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# HONEY HILL: A SYSTEMS ANALYSIS FOR PLANNING THE MULTIPLE USE OF CONTROLLED WATER AREAS

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Director

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# HONEY HILL: A SYSTEMS ANALYSIS FOR PLANNING THE MULTIPLE USE OF CONTROLLED WATER AREAS

A Report Submitted to the

U. S. Army Engineer Institute for Water Resources
2461 Eisenhower Avenue
Alexandria, Virginia 22314

By

Department of Landscape Architecture Research Office
Graduate School of Design
Harvard University

Timothy Murray
Peter Rogers
David Sinton
Carl Steinitz
Richard Toth
Douglas Way

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# FOREWORD

## PURPOSE

This research by the Department of Landscape Architecture Research Office, Harvard University, had two major aims. The first purpose was to focus attention on ways and means for measuring non-monetary social and environmental costs and benefits and comparing them with costs and benefits measurable in dollars. The second purpose was to develop better ways to plan for the multiple use of water and related land resources, with emphasis on recreation uses.

## FINDINGS

The first phase of the study was an inventory by map subdivisions of the existing resources of the Honey Hill area of Swanzey, New Hampshire, for a variety of resource and resource-based uses. The data on the area were stored, analyzed and displayed using computer graphics techniques developed by the investigators.

The second phase of the study was the development of quality indices for visual quality, ecological damage, wildlife habitat, etc., which utilized pertinent parameters from the resource inventory. The quality indices were then related to possible land uses including recreation. Finally, the grid areas of Honey Hill were evaluated and ranked in terms of various uses, thus laying the basis for a planning evaluation process for site development.

The third stage of the study was the development and investigation of possible planning evaluation approaches. A simulation model was developed which allows for comparison of the effects over time of alternative plans for use of the area. The model can be run on the basis of days, weeks, months, seasons or years. Alternative plans were developed and tested in the model utilizing both "best professional judgment plans" and alternatives derived from a mathematical programming model developed by the authors. In applying the simulation model the authors assumed various levels of total use from nine combinations of income and travel time-distance to the site. Outputs of the model include: (1) the dollar income generated by the alternative; (2) the dollar costs of construction, management and maintenance; (3) the quality of recreation experience, by activity and by consumer group; and (4) resulting site resource quality.

## ASSESSMENT

The techniques developed from this research appear to offer the Corps planner a powerful means for analyzing complex resource allocation problems. The study demonstrates that a variety of planning procedures can be developed from the basic components of the research: resource inventory, quality evaluations, measurements of impact, and various allocation procedures. The efficiency of utilizing a computer for these purposes has also been demonstrated. Application of the research is seen as especially useful in cases where inadequate data on demand are available and in which the "environmental carrying capacity" of the site must be pre-determined to set limits for development. The limitation of the methodology lies in the quantitative and qualitative assumptions that must be made in the absence of reliable data, or where data collection is costly. This limitation could ultimately be largely removed through research in the following basic areas: (1) the impact of various kinds and intensities of activity on different site conditions; (2) the influences of income, travel distance, and age of participants on the demand for activities; and (3) the quality of recreation experiences.

The findings, conclusions and independent judgment of the researchers are nevertheless their own. The report is not to be construed as necessarily representing the views of the federal government nor the Corps of Engineers.

## STATUS

The Institute for Water Resources is currently pilot testing the techniques developed by the Harvard researchers in the Santa Ana River Basin, Los Angeles District. In this effort the data collection, modeling, programming and analysis are being carried out almost entirely by Corps' personnel. In addition to determining the workability of these techniques at the field level, this pilot test will serve to develop computer graphics skills among a team of engineers, programmers, and environmentalists in the Los Angeles District. If the pilot testing should demonstrate that the planning techniques do, in fact, contribute to improved planning at the field level, the next step will be to develop procedures to bring these tools to the hands of planners throughout the Corps.

ACKNOWLEDGEMENTS

The authors wish to acknowledge the efforts of the many people who contributed to this project. Diana Toth, Robert Berwick, Howard Slavin and Dennis Tihansky made important contributions to the development of the research. Linda Peacock, Lois Kramer, Terry Brown, C. J. Frederick, John Hepting, and members of the Harvard Computation Center were of great assistance in the production of this report. Sandra Rawlett's patience is greatly appreciated.

David Aggerholm, Ray Cason, James Evans, Joseph Ignazio, William McCarthy, John Smith and Harry Schwarz, all of the Corps of Engineers, provided creative criticism and support. And our colleagues in the Department of Landscape Architecture, faculty and students, provided the discipline of intense questioning.

Credit for this report must clearly be shared; responsibility for its shortcomings rests with the authors.

T.M., P.R., D.S., C.S., R.T., D.W.
Cambridge, Massachusetts
January, 1970

TABLE OF CONTENTS

VOLUME 1

FOREWORD iii

ACKNOWLEDGEMENTS v

TABLE OF CONTENTS vi

LIST OF FIGURES xiv

LIST OF TABLES xxx

CHAPTER I: THE PROBLEM DEFINED AND THE RESEARCH STRATEGY 1

A. The Problem 1
B. The Decision-Making Context of the Research 2
C. The Research Strategy 3

CHAPTER II: HONEY HILL: THE STUDY AREA 7

CHAPTER III: DATA INVENTORY 14

A. A Computer Compatible Inventory 14
B. The Spatial Coordinate System: UTM 16
C. Data Cell Size and Spatial Accuracy 17
D. Defining the Study Area 18
E. Data Sources 20
F. The Data Inventory Process 21
G. Data Files 26
H. Selection of the Variables 26

1. Topographic Elevation to the Nearest 5' 27
2&3. Topographic Orientation 27
4. Topographic Slope 35
5. Surficial Landform 35
6. Soil Type 38
7. Bedrock Depth 40
8. Soil Moisture 40
9. Depth to Subsurface Water 40
10. Surface Water - Predominant Type 44
11. Forest Type 44
12. Forest Density 47
13. Forest Height 47
14. Agricultural Activity 47
15. Residential Activity 51
16. Development Activity 51
17. Transportation, Road Type, Existing 51

18. Transportation, Road Type, Proposed 55
19. 5 Minute Time Zones from Point #1 (from East) on Existing Road Network 55
20. 5 Minute Time Zones from Point #2 (from North) on Existing Road Network 55
21. 5 Minute Time Zones from Point #3 (from West) on Existing Road Network 55
22. 5 Minute Time Zones from Point #4 (from Sough) on Existing Road Network 60
23. Proximity to Roads, Existing 60
24. Proximity to Roads, Proposed 60
25. Watersheds 60
26. Proximity to Water, Existing 65
27. Proximity to Water, Proposed 65
28. Proposed Reservation and Recreation Facility 65
29. Visual - Water Awareness 69
30. Microclimate 69

I. Data Other than that on Site Resources 80

1. Zoning 80
2. Land Value 80
3. Water and Sewer 80
4. Land Use 80
5. Local Recreation Demands 80
6. Demographic and Socio-economic 83

CHAPTER IV: PROPOSED ACTIVITIES: "ATTRACTIVENESS" 84

A. The Selection of Activities 84
B. "Attractiveness" Criteria and Standards 89

CHAPTER V: SITE RESOURCE SYSTEMS: "VULNERABILITY" 131

A. Site Resource Systems 131

1. Surface Water 131
2. Surficial Aquifer 132
3. Shoreline 132
4. Soils 132
5. Vegetation 133
6. Wildlife 133
7. Insects 133
8. Potential Scientific Resources 133
9. Visual Impact 133
10. Dry Beach 134
11. Wet Beach 134

B. The Model 134

CHAPTER VI: THE EFFECTS OF ACTIVITIES ON THE SITE RESOURCE SYSTEMS: "IMPACT" 174

A. Total Impact 174
B. The Impacts of Highways on the Site Resource Systems 174

1. Impact of Highways on Surface Water Pollution 200
2. Impact of Highways on Aquifer Pollution 202
3. Impact of Highways on Shoreline Erosion and Turbidity 202
4. Impact of Highways on Soil Erosion 205
5. Impact of Highways on Forest Fire 205
6. Impact of Highways on Wildlife Habitat 205
7. Impact of Highways on Insect Habitat 209
8. Impact of Highways on Scientific Resources 209
9. Impact of Highways on Scenic Resources 212

CHAPTER VII: DEMANDS 214

CHAPTER VIII: DOLLAR COSTS AND BENEFITS 224

A. Costs 224
B. Local and Regional Income 224

CHAPTER IX: THE SIMULATION MODEL 227

CHAPTER X: MAKING PLANS: BEST PROFESSIONAL JUDGMENT 250

A. Two Approaches to Making Plans 250
B. The Professional Judgment Plans: Initial Proposals 251
C. Evaluating the Initial Plans 261
D. Improving the Plans 275

CHAPTER XI: MAKING PLANS: A LINEAR PROGRAMMING MODEL 303

A. Introduction to the Linear Programming Model 303
B. The Linear Programming Model 305

1. Overview 305
2. Constraints on the System 310
3. Objective Function 322
4. Other Considerations Regarding Reservoir Development Objectives 331
5. Summary 333

C. Input Data for the Honey Hill Project 335
D. Results of Computations 353
E. Making Plans from the Linear Program 361
F. Improving the Plans 363

CHAPTER XII: SUMMARY AND CONCLUSIONS 393

A. Summary 393
B. Limitations and Areas for Further Research 397
C. Conclusion 400

VOLUME 2

APPENDIX A: THE PUBLIC DECISION-MAKING PROCESS 404

APPENDIX B: THE CONNECTICUT RIVER BASIN PLAN 411

APPENDIX C: HONEY HILL: A HISTORICAL PERSPECTIVE 431

A. A Physical History 431
B. A Developmental History 436

APPENDIX D: A SURVEY OF CURRENT APPROACHES TO RESOURCE ANALYSIS 441

A. Selected Resource Analysis Approaches 441
B. Methods of Resource Analysis 442

1. General Goals 442
2. Description 446

C. Static Analyses 447

1. Single-Factor Analyses 447
2. Multiple-Factor Analyses 447

a. Overlays 448
b. Point Rating Systems 449
c. Key Element Systems 449

D. Dynamic Analyses 450

1. Systems Analysis Models 450
2. Types of Models 452
3. Single Sector Models 455

a. Flow Systems 455
b. Growth Systems 455

c. Dispersion Systems 456
d. Search Systems 456

4. Multiple Sector Models 456

E. Summary 460

APPENDIX E: THE ROLE OF COMPUTERS IN RESOURCE ANALYSIS 463

A. Data Input 464

1. Preparation of Data in Machine Readable Form 464
2. Recording and Keypunching 464
3. The Medium of Storage 465
4. Long-Term Preservation of Data 466

B. Data Storage 467

1. Definitions 467
2. Types of Data Files 467
3. Two Alternative Data File Structures 468
4. Grid Data Files 470

C. Data Processing 471
D. Output - Computer Graphics 473

1. Criteria for Using Computer Graphics 473
2. Output Hardware 474
3. Software 477

E. The Grid Program 479

APPENDIX F: SPATIAL DATA SYSTEMS FOR RESOURCE ANALYSIS 482

A. Management Issues in Systems Design 482

1. Previous Problems 482
2. System Goals 483
3. Some Important Questions 483

B. Spatial Description 484

1. Defining the Study Area 484
2. Geocoding 486
3. Spatial Types 491
4. Zones for Data Grouping 492

5. Spatial Accuracy 494
6. The Grid as the Basis of Data Organization 495
495

a. Coding Zone Sets to a Grid 500
b. Special Considerations About Using Grids 501

- The Management of Objects of Discrete Events by Grid Cells 501
- Linear Characteristics 502
- Disaggragating Characteristics of Larger Zones to Grid Cells 502

C. Data Categories 503

1. Zone Sets and Classification 503
2. Selection of Data Variables 506

D. Scaling 506
E. Categorization 511

APPENDIX G: A SURVEY OF ACQUISITION METHODS FOR RESOURCE DATA 513

A. Data Acquisition 513

1. Past Experience 513
2. General Issues 514
3. Alternative Existing Data Sources 515
4. Alternative Data Sensing Methods 517
5. Summary Tables 521
6. Data on Demand Factors 527

APPENDIX H: PROFESSIONAL JUDGMENT "A" PLANS 528

H.A. Steinitz "A"
H.B. Toth "A"
H.C. Way "A"
H.D. Peacock "A"

APPENDIX I: PROFESSIONAL JUDGMENT "A" PLANS 569

I.A. Steinitz "B"
I.B. Toth "B"
I.C. Way "B"
I.D. Peacock "B"

APPENDIX J: IMPROVING THE PROFESSIONAL JUDGMENT "B" PLANS 592

J.A. Murray "B" - Initial Plan
J.B. Murray "B" - Improved Via Impact Evaluation
J.C. Murray "B" - Improved Via Attractiveness Evaluation
J.D. Murray "B" - Improved Via Simulation Model Evaluation

APPENDIX K: LINEAR PROGRAM "B" PLAN AND IMPROVED PLAN 626

K.A. Linear Program "B" - Initial Plan
K.B. Linear Program "B" + Program "A"
K.C. Linear Program "B" - Improved Via Simulation Evaluation

APPENDIX L: GRID USERS REFERENCE MANUAL 656

A. Introduction 657
B. Basic Principles 657
C. Data Input 658
D. Map Package 659
E. Irregular Outlines 660
F. Multiple Data Sets 661
G. Subroutine Flexin 663
H. Computer Submissions 664

APPENDIX M: DATA FILES 690

M.A. HONYHIL3: Original Data Inventory
M.B. NRMACT10: Normalized Site Attractiveness Scroes for Each Activity
M.C. HONEYMTX: Input Values for Each Activity on Each Site Resource System
M.D. IMPACT2: Total Impact of Each Activity on all Site Resource Systems, and Total Impact on Each Site Resource Systev by all Activities
M.E. HONYHL11: Professional Judgment Plans
M.F. NEWPLN18: Plans for Sivulation Model Evaluations

BIBLIOGRAPHY 1: BIBLIOGRAPHY FOR APPENDICES 702

BIBLIOGRAPHY 2: BIBLIOGRAPHY OF SELECTED REFERENCES TO RESOURCE ANALYSIS METHODS 711

BIBLIOGRAPHY 3: RESEARCH BIBLIOGRAPHY 721

LIST OF FIGURES

Fig. II.1
The Honey Hill Area in Southern New England

Fig. II.2
Recreation Attractions of the Monadnock Region

Fig. II.3
Aerial View of the Northern End of the Proposed Reservoir Site

Fig. II.4
View Looking West over the Proposed Reservoir Site

Fig. II.5
View Looking Southeast over the Proposed Reservoir Site

Fig. II.6
View Looking Southeast over the Proposed Reservoir Site

Fig. II.7
View Looking East from the Southwest Corner of the Proposed Reservoir Site

Fig. II.8
View Looking Southwest over the Proposed Reservoir from the Southern Base of Honey Hill

Fig. III.1
The Honey Hill Study Area

Fig. III.2
Aerial Photograph of Honey Hill Study Area

Fig. III.3
Combined Aerial Photographs of Honey Hill Study Area

Fig. III.4
Completed Aerial Mosaic of Honey Hill Study Area

Fig. III.5
U.S.G.S. Quadrangle Map of Honey Hill Study Area Divided into 1/100 Square Kilometer Grid

Fig. III.6
Topographic Elevation to the Nearest 5'

Fig. III.7
Oblique View of Topographic Contours in the Study Area as seen from the South

Fig. III.8
Topographic Contours in the Study Area as seen from the North

Fig. III.9
Topographic Contours & Vegetation Type in the Study Area as seen from the North

Fig. III.10
Topographic Contours & vegetation Type in the Study Area as seen from the Northeast

Fig. III.11
Topographic Orientation

Fig. III.12
Topographic Slope

Fig. III.13
Surficial Landform

Fig. III.14
Soil Type

Fig. III.15
Bedrock Depth

Fig. III.16
Soil Moisture

Fig. III.17
Depth to Subsurface Water

Fig. III.18
Surface Water - Predominant Type

Fig. III.19
Forest Type

Fig. III.20
Forest Density

Fig. III.21
Forest Height

Fig. III.22
Agricultural Activity

Fig. III.23
Residential Activity

Fig. III.24
Development Activity

Fig. III.25
Transportation, Road Type, Existing

Fig. III.26
Transportation, Road Type, Proposed

Fig. III.27
5 Minute Time Zones from Point #1 (from East) on Existing Road Network

Fig. III.28
5 Minute Time Zones from Point #2 (from North) on Existing Road Network

Fig. III.29
5 Minute Time Zones from Point #3 (from West) on Existing Road Network

Fig. III.30
5 Minute Time Zones from Point #4 (from South) on Existing Road Network

Fig. III.31
Proximity to Roads, Existing

Fig. III.32
Proximity to Roads, Proposed

Fig. III.33
Watersheds

Fig. III.34
Proximity to Water, Existing

Fig. III.35
Proximity to Water, Proposed

Fig. III.36
Proposed Reservoir & Land Acquisitions

Fig. III.37
Visual Analysis of River Corridor - Location 5-31

Fig. III.38
Visual Analysis of River Corridor - Location 15-31

Fig. III.39
Visual Analysis of River Corridor - Location 35-27

Fig. III.40
Visual Analysis of River Corridor - Location 43-12

Fig. III.41
Visual Analysis of River Corridor - Location 55-10

Fig. III.42
Visual Analysis of River Corridor - Location 75-35

Fig. III.43
Visual Analysis of River Corridor - Location 65-33

Fig. III.44
Visual Analysis of River Corridor - Location 55-38

Fig. III.45
Visual Analysis of River Corridor - Location 45-39

Fig. III.46
Visual Analysis of River Corridor - All Nine Points

Fig. III.47
Ranges of High Temperatures in December, 1969

Fig. III.48
Ranges of Low Temperatures in December, 1969

Fig. IV.1
Attractiveness for Hunting

Fig. IV.2
Attractiveness for Fishing

Fig. IV.3
Attractiveness for Beaches (Swimming)

Fig. IV.4
Attractiveness for Swimming (Water)

Fig. IV.5
Attractiveness for Hiking

Fig. IV.6
Attractiveness for Camping

Fig. IV.7
Attractiveness for Picnic Areas

Fig. IV.8
Attractiveness for General Field Sports and Activities

Fig. IV.9
Attractiveness for Marinas

Fig. IV.10
Attractiveness for Boating

Fig. IV.11
Attractiveness for Snow Shoe Trail

Fig. IV.12
Attractiveness for Cross Country Skiing

Fig. IV.13
Attractiveness for Snowmobiling

Fig. IV.14
Attractiveness for Downhill Skiing

Fig. IV.15
Attractiveness for Ice Skating

Fig. IV.16
Attractiveness for Residential

Fig. IV.17
Attractiveness for Parking

Fig. IV.18
Attractiveness for Highway

Fig. V.1
Vulnerability to Pollution (Degradation) - Surface Water

Fig. V.2
Vulnerability to Pollution - Surficial Aquifer

Fig. V.3
Vulnerability to Turbidity and Shoreline Erosion

Fig. V.4
Vulnerability to Soil Erosion

Fig. V.5
Vulnerability to Forest Fires

Fig. V.6
Vulnerability to Wildlife Habitat

Fig. V.7
Vulnerability to Insects

Fig. V.8
Vulnerability to Scientific Resources

Fig. V.9
Vulnerability to Scenic Resources

Fig. V.10
Vulnerability to Water Fluctuation Damage - Dry Beach

Fig. V.11
Vulnerability to Water Fluctuation Damage - Wet Beach

Fig. VI.1
Total Impact: Hunting

Fig. VI.2
Total Impact: Fishing

Fig. VI.3
Total Impact: Swimming (Beach)

Fig. VI.4
Total Impact: Swimming (Water)

Fig. VI.5
Total Impact: Hiking

Fig. VI.6
Total Impact: Camping

Fig. VI.7
Total Impact: Picnicking

Fig. VI.8
Total Impact: Field Sports

Fig. VI.9
Total Impact: Marinas

Fig. VI.10
Total Impact: Boating

Fig. VI.11
Total Impact: Residential (2 Units/Acre)

Fig. VI.12
Total Impact: Residential (12 Units/Acre)

Fig. VI.13
Total Impact: Parking

Fig. VI.14
Total Impact: Primary Roads

Fig. VI.15
Total Impact: Snow Snoeing

Fig. VI.16
Total Impact: Cross Country Skiing

Fig. VI.17
Total Impact: Snowmobiling

Fig. VI.18
Total Impact: Downhill Skiing

Fig. VI.19
Total Impact: Ice Skating

Fig. VI.20
Total Impact: Residential (2 Units/Acre)

Fig. VI.21
Total Impact: Residential (12 Units/Acre)

Fig. VI.22
Total Impact: Parking

Fig. VI.23
Total Impact: Primary Roads

Fig. VI.24
Total Impact: Reservoir Operation (As Planned)

Fig. VI.25
Total Impact: Reservoir Operation (Daily Fluctuation)

Fig. VI.26
Total Impact: Primary Highways on Surface Water Pollution

Fig. VI.27
Total Impact: Primary Highways on Aquifer Pollution

Fig. VI.28
Total Impact: Primary Highways on Erosion and Turbidity

Fig. VI.29
Total Impact: Primary Highways on Soil Erosion

Fig. VI.30
Total Impact: Primary Highways on Forest Fire

Fig. VI.31
Total Impact: Primary Highways on Wildlife Habitat

Fig. VI.32
Total Impact: Primary Highways on Insect Habitat

Fig. VI.33
Total Impact: Primary Highways on Scientific Resources

Fig. VI.34
Total Impact: Primary Highways on Scenic Resources

Fig. VI.35
Total Impact: Primary Highways on Water Fluctuation - Wet Beach

Fig. VI.36
Total Impact: Primary Highways on Water Fluctuation - Dry Beach

Fig. VII.1
One Hour Time-distance to Site

Fig. X.1
Areas of Required Activity Locations

Fig. X.2
Grid Coding of a Plan at the Worksheet Stage

Fig. X.3
Murray "A": Summer Plan

Fig. X.4
Murray "A": Winter Plan

Fig. X.5
Murray "A": Attractiveness Evaluation

Fig. X.6
Murray "A": Total Impact on Resource Systems

Fig. X.7
Murray "A": Impact on Surface Water System

Fig. X.8
Murray "A": Impact on Wildlife Habitat

Fig. X.9
Murray "A" + Impact Evaluations - Summer Plan

Fig. X.10
Murray "A" + Impact Evaluations - Winter Plan

Fig. X.11
Murray "A" with Impact Evaluation: Attractiveness Evaluation

Fig. X.12
Murray "A" with Impact Evaluations: Total Impact on Resources with Impact Evaluations

Fig. X.13
Murray "A" + Attractiveness Evaluations: Summer Plan

Fig. X.14
Murray "A" + Attractiveness Evaluations: Winter Plan

Fig. X.15
Murray "A" + Attractiveness Evaluations: Attractiveness

Fig. X.16
Murray "A" + Attractiveness Evaluation: Total Impact

Fig. X.17
Murray "A" + Attractiveness Evaluation + Impact Evaluation + Simulation Evaluation (N=3000) - Summer Plan

Fig. X.18
Murray "A" + Attractiveness Evaluation + Impact Evaluation + Simulation Evaluation (N=3000) - Winter Plan

Fig. X.19
Murray "A" with Attractiveness & Impact Evaluation + Simulation Evaluation

Fig. X.20
Murray "A" with Attractiveness & Impact + Simulation Evaluation - Total Impact on All Resource Systems

Fig. X.21
Murray "A" + Attractiveness + Simulation Evaluation - Impact on Surface Water System

Fig. X.22
Murray "A" + Attractiveness + Simulation Evaluation - Impact on Wildlife Habitat

Fig. XI.1
Schematic Diagram of the Proposed Mathematical Model

Fig. XI.2
Schematic Diagram of Net Benefit

Fig. XI.3
Schematic Diagram of Initial Construction Costs

Fig. XI.4
Relationship Between Storage & Surface Area of Reservoir

Fig. XI.5
Typical Benefit Function in the Model

Fig. XI.6
Typical Cost Function in the Model

Fig. XI.7
Power Benefits in the Model

Fig. XI.8
Water Supply Benefits in the Model

Fig. XI.9
Direct Recreational Benefits in the Model

Fig. XI.10
Forest Product Benefits in the Model

Fig. XI.11
Objective Priorities in the Model Formulation

Fig. XI.12
Layout of Zones for Linear Programming Model

Fig. XI.13
The "A" Matrix

Fig. XI.14
Linear Program "A": Summer Plan

Fig. XI.15
Linear Program "A": Winter Plan

Fig. XI.16
Linear Program "A": Attractiveness Evaluation

Fig. XI.17
Linear Program "A": Total Impact

Fig. XI.18
Linear Program "A": Impact on Surface Water System

Fig. XI.19
Linear Program "A": Impact on Wildlife Habitat

Fig. XI.20
Linear Program "A" + Program "A" - Summer Plan

Fig. XI.21
Linear Program "A" + Program "A" - Winter Plan

Fig. XI.22
Linear Program "A" + Program "A" - Attractiveness Evaluation

Fig. XI.23
Linear Program "A" + Program "A" - Total Impact

Fig. XI.24
Linear Program "A" + Program "A" + Simulation Evaluation:
Summer Plan

Fig. XI.25
Linear Program "A" + Program "A" + Simulation Evaluation:
Winter Plan

Fig. XI.26
Linear Program "A" + Program "A" + Simulation Evaluation:
Attractiveness Evaluation

Fig. XI.27
Linear Program "A" + Program "A" + Simulation Evaluation:
Total Impact

Fig. XI.28
Linear Program "A" + Program "A" + Simulation Evaluation:
Impact on Surface Water System

Fig. XI.29
Linear Program "A" + Program "A" + Simulation Evaluation:
Impact on Wildlife Habitat

Fig. B.1
1980 Early Action Plan Connecticut River Basin

Fig. B.2
Comprehensive Plan of Development

Fig. C.1
Map of Swanzey - 1890

Fig. F.1
The Least Common Denominator

Fig. H.1.1
Steinitz "A" - Summer Plan

Fig. H.1.2
Steinitz "A" - Winter Plan

Fig. H.1.3
Steinitz "A" - Attractiveness Evaluation

Fig. H.1.4
Steinitz "A" - Total Impact

Fig. H.1.5
Steinitz "A" - Impact on Surface Water System

Fig. H.1.6
Steinitz "A" - Impact on Wildlife Habitat

Fig. H.2.1
Toth "A": Summer Plan

Fig. H.2.2
Toth "A": Winter Plan

Fig. H.2.3
Toth "A": Attractiveness Evaluation

Fig. H.2.4
Toth "A": Total Impact

Fig. H.2.5
Toth "A": Impact on Surface Water System

Fig. H.2.6
Toth "A": Impact on Wildlife Habitat

Fig. H.3.1
Way "A": Summer Plan

Fig. H.3.2
Way "A": Winter Plan

Fig. H.3.3
Way "A": Attractiveness Evaluation

Fig. H.3.4
Way "A": Total Impact

Fig. H.3.5
Way "A": Impact on Surface Water System

Fig. H.3.6
Way "A": Impact on Wildlife Habitat

Fig. H.4.1
Peacock "A": Summer Plan

Fig. H.4.2
Peacock "A": Winter Plan

Fig. H.4.3
Peacock "A": Attractiveness

Fig. H.4.4
Peacock "A": Total Impact

Fig. H.4.5
Peacock "A": Impact on Surface Water System

Fig. H.4.6
Peacock "A": Impact on Wildlife Habitat

Fig. I.1.1
Steinitz "A": Summer Plan

Fig. I.1.2
Steinitz "B": Winter Plan

Fig. I.1.3
Steinitz "B": Attractiveness

Fig. I.1.4
Steinitz "B": Total Impact

Fig. I.2.1
Toth "B": Summer Plan

Fig. I.2.2
Toth "B": Winter Plan

Fig. I.2.3
Toth "B": Attractiveness

Fig. I.2.4
Toth "B": Total Impact

Fig. I.3.1
Way "B": Summer Plan

Fig. I.3.2
Way "B": Winter Plan

Fig. I.3.3
Way "B": Attractiveness

Fig. I.3.4
Way "B": Total Impact

Fig. I.4.1
Peacock "B": Summer Plan

Fig. I.4.2
Peacock "B": Winter Plan

Fig. I.4.3
Peacock "B": Attractiveness

Fig. I.4.4
Peacock "B": Total Impact

Fig. J.1.1
Murray "B": Summer Plan

Fig. J.1.2
Murray "B": Winter Plan

Fig. J.1.3
Murray "B": Attractiveness

Fig. J.1.4
Murray "B": Total Impact

Fig. J.1.5
Murray "B": Impact on Surface Water Systems

Fig. J.1.6
Murray "B": Impact on Wildlife Habitat

Fig. J.2.1
Murray "B" + Impact Evaluations: Summer Plan

Fig. J.2.2
Murray "B" + Impact Evaluations: Winter Plan

Fig. J.2.3
Murray "B" + Impact Evaluations: Attractiveness

Fig. J.2.4
Murray "B" + Impact Evaluations: Total Impact

Fig. J.3.1
Murray "B" + Attractiveness Evaluations: Summer Plan

Fig. J.3.2
Murray "B" + Attractiveness Evaluations: Winter Plan

Fig. J.3.3
Murray "B" + Attractiveness Evaluations: Attractiveness

Fig. J.3.4
Murray "B" + Attractiveness Evaluations: Total Impact

Fig. J.4.1
Murray "B" + Attractiveness Evaluation + Impact Evaluation + Simulation Model: Summer Plan

Fig. J.4.2
Murray "B" + Attractiveness Evaluation + Impact Evaluation + Simulation Model: Winter Plan

Fig. J.4.3
Murray "B" + Attractiveness Evaluation + Impact Evaluation + Simulation Model: Attractiveness

Fig. J.4.4
Murray "B" + Attractiveness Evaluation + Impact Evaluation + Simulation Model: Total Impact

Fig. J.4.5
Murray "B" + Attractiveness Evaluation + Impact Evaluation + Simulation Model: Impact on Surface Water System

Fig. J.4.6
Murray "B" + Attractiveness Evaluation + Impact Evaluation + Simulation Model: Impact on Wildlife Habitat

Fig. K.1.1
Linear Program "B" N=3000: Summer

Fig. K.1.2
Linear Program "B" N=3000: Winter

Fig. K.1.3
Linear Program "B": Attractiveness

Fig. K.1.4
Linear Program "B": Total Impact

Fig. K.1.5
Linear Program "B": Impact on Surface Water System

Fig. K.1.6
Linear Program "B": Impact on Wildlife Habitat

Fig. K.2.1
Linear Program "B" (N=3000) + Program "A": Summer

Fig. K.2.2
Linear Program "B" (N=3000) + Program "A": Winter

Fig. K.2.3
Linear Program "B" + Program "A": Attractiveness

Fig. K.2.4
Linear Program "B" + Program "A": Total Impact

Fig. K.3.1
Linear Program "B" + Program "A" + Simulation Evaluation (N=3000): Summer

Fig. K.3.2
Linear Program "B" + Program "A" + Simulation Evaluation (N=3000): Winter

Fig. K.3.3
Linear Program "B" + Program "A" + Simulation Evaluation: Attractiveness

Fig. K.3.4
Linear Program "B" + Program "A" + Simulation Evaluation: Total Impact

Fig. K.3.5
Linear Program "B" + Program "A" + Simulation Evaluation: Impact on Surface Water

Fig. K.3.6
Linear Program "B" + Program "A" + Simulation Evaluation: Impact on Wildlife Habitat

LIST OF TABLES

Table IV.1
Pictorial Representation of Total Population Factor Pattern

Table IV.2
Activities Favored by Persons with High Scores on the Factor

Table IV.3
Activities Proposed for the Honey Hill Study

Table VII.1
Number of Households by Income and Time-distance to Site (x 1000)

Table VII.2
Number of Households by Income and Time-distance to Site, Aggregated (x 1000)

Table VII.3
Demand: Propensities of Activity Participation, in Days/Person by Season, by Income and Time-distance to Site

Table VII.4
Demand: Number of First Choice Activity Participants by Season per N=1000 Cars (3250 Persons) by Income and Time-distance to Site

Table VIII.1
Costs of Activity Facilities/Cell (2.5 Acres)

Table VIII.2
Direct Local Income and Regional Multiplier by Activity, by Participant Day

Table IX.1
Summer Propensities of Activity Consumption

Table IX.2
Summer Rates of Activity Consumption (N=3000)

Table IX.3
Winter Propensities of Activity Consumption

Table IX.4
Winter Rates of Activity Consumption (N=3000)

Table IX.5
Space Standards by Activity, Persons per Acre

Table IX.6
Crowding by Activity, Evaluation by Cell

Table IX.7
Number of Cells/Activity/Crowding

Table IX.8
Number of People/Activity/Crowding

Table IX.9
Income/Activity

Table IX.10
Summer Plan Attractiveness

Table IX.11
Winter Plan Attractiveness

Table IX.12
Capital Costs of Plan

Table IX.13
The Simulation Model Steps 1-9

Table IX.14
The Simulation Model Steps 10-13

Table X.1
Professional Judgment Plans - Initial Development Program

Table X.2
Professional Judgment Plans: Initial Site Criteria

Table X.2a
Professional Judgment Plans: Initial Site Criteria: Murray

Table X.3
Activity Code

Table X.4
Murray "A": Initial Plan
Summer N=3000
No. Cells/Activity/Crowding

Table X.5
Murray "A": Initial Plan
Summer N=3000
No. People/Activity/Crowding

Table X.6
Murray "A": Initial Plan
Summer N=3000
Income/Activity

Table X.7
Murray "A": Initial Plan
Winter N=3000
No. Cells/Activity/Crowding

Table X.8
Murray "A": Initial Plan
Winter N=3000
No. People/Activity/Crowding

Table X.9
Murray "A": Initial Plan
Winter N=3000
Income/Activity

Table X.10
Murray "A": Initial Plan
Attractiveness Summary

Table X.11
Murray "A": Initial Plan
Plan Impact

Table X.12
Murray "A": Initial Plan
Capital Costs of Plan

Table X.13
Murray "A": Initial Plan
Summary Under Demands N=1000
Through N=3500

Table X.14
Murray "A" + Impact Evaluations
Summer N=3000
No. Cells/Activity/Crowding

Table X.15
Murray "A" + Impact Evaluations
Summer N=3000
No. People/Activity/Crowding

Table X.16
Murray "A" + Impact Evaluations
Summer N=3000
Income/Activity

Table X.17
Murray "A" + Impact Evaluations
Winter N=3000
No. Cells/Activity/Crowding

Table X.18
Murray "A" + Impact Evaluations
Winter N=3000
No. People/Activity/Crowding

Table X.19
Murray "A" + Impact Evaluations
Winter N=3000
Income Activity

Table X.20
Murray "A" + Impact Evaluations
Attractiveness Summary

Table X.21
Murray "A" + Impact Evaluations
Plan Impact

Table X.22
Murray "A" + Impact Evaluations
Capital Costs of Plan

Murray "A" + Attractiveness Evaluation
Table X.23: "Summer N=3000"
No. Cells/Activity/Crowding

Murray "A" + Attractiveness Evaluation
Table X.24: "Summer N=3000"
No. People/Activity/Crowding

Murray "A" + Attractiveness Evaluation
Table X.25: "Summer N=3000"
Income/Activity

Murray "A" + Attractiveness Evaluations
Table X.26: "Winter N=3000"
No. Cells/Activity/Crowding

Murray "A" + Attractiveness Evaluation
Table X.27: "Winter N=3000"
No. People/Activity/Crowding

Murray "A" + Attractiveness Evaluations
Table X.28: "Winter N=3000"
Income/Activity

Murray "A" + Attractiveness Evaluations
Table X.29: Summary

Murray "A" + Attractiveness Evaluations
Table X.30: Plan Impact

Murray "A" + Attractiveness Evaluations
Table X.31: Capital Costs of Plan

Murray "A" + Simulation Evaluation
Table X.32: "Summer N=3000"
No. Cells/Activity/Crowding

Murray "A" + Simulation Evaluation
Table X.33: "Summer N=3000"
No. People/Activity/Crowding

Murray "A" + Simulation Evaluation
Table X.34: "Summer N=3000"
Income/Activity

Murray "A" + Simulation Evaluation
Table X.35: "Winter N=3000"
No. Cells/Activity/Crowding

Murray "A" + Simulation Evaluation
Table X.36: "Winter N=3000"
No. People/Activity/Crowding

Murray "A" + Simulation Evaluation
Table X.37: "Winter N=3000"
Income/Activity

Murray "A" + Simulation Evaluation
Table X.38: Summary

Murray "A" + Simulation Evaluation
Table X.39: Plan Impact

Murray "A" + Simulation Evaluation
Table X.40: Capital Costs of Plan

Table X.41
Murray "A" Plan: Improvements, N=3000

Table XI.1
List of Symbols in the Environmental Quality Model

Table XI.2
Number of Unknowns in Optimization Problem

Table XI.3
Number of Constraints in Optimization Problem

Table XI.4
Zones for Honey Hill

Table XI.5
Possible Recreation Activities

Table XI.6
Linear Program Output, "B" Plan, N=3000

Table XI.7
Honey Hill Economic Efficiency - Restriction to State Park & Reservoir (Type "A")

Table XI.8
Honey Hill - Economic Efficiency

Table XI.9
Honey Hill - Economic Efficiency (Restriction on Swanzey Lake -- Parking to 100 Cars)

Table XI.10
Linear Program "A": Program for the Initial Plan, N=3000

Linear Program "A": Initial Plan
Table XI.11: "Summer N=3000"
No. Cells/Activity/Crowding

Linear Program "A": Initial Plan
Table XI.12: "Summer N=3000"
No. People/Activity/Crowding

Linear Program "A": Initial Plan
Table XI.13: "Summer N=3000"
Income/Activity

Linear Program "A": Initial Plan
Table XI.14: "Winter N=3000"
No. Cells/Activity/Crowding

Linear Program "A": Initial Plan
Table XI.15: "Winter N=3000"
No. People/Activity/Crowding

Linear Program "A": Initial Plan
Table XI.16: "Winter N=3000"
Income/Activity

Linear Program "A": Initial Plan
Table XI.17: Summary

Linear Program "A": Initial Plan
Table XI.18: Plan Impact

Linear Program "A": Initial Plan
Table XI.19: Capital Costs of Plan

Table XI.20
Linear Program "A": Additional Program Requirements

Linear Program "A" + Program "A"
Table XI.21: "Summer N=3000"
No. Cells/Activity/Crowding

Linear Program "A" + Program "A"
Table XI.22: "Summer N=3000"
No. People/Activity/Crowding

Linear Program "A" + Program "A"
Table XI.23: "Summer N=3000"
Income/Activity

Linear Program "A" + Program "A"
Table XI.24: "Winter N=3000"
No. Cells/Activity/Crowding

Linear Program "A" + Program "A"
Table XI.25: "Winter N=3000"
No. People/Activity/Crowding

Linear Program "A" + Program "A"
Table XI.26: "Winter N=3000"
Income/Activity

Linear Program "A" + Program "A"
Table XI.27: Summary

Linear Program "A" + Program "A"
Table XI.28: Plan Impact

Linear Program "A" + Program "A"
Table XI.29: Capital Costs of Plan

Table XI.30
Linear Program "A": Proposed Program Changes form Simulation Model Evaluations

Linear Program "A" + Simulation Evaluation
Table XI.31: "Summer N=3000"
No. Cells/Activity/Crowding

Linear Program "A" + Simulation Evaluation
Table XI.32: "Summer N=3000"
No. People/Activity/Crowding

Linear Program "A" + Simulation Evaluation
Table XI.33: "Summer N=3000"
Income/Activity

Linear Program "A" + Simulation Evaluation
Table XI.34: "Winter N=3000"
No. Cells/Activity/Crowding

Linear Program "A" + Simulation Evaluation
Table XI.35: "Winter N=3000:
No. People/Activity/Crowding

Linear Program "A" + Simulation Evaluations
Table XI.36: "Winter N=3000"
Income/Activity

Linear Program "A" + Simulation Evaluation
Table XI.37: Summary

Linear Program "A" + Simulation Evaluation
Table XI.38: Plan Impact

Linear Program "A" + Simulation Evaluation
Table XI.39: Capital Costs

Table XI.40
Linear Program "A" Plan: Improvements, N=3000

Table A.1
Interest Groups

Table C.1
Population of Swanzey & Cheshire County, New Hampshire

Table D.1
Classification of Selected Resource Analysis Studies

Table D.2
Classification of Models

Table F.1
Frequency of Use of Variables

Table G.1
Applications of Data Acquisition Techniques & Sources

Table G.2
Relative Effectiveness of Data Sources for Variables Typically Encountered in Land Planning Data Inventories

Table H.1
Professional Judgment Plans: Initial Site Criteria: Steinitz

Steinitz "A"
Table H.1.1: "Summer N=3000"
No. Cells/Activity/Crowding

Steinitz "A"
Table H.1.2: "Summer N=3000"
No. People/Activity/Crowding

Steinitz "A"
Table H.1.3: "Summer N=3000"
Income/Activity

Steinitz "A"
Table H.1.4: "Winter N=3000"
No. Cells/Activity/Crowding

Steinitz "A"
Table H.1.5: "Winter N=3000"
No. People/Activity/Crowding

Steinitz "A"
Table H.1.6: "Winter N=3000"
Income/Activity

Steinitz "A"
Table H.1.7: Attractiveness Summary

Steinitz "A"
Table H.1.8: Plan Impact

Steinitz "A"
Table H.1.9: Capital Costs of Plan

Table H.1.10
Steinitz "A": Initial Plan
Summary Under Demands N=1000, N=3000

Table H.2
Professional Judgment Plans: Initial Site Criteria: Toth

Toth "A"
Table H.2.1: "Summer N=3000"
No. Cells/Activity/Crowding

Toth "A"
Table H.2.2: "Summer N=3000"
No. People/Activity/Crowding

Toth "A"
Table H.2.3: "Summer N=3000"
Income/Activity

Toth "A"
Table H.2.4: "Winter N=3000"
No. Cells/Activity/Crowding

Toth "A"
Table H.2.5: "Winter N=3000"
No. People/Activity/Crowding

Toth "A"
Table H.2.6: "Winter N=3000"
Income/Activity

Toth "A"
Table H.2.7: Summary Attractiveness

Toth "A"
Table H.2.8: Plan Impact

Toth "A"
Table H.2.9: Capital Costs of Plan

Table H.2.10
Toth "A": Initial Plan
Summary Under Demands N=1000 Through N=3000

Table H.3.1
Professional Judgment Plans: Initial Site Criteria: Way

Table H.4.1
Professional Judgment Plans: Initial Site Criteria:
Peacock

Steinitz "B"
Table I.1.1: "Summer N=3000"
No. Cells/Activity/Crowding

Steintiz "B"
Table I.1.2: "Summer N=3000"
No. People/Activity/Crowding

Steinitz "B"
Table I.1.3: "Summer N=3000"
Income/Activity

Steinitz "B"
Table I.1.4: "Winter N=3000"
No. Cells/Activity/Crowding

Steinitz "B"
Table I.1.5: "Winter N=3000"
No. People/Activity/Crowding

Steinitz "B"
Table I.1.6: "Winter N=3000"
Income/Activity

Steinitz "B"
Table I.1.7: Attractiveness Summary

Toth "B"
Table I.2.1: "Summar N=3000"
No. Cells/Activity/Crowding

Toth "B"
Table I.2.2: "Summer N=3000"
No. People/Activity/Crowding

Toth "B"
Table I.2.3: "Summer N=3000:
Income/Activity

Toth "B"
Table I.2.4: "Winter N=3000"
No. Cells/Activity/Crowding

Toth "B"
Table I.2.5: "Winter N=3000"
No. People/Activity/Crowding

Toth "B"
Table I.2.6: "Winter N=3000"
Income/Activity

Toth "B"
Table I.2.7: Attractiveness Summary

Toth "B"
Table I.2.8: Plan Impact

Toth "B"
Table I.2.9: Capital Costs of Plan

Murray "B"
Table J.1.1: "Summer N=3000"
No. Cells/Activity/Crowding

Murray "B"
Table J.1.2: "Summer N=3000"
No. People/Activity/Crowding

Murray "B"
Table J.1.3: "Summer N=3000"
Income/Activity

Murray "B"
Table J.1.4: "Winter N=3000"
No. Cells/Activity/Crowding

Murray "B"
Table J.1.5: "Winter N=3000"
No. People/Activity/Crowding

Murray "B"
Table J.1.6: "Winter N=3000"
Income/Activity

Murray "B"
Table J.1.7: Attractiveness Summary

Murray "B"
Table J.1.8: Plan Impact

Murray "B"
Table J.1.9: Capital Costs of Plan

Murray "B" + Impact Evaluations
Table J.2.1: "Summer N=3000"
No. Cells/Activity/Crowding

Murray "B" + Impact Evaluations
Table J.2.2: "Summer N=3000"
No. People/Activity/Crowding

Murray "B" + Impact Evaluations
Table J.2.2: "Summer N=3000"
Income/Activity

Murray "B" + Impact Evaluations
Table J.2.4: "Winter N=3000"
No. Cells/Activity/Crowding

Murray "B" + Impact Evaluations
Table J.2.5: "Winter N=3000"
No. People/Activity/Crowding

Murray "B" + Impact Evaluations
Table J.2.6: "Winter N=3000"
Income/Activity

Murray "B" + Impact Evaluations
Table J.2.7: Attractiveness Summary

Murray "B" + Impact Evaluations
Table J.2.8: Plan Impact

Murray "B" + Impact Evaluations
Table J.2.9: Capital Costs of Plan

Murray "B" + Attractiveness Evaluations
Table J.3.1: "Summer N=3000"
No. Cells/Activity/Crowding

Murray "B" + Attractiveness Evaluations
Table J.3.2: "Summer N=3000"
No. People/Activity/Crowding

Murray "B" + Attractiveness Evaluations
Table J.3.3: "Summer N=3000"
Income/Activity

Murray "B" + Attractiveness Evaluations
Table J.3.4: "Winter N=3000"
No. Cells/Activity/Crowding

Murray "B" + Attractiveness Evaluations
Table J.3.5: "Winter N=3000"
No. People/Activity/Crowding

Murray "B" + Attractiveness Evaluations
Table J.3.6: "Winter N=3000"
Income/Activity

Murray "B" + Attractiveness Evaluations
Table J.3.7: Attractiveness Summary

Murray "B" + Attractiveness Evaluations
Table J.3.8: Plan Impact

Murray "B" + Attractiveness Evaluations
Table J.3.9: Capital Costs of Plan

Murray "B" + Attractiveness Evaluation + Simulation Model
Table J.4.1: "Summer N=3000"
No. Cells/Activity/Crowding

Murray "B" + Attractiveness Evaluation + Simulation Model
Table J.4.2: "Summer N=3000"
No. People/Activity/Crowding

Murray "B" + Attractiveness Evaluation + Simulation Model
Table J.4.3: "Summer N=3000"
Income/Activity

Murray "B" + Attractiveness Evaluation + Simulation Model
Table J.4.4: "Winter N=3000"
No. cells/Activity/Crowding

Murray "B" + Attractiveness Evaluation + Simulation Model
Table J.4.5: "Winter N=3000"
No. People/Activity/Crowding

Murray "B" + Attractiveness Evaluation + Simulation Model
Table J.4.6: "Winter N=3000"
Income/Activity

Murray "B" + Attractiveness Evaluation + Simulation Model
Table J.4.7: Attractiveness Summary

Murray "B" + Attractiveness Evaluation + Simulation Model
Table J.4.8: Plan Impact

Murray "B" + Attractiveness Evaluation + Simulation Model
Table J.4.9: Capital Costs of Plan

Table J.4.10
Murray "B" Plan: Improvements, N=3000

Table K.A.1
Linear Program "A": Program for the Initial Plan, N=3000

Linear Program "B": Initial Plan
Table K.1.1: "Summer N=3000"
No. Cells/Activity/Crowding

Linear Program "B": Initial Plan
Table K.1.2: "Summer N=3000"
No. People/Activity/Crowding

Linear Program "B": Initial Plan
Table K.1.3: "Summer N=3000"
Income/Activity

Linear Program "B": Initial Plan
Table K.1.4: "Winter N=3000"
No. Cells/Activity/Crowding

Linear Program "B": Initial Plan
Table K.1.5: "Summer N=3000"
No. People/Activity/Crowding

Linear Program "B": Initial Plan
Table K.1.6: "Winter N=3000"
Income/Activity

Linear Program "B": Initial Plan
Table K.1.7: Summary

Linear Program "B": Initial Plan
Table K.1.8: Plan Impact

Linear Program "B": Initial Plan
Table K.1.9: Capital Costs

Linear Program "B" + Program "A"
Table K.2.1: "Summer N=3000"
No. Cells/Activity/Crowding

Linear Program "B" + Program "A"
Table K.2.2: "Summer N=3000"
No. People/Activity/Crowding

Linear Program "B" + Program "A"
Table K.2.3: "Summer N=3000"
Income/Activity

Linear Program "B" + Program "A"
Table K.2.4: "Winter N=3000"
No. Cells/Activity/Crowding

Linear Program "G" + Program "A"
Table K.2.5: "Winter N=3000"
No. People/Activity/Crowding

Linear Program "B" + Program "A"
Table K.2.6: "Winter N=3000"
Income/Activity

Linear Program "B" + Program "A"
Table K.2.7: Summary

Linear Program "B" + Program "A"
Table K.2.8: Plan Impact

Linear Program "B" + Program "A"
Table K.2.9: Capital Costs of Plan

Table K.C.1
Linear Program "B": Proposed Program Changes from Simulation Model Evaluation

Linear Program "B" + Simulation Evaluation
Table K.3.1: "Summer N=3000"
No. Cells/Activity/Crowding

Linear Program "B" + Simulation Evaluation
Table K.3.2: "Summer N=3000
No. People/Activity/Crowding

Linear Program "B" + Simulation Evaluations
Table K.3.3: "Summer N=3000"
Income/Activity

Linear Program "B" + Simulation Evaluation
Table K.3.4: "Winter N=3000"
No. Cells/Activity/Crowding

Linear Program "B" + Simulation Evaluation
Table K.3.5: "Winter N=3000"
No. People/Activity/Crowding

Linear Program "B" + Simulation Evaluation
Table K.3.6: "Winter N=3000"
Income/Activity

Linear Program "B" + Simulation Evaluation
Table K.3.7: Summary

Linear Program "B" + Simulation Evaluation
Table K.3.8: Plan Impact

Linear Program "B" + Simulation Evaluation
Table K.3.9: Capital Costs of Plan

Table K.3.10
Linear Program "B" Improvements, N=3000

# CHAPTER I: THE PROBLEM DEFINED, AND THE RESEARCH STRATEGY

## A. THE PROBLEM

The problem which the research team undertook can be defined by several questions. Concisely stated the first and overriding question is, "How can one plan for the multiple use of a reservoir site when the activity demands on that site are unclear and when the costs and benefits to be derived from any proposal must be evaluated in terms of multiple objectives, including dollar benefits and costs, environmental resource quality, and the social benefits of consumer satisfaction?" The problem of the development of a body of water in a watershed for a variety of activities, basically recreation but with other residential and agricultural components, is a common one which can be considered as a class of problem. It is typical of many of the development projects which constitute some of the major river basin planning projects of the Corps of Engineers as well as being typical of many land development projects in the private sector. The general problem is thus seen to be both common and important, and a well-designed methodology for its analysis and solution should have considerable potential application.

The second question which helps define the problem is distinctly related to the location of our study area at the fringe of a densely populated megalopolis. It would appear that activity demands are so large relative to the supply of recreational opportunities that one could build virtually anything and it would be used to capacity at any reasonable set of user fees. The question must therefore be asked, particularly in the absence of a clearly proven demand estimation methodology, "How much can one develop a site before 'we kill the goose that laid the golden egg'?"

The third question, "What is the appropriate methodology for site development scale analysis?", is derived from the earlier studies which the research team had made with the support of the Corps of Engineers (101.22, A Comparative Evaluation of Resource Analysis Methods, and 101.23, Qualitative Values in Environmental Planning, A Study of Resource Use in Urbanizing Watersheds). We wished to undertake a more applied project at a site development scale in order to develop and test further our methods of data inventory, data handling, and resource analysis. In particular, the team was interested in investigating and developing strategies for planning, design, and evaluation

of proposals. We also sought to further our work on component systems models and to investigate the roles of mathematical programming models in the development and evaluation of alternative proposals.

The team believed that the issues which were being explored were so complex that one could not simply rely on the professional judgment and experience of planners and designers. We furthermore believed that it was necessary to develop an approach which could systematically organize the planning and design process into a series of discrete steps, each of which could be accomplished relatively efficiently, and the sum of which should produce a solution superior to that achieved by the often ambiguous judgment-dependent processes which are typically employed. Thus the third problem-defining question can be restated as, "Are there systematic planning/design processes which, in general, should lead to better plans at the site planning scale?"

## B. THE DECISION-MAKING CONTEXT OF THE RESEARCH

In attempting to answer the questions posed in the definition of the problem, we have identified a major dichotomy which may be useful to amplify before we proceed with the report on the research. Basically, we find that we are dealing with two types of conflict: conflict for resource use within a given specified project between man and his environment; and conflict between man and man in the political context. While our analyses are directed at the former, the latter is probably more important in the actual implementation of planning policy decisions.

The challenge of any systems analysis study is to be relevant to an *a priori* analysis of the political context of policy decisions. Unfortunately, this is easier said than done, and this is not due to any fault of the analysts. Rather, it is because of the inherently unsolvable nature of "n-person non-zero-sum games." Some progress has, however, been made toward this end. [The interested reader is referred to Dorfman and Jacoby ( 167 ) for an analysis of political conflict over river pollution which relies upon system analysis models to map the responses of various political strategies.]

In the Honey Hill context, we spent some time identifying the major agencies, groups and actors who would be party to any decisions regarding the project and the relative emphases within the project. It was our intention to then

make clear in any subsequent analyses "who got what, when and how." However, as an examination of Appendix A will show, there are so many groups, agencies and actors involved in these particular planning decisions that we were unable to follow through with out original intentions. Conceptionally, however, it is possible to do so and we believe that subsequent studies of this type should be provided with the resources to enable this type of analysis to be pursued.

As can be seen from Appendix A, it is obvious that there are three major factors that all of the interest groups would have to consider in evaluating any proposal: dollar benefits and costs, social benefits, and environmental quality. Our research is therefore organized around these three factors in its planning and evaluation procedures.

## C. THE RESEARCH STRATEGY

The research strategy consisted of the development and testing of methods for the planning and evaluation of the multiple use of a typical controlled water area.

The first phase of the study was the selection of a test area (Chapter II). The Corps of Engineers' previously proposed Honey Hill area in Swanzey, New Hampshire, which is a component of the Connecticut River Plan, was selected The attempt was then made to define the problem in terms of its objective function. This function may be described as the satisfaction of a mix of fiscal, social, and environmental goals.

The second phase consisted of the creation of a data bank on the site resources of the study area (Chapter III). Based upon aerial photographic interpretation, existing sources, and field visits, this inventory represented an application of some of the methods previously developed by the research team. The data were stored, analyzed, and displayed using the computer methods also previously developed by the investigators. The data scale chosen for this inventory and used throughout the research was 1/100 square kilometer (approximately 2.5 acres).

