..	..	..	..	..	..	..	..
Groundwater Monitoring	U	U	B	..	?	..	..	U	..	U	..	..	B	..	..	..	..	..	..	..	..	U	B	..	..	..	..	..	..	..	..	U	U
Recreation	U	U	..	..	..	..	U	U	U	U	U	U	G	..	..	..	..	G	..	U	U	..	..	B	B	..	U	..	U	U	B	..	..
Archeology	B	B	U	..	?	..	B	U	U	B	B	U	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Other Parcel Characteristics	B	B	B	..	U	G	U	..	U	..	G	..	?	B	U	U	..	B	B	U	..	..	B	..	B	B	..	B	U	B	..	U	U
Earth Change Permits	U	U	U	?	..	?	U	U	..	..	..	..	?	?	..	..	..	U	U	..	..	..	B	..	U	..	..	..	..	B	U	U	..
Forest Cover	..	B	..	..	..	..	..	U	U	U	..	..	B	..	U	U	..	..	..	..	..	..	..	B	B	U	..	U	..	U	B	B	U
Water Transport	..	U	..	..	..	..	..	U	..	U	..	..	B	..	U	U	..	?	..	..	..	..	?	U	B	..	B	..	..	..	B	..	..
Roads	U	B	..	..	..	U	U	..	U	U	..	..	?	U	U	U	U	..	..	U	U	..	B	U	U	U	U	U	U	U	B	..	U
Sewage Plants & Mains	U	B	U	..	U	..	B	U	U	U	..	..	U	..	..	U	..	..	..	..	..	U	B	..	U	..	U	..	..	B	..	..	..
Water Plants & Mains	U	B	U	..	..	..	U	U	U	U	..	..	..	..	U	U	..	..	..	..	..	U	B	..	U	B	U	..	U	B	..	U	U
Phone & Cable TV Lines	..	..	..	..	..	..	..	..	..	..	U	U	?	B	..	?	..	U	..	..	..	..	..	..	U	..	..	B	U	..	..	..	..
Ghuts, Culverts & Bridges	U	U	U	?	?	U	U	..	U	..	..	..	U	..	..	B	..	..	..	..	..	..	B	U	B	..	..	..	..	B	U	B	..
Public Facilities	U	B	U	..	U	B	B	B	..	B	U	B	U	B	..	U	U	..	..	..	B	B	B	B	B	U	B	..	U	B	B	..	..
Air and Other Transport	U	U	..	..	..	..	..	U	..	U	..	..	..	..	..	U	..	..	..	..	..	..	B	U	B	U	B	..	..	..	U	..	..
Boat Registration	U	U	B	?	?	..	..	U	U	U	U	..	B	..	..	?	..	?	?	..	..	..	..	U	U	..	U	..	..	..	U	..	..
Fish Catch Data	U	U	B	..	..	..	..	..	U	U	..	..	B	..	..	..	..	..	..	..	..	..	..	..	U	..	U	..	..	..	B	..	U
Fish Licenses	U	U	B	..	..	..	..	..	U	U	..	..	B	..	..	..	..	..	..	..	..	..	..	..	U	..	U	..	..	..	U	..	U
Hunting Data	U	U	B	..	..	..	..	U	U	U	..	..	B	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Flood Plains	U	U	B	..	..	..	U	..	..	U	..	U	..	..	..	B	..	..	..	..	..	..	B	..	U	..	..	..	..	U	..	U	U
Deeds, Liens and Easements	..	..	..	..	..	U?	U	..	..	..	..	..	..	G	..	U	..	U	..	..	..	..	B	B	..	B	..	B	B	B	U	..	..
Assessment Data	U	U	..	..	..	..	..	U	..	U	U	..	..	B	..	U	U	U	B	..	..	..	U	..	U	U	..	U	U	B	U	U	U
Soils	..	U	?	..	..	..	U	U	U	U	..	..	U	..	..	U	..	..	..	..	..	..	B	U	B	..	..	..	..	U	B	B	U
Farm Planning	..	U	..	..	..	..	U	..	..	U	G	..	..	..	..	..	..	..	..	..	..	..	..	..	B	..	..	..	..	..	..	B	U
Property Sales	U	U	..	..	..	B	U	..	..	U	..	..	..	B	..	U	U	..	U	..	..	..	U	..	..	U	..	U	G	U	..	U	..
Buildings & Improvements	B	U	B	..	?	..	U	..	..	U	U	..	..	B	U	U	..	..	U	..	B	B	B	B	B	U	B	U	U	G	..	..	..
Epidemeology	..	..	..	..	..	..	..	..	..	..	..	..	U	..	..	U	..	U	..	..	..	B	..	..	..	..	..	..	..	..	..	..	..
Voting Districts	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	B	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
School Districts	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	B	..	..	..	..	..	..	..	..	..	..	..	..
Monument Locations	..	U	U	..	..	B	U	..	..	..	U	..	..	U	..	?	..	..	..	..	..	..	B	U	..	..	B	..	U	U	U	U	..
Census Data	U	U	..	U	..	U	..	U	..	U	..	U	U	U	U	U	U	U	..	U	U	U	U	U	U	U	..	U	U	..	U	U	U
Crimes	..	..	G	..	?	..	..	..	..	..	..	..	..	..	..	..	..	U	U	B	..	..	U	..	..	..	..	U	U	..	..	..	..
Fires	..	..	..	..	..	..	..	..	..	..	..	..	U	..	B	U	..	..	..	..	..	..	U	..	..	..	..	U	..	..	..	..	..
Ambulance Calls	..	..	..	..	..	..	..	..	..	..	..	..	..	..	B	U	..	..	..	..	..	B	U	..	..	..	..	U	..	..	..	..	..

G = Generator of Data
U = User of Data
B = Both
? = Question/To Be Determined

Parcel-based Database Design

The proposed database for land uses in the Virgin Islands is designed to be a parcel-based system, which should be closely tied to the records of the Tax Assessor's Office to keep pace with the high rate of property transactions experienced in the Virgin Islands. Integration with fast-changing Tax Assessor records provides the advantage of a more up-to-date database.

Full operation of a land use database by the Department is estimated to take at least a year to implement. The advantage of refining such a system is that this effort replicates (in miniature)) most of the steps the Department will have to follow to implement a geographic information system (GIS). In fact, a careful land use database design will solve many of the design and operational problems which must be addressed by the GIS. The land use database will anticipate, not duplicate, many of the most important tasks of the GIS.

Marine Parcels

The parcel-based land use database described here will face special problems in the marine sphere, as do other land record systems. In brief, all Virgin Island land record systems have been designed and implemented on land. To the best of our knowledge:

(1) There is no readily accepted definition of the seaward boundary of the Tax Assessor's map-and-grid coordinate system for property identification; and

(2) There is no accepted nomenclature as an alternative to the "Estate and Quarter" legal descriptions of terrestrial properties.

This is a difficult problem, which can only be solved with the involvement of several Virgin Islands and federal government offices and through study of alternative models which have been developed in other coastal communities. (It might be worth examining how the Danish crown was able to award property rights under Long Bay in St. Thomas Harbor to the West India Company.) In spite of its complexity, increasing pressure on land use and increasing conflicts over marine resource uses make it important to solve the definitional issues as soon as possible.

Architecture, Hardware and Database Language

Detailed design considerations will determine if the land use database system should be implemented as two (or three) separate systems, operated autonomously on each island, or if it is possible to keep just one integrated database for all islands. Basic to this decision will be an examination of the update and revision process for the Tax Assessor's records. If the decentralized architecture is chosen, it will still be necessary to have an integrated database for territory-wide analyses.

Assuming a maximum of 50,000 land parcels, the proposed database is well within the processing capability of current state-of-the-art microcomputers. One such physical architecture would include a medium-speed 286 (i.e., AT compatible) processor, the standard 640K of main memory, and a 120 megabyte hard disk.

Because the "Land Use Survey" Contract specifies that this database should be in dBASE III Plus, that has been the focus of this design. Notwithstanding the contract terms, the choice of a programmable, relational database technology is very appropriate for the Department's needs. IRF would recommend a dBASE III-based (or dBASE IV) system even if it were not required.

With a full 50,000 parcel database, the Departmental users of the land use database will find processing speeds to be unacceptably slow for interpreted versions of the dBASE III language. Fortunately, several compiled versions of the language are available, including Quicksilver, Clipper, and Foxbase, as well as the soon-to-be-released compiler for dBASE IV. If the Virgin Islands Government proceeds with its plans to establish an Information Center, in which centralized batch file systems could be re-organized as on-line databases, DPNR should look to a database language with good SQL (Structured Query Language) interface. (dBXL has one of the best of such systems now -- this is new technology which should be mature in another year or two.)

As with any major systems application, the DPNR land use database should be tried-out experimentally as a prototype. The island of St. John provides one possible example, but there may be other ways for the Department to check out the basic design and operation of the system. This initial prototype implementation can probably use an interpreted dialect (cheaper, easier to modify) of dBASE.

Major Database Fields

Data from the Tax Assessor:

Parcel ID

Using the Island-Map-Grid-Parcel Number identification system assigned by the Tax Assessor has several advantages, not the least of which is that aggregation at the Map or Grid level for some variables could quickly provide gross indices of many characteristics. Even in the absence of a graphic interface for a true GIS, analyses which can highlight general areas of the territory with special characteristics can be very useful for planning.

Legal Description

This is a two field description, based on the traditional house number, Estate and Quarter property descriptions still used by the Recorder of Deeds.