The third phase of the research was the selection of a range of activities which might be considered as components of the multiple use of the study area (Chapter IV). For each activity, an evaluation was made of its site requirements, and criteria were established which would enable the relative attractiveness of each site for each activity to be evaluated.

Since the multiple objective function consisted of environmental quality, the satisfaction of socially-determined demands, and the fiscal costs and benefits, the next phases of the research involved an investigation into each of these. The fourth phase of the research was therefore the identification of eleven important site resource systems (Chapter V). For each system, a model was hypothesized which would evaluate its vulnerability to damage by each of the potential activities. The potential impact of each activity on each site resource system on each possible location was the focus of the evaluations in the next phase (Chapter VI). Taken together, these "environmental quality" models represent a major emphasis of the research strategy.

Phase six was an estimate of the potential demand for the various possible activities (Chapter VII). Two major variables--income and distance from the site--were taken as the defining factors for the relative rates of activity participation.

Phase seven consisted of the derivation of the dollar costs of providing activity facilities, and of the dollar benefits which would accrue locally and regionally as a result of participation in those activities (Chapter VIII).

The next major aspect of the research was the development and utilization of a simulation model (Chapter IX). Simulation models are much more flexible than the analytical mathematical programming models and they enables us to incorporate more complex physical, ecologic, and economic relationships. Since they can operate at the scale of the data, the major contribution of this part of the study was the tying together of the more formal models of revenue maximization and cost minimization with sets of system constraints derived from the visual, the physical, and the ecological quality of the local environment. The simulation model could be run on the basis of days, weeks, months, seasons, or years. Total demand was set exogenously, but activity preferences were keyed to nine combinations of income and travel time-distance to the site.

Output of the model included:

1. Activity location attractiveness.
2. Site resource system quality impacts.
3. The quality of recreation experience, by activity and by consumer group.

4. The dollar income of the proposal.
5. The dollar costs of construction.

The model could be used in three ways. First, it could simulate and evaluate the proposed alternatives arising from the "best professional judgment" schemes to evaluate "how well they do." Second, it could test the plans implied by the linear programming model. Thus, the simulation model would be used as a laboratory for testing in the two instances below. Third, one could use the simulation model as a means of "pulling itself up by its bootstraps"--i.e., through further refinement of itself, to try to reach an optimal solution.

The next major aspect of the research consisted of the investigation of alternative strategies of developing and evaluating plan proposals. Two general procedures were investigated separately and in combination. They were "professional judgment," and mathematical programming models.

The ninth phase of the research involved the use of "best professional judgment" to develop the site schemes (Chapter X). The members of the research team produced alternative proposals. The proposals are specific to the scale of the data grid. They were evaluated and improved using the analysis and simulation models.

The strategy investigated in phase ten employed the use of analytical mathematical programming models such as linear or piece-wise linear programming models (Chapter XI). These models could enable us to investigate various objective sets as mechanisms to inform our recreation allocation decisions. Using these models, one could investigate how the objectives for the Federal agencies, for the local State agencies, and for local interests change the allocations. Examples of such objective functions could be the minimization of costs, the maximization of revenue, and the maximization of consumption of local goods and services. As expected, these objective functions were restricted by sets of constraints. Given certain physical, ecological, and economic constraints, the objective function of the model described in this report was the maximization of net benefits for the development of the Honey Hill reservoir. The solution consisted of the decision variables for which the objective function will attain its maximum value.

The model had the following components as constraints:

1. Recreation activity levels (8 types--winter and summer)
2. Roads and parking
3. Wildlife management
4. Forest management
5. Water pollution control standards
6. Power target levels
7. Flood control target levels
8. Low flow augmentation
9. Water supply

The following were solution components:

1. Recreation activity levels
2. Wildlife densities/qualities
3. Forest densities/qualities
4. Power releases
5. Water supply releases
6. Water storage volume

The output of the mathematical programming model provided "optimal" development proposals within 23 predefined zones. Part of the mathematical programming analysis was a parametric study of the system response (allocation between various recreation activities) to changes in the demand parameters. Plans were made from the linear program output, evaluated and improved via the simulation model.

The last and eleventh phase of the research consisted of a comparative evaluation of the various plan-making and evaluation strategies, and the identification of those combinations of steps which, for differing degrees of effort, would produce "better" proposals (Chapter XII).

## CHAPTER II: HONEY HILL: THE STUDY AREA

The proposed Honey Hill Reservoir and State Park were selected as the study area to which the research effort would be applied. The proposed Honey Hill Reservoir and State Park is one component of the Connecticut River Basin Plan. Appendix B presents a summary of the comprehensive study of the Connecticut River Basin, prepared by the Connecticut River Basin Coordinating Committee.

This project was chosen as an example of the type of site which the research team felt was most appropriate for study. It must be emphasized that the actual proposal components considered within the framework of this research are not those which the Corps of Engineers has proposed for its actual project plan, and therefore none of the proposals and evaluations incorporated into this research study can be directly adopted.

Appendix C presents a brief historical account of the development of the study area and an historical account of its physical condition. The Honey Hill study area is situated in the southwestern corner of the State of New Hampshire in the town of Swanzey, Cheshire County. The site's general location in New England is shown in Figure II.1. The current travel distance between Honey Hill and Boston, for example, is approximately one and three quarters hours. The study area is in what is known as the Monadnock Region of New Hampshire, an area which can appropriately be characterized as being a major recreation resource for the Southern New England area. Figure II.2 describes some of the current recreation attractions of the Monadnock area. As can be seen, the Honey Hill area is approximately four miles from a proposed 20 square mile Pisgah Wilderness State Park lying to the west, and the major attraction of Mt. Monadnock and Monadnock State Park, situated approximately six miles to the east. The easy access to the site by a large population, its proximity to the services provided by the City of Keene, and its location among a variety of contrasting major recreational attractions make the Honey Hill study area particularly suitable for the investigations which the research team sought to undertake.

The proposed Honey Hill dam on the South Branch of the Ashuelot River would, if built, create one of the largest publically owned bodies of water within a reasonable drive of its highly populated service area. The proposed project

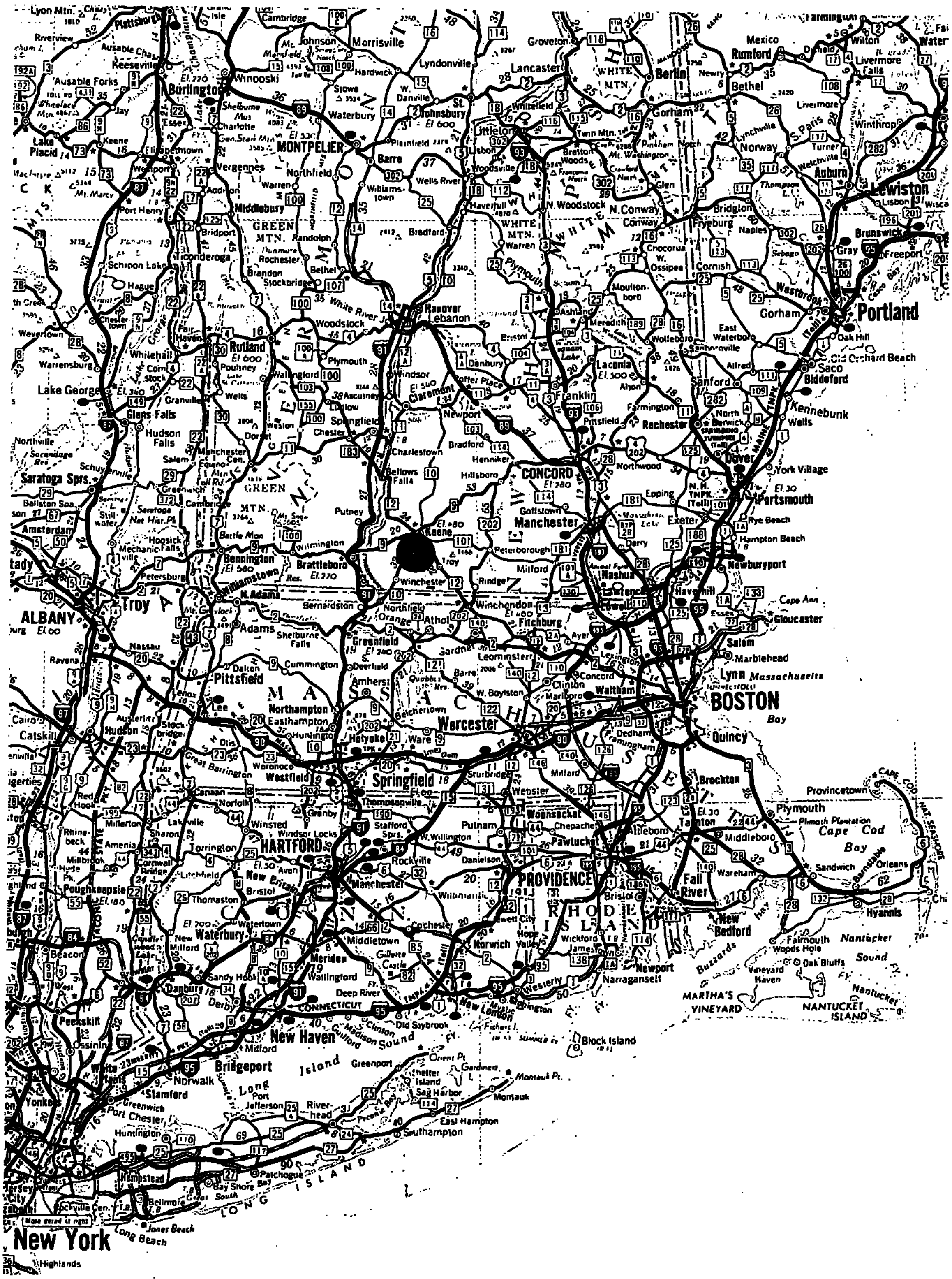


Fig. II.1
The Honey Hill Area in Southern New England

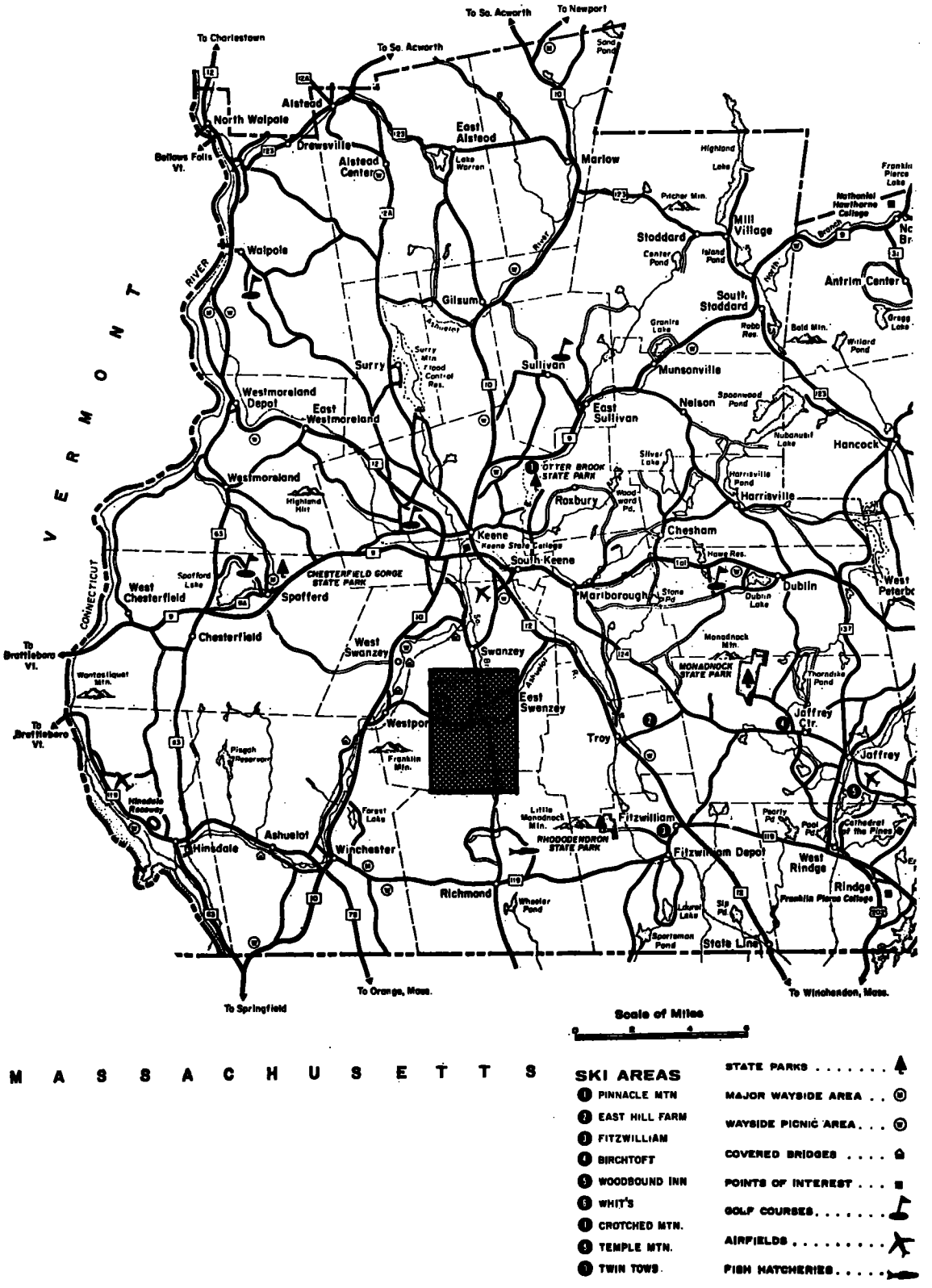


Fig. II.2
Recreation Attractions of the Monadnock Region

would have as its purposes the construction of a multi-purpose reservoir for flood control, low flow augmentation for fish and wildlife habitat, and some water quality, potential industrial water supply, and extensive water and land use recreational opportunities. The proposed State Park land acquisition surrounding the reservoir would make a major contribution to the public recreation facilities of the Monadnock Region.

The immediate site area can now be characterized as residential for people who are employed in Keene and the other towns of the region, and as a place of vacation and retirement homes. There is still some lumbering and agriculture in the valley bottoms, but these are not the basic economic generators that they once were. The major portions of the region are "undeveloped." Figures II.3 through II.8 offer some views of the study area as it currently exists.

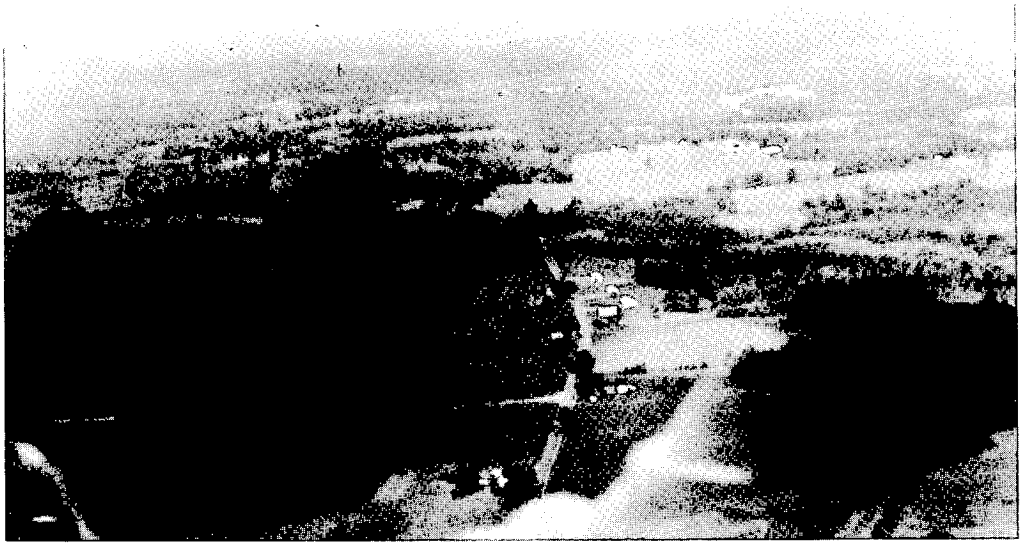

Fig. II.3
Aerial View of the Northern End of the Proposed Reservoir Site

Fig. II.4
View Looking West over the Proposed Reservoir Site

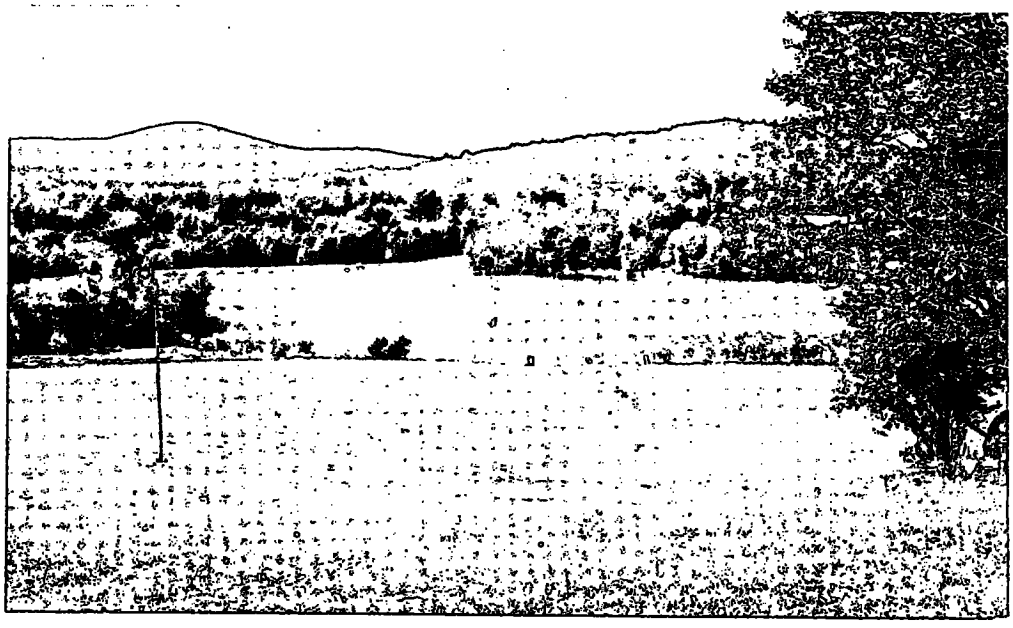

Fig. II.5
View Looking Southeast over the Proposed Reservoir Site

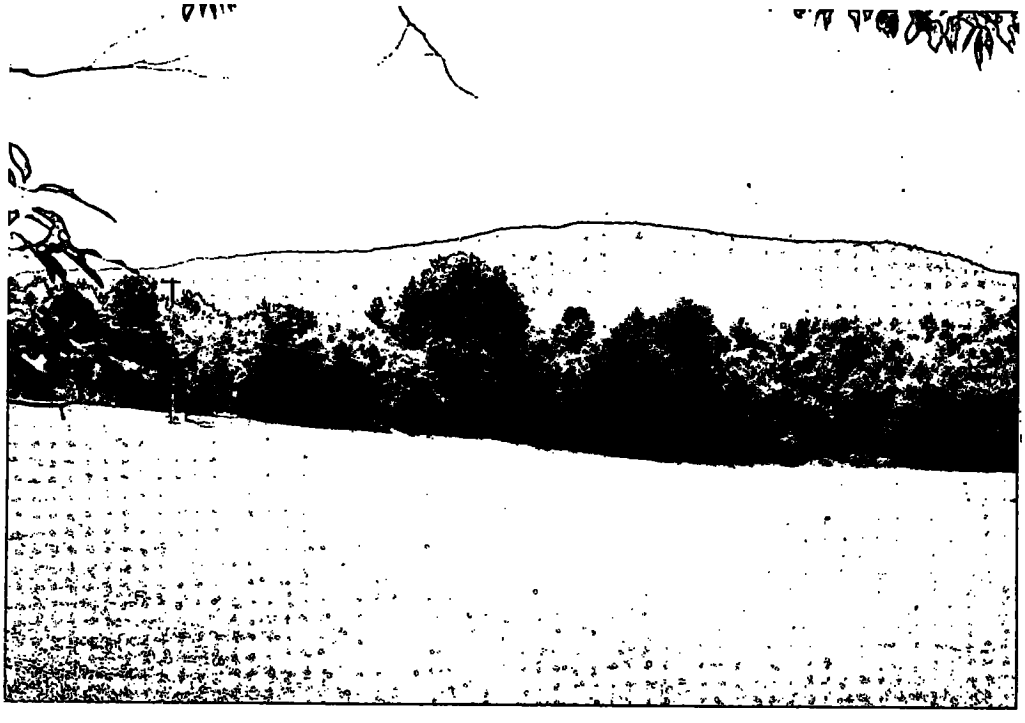

Fig. II.6
View Looking Southeast over the Proposed Reservoir Site

Fig. II.7
View Looking East from the Southwest Corner of the Proposed Reservoir Site

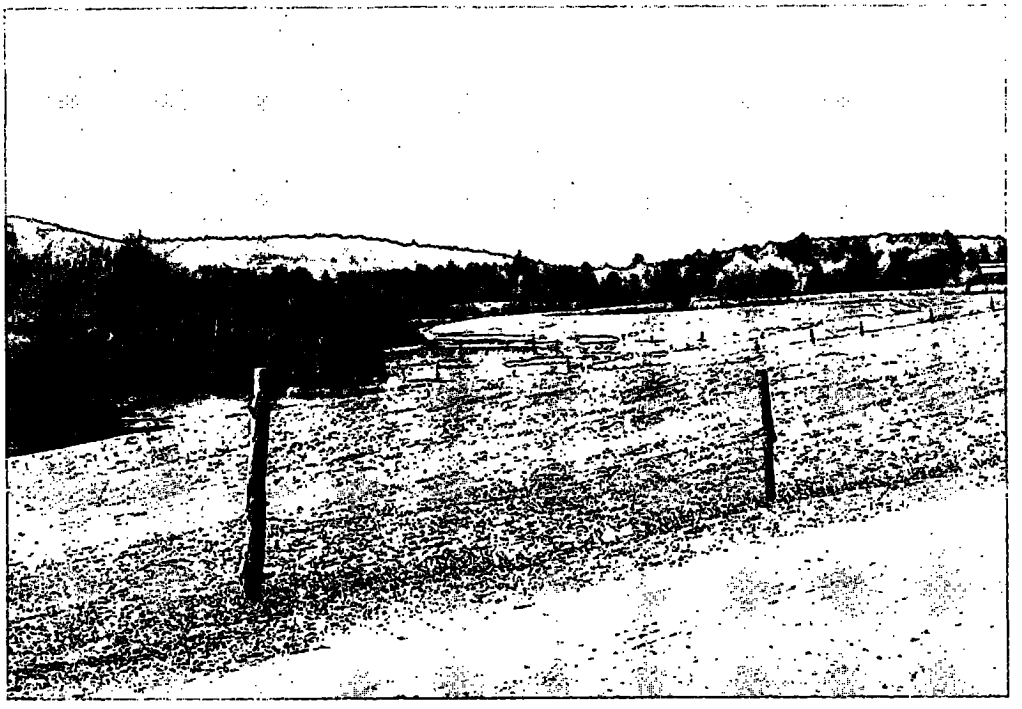

Fig. II.8
View Looking Southwest over the Proposed Reservoir from the Southern Base of Honey Hill

## CHAPTER III: THE DATA INVENTORY

This chapter briefly describes the methods which the research team has developed for the collection, storage, and display of resource data inventories. These methods have been applied in the creation of the Honey Hill data bank. Many of the important issues which underlie the inventory and use of resource data are more fully presented in Appendices D: A Survey of Current Approaches to Resource Analysis, E: The Role of Computers in Resource Analysis, F: Spatial Data Systems for Resource Analysis, and G: A Survey of Acquisition Methods for Resource Data. The nature of the research project, representing as it does the multiple use of a consistent data base, lends itself well to the demonstration of our computer-compatible methods in an "applied" context.

### A. A COMPUTER COMPATIBLE INVENTORY

The preparation of a computer map requires three steps: providing the computer with data in a form acceptable to the machine (input); the manipulation of the data and preparation of the map within the computer's memory (processing); and the actual display of a map by the computer (output). To be accepted by a computer and displayed as a map, data must be available in a form which is compatible with the computer equipment (hardware) and the programs (software) with which it will be processed. Further, the computer must be able to identify every possible location on the surface of the map which it is to prepare. The most common solution is a grid coordinate, or x-y reference system, to which the computer can refer whenever it must identify the location of any one point in relation to all other points on the map.

The data should have some of the following characteristics: large amounts of data are to be mapped; the data are in machine readable form or can be readily converted; the data contain geographic codes for the zones by which they are to be mapped or includes basic record identifiers which can be used to aggregate the data into map zones; and accurate data are available. Obviously, inaccurate data should not be used, whether maps are prepared by hand or by computer, but this is particularly true of computer prepared maps because of the unwarranted aura of infallibility which for many people surrounds anything produced by a computer.

Once supplied with data values for a given location, a computer can be programmed to perform a multitude of arithmetic and logical operations upon this data. In addition, it is able to perform operations which use locational data, including calculations based upon spatial proximity. Whether the value mapped is one put into the computer or one derived by the computer, the resulting map image is constructed by numbers or other graphic symbols based on coordinate locations. For the purposes of this study, the computer-compatible analytic format will have as its display mode, maps prepared by the GRID computer graphics program.

GRID is a computer program created by Messrs. Sinton and Steinitz specifically to provide a highly efficient means for graphic display of large quantities of information collected on the basis of a rectangular coordinate grid. The program is written in FORTRAN IV and is currently being operated on an IBM 7094 with a 32k memory, or an IBM 360/65 using 120k byte memory. With some internal adjustments, it can be run on a computer with a memory as small as 12k words. The program requires two sets of data input--first, the data values associated with a spatial grid, and second, a series of instructions to the program about the particular procedures and forms that are to be used for analysis and display.

Each data value is assumed to be associated with a cell on the grid. It is essential that the values should be processed in the correct order, since the program accepts the data in the order in which it prints the maps. By the standardized printing process, the program starts at the top of the map and processes the data horizontally, row by row, and from left to right in each row. The numbers below represent the order in which 30 data values in a six by five grid will be printed and processed.

| | | | | | |
|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 |
| 7 | 8 | 9 | 10 | 11 | 12 |
| 13 | 14 | 15 | 16 | 17 | 18 |
| 19 | 20 | 21 | 22 | 23 | 24 |
| 25 | 26 | 27 | 28 | 29 | 30 |

The user specifies the size and the shape of his grid. While the program is normally used in rectangular grids, it provides two methods of specifying irregular outlines. The program has been designed with an internal loop that permits an unlimited number of cells to be mapped. However, in normal usage, it is not expected that the average grid will be greater than 10,000 data points.

While the program is designed for use by persons with very little programming experience, it is necessary for the user to specify his own data format in a subroutine called FLEXIN. Since the program is designed for general use on a variety of data sources, it was felt that it is easier for diverse users to write their own input-output formats and not be constrained by fixed formats internally specified within the program. Before printing the spatial diagram, the actual data values are generalized into groups, each group having a unique graphic symbol associated with it. Using options, the user can then specify the number of levels, the maximum value of the data, the minimum value of the data, and the relative size of each of the levels in the range of the data. Thus, the user has complete control over the levels into which his data are divided. The user also has control over the symbolism which is used to print the spatial diagram, e.g., a gray scale between white and black, a dot map, or any alphanumeric symbols. The program will also print specified information about the data analyses which are being mapped, and it will print the numbers of the grid coordinate system around the edges of the map.

## B. THE SPATIAL COORDINATE SYSTEM: UTM

Any data which is to be mapped by computer must be identified by numerical coordinates which describe the relative location of each geographic unit. Of the several geo-coding systems available for use, we have adopted the Transverse Mercator System, a map projection system, as the locational coordinate basis of our data bank. Known as the Universal Transverse Mercator grid system, UTM is widely used throughout the world. It includes the area between eighty degrees north and south latitude, and extends around the world in sixty north-south zones, each zone covering six degrees with one-half degree overlap. The accuracy within each zone is one part in 2500. The size of the individual grid cell or data unit can be varied within the same system, according to user needs. The system is well-established and can be extended to include areas adjoining the United States. It is indicated on most USGS maps.

In addition, each UTM grid unit is square and of constant size, which aids in computer analysis and display; the coordinates are expressed metrically, which would reduce transitional difficulties if the metric system of measurement were adopted; and the UTM grid system is of global extent and availability. As a result of the last of these

factors, the UTM grid system will undoubtedly be used to reference satellite photography and other remote sensor data, which may, in time, provide the major portion of natural resource data. All of the other standard geographical referencing systems, such as longitude-latitude and the various state plane coordinate systems are transferable to the UTM grid by computer program.

## C. DATA CELL SIZE AND SPATIAL ACCURACY

Having selected a grid coordinate system for geographic referencing and having decided to use the grid cell as the basic unit for all data acquisition, processing, storage, analysis, and display, a key decision will be the size of the grid cell. Among the important factors entering into the decision on cell size are the zones at which data are available and the scale of the uses to which data analyses are to be applied. In defining the grid cell, size, we use the rule of "the least common denominator": find the cell size which is the smallest unit resulting from the overlay of the various data zones. This cell size will be able to be adequately aggregated into any of the zones, and by itself will lose no data detail.

The cell size is then evaluated for its practical efficiency in data handling. There is a necessary compromise between a small basic data unit and a large one. When the data unit is small, the "natural" borders of larger data zones can be more closely approximated and the assumption of data value homogeneity, which most resource inventory methods make, is more likely to be valid. With a small unit, any study based upon the data bank can be considered in finer grain and will therefore be more useful for project planning and design. The use of the computer for data handling also affects decisions on cell size in that their ability to rapidly analyze large quantities of data allows for smaller grid cell sizes. The major advantage of a larger unit is lower data collection and analysis costs. To the degree that manual processes are used, these costs can be substantial, thus arguing for a larger size. The scale of the decisions required of the analysis is also related to the choice of grid cell size. For example, if one is locating camping areas that might average 5 acres in size, it would be an advantage to have site analyses at that scale or finer. These use-sizes vary by type, regionally, and over time, and so this influence on data scale can only be based on pragmatic experience.

This research team has been involved in several studies which have given us experience in evaluating the relationship between data scale and use. We have used grid cell sizes ranging from one acre to four square miles.

For site development studies, a cell size of 1/100 square kilometer (2.5 acres) has been shown to be generally satisfactory and therefore the one kilometer square UTM grid has been chosen as the basic geocoding system and has been subdivided into 100 subunits for the data inventory.

The spatial accuracy of data inventory and analysis is limited by the cell size. Thus, for point data (for example, at our scale, the location of individual residences), we know the coordinates of the cell in which the point is located, but we cannot specify the location within the cell. On the other hand, it would be quite possible to specify absolutely pinpoint accuracy on any point data by adding extra digits to the coordinate coding system. For line data (for example, at our scale, roads), we can specify roads within cells but not the location of the road within the cell, and we can specify origin and destination cells but not necessarily routes. Again, if one know the location of a specific route between two points, it could be specified cell by cell. For area data (for example, at our scale, the forest density) we can specify a value, but not the pattern of that value within the cell. As a rule, any analysis derived from a combination of several variables from several types of zone is spatially accurate only to the scale of its coarsest data zone. Efficiency versus accuracy judgments must always be made, and have been made by the authors in the selection of cell size and data coding procedures.

## D. DEFINING THE STUDY AREA

Defining the study area raises all the classic arguments and questions involved in defining regions. In general, the "free body cut" should be made around the smallest area which encloses all the data zones and systems which impinge on the geographical area or content under study. All data systems are then assumed to be closed within this area, an assumption which, in the light of the "spaceship earth" argument, must be heavily qualified. The area for which data are available should therefore always be larger than or equal to the area of interest. Political and physiographic data borders will rarely be as satisfactory as a somewhat arbitrary larger border which will include within

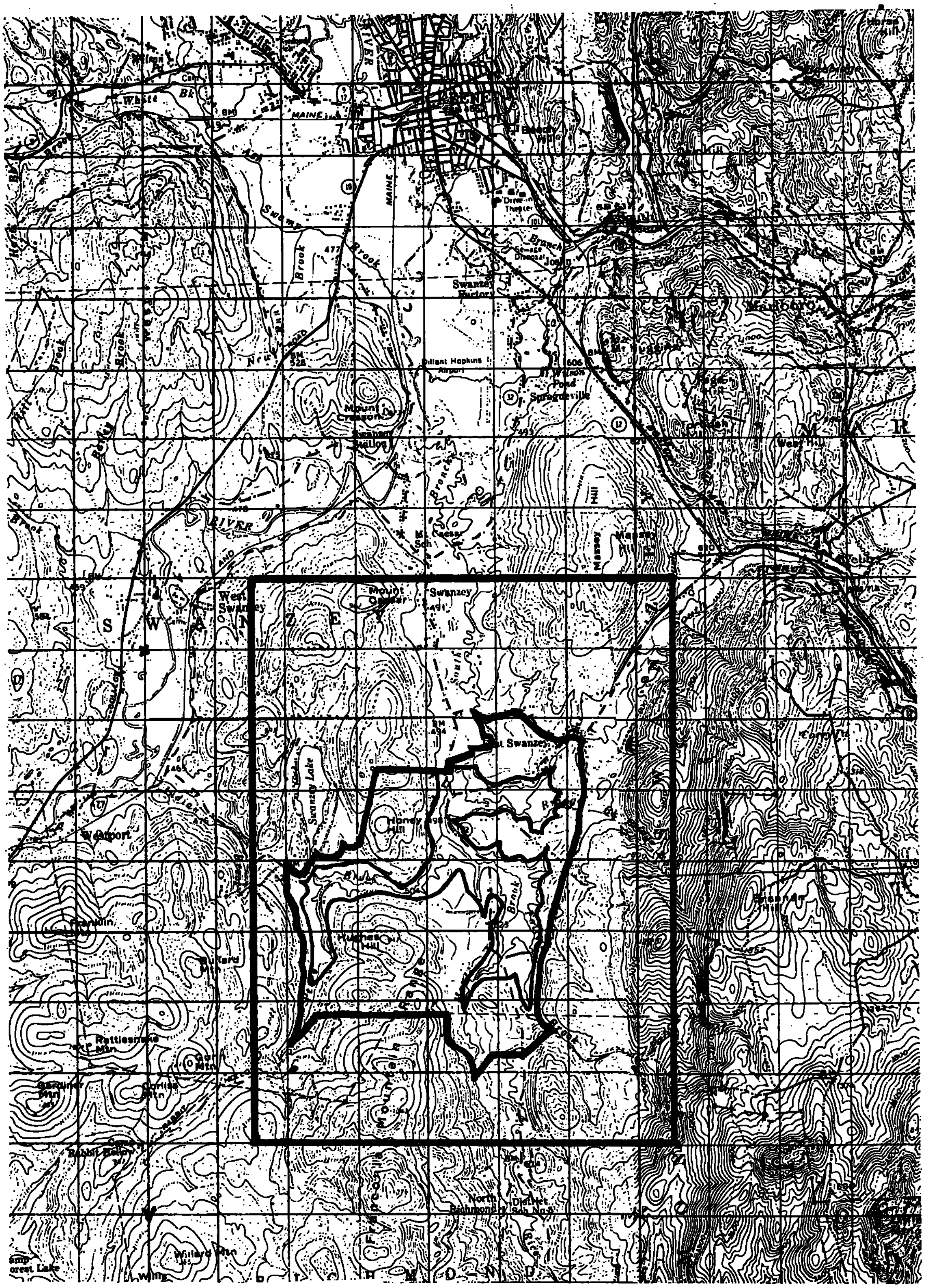


Fig. III.1
The Honey Hill Study Area

it the relevant political or physiographic areas of interest. Figure III.1 shows the study area defined for the Honey Hill data bank.

## E. DATA SOURCES

Aerial photographs, U.S. topographic maps, and field investigations constituted the major portion of the data base for the Honey Hill study. The data categories were for the most part interpreted from all three data sources, with the primary source depending upon the specific category. Within this section, each data category will be defined and the original data source and process will be specified.

The initial problem in the establishment of a data bank is the collection of existing data source materials, with varying scales, accuracy levels, and ages. In gathering the components of the Honey Hill data bank, much of the data was generated by the interpretation of aerial photographs, whereas other categories were generated by a combination of field work and existing sources of information.

The type of data that can be interpreted from any given set of photographs depends upon the scale and data of the photography. For many categories, depending upon the complexity of the conditions and the experience of the interpretor, field investigations would be necessary for data verification.

Black and white aerial photos taken in 1952 for the Honey Hill area are available from the U.S. Department of Agriculture[1] at the scale of 1:20,000, and more recently (1965) from a commercial firm[2] at the scale of 1:20,000. The commercial aerial photographs taken in 1965 are more useful for data gathering because of the more recent coverage and were therefore purchased. Mosaics of the

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[1] U.S. Department of Agriculture; Agriculture Stabilization and Conservation Service; Washington, D.C.; Flown 7/1/52; scale 1:20,000 symbol DQT-(Cheshire Co.) site coverage: DQT-3K-45-53;3K-94-102;3k-119-126; 3K-168-175.

[2] Aero Service; Philadelphia, Pa., Flown 5/7/65; scale 1:20,000 symbol - 1320 (Cheshire Co.) site coverage: 1320-18-689-695; 1320-19-638-642; 1320-20-419-424; 1320-21-531-536.

1952 coverage were also purchased to provide land use growth information during the thirteen year period.

U.S. topographic maps[3] are available at the 15 minute or 1:62,500 scale. National map standards call for an accuracy level of ±1/2 contour interval which, in the Honey Hill study area, could change an interpreted proposed shoreline substantially. This topographic accuracy problem remains a constraint on the accuracy of the research.

Field checking was done in conjunction with many of the data categories to provide suitable accuracy checks. This was accomplished by taking several field trips to obtain soil samples, vegetation samples, climatic readings, and land use patterns. An aerial reconnaissance was also undertaken to provide low altitude color slides providing additional geologic, soils, vegetation and land use information.

## F. THE DATA INVENTORY PROCESS

Aerial photographs, flown at a scale of 1:20,000, were received from Aero Survey in consecutive overlapping flight strips, giving the required stereo coverage (Figure III.2). These photographs were then arranged in a non-controlled, semi-permanent mosaic utilizing every other photo from the original set (Figures III.3 and III.4). This mosaic could then be used for stereo or overall examination. The 1 sq. km. grid established on the U.S. topographic quadrangle maps utilizing the UTM grid system was then transferred to the photographic mosaic. This was done by relocating grid coordinates to accurately compensate for camera parallax and tilt. Because of this, the gridded kilometers on the mosaic were not exactly square and contained small variances in x + y directions. Acetate gridded overlays divided into 1/100 sq.km. were then utilized to transfer information from the U.S. topographic maps and the aerial mosaic for coding. Only one sq.km. with its 100 subunits could be accurately overlaid and transferred at any time because of the parallax discrepencies.

In applying air photo interpretation to geologic and natural feature interpretation, a hierarchy of category interpretation was followed in order to achieve the greatest

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[3] U.S. Topographic Maps: Keene, N.H. and Monadnock, N.H., quadrangles, available from U.S. Geologic Survey, Map Information Office, Arlington, Va.

Fig. III.2
Aerial Photograph of Honey Hill Study Area

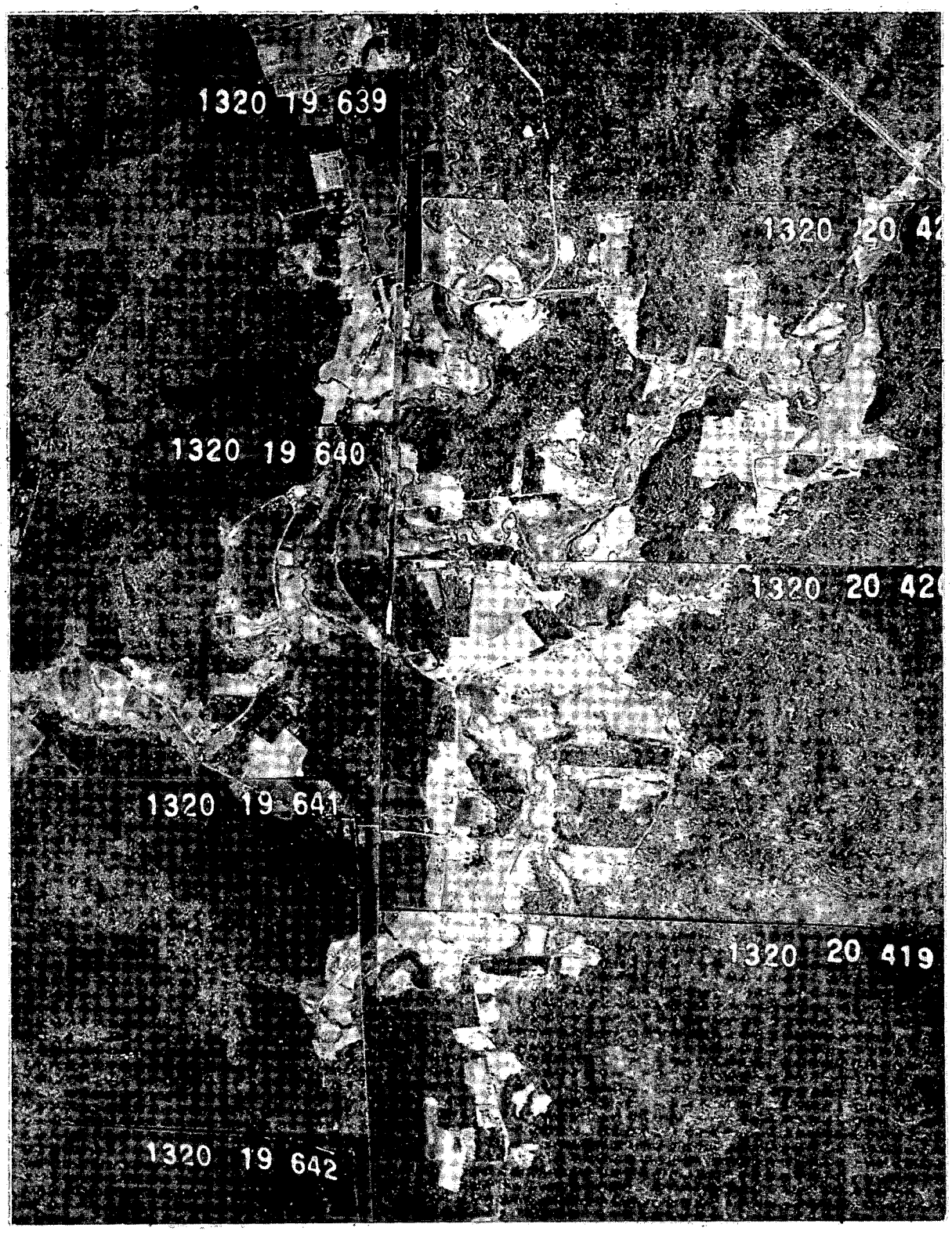



Fig. III.3
Combined Aerial Photographs of Honey Hill
Study Area

Fig. III.4
Completed Aerial Mosaic of Honey Hill
Study Area

Fig. III.5
U.S.G.S. Quadrangle Map of Honey Hill Study Area Divided into 1/100 Square Kilometer Grid

efficiency. The bedrock types were defined first, geologic landform second, and bedrock depth, soil moisture, soil texture, water table, third. Forest type followed, continuing with tree height and crown closure measurements. Land uses may be defined at any time, but in this instance it was found to be most efficient to examine residential development first. It was also found to be more efficient to interpret these data groupings for each 1 sq.km. unit and to generate the data bank for the entire study area after the initial interpretation phase.

The U.S.G.S. quadrangle maps used for base sheets were divided into the standard 1/100 square kilometer grid derived from the UTM grid (Figure III.5). As each category of data was interpreted, the actual values were recorded on prints of the base map. This process enabled the information to be keypunched directly without risking errors in recopying onto data input formats.

## G. DATA FILES

Data were coded on the basis of the grid and then keypunched as data records with one or more cards for each grid cell. A data record is that set of cards which contains all the information about each grid cell. Each data record can be considered as an array of pieces of data, with each piece having a specific location within that array and thus a specific position on the card or cards which refer to each grid cell. The data were stored on cards and on a disc pack.

All data files are organized on the basis of spatial location, that is to say, the grid cell and its other zones, such as a watershed. In order to retrieve a specific piece of information about a location, one first searches for the data record which refers to that location and then finds the specific piece of information which is desired. In normal data processing the data banks are organized so that the grid cells are in exactly the same order in which they are required for processing by the GRID program.

## H. SELECTION OF VARIABLES

The selection of data variables to be included in the inventory is based upon availability and anticipated needs. Under no circumstances should a data bank be an all-inclusive data depository. Data collection is expensive and must be

approached with efficiency. Since the design of the data must be compatible with its use and since its use is often unpredictable, the data bank must be expandable and able to be updated.

The following sections contain a description of the interpretive process for each data variable used in this study.

1. TOPOGRAPHIC ELEVATION TO THE NEAREST 5' (Figure III.6)

The centroid elevation of each cell is recorded to the nearest five foot interval by direct visual interpolation of the elevations from the topographic information contained on the U.S.G.S. maps. Most of these maps are accurate to ± 1/2 the contour interval; therefore, the selection of a five foot estimated elevation for grid cell centroids may not always be within the accuracy limits of the map.

470' = Lowest elevation in study area
to
1340' = Highest elevation in study area

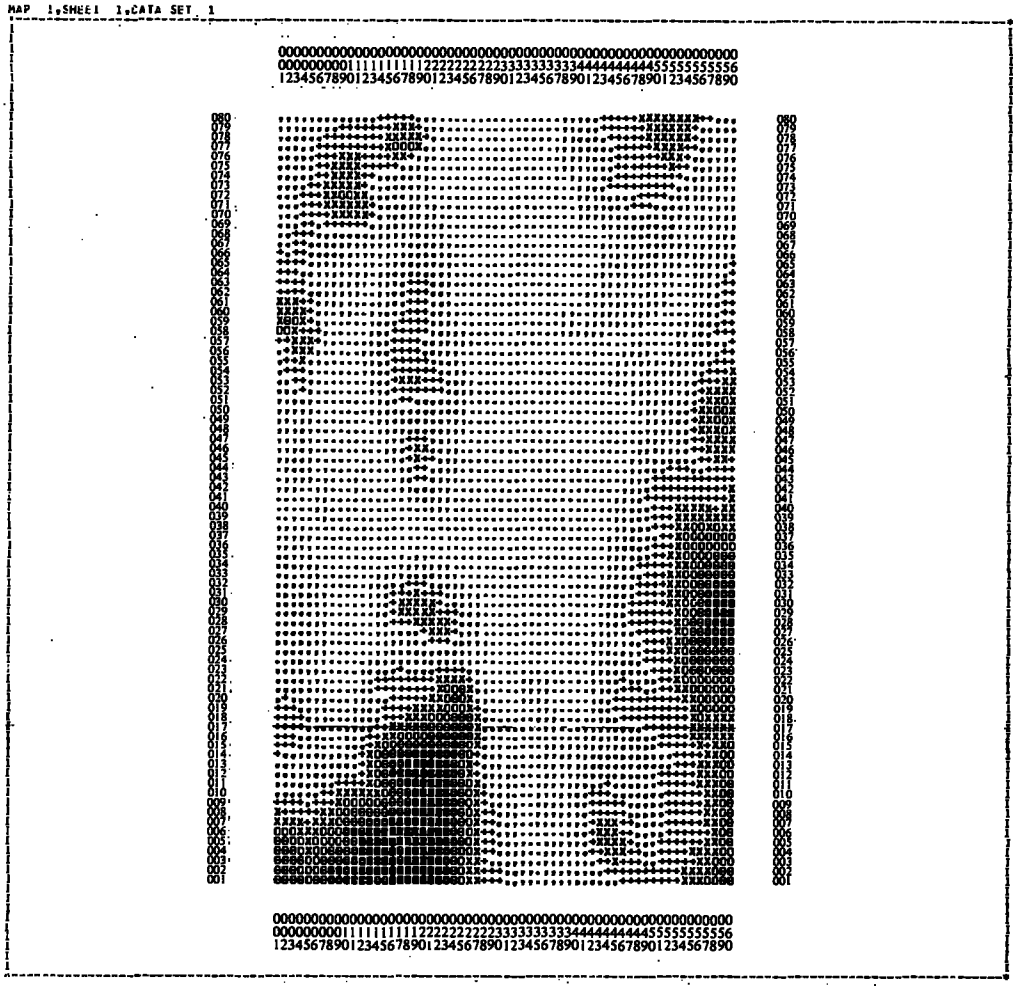
Figures III.7 through III.10 display the topographic elevation data in color oblique views produced by the OBLIX program. This program, written by Mr. Adrian Thomas at the Laboratory for Computer Graphics and Spatial Analysis of Harvard University, accepts data on the basis of grid cell values and produces combinations of vertical and horizontal sections in a variety of map projections. Figure III.7 shows the study area as seen from the South. Figure III.8 shows the study area as seen from the North, with colors representing elevation ranges.

The OBLIX program also allows a second variable to be superimposed upon the basic topographic contours. In the following figures, vegetation type is shown in color and outline, with green representing coniferous trees, blue representing deciduous trees, and brown indicating the absence of trees. Figure III.9 shows the study area from the North, and Figure III.10 presents a view from the Northeast.

2&3. TOPOGRAPHIC ORIENTATION (Figure 111.11)

Topographic orientation is recorded for each cell of the Honey Hill region. The coding and interpretation are based upon the predominant orientation existing within each 1/100

MAP 1,SHEET 1,DATA SET 1



TOPOGRAPHY - CENTROID ELEVATION

HONEY HILL CASE STUDY

U.S. ARMY CORPS OF ENGINEERS

DATA MAPPED IN 10 LEVELS BETWEEN EXTREME VALUES OF 470.00 AND 1340.00

ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| MINIMUM | 470.00 | 557.00 | 644.00 | 731.00 | 818.00 | 905.00 | 992.00 | 1079.00 | 1166.00 | 1253.00 |
| MAXIMUM | 557.00 | 644.00 | 731.00 | 818.00 | 905.00 | 992.00 | 1079.00 | 1166.00 | 1253.00 | 1340.00 |

PERCENTAGE OF TOTAL ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 |

FREQUENCY DISTRIBUTION OF DATA POINT VALUES IN EACH LEVEL

| LEVELS | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|---|
| SYMBOLS | | | | | | | | | | |
| FREQUENCY | 1560 | 923 | 795 | 679 | 332 | 170 | 132 | 67 | 85 | 32 |

Fig. III.6
Topographic Elevation to the Nearest 5'

Figures III. 7 through II. 10 display the topographic elevation data in color oblique views produced by the OBLIX program. This program, written by Mr. Adrian Thomas at the Laboratory for Computer Graphics and Spatial Analysis of Harvard University, accepts data on the basis of grid cell values and produces combinations of vertical and horizontal sections in a variety of map projections. Figure III. 7 shows the study area as seen from the South. Figure III. 8 shows the study area as seen from the North, with colors representing elevation ranges.

The OBLIX program also allows a second variable to be superimposed upon the basic topographic contours. In the following figures, vegetation type is shown in color and outline, with green representing coniferous trees, blue representing deciduous trees, and brown indicating the absence of trees. Figure III.9 shows the study area from the North, and Figure III. 10 presents a view from the Northeast.