[See the section on "Marine Parcels," above, for a discussion of the special problems of relating marine spaces to both traditional legal descriptions and Parcel IDs.]

Owner Name and Address

These codes can be borrowed from the Tax Assessor records, but they will require significant editing to be useful. For example, last name and first name of owners are in one field, as are city, state and zip code.

Land and Structure Area and Related Information

Tax Assessor records can be used to provide land area of the parcel directly. Area of structures on the land can be calculated from the records, but it will require careful examination and analysis to determine if these are sufficiently accurate to warrant inclusion in the land use database.

A special problem faced by the land use database is the question of how to count (and what to record) multiple buildings on the same parcel of land. At the least, the database should record the number of structures on the parcel.

Additional factors of this nature which are provided on the Tax Assessor record system include: the "class" of each floor; the "ceiling height;" the "number of units;" the shape of the structure; the year of construction; and numerous indicators of building infrastructure, including salt or fresh water toilet systems, cisterns, swimming pools, fences, and so on.

Use Type

The Tax Assessor's record has a field for "Use Type," which should probably be captured. According to coding notations, however, the only characteristics recorded are, "single family housing, multifamily housing, and industrial." As with most other variables in the Tax Assessor's file, the actual coding employed for this field should be checked.

In addition, the land use database will include a three digit field to record the parcel's predominant land use, according to the detailed land use classification schema proposed in this project.

Land and Improvement Value

These are basic items which should be included, if privacy laws permit. It should be noted that these are raw estimated values of land and improvements, not property assessments. The record does not appear to indicate the date of either the estimate or the current assessment.

Assessed Value

As permitted, the assessed value of parcels and improvements should be recorded to facilitate later analysis and modeling of the real estate tax implications of alternative land use policies.

Other Tax Related Information

Important additional land use information in the tax record is the existence of "Exemptions" for farming, homesteads, and the elderly as well as the new sewer fees being levied on property owners receiving such service. Although not directly relevant to land use, "Veterans' Exemptions" should be coded, if only to capture a complete picture of the operation of the property tax system.

A History File

As currently constituted, the Tax Assessor's file is only a statement of current conditions. Updates overwrite and destroy previous information. For the analytical and planning needs of DPNR, it will be important to build a history file, associating each parcel with changes in status and the dates of those changes.

At this time, it is impossible to predict the pattern of changes in land parcel records. Therefore, the simplest way to build a history file is to duplicate the prior record and write it to the history file, every time a record is changed. After accumulating a few months (a year, if disk space permits) of such status changes, the history file can be analyzed to determine the best means of capturing those changes in the Tax Assessor's records that are most relevant to DPNR needs.

This is the apparent limit of the information which can be gleaned from the basic source records in the Tax Assessor's automated files. In addition to the data described above, there is one other piece of information which must be added to the available tax assessor information for each individual parcel record. That is the geographic coordinates, as described briefly below, and extensively in Chapter 3, above.

Geographic Coordinates

These should be based on the grid system and parcel identification technique which the Department decides to adopt. This report recommends the use of the Virgin Island extension of the Puerto Rican grid for all coordinates. The database should keep coordinates in only one system, and provide the translation to the other(s), as needed for specific system outputs.

Land Use Data from Other Sources

The following pieces of information (data record fields or related files) need to be extracted from other sources. It is legitimate to question whether such data is worth the cost of collection and maintenance, if it has to be manually extracted and associated with each of the 40,000 property parcels in the territory. Three alternatives to this costly and time-consuming process are possible:

- Hold off on collecting the information until it becomes more cheaply available as part of a larger mapping or GIS process.
- Eliminate the information as being too costly for the intended uses of the database. (See the recommendation for a detailed DPNR needs assessment in the first part of this chapter.)
- Set up an interim database design which would relate many of these variables only to larger geographic units such as the map or grid coordinates of the Tax Assessor's maps. This would reduce the cost of

collecting and tabulating such data, at a significant reduction in the usefulness of such data in areas of high density or complex multiple use. It is assumed that for the interim period, this imprecision would not be a crippling defect in the development of this phase of the database. This is the alternative which we have followed for the design of this system.

It is also worth noting that the information in the following classes of data is generally more stable than the information which is available from the Tax Assessor's records. This implies that a greater conversion cost for these variables might be acceptable, because the longer term costs of maintenance would be less.

<u>Land Use</u>

As mapped in this survey. The proposed detailed land use categories would include a three digit code, referring to seventy-some classifications.

<u>Zoning and Coastal Zone Designations</u>

These should be provided in two separate variables to avoid unnecessary complexity in coding.

<u>Design Issues</u>

This should be at least two different variables. One would be a three digit code indicating such key conditions as being in an Historic Preservation District, an archaeological or historic site on the parcel, a significant cultural or natural landmark, visual quality factors, and so on. In addition, there should be an open-ended 50-character text variable to note major issues.

<u>Land Use Plan Categories</u>

A three digit variable reserved for the day when the territory has a land use plan.

<u>Soil Classifications</u>

A three digit code identifying major Virgin Islands soil types.

<u>Slope and Aspect</u>

As the simplest topographical variables affecting land use, slope and aspect (direction of downslope) should be recorded at the parcel level. As a true GIS is implemented, however, topography at a considerable level of detail should be included. This will permit the crucial viewshed and line-of-sight analyses which should guide permitting and land use policy making.

<u>Hydrology</u>

One three digit variable can be used to highlight flood risk, sensitive erosion-prone watercourses and shorelines, and aquifer recharge zones.

<u>Seismic Constraints</u>

At the present time, the best indicator that can be achieved is a three digit variable indicating one of eight categories of risk for a parcel, based on the following factors: over or adjacent to known faults; areas of potential liquifaction; tsunami potential; inundation (subsidence risk) area; seismic zones of intensities one (low) to four (highest).

Geological Constraints

This category may cover land use factors which have been sufficiently handled by other variables. Major values would include: landslide susceptibility; subsidence or sinkhole potential.

Conclusion

For further information on this design, see the dBASE database description which follows, and which has also been submitted on a floppy disk.

The proposed database consists of two related files: one (DPNRTAX.DBF) consisting primarily of data at the parcel level, extracted from the georeferencing system and the records of the Office of the Tax Assessor; and one (DPNRLUSE.DBF) consisting of more general attribute information related to land use, registered at the map-grid number level. These two files are related through the map-grid index number. In addition, the parcel-based file is indexed on the parcel identification number assigned by the Tax Assessor. Not shown in the following lists is the history file, which, as described above, should duplicate DPNRTAX.DBF, the parcel-based file, with a field for the date of the transaction. The actual method by which this record is generated will depend on the Department's overall systems design for updating these records.

As with any major database design, these proposed files should be considered preliminary and tentative. In the specific case of this study, lack of access to DPNR record systems for the Department's land records has been a special problem. While we know the detailed composition of the Tax Assessor's computer files, we don't know the form or filing procedures for DPNR's own land record systems. In particular, there may be ways to get good indicators of major issues, such as energy use, building height, water storage and use, sewage systems, and so on. A major advantage of designing a database management system such as dBASE III is that record systems and files can be revised with relative ease.

The structure for the database file DPNRTAX.DBF is as follows:

Field	Field Name	Type	Length	Comment
1	PARCEL_NO	Character	12	Tax Assessor's Parcel ID
2	MAP_GRIDNO	Character	10	Calculate from Parcel ID
3	LEGAL_DES1	Character	24	Tax Asses or Rec. of Deeds
4	LEGAL_DES2	Character	20	Tax Asses or Rec. of Deeds
5	LNAME	Character	20	Adapt from Tax Assessor
6	FNAME	Character	20	" " " "
7	MNAME	Character	12	" " " "
8	ORG_NAME	Character	24	" " " "
9	ADD1	Character	24	" " " "
10	ADD2	Character	24	" " " "
11	CITY	Character	24	" " " "
12	STATE	Character	20	" " " "
13	COUNTRY	Character	15	" " " "
14	ZIP	Character	9	" " " "
15	LAND_AREA	Numeric	12	Cadastre or Tax Assessor
16	BLDG_AREA	Numeric	12	Cad., Tax Assessor or DPW
17	TA_USE_TYP	Character	1	Tax Assessor Rec #5
18	LAND_VALUE	Numeric	12	Tax Assessor Rec #2
19	IMPRV_VALU	Numeric	12	Tax Assessor Rec #2
20	FARM_EXEMP	Numeric	12	Tax Assessor Rec #2
21	HOME_EXEMP	Numeric	12	Tax Assessor Rec #2
22	ELDEREXEMP	Numeric	12	Tax Assessor Rec #2
23	VETS_EXEMP	Numeric	12	Tax Assessor Rec #2
24	SEWER_FEE	Numeric	12	Tax Assessor Rec #2
25	ASSESVALUE	Numeric	12	Calculated
26	DATE_BUILT	Date	8	Tax Assessor Rec #6
27	NUM_BLDGS	Numeric	3	Tax Assessor Rec #6
28	CONST_MATS	Character	1	Tax Assessor Rec #6
29	GEO_COORDX	Numeric	12	DPNR GeoReference System
30	GEO_COORDY	Numeric	12	DPNR GeoReference System

The total record is 416 characters. Two index files are specified, based on the PARCEL_NO (DPTAXPAR.NDX) and the MAP_GRIDNO (DPTAXMAP.NDX).