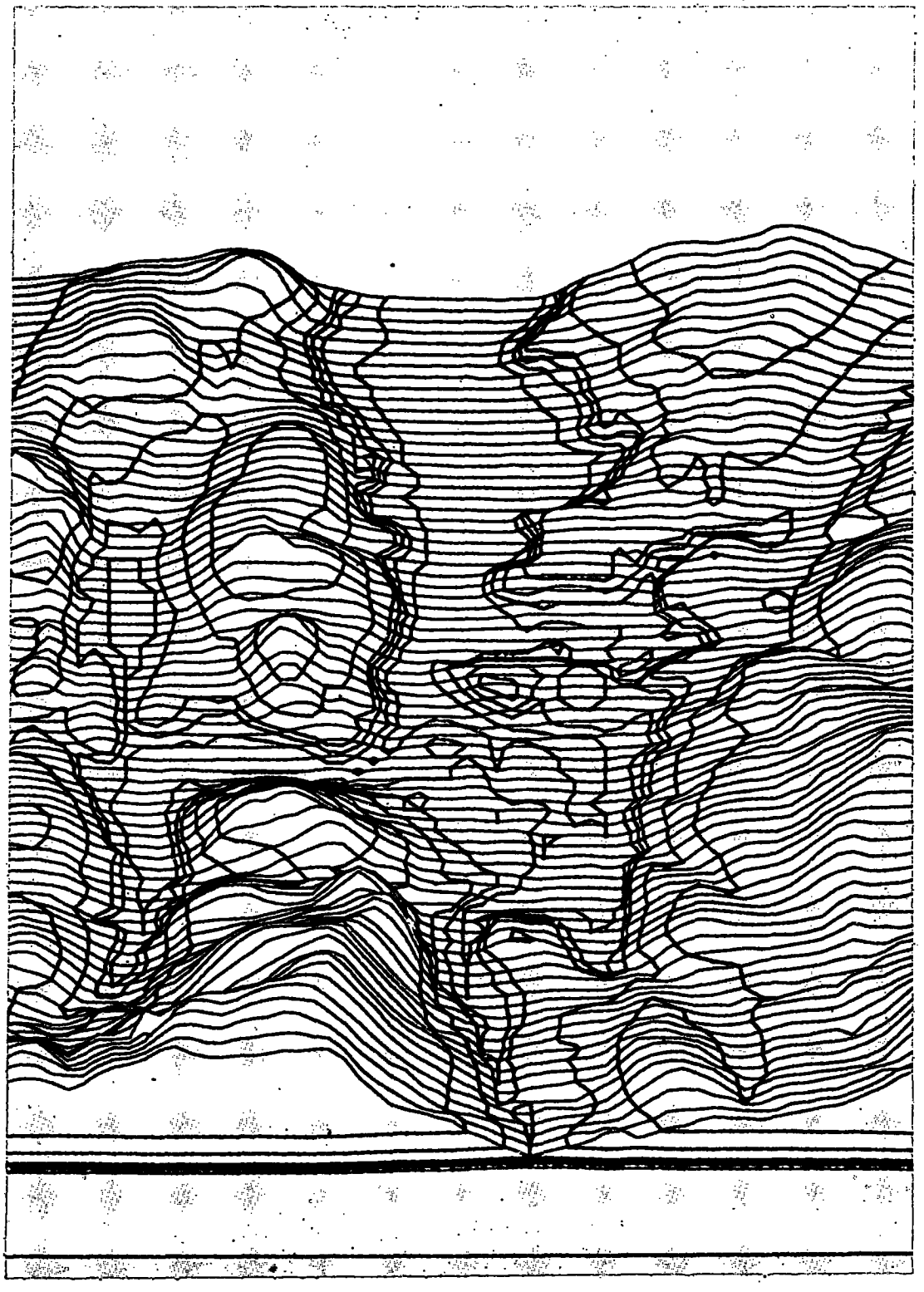


Fig. III.7
Oblique View of Topographic Contours in the Study Area as seen from the South

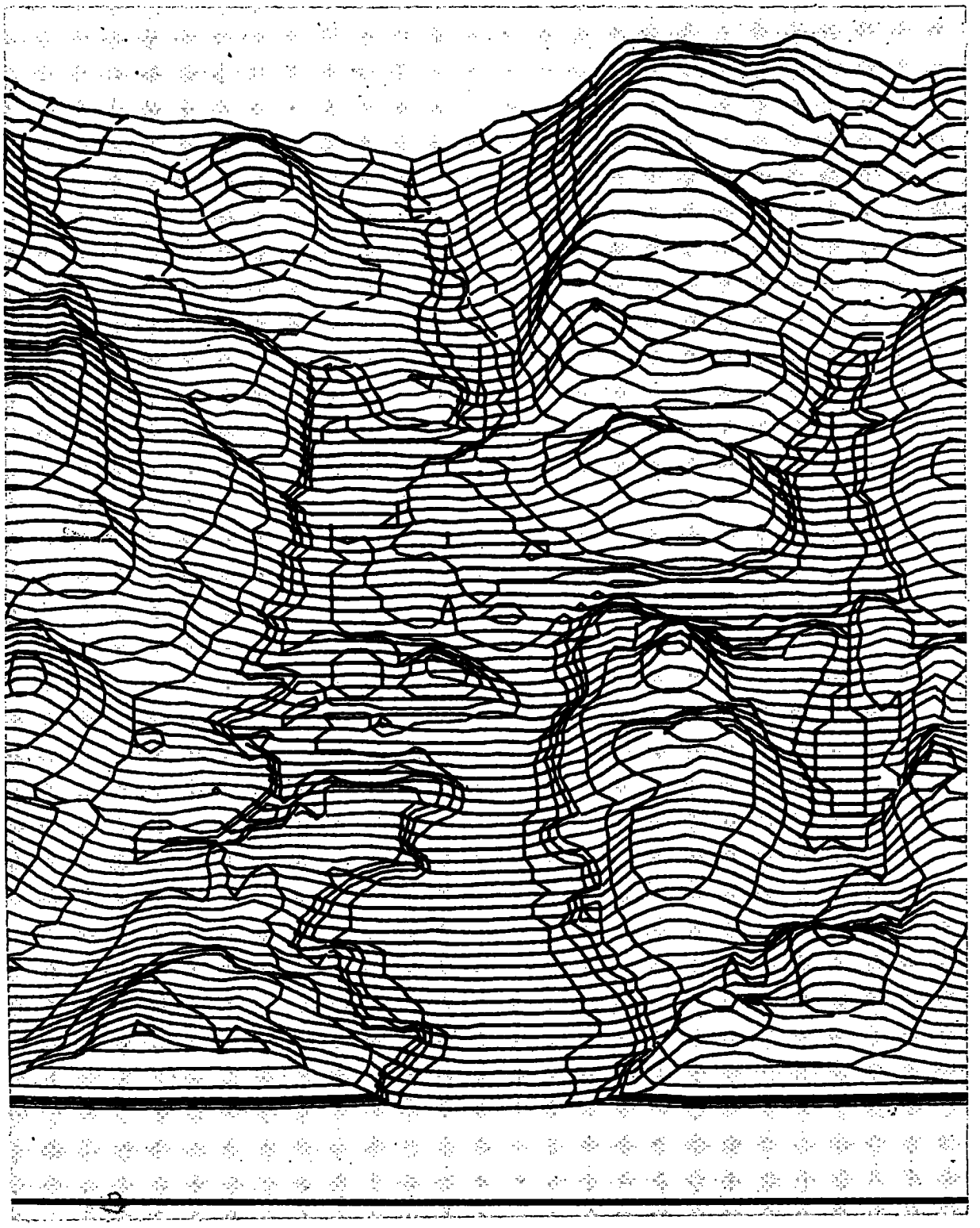


Fig. III.8
Topographic Contours in the Study Area as seen from the North

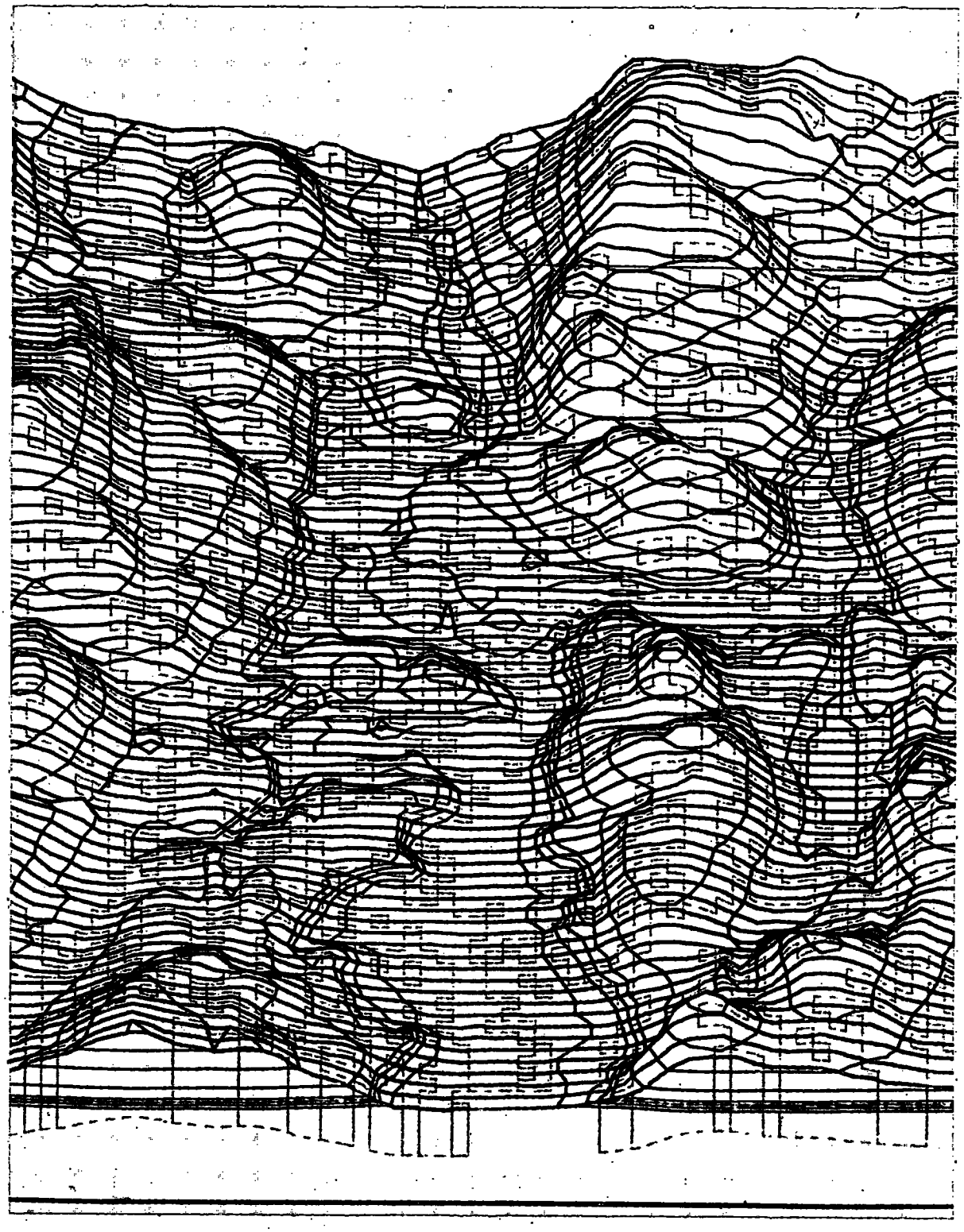


Fig. III.9
Topographic Contours & Vegetation Type in the Study Area as seen from the North

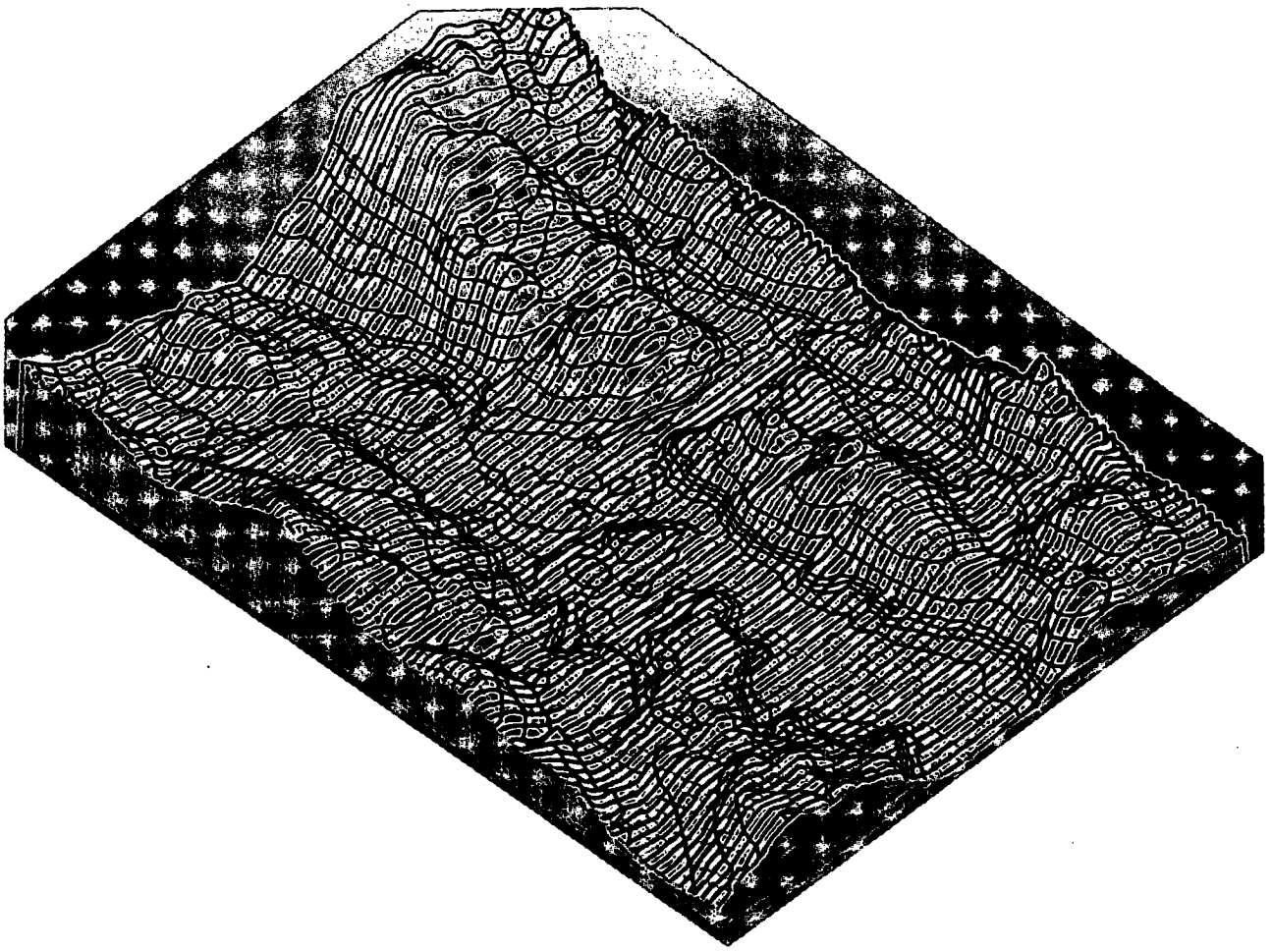
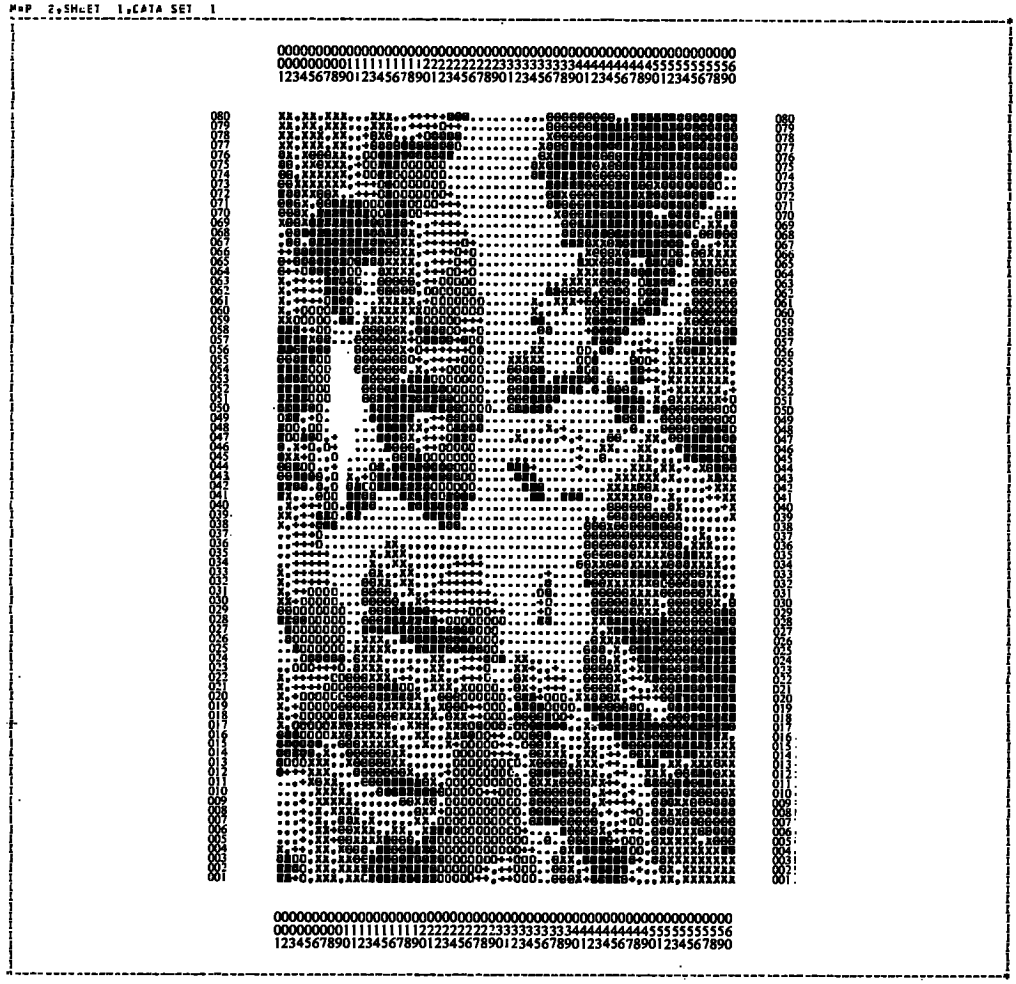


Fig. III.10
Topographic Contours & Vegetation Type in the Study Area as seen from the Northeast

MAP 2,SHEET 1,DATA SET 1



TOPOGRAPHY.- ORIENTATION

HONEY HILL CASE STUDY

U.S. ARMY CORPS OF ENGINEERS

LEGEND..
0 = WATER
1 = FLAT
2 = NORTH
3 = NORTHEAST
4 = NORTHWEST
5 = EAST
6 = WEST
7 = SOUTHEAST
8 = SOUTHWEST
9 = SOUTH

Fig. III.11
Topographic Orientation

square kilometer cell. The predominant directions are ordered on the basis of their probable effect on microclimate and activity location, rather than by direction.

0 = Water
1 = Flat
2 = North
3 = Northeast
4 = Northwest
5 = East
6 = West
7 = Southeast
8 = Southwest
9 = South

4. TOPOGRAPHIC SLOPE (Figure III.12)

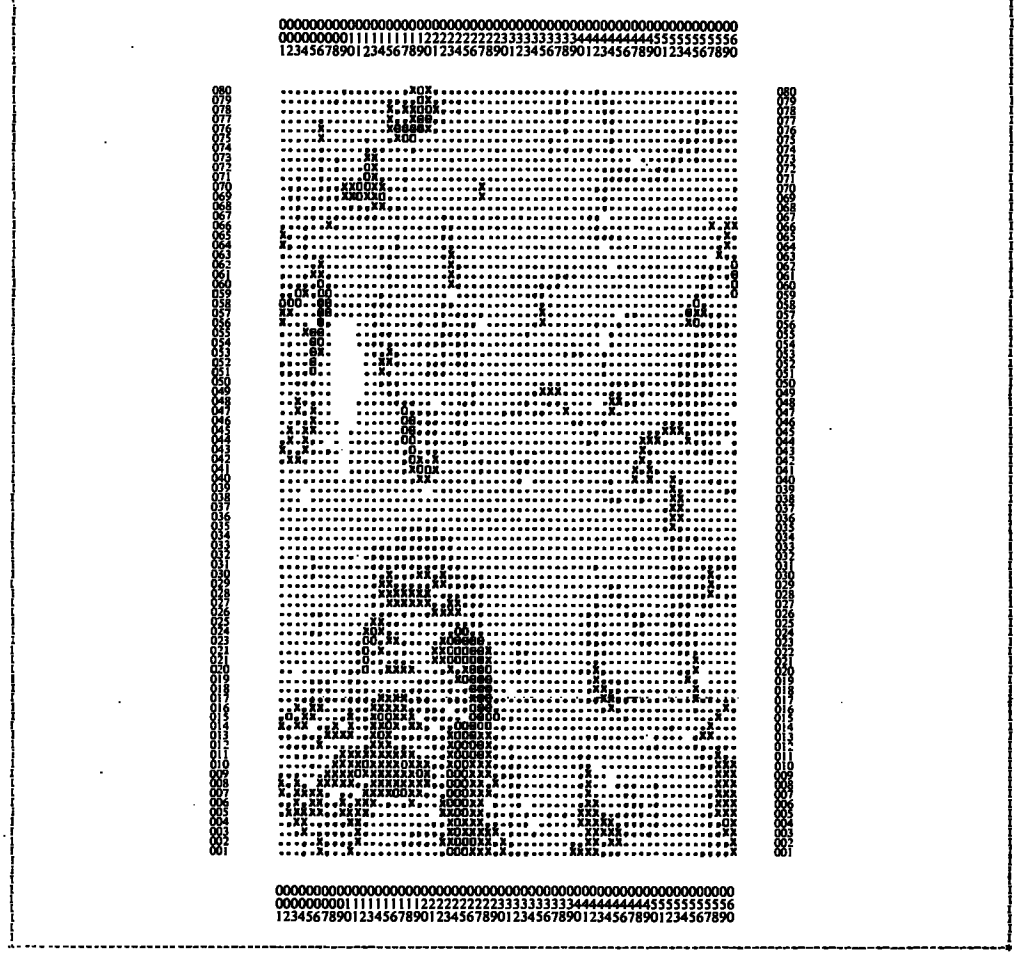
Topographic slope can be recorded in a variety of classification schemes, including listing single percentages. If this is done, the resultant data will have the greatest analytic flexibility. However, the cost of collecting such detailed categories is prohibitive under normal circumstances. Since available topographic information was only accurate to ± 10 feet within 20' contours, the grouping of slope categories was necessary. The groupings listed are derived from an investigation of significant slope groupings as they relate to construction for land uses and activities. The categories of slope were measured directly from gridded U.S.G.S. maps, and were recorded by the predominant type within each cell.

0 = No Slope
1 = 0-4%
2 = >4-8%
4 = >8-10%
5 = >10-12%
6 = >12-15%
7 = >15-25%
8 = >25-35%
9 = >35+%

5. SURFICIAL LANDFORM (Figure III.13)

The interpretation and identification of these landforms is rather complex. It is specifically defined in [101.26] Air Photo Interpretation for Land Planning, by Douglas Way,

MAP 3.SHEET 1.DATA SET 1



TOPOGRAPHY - SLOPE

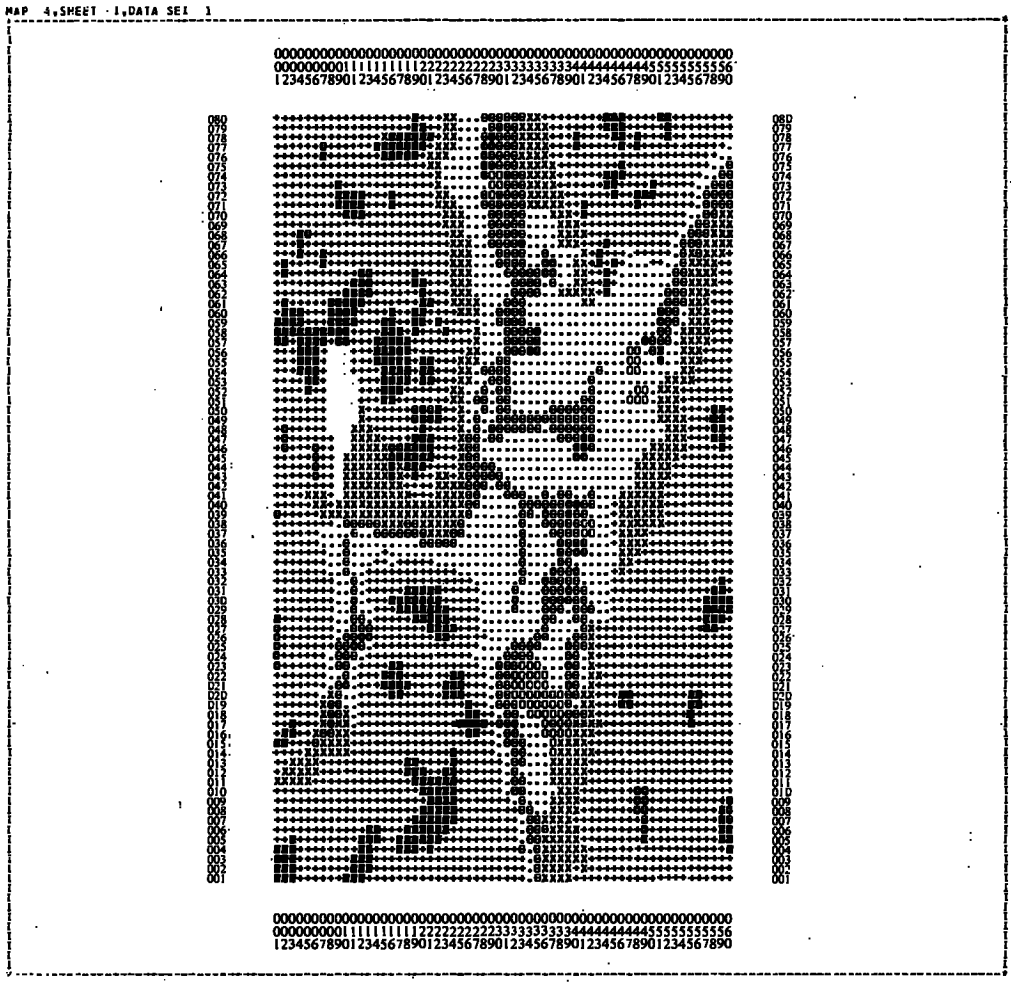
HONEY HILL CASE STUDY

U.S. ARMY CORPS OF ENGINEERS

LEGEND
0 = NO SLOPE
1 = 0-4%
2 = 4-8%
4 = 8-10%
5 = 10-12%
6 = 12-15%
7 = 15-25%
8 = 25-35%
9 = 35%+

| LEVELS | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|---|
| SYMBOLS | | | | | | | | | | |
| FREQUENCY | 65 | 3177 | 958 | 0 | 395 | 104 | 30 | 15 | 0 | 0 |

Fig. III.12
Topographic Slope




LANDFORM - PREDOMINANT TYPE

HONEY HILL CASE STUDY

U.S. ARMY CORPS OF ENGINEERS

LEGEND
0 = NONE
1 = OUTWASH
3 = TILL
4 = KAME TERRACES
5 = KAME
6 = FLOOD PLAIN
7 = ORGANIC
9 = ROCK

| LEVELS | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|---|
| SYMBOLS | | | | | | | | | | |
| FREQUENCY | 41 | 858 | 0 | 2389 | 523 | 61 | 42E | 1GC | 27 | 373 |

Fig. III.13
Surficial Landform

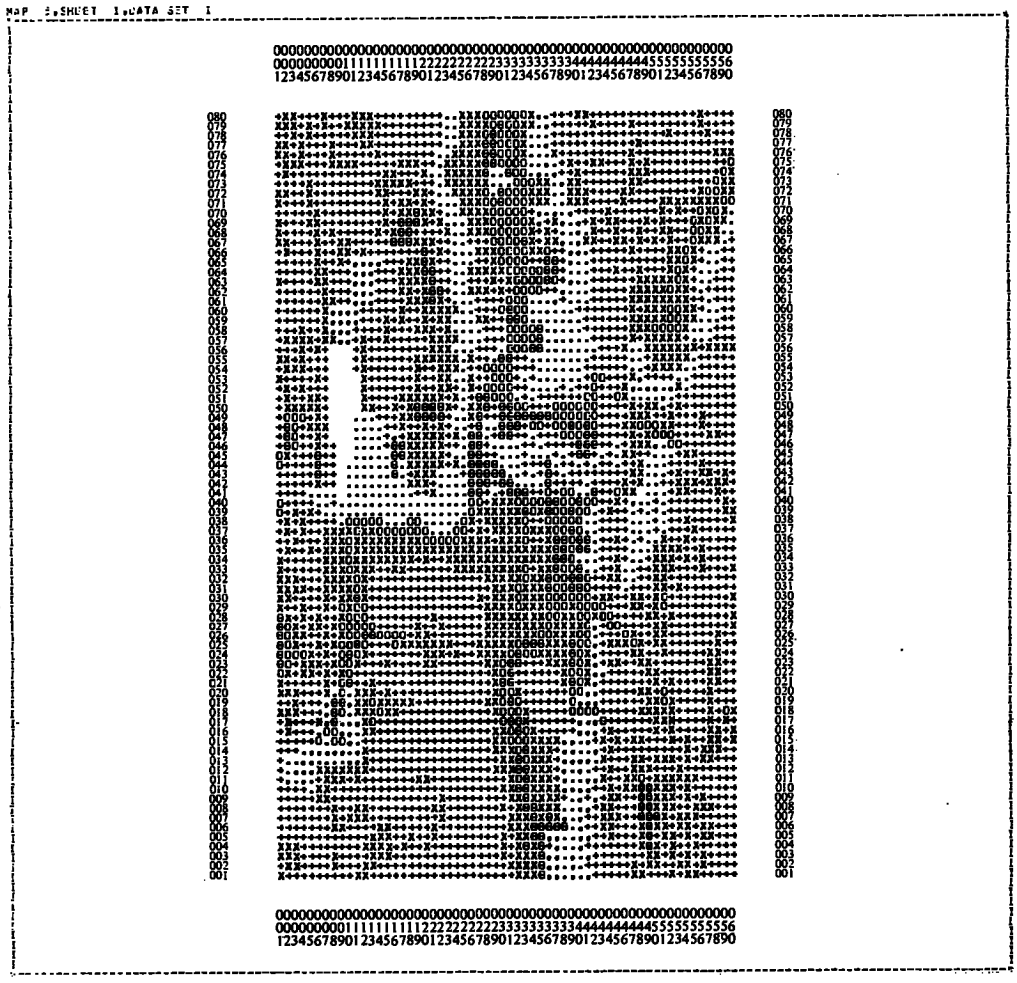
1968. (Counties that have recently published soil surveys by the Soil Conservation Service will have landform information available).

The Honey Hill region was covered with glacial ice that contained a heterogenous mixture of boulders, cobbles, gravel, sand, silt, and clay. This mixture was picked up and transported from northern regions that contained mostly igneous and metamorphic rock. Because of the origin of this material, it tends to be granular in texture. As the ice melted or retreated, the material held in the ice was deposited as till upon the surface of the underlying terrain. As the ice was in the process of melting, other forms such as kames and kame terraces were formed from the contact with the ice. These forms are commonly located along the valley sides, appearing as small rugged hills with sharp ridges. The melt water from the melting glaciers caused large floods and river systems that deposited deep stratified sands and gravels. This material is indicated on the map as outwash. After glaciation, the continued drainage of the area formed rivers in the valleys with their own flood plains. Depressions both in upland and lowland regions filled with water and formed swamps, marshes, and bogs, referred to as organic deposits. Some of the upland ridges have very shallow glacial till cover over the bedrock and these areas are indicated as "rocks."

1 = Outwash
3 = Till
4 = Kame Terraces
5 = Kame
6 = Flood Plain
7 = Organic
9 = Rock

6. <u>SOIL TYPE</u> (Figure III.14)

Once the landforms are defined, the soil types can be interpreted by close examination of the aerial photographs with supporting field checks. The soils are listed in seven sub-categories of the Unified Soil Classification System developed for the Bureau of Public Roads. The advantage of utilizing the Unified system lies with its defined engineering characteristics for each of the soil units. The listing occurring within this particular data bank only makes seven distinctions of the broad Unified categories. It was felt that for the issues being considered in this project, this level of classification was



SOIL TYPE

HONEY HILL CASE STUDY

U.S. ARMY CORPS OF ENGINEERS

LEGEND
0 = NONE
1 = GRAVEL - COURSE
2 = GRAVEL - FINE
3 = SAND - COURSE
4 = SAND - FINE
5 = SILTS AND CLAYS LIQ LT 50
6 = SILTS AND CLAYS LIQ GT 50
7 = PEAT

| LEVELS | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|---|
| SYMBOLS | | | | | | | | | | |
| FREQUENCY | 43 | 480 | 149 | 2295 | 1240 | 360 | 201 | 12 | 0 | 0 |

Fig. III.14
Soil Type

relevant. The organic soild, OL and OH, are not listed here due to their insignificant occurrence within the study area. Coding is by predominant type.

1 = Gravel - Coarse
2 = Gravel - Fine
3 = Sand - Coarse
4 = Sand - Fine
5 = Silts and Clays liq<50
6 = Silts and Clays liq>50
7 = Peat

7. BEDROCK DEPTH (Figure III.15)

The depth to bedrock is interpreted from the landform information, detail examination of the photographs, and field investigations. The categories listed have proven to be related to several construction problems. The coding represents the average value for the particular category coded. Therefore, variations will exist in each cell area.

1 = Exposed
3 = 0-1'
5 =>1'-3'
7 =>3'-10'
9 =>10'

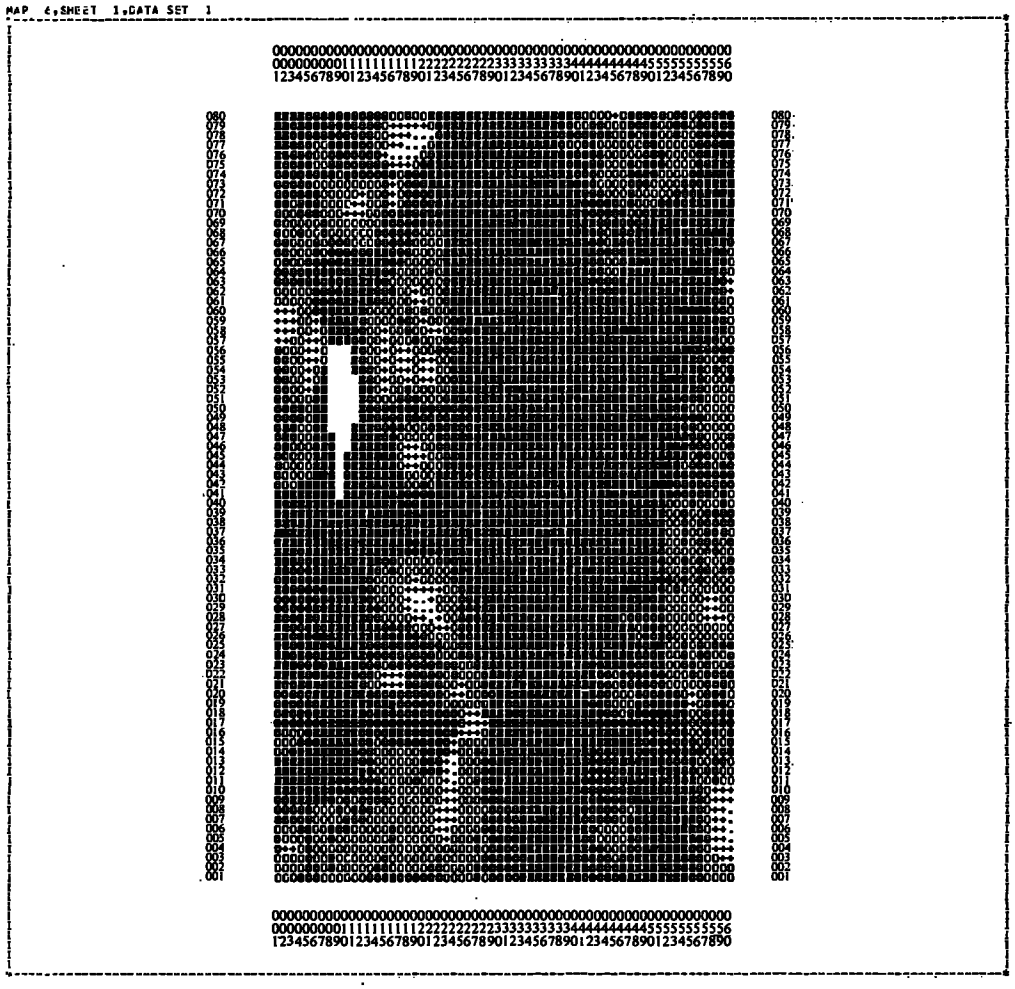
8. SOIL MOISTURE (Figure III.16)

Soil Moisture was interpreted as the average moisture available to vegetation over a yearly period. The interpretation was completed by defining the parent landform, detailed examination of photographs, definition of soil texture, depth to bedrock, and field investigations. It should be noted that the soils will be significantly wetter during the spring season.

0 = Water
3 = Wet
5 = Moist
7 = Fresh
9 = Dry

9. DEPTH TO SUBSURFACE WATER (Figure III.17)

The depth to watertable is important in determining the capability of the land to support specific land uses and




BEDROCK DEPTH

MONEY HILL CASE STUDY

U.S. ARMY CORPS OF ENGINEERS

LEGEND
0 = NONE
1 = EXPOSED
3 = 0-1'
5 = 1-3'
7 = 3-10'
9 = 10'+

| LEVELS | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|---|
| SYMBOLS | | ..... | ..... | +++++++++ | XXXXXXXX | 00000000 | 88888888 | ******** | ######## | ######## |
| FREQUENCY | 41 | 23 | 0 | 160 | C | 926 | D | 1252 | 0 | 2398 |

Fig. III.15
Bedrock Depth

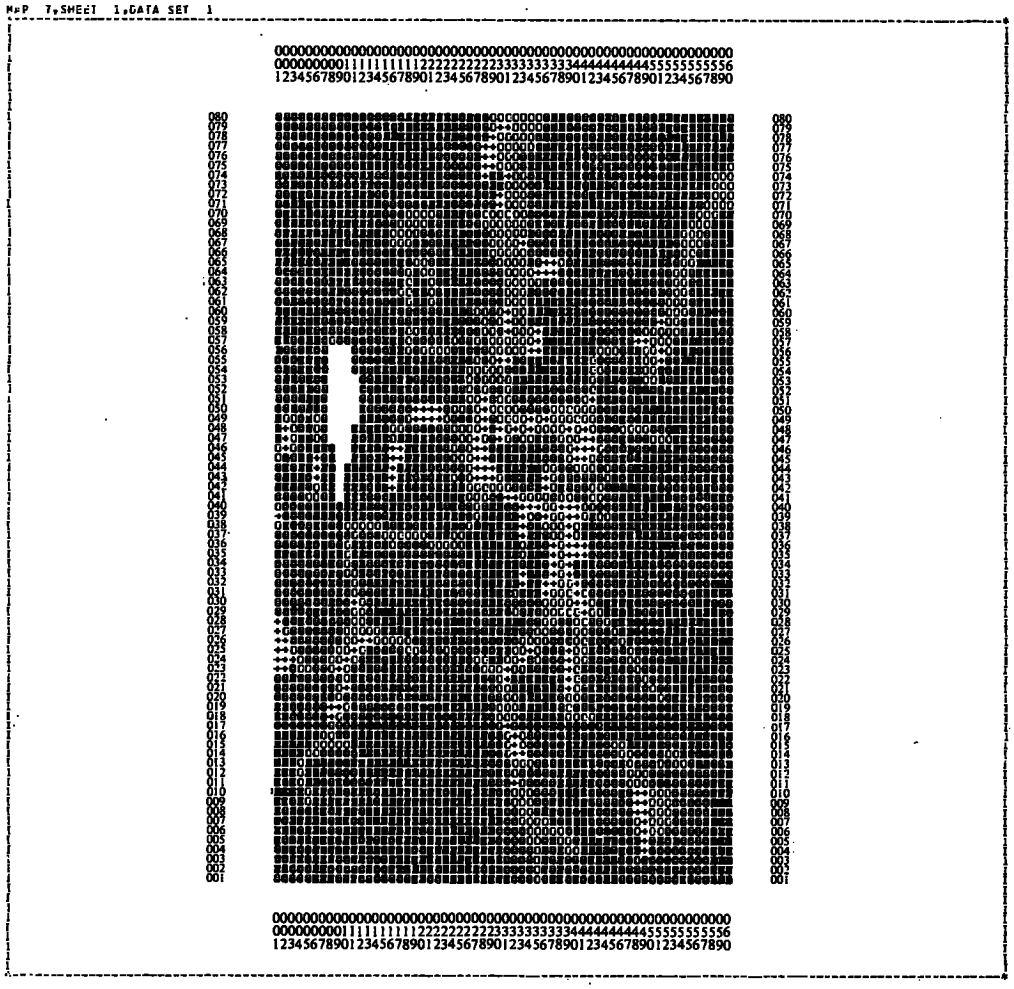



Fig. III.16
Soil Moisture

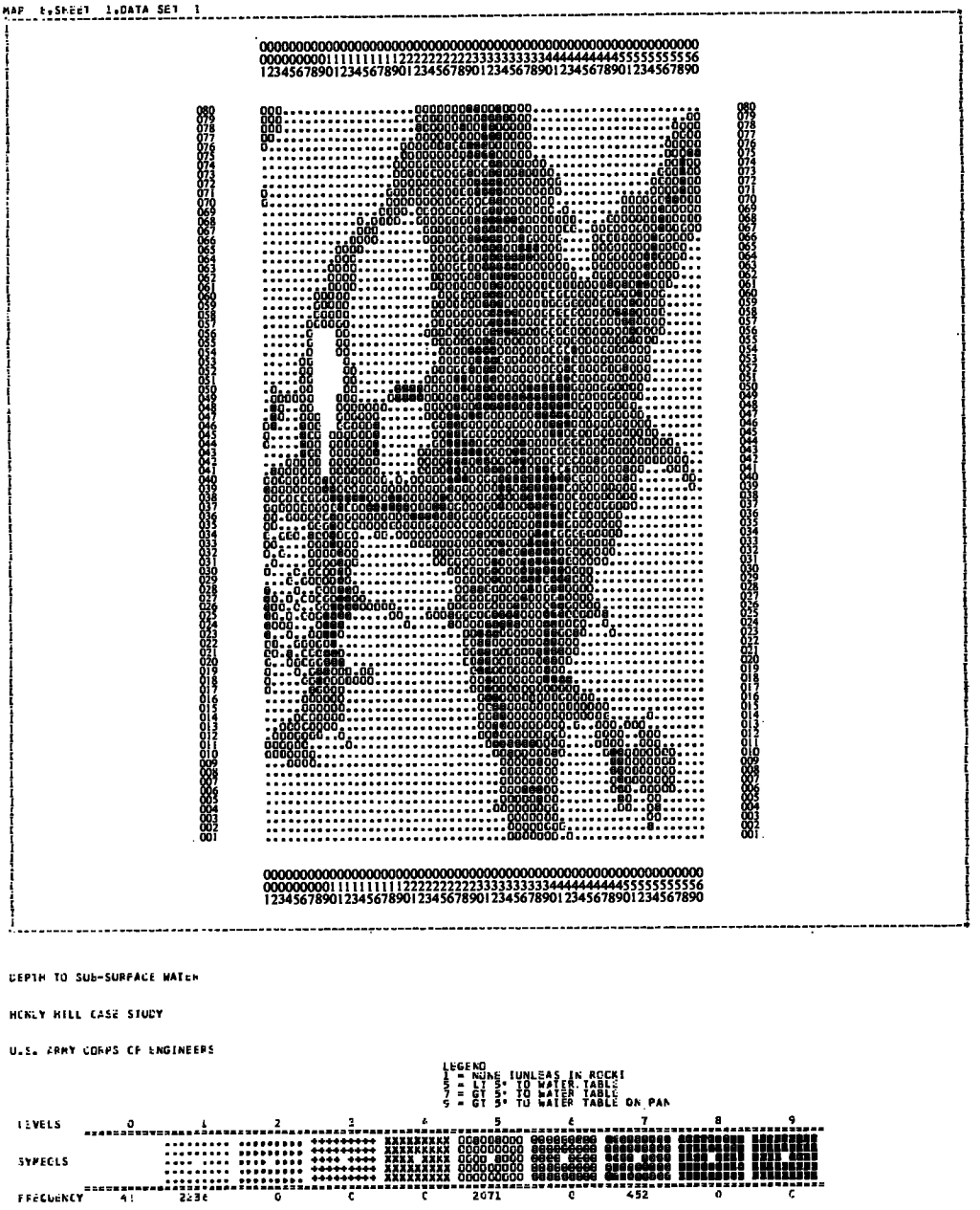



Fig. III.17
Depth to Subsurface Water

activities. The coding is done on a relative basis utilizing the landform, soil texture, detailed examination of the photographs, and field investigations.

The depth recorded represents the average yearly condition during the spring thaw, when watertables are temporarily close to the surface even in elevated areas. Counties that have active Soil Conservation Service offices or recently published soil surveys may be able to provide this information.

1 = None (unless in rock)
5 = < 5' to water table
7 = > 5' to table
9 = < 5' to table on pan

10. SURFACE WATER - PREDOMINANT TYPE (Figure III.18)

The water classification system identifies the predominant type of water feature in each cell, using the terms indicated by the U.S. Geologic Survey. First order streams were added to the classification due to their significance in determining stream quality and potential damage. The predominant water feature was recorded as the higher number listed in the coding when two different water features occurred in any one cell.

0 = None
1 = Swales
2 = Wetlands
3 = Small Streams
4 = 1st Order Streams
5 = Ponds
6 = Reservoirs
7 = Lakes
8 = Minor Rivers
9 = Major Rivers

11. FOREST TYPE (Figure III.19)

The forest type identification in this data bank was done directly from aerial photographs. The photos were taken in early May when the deciduous trees lacked their foliage, making it easier to distinguish between deciduous and coniferous cover. Newly cut areas (as of 1965) were also identified and coded because of their significance to wildlife.

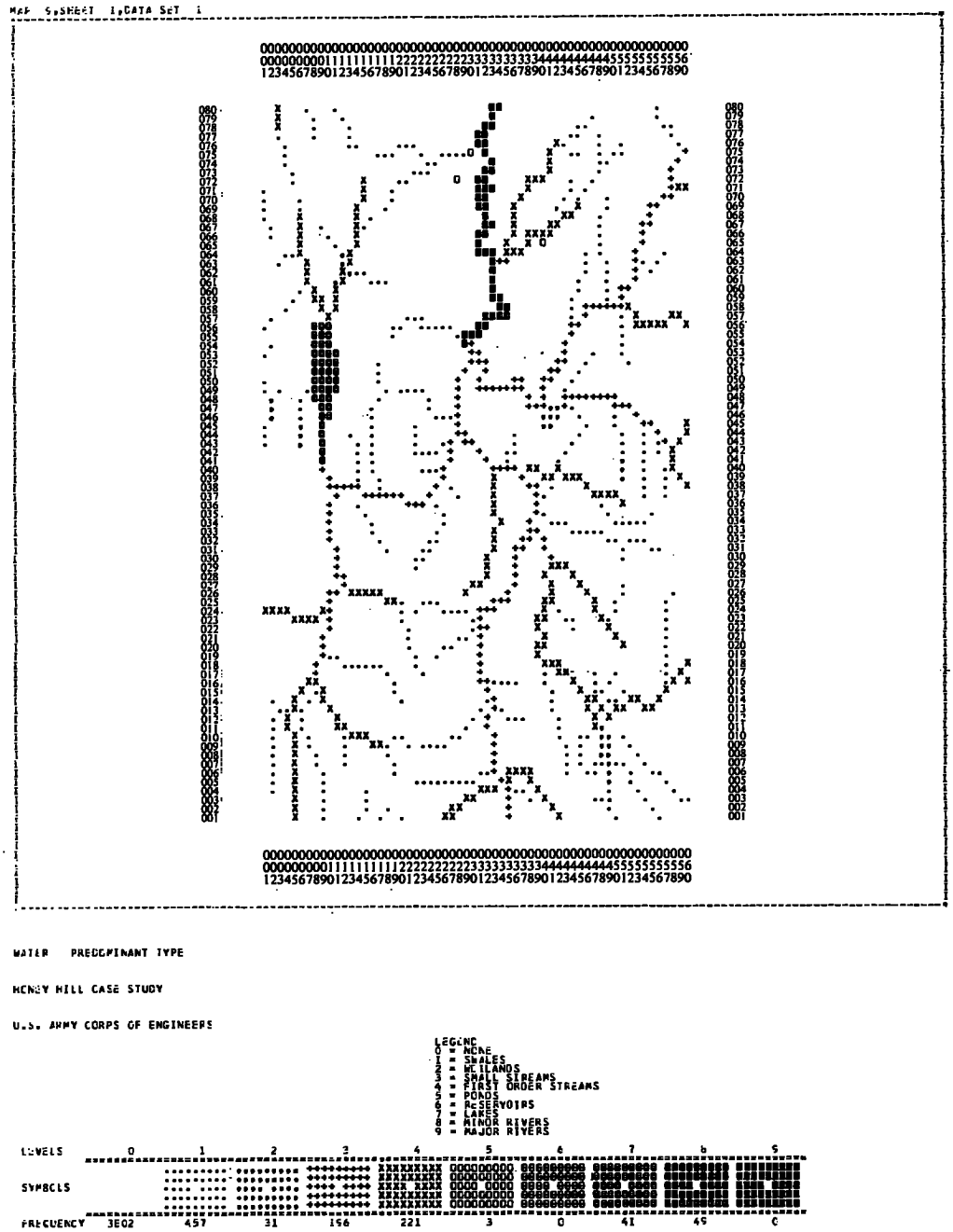
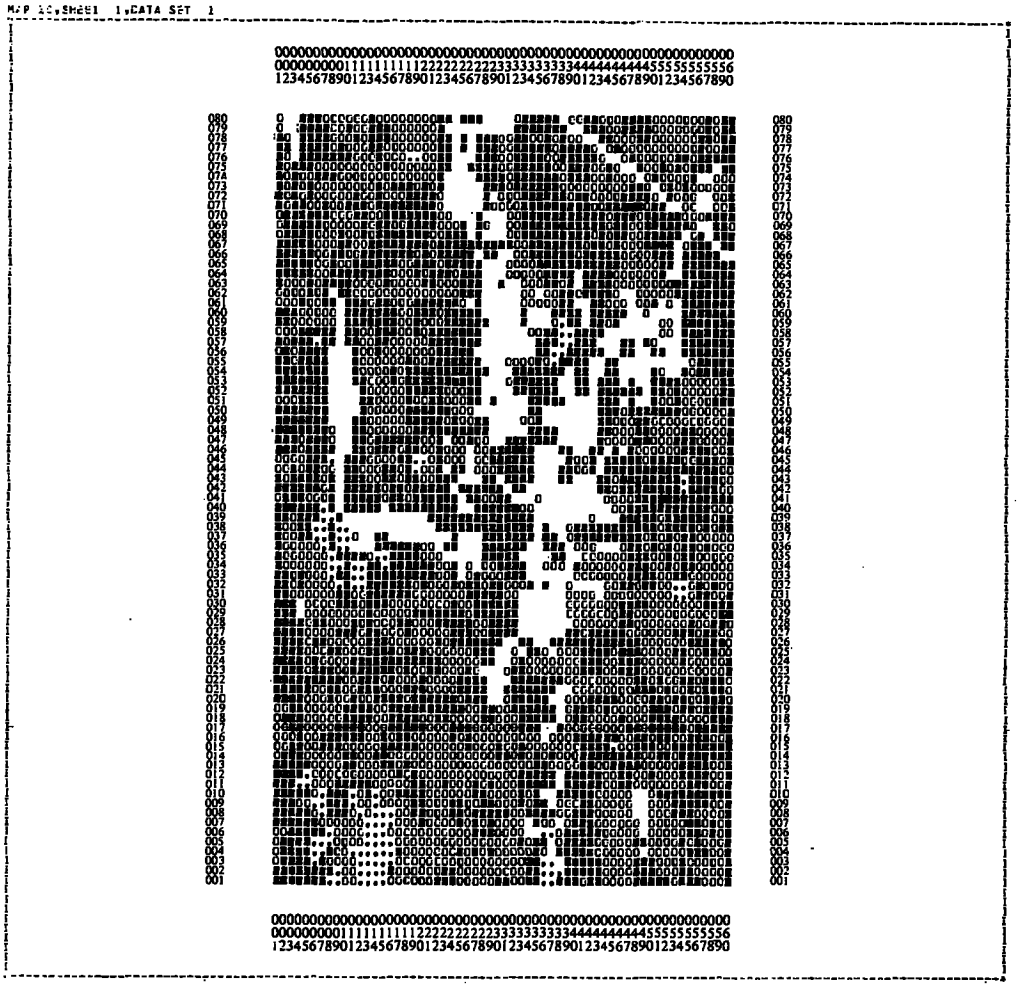



Fig. III.18
Surface Water - Predominant Type



FOREST TYPE

HONEY HILL CASE STUDY

U.S. ARMY CORPS OF ENGINEERS

LEGEND
0 = AGAE
1 = CUT AND REGROWTH AREA
2 = DECIDUOUS
3 = CONIFEROUS

| LEVELS | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|---|
| SYMBOLS | | | | | | | | | | |
| FREQUENCY | 588 | 6 | 108 | 0 | 0 | 1776 | 0 | 0 | 0 | 2322 |

Fig. III.19
Forest Type

Since forest type, density and height apply to the same cells, these forested areas were identified as the first step in the interpretation process.

0 = None
2 = Cut and Regrowth Area
5 = Deciduous
9 = Coniferous

12. FOREST DENSITY (Figure III.20)

The density of the tree crown cover was interpreted from the aerial photographs. Tree crown density screens commonly used by the U.S. Forest Service were employed as standards. Copies of these screens are available from commercial forestry equipment suppliers or any district office of the U.S. Forest Service.

0 = None
2 = Less than 30% Crown Coverage
4 = 31-50% Crown Coverage
6 = 51-80% Crown Coverage
8 = 81-100% Crown Coverage

13. FOREST HEIGHT (Figure III.21)

The height of the vegetation in forested cells was measured on a relative basis, using U.S. Forest Service categories which relate to known heights of objects that appear on the photographs, e.g., houses, barns, etc. Spot field checking was also done to provide the necessary accuracy control, especially in deciduous areas where the leafless tree heights were more difficult to determine.

0 = None
1 = Less than 20'
3 = 21'-40'
5 = 41'-60'
7 = 61'-80'
9 = Greater than 80'

14. AGRICULTURAL ACTIVITY (Figure III.22)

This category was established to code the locations of cropland and pasture land associated with farmsteads.