The structure of the DPNRLUSE.DBF file is as follows:

Field	Field Name	Type	Length	Comment
1	MAP_GRIDNO	Character	10	from Real Estate Map
2	LAND_USE	Character	3	DPNR
3	ZONING	Character	6	DPNR
4	CZM_CAT	Character	6	DPNR Permits
5	DESIGN	Character	3	DPNR Tech Review
6	DESGN_CMNT	Character	50	DPNR Tech Review
7	LUSE_PLAN	Character	3	DPNR Comp Planning
8	SOIL_CLASS	Character	3	SCS or Dept of Ag
9	SLOPE	Character	1	DPNR Tech Review
10	ASPECT	Character	1	DPNR Tech Review
11	HYDROLOGY	Character	3	CRI Water Resource Center
12	SEISMIC	Character	3	VITEMA
13	GEOLOGY	Character	6	

The total length of the file record is 99 characters. The index file is DPLUSMAP.NDX, based on the MAP_GRIDNO field.

CHAPTER 6

SEMINAR ON GIS

The following notes are adapted from lecture notes distributed at a seminar on current topics in Geographic Information Systems, held in the Conference Room of the Department of Planning and Natural Resources on April 17, 1989.

Summary Information on:

Geographic Information Systems

Land Information Systems

Multi-Purpose Cadastre

Multi-Purpose Land Information Systems

Automated Mapping/Facilities Mapping Systems
(all of the above are roughly the same)

A suggested definition:

Geographic Information System:

A Technology for combining Graphic (map) Data and Tabular (database) Information in a topologically related system permitting analysis and display of both graphic and tabular information.

WHY NOW?

GIS/LIS projects are not new.
Even state-wide programs date back to the 1960's.

1. Power of cheap "super-micros" and workstations.

2. Durability and flexibility of digital mapping systems

3. Wide use of computerized databases.

4. Demands for increased accuracy and productivity (including increased legal liability).

5. Improved high resolution display and hardcopy devices.

"GRAPHIC DATA:"

MAPS separated into

Themes (Layers) (e.g.):

Quarter and Estate Boundaries

Water

Land Use

Parcels

Roads

Geodetic Reference

* * * * * * * * * * * *

"TABULAR DATA:"

From files and databases

currently maintained by

PNR and other Government Agencies.

Need Relational DB Structure

Breakthru technology:

"truly distributed" relational database technology

Overlay Example for GIS Analysis

A. Parcels -- Lt. Governor

B. Zoning -- DPNR

C. Floodplains -- VITEMA

D. Wetlands -- DPNR

E. Land Cover -- ED & Ag

F. Soils -- SCS

G. Reference -- USGS or DPNR

H. OVERLAY

GIS GRAPHIC SYSTEMS:

Grid-Based (Raster)

PRO:

- Easy data entry
- Very strong analysis
- Used for Natural Resource Management
- Efficient data storage

CON:

- Coarse resolution

EXAMPLES:

- MAP, etc.
- EPPL7
- MOSS
- GRASS
- ERDAS (satellite display)
- SPAN by GEOVISION

GIS GRAPHIC SYSTEMS:

Vector-based (arc) Systems:

PRO:

- High Resolution
- Accuracy

CON:

- Complex links to tabular data
- Proliferation of slivers
- CPU-intensive processing

EXAMPLES:

- ARC/INFO by ESRI
- Synercom
- Intergraph
- GFIS by IBM

New Technology (possible breakthrough):

"FEATURE ORIENTED" SYSTEMS

- System 9 by Wild
- TIGRIS by Intergraph

Recommended System

The Rules

Do not unnecessarily commit to a single system or vendor

Choose elements with broad acceptance for the intended use
(e.g., Synercom for mapping, not necessarily for GIS)

Choose modular, proven upgradeable systems
(many false claims of compatibility)

Both for hardware platforms, and

for expanded software functionality.

The VI needs new base map. Get maximum affordable resolution (with minimum number of features)

Conduct extended proto-typing

* * * * * * * * * * * *

THE SYSTEM

1. AutoCad or Intergraph mapping system(s)

2. ARC/INFO or pcARC/INFO GIS, integrated with ERDAS raster-based display technology

PREDICTABLE PROBLEMS

1. Inter-departmental cooperation
2. Inter-divisional coordination
3. Sustaining a five-year project
4. Retaining qualified staff
5. Managing multiple contracts for geodesy, photogrammetry, data conversion, etc., etc.
6. Maintaining databases in the future.

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PARTIAL SOLUTIONS

Active gubernatorial support

High level project leadership in PNR

Contract most non-operational expenses to reliable "prime" consultant/ contractor

Develop cost-sharing systems with private sector.

RESOURCES

URISA

Urban and Regional Information Systems Association
319 C Street SE
Washington, DC 20003
"Best Buy" among the associations.