0 = None
9 = Farmstead

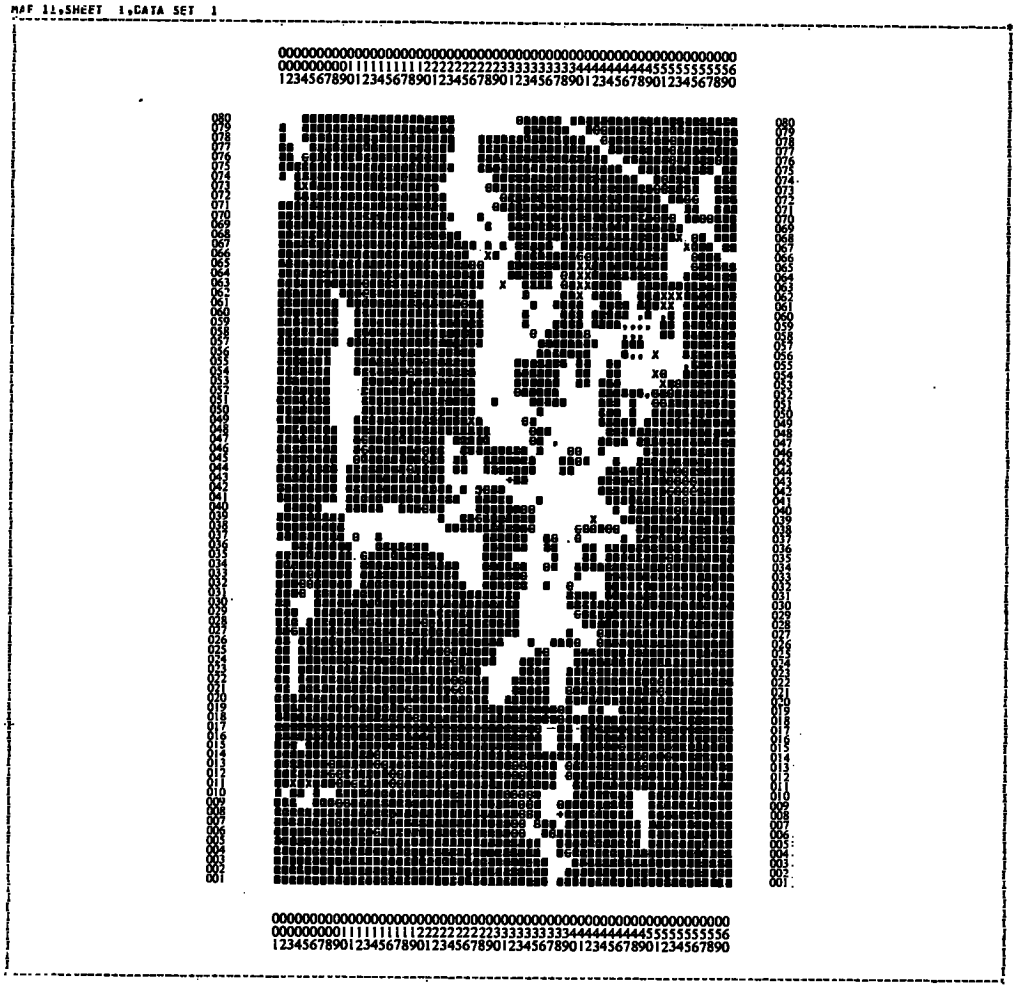
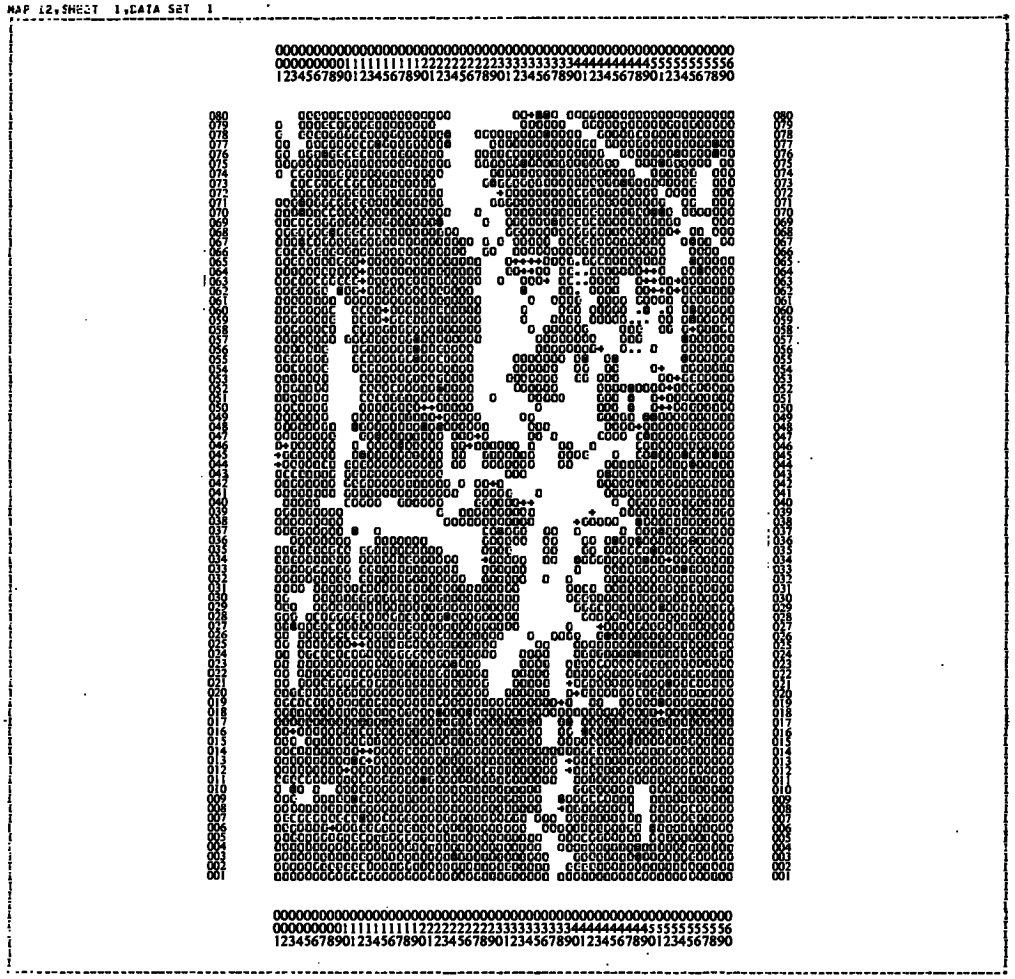



Fig. III.20
Forest Density

MAP 12,SHEET 1,DATA SET 1



FOREST - HEIGHT

HONEY HILL CASE STUDY

U.S. ARMY CORPS OF ENGINEERS

LEGEND
0 = NONE
1 = LT 20'
3 = 21-40'
5 = 41-60'
7 = 61-80'
9 = GT 80'

| LEVELS | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|---|
| SYMBOLS | | ..... | ..... | +++++++++ | XXXXXXXXX | 00000000 | 88888888 | ######### | ######### | ######### |
| FREQUENCY | 803 | 13 | C | 64 | C | 3836 | 1 | 81 | 2 | C |

Fig. III.21
Forest Height

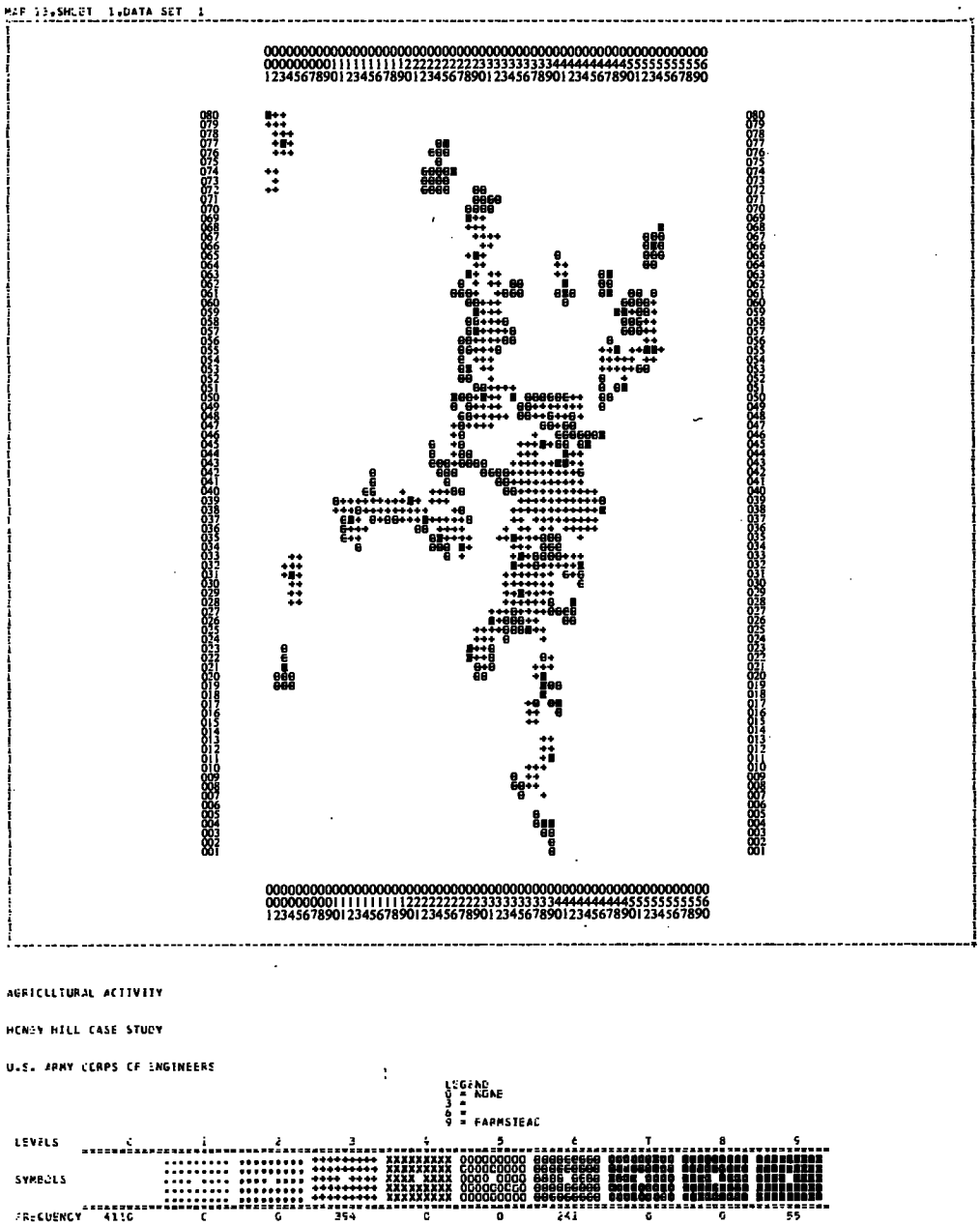



Fig. III.22
Agricultural Activity

15. RESIDENTIAL ACTIVITY (Figure III.23)

The location and activity of residential land use as interpreted from aerial photographs were recorded. The specific location of residential structures appear as value 9 on the printout, whereas lands associated with residential structure are shown by value 3.

0 = None
3 = Miscellaneous Land Associated with Residences
9 = Residence

16. DEVELOPMENT ACTIVITY (Figure III.24)

This category included other development activities occurring in the study area. The data was interpreted from aerial stereo photographs, U.S.G.S. maps, and field investigations.

0 = None
2 = Recreation
4 = Public Building
5 = Cemetary
7 = Gravel Extraction
8 = Industry
9 = Power Line

17. TRANSPORTATION, ROAD TYPE, EXISTING (Figure III.25)

The types of highway indicated on the U.S.G.S. maps were coded in a classification system which referred to surface type and traffic capacity. Aerial photographs and field investigations updated the existing information. When two different road types occurred within the same cell, the type with the higher traffic capacity had preference and was recorded.

0 = None
1 = Jeep Track
2 = Unimproved Roads
3 = Gravel Road
4 = Light Duty Paved Roads
5 = Medium Duty Paved Roads
6 = Urban Streets
7 = Heavy Duty Paved Roads
8 = Limited Access Highway
9 = Interchange of Limited Access Highways

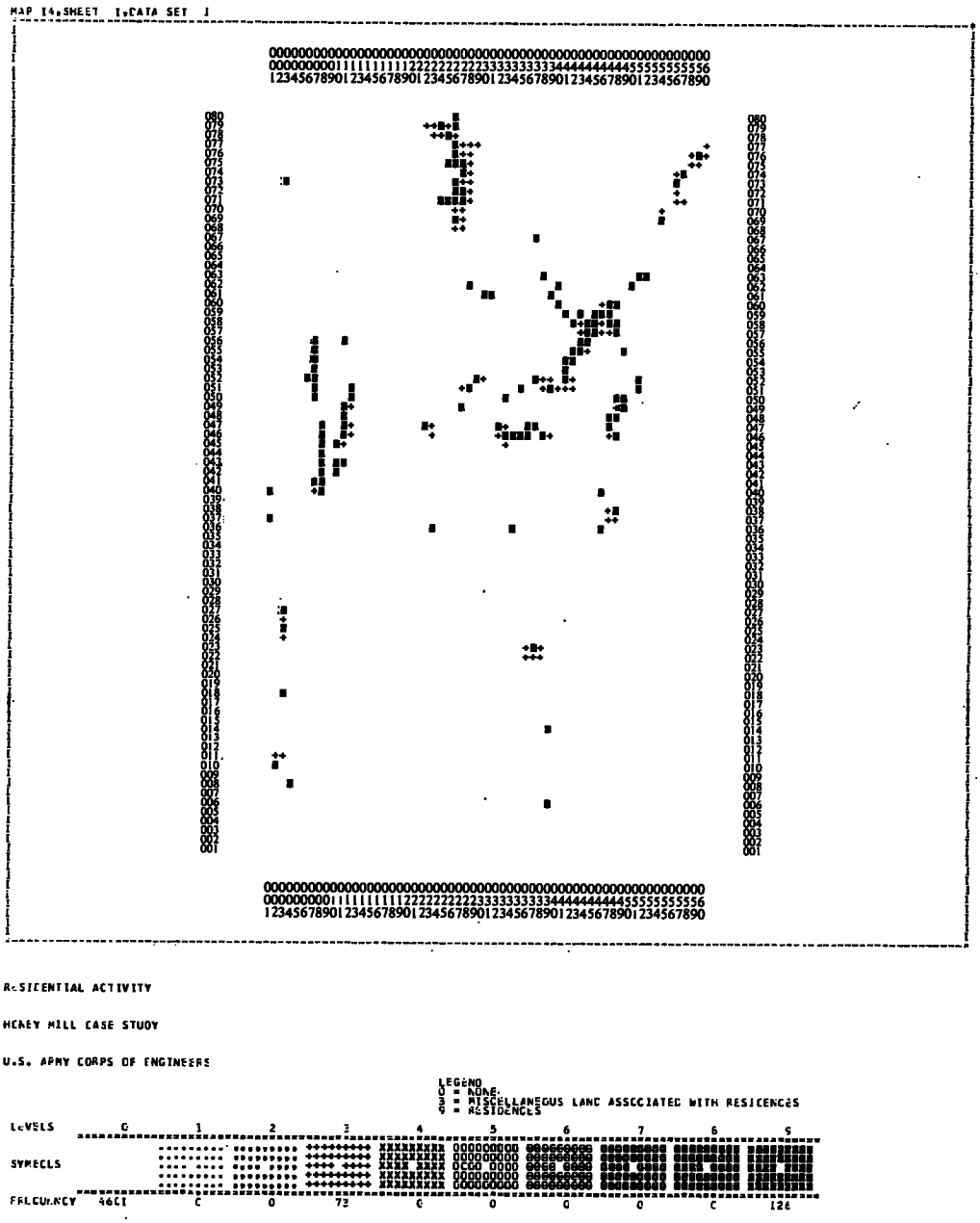



Fig. III.23
Residential Activity

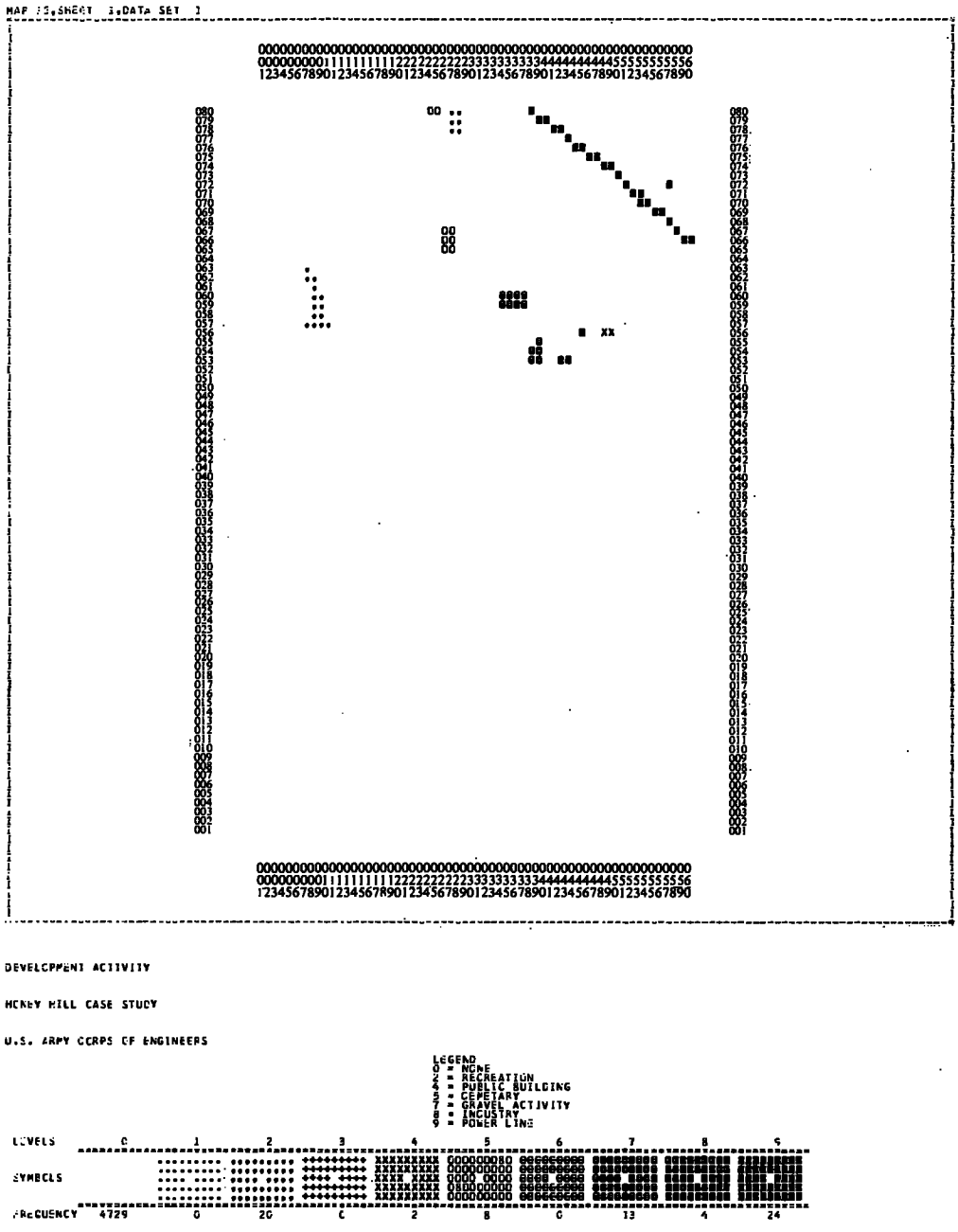



Fig. III.24
Development Activity

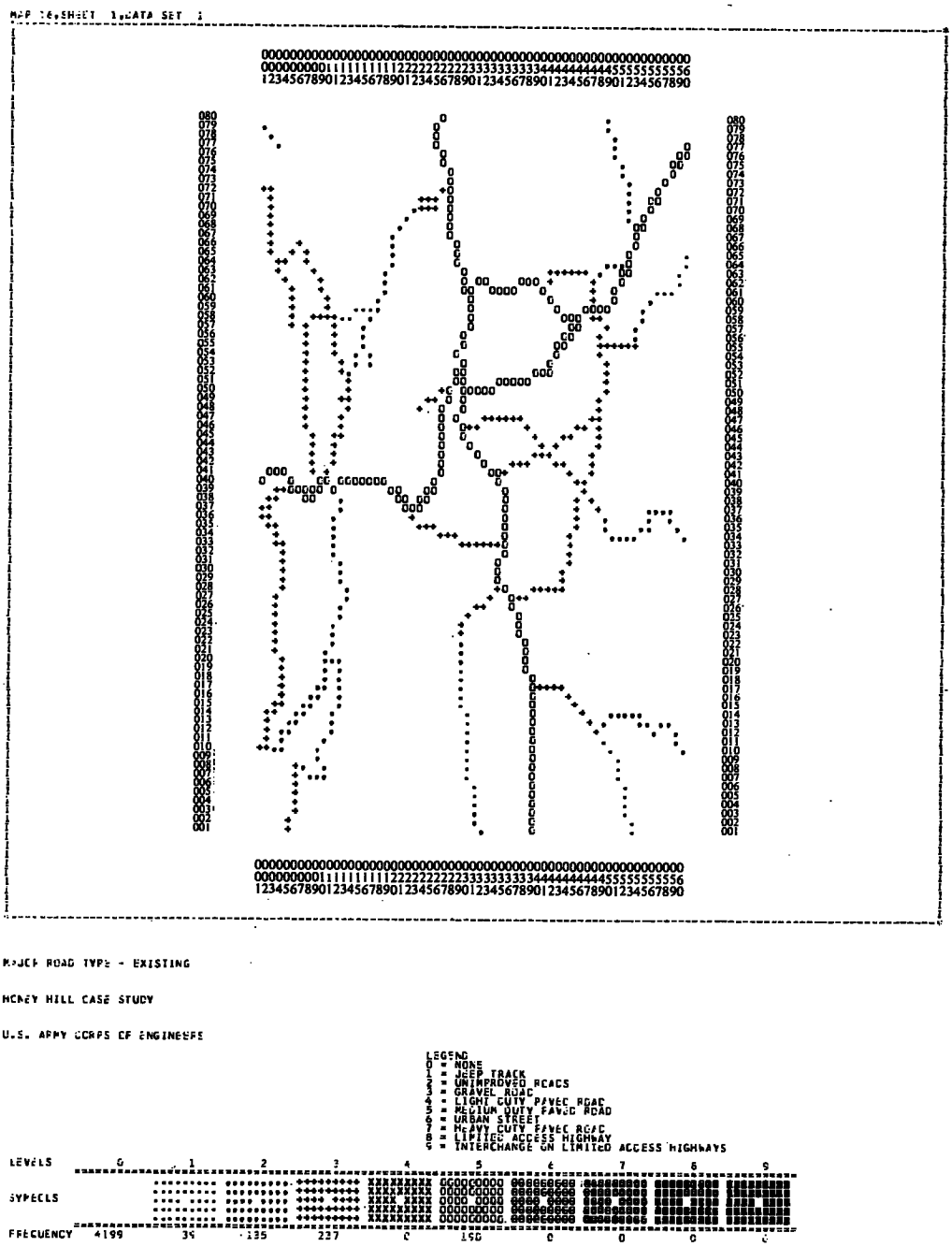



Fig. III.25
Transportation, Road Type, Existing

18. TRANSPORTATION, ROAD TYPE, PROPOSED (Figure III.26)

Changes in the existing pattern were taken from preliminary proposals by the New Hampshire Department of Public Works and Highways. These proposals took into account the proposed reservoir location and water elevation.

0 = None
1 = Jeep Track
2 = Unimproved Roads
3 = Gravel Road
4 = Light Duty Paved Roads
5 = Medium Duty Paved Roads
6 = Urban Streets
7 = Heavy Duty Paved Roads
8 = Limited Access Highway
9 = Interchange of Limited Access Highways

19. FIVE MINUTE TIME ZONES FROM POINT #1 (FROM EAST) ON EXISTING ROAD NETWORK (Figure III.27)

Four points of potential entry were chosen. These were the junctions of the East, North, West, and South entry roads with the edges of the study area. Through field investigation, distance based on normal driving and walking speed was measured on varying types of road and terrain. The resulting travel times are described in the coding and figures in terms of ten time zones of five minutes each.

0 = 0-5 minutes from point
1 = 5-10 " " "
2 = 10-15 " " "
3 = 15-20 " " "
4 = 20-25 " " "
5 = 25-30 " " "
6 = 30-35 " " "
7 = 35-40 " " "
8 = 40-45 " " "
9 = More than 45 minutes from point

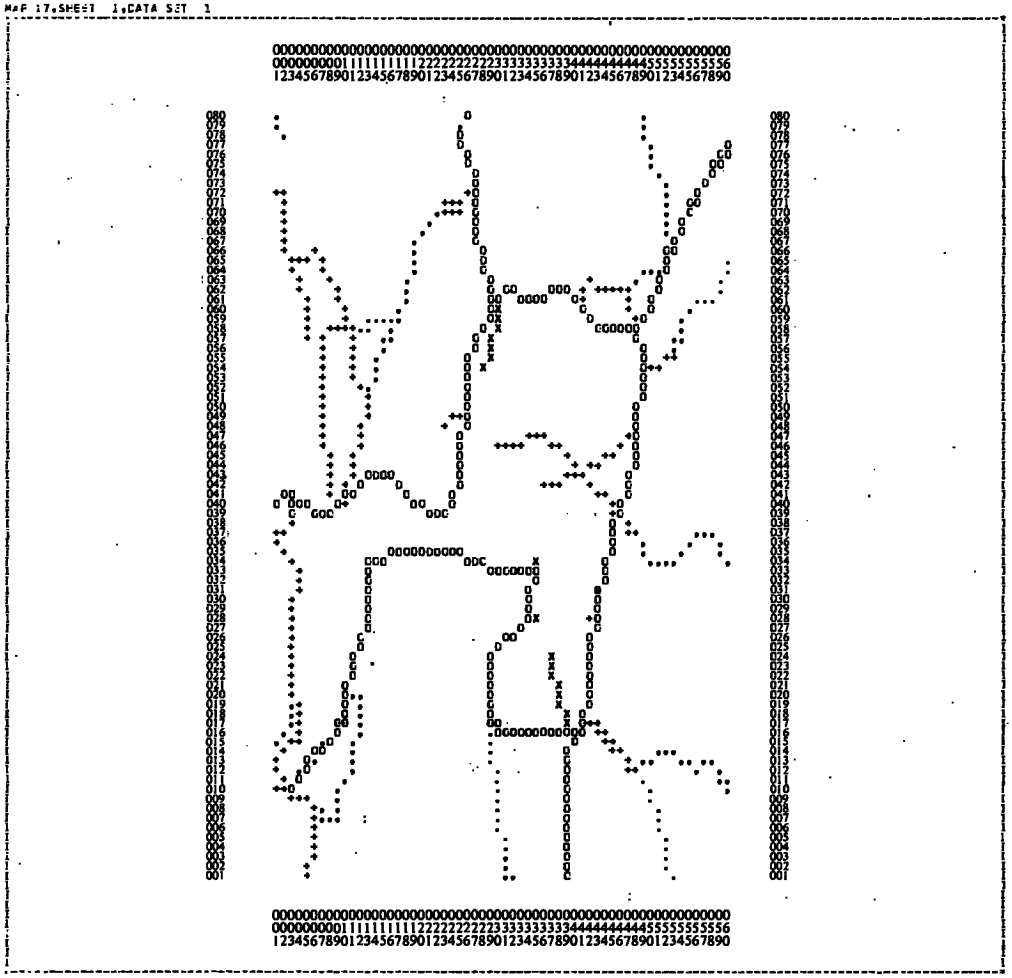
20. FIVE MINUTE TIME ZONES FROM POINT #2 (FROM NORTH) ON EXISTING ROAD NETWORK (Figure III.28)

Described and coded as above.

21. FIVE MINUTE TIME ZONES FROM POINT #3 (FROM WEST) ON EXISTING ROAD NETWORK (Figure III.29)

Described and coded as above.

MAP 17,SHEET 1,DATA SET 1



MAJOR ROAD - PROPOSED

HONEY HILL CASE STUDY

U.S. ARMY CORPS OF ENGINEERS

LEGEND
0 = NONE
1 = JEEP TRACK
2 = UNIMPROVED ROADS
3 = GRAVEL ROAD
4 = LIGHT DUTY PAVED ROAD
5 = MEDIUM DUTY PAVED ROAD
6 = URBAN STREET
7 = HEAVY DUTY PAVED ROAD
8 = LIMITED ACCESS HIGHWAY
9 = INTERCHANGE ON LIMITED ACCESS HIGHWAYS

| LEVELS | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|---|
| SYMBOLS | | | | | | | | | | |
| FREQUENCY | 4223 | 37 | 165 | 176 | 17 | 241 | 0 | 1 | 0 | 0 |

Fig. III.26
Transportation, Road Type, Proposed

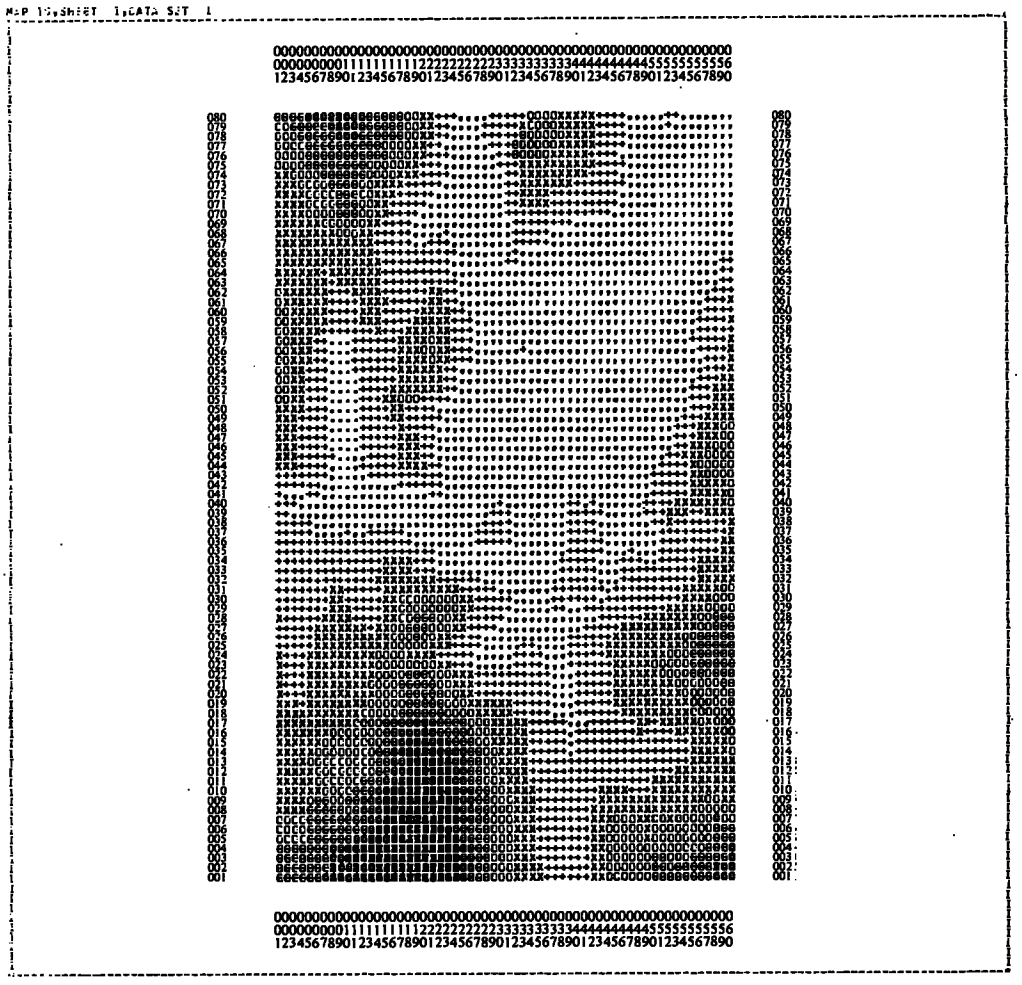
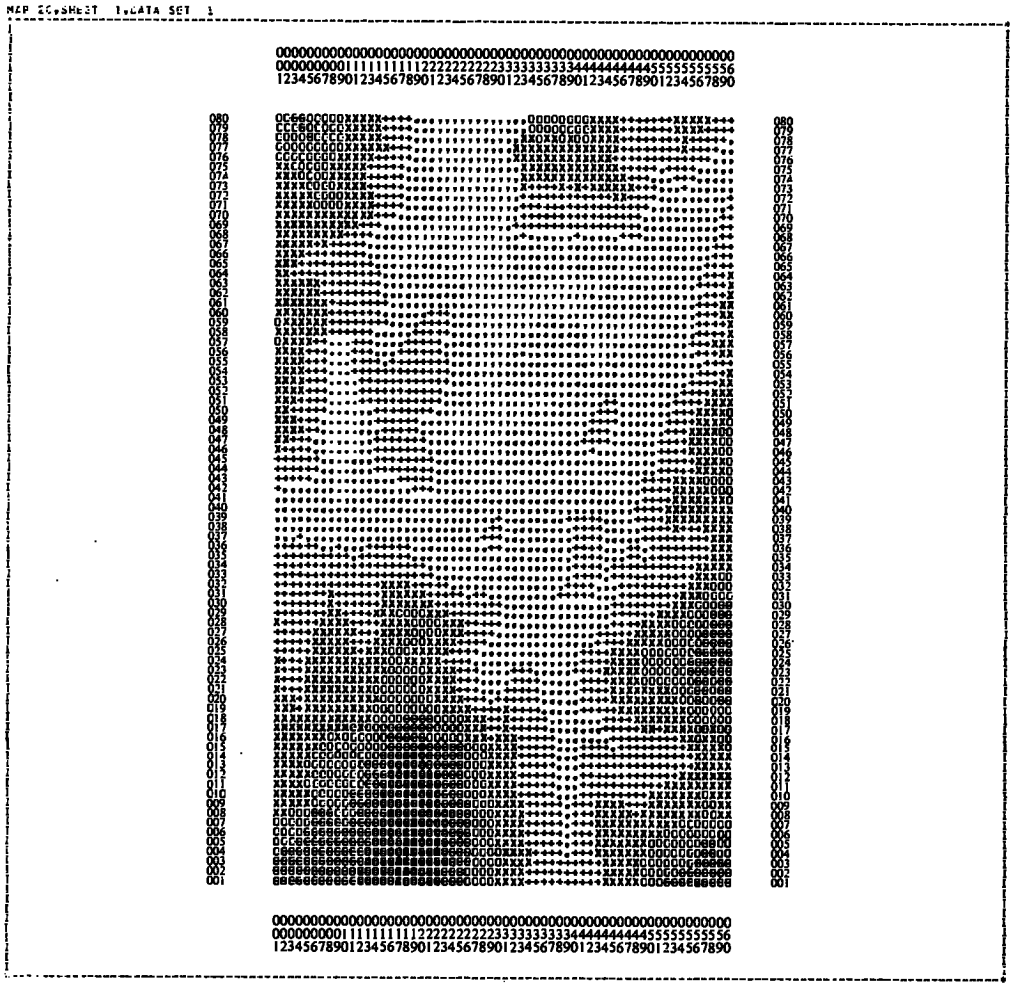



Fig. III.27
5 Minute Time Zones from Point #1 (from East)
on Existing Road Network



TRAVEL TIME FROM POINT 2

HONEY HILL CASE STUDY

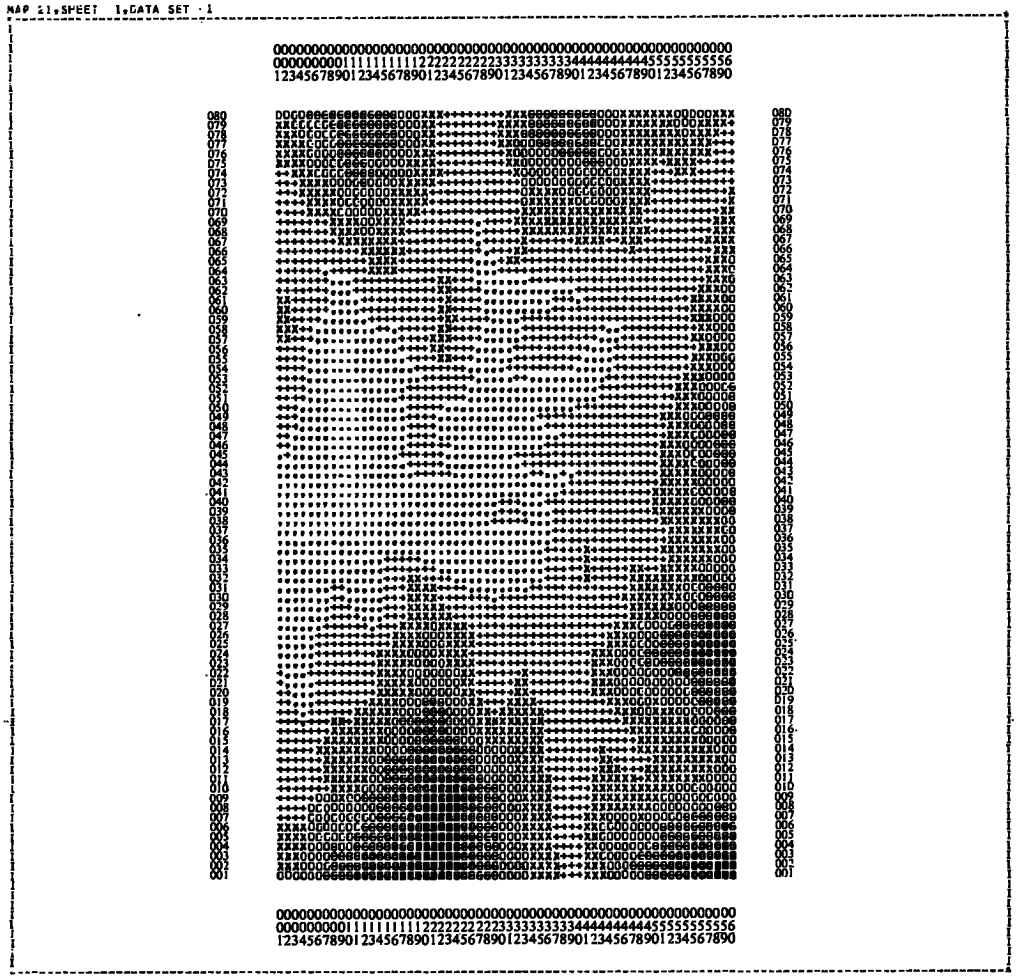
U.S. ARMY CORPS OF ENGINEERS

LEGEND
0 = 0-5 MINUTES FROM POINT
1 = 5-10 MINUTES FROM POINT
2 = 10-15 MINUTES FROM POINT
3 = 15-20 MINUTES FROM POINT
4 = 20-25 MINUTES FROM POINT
5 = 25-30 MINUTES FROM POINT
6 = 30-35 MINUTES FROM POINT
7 = 35-40 MINUTES FROM POINT
8 = 40-45 MINUTES FROM POINT
9 = MORE THAN 45 MINUTES FROM POINT

| LEVELS | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|---|
| SYMBOLS | ..... | ..... | ..... | ++++ | XXXX | OOOO | 0000 | 0000 | ▒▒▒▒ | ▒▒▒▒ |
| FREQUENCY | 57 | 324 | 1414 | 1280 | 917 | 443 | 240 | 108 | 12 | 0 |

Fig. III.28
5 Minute Time Zones from Point #2 (from North)
on Existing Road Network

MAP 21,SHEET 1,DATA SET 1



TRAVEL TIME FROM POINT 3

HONEY HILL CASE STUDY

U.S. ARMY CORPS OF ENGINEERS

LEGEND
0 = 0-5 MINUTES FROM POINT
1 = 5-10 MINUTES FROM POINT
2 = 10-15 MINUTES FROM POINT
3 = 15-20 MINUTES FROM POINT
4 = 20-25 MINUTES FROM POINT
5 = 25-30 MINUTES FROM POINT
6 = 30-35 MINUTES FROM POINT
7 = 35-40 MINUTES FROM POINT
8 = 40-45 MINUTES FROM POINT
9 = MORE THAN 45 MINUTES FROM POINT

| LEVELS | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|---|
| SYMBOLS | | | | | | | | | | |
| FREQUENCY | 53 | 54 | 800 | 1724 | 926 | 651 | 344 | 138 | 66 | 4 |

Fig. III.29
5 Minute Time Zones from Point #3 (from West) on Existing Road Network

22. FIVE MINUTE TIME ZONES FROM POINT #4 (FROM SOUTH) ON EXISTING ROAD NETWORK (Figure III.30)

Described and coded as above.

23. PROXIMITY TO ROADS, EXISTING (Figure III.31)

This data category served to record the proximity of each cell to road types 5-9 as listed in categories numbered 17 and 18. The measurements were recorded to the nearest .1 kilometer (.06 mile) and coded directly on the gridded U.S.G.S. base map.

(Road is defined as type 5 or greater)
0 = No Road within 6 kms.
1 = Nearest Road 4-6 kms.
2 = Nearest Road 3-4 kms.
3 = Nearest Road 2-3 kms.
4 = Nearest Road 1.5-2 kms.
5 = Nearest Road 1-1.5 kms.
6 = Nearest Road .5-1 km.
7 = Nearest Road .2-.5 km.
8 = Nearest Road in Neighboring Cell
9 = Road in Grid Cell

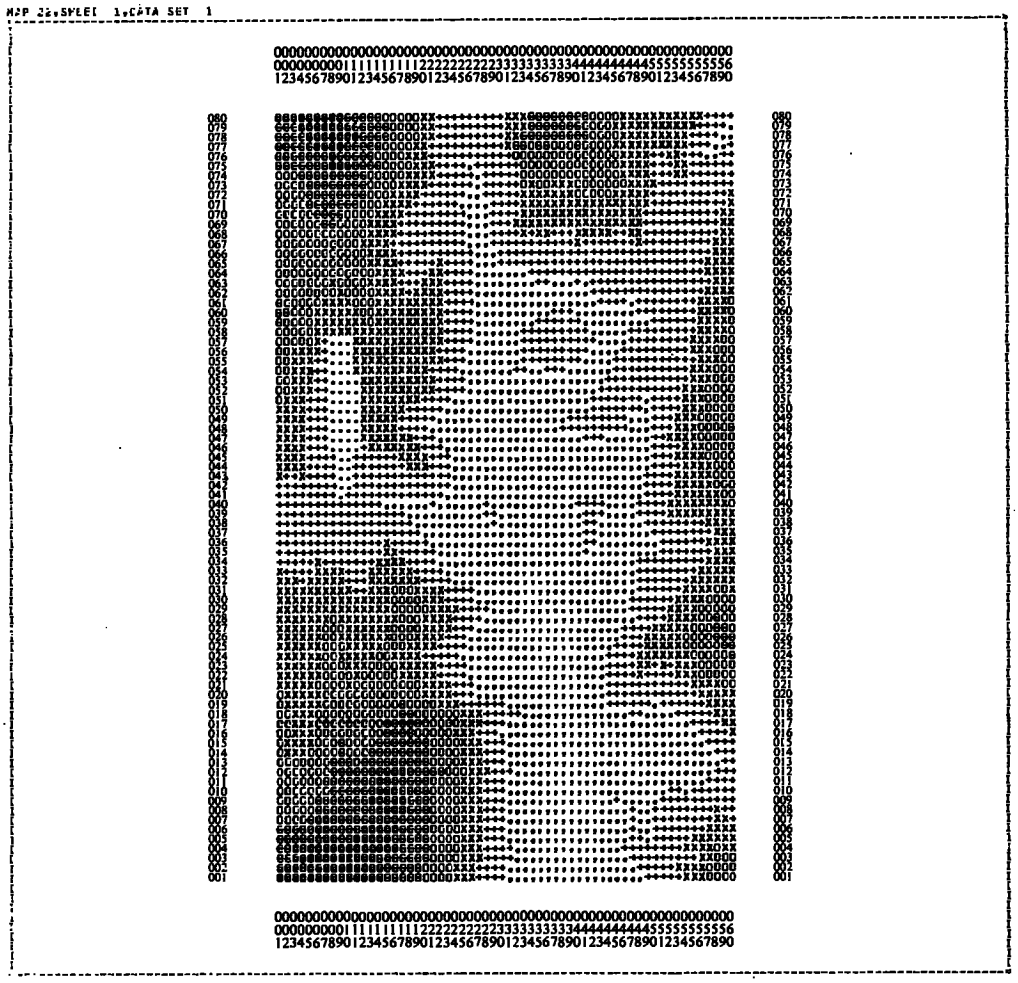
24. PROXIMITY TO ROADS, PROPOSED (Figure III.32)

Proximity measurements for new proposed roads were coded similarly in the process outlined for category 23.

(Road defined as type 3 or greater)
0 = Nearest road over 1.5 kms.
1 = Nearest road over 1.4-1.5 kms.
2 = Nearest road over 1.2-1.3 kms.
3 = Nearest road over 1.0-1.1 kms.
4 = Nearest road over .8-.9 kms.
5 = Nearest road over .6-.7 kms.
6 = Nearest road over .4-.5 kms.
7 = Nearest road over .2-.3 kms.
8 = Nearest road in Neighboring Cell
9 = Road in Grid Cell

25. WATERSHEDS (Figure III.33)

Watersheds, as defined by the contours on the U.S.G.S. base map, were coded in a three-digit system. The linkage of



TRAVEL TIME FROM POINT 4

HONEY HILL CASE STUDY

U.S. ARMY CORPS OF ENGINEERS

LEGEND
0 = 0-5 MINTUES FROM POINT
1 = 5-10 MINTUES FROM POINT
2 = 10-15 MINTUES FROM POINT
3 = 15-20 MINTUES FROM POINT
4 = 20-25 MINTUES FROM POINT
5 = 25-30 MINTUES FROM POINT
6 = 30-35 MINTUES FROM POINT
7 = 35-40 MINTUES FROM POINT
8 = 40-45 MINTUES FROM POINT
9 = MORE THAN 45 MINTUES FROM POINT

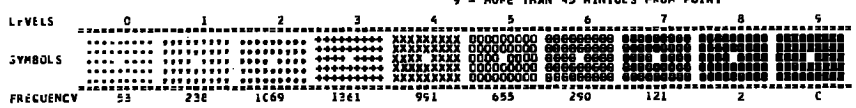
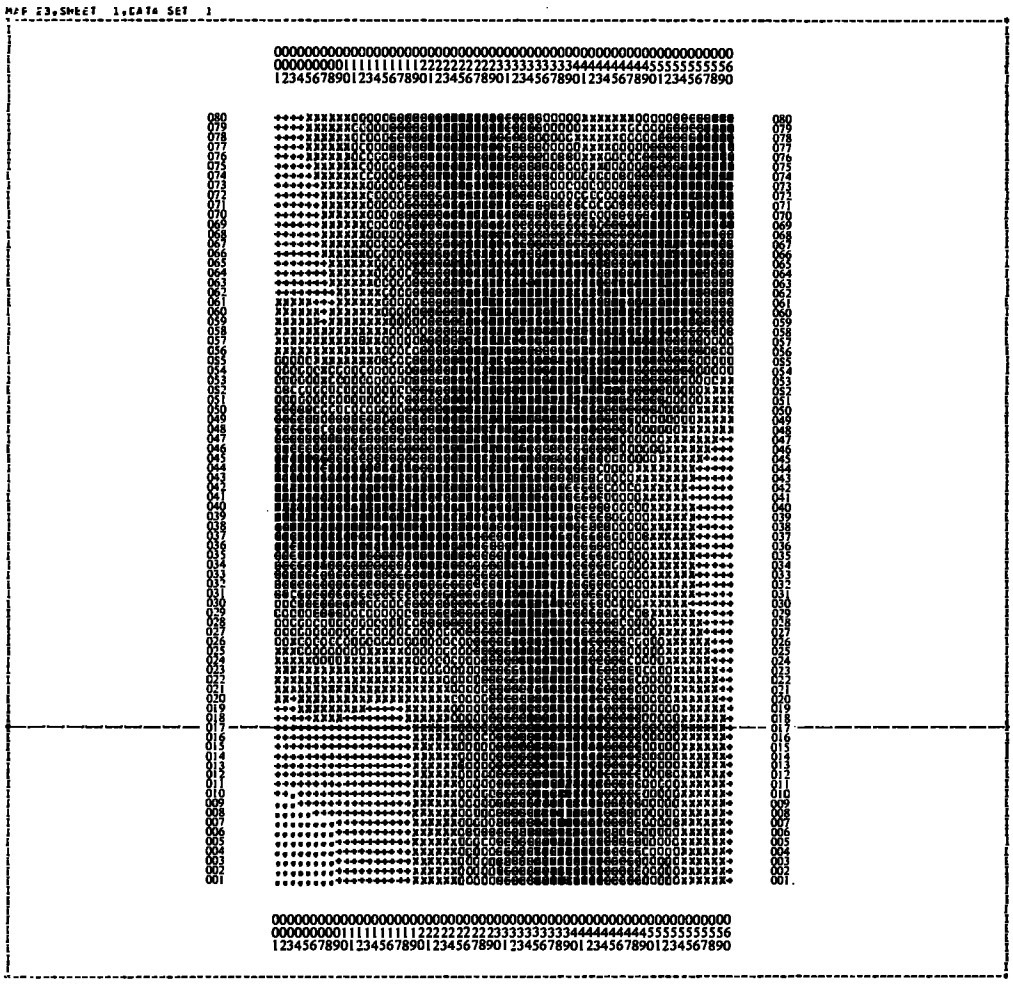



Fig. III.30
5 Minute Time Zones from Point #4 (from South)
on Existing Road Network



PROXIMITY TO HIGHWAYS - EXISITNG

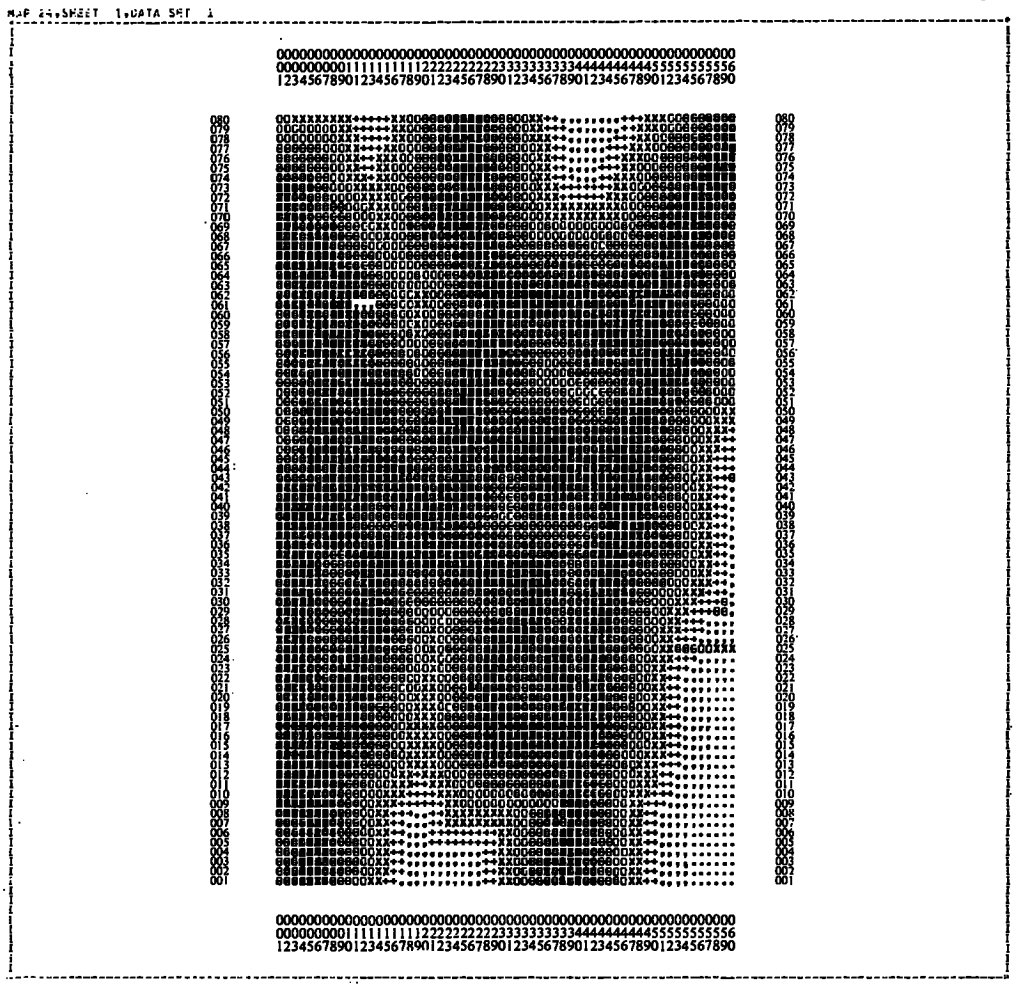
MCKEY HILL CASE STUDY

U.S. ARMY CORPS OF ENGINEERS

LEGEND
0 = NO ROAD WITHIN 4 KMS.
1 = NEAREST ROAD 4-4 KMS.
2 = NEAREST ROAD 3-4 KMS.
3 = NEAREST ROAD 2-3 KMS.
4 = NEAREST ROAD 1.5-2.0 KMS.
5 = NEAREST ROAD 1.0-1.5 KMS.
6 = NEAREST ROAD 0.5-1.0 KMS.
7 = NEAREST ROAD 0.2-0.5 KMS.
8 = NEAREST ROAD IN NEIGHBORING CELL
9 = ROAD IN CELL

| LEVELS | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|---|
| SYMBOLS | ..... | ..... | ..... | ++++++++ | XXXXXXXX | OOOOOOOO | 88888888 | ######## | ######## | ######## |
| | ..... | ..... | ..... | ++++ ++++ | XXXX XXXX | OOOO OOOO | 8888 8888 | #### #### | #### #### | #### #### |
| | ..... | ..... | ..... | ++++++++ | XXXXXXXX | OOOOOOOO | 88888888 | ######## | ######## | ######## |
| FREQUENCY | 0 | 0 | 65 | 511 | 783 | 652 | 1105 | 856 | 438 | 190 |

Fig. III.31
Proximity to Roads, Existing



PROXIMITY TO HIGHWAYS - PROPOSED

HONEY HILL CASE STUDY

U.S. ARMY CORPS OF ENGINEERS

LEGEND
0 = NO ROAD WITHIN 6 KMS.
1 = NEAREST ROAD 4-6 KMS.
2 = NEAREST ROAD 3-4 KMS.
3 = NEAREST ROAD 2-3 KMS.
4 = NEAREST ROAD 1.5-2.0 KMS.
5 = NEAREST ROAD 1.0-1.5 KMS.
6 = NEAREST ROAD 0.5-1.0 KMS.
7 = NEAREST ROAD 0.2-0.5 KMS.
8 = NEAREST ROAD IN NEIGHBORING CELL
9 = ROAD IN CELL

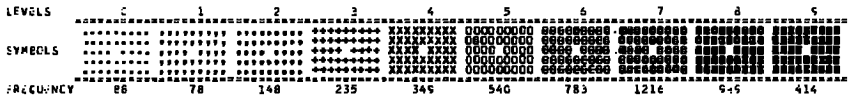



Fig. III.32
Proximity to Roads, Proposed

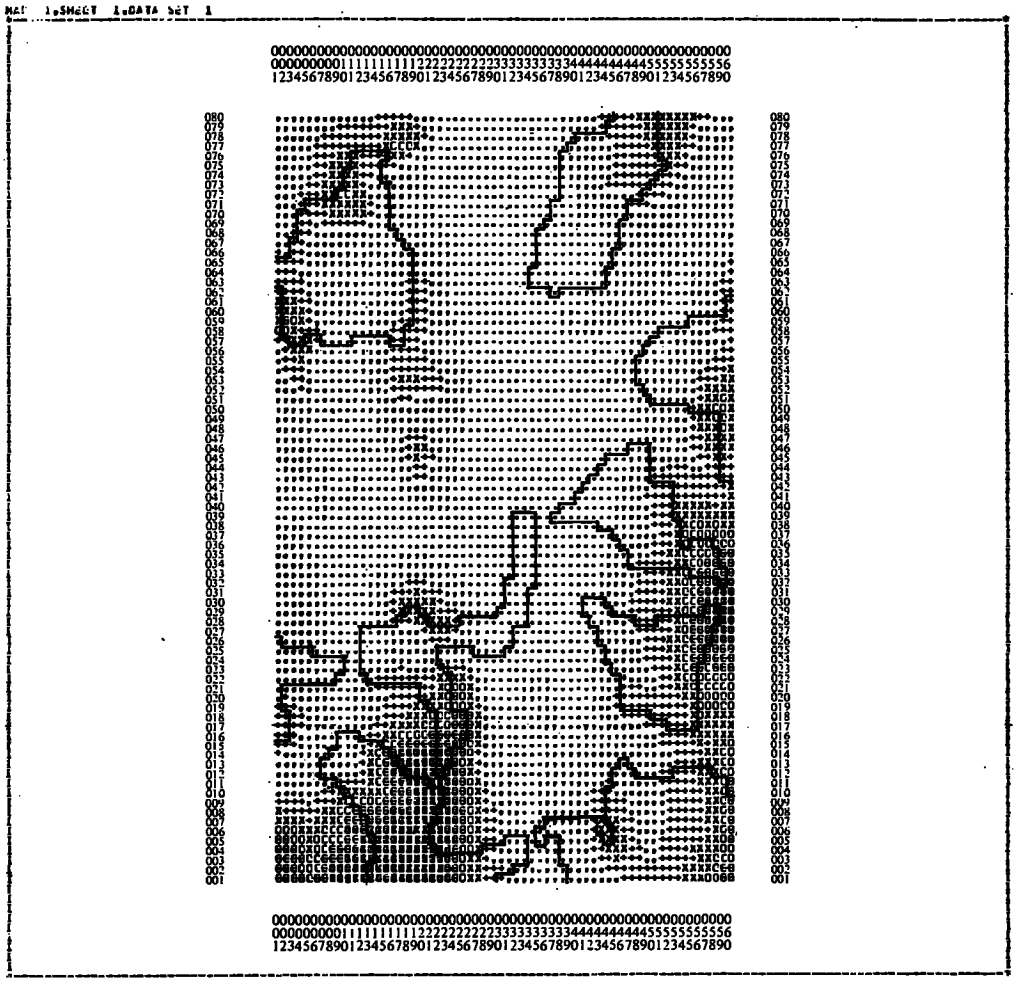



Fig. III.33
Watersheds

watersheds defined in this manner is useful in recording sources of pollution, control of stream quality, and run-off.

0 = Watersheds outside area
first digit = Major Watersheds (1-4)
second digit = Subwatersheds
third digit - 0 = free drain area
1-4 = first order Watersheds

26. PROXIMITY TO WATER, EXISTING (Figure III.34)

Water proximity, coded in linear distance, is similar to that established for the road network. Water is defined as reservoirs, lakes, minor and major rivers. The values were recorded directly on the U.S.G.S. base map.

0 = No water within 6 kms.
1 = Nearest Water 4-6 kms.
2 = Nearest Water 3-4 kms.
3 = Nearest Water 2-3 kms.
4 = Nearest Water 1.5-2 kms.
5 = Nearest Water 1.0-1.5 kms.
6 = Nearest Water .5-1.0 kms.
7 = Nearest Water .2-.5 kms.
8 = Nearest Water in Neighboring Cell
9 = Water in Cell

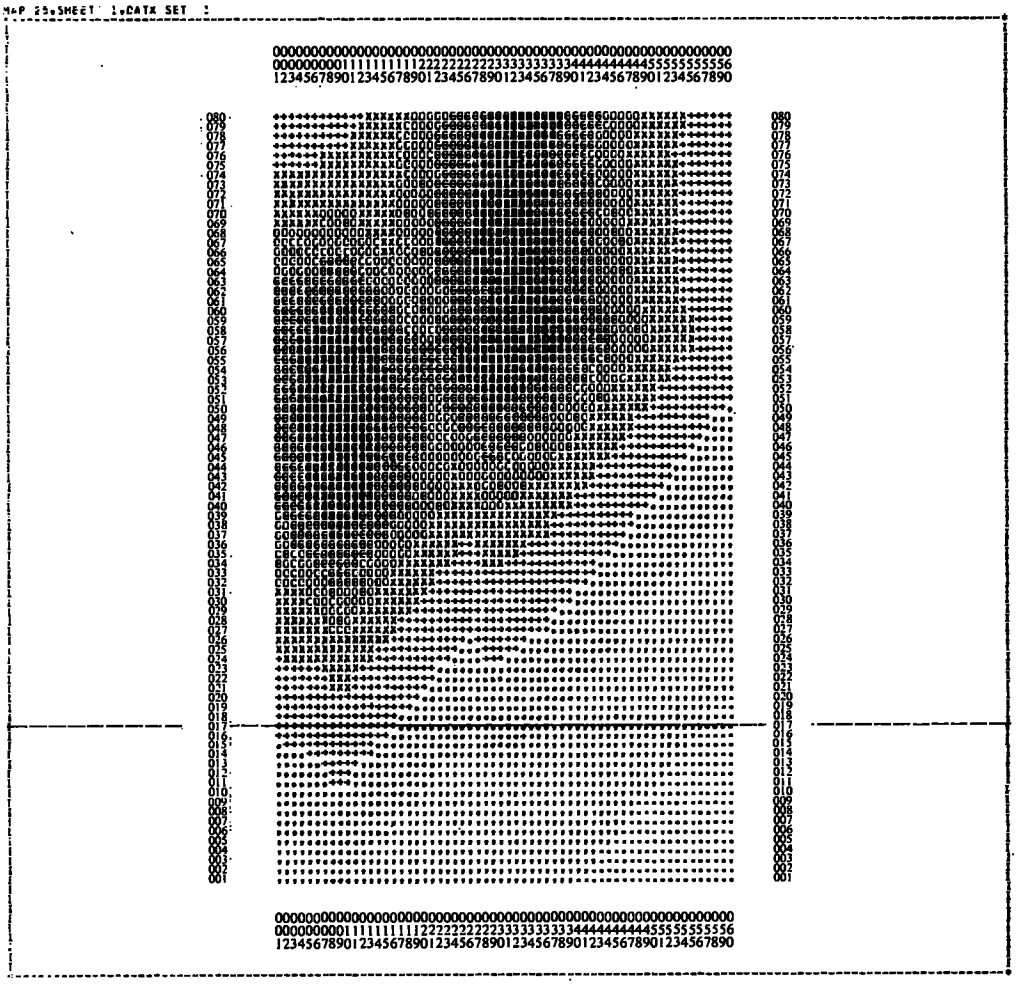
27. PROXIMITY TO WATER, PROPOSED (Figure III.35)

Described and coded as above.

28. PROPOSED RESERVOIR AND LAND ACQUISITION (Figure III.36)

The boundary information associated with the proposed reservoir and state park was supplied by the U.S. Army Corps of Engineers.

0 = Outside Proposed Area
1 = June Pool @ 511.0
3 = Pool Crest @ 524.0
5 = Federal Land Taking Around Crest
7 = State Land Taking
9 = Dam



PROXIMITY TO WATER - EXISTING

HONEY HILL CASE STUDY

U.S. ARMY CORPS OF ENGINEERS

LEGEND
0 = NO WATER WITHIN 6 KMS.
1 = NEAREST WATER 4-6 KMS.
2 = NEAREST WATER 3-4 KMS.
3 = NEAREST WATER 2-3 KMS.
4 = NEAREST WATER 1.5-2.0 KMS.
5 = NEAREST WATER 1.0-1.5 KMS.
6 = NEAREST WATER 0.5-1.0 KMS.
7 = NEAREST WATER 0.2-0.5 KMS.
8 = NEAREST WATER IN NEIGHBORING CELL
9 = WATER IN CELL

| LEVELS | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|---|
| SYMBOLS | | | | | | | | | | |
| FREQUENCY | 215 | 751 | 596 | 805 | 612 | 590 | 646 | 324 | 131 | 50 |

Fig. III.34
Proximity to Water, Existing

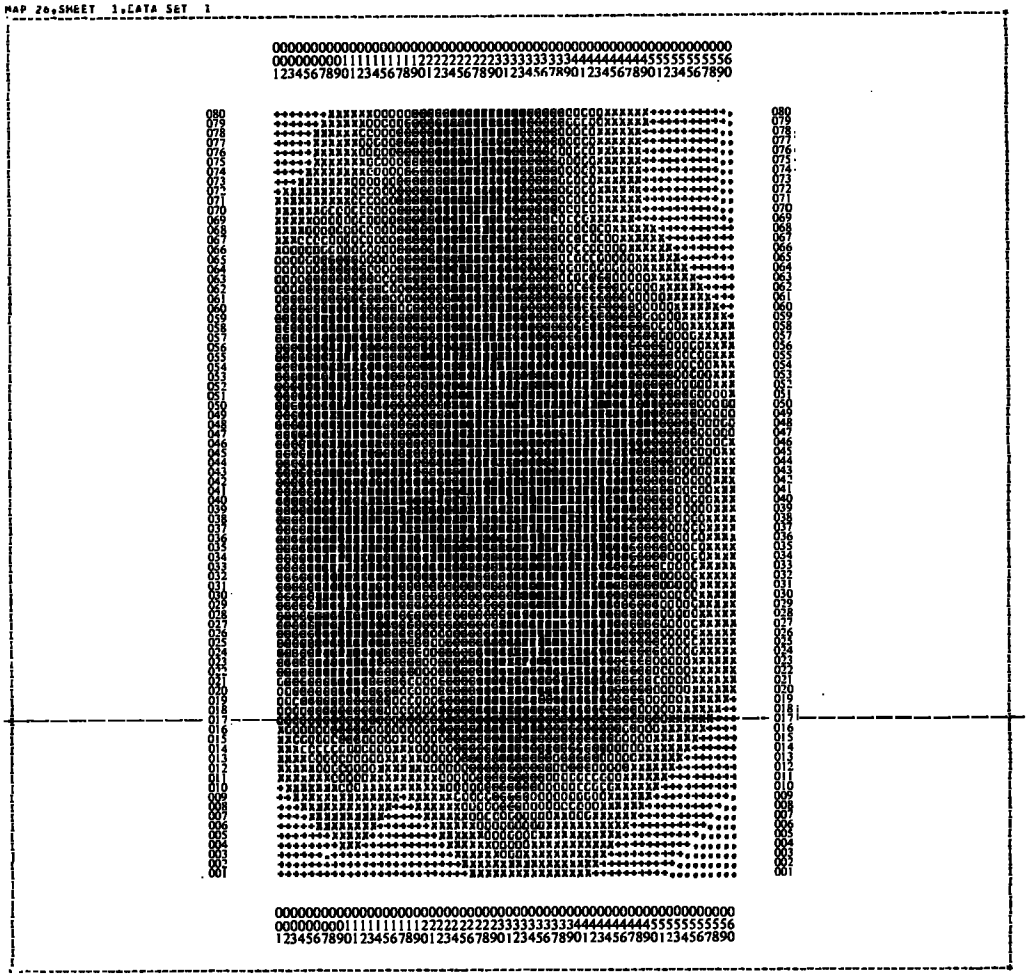



Fig. III.35
Proximity to Water, Proposed

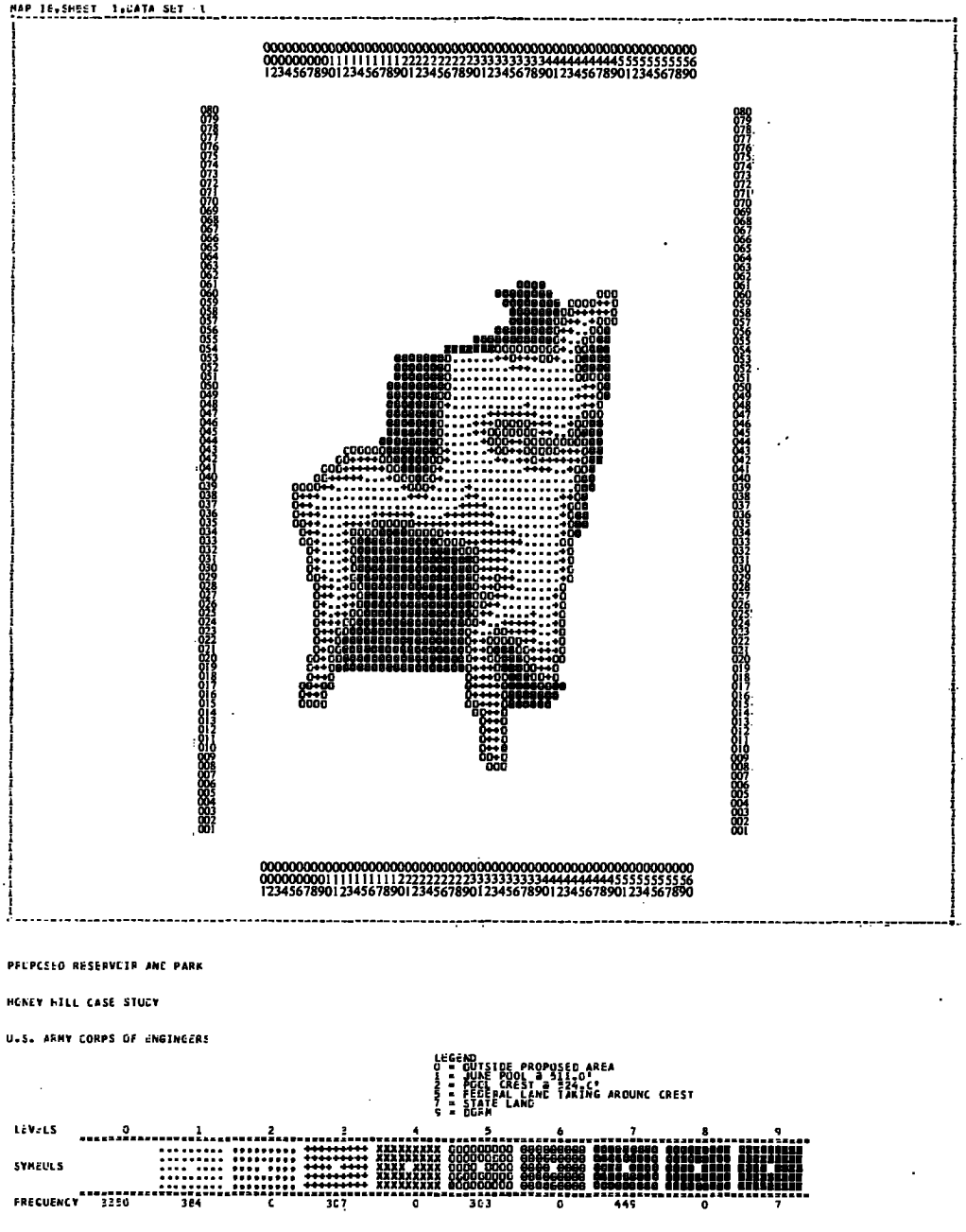



Fig. III.36
Proposed Reservoir & Land Acquisitions

29. VISUAL - WATER AWARENESS (Figures III.37 through III.46)

The search program, VIEWS, generated figures illustrating the relative amounts of area that could be viewed from any potential cell within the data bank. VIEWS, a program written by D. Sinton (101.14), is based on the visual analyses of digital terrain models which were developed by Elliot L. Amidon and Gary H. Elsner (4). The results are graphically portrayed using the GRID program. It is a simple search program which determines the intervisibility of points on a surface and is applicable to any search procedures on three-dimensional surfaces, by they topographic or abstract surfaces.

Figures III.37 through III.45 show the VIEWS program applied to a visual analysis from nine points around the edge of the reservoir site. Figure III.46 is a summary of areas seen from any of these points.

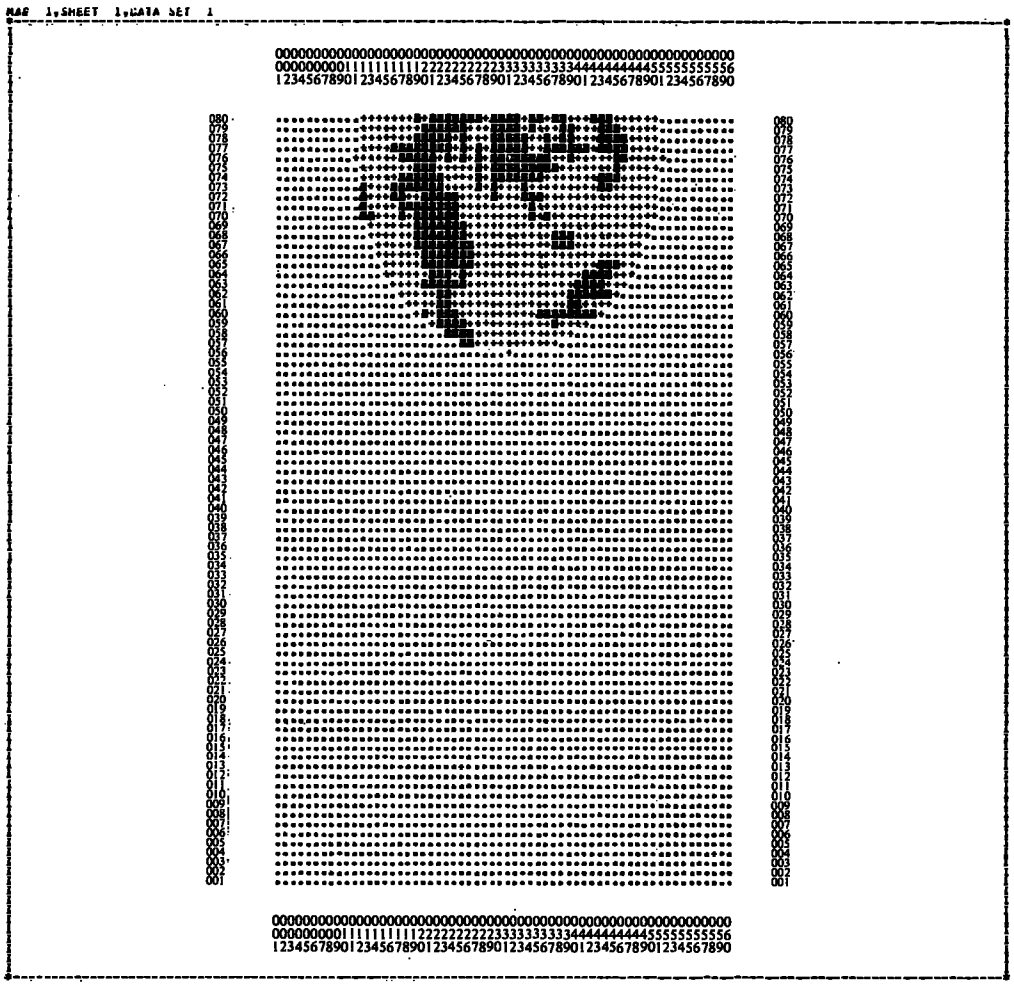
0 = Cannot see Water
1 = Can see One Area of Water
2 = Can see Two Areas of Water
3 = Can see Three Areas of Water
4 = Can see Four Areas of Water
5 = Can see Five Areas of Water
6 = Can see Six Areas of Water
7 = Can See Seven Areas of Water
8 = Can see Eight Areas of Water
9 = Can see Nine Areas of Water

30. MICROCLIMATE

No microclimate data were directly available for the study area. Temperature data were therefore collected over a one year period at eleven different points within the study area. The data were collected weekly and consisted of recordings of the highest temperature during the week, the lowest temperature, and the temperature at the time of recording.

The eleven stations were located along two transects in the study area. One transect was laid out along a line running Southeast to Northwest from the top of Honey Hill out through the site of the proposed reservoir. Another line ran North to South from Honey Hill to the middle of the proposed reservoir.

The thermometers were placed in areas that varied by elevation, vegetation cover and type at the same elevation,



VISUAL ANALYSIS OF RIVER CORRIDOR - LOCATION 5-31

MONEY HILL PROJECT

| LEVELS | C | 1 | 2 | 3 |
|---|---|---|---|---|
| SYMBOLS | . | + | G | G |
| FREQUENCY | 3995 | 533 | 271 | 1 |

Fig. III.37
Visual Analysis of River Corridor -
Location 5-31

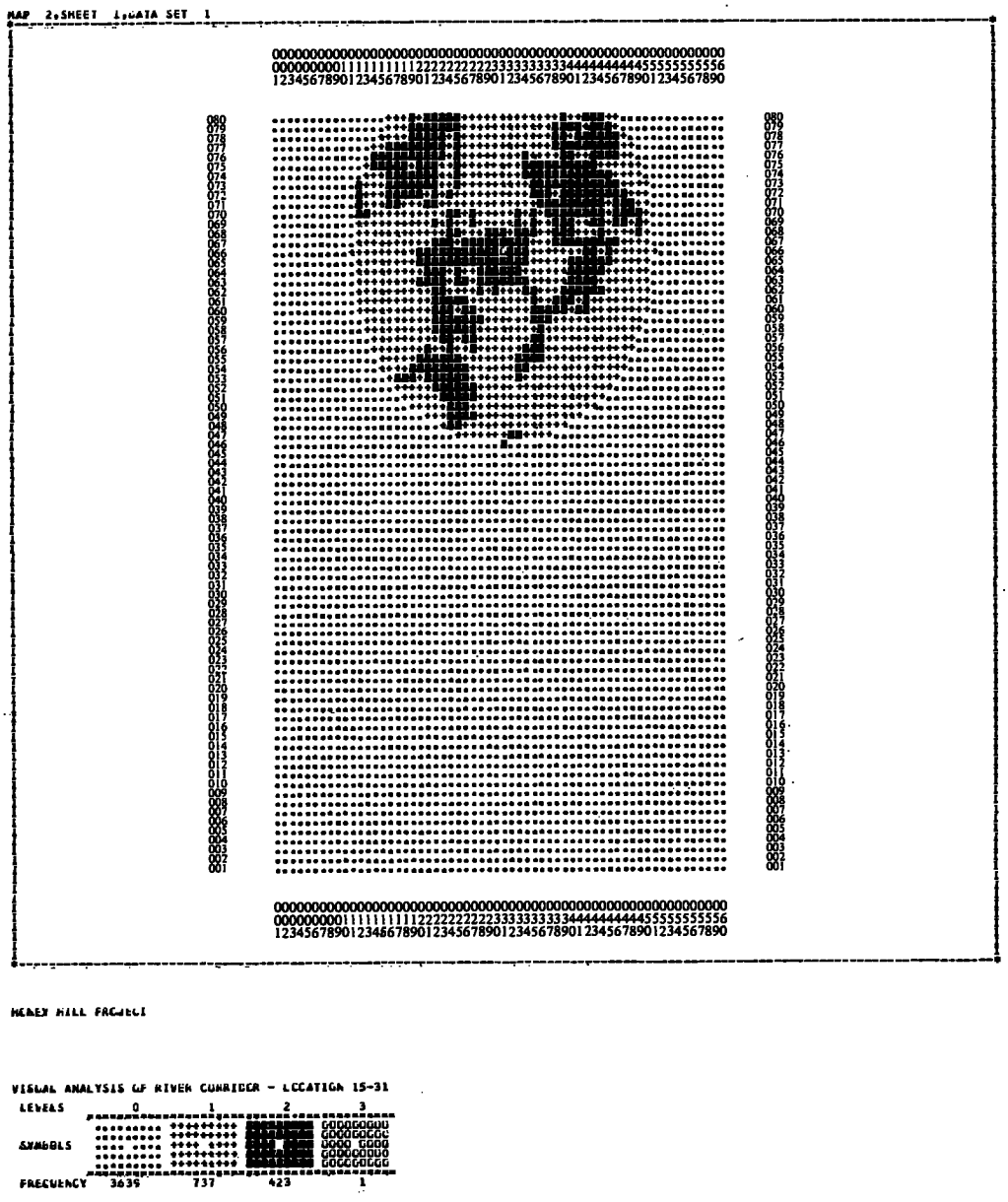



Fig. III.38
Visual Analysis of River Corridor - Location 15-31

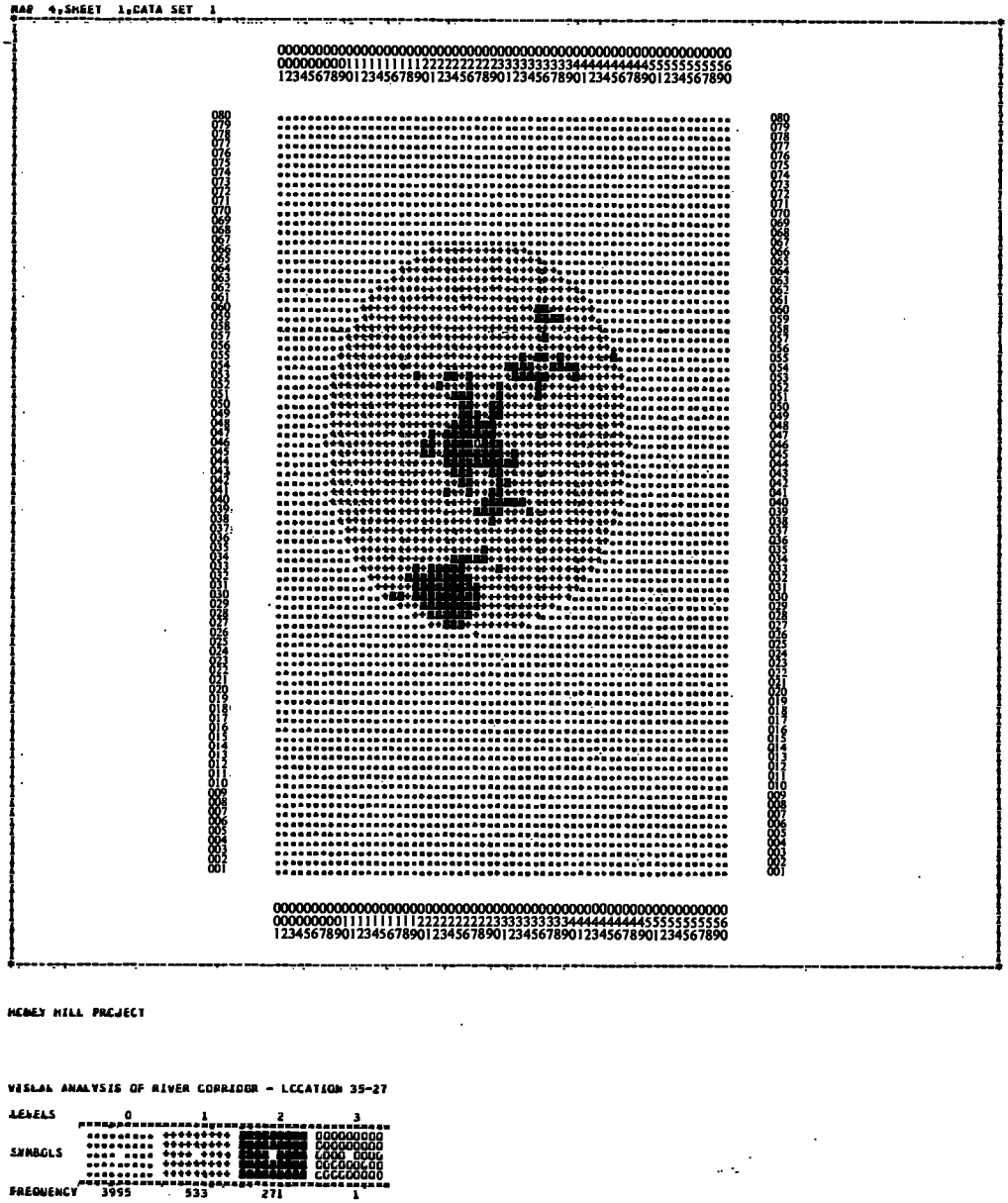
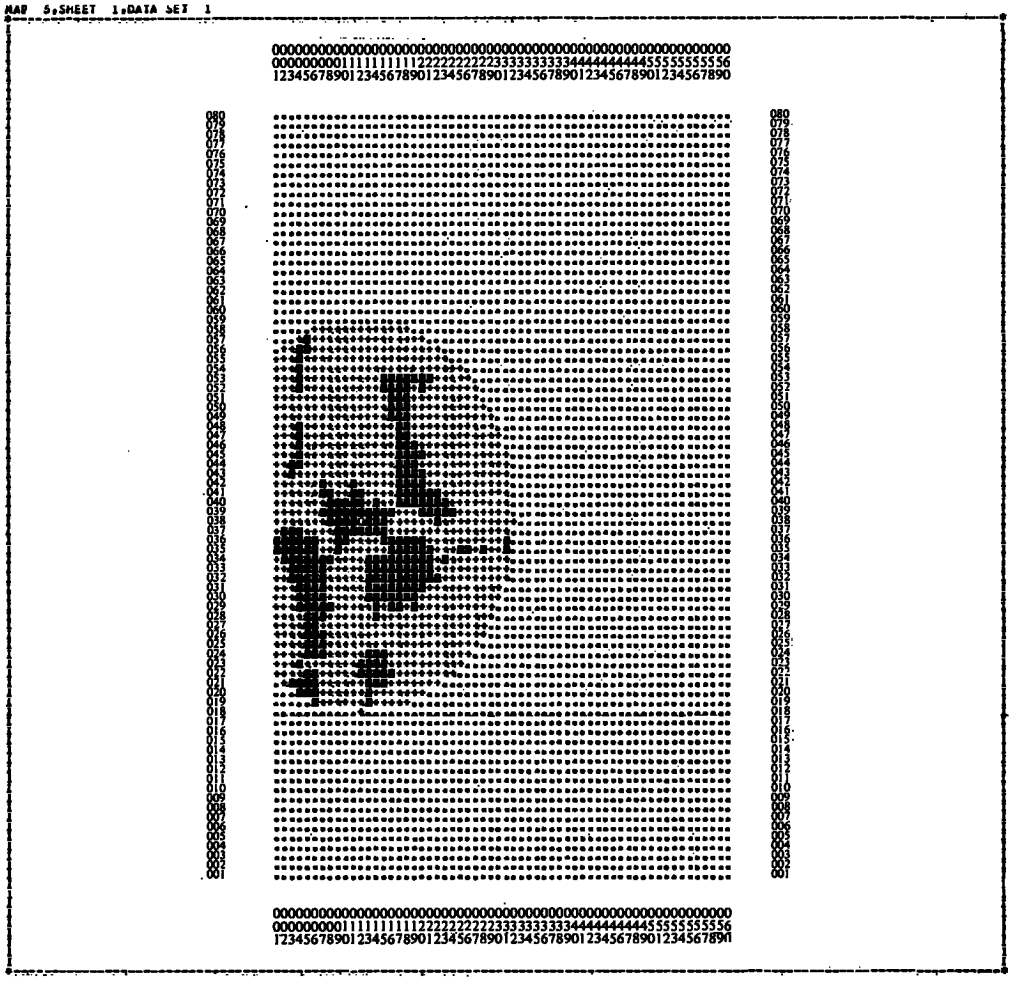



Fig. III.39
Visual Analysis of River Corridor -
Location 35-27

MAP 5,SHEET 1,DATA SET 1



HONEY HILL PROJECT

VISUAL ANALYSIS OF RIVER CORRIDOR - LOCATION 43-12

| LEVELS | 0 | 1 | 2 | 3 |
|---|---|---|---|---|
| SYMBOLS | ..... | ++++++ | ###### | OOOOOOOO |
| | ..... | ++++++ | ###### | OOOOOOOO |
| | ..... | ++++++ | ###### | OOOO OOOO |
| | ..... | ++++++ | ###### | OOOOOOOO |
| | ..... | ++++++ | ###### | OOOOOOOO |
| FREQUENCY | 3712 | 819 | 268 | 1 |

MAP TITLE

HONEY HILL PROJECT

VISUAL ANALYSIS OF RIVER CORRIDOR - LOCATION 45-22

ELEGIEVES USED FOR THIS MAP

Fig. III.40
Visual Analysis of River Corridor - Location 43-12

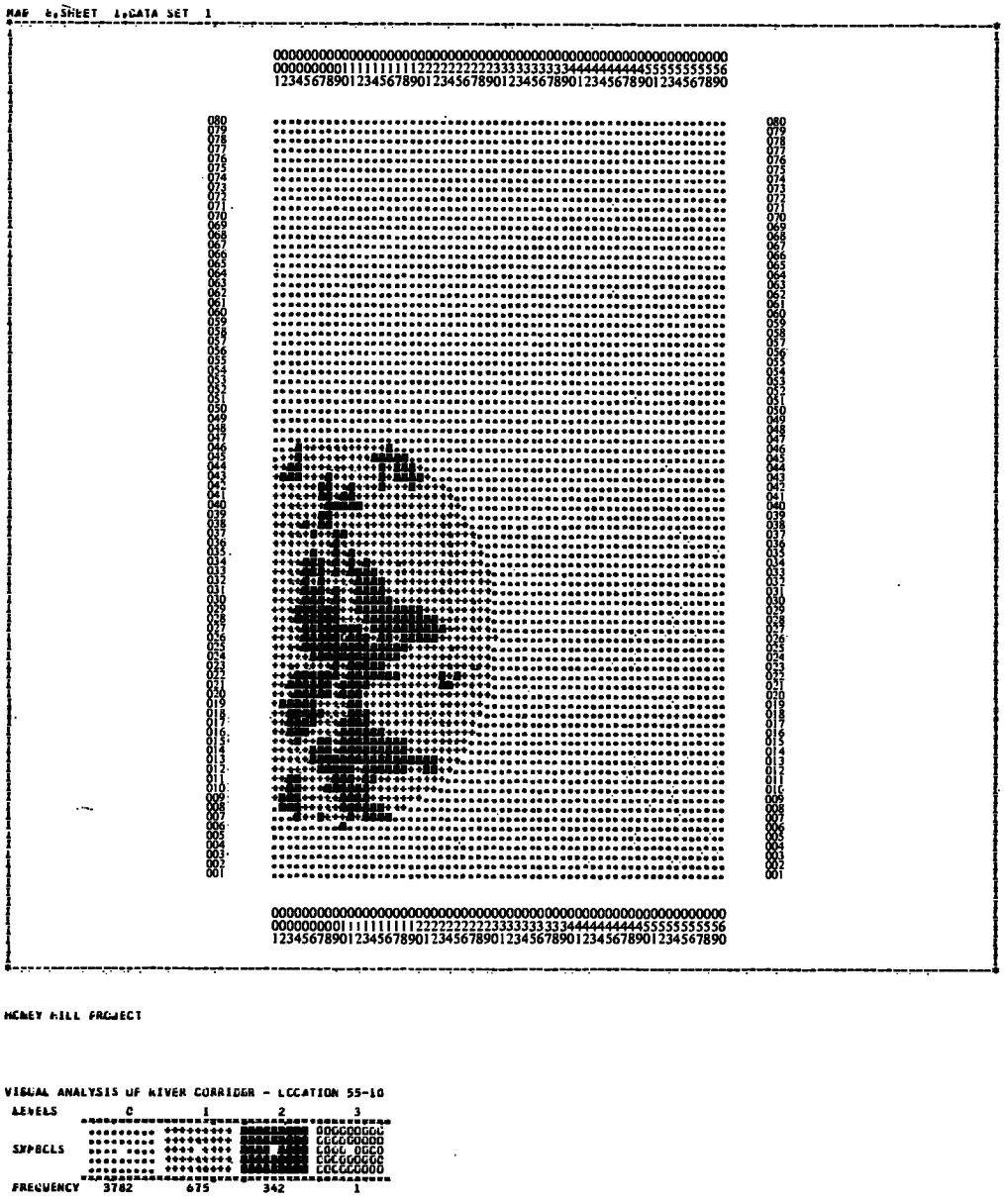



Fig. III.41
Visual Analysis of River Corridor - Location 55-10

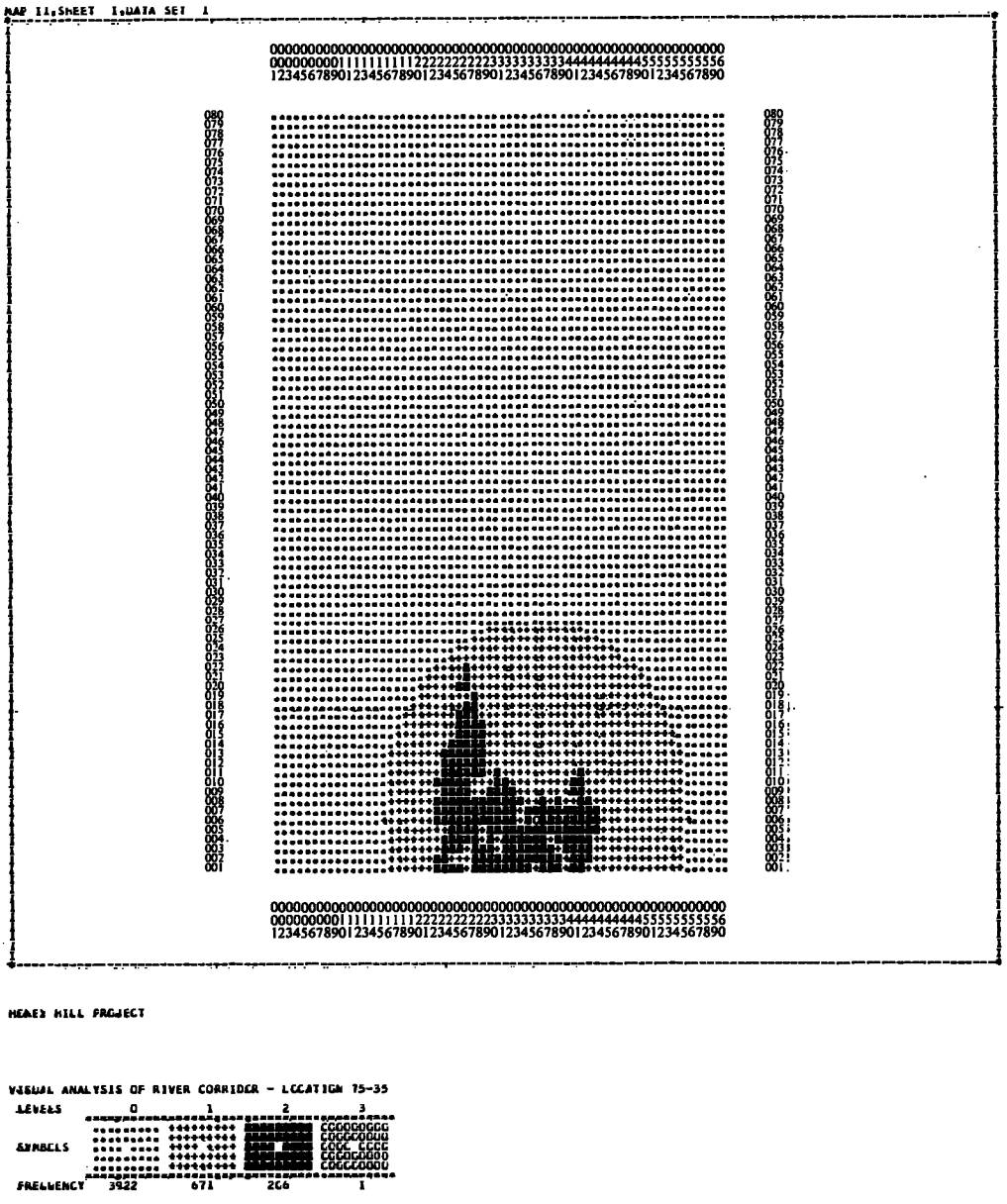



Fig. III.42
Visual Analysis of River Corridor -
Location 75-35

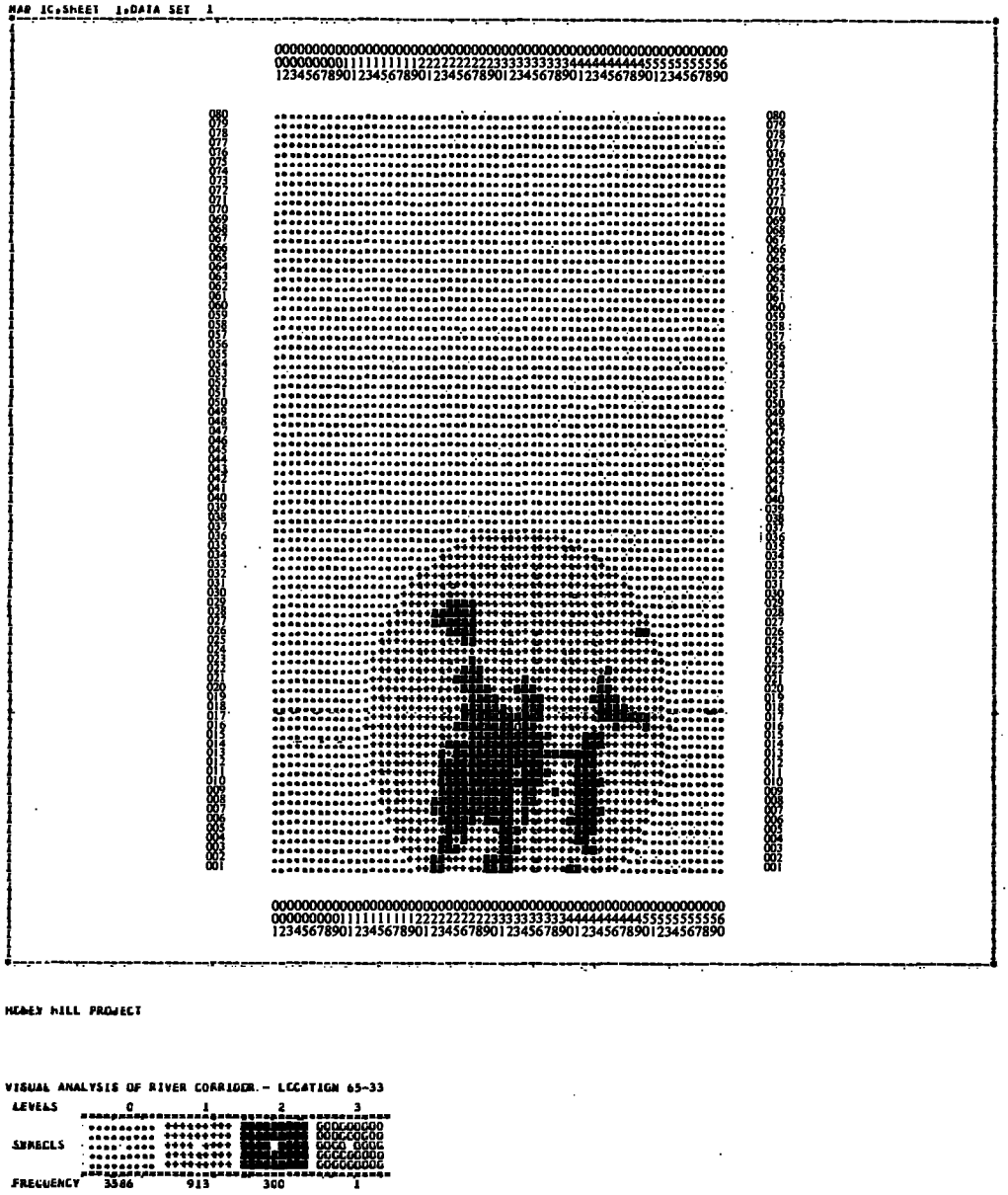



Fig. III.43
Visual Analysis of River Corridor -
Location 65-33

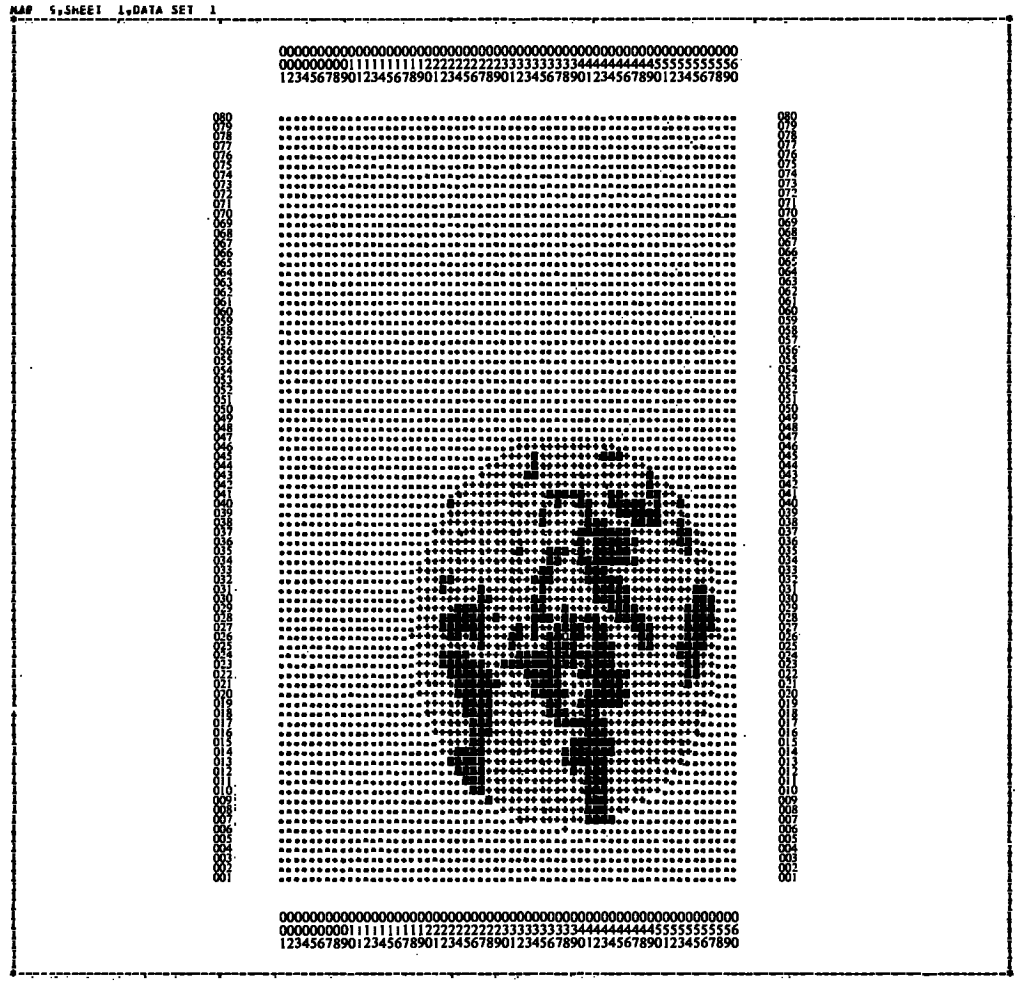



Fig. III.44
Visual Analysis of River Corridor -
Location 55-38

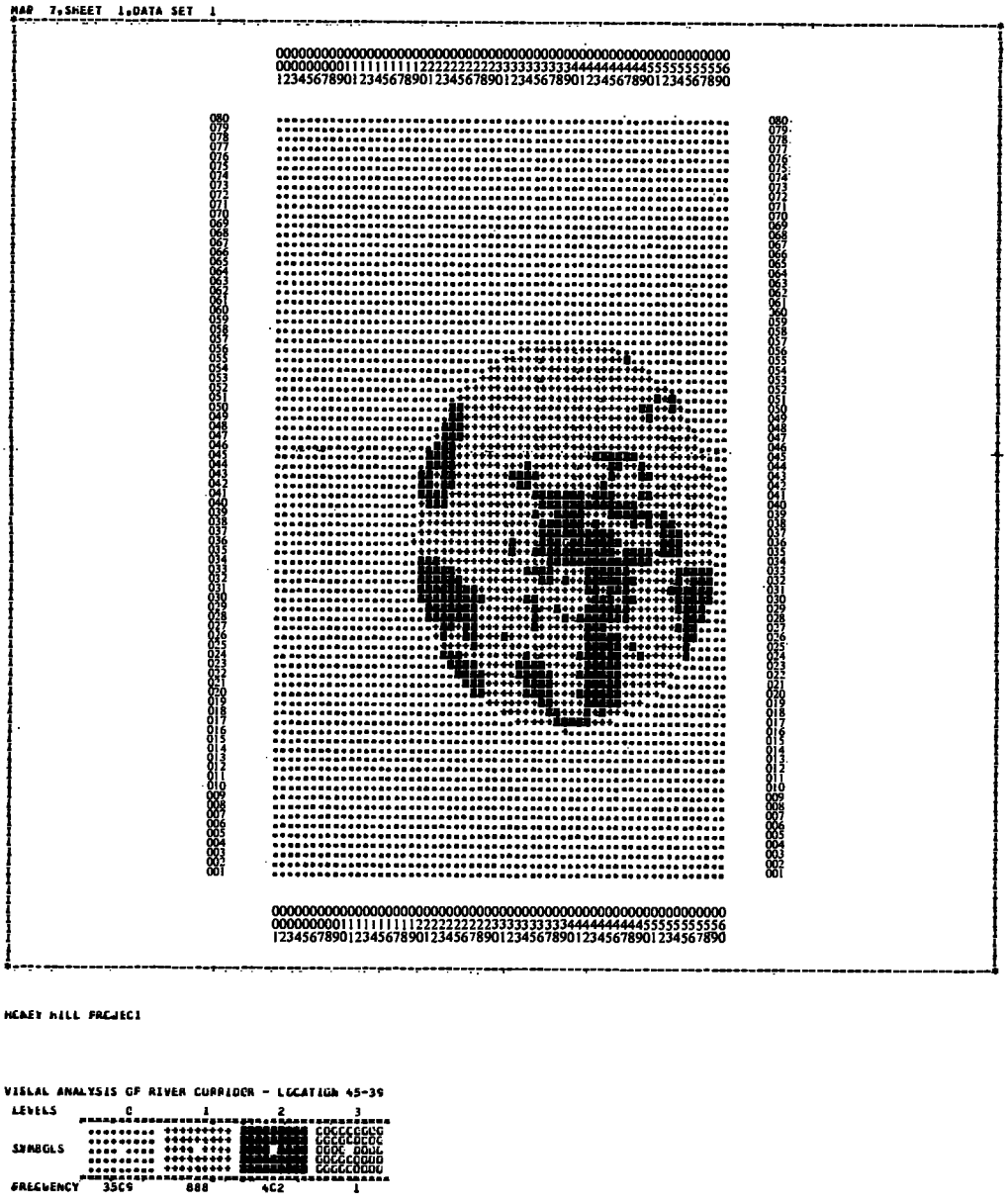
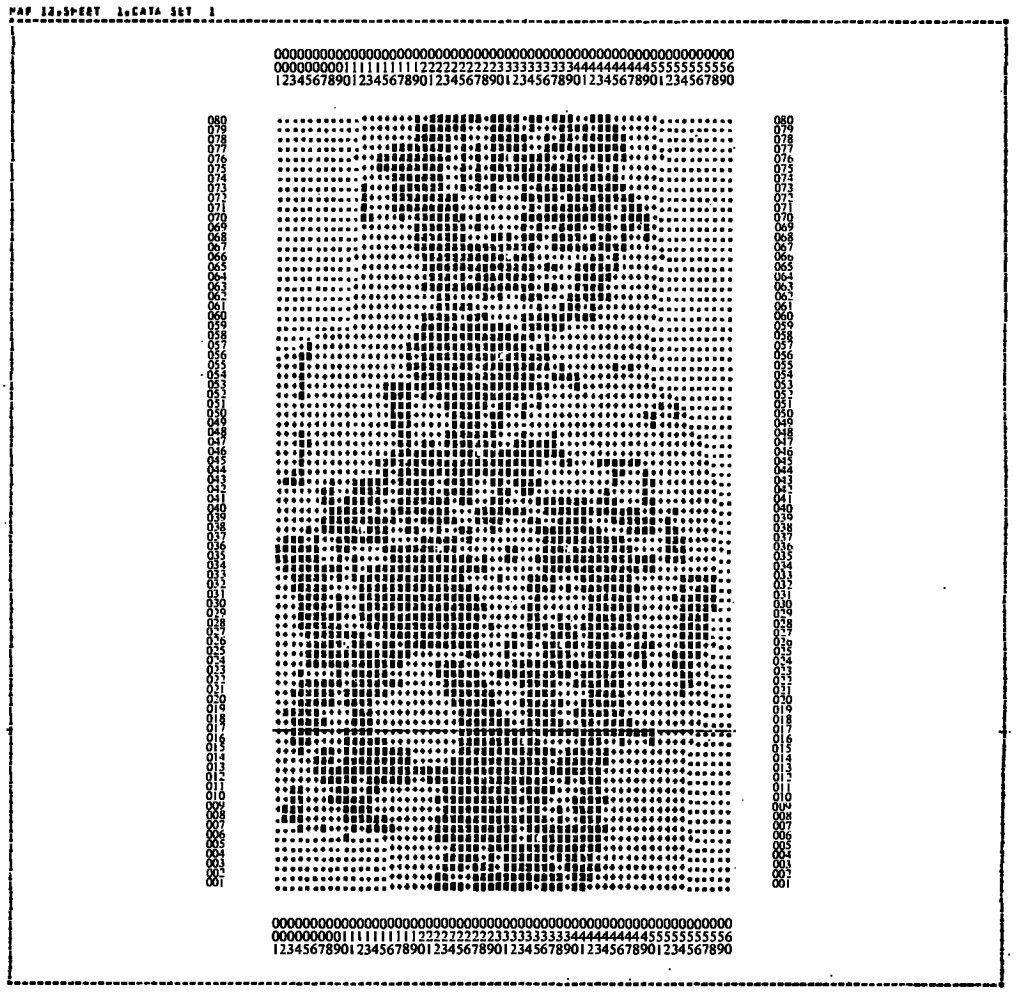



Fig. III.45
Visual Analysis of River Corridor -
Location 45-39



VISUAL ANALYSIS OF RIVER CORRIDOR - ALL POINTS

HONEY HILL PROJECT

| LEVELS | C | 1 | 2 | 3 |
|---|---|---|---|---|
| SYMBOLS | ..... | ..... | ..... | ..... |
| FREQUENCY | 828 | 1919 | 2642 | 11 |

Fig. III.46
Visual Analysis of River Corridor -
All Nine Points

physionomic type, and orientation. Temperature variation was then correlated to the various data variables in the data bank that described the eleven cells where the thermometers were located. These descriptions of the cell served as the independent variables in a multiple regression analysis. The coefficients for each of the variables as derived from the regression analysis were applied to the significant variables in all 4800 data cells to make maps that showed the relative ranges of high and low temperatures in December (Figures III.47 and III.48).

## I. DATA OTHER THAN THAT ON SITE RESOURCES

At the local level, the town of Swanzey is the source of data on zoning, property ownership, and assessed valuations. Few other data which are relevant to the study were available. It appears as though county government in New Hampshire functions as a data source only when the towns decide to file data with them. This research project could obtain no major categories of data from Cheshire County.

Among the data sought, and either unavailable or of a degree of quality or variation which excluded it as a variable in the study, were the following:

1. Zoning: There is a zoning ordinance with amendments and a zoning map. In general the only restriction in the study area is that any proposed use within 300' of a highway requires a permit from the town. Any conflicts or controversial proposals are voted on by the selectmen or town meeting.

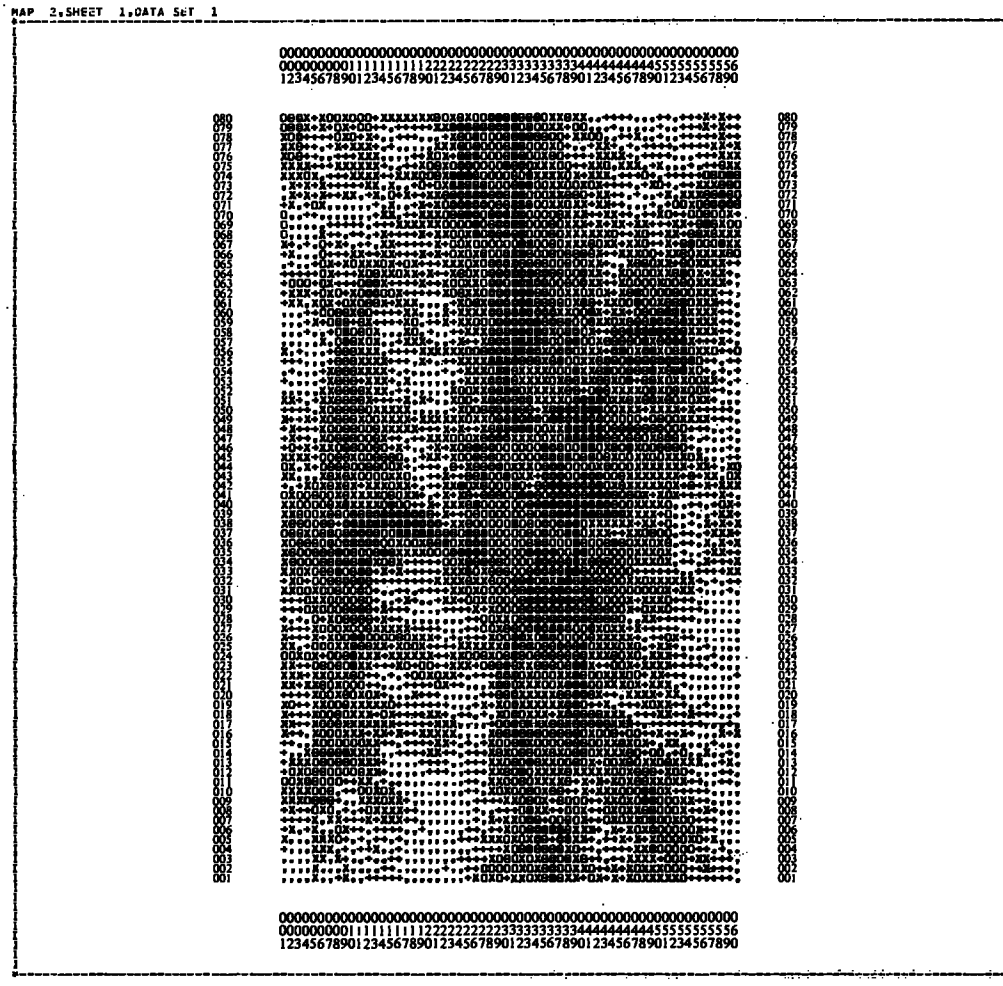
2. Land Value: The Annual Town Report lists assessed valuation and amounts of tax for all property holders within town, but not on a parcel basis. It is thus not possible to get data on land value by grid cell.