AAG

Association of American Geographers
Arlington, VA

AM/FM International

Automated Mapping/Facilities Mapping
(Low-scale mapping and engineering drawing -- the province of departments of public works.)
Chicago, IL

ASPRS

American Society for Photogrammetry and Remote Sensing
Arlington, VA

ACSM

American Congress for Surveying and Mapping
Arlington, VA

Note: ASPRS and ASCM have two videotapes on GIS technology that might be a good introduction for PNR staff.

GIS/LIS '89

Fourth annual November meeting, sponsored by five groups above, devoted exclusively to GIS issues. In each of the past three years, annual participation has doubled. Three thousand in San Antonio last December.
1989 Meeting will be in Orlando.

Institute for Environmental Studies

University of Wisconsin
Publishes the series:
"Wisconsin Land Information Reports"at $7.50 per volume, these are a "Best Buy"for introductory information on GIS.

North Carolina has also had a recent, well documented state LIS program.

Annotated List of References Provided:

Chrisman, Nicholas R. "Effective Digitizing: Advances in Software and Hardware," A Primer on Multipurpose Land Information Systems. Wisconsin Land Information Report 4, Institute for Environmental Studies, pp. 83-91. Madison, 1988.

Describes why data entry is so costly, and the relatively minor increases in productivity which result from the latest technologies. Good sober antidote to salesmen.

Croswell, Peter L. "Definition of Applications as a Basis for GIS Planning and System Procurement," in URISA Proceedings for 1988 Annual Meeting, Mapping the Future, Volume II, page 13-20. Washington, 1989.

Excellent short summary of GIS planning process.

Dangermond, Jack. "The Land Record Transaction," paper presented and privately distributed at AutoCarto 9, Baltimore, March, 1989.

Wisdom about processing land records in a GIS, from the President of the Environmental Systems Research Institute, publishers of the most successful GIS in the world.

Dueker, Kenneth J. "Urban Applications of Geographic Information Systems Technology: A Grouping into Three Levels of Resolution," in URISA Proceedings for 1988 Annual Meeting, Mapping the Future, Volume II, page 104. Washington, 1989.

Short, tabular presentation of scale and cost factors for various sorts of GIS, ranging from three week to ten year projects.

Hanigan Group. "GIS Recognized as Valuable Tool for Decision Makers," in THE GIS FORUM. Premier Issue, page 4. San Antonio, 1989.

Good survey of the breadth of GIS-type applications, with the major vendors in each market.

Hanigan Group. "Metrocom, A $25 Million Parable," in THE GIS FORUM. Premier Issue, page 1. San Antonio, 1989.

Houston's costly experience in learning that GIS requires basic changes in management, more than reorganization of dp shop.

Thompson, Robert W. "Conversion Issues," paper presented and distributed in mimeograph at AutoCarto 9, Baltimore, March, 1989.

Operational pointers on how to plan and manage the GIS data conversion process from one of America's most experienced practitioners.

Thorpe, John. Privately circulated lecture notes, "Comparative GIS base map cost factors for various features and scale." GIS/LIS III. San Antonio, December 1989.

Tilley, Scott and Stephen L. Sperry. "Raster and Vector Integration," in Computer Graphics World, August, 1988.

Description of the technology used to integrate ERDAS and ARC/INFO GIS display systems, permitting the apparent combination of satellite imagery and more conventional map and GIS products. Leading edge technology.

CHAPTER 7

PLANNING, DATA MANAGEMENT AND POLICY RECOMMENDATIONS

In concluding this project,the research and mapping team reached a kind of consensus on three general observations: (1) the pace and scope of development on St. Thomas, St. Croix and St. John have increased significantly in the last decade, and both the visible and more subtle induced changes in the landscape warrant more detailed assessment and mapping; (2) the quality ,quantity, accessibility and flexibility of the Virgin Islands' land use database in its various manifestations is simply not adequate to meet the complex planning and management needs of today; and (3) more anticipatory planning, more aggressive growth management, and more efficient natural resource system protection appear necessary to reverse the increasingly visible gradual decay of environmental quality in the Virgin Islands. This chapter will elaborate on these themes and offer some recommendations regarding identified areas of concern.

IRF's eight week contract with DPNR called for not only a land use mapping initiative demarcating distinctive kinds of land use but also called for the calculation of the proportion of each of the major land uses in the Virgin Islands. IRF has measured areas covered by each class and then calculated the proportionate share of the total for each land use class or category that was used in preparing the land use maps. The results of these calculations are as follows:

LAND USE CLASSES	St.JOHN	ST.THOMAS	ST.CROIX
AGRICULTURE	0-1%	0-1 %	12%
RESORT/HOTEL	1%	1%	0-1%
RETAIL/COMMERCIAL	0-1%	1%	0-1%
INDUSTRIAL/MANUFACTURING	0-1%	0-1%	5%
PUBLIC FACILITIES	0-1%	4%	5%
LOW DENSITY RESIDENTIAL	2%	12%	10%
MEDIUM DENSITY RESIDENTIAL	1%	13%	3%
HIGH DENSITY RESIDENTIAL	0%	1%	0-1%
ALL RESIDENTIAL	3%	26%	14%
URBAN	0%	2%	0-1%
WATERFRONT/MARINE	0-1%	0-1%	0-1%
PARKS/RECREATION/OPEN SPACE	68%	1%	3%
UNDEVELOPED	26%	61%	59%

Note 1: Totals may not add up to 100% due to rounding.