3. Water and Sewer: No public water supplies or sewer systems exist in the study area, although a public sewer system for Keene is nearby to the North. The entire area, when serviced, uses wells or springs and septic tanks.

4. Land Use: No land use maps exist at the local level.

5. Local Recreation Demands: No formal data exist. Boating, hunting, fishing and snowmobile registrations are available but are unreliable since licenses are not required (or enforced) for activities on one's own property.

MAP 2,SHEET 1,DATA SET 1



RANGE OF HIGHS IN DECEMBER 1969

HONEY HILL CASE STUDY

U.S. ARMY CORPS OF ENGINEERS

REGRESSION COEFFICIENTS

| VARIABLE | COEFFICIENT |
|---|---|
| SOIL MOISTURE | .13 |
| ORIENTATION | -.41 |
| ELEVATION | -.007 |
| SUB WATER | .09 |
| VEGETATION HEIGHT | .13 |
| VEGETATION TYPE | .59 |
| VEGETATION DENSITY | -.65 |

DATA MAPPED IN 10 LEVELS BETWEEN EXTREME VALUES OF 9.78 AND 31.47

ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| MINIMUM | 9.78 | 11.95 | 14.12 | 16.29 | 18.46 | 20.63 | 22.80 | 24.97 | 27.14 | 29.31 |
| MAXIMUM | 11.95 | 14.12 | 16.29 | 18.46 | 20.63 | 22.80 | 24.97 | 27.14 | 29.31 | 31.47 |

PERCENTAGE OF TOTAL ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

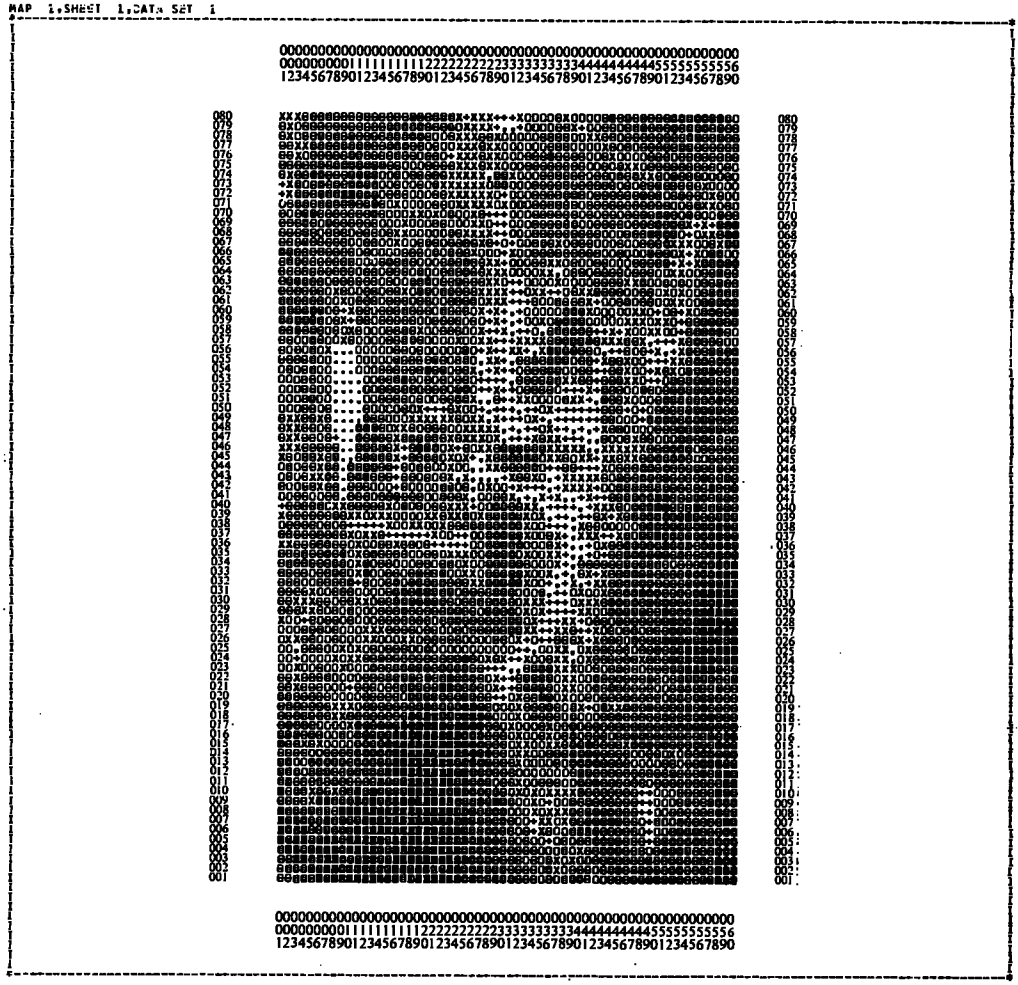
| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 |

FREQUENCY DISTRIBUTION OF DATA POINT VALUES IN EACH LEVEL

| LEVELS | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|---|
| SYMBOLS | | | | | | | | | | |
| FREQUENCY | 27 | 159 | 483 | 996 | 1211 | 882 | 463 | 454 | 116 | 9 |

Fig. III.47
Ranges of High Temperatures in December, 1969

MAP 1,SHEET 1,DATA SET 1



RANGE OF LOWS IN DECEMBER 1969

MONEY HILL CASE STUDY

U.S. ARMY CORPS OF ENGINEERS

REGRESSION COEFFICIENTS

| VARIABLE | COEFFICIENT |
|---|---|
| SOIL MOISTURE | .89 |
| ORIENTATION | -.58 |
| ELEVATION | .02 |
| SUB WATER | 2.18 |
| VEGETATION HEIGHT | -.16 |
| VEGETATION TYPE | .34 |
| VEGETATION DENSITY | -.22 |

DATA MAPPED IN 10 LEVELS BETWEEN EXTREME VALUES OF 20.27 AND 67.16

ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| MINIMUM | 20.27 | 24.56 | 29.85 | 34.34 | 39.03 | 43.71 | 48.40 | 53.09 | 57.78 | 62.47 |
| MAXIMUM | 24.56 | 29.85 | 34.34 | 39.03 | 43.71 | 48.40 | 53.09 | 57.78 | 62.47 | 67.16 |

PERCENTAGE OF TOTAL ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 |

FREQUENCY DISTRIBUTION OF DATA POINT VALUES IN EACH LEVEL

| LEVELS | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|---|
| SYMBOLS | | | | | | | | | | |
| FREQUENCY | 39 | 2 | 71 | 267 | 459 | 917 | 1639 | 1046 | 244 | 76 |

Fig. III.48
Ranges of Low Temperatures in December, 1969

6. Demographic, Socio-Economic: No local records are kept other than basic demographic records. The U.S. Census and the State of New Hampshire are the basic sources. This study made use of 1960 U.S. Census data in its estimates of activity demands.

## CHAPTER IV: PROPOSED ACTIVITIES: "ATTRACTIVENESS"

### A. THE SELECTION OF ACTIVITIES

The next phase in this study consisted of the identification of those activities which could be components of any proposal for the study area. A large list of possible activities was considered, including a full range of land uses emphasizing recreation. A final selection was made for the study on the basis of two major criteria. The first was the probable range of activities which could be considered under normal circumstances for a project such as the Honey Hill reservoir and park. The second was to have examples of a range of activities which demonstrated different characteristics, either in their space requirements, their demands, or their impacts on the site. Aside from the activities involved in the operation of the reservoir itself, the final selection was organized into three principal land uses: recreation, residence, and transportation infrastructure.

The recreation activities were selected for three major criteria. The first was to assure a representation for different demand groups of their preferred activities. Each of the activity groupings by cultural context, as identified in the Outdoor Recreation Resources Review Commission (ORRRC), is to some extent satisfied. These have been described as follows in ORRRC Report 1, pp. 81-83:

"Activity Groupings by Cultural Context

I Backwoods--The relevant standards are escape from formality of interpersonal relations and observance of rules for gaining approval which are mutually exclusive with those used in work-a-day situations. The activities which in many cases seem to answer to these role specifications are: Camping, fishing, hunting, nature walks, hiking, mountain climbing, and canoeing.

II Boat culture--Originally this was named Mobility Culture and would have covered motorcycles and sports cars, as well as boats and automobiles, but the relevant activities distinguished on the questionnaire list are simply: Boating and water skiing. Gregory Stone used the term 'highway culture' to describe the features of

shiny, long-tail fins, speed, showmanship, and the element of risk involved and these seem to underly the activities considered.

III Country Club to Picnic Ground Complex--These are activities of moderate to heavy public setting with rather elaborate 'rules of the game' and traditions with widely distributed and agreed-upon standards of excellence. Here we include: Sailing, swimming, bicycling, horseback riding, outdoor games or sports, and picnicking.

IV Passive Pursuits--Driving for pleasure, walking for pleasure, sightseeing, attending outdoor concerts, and attending sporting events."

The activities preferred by these groups are further differentiated in Table IV.1 and Table IV.2.

The second criterion for selection was to have a representation of different seasonal activities, since seasonal variations were to be one of the components of both the planning and evaluation procedures. The third criterion for the selection of recreation activities was the spatial demands of the activity. For example, we have included what in our scale and context can be considered point activities (camping and boat launching), linear activities (trail hiking, snowmobiling), and area activities (hunting, fishing, ice skating). Each of these groupings would have a somewhat different site selection procedure in later stages of the design process.

Some of the activities which we have chosen are of obvious importance for a project such as this. In particular, one would cite swimming, camping, and picnicking. Some of the activities are questionable, such as downhill skiing. The downhill skiing potential of the study area, when seen in the context of its larger region, is not particularly attractive. Here, however, it is important to clearly recognize that we are attempting to develop a general model which must be able to accommodate a variety of potential components. If the regional attractiveness of skiing were indeed high, it would be important for us to be able to include this highly popular, winter, extensive area, and high-income producing activity. Rather than undertake a study of intervening and alternative opportunities for each

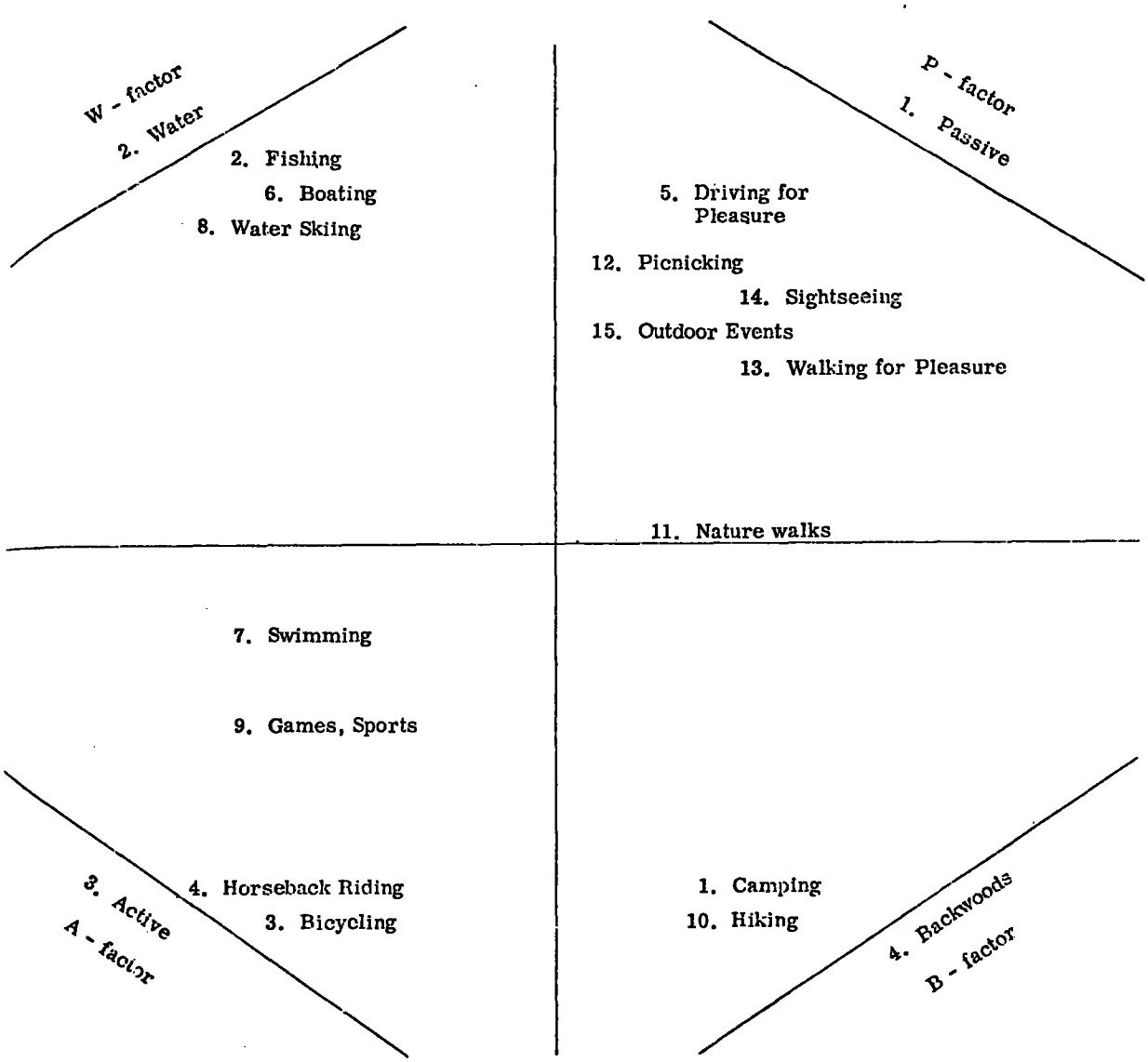



Table IV.1
Pictorial Representation of Total Population
Factor Pattern

| Factor | High | Moderate | Opposed |
|---|---|---|---|
| P-factor<br>Passive pursuits | Driving for pleasure<br>Sightseeing | Walking for pleasure<br>Picnicking<br>Nature walks<br>Outdoor events | None |
| W-factor<br>Water related activities | Boating<br>Water skiing<br>Fishing | Swimming<br>Camping | Walking for pleasure |
| A-factor<br>Physically demanding activities | Games, sports<br>Bicycling | Swimming<br>Horseback riding<br>Outdoor events | |
| B-factor<br>Backwoods activities | Hiking<br>Camping | Nature walks | Outdoor events<br>Driving for pleasure |

Table IV.2
Activities Favored by Persons with High Scores on the Factor

of our potential recreation activities, we purposely chose the strategy of including a full range of activities for the purposes of developing the most widely applicable site planning and evaluation procedures.

The second major category of activity which we chose to include was that of residential development. Several types of housing were included because it was felt that even though the U.S. Army Corps of Engineers does not include residential developments within its development planning, the impact of adjacent residential development should be taken into account in a general site development model. Furthermore, the many examples which can be cited of equivalent development projects in the private sector, for example, the several in which a large lake is to be developed for recreation and housing, made the inclusion of residence an important part of a general model. Finally, we did not wish to be limited strictly to considering recreational alternatives when we were in reality attempting to deal with multiple use.

The third major category of land use consisted of the transportation infrastructure which is a major part of any development project. Parking and roads are usually a major component of the capital and maintenance costs of any such project. In addition, they are often the component which is potentially the most damaging to site resources and are thus necessarily subject to particular site planning care.

Table IV.3 lists the activities which have been considered for potential inclusion into the site plans for the Honey Hill study area.

TABLE IV. 3

ACTIVITIES PROPOSED FOR THE HONEY HILL STUDY

1. Summer Plan

   1. 1. Hunting
   1. 2. Fishing
   1. 3. Swimming
   1. 4. Trail hiking
   1. 5. Camping
   1. 6. Picnicking
   1. 7. Boating and Marina
   1. 8. Residential
   1. 9. Parking
   1. 10. Major Roads

2. Winter Plan

2. 1. Hunting
2. 2. Snowshoeing
2. 3. Cross Country Skiing
2. 4. Trail Hiking
2. 5. Snow Mobiling
2. 6. Downhill Skiing
2. 7. Ice Skating
2. 8. Residential
2. 9. Parking
2. 10. Major Roads

The summer activities in Table I include hunting, fishing, and swimming (area), trail hiking (linear), camping, picnicking, and boat launching (point), residential, parking, and major roads. The winter activities include hunting and snowshoeing (area), cross-country skiing, trail hiking, snow mobiling, and downhill skiing (linear), ice skating (point), residential, parking, and roads. Hunting, residential, parking, roads, and hiking are double-listed, since they will appear in both the summer and winter plans and evaluations. We are therefore considering a total range of fifteen alternative activities in which any seasonal plan can include ten.

## B. "ATTRACTIVENESS" CRITERIA AND STANDARDS

For each of these activities, a search of the literature was conducted in order to develop information under the following headings: 1) general space standards; 2) site requirements; 3) service and accessibility requirements; 4) improvements which might be considered necessary or desirable for the activity; and 5) conflicting activities which could not or should not occupy the same general area.

For each activity a program was prepared which would evaluate relevant data variables as site criteria and produce a map which indicated the attractiveness of each potential cell for that activity. The program combined variables which were selected and weighted by the research team to represent the attractiveness to the consumer of that activity of each 2.5 acre grid cell. The general question of variable selection and weighting is a complex one. It is discussed further in Appendix D, A Survey of Current Approaches to Resource Analysis. Since there were no data available for the study area and its surrounding region from which attractiveness variables and their coefficients could be derived by

analysis, the research team was forced to define attractiveness on the basis of its best professional judgment.

Many of the variables are expressed in the data bank as ordinal or numerical descriptors. The use of these variables in a numerical analysis such as an attractiveness index requires an intermediate step to transform the raw data into relevant components which represent an interval scale. An example of the judgments that have to be made in the transformation of the data and the combination of the resultant attractiveness components is provided for activity 2.10, Major Roads.

## 1.1 and 2.1. HUNTING (Figure IV.1)

### General Space Standards

#### Small Game Hunting

8-10 acres of range per hunter. Source: Recreation in Wisconsin, p. 67.

#### Water Fowl Hunting

1 blind for each 9 acres of marsh habitat. Recreation in Wisconsin, p. 67. Blinds are spaced at least 200 yards apart.

#### Larger Game Hunting

1/10 square mile per range of hunter, Controlled Shooting (Preserve). An area large enough to encompass this activity should be 300-500 acres with 50 acres per every 4 hunters. Should have approximately 5000 birds annually to release. Source: FHA Bulletin, "Facts and Suggestions on Shooting Preserves," pp. 1-4.

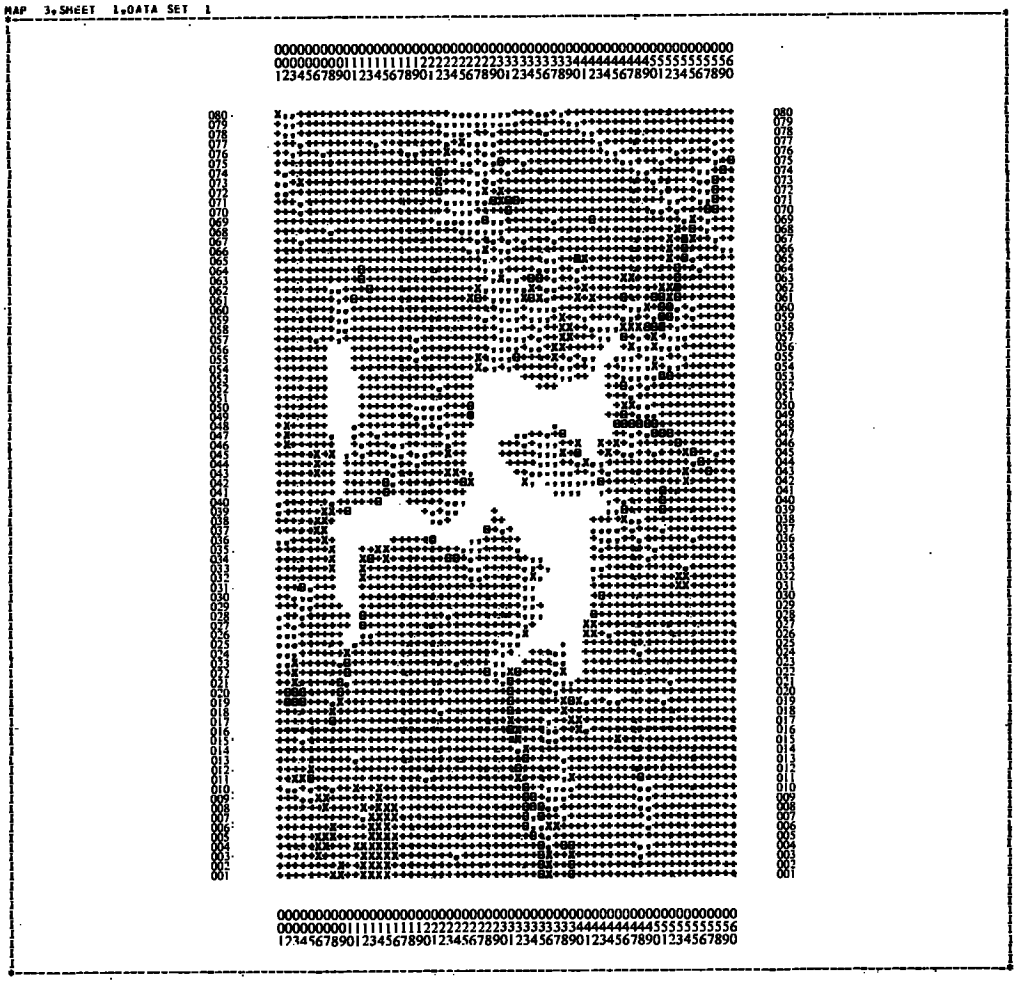
### Site Requirements

favorable habitat
preserves of game
isolation from other developments and activities
variation of topography

### Service and Accessibility Requirements

Access to point of departure from automobile. No service facilities.

MAP 3, SHEET 1, DATA SET 1



ATTRACTIVENESS FOR HUNTING

HONEY HILL CASE STUDY

U.S. ARMY CORPS OF ENGINEERS

LIMITING FACTORS
RESERVOIR
LAKES
MAJOR RIVERS

| VARIABLE | WEIGHT | VARIABLE | WEIGHT |
|---|---|---|---|
| SOIL MOISTURE | 1 | FOREST HEIGHT | 1 |
| WATER TYPE | 1 | AGRICULTURAL ACTIVITY | 1 |
| FOREST TYPE | 1 | PROXIMITY TO ROADS-PROPOSED | 1 |
| FOREST DENSITY | 1 | | |

DATA MAPPED IN 10 LEVELS BETWEEN EXTREME VALUES OF 0.0 AND 100.00

| ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| MINIMUM | 0.0 | 10.00 | 20.00 | 30.00 | 40.00 | 50.00 | 60.00 | 70.00 | 80.00 | 90.00 |
| MAXIMUM | 10.00 | 20.00 | 30.00 | 40.00 | 50.00 | 60.00 | 70.00 | 80.00 | 90.00 | 100.00 |

| PERCENTAGE OF TOTAL ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 |

FREQUENCY DISTRIBUTION OF DATA POINT VALUES IN EACH LEVEL

| | LOW VALUES | | | | | | | | | | HIGH VALUES |
|---|---|---|---|---|---|---|---|---|---|---|---|
| LEVELS | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
| SYMBOLS | | | | | | | | | | | | |
| FREQUENCY | 0 | 9 | 245 | 273 | 3543 | 178 | 0 | 114 | 10 | 2 | 1 | 0 |

Fig. IV.1
Attractiveness for Hunting

Improvements

| Minimum Facilities | #1 | #2 |
|---|---|---|
| transportation to site | hunting preserve | wildlife management policies |
| parking | snacks, food and beverages | |

Conflicting Activities

All other activities located in the areas of hunting.

1.2. FISHING (Figure IV.2)

General Space Standards

Water - General

Fishing boats require eight acres of water. Thirteen fishing boats require 104 acres of water to support one boat ramp.

An average of 2.2 persons per boat would produce eighty-eight optimum user days per forty fishing boats during one day, or eighty-eight persons per acre of land and .846 user days per acres of water. This would be .0114 acres of land and 1.182 acres of water per user day.

Source: Louisiana Parks and Recreation Commission, p. 3.0.16.

Water - Anchored Boats

Four to seven boats per acre. Source: Soil Conservation Service, Book of Recreation Resources, pp. 1,6.

Water - Trolling Boats

Two to four boats per acre. Source: Soil Conservation Service, Book of Recreation Resources, pp. 1,6.

Land - General

Public fishing access area of ten to forty acres averaging at least fifteen acres with a seven hundred

and fifty feet of water frontage. One per three hundred acres of water surface. Source: Tennessee State Planning Commission, Part II, Vol. II, p. 24.

Land - Stream Fishing

One fisherman per mile of stream. Source: Placer County, California Recreation Commission, pp. 1-9.

Land - River Fishing

One fisherman per one-quarter mile, approximately three acres per fisherman. Source: Comprehensive Plan for Wisconsin, Outdoor Recreation, pp. G-10, G-11.

Site Requirements

Favorable habitats
Fish
More than three acres water for lake fishing
Near stream entrances into reservoir
Diverse shoreline
Cannot fish near other water activities

Service and Accessibility Requirements

No specific requirements.

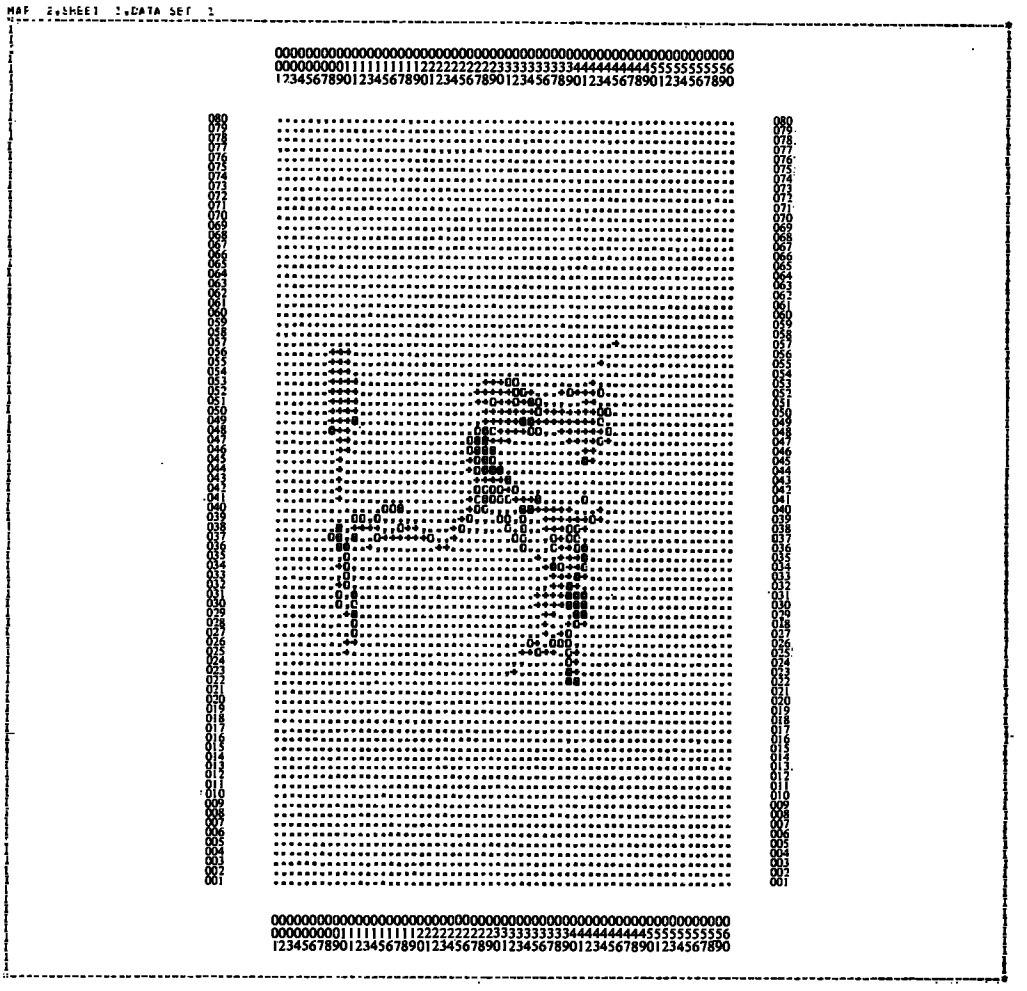
Improvements

| Minimum Facilities | #1 | #2 |
|---|---|---|
| adequate boat launch site and parking | boat rental<br>bait shop<br>snacks | fish stocking policy |

Conflicting Activities

Boating
Swimming
Hunting

MAP 2,SHEET 1,DATA SET 1



ATTRACTIVENESS FOR FISHING (WATER)

HONEY HILL CASE STUDY

U.S. ARMY CORPS OF ENGINEERS

LIMITING FACTORS
ALL EXISTING WATER

| VARIABLE | WEIGHT | VARIABLE | WEIGHT |
|---|---|---|---|
| DEPTH OF RESERVOIR | 1 | TOPOGRAPHIC SLOPE | 1 |
| DEPTH OF RESERVOIR | 1 | FOREST TYPE | 1 |
| SOIL TYPE | 1 | FOREST DENSITY | 1 |

DATA MAPPED IN 10 LEVELS BETWEEN EXTREME VALUES OF 0.00 AND 100.00

ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| MINIMUM | 0.00 | 10.00 | 20.00 | 30.00 | 40.00 | 50.00 | 60.00 | 70.00 | 80.00 | 90.00 |
| MAXIMUM | 10.00 | 20.00 | 30.00 | 40.00 | 50.00 | 60.00 | 70.00 | 80.00 | 90.00 | 100.00 |

PERCENTAGE OF TOTAL ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 |

FREQUENCY DISTRIBUTION OF DATA POINT VALUES IN EACH LEVEL

| LEVELS | LOW VALUES 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | HIGH VALUES 11 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SYMBOLS | | | | | | | | | | | | |
| FREQUENCY | 0 | 4414 | 54 | 0 | 264 | 0 | 83 | 0 | 43 | 0 | 2 | 0 |

**Fig. IV.2**
**Attractiveness for Fishing**

## 1.3. SWIMMING (Figures IV.3 and IV.4)

### General Space Standards

25 effective feet of shoreline for each 50 swimmers. 25 effective feet include: 1) 5,000 sq. ft. for sun bathing; 2) 25,000 sq. ft. for buffer and picnic area; and 3) 1,000 sq. ft. for water area for swimming. An effective foot consists of one lineal foot of shore, 100 foot wide band of water suitable for swimming, 200 feet wide strip of beach for sun bathing, 100 foot wide buffer zone for utilities and picnicking. Turn-over rate is generally 3 times per day or 150 persons per day per 25 effective feet of shoreline. Source: California Public Outdoor Recreation Plan, Part II, pp. 48, 84. Parking should be provided at one parking space per 3 swimmers. Source: T. Murray.

Beach - 50 sq. feet/person, Source: U.S. Army Corps of Engineers ER 1130-2-312, page 8.
At any given time, 60% of bathers on beach, 30% in water, and 10% other areas, source: Ibid, page 9.
25 lineal feet of shore = 50 persons at one time.
x factors for turn-over of 3 = 150 persons, source: Ibid., page 10.
580 persons/acre of beach, Source: Ibid., page 23.

### Site Requirements

Clean water over 3 feet deep
Lake bottom free of obstructions
Water temperature $50^{o}$+
South orientation
Away from boating, fishing
Near picnic facilities
Less than 4% slope
Proximity to other activities
Natural sand areas
Adequate subsurface slopes

### Service and Accessibility Requirements

Hard top road or well-maintained gravel road
Service consists of routine maintenance, water clean-up, seasonal improvements and emergency services

Improvements

| Minimum Facilities | #1 | #2 | #3 |
|---|---|---|---|
| access to water | sandy, dry beach | controlled swimming area | picnic facilities |
| water | sandy, wet beach | lifeguard | diving board |
| adequate land-water area | parking area | controlled parking | showers |
| | changing area | dock and raft facilities | flush toilets |
| | | changing rooms | telephone |
| | | toilets | food/ beverages |
| | | snack bar | |

1.4 and 2.4. TRAIL HIKING (Figure IV.5)

General Space Standards

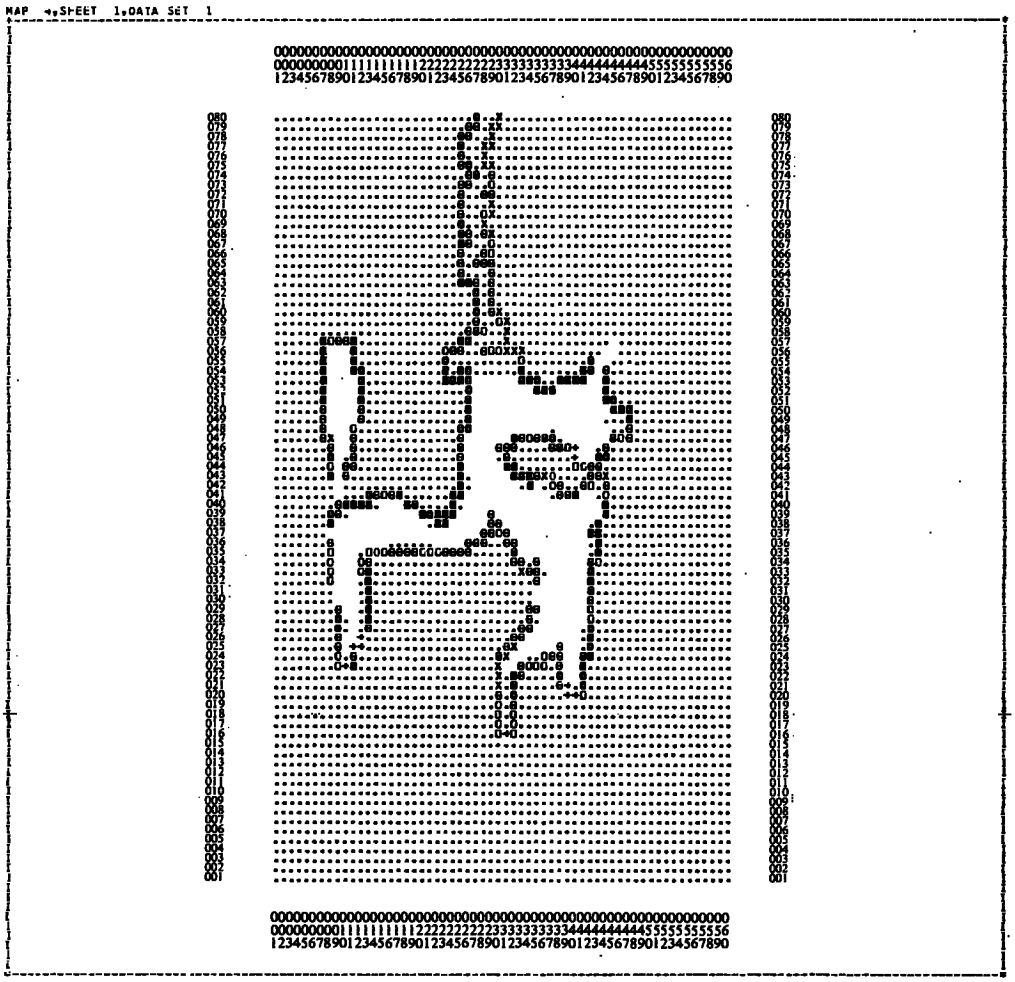
Nature Trail

50 people per mile of trail, trails are 1-2 miles long, with a turn-over rate of 8. There are 400 people per mile of trail per day. Source: Comprehensive Plan for Wisconsin, Outdoor Recreation, pp. G-7, G-8.

Hiking Trail

A hiking trail should be 10 feet wide over a distance of 20 miles. It requires 24 acres of land. In addition, 10 acres of parking and camping area are needed. This includes 2 campsites of 5 acres each, 15-20 miles apart, making a total of 34 acres. Water should be available at 6 mile intervals. About 20 hikers per mile of trail is capacity. Since a trail of 20 miles takes about 5 hours to hike during the daylight hours, a turn-over rate of 5 is considered reasonable to produce 100 hiker user days. This amounts to .34 acres per user day or 2.96 user days per acre. Source: Louisiana Parks and Recreation Commission, pp. 3.0.17, 3.0.18.

MAP 4,SHEET 1,DATA SET 1



ATTRACTIVENESS FOR BEACHES (SWIMMING)

HONEY HILL CASE STUDY

U.S. ARMY CORPS OF ENGINEERS

LIMITING FACTORS
RESERVOIR
LAKES
MAJOR RIVERS
NEAREST WATER NOT IN NEIGHBORING CELL

| VARIABLE | WEIGHT | VARIABLE | WEIGHT |
|---|---|---|---|
| TOPOGRAPHY--ORIENTATION | 1 | FOREST TYPE | 1 |
| TOPOGRAPHIC SLOPE | 1 | FOREST DENSITY | 1 |
| SOIL TYPE | 1 | FOREST HEIGHT | 1 |
| BEDROCK DEPTH | 1 | PROXIMITY TO WATER | 1 |
| SOIL MOISTURE | 1 | | |

DATA MAPPED IN 10 LEVELS BETWEEN EXTREME VALUES OF 0.0 AND 100.00

ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| MINIMUM | 0.0 | 10.00 | 20.00 | 30.00 | 40.00 | 50.00 | 60.00 | 70.00 | 80.00 | 90.00 |
| MAXIMUM | 10.00 | 20.00 | 30.00 | 40.00 | 50.00 | 60.00 | 70.00 | 80.00 | 90.00 | 100.00 |

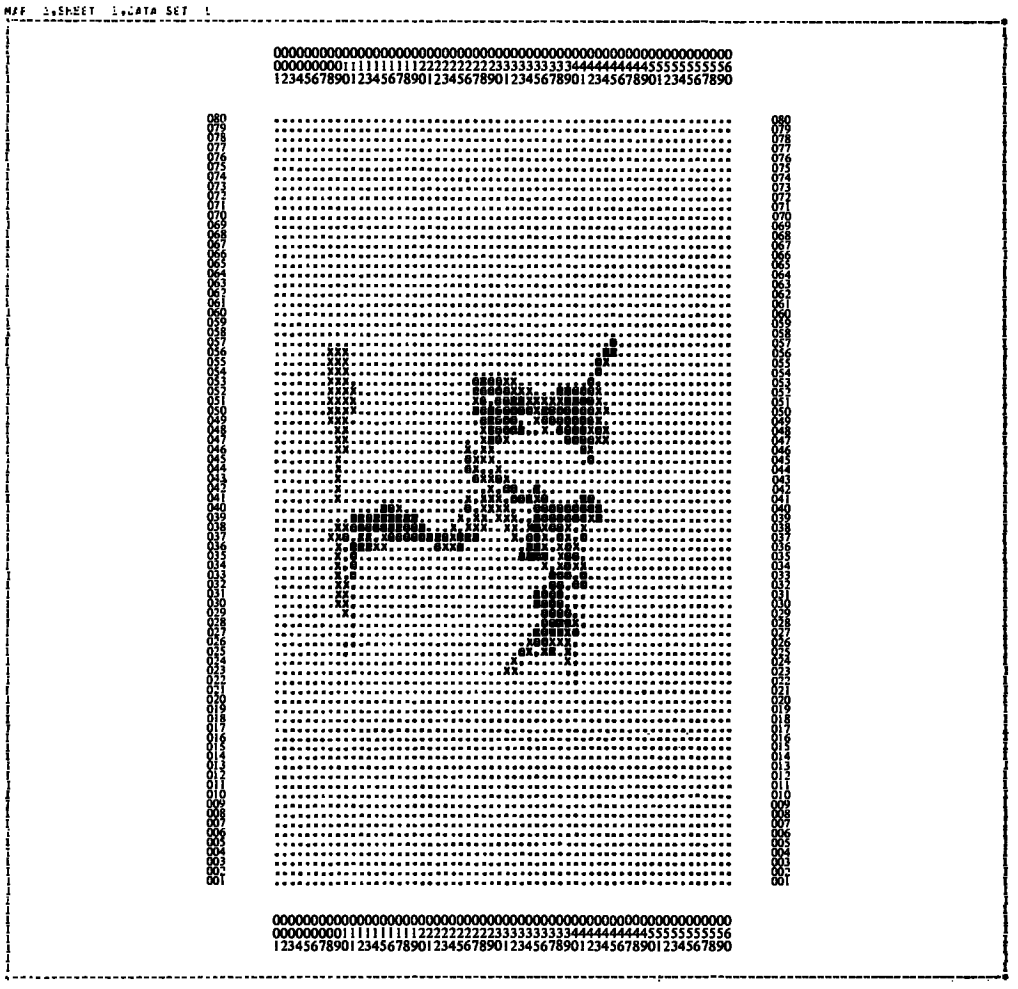
PERCENTAGE OF TOTAL ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 |

FREQUENCY DISTRIBUTION OF DATA POINT VALUES IN EACH LEVEL

| LEVELS | LOW VALUES 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | HIGH VALUES 11 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SYMBOLS | | | | | | | | | | | | |
| FREQUENCY | 0 | 9015 | 0 | 0 | 10 | 29 | 54 | 126 | 47 | 61 | 13 | 0 |

Fig. IV.3
Attractiveness for Beaches (Swimming)



ATTRACTIVENESS FOR SWIMMING (WATER)

HONEY HILL CASE STUDY

U.S. ARMY CORPS OF ENGINEERS

LIMITING FACTORS
ALL EXISTING WATER.
BEDROCK DEPTH < 1'.
HEAVILY TRAVELED ROADS

| VARIABLE | WEIGHT | VARIABLE | WEIGHT |
|---|---|---|---|
| TOPOGRAPHICAL SLOPE | 1 | FOREST DENSITY | 1 |
| SOIL TYPE | 1 | FOREST TYPE | 1 |

DATA MAPPED IN 10 LEVELS BETWEEN EXTREME VALUES OF 0.0 AND 100.00

ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| MINIMUM | 0.0 | 10.00 | 20.00 | 30.00 | 40.00 | 50.00 | 60.00 | 70.00 | 80.00 | 90.00 |
| MAXIMUM | 10.00 | 20.00 | 30.00 | 40.00 | 50.00 | 60.00 | 70.00 | 80.00 | 90.00 | 100.00 |

PERCENTAGE OF TOTAL ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 |

FREQUENCY DISTRIBUTION OF DATA POINT VALUES IN EACH LEVEL

| LEVELS | LOW VALUES 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | HIGH VALUES 11 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SYMBOLS | | | | | | | | | | | | |
| FREQUENCY | 0 | 4377 | 0 | 75 | 0 | 150 | 0 | 0 | 135 | 0 | 63 | 0 |

# LINES OF PRINT = 796

**Fig. IV.4**
**Attractiveness for Swimming (Water)**

One Day or Less

Well defined and maintained track up to 10' wide, grades not to exceed 5% average with a maximum of 15%. Source: California Public Outdoor Recreation Plan, Part II, p. 85.

Parking

Minimum parking for 25 autos at any access point. On short, scenic, well-known trails this might be extended to 100 spaces. Source: California Public Outdoor Recreation Plan, Part II, p. 85.

Hiking Area

Minimum of 10 acres provide a 3 mile trail, and a 1-1 1/ mile trail. Source: Carbon County, Pa. (Mauch Chunk Watershed, Table 5).

Site Requirements and Considerations

Slopes between 5% and 15%
Fresh or dry soil
Vegetation density--medium to low
Height--preferably over 20'
High visual contrast
Variety of orientation of slopes
Near shoreline
Should connect unique areas
High points
On ridges
Away from development

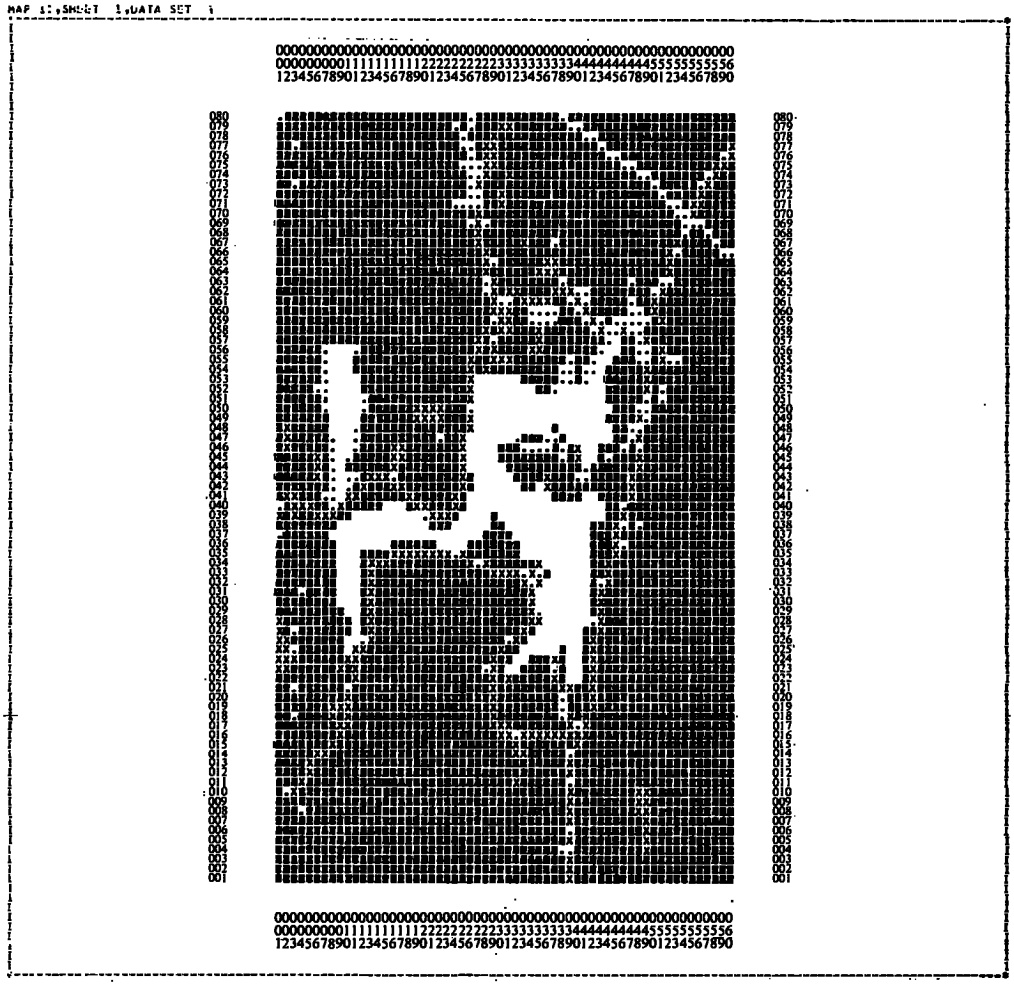
Service and Accessibility Requirements

The trail will be maintained by workers on foot.
Accessibility -- Parking.

Improvements

Minimum Facilities

MAP 1:SHEET 1,DATA SET 1



ATTRACTIVENESS FOR HIKING

HONEY HILL CASE STUDY

U.S. ARMY CORPS OF ENGINEERS

LIMITING FACTORS
RESERVOIR
LAKES
MAJOR RIVERS
FARMSTEAD
RESIDENCE
PUBLIC BUILDING
GRAVEL ACTIVITY
POWER LINE

| VARIABLE | WEIGHT | VARIABLE | WEIGHT |
|---|---|---|---|
| SOIL MOISTURE | 1 | ROAD TYPE | 1 |

DATA MAPPED IN 10 LEVELS BETWEEN EXTREME VALUES OF 0.0 AND 100.00

ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| MINIMUM | 0.0 | 10.00 | 20.00 | 30.00 | 40.00 | 50.00 | 60.00 | 70.00 | 80.00 | 90.00 |
| MAXIMUM | 10.00 | 20.00 | 30.00 | 40.00 | 50.00 | 60.00 | 70.00 | 80.00 | 90.00 | 100.00 |

PERCENTAGE OF TOTAL ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 |

FREQUENCY DISTRIBUTION OF DATA POINT VALUES IN EACH LEVEL

| LEVELS | LOW VALUES 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | HIGH VALUES 11 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SYMBOLS | | ..... | ..... | ..... | +++++ | XXXXX | 00000 | ..... | ..... | ..... | ..... | |
| FREQUENCY | 0 | 205 | 0 | 0 | 0 | 305 | 0 | 0 | 0 | 0 | 3865 | 0 |

Fig. IV.5
Attractiveness for Hiking

Conflicting Activities

Water skiing
Power boating
Riding
Organized games--on beach
Hunting

## 1.5. CAMPING (Figure IV.6)

General Space Standards

Tent

4 units per acre--includes parking. Source: California Public Outdoor Recreation Plan, Part II, p. 84. A good camping ground should provide for a minimum of 90-120 camp sites on 12-30 acres with 4.7 camp sites/acre. Source: National Park Service Handbook, "Special Park Uses: Campground Planning," pp. 1-6.

Ground Camping

Five acres for 50 persons for short periods of time. Five acres includes sanitary water, and basic cooking facilities, open spaces for tents and spaces for 25 automobiles. Source: California Public Outdoor Recreation Plan, Part II, P. 84. Space generally 3.7 people per unit. Source: Placer County, California Recreation Commission, p. 35.

1 area/7500-10,000 annual visitors
7 spaces minimum per area
Source: U.S. Army Corps of Engineers ER 1130-2-314, p. 4.

Site Requirements

Slopes 4-12%
Not north, northeast or northwest orientation
Dry stable soil
Trees over 20 feet, medium to low density
Adequate ground water supply
High visual quality
Proximity to water

Diversity of area
Away from development
Good access
Proximity to unique features

Service and Accessibility Requirements

Areas must be located near hard surface roads due to numbers of vehicles and trailers using facility. Service consists of day to day maintenance, collection of fees and routine patrols. Source: T. Murray.

Improvements

| Minimum Facilities | #1 | #2 | #3 |
|---|---|---|---|
| flat, open sites | designed camp layout | flush toilets | showers |
| parking space | tables | water supply | flush toilets |
| access | cooking facilities | firewood | electricity |
| | toilet facilities | controlled parking | laundry facilities |
| | | beach development | store nearby |
| | | reservation system | snackbar |
| | | | playground equipment |
| | | | organized game area |

Conflicting Activities

Picnicking and organized games
Hunting
Launch area
Residential

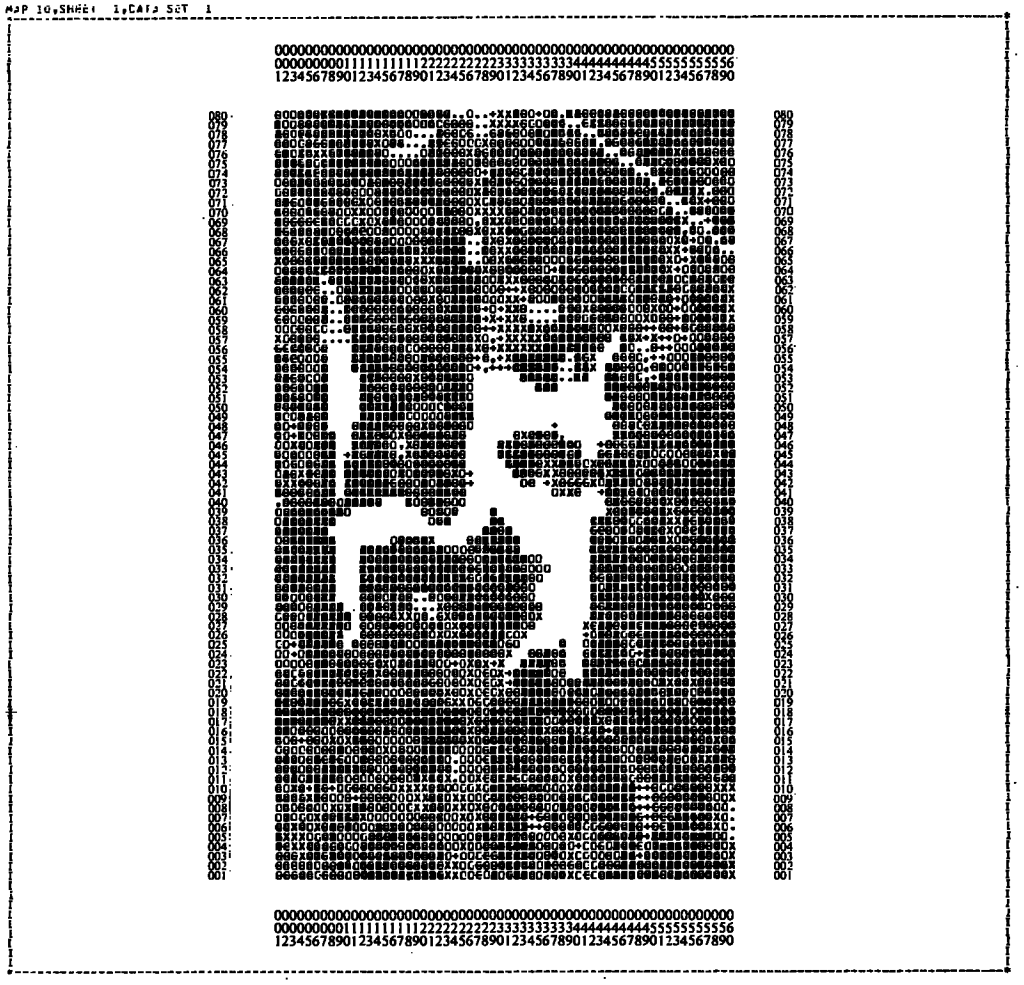
1.6. PICNICKING (Figures IV.7 and IV.8)

General Space Standards

General

1 developed acre for each forty picnickers at eight tables (eight units) per acre with twenty undeveloped acres, turn-over rate of 1.6 persons per table and

MAP 10,SHEET 1,DATA SET 1



ATTRACTIVENESS FOR CAMPING

HONEY HILL CASE STUDY

U.S. ARMY CORPS OF ENGINEERS

LIMITING FACTORS
RESERVOIR
LAKES
MAJOR RIVERS
BEDROCK DEPTH 0-1'
DEVELOPMENT ACTIVITY

| VARIABLE | WEIGHT | VARIABLE | WEIGHT |
|---|---|---|---|
| TOPOGRAPHIC SLOPE | 1 | BEDROCK DEPTH | 1 |
| SOIL MOISTURE | 1 | FOREST TYPE | 1 |
| FOREST DENSITY | 1 | FOREST HEIGHT | 1 |
| FOREST DENSITY | 1 | FOREST HEIGHT | 1 |
| ROAD TYPE | 1 | PROXIMITY TO WATER | 1 |

DATA MAPPED IN 10 LEVELS BETWEEN EXTREME VALUES OF 0.0 AND 100.00

ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| MINIMUM | 0.00 | 10.00 | 20.00 | 30.00 | 40.00 | 50.00 | 60.00 | 70.00 | 80.00 | 90.00 |
| MAXIMUM | 10.00 | 20.00 | 30.00 | 40.00 | 50.00 | 60.00 | 70.00 | 80.00 | 90.00 | 100.00 |

PERCENTAGE OF TOTAL ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 |

FREQUENCY DISTRIBUTION OF DATA POINT VALUES IN EACH LEVEL

| LEVELS | LOW VALUES 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | HIGH VALUES 11 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SYMBOLS | | ..... | ..... | ..... | +++++++++ | XXXXXXXXX | OOOOOOOOO | 00000000 | 00000000 | ######## | ######## | |
| | | ..... | ..... | ..... | ++++ ++++ | XXXX XXXX | OOOO OOOO | 0000 0000 | 0000 0000 | #### #### | #### #### | |
| | | ..... | ..... | ..... | +++++++++ | XXXXXXXXX | OOOOOOOOO | 00000000 | 00000000 | ######## | ######## | |
| FREQUENCY | 0 | 91 | 2 | 10 | 79 | 229 | 552 | 736 | 1435 | 1007 | 194 | 0 |

Fig. IV.6
Attractiveness for Camping

with over three people per table, forty persons per acre each day. Source: A Comprehensive Plan for Wisconsin, p. G6.

Group Picnic Area

25 units per acre. 600 activity days annually per unit. 50 car spaces for every acre 25 units. Source: California Public Outdoor Recreation Plan, Part II, p. 84.

1 parking space required for each unit, i.e., eight parking spaces per acre of picnic land. Source: American Society of Planning Officials, p. 32. Overall maximum average of 220.1 picnickers per day per acre of land. Source: National Recreation and Park Association, Bulletin No. 4, pp. 8-22. Generally 1 table for each 4,000 annual visitors.

1 table for each 75 summer weekend day visitors (est. 10-15 picnickers)
5-50 tables/area
1 parking space/table
Source: U.S. Army Corps of Engineers ER 1130-2-312, p. 3

Site Requirements

Orientation not north, northeast or northwest
Slopes less than 8%
Fresh or dry soil
Mixture of trees (deciduous & conferous) and open space
Vegetation height greater than 20 feet
Adequate ground water supply
View of water
Proximity to water, away from developments, new unique features

Service and Accessibility Requirements

Service involves maintenance, trash collecting and general upkeep. Requires hard surface road. Source: T. Murray

Improvements

| Minimum Facilities | #1 | #2 | #3 |
|---|---|---|---|
| parking area | tables<br>grills | toilets<br>water supply<br>shelter<br>game area | playground equipment<br>flush toilets<br>showers<br>electricity<br>store facilities |

Open area for field sports and games.

Conflicting Activities

Hunting

1.7. BOATING AND MARINA (Figures IV.9 and IV.10)

General Space Standards

Power Boating - Water

One person per 8 acres of water surface. Estimated 2.5 persons/boat, or 20 acres per boat. Small lakes with restricted motor sizes could support more than 1 boat per 20 acres. Source: Comprehensive Plan for Wisconsin, Outdoor Recreation, pp. G-10, G-11.

Row Boating - Water

One boat per 1 acre of water surface. Two people per boat. Source: T. Murray.

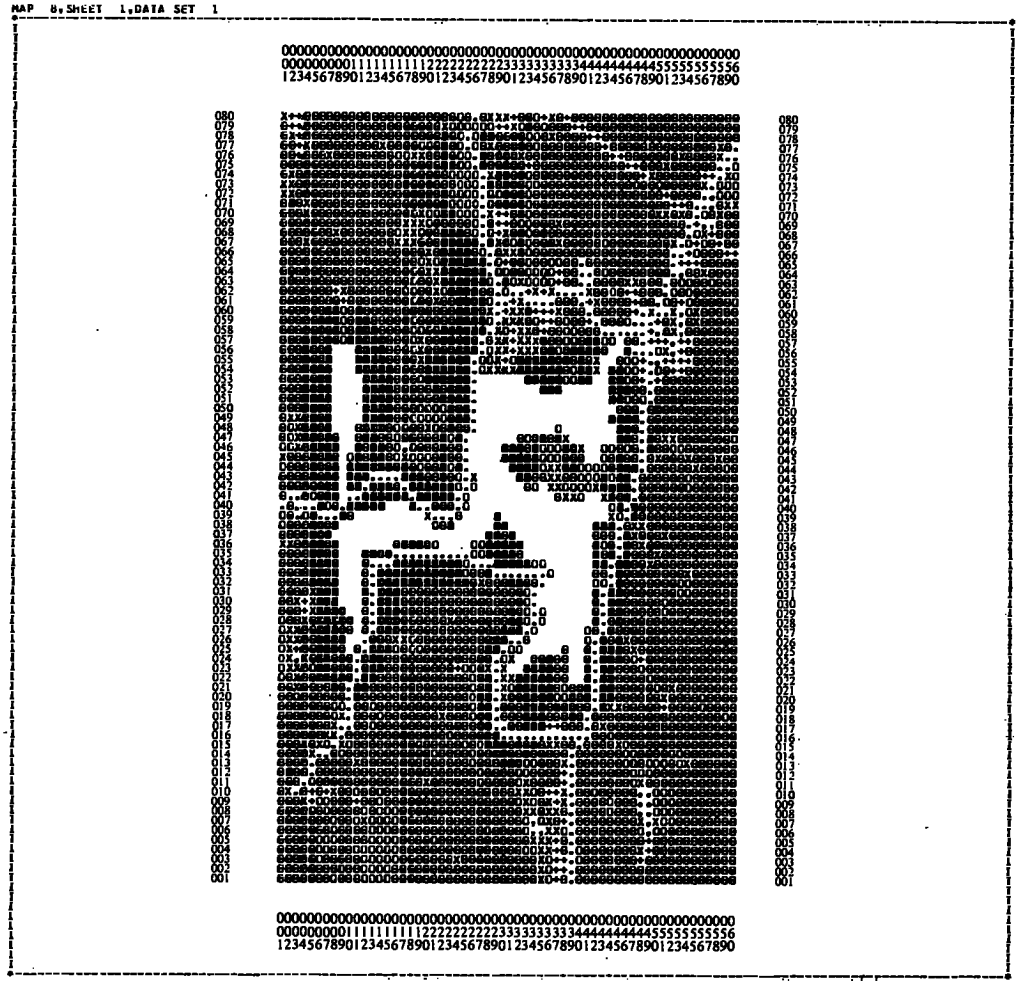
Canoeing - Water

One person per 1/4 mile of stream. Estimated 2 persons per canoe on 1/2 mile stream. Source: Comprehensive Plan for Wisconsin, Outdoor Recreation, pp. G-10, G-11.

Water Skiing - Water

One person per 13 acres of water. Estimated 3 persons per boat, 20 acres per boat may be adequate,

MAP 8,SHEET 1,DATA SET 1



ATTRACTIVENESS FOR PICNIC AREAS

HUNEY HILL CASE STUDY

U.S. ARMY CORPS OF ENGINEERS

LIMITING FACTORS
RESERVOIR
LAKES
MAJOR RIVERS
FOREST HEIGHT < 20

| VARIABLE | WEIGHT | VARIABLE | WEIGHT |
|---|---|---|---|
| TOPOGRAPHY--ORIENTATION | 1 | FOREST TYPE | 1 |
| TOPOGRAPHIC SLOPE | 1 | FOREST HEIGHT | 1 |
| SOIL TYPE | 1 | ROAD TYPE | 1 |
| SOIL MOISTURE | 1 | PROXIMITY TO WATER | 1 |
| SUB-SURFACE WATER | 1 | | |

DATA MAPPED IN 10 LEVELS BETWEEN EXTREME VALUES OF 0.0 AND 100.00

ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| MINIMUM | 0.0 | 10.00 | 20.00 | 30.00 | 40.00 | 50.00 | 60.00 | 70.00 | 80.00 | 90.00 |
| MAXIMUM | 10.00 | 20.00 | 30.00 | 40.00 | 50.00 | 60.00 | 70.00 | 80.00 | 90.00 | 100.00 |

PERCENTAGE OF TOTAL ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 |

FREQUENCY DISTRIBUTION OF DATA POINT VALUES IN EACH LEVEL

| LEVELS | LOW VALUES 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | HIGH VALUES 11 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SYMBOLS | | | | | | | | | | | | |
| FREQUENCY | C | 254 | 7 | 10 | 115 | 231 | 433 | 2552 | 176 | 584 | 5 | C |

Fig. IV.7
Attractiveness for Picnic Areas

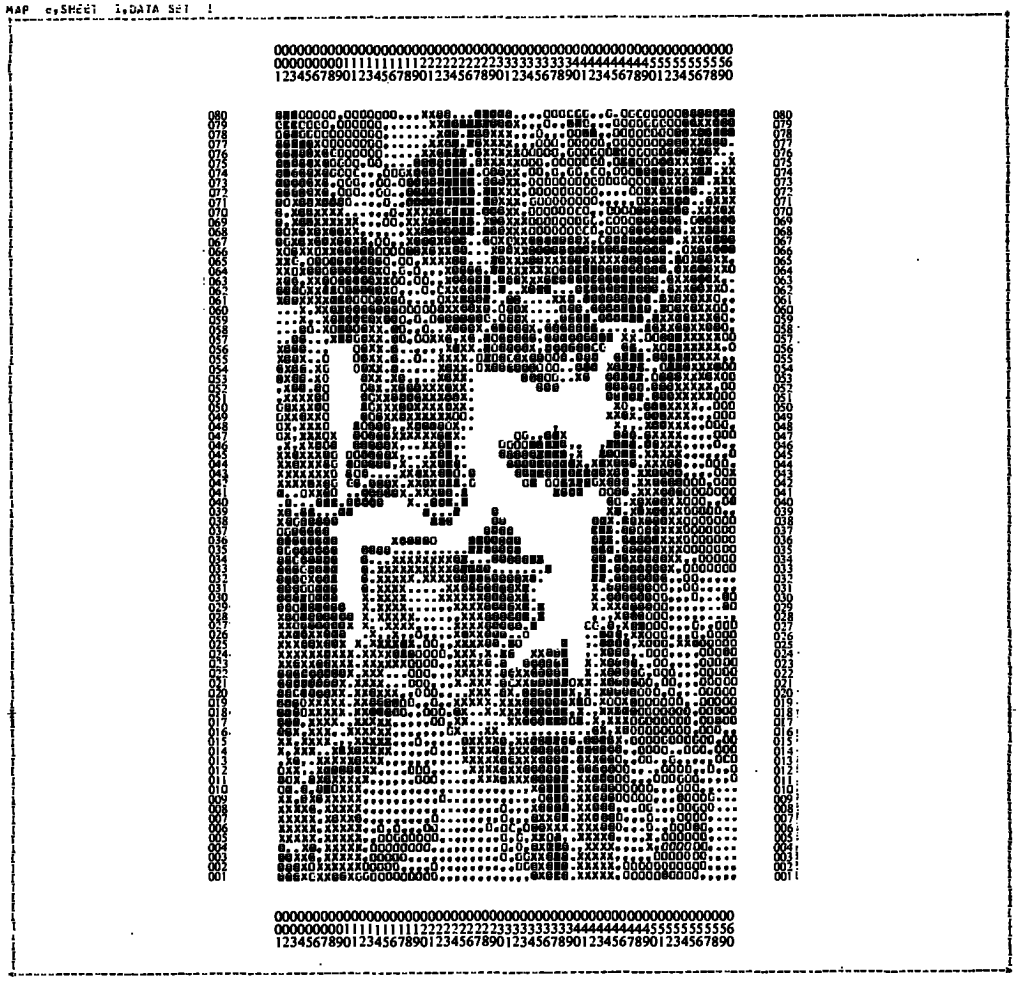



Fig. IV.8
Attractiveness for General Field Sports and Activities

but 40 acres per boat is more desirable. Source: Comprehensive Plan for Wisconsin, Outdoor Recreation, pp. G-10, G-11.

## Launch Area

One launch facility per 160 surface acres of boating water. Parking space for 75 autos and boat trailers for each launch facility. Source: California Public Outdoor Recreation Plan, Vol. II, p. 84. Forty boats per line of launching ramp. Area is 1-1 1/2 acres with parking for 60 to seventy-five cars with boat trailers. At least one ramp should be proveded for areas having 5,000-40,000 annual visitors or at any one area where 40 boat launchings projected per peak day.

1 facility for each 40,000 annual visitors
1 ramp = 40 boats/day (1 hour maximum delay)
10-25 parking with trailer/ramp
Source: U.S. Army Corps of Engineers ER 1130-2-312, p.3.

## Marina Facilities

At least twenty-five acres to insure proper lay-out and design of facility. Source: National Recreation and Park Association Bulletin No. 54, pp. 6-9.

## Site Requirements

Water and adequate launch area

## Service and Access Requirements

No service requirements unless a marina is developed. Access road should be paved or gravel in good condition.

Improvements

| Minimum Facilities | #1 | #2 | #3 |
|---|---|---|---|
| 100+ acres water<br>small launch area<br>uncontrolled parking | dock area<br>launch site<br>parking lot<br>toilet facility | fuel supply<br>snack bar<br>boat rentals<br>outdoor storage<br>electricity<br>marina development | boat sales & service<br>restaurant<br>dry and wet storage<br>snacks and beverages<br>flush toilets<br>showers |

Conflicting Activities

Fishing
Swimming

2.2. SNOW SHOEING TRAIL (Figure IV.11)

General Space Standards

No specific standards in the literature--standards for hiking trails will be assumed at 10/acre.

Site Requirements

Slopes not over 15%
Low vegetation density
Vegetation height over 20'
Variety of slope orientation but should be predominantly warmer in winter.

Service and Accessibility Requirements

No requirements for service or accessibility, except must have parking for starting point.

Improvements

| Minimum Facilities | #1 | #2 | #3 |
|---|---|---|---|
| parking | trails<br>shelter | warming house<br>toilet<br>electricity | rentals<br>flush toilet<br>food/ beverage |

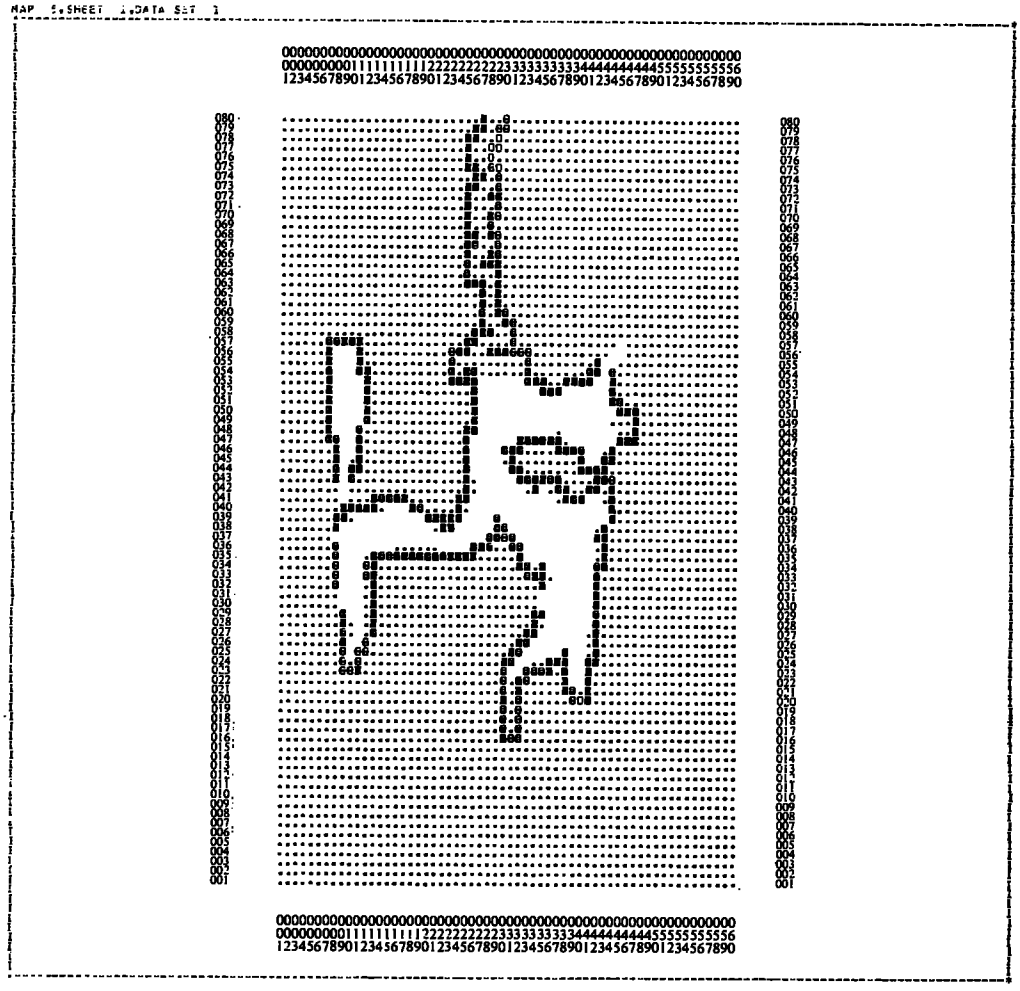



Fig. IV.9
Attractiveness for Marinas

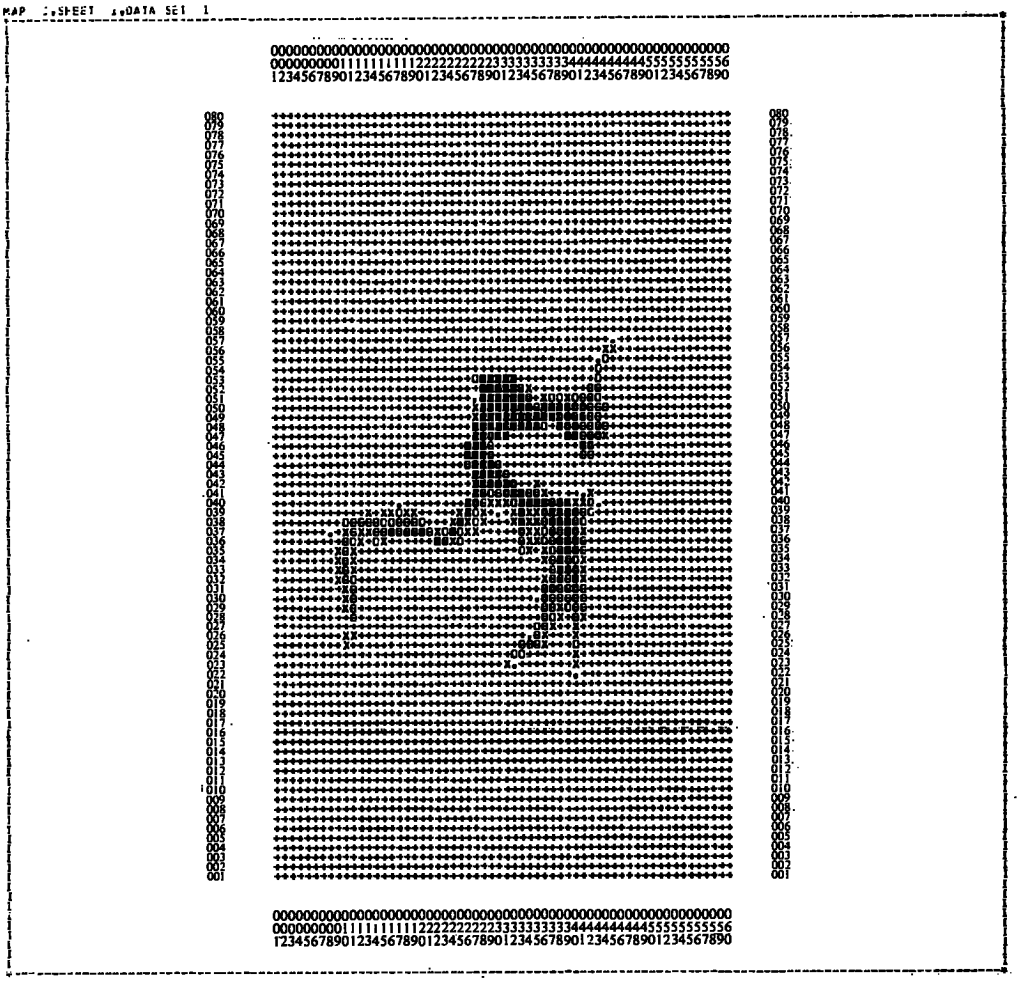



Fig. IV.10
Attractiveness for Boating

Conflicting Activities

Snow mobile
Downhill skiing
Hunting

## 2.3. CROSS COUNTRY SKIING (Figure IV.12)

General Space Standards

No reported standards--assume the same general space standards as hiking trails.

Parking: assume the same as for hiking.

Site Requirements

Slopes between 5-15%
Vegetation density--low to medium
Vegetation height--over 20'
Warmer slopes

Service and Accessibility Requirements

No specific service requirements
Access from plowed roads
Parking

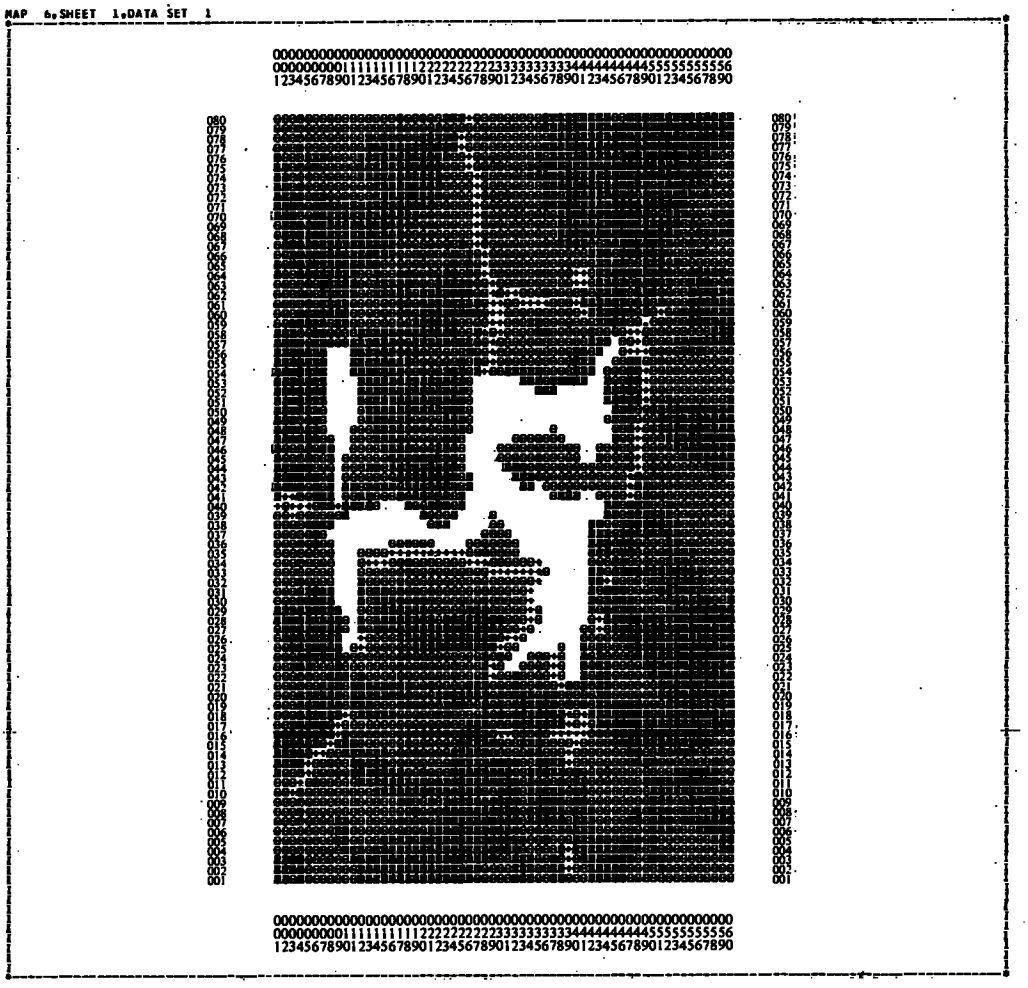
Improvements

| Minimum Facilities | #1 | #2 |
|---|---|---|
| parking | trails | warming house |
| | shelters | interpretive trail |
| | | toilet |
| | | electricity |

Conflicting Activities

Snow mobiling
Downhill skiing
Hunting

MAP 6. SHEET 1. DATA SET 1



ATTRACTIVENESS FOR SNOW SHUE TRAIL

HONEY HILL CASE STUDY

U.S. ARMY CORPS OF ENGINEERS

| VARIABLE | WEIGHT | VARIABLE | WEIGHT |
|---|---|---|---|
| TOPOGRAPHY--ORIENTATION | 1 | FOREST HEIGHT | 1 |
| TOPOGRAPHIC SLOPE | 1 | ROAD TYPE | 1 |

DATA MAPPED IN 10 LEVELS BETWEEN EXTREME VALUES OF 0.0 AND 100.00

ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| MINIMUM | 0.0 | 10.00 | 20.00 | 30.00 | 40.00 | 50.00 | 60.00 | 70.00 | 80.00 | 90.00 |
| MAXIMUM | 10.00 | 20.00 | 30.00 | 40.00 | 50.00 | 60.00 | 70.00 | 80.00 | 90.00 | 100.00 |

PERCENTAGE OF TOTAL ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

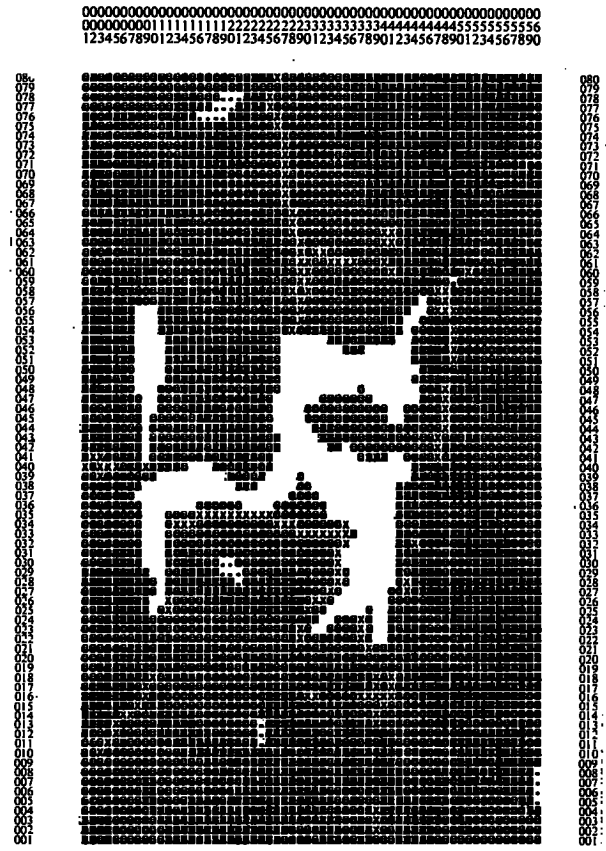
| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 |

FREQUENCY DISTRIBUTION OF DATA POINT VALUES IN EACH LEVEL

| LEVELS | LOW VALUES 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | HIGH VALUES 11 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SYMBOLS | | ..... | ..... | ..... | +++++ | XXXXX | 00000 | @@@@@ | ##### | ##### | ##### | |
| FREQUENCY | 0 | 1 | 0 | 0 | 140 | 0 | 0 | 2066 | 0 | 0 | 2168 | 0 |

Fig. IV.11
Attractiveness for Snow Shoe Trail

MAP 7.SHEET 1.DATA SET 1



ATTRACTIVENESS FOR CROSS COUNTRY SKIING

HONEY HILL CASE STUDY

U.S. ARMY CORPS OF ENGINEERS

LIMITING FACTORS
EXPOSED BEDROCK

| VARIABLE | WEIGHT | VARIABLE | WEIGHT |
|---|---|---|---|
| TOPOGRAPHY--ORIENTATION | 1 | FOREST HEIGHT | 1 |
| TOPOGRAPHIC SLOPE | 1 | ROAD TYPE | 1 |

DATA MAPPED IN 10 LEVELS BETWEEN EXTREME VALUES OF 0.0 AND 100.00

ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| MINIMUM | 0.0 | 10.00 | 20.00 | 30.00 | 40.00 | 50.00 | 60.00 | 70.00 | 80.00 | 90.00 |
| MAXIMUM | 10.00 | 20.00 | 30.00 | 40.00 | 50.00 | 60.00 | 70.00 | 80.00 | 90.00 | 100.00 |

PERCENTAGE OF TOTAL ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 |

FREQUENCY DISTRIBUTION OF DATA POINT VALUES IN EACH LEVEL

| LEVELS | LOW VALUES 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | HIGH VALUES 11 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SYMBOLS | | ..... | ..... | ..... | +++++ | XXXXX | OOOOO | ..... | ..... | ..... | ..... | |
| FREQUENCY | 0 | 23 | 0 | 1 | 0 | 140 | 0 | 0 | 2062 | 0 | 2149 | 0 |

Fig. IV.12
Attractiveness for Cross Country Skiing

## 2.5. SNOW MOBILING (Figure IV.13)

### General Space Standards

#### Trails

No specific standards are available in the literature. We assume that a maximum of 10/mile of trail, and 1.5 persons per vehicle. Many trails systems use hiking trails, firelanes and old road tracks as the framework of the trail system.

#### Area

No specific standards are available in the literature. Assume a maximum of 1 snow mobile/acre of land.

### Site Requirements

Slopes--under 15%
Low vegetation density or open area
Tree height over 20'

### Accessibility and Service Requirements

None

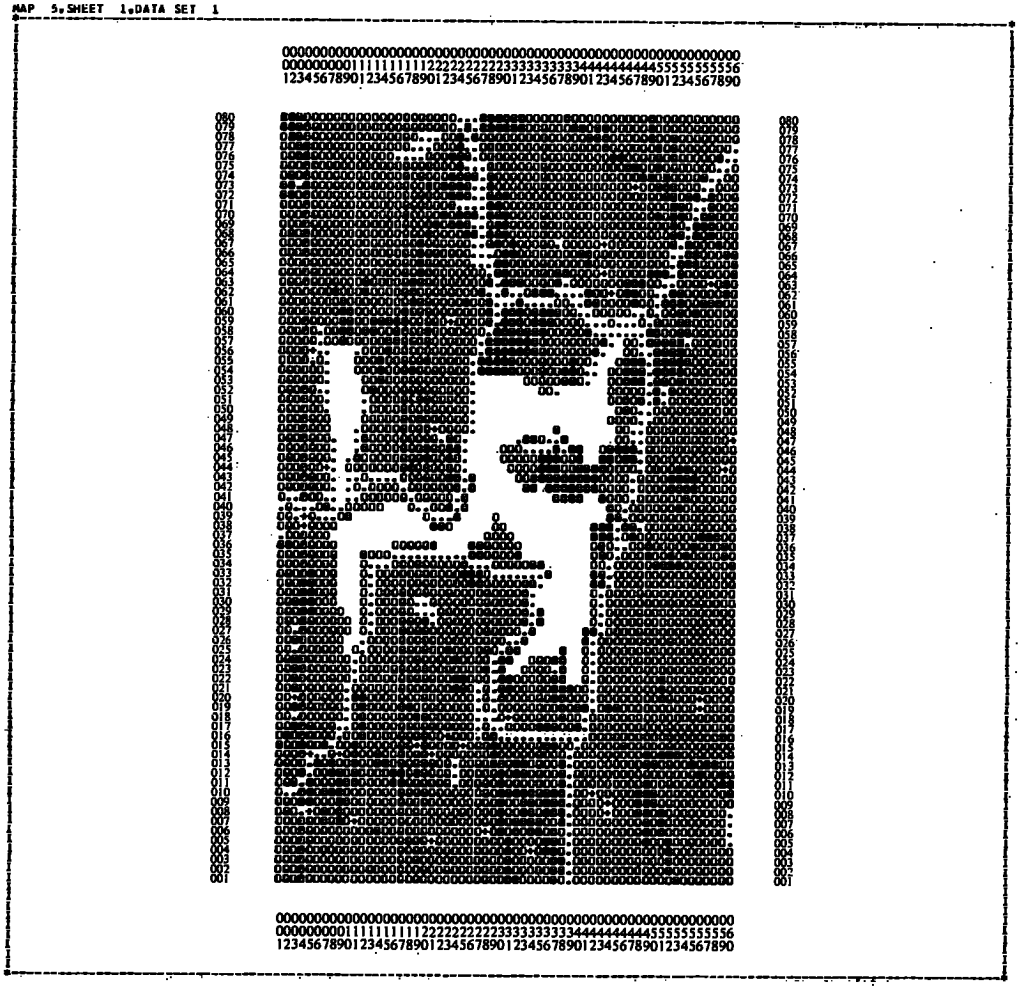
### Improvements

| Minimum Facilities | #1 | #2 |
|---|---|---|
| unloading area | trails | sales/service |
| parking | shelters | rentals |
| | warming house | food/beverage |
| | picnic facility | organized races |
| | toilet | |
| | water | |

### Conflicting Activities

All other trail activities
Downhill skiing
Hunting

MAP 5.SHEET 1.DATA SET 1



ATTRACTIVENESS FOR SNOW MOBILING

HONEY HILL CASE STUDY

U.S. ARMY CORPS OF ENGINEERS

LIMITING FACTORS
TOPOGRAPHIC SLOPE > 15%
EXPOSED BEDROCK
RESIDENTIAL AREA
PUBLIC BUILDINGS
CEMETARY
HEAVILY TRAVELED ROADS

| VARIABLE | WEIGHT | VARIABLE | WEIGHT |
|---|---|---|---|
| TOPOGRAPHIC SLOPE | 1 | FOREST HEIGHT | 1 |
| BEDROCK DEPTH | 1 | ROAD TYPE | 1 |
| FOREST DENSITY | 1 | | |

DATA MAPPED IN 10 LEVELS BETWEEN EXTREME VALUES OF 0.0 AND 100.00

ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| MINIMUM | 0.0 | 10.00 | 20.00 | 30.00 | 40.00 | 50.00 | 60.00 | 70.00 | 80.00 | 90.00 |
| MAXIMUM | 10.00 | 20.00 | 30.00 | 40.00 | 50.00 | 60.00 | 70.00 | 80.00 | 90.00 | 100.00 |

PERCENTAGE OF TOTAL ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 |

FREQUENCY DISTRIBUTION OF DATA POINT VALUES IN EACH LEVEL

| LEVELS | LOW VALUES 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | HIGH VALUES 11 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SYMBOLS | | ..... | ..... | ..... | +++++ | XXXXX | 00000 | ..... | ..... | ..... | ..... | |
| FREQUENCY | 0 | 374 | 0 | 0 | 31 | 0 | 3295 | 0 | 663 | 0 | 12 | 0 |

Fig. IV.13
Attractiveness for Snowmobiling

## 2.6. DOWNHILL SKIING (Figure IV.14)

Ski slopes are measured in terms of vertical descent and overall length.

Novice slopes vary from 0%-20% grade.

Intermediate slopes from 20-35% grade.

Expert slopes from 35% on up.

The minimum width of a slope should be no less than 100-250 feet.

Average consumer demands 8,000 vertical feet of skiing per day.

An average beginner wants 5,600 vertical feet per day.
Source: National Recreation and Park Association Bulletin #36, p. 8-11.

1 acre of ski slope for each 30 skiers. Parking of one acre for each 10 acres of ski slope to accommodate 75 autos.
Source: California Public Outdoor Recreation Plan, Part II, p. 84.

### Site Requirements

Southeast to Northwest orientation of slope
Annual snowfall of 60 inches or more, or capacity for making an equivalent in artificial snow.
Slopes greater than 15%.
Adequate vertical drop.
At least over 200 feet run.
Adequate vegetation with density sufficient to cut winds and allow for snow accumulation.

### Service and Accessibility Requirements

General maintenance and routine service
Hard top or well maintained gravel roads

Improvements

| Minimum Facilities | #1 | #2 |
|---|---|---|
| parking for car | designated runs | chair lift |
| place to put on skis | rope tows | chalet |
| | shelters | flush toilets |
| | toilet | ski rentals |
| | water supply | locker room |
| | | ski lessons |
| | | ski patrol |
| | | snack bar |
| | | electricity |
| | | telephone |

Conflicting Activities

Snow mobiling
Cross-country skiing
Hiking
Hunting

## 2.7. ICE SKATING (Figure IV.15)

General Space Requirements

30 sq. ft. per skater is accepted by experts as desirable for determining capacity. Source: National Recreation and Park Association, Bulletin No. 38, p. 17.

Site Requirements

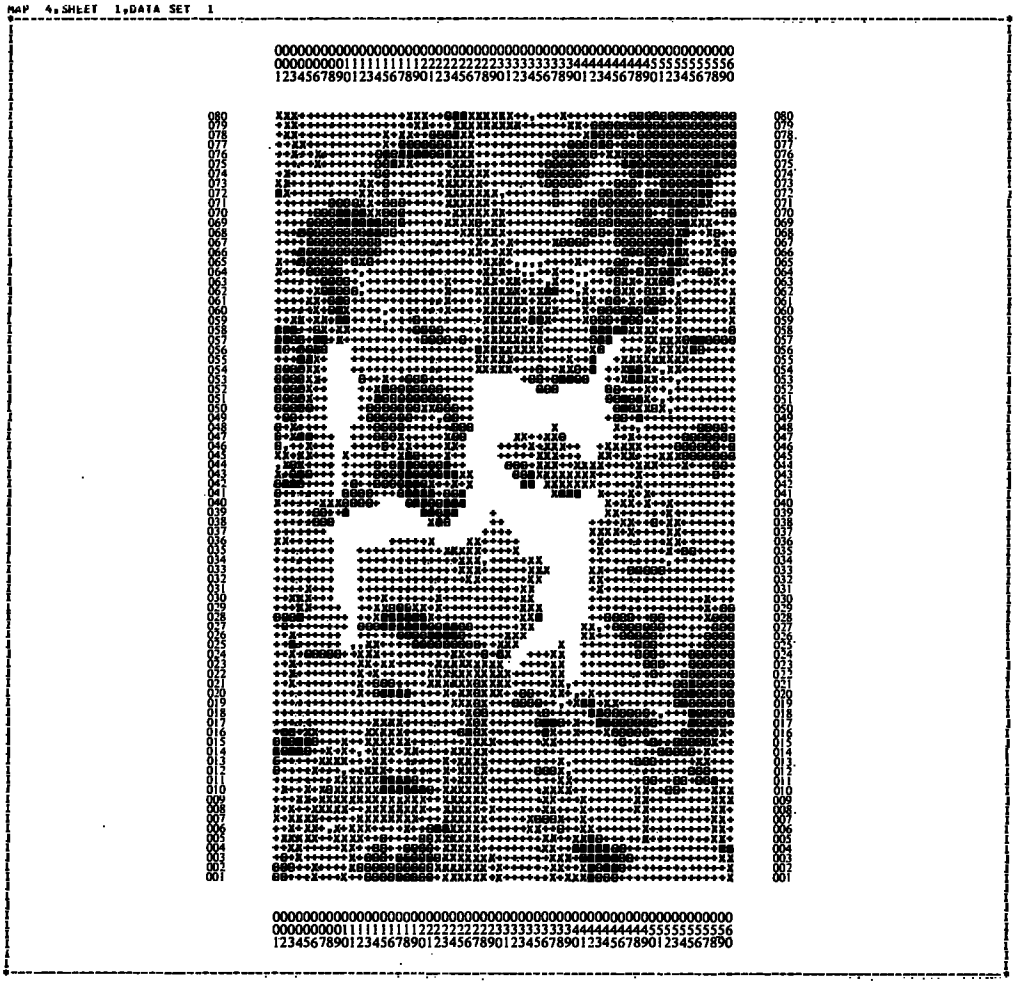
Lakes

No specific requirements for skating, except that the area designated must freeze smooth, be in an area where the snow does not drift, and the ice must be over 3" thick. Parking, 1 car per 3 skaters, near activity area, good access.

Rink

Flat, open land, protection from wind

MAP 4, SHEET 1, DATA SET 1



ATTRACTIVENESS FOR DOWNHILL SKIING

HONEY HILL CASE STUDY

U.S. ARMY CORPS OF ENGINEERS

LIMITING FACTORS
RESERVOIR
LAKES
MAJOR RIVERS

| VARIABLE | WEIGHT | VARIABLE | WEIGHT |
|---|---|---|---|
| TOPOGRAPHIC ORIENTATION | 1 | FOREST DENSITY | 1 |
| TOPOGRAPHIC SLOPE | 1 | FOREST HEIGHT | 1 |
| BEDROCK DEPTH | 1 | | |

DATA MAPPED IN 10 LEVELS BETWEEN EXTREME VALUES OF 0.0 AND 100.00

ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| MINIMUM | 0.00 | 10.00 | 20.00 | 30.00 | 40.00 | 50.00 | 60.00 | 70.00 | 80.00 | 90.00 |
| MAXIMUM | 10.00 | 20.00 | 30.00 | 40.00 | 50.00 | 60.00 | 70.00 | 80.00 | 90.00 | 100.00 |

PERCENTAGE OF TOTAL ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 |

FREQUENCY DISTRIBUTION OF DATA POINT VALUES IN EACH LEVEL

| LEVELS | LOW VALUES 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | HIGH VALUES 11 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SYMBOLS | | | | | | | | | | | | |
| FREQUENCY | 0 | 0 | 44 | 0 | 2440 | 848 | 0 | 833 | 0 | 236 | 4 | 0 |

Fig. IV.14
Attractiveness for Downhill Skiing

Service and Accessibility Requirements

Snow removal
Flooding and repair to rink
Must be accessible from paved road
Parking required

Improvements

| Minimum Facilities | #1 | #2 | #3 |
|---|---|---|---|
| parking | shelter | warming house | lighting |
| place to put on skates | | protection from wind | hockey rink |
| | | toilets | food/beverage |

Conflicting Activities

Snow mobiling
Trail activities
Hunting

1.8 and 2.8. RESIDENTIAL (Figure IV.16)

a) 1.8.1 and 2.8.1. RESIDENTIAL, WATER VIEW

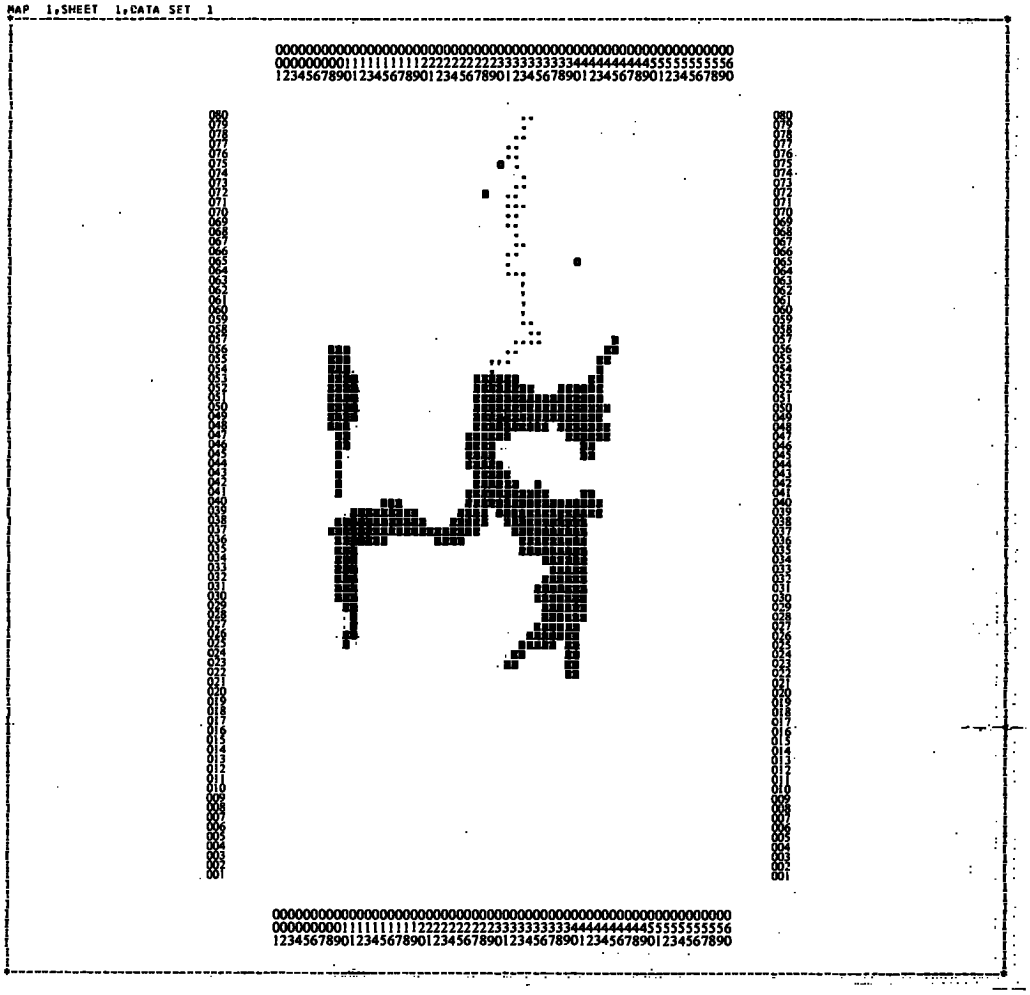
General Space Standards

One acre/unit

Site Requirements

Vegetation--prefer deciduous
Greater than 10' to bedrock
Kame terraces
Southwest to Southeast Orientation
Less than 8% slope
Sand soil or gravel soil
View of water bodies
Good access
Utilities
Good soils for septic tank operation
Ground water available

MAP 1,SHEET 1,DATA SET 1



ATTRACTIVENESS FOR ICE SKATING

HONEY HILL CASE STUDY

U.S. ARMY CORPS OF ENGINEERS

| VARIABLE | WEIGHT | VARIABLE | WEIGHT |
|---|---|---|---|
| WATER TYPE | 1.0 | ROAD ACCESS | 0.5 |

DATA MAPPED IN 10 LEVELS BETWEEN EXTREME VALUES OF 2.00 AND 14.00

ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| MINIMUM | 2.00 | 3.20 | 4.40 | 5.60 | 6.80 | 8.00 | 9.20 | 10.40 | 11.60 | 12.80 |
| MAXIMUM | 3.20 | 4.40 | 5.60 | 6.80 | 8.00 | 9.20 | 10.40 | 11.60 | 12.80 | 14.00 |

PERCENTAGE OF TOTAL ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 |

FREQUENCY DISTRIBUTION OF DATA POINT VALUES IN EACH LEVEL

| LEVELS | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|---|
| SYMBOLS | ..... | ..... | ..... | +++++ | XXXXX | 00000 | 00000 | ..... | ..... | ..... |
| FREQUENCY | 42 | 7 | 0 | 0 | 0 | 0 | 0 | 2 | 9 | 417 |

Fig. IV.15
Attractiveness for Ice Skating

Service and Accessibility Requirements

Adequate road access year-round
Must have water and other utilities

Conflicting Activities

Most activities engaged in by people other than those owning or renting the structure.

b) 1.8.2 and 2.8.2. RESIDENTIAL, WOOD VIEW

General Space Standards

One acre/unit

Site Requirements

Vegetation--prefer coniferous
Southeast to southwest orientation
Greater than 10' to bedrock
Kame terraces, sand or gravel soil
Less than 8% slope
Greater than 5' to water table
Utilities
Access
Good soils for septic tank operation
Available ground water

Service and Accessibility Requirements

Adequate road access--generally for summer, but emergency access is needed for year-round.
Must have water and other utilities.

Conflicting Activities

Most activities

c) 1.8.3 and 2.8.3. RESIDENTIAL, FARMSTEAD

General Space Standards

Five acres/unit

Site Requirements

Mixture of open fields and trees
Less than 8% slope
View of water
Southeast to southwest orientation
Access
Utilities
Good soil for septic tank operation

Service and Accessibility Requirements

Adequate road access--year-round
Utilities
Water Supply

Conflicting Activities

Most activities

d) 1.8.4 and 2.8.4. RESIDENTIAL, CONDIMINIUM

General Space Standards

Approximately 1/4 acre/unit

Site Requirements

Vegetation--deciduous
Greater than 10' to bedrock
Kame terrace--sand-gravel
Southeast to southwest orientation
Proximity to water
View of water
Good soils for septic tank operation
Greater than 5' to water table

Service and Accessibility Requirements

Adequate road access, year-round
Utilities
Water supply
Service will include maintenance, garbage and trash pick-up, etc.

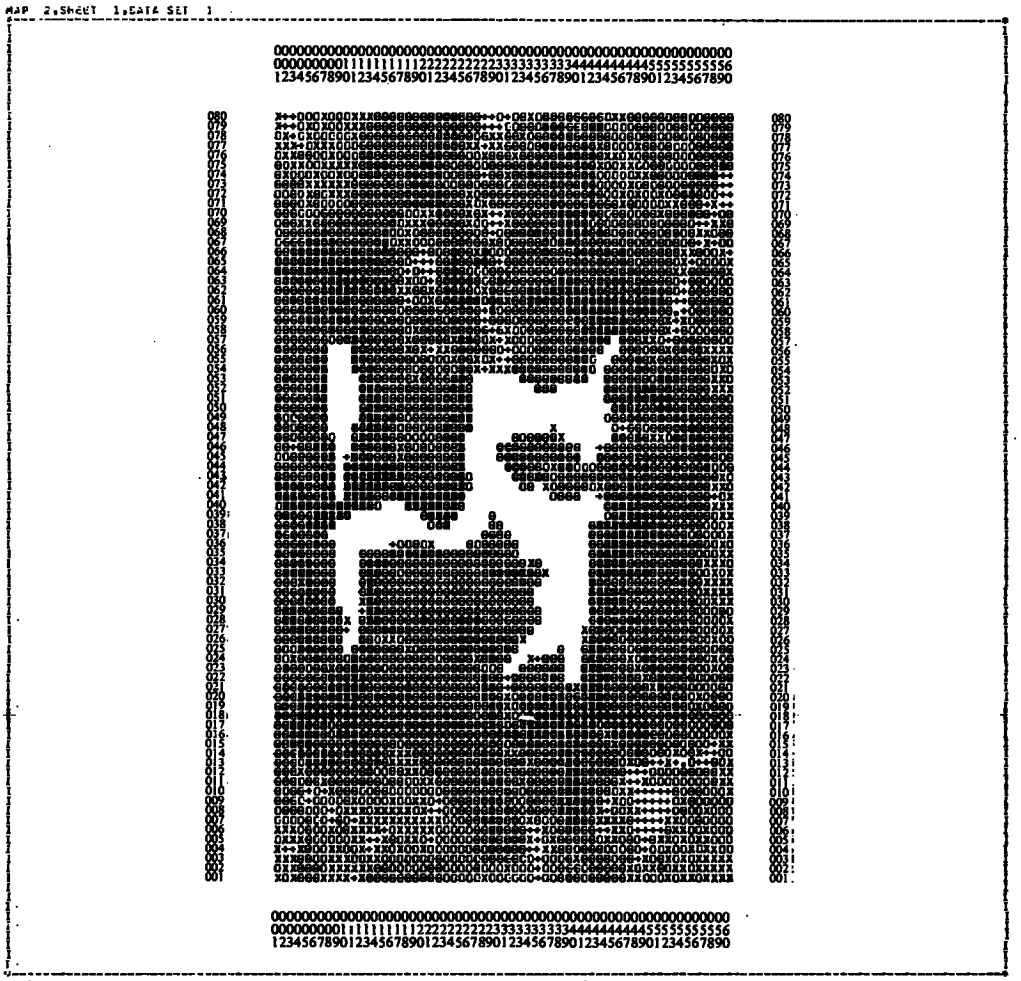



Fig. IV.16
Attractiveness for Residential

Conflicting Activities

Most activities

1.9 and 2.9. PARKING (Figure IV.17)

General Space Standards

75 cars/acre = 188 cars/cell

Site Requirements

Level slope, or grading into levels
Less than 4% slope
Sand or gravel soil
Not shallow water table
No forest

Service and Accessibility Requirements

Required road access
Snow removal (if year-round facility)
Annual maintenance

Conflicting Activities

Most activities

Improvements

| Minimum Facilities | #1 | #2 |
|---|---|---|
| off-road parking spaces for 4-5 cars (no control) | gravel for drainage gravel base | black-top surface organized spaces |

1.10 and 2.10. MAJOR ROADS (Figure IV.18)

Site Requirements

The site has been evaluated for three major aspects related to the costs of the location for a primary state highway;

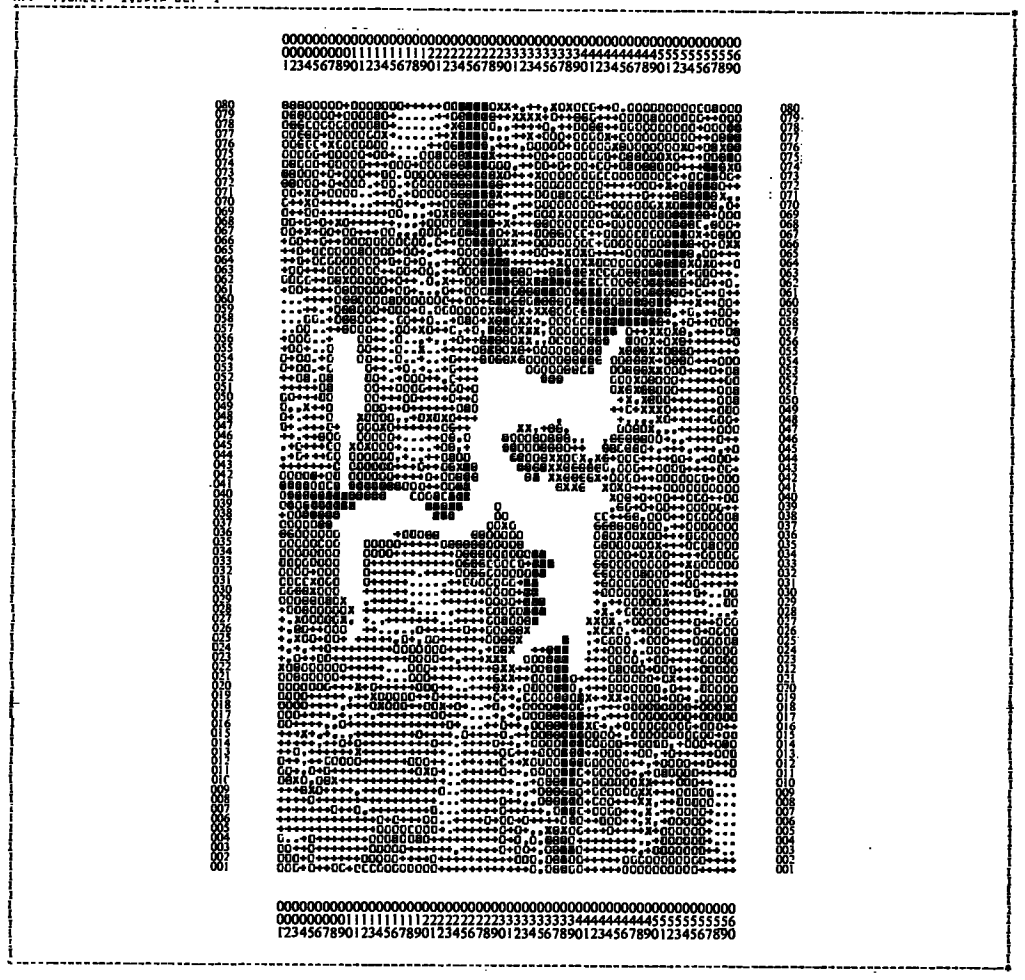



Fig. IV.17
Attractiveness for Parking

design, construction and maintenance. Slope is the first data category entered. 0-4% is noted due to its minimum requirement for cut and fill, and its greatest flexibility to horizontal alignment. The second slope factor is 4-8%, which is still a workable gradient and represents no threat to vertical alignment. 8-10% represents the upper slope limit for a standard primary state highway facility. It is usually at 10% that major cut and fill operations begin to take place when the road is running perpendicular to the gradient. 10-12% is entered because if the road hits this topography at a diagonal, it is still a manageable slope although it would begin to represent a limit to the economical construction of the road. Another aspect related to a 12% limit would be the exposed areas flanking either side of the road due to the cut and fill gradients necessary to maintain the road bed. During the construction of a road, these areas tend to develop excessive sheet erosion which causes puddling in swales and silting in minor streams.