Note 2: Percentages are calculated as number of acres of each use divided by total land area of each island; example: there are 2,313 acres of land in low density use in St. Thomas, there are 18,817 acres of land in St. Thomas (excluding offshore cays); 2,313 divided by 18,817 equals .1229 or 12 %.

This statistical array needs to be used in conjunction with the land use maps that accompany this report. The purpose of the land use information developed by this project is to present a picture of the extent and type of land use in the Virgin Islands. As such, the maps and other information collected for this report and the accompanying graphics are one of many planning tools necessary to produce a land and water use plan. Data collection, however, should not be confused with planning. Planning is a method of developing policies, laws and other actions that manage growth and development decisions that are to be made in the near and long term future. Data collection on the other hand is an assessment of current conditions from which various conclusions can be reached and planning policies developed.

It is beyond the scope of this project, however, to make judgments regarding the land use data presented on the maps and in this report. For instance, whether there is too much or too little land on St.Thomas devoted to residential use is a policy decision that can only be made by the Government of the Virgin Islands.

On the other hand, certain patterns can be discerned that indicate areas where development has tended to cluster or where there is a distinct lack of recreation areas. If one were to look only at the percentages of land use types, one would see, for example, that only about one per cent of the land area of St. Thomas is devoted to hotel-resort use. This figure provides a distorted picture of the actual situation. If one were to look at the land use map, it would be clear that the preferred location of a resort-hotel is on a beachfront site. It would also be noticed that most resort-hotels are, in fact, located on a beachfront site. It would also be noticed that beachfront sites are few in number in St. Thomas, and of these few sites the vast majority currently have situated on them at least one resort-hotel.

Both the statistical evidence and the maps clearly show that the amount of land dedicated to parks, recreation and open space in St. Thomas and St. Croix is minimal. On St. John the presence of the Virgin Islands National Park skews the data. It is clear from viewing the land use pattern on St. John that the non-park areas east and southeast of Cruz Bay are experiencing intense growth pressure.

Although the presentation of the proportional data of the various land uses of the Virgin Islands provides a picture of the existing situation, it would be useful and would have real planning significance to map the same land use categories with air photographs from selected prior year(s) such as 1975 or 1980. Further analysis is required to calculate the proportion of each land use to the amount of land available and suitable to accommodate that use. This task requires an analysis of both zoning categories and land capability characteristics such as slope, soils, views, and water access.

PLANNING INFORMATION

A geographic information system would be of great use as a tool to manage the complex interactions between land uses and land characteristics. A GIS can be used to help manage future land use based on slope, soils, road access, etc. The major advantage of a GIS is the ability to perform simultaneous analyses of multiple factors, a process that is too complex to do manually, especially when large land areas are involved.

A GIS -- especially one including databases extending beyond land use -- can also help DPNR to focus on areas where environmental problems tend to cluster (e.g., first tier of the coastal zone). In addition, there is a great need in the Virgin Islands to dis-aggregate and conduct detailed analyses on those land use areas which comprise a large percentage of an island's total land area such as "low density residential" and the "undeveloped" class. Again, a GIS can be of major assistance in this task.

The implications of observations such as these: the apparent lack of adequate parks and recreational facilities; the few remaining beaches that do not have a hotel situated on them; the tendency of land outside of the National Park boundaries in St. John to become extremely valuable and subject to intense growth pressure; the apparent loss of agricultural land on St. Thomas and St. John; the concentration of population in certain nodes such as Sion Farm, Red Hook, and Tutu; transportation problems engendered by the distance between population and employment centers and health care facilities; the distinct lack of development in certain portions of the islands (Coral Bay, St. John; West End, St. Thomas; East End, St. Croix); and the general "suburbanization" of development around the four town centers (Charlotte Amalie, Christiansted, Frederiksted, and Cruz Bay) all require further study of the pattern and dynamics of change and more detailed planning.

It is clear that the Virgin Islands are experiencing what could be called a pattern of "Florida style" development. Such development tends to override the island's West Indian identity. It seldom recognizes the special development constraints that smaller, dry, tropical islands face. Techniques such as adaptation to steep topography, protecting views, providing adequate infrastructure and protecting unique features and regional identity need to be introduced into the planning and management process.

A recent Conservation Foundation newsletter story (Buchta, 1987) has drawn our attention to many locations in the United States that are in danger of becoming "accidental cities". According to the Conservation Foundation,

> a wave of poorly managed growth is transforming America's suburbs and small towns, changing some suburbs into "accidental cities" and small towns into suburbs. This transformation is bringing to these communities many of the drawbacks of big cities, such as traffic congestion, with few of the positive qualities that can make cities exciting and enjoyable places. While citizens, officials and planners ponder what to do, some of the ingredients critical to making a community more livable -- open space, rivers and other natural features, scenic and productive agricultural lands, historic buildings -- are deteriorating or disappearing rapidly.

The problems characterized by the Conservation Foundation as "accidental cities" are common to many locations that are subject to rapid growth. The Virgin Islands are no exception to the planning problems facing such areas. The Virgin Islands, however, perhaps have more at stake than most areas This is because the Virgin Islands are a small closed, bound system from a planning perspective. Unlike some areas where there is almost unlimited land for expansion and the accommodation of a wide variety of uses, the Virgin Islands must accommodate all uses within a limited land area. For example, many communities the size of St.Thomas could not easily accommodate a major airport, a large landfill and a hospital . St. Thomas and St. Croix, of course, must find space for these and many other potentially incompatible uses.

As has been well documented, the planning problems of small islands require a high level of attention. The quality of the environment as well as many components of the quality of life for island residents can only be optimized by careful planning and informed natural resource management, sensitive to the ecological base with its various free services which undergird our community structure. As noted it is beyond the scope of this project to suggest planning solutions and management recommendations. The results of the land use survey clearly indicate, however, that there are acute and long-range planning issues that need to be addressed. The Virgin Islands are in danger of becoming an "accidental city" if a meaningful land and water use plan is not developed, adopted and implemented in the near future.

RECOMMENDATIONS

A second element of this project was the development of the framework for a land use database for the Virgin Islands. Chapter 5 of this report contains the recommended database design. In the course of developing the database certain observations were made relating to land use data in the Virgin Islands.

In the first place, it appears that the Department of Planning and Natural Resources is in urgent need of improving its data collection and information management system. We note that the Department does not have an orderly method of collecting, storing or retrieving land use and natural resources data. DPNR could not, for instance, provide IRF with information on the location of approved subdivisions and approved major development projects. Also unavailable was a running inventory and map of historic and archaeological sites, either marine or terrestrial. In addition information related to permit granting such as number and type of permits, value of permitted construction, and number of permits issued by year seems to be unavailable. It also appears from preliminary evidence that the various DPNR permit application forms were designed individually and do not provide a unified data collection program. An immediate improvement in data collection would be achieved should DPNR design a unified permit application, or at least a standardized cover sheet, based on the database proposed in this report.

A separate but related issue is that of data storage, archiving, security, and retrieval. It appears that within DPNR there is no systematic labelling, coding, cross-referencing or cataloging of important land use data such as maps, reports, air photographs, and permit files. An expanded database can be designed which can assist with the maintenance, analysis and use of permit files. A simple coding and catalog program for maps, reports and other land use information can be easily structured. Better still, establish a library so documents can be signed out to individuals and a custody trail established.

One of the advantages of a geographic information system for the Virgin Islands would be the ability to revise and produce all maps in usable and retrievable form. In addition, a GIS would enable the up-dating of land use information on a regular, even daily, basis.

As recommended in this report, the Virgin Islands Government needs to move in the direction of a more systematic and standardized method of collecting land use information. As a start, systematic and standardized geo-positioning information should be required elements of all maps and reports. It is also recommended that the data use requirements of the various Virgin Islands Government agencies (DPNR, WAPA, Public Works, Port Authority Tax Assessor, Police/Fire Departments, etc.) be assessed as it is likely that a coordinated and shared data collection system can be devised. Such a system, perhaps with shared computer facilities, could be cost effective and produce major benefits to the Virgin Islands.

A few final observations are in order. The first is that it has not been the intention of this report to single out the Virgin Islands as an example of a location in need of improved data management. In fact most state and local governments in the United States are in the same position. What IRF has tried to do is be specific and report findings and conclusions from the land use survey project as objectively as possible. More importantly, rather than simply highlight problems, we have tried to highlight options that would lead to realistic solutions.

As noted, certain "low tech" steps can be taken by DPNR to make quick improvements in land use data management. These include the development of a simple code and label system for all maps within the Department and a redesign of permit applications to ensure that geo-positioning information and other data which may be feed into the database is collected.

Additionally, we have noted often in this report the importance of geographic information systems. We have provided DPNR with recent information on the application of a GIS as well as on the positive and negative aspects of such systems. The Virgin Islands Government is perhaps fortunate not to be locked into the hardware and software of any one geographic information system. It is better to evaluate the Territory's needs and budget in a orderly fashion before committing to one GIS or another. The good news is that the technology exists to provide the Virgin Islands with a GIS that will meet the challenges of the 1990's.

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