The second data category entered is Soil Type. Coarse sands and coarse gravels are generally acceptable for most road construction as sub-base and back-fill. They are generally well drained soils. Fresh soil is another acceptable category since normal base preparations could be made to maintain good internal drainage beneath the pavement.

The third data category is Depth to Bedrock. The preferred component is an over-burden which is greater than 10 feet to bedrock, for greater depth adds greater flexibility to normal cut operations without requiring any blasting or ripping of bedrock structure. 3-10' in depth to bedrock would still be acceptable due to the initial minimum gradients accepted under the slope categories. If higher slope categories are allowed, one must obviously begin to accept the possibility of encountering bedrock along that particular alignment.

The fourth data category is Subsurface Water. >5' to water table would be sought. The deeper the water table, the less fill will be needed and the less likely is the occurrence of standing water either in cut areas, side ditches or swales. The interception of major ground water movements, which would result in springs or weeping along areas of cut, would also be lessened. Those areas with shallower depth to subsurface water would intercept the ground water, drain it off into culverts, and reduce the ground water supply on the other side of the road. The road and its drainage ditches would act as an interceptor pipe.

The fifth data category is Water Type. Natural drainage swales are entered because a fill operation might impound

the water behind the road, thus directly affecting surface runoff in quantity and direction. This would also negatively effect the vegetation and wildlife in the area. Small streams are entered because, while they can be easily spanned by normal culvert installations, construction precautions should be taken to prevent any siltation or erosion at these crossing points. Minor or major rivers are entered because costly major structures are needed to cross these features.

The sixth data category is Orientation of Slope. Generally, flat areas have the least cost in the design, construction and maintenance of a highway facility. The next preferred area would be slopes of a southeast orientation in order to minimize the amount of frost action due to the minimal time of exposure of the sun in winter. Excessive freeze-thaw action on warmer slopes during winter causes a break-up and slumping of cut and filled areas in the road and also creates problems of melt water during the day and freezing in the evening, thus creating safety and ice maintenance problems.

The seventh data category is Forest Density. Total absence of cover would of course have the least cost of clearing and grubbing of trees. 0-30% and 31-50% are the next categories entered. As one exceeds 50% of the area covered in trees, there are more costs for the clearing and grubbing of vegetation and there will be more severe secondary impacts on erosion, etc.

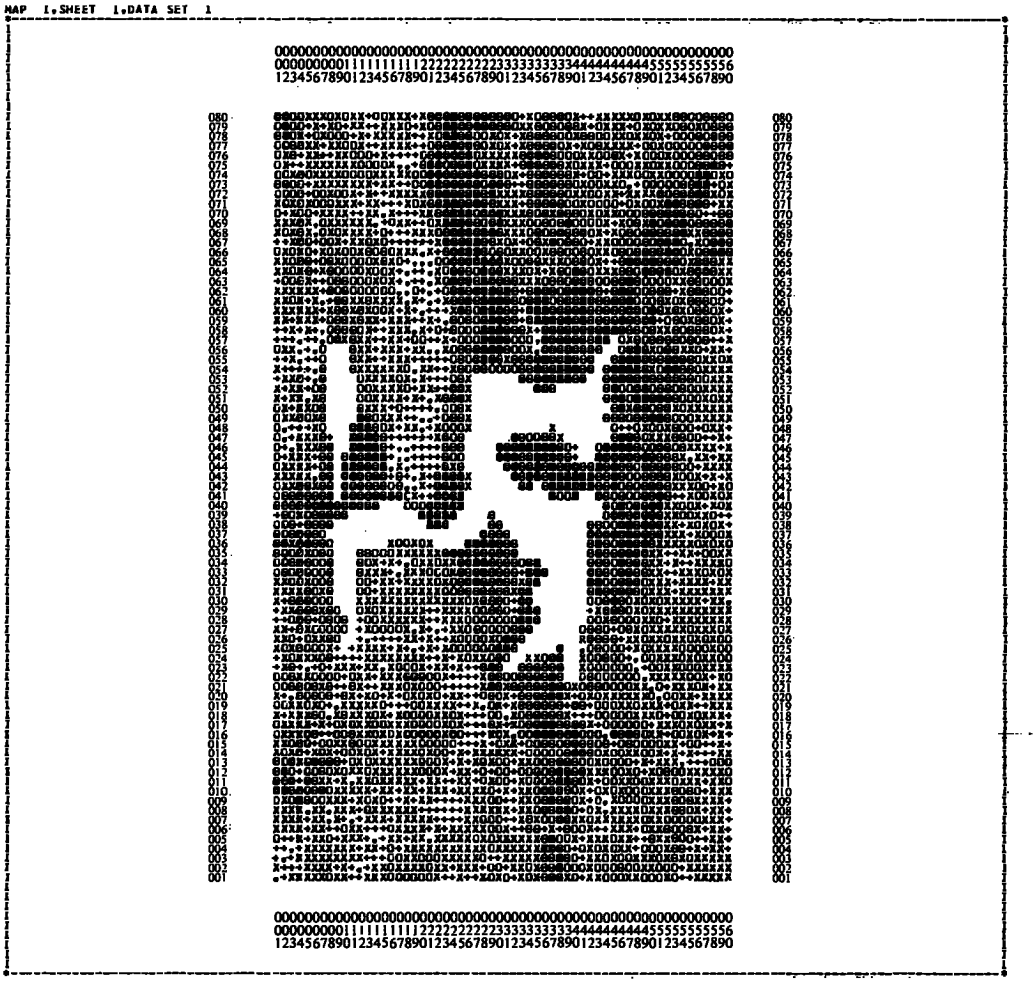
The eighth data category is Surface Land Form. Kame terraces would serve as excellent areas to traverse due to their good internal drainage. They are also good areas for borrow. The outwash and till areas, although not as good as the kame terraces are still acceptable due to their limited soil moisture.

The ninth data category is Forest Type. No vegetation is obviously an asset to the economy of the road. The acceptance of deciduous material is based on the fact that it does allow penetration of sunlight during the winter periods for snow melt and consequently requires less snow or winter maintenance on the road. Deciduous material as opposed to coniferous also does not act as a barrier throwing snow into drifts. Consequently, there is less opportunity for snow to drop into right-of-way cuts.

The tenth data category is Forest Height. Again no forest cover is preferred, but if one is to begin to accept plant material in the right of way, then the younger (shorter) the plant material, the better. These are normally smaller in caliber and are more easily removed, either by chain

grubbing or mechanical chipping, as opposed to required sawing and removal of logs by truck with larger species. Remaining young material can also recover much more quickly from clearing and grubbing from mechanical equipment operating around their base and from changes in water table. Young stands also have a tendency not to contain any dead or large species that can fall either across or onto the roadway, thus causing potential traffic hazards.

MAP 1, SHEET 1, DATA SET 1



ATTRACTIVENESS FOR HIGHWAY - LEAST CLST CORRIDORS

HUNEY HILL CASE STUDY

U.S. ARMY CORPS OF ENGINEERS

LIMITING FACTORS
RESERVOIR
MAJOR RIVERS
LAKES

| VARIABLE | WEIGHT | VARIABLE | WEIGHT |
|---|---|---|---|
| TOPOGRAPHIC SLOPE | 2 | WATER (SUB-SURFACE) | 1 |
| BEDROCK DEPTH | 2 | FOREST DENSITY | 1 |
| SOIL MOISTURE | 1 | LANDFORM | 1 |
| TOPOGRAPHIC ORIENTATION | 1 | FOREST TYPE | 1 |
| SOIL TYPE | 2 | FOREST HEIGHT | 1 |
| SURFACE WATER | 1 | | |

DATA MAPPED IN 10 LEVELS BETWEEN EXTREME VALUES OF 0.0 AND 100.00

ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| MINIMUM | 0.0 | 10.00 | 20.00 | 30.00 | 40.00 | 50.00 | 60.00 | 70.00 | 80.00 | 90.00 |
| MAXIMUM | 10.00 | 20.00 | 30.00 | 40.00 | 50.00 | 60.00 | 70.00 | 80.00 | 90.00 | 100.00 |

PERCENTAGE OF TOTAL ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 |

FREQUENCY DISTRIBUTION OF DATA POINT VALUES IN EACH LEVEL

| LEVELS | LOW VALUES 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | HIGH VALUES 11 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SYMBOLS | | | | | | | | | | | | |
| FREQUENCY | 9 | 0 | 5 | 90 | 571 | 1388 | 1009 | 656 | 471 | 151 | 34 | 0 |

Fig. IV.18
Attractiveness for Highway

## CHAPTER V: SITE RESOURCE SYSTEMS: "VULNERABILITY"

### A. SITE RESOURCE SYSTEMS

Honey Hill is a complex site. It would be futile for this research team, in a brief time, to attempt to adequately model all the various interrelated site resource systems which exist in the area. This is not our purpose. Rather, our purpose is to be able to comparatively evaluate the most significant impacts of any proposed plan on the site. In order to do this, we find it useful to conceptualize this complex and interlocking set of systems as a series of separable site resource systems, each of which can be separately identified, defined in terms of its vulnerability, and evaluated in terms of the impact that each of our potential activities would place upon it. Eleven site resource evaluation models have been prepared for this study. Each is evaluated separately. The eleven include:

1. Surface Water
2. Surficial Aquifer
3. Shoreline
4. Soils
5. Vegetation
6. Wildlife
7. Insects
8. Potential Scientific Resources
9. Visual Impact
10. Dry Beach
11. Wet Beach

### 1. SURFACE WATER - VULNERABILITY TO POLLUTION AND STREAM DEGRADATION

The importance of high water quality in relationship to a proposed reservoir multi-purpose recreation activity is certainly obvious. It is the purpose of the surface water impact model to try and identify those areas which are highly susceptible to the rapid deterioration of that quality. If the water quality of the major recreation pool and its influent stream systems are seriously jeapordized by the improper location of various land use activities, a major portion of the recreational assets would be threatened. The repercussions of water pollution would be felt not only interior to the site boundaries but also to downstream users as well.

## 2. SURFICIAL AQUIFER - VULNERABILITY TO POLLUTION

Most of the domestic water supply in the Honey Hill area is obtained from surface water or surficial sand and gravel deposits found along larger stream corridors or in broad valley bottoms. The water supply for the development of the site will undoubtedly come from one of the two areas. Consequently, the protection of the surficial aquifer should be of high priority in the location of land uses.

## 3. SHORELINE - VULNERABILITY TO TURBIDITY AND SHORELINE EROSION

This model extends a little further some of the concerns for surface water quality. The shoreline of the recreational pool will have many diverse activities taking place in it. The shoreline is a transitional zone between the free water surface area and the land itself and it consequently becomes the habitat of many diverse species of fish and wildlife. This zone is used for food, shelter, and breeding of many of these species, and any activity which would continually disrupt this zone would certainly reduce this resource potential. Extended periods of turbidity and the creation of muddy bottoms would negatively influence the quality of fish in the reservoir, swimming, and the general visual attractiveness of the area. Because of existing site conditions, the proposed reservoir will have a very diverse shoreline, ranging from silt or mud bottoms to various rocky situations. It is the purpose of this model to try and maintain that diversity as opposed to the long term creation of a homogenous edge of silt.

## 4. SOILS - VULNERABILITY TO EROSION

The purpose of this model is to identify those areas on the site which would be most susceptible to erosional processes. Erosion, aside from being unsightly, is also important for its impact on surface water quality. Extensive gullying and sheet erosion along stream borders can greatly affect existing stream quality and natural characteristics. The stream can silt up which will reduce its carrying capacity, thus causing flooding in areas heretofore not flooded at spring peak flows. It is also important to keep at a minimum the sediment yield entering the reservoir by way of the influent stream systems, in order not to aggravate the normal projected quantities of sediment reaching the reservoir during periods of extensive runoff and flooding.

## 5. VEGETATION - VULNERABILITY TO FOREST FIRES

Due to the type of recreation activities programmed for the site, it was felt that a model of this type would be useful in order to reduce as much as possible the probability of forest fires, with their consequent negative visual quality, short-term damage to wildlife habitat, and generally negative site attractiveness.

## 6. WILDLIFE - VULNERABILITY OF HABITAT

The presence and maintenance of wildlife in the site has two significant recreation values. The first is for the sport of hunting, and the second, though less active, is for game and bird observation. It is obvious that in order to maintain both of these activities, proposals should provide for the expectation of a rich diversity of fauna.

## 7. INSECTS - VULNERABILITY OF HABITAT

This model has a close relationship to the wildlife model for it attempts to locate those areas where there would be an abundance of insects for wildlife food. Conversely, it would also be useful in allocating those activities where insects would be considered a high nuisance factor, such as for swimming, camping and picnicking.

## 8. POTENTIAL SCIENTIFIC RESOURCES - VULNERABILITY

It is the intent of this model to identify those areas on the site which would be of significant interest from the standpoint of vegetation and water, and their related flora and fauna uniqueness. These areas could be set aside for limited use only, or they might serve as field laboratories for schools and conservation groups.

## 9. VISUAL IMPACT - AREAS VULNERABLE TO VISUAL CHANGE

This model locates those areas on the site where activity or construction would cause the greatest amount of visual change to the site. The subjective values of visually "good" or "bad" which can be associated with this model will have to be weighed for the purpose and type of activity proposed for these areas.

10. DRY BEACH - VULNERABILITY TO WATER FLUCTUATION DAMAGE

11. WET BEACH - VULNERABILITY TO WATER FLUCTUATION DAMAGE

These last two models represent the impact of the operation of the reservoir on some of the natural site conditions in the zone affected by water fluctuation. It effects the types of activities which are proposed for this area and which utilize this zone as primary site resources.

## B. THE MODEL

The site resource models have the following general framework:

First, the site resource system is described in terms of those key variables which identify areas of sufficiently different character. These site types, or combinations of variables, describe areas of different vulnerability to potential damage by activities. The definitions of site type are specific to the landscape being analyzed and the type of potential damage to the site resource system.

The second stage in the model is the grouping of all potential activities according to the severity with which they may cause change, or impact, on the site resource system.

The third stage in the model is the evaluation of the impact of each activity grouping on each site type. Four levels of impact are identified:

1. Compatible - having no short term or long term effect on the resource;

2. Moderate - causing some but not serious change in the resource;

3. Severe - serious modification of resource; and

4. Threshhold - modification to the extent that recovery via natural processes is not feasible.

Following this brief description of the general site resource model, it seems appropriate to explain the construction and use of one model in order that the reader have as full an understanding of their use as possible.

The first site resource system model is Surface Water. There could, obviously, be many sub-impact analyses, but for our purposes, in this study we concluded that pollution or other physical degradation of the surface water regime was of prime importance in relation to the activities planned for the site. In the construction of this model, as with all others, it is first necessary to determine what are the major functional and structural components of the resource system in this landscape. The variables selected to define site types for vulnerability to pollution and degradation to surface water, are: topographic slope, soil type, and water type. In the data bank, these three variables combine to a total of 27 site types.

It also should be clear that the variables selected to describe the resource system only represent that system in relationship to the type of impact being modelled. For example, for surface water, sub-impact--water quantity--the variables used might be: (1) limits to % area of watershed developed; (2) % of vegetation to guarantee infiltration and quality; (3) % of swales, swamps, wetlands and flood plains preserved to maintain seasonal flow augmentation.

Surface water type describes the structure of the surface water pattern. This pattern consists of swales, wetlands, small streams, 1st order streams, ponds, reservoirs, lakes, minor rivers and major rivers. They are in the data bank as follows:

10. SURFACE WATER - PREDOMINANT TYPE (Figure III.18)
    0 = None
    1 = Swales
    2 = Wetlands
    3 = Small Streams
    4 = 1st Order Streams
    5 = Ponds
    6 = Reservoirs
    7 = Lakes
    8 = Minor Rivers
    9 = Major Rivers

Soil Type is composed of the following sub-variables:

6. SOIL TYPE (Figure III.14)
    1 = Gravel - Coarse
    2 = Gravel - Fine
    3 = Sand - Coarse

4 = Sand - Fine
5 = Silts and Clays liq $<50$
6 = Silts and Clays liq $>50$
7 = Peat

Since the soil classification is associated with the United Soils Classification System, information related to their physical properties, e.g., bearing capacity, erodibility, plasticity, and engineering properties, can be interpreted from the identification. The subvariables under Topographic Slope have been primarily constructed in relationship to various construction standards in land use activities. They are in the data bank as follows:

3&4. TOPOGRAPHIC SLOPE (Figure III.12)
0 = No Slope
1 = 0-4%
2 = 4-8%
4 = 8-10%
5 = 10-12%
6 = 12-15%
7 = 15-25%
8 = 25-35%
9 = 35+%

The relationship and function of each of these variables in this landscape must of course be understood in order to give order and priority to each in relationship to the resource system model. The major variables (topographic slope, soil type, water type) have been entered in an order which relates their importance to the identification of the vulnerability evaluation. The subvariables are entered similarly, thus constituting degrees of vulnerability. An example related to the first model would be:

SLOPE - an area of low gradient, 0-8%, would constitute low stream velocity and pockets of sluggish water. There would also be little if any mechanical re-aration, causing possible shortages in dissolved oxygen. Such characteristics would allow pollutants to remain for relatively longer period of time. There is also more opportunity for sedimentation to take place and silt up with less opportunity for scour and transport at seasonal high water periods. Greater slopes lessen the vulnerability to these problems.

SOILS - silts, clay, and peaty soils will contribute heavily to bed load, turbidity and detritus with relation to water quality. These can cause a reduction of the light penetration which is necessary for photosynthesis and, which, if

sustained for a relatively long period of time, can cause significant damage to water flora and species of fish.

Already from the combination of these two major variables, we can see a delicate area developing with regard to surface water. The next and last variable to be entered, Surface Water Type, will give us some indication of the degree of impact on the total surface water pattern. The most vulnerable subvariables entered are those which generally constitute the head-waters in this landscape. Consequently, any activity which causes pollution or other ill effects will be felt throughout the entire water system in various degrees. These subvariables are: swales, wetlands, first order streams and ponds.

The variables are then combined into site types and ranked according to their vulnerability. The degrees of vulnerability are displayed in matrices. The matrix on the left builds X,Y,Z factors from the first two major variables. They are ordered X (most vulnerable) to Z (least vulnerable). Matrix I and Matrix II are constructed by the X,Y,Z factors on the y axis and the entry of the third major subvariable on the x axis. As an example of this ranking, a first order stream in silts, clays, or peat areas with a low gradient will suffer more damage for a relatively longer period of time due to an activity operating on it, than will a small river in the study area having a 15% gradient with coarse gravelly soils associated with it. The former is therefore more vulnerable.

The next area of concern is the determination of the extent of impact by an activity on the site types which have been ordered on the basis of vulnerability in the matrices. In order to arrive at a value for the degree of impact, we must first determine whether an activity or use would create an impact; for example, fishing areas would have little or no impact on water degradation. If the activities do create a potential impact, a value which represents its type and intensity of contact with the resource system must be entered into the matrices for each site type. For convenience, activities are grouped by their potential impacts.

For example,

RELATIVE IMPACT OF LAND USES

Key: 0: none
I: see Matrix I
II: see Matrix II

| | | |
|---|---|---|
| Summer Camping | 0 - | Little or no interaction with surface water system |
| Beaches | I - | Construction of beaches, limited pollution via swimming activity |
| Marinas | II- | Construction of marinas, petroleum pollution via boat ramps, spillage and maintenance. |

Etc.

Having set relative impact groupings on the activities, we now return to the appropriate matrix with only one last judgment to make; e.g., the degree to which the activity will effect the resource system. This determination has four ranges of impact: 1. Compatible - having no short or long term effect on the resource (e.g., white water canoeing on the river); 2. Moderate - causing some but not serious change on the resource (e.g., jeep trail crossing small stream); 3. Severe - serious modification of resource (e.g., stream bed filled for crossing of secondary road); 4. Threshold - boundary of the system where recovery via natural process is not feasible (e.g., filling of wetland for parking area). The matrices are then completed with the previously described values.

The matrix values are then coded for computer storage, providing the relative vulnerability of each site resource system for each cell, to the potential impact of each activity. The vulnerability of each cell is mapped showing the severest impact caused by the activity group with the lowest potential impact.

RESOURCE SYSTEM 1: Surface Water

IMPACT: Vulnerability to Pollution (Degradation) of Surface Water System (Figure V.1)

SITE TYPE VARIABLES: The variables are listed in the order by which they contribute to the definition of site types for the analysis of this resource system. The Variable Ranges are described from the most vulnerable to the least vulnerable.

| REF. | VARIABLE | REF. | RANGE | |
|---|---|---|---|---|
| 3&4 | Topographic Slope | 0,1, 2 | 0-8% | Low velocity; sluggish water; deposition of suspended land; little mechanical re-airation. |
| | | 4,5,6 | 8-15% | |
| | | 7,8,9 | 15-35% | Increased ability to move and carry suspended load; little deposition thus less eutrophication; more mechanical airation. |
| 6 | Soil Type | 2,5,6 | Silt, clays, fine gravel | Soil types contributing heavily to turbidity due to fine particle size causing reduction of light, penetration necessary for photosynthesis; easily eroded; tend to stay in suspension longer than coarse particles, settle out in quiet waters. |
| | | 3,4 | Sands | |
| | | 0,1 | Coarse gravel | Large particle size, not easily dislocated; drops readily from stream load; does not contribute to turbidity. |
| 10 | Water Type | 1,2,4, 5 | Swales wetlands 1st order streams, ponds | Generally constitute head waters of stream systems; in ponds and wetlands flow of water is sluggish; wetlands significant in maintaining seasonal flow. |

RESOURCE SYSTEM 1: Surface Water (Cont'd)

| REF. | VARIABLE | REF. | RANGE | |
|---|---|---|---|---|
| | | 3,6,8 | Small streams, minor rivers, reservoirs | |
| | | 7,9,0 | Lakes, major rivers, none | Lakes - able to accept more deposition due to large volume of water; major rivers - self-cleansing capacity able to accept limited amounts of degradable pollutants with ill effect. |

## RELATIVE IMPACT OF LAND USE

Key: 0: none
I: see Matrix I
II: see Matrix II

### 1. SUMMER PLAN

| | | |
|---|---|---|
| 1.1. | Hunting | 0 |
| 1.2. | Fishing | 0 |
| 1.3. | Swimming | I |
| 1.4. | Trail/Hiking | 0 |
| 1.5. | Camping | 0 |
| 1.6. | Picnicking | 0 |
| 1.7. | Boating | II |
| 1.7. | Marina | II |
| 1.8. | Residential 12u/a | II |
| 1.8. | Residential 2u/a | II |
| 1.9. | Parking | I |
| 1.10. | Major Roads | II |
| 1.11. | Secondary Roads | I |
| 1.12. | Agriculture | I |

### 2. WINTER PLAN

| | | |
|---|---|---|
| 2.1. | Hunting | 0 |
| 2.2. | Snowshoeing | 0 |
| 2.3. | X-Country Ski | 0 |
| 2.4. | Trail/Hiking | 0 |
| 2.5. | Snow Mobiling | 0 |
| 2.6. | Downhill Ski | I |
| 2.7. | Ice Skating | 0 |
| 2.8. | Residential 12u/a | II |
| 2.8. | Residential 2u/a | II |
| 2.9. | Parking | I |
| 2.10. | Major Roads | II |
| 2.11. | Secondary Roads | I |

## IMPACT ON RESOURCE SYSTEM BY SITE TYPE

Key: 4: Threshold
3: Severe
2: Moderate
1: Compatible

| SOIL TYPE | TOPOGRAPHIC SLOPE 0,1,2 | 4,5,6 | 7,8,9 |
|---|---|---|---|
| 2,5,6 | X | X | Y |
| 3,4 | X | Y | Z |
| 1 | Y | Z | Z |

| | WATER TYPE 1,2,4,5 | 3,6,8 | 7,9,0 |
|---|---|---|---|
| X | 3 | 3 | 2 |
| Y | 3 | 3 | 1 |
| Z | 2 | 2 | 1 |

Matrix I

| | WATER TYPE 1,2,4,7 | 3,6,8 | 7,9,0 |
|---|---|---|---|
| X | 4 | 3 | 3 |
| Y | 3 | 3 | 2 |
| Z | 3 | 2 | 2 |

Matrix II

X: Most Vulnerable
Y:
Z: Least Vulnerable

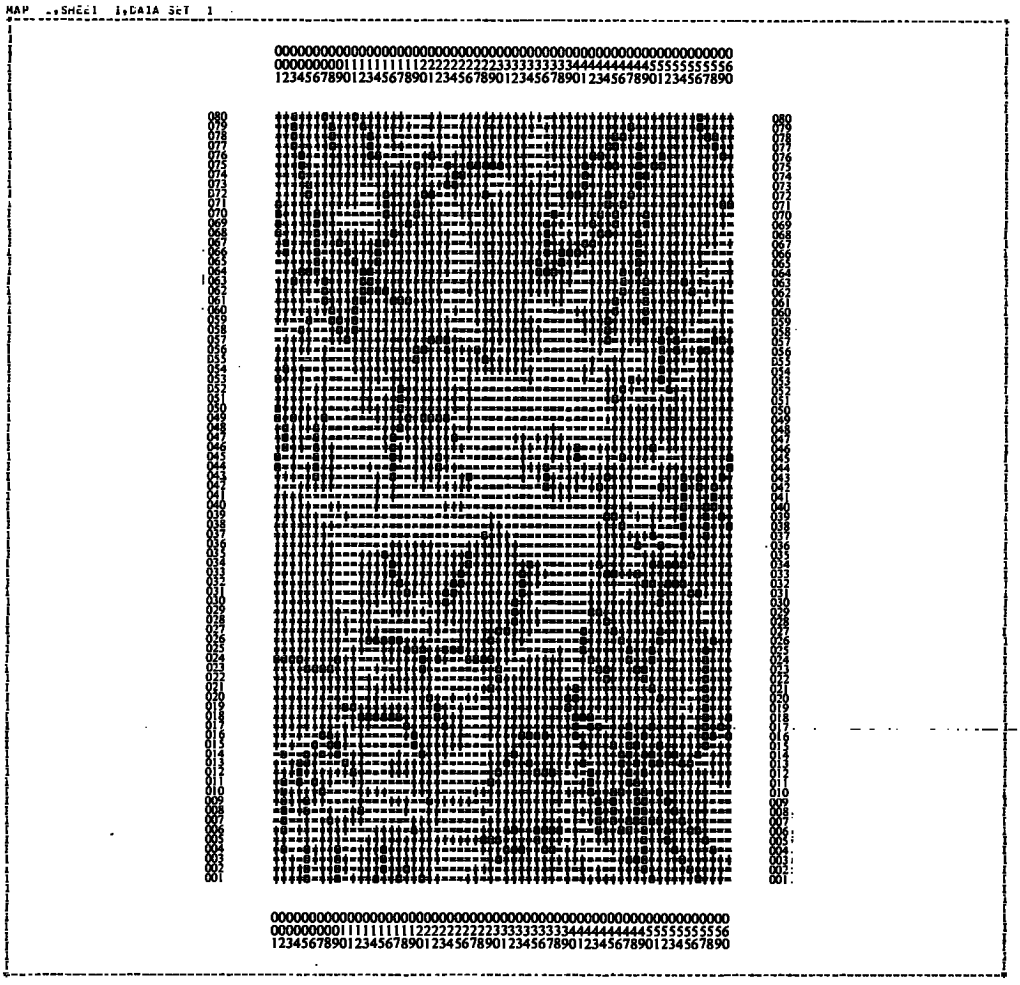



Fig. V.1
Vulnerability to Pollution (Degradation) - Surface Water

RESOURCE SYSTEM 2: Surficial Aquifer

IMPACT: Vulnerability to Pollution (Figure V.2)

SITE TYPE VARIABLE: The variables are listed in the order by which they contribute to the definition of site types for the analysis of this resource system. The Variable Ranges are described from the most vulnerable to the least vulnerable.

| REF. | VARIABLE | REF. | RANGE | |
|---|---|---|---|---|
| 3&4 | Topographic Slope | 0-2 | 0-8% | Ponding of water--longer time for infiltration of pollutants. |
| | | 4-6 | 8-15% | |
| | | 7-9 | 15-35+% | Rapid runoff because of rugged topography. |
| 5 | Land Form | 1,6 | Flood plain | Surface exposed, susceptible to pollution from development in the event of catastrophic flood; susceptibility to pollution from river infiltration. |
| | | 1-3 | Outwash Fill | |
| | | 4,5, 7,9 | Kame, rock | Low infiltration, high runoff. |
| 9 | Depth to Sub-Surface Water | 0,7,9 | <5' to water-table | High water table; more susceptible to surface pollution, less distance for filtration. |
| | | | >5' to water-table on pan | |
| | | 5 | >5' to water table | |
| | | 1 | None | No contact with ground water. |

## RELATIVE IMPACT OF LAND USE

Key: 0: none
I: see Matrix I
II: see Matrix II

### 1. SUMMER PLAN

| | | |
|---|---|---|
| 1.1. | Hunting | 0 |
| 1.2. | Fishing | 0 |
| 1.3. | Swimming | I |
| 1.4. | Trail/Hiking | 0 |
| 1.5. | Camping | I |
| 1.6. | Picnicking | 0 |
| 1.7. | Boating | 0 |
| 1.7. | Marina | I |
| 1.8. | Residential 12u/a | II |
| 1.8. | Residential 2u/a | II |
| 1.9. | Parking | I |
| 1.10. | Major Roads | I |
| 1.11. | Secondary Roads | 0 |
| 1.12. | Agriculture | II |

### 2. WINTER PLAN

| | | |
|---|---|---|
| 2.1. | Hunting | 0 |
| 2.2. | Snowshoeing | 0 |
| 2.3. | X-Country Ski | 0 |
| 2.4. | Trail/Hiking | 0 |
| 2.5. | Snow Mobiling | 0 |
| 2.6. | Downhill Ski | 0 |
| 2.7. | Ice Skating | 0 |
| 2.8. | Residential 12u/a | II |
| 2.8. | Residential 2u/a | II |
| 2.9. | Parking | I |
| 2.10. | Major Roads | I |
| 2.11. | Secondary Roads | 0 |

## IMPACT ON RESOURCE SYSTEM BY SITE TYPE

Key: 4: Threshold
3: Severe
2: Moderate
1: Compatible

| LAND FORM | TOPOGRAPHIC SLOPE 0-2 | 4-6 | 7-9 |
|---|---|---|---|
| 6 | X | X | Y |
| 1,3 | Y | Z | Z |
| 4,5, 7,9 | Z | Z | Z |

| | DEPTH TO SUB-SURFACE WATER 7,9 | 5 | 1 |
|---|---|---|---|
| X | 2 | 2 | 1 |
| Y | 2 | 1 | 1 |
| Z | 1 | 1 | 1 |

Matrix I

| | DEPTH TO SUB-SURFACE WATER 7,9 | 5 | 1 |
|---|---|---|---|
| X | 3 | 3 | 2 |
| Y | 3 | 2 | 1 |
| Z | 2 | 2 | 1 |

Matrix II

X: Most Vulnerable
Y:
Z: Least Vulnerable

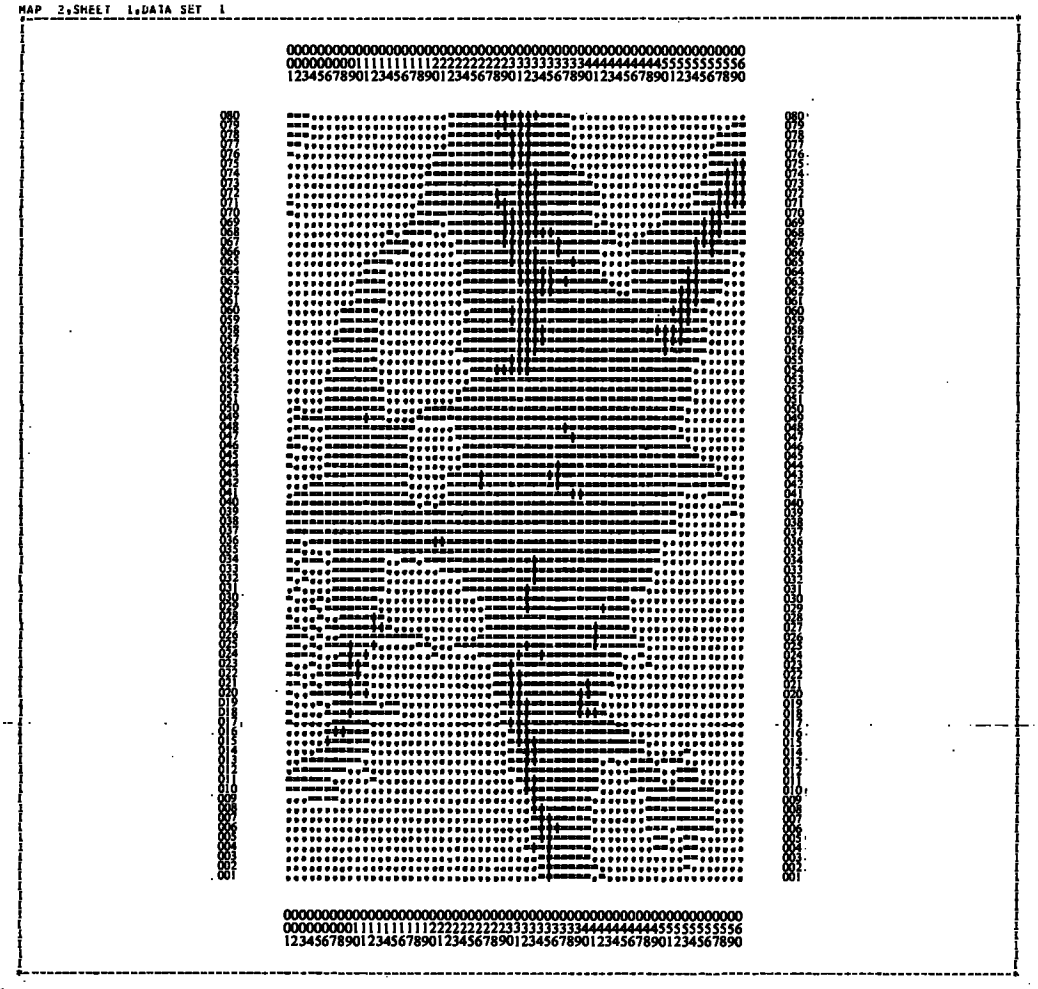



Fig. V.2
Vulnerability to Pollution - Surficial Aquifer

RESOURCE SYSTEM 3: Shoreline

IMPACT: Turbidity and Shoreline Erosion (Figure V.3)

SITE TYPE VARIABLES: The variables are listed in the order by which they contribute to the definition of site types for the analysis of this resource system. The Variable Ranges are described from the most vulnerable to the least vulnerable.

| REF. | VARIABLE | REF. | RANGE | |
|---|---|---|---|---|
| 3&4 | Topographic | 0,1,9 | none, 0-4%, 35+% | Because of physical characteristics of waves; slopes 0-4% most susceptible to bottom disturbances from motor boating and wind action; slopes 35+% too steep to dissipate wave energy; both slope categories will tend to be turbid and full of debris. |
| | | 6,7,8 | 12-35% | |
| | | 2,4,5 | 4-12% | Depth of water sufficient to absorb wave energy from bottom and bank. |
| 6 | Soil Type | 0,5, 6,7 | Peat, silts, clays | Soil types contributing heavily to turbidity due to fine particle size; causing reduction of light penetration necessary for photosynthesis; easily eroded; tend to stay in suspension longer than coarse particles, settle out in quiet waters. |
| | | 2,4 | Fine sand gravel | |
| | | 1,3 | Coarse gravel sand | Large particle size not easily dislocated; drops readily from stream load; does not contribute to turbidity. |

RESOURCE SYSTEM 3: Shoreline (Cont'd)

| REF. | VARIABLE | REF. | RANGE | |
|---|---|---|---|---|
| 13 | Forest Height | 7,9,0 | None 61-80' | Mature forest, little secondary growth. Root system relatively diffuse; large anchoring roots with little soil holding capacity. |
| | | 3,5 | 21-60' | |
| | | 1 | 20' | Shrubby shoreline thicket; dense root network with great soil holding capacity. |

## RELATIVE IMPACT OF LAND USE

Key: 0: none
I: see Matrix I
II: see Matrix II

### 1. SUMMER PLAN

| | | |
|---|---|---|
| 1.1. | Hunting | 0 |
| 1.2. | Fishing | I |
| 1.3. | Swimming | I |
| 1.4. | Trail/Hiking | 0 |
| 1.5. | Camping | I |
| 1.6. | Picnicking | I |
| 1.7. | Boating | II |
| 1.7. | Marina | II |
| 1.8. | Residential 12u/a | II |
| 1.8. | Residential 2u/a | II |
| 1.9. | Parking | I |
| 1.10. | Major Roads | II |
| 1.11. | Secondary Roads | II |
| 1.12. | Agriculture | I |

### 2. WINTER PLAN

| | | |
|---|---|---|
| 2.1. | Hunting | 0 |
| 2.2. | Snowshoeing | 0 |
| 2.3. | X-Country Ski | 0 |
| 2.4. | Trail/Hiking | 0 |
| 2.5. | Snow Mobiling | 0 |
| 2.6. | Downhill Ski | 0 |
| 2.7. | Ice Skating | 0 |
| 2.8. | Residential 12u/a | II |
| 2.8. | Residential 2u/a | II |
| 2.9. | Parking | I |
| 2.10. | Major Roads | II |
| 2.11. | Secondary Roads | II |

## IMPACT ON RESOURCE SYSTEM BY SITE TYPE

Key: 4: Threshold
3: Severe
2: Moderate
1: Compatible

| SOIL TYPE | TOPOGRAPHIC SLOPE 0,1, 9 | 6,7, 8 | 2,4, 5 |
|---|---|---|---|
| 5,6, 7 | X | Y | Y |
| 4,2 | Y | Y | Z |
| 3,1 | Y | Z | Z |

X: Most Vulnerable
Y:
Z: Least Vulnerable

| | FOREST HEIGHT 7,9, 0 | 3,5 | 1 |
|---|---|---|---|
| X | 3 | 2 | 1 |
| Y | 2 | 2 | 1 |
| Z | 1 | 1 | 1 |

Matrix I

| | FOREST HEIGHT 7,9, 0 | 3,5 | 1 |
|---|---|---|---|
| X | 4 | 3 | 2 |
| Y | 3 | 3 | 2 |
| Z | 2 | 2 | 2 |

Matrix II

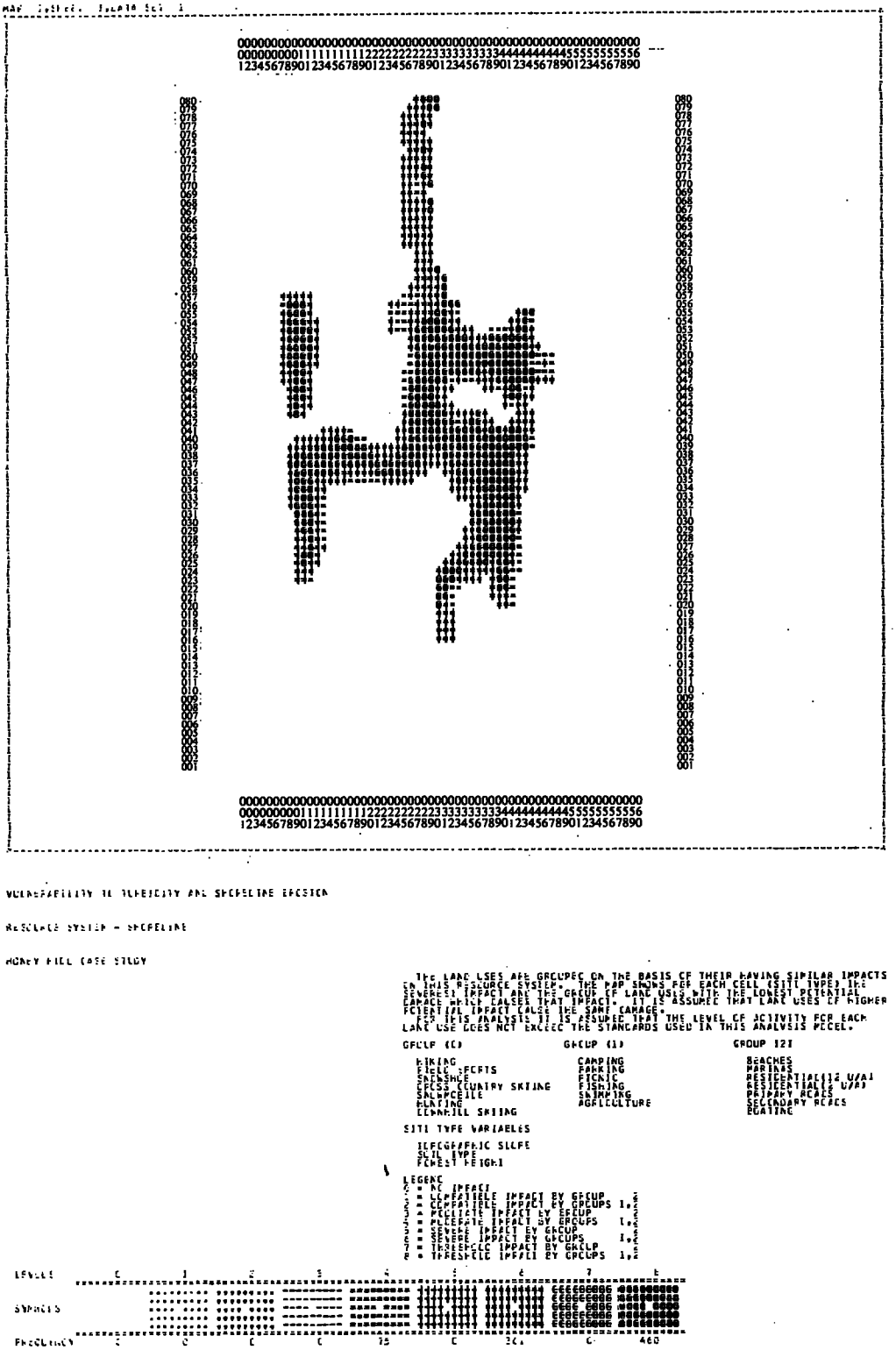



Fig. V.3
Vulnerability to Turbidity and Shoreline Erosion

RESOURCE SYSTEM 4: Soils

IMPACT: Erosion (Figure V.4)

SITE TYPE VARIABLE: The variables are listed in the order by which they contribute to the definition of site types for the analysis of this resource system. The Variable Ranges are described from the most vulnerable to the least vulnerable.

| REF. | VARIABLE | REF. | RANGE | |
|---|---|---|---|---|
| 3&4 | Topographic Slope | 6-9 | 12-35+% | Rapid runoff with increased velocity. |
| | | 2,4,5 | 4-12% | |
| | | 0,1 | 0-4% none | Little runoff; more opportunity for adsorption of precipitation, low velocity. |
| 6 | Soil Type | 5,6,7 | silts, clays, peat | Relatively impervious; thus increasing runoff. Particles easy to dislocate and transport. |
| | | 2,4 | gravel, fine sand fine | |
| | | 0,1,3 | gravel, coarse sand, coarse | Greater porosity, large particles; more difficult for runoff to dislocate and transport. |
| 11 | Forest Type | 0 | none | Increase runoff because of lack of evapo-transpiration. Water flow not interrupted by vegetation and surface litter. |
| | | 2 | cut, regrowth | |
| | | 5,9 | decid. conif. | Impact of precipitation broken by canopy. Increased evapo-transpiration - Forest litter and duff reduce surface runoff. |

## RELATIVE IMPACT OF LAND USE

Key: 0: none
I: see Matrix I
II: see Matrix II

### 1. SUMMER PLAN

| | | |
|---|---|---|
| 1.1. | Hunting | 0 |
| 1.2. | Fishing | 0 |
| 1.3. | Swimming | 0 |
| 1.4. | Trail/Hiking | 0 |
| 1.5. | Camping | I |
| 1.6. | Picnicking | I |
| 1.7. | Boating | I |
| 1.7. | Marina | I |
| 1.8. | Residential 12u/a | II |
| 1.8. | Residential 2u/a | I |
| 1.9. | Parking | I |
| 1.10. | Major Roads | II |
| 1.11. | Secondary Roads | I |
| 1.12. | Agriculture | I |

### 2. WINTER PLAN

| | | |
|---|---|---|
| 2.1. | Hunting | 0 |
| 2.2. | Snowshoeing | 0 |
| 2.3. | X-Country Ski | 0 |
| 2.4. | Trail/Hiking | 0 |
| 2.5. | Snow Mobiling | 0 |
| 2.6. | Downhill Ski | I |
| 2.7. | Ice Skating | 0 |
| 2.8. | Residential 12u/a | II |
| 2.8. | Residential 2u/a | I |
| 2.9. | Parking | I |
| 2.10. | Major Roads | II |
| 2.11. | Secondary Roads | I |

## IMPACT ON RESOURCE SYSTEM BY SITE TYPE

Key: 4: Threshold
3: Severe
2: Moderate
1: Compatible

| SOIL TYPE \ TOPOGRAPHIC SLOPE | 6-9 | 2,4, 5 | 1 |
|---|---|---|---|
| 5,6, 7 | X | Y | Z |
| 2,4 | X | Z | Z |
| 1,3 | Y | Z | Z |

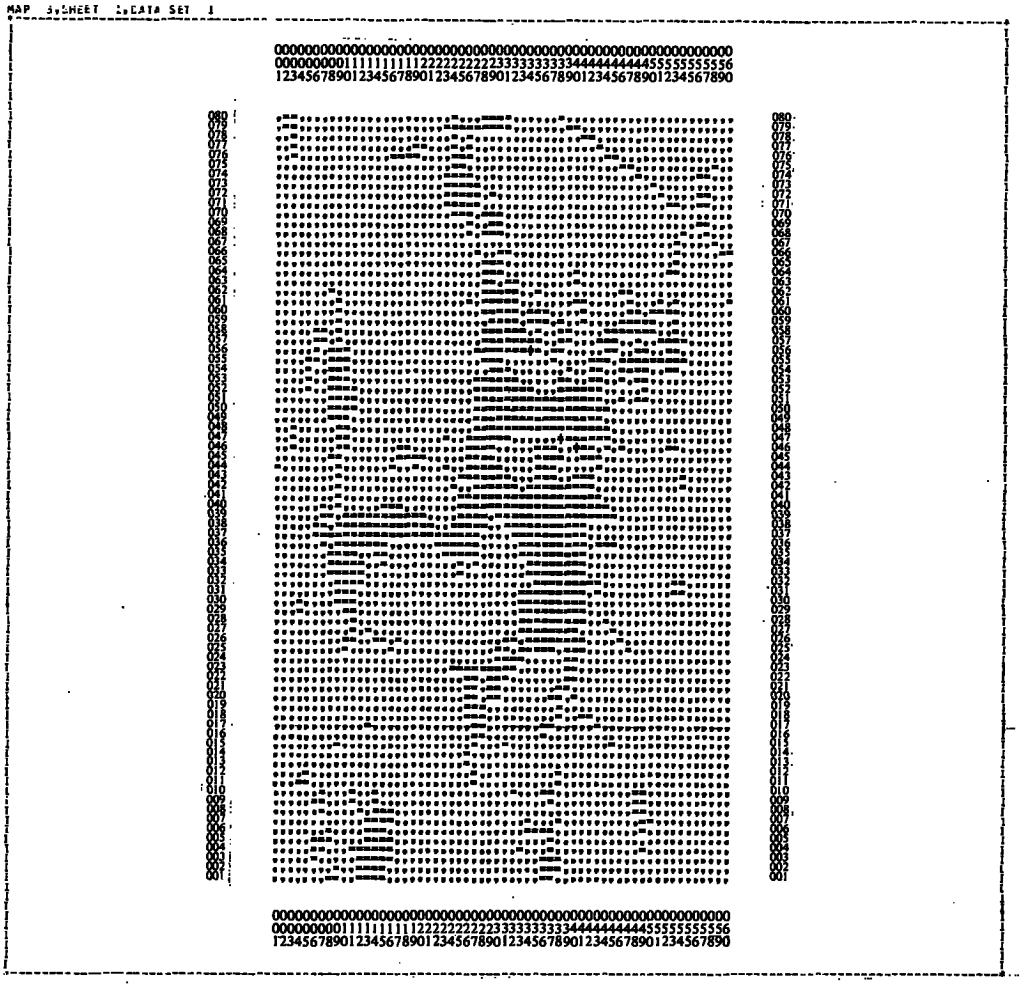
X: Most Vulnerable
Y:
Z: Least Vulnerable

| | FOREST TYPE 0 | 2 | 5,9 |
|---|---|---|---|
| X | 3 | 2 | 1 |
| Y | 2 | 1 | 1 |
| Z | 2 | 1 | 1 |

Matrix I

| | FOREST TYPE 0 | 2 | 5,9 |
|---|---|---|---|
| X | 4 | 3 | 2 |
| Y | 3 | 2 | 2 |
| Z | 2 | 2 | 1 |

Matrix II




VULNERABILITY TO SOIL EROSION

RESOURCE SYSTEM - SOILS

HONEY HILL CASE STUDY

THE LAND USES ARE GROUPED ON THE BASIS OF THEIR HAVING SIMILAR IMPACTS ON THIS RESOURCE SYSTEM. THE MAP SHOWS FOR EACH CELL (SITE TYPE) THE SEVEREST IMPACT AND THE GROUP OF LAND USES WITH THE LOWEST POTENTIAL DAMAGE WHICH CAUSES THAT IMPACT. IT IS ASSUMED THAT LAND USES OF HIGHER POTENTIAL IMPACT CAUSE THE SAME DAMAGE.
FOR THIS ANALYSIS IT IS ASSUMED THAT THE LEVEL OF ACTIVITY FOR EACH LAND USE DOES NOT EXCEED THE STANDARDS USED IN THIS ANALYSIS MODEL.

GROUP 101

BEACHES
MARINAS
FISHING
SWIMMING
SNOWSHOE
CROSS COUNTRY SKIING
SNOWMOBILE
HUNTING
HIKING

GROUP 111

CAMPING
PARKING
PICNIC
SECONDARY ROADS
FIELD SPORTS
EATING
AGRICULTURE
RESIDENTIAL(2 D/A)
DOWNHILL SKIING

GROUP 121

RESIDENTIAL(2 D/A)
PRIMARY ROADS

SITE TYPE VARIABLES

TOPOGRAPHIC SLOPE
SOIL TYPE
FOREST TYPE

LEGEND
0 = NO IMPACT
1 = COMPATIBLE IMPACT BY GROUP 2
2 = COMPATIBLE IMPACT BY GROUPS 1,2
3 = MODERATE IMPACT BY GROUP 2
4 = MODERATE IMPACT BY GROUPS 1,2
5 = SEVERE IMPACT BY GROUP 2
6 = SEVERE IMPACT BY GROUPS 1,2
7 = THRESHOLD IMPACT BY GROUP 2
8 = THRESHOLD IMPACT BY GROUPS 1,2

| LEVELS | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|---|---|
| SYMBOLS | | | | | | | | | |
| FREQUENCY | 0 | 0 | 3820 | 0 | 967 | 0 | 3 | 0 | 0 |

Fig. V.4
Vulnerability to Soil Erosion

RESOURCE SYSTEM 5: Vegetation

IMPACT: Forest Fires (Figure V.5)

SITE TYPE VARIABLES: The variables are listed in the order by which they contribute to the definition of site types for the analysis of this resource system. The Variable Ranges are described from the most vulnerable to the least vulnerable.

| REF. | VARIABLE | REF. | RANGE | |
|---|---|---|---|---|
| 8 | Soil Moisture | 9 | Dry | More susceptibility to surface and ground fires; more leaf litter; fires more likely to start on dry ground. |
| | | 5,7 | Moist, fresh | |
| | | 0,3 | Wet, water | Higher kindling point necessary because of increased moisture, resulting in low probability of fire. |
| 11 | Forest Type | 9 | Conif. | Twelve month threat due to crown material. |
| | | 5 | Decid. | |
| | | 0,2 | Cut, regrowth, none | Scarce vegetation, crown fire not threat |
| 12 | Forest Density | 8 | 81-100% | Opportunity is high for fire to breach natural fire breaks. |
| | | 4,6 | 31-80% | |
| | | 0,2 | 0-30% | Large breaks in forest cover contains spread of fire. |

## RELATIVE IMPACT OF LAND USE

Key: 0: none
I: see Matrix I
II: see Matrix II

### 1. SUMMER PLAN

| | | |
|---|---|---|
| 1.1. | Hunting | I |
| 1.2. | Fishing | I |
| 1.3. | Swimming | 0 |
| 1.4. | Trail/Hiking | I |
| 1.5. | Camping | II |
| 1.6. | Picnicking | II |
| 1.7. | Boating | 0 |
| 1.7. | Marina | I |
| 1.8. | Residential 12u/a | I |
| 1.8. | Residential 2u/a | II |
| 1.9. | Parking | 0 |
| 1.10. | Major Roads | I |
| 1.11. | Secondary Roads | II |
| 1.12. | Agriculture | 0 |

### 2. WINTER PLAN

| | | |
|---|---|---|
| 2.1. | Hunting | I |
| 2.2. | Snowshoeing | 0 |
| 2.3. | X-Country Ski | 0 |
| 2.4. | Trail/Hiking | I |
| 2.5. | Snow Mobiling | 0 |
| 2.6. | Downhill Ski | 0 |
| 2.7. | Ice Skating | 0 |
| 2.8. | Residential 12u/a | I |
| 2.8. | Residential 2u/a | II |
| 2.9. | Parking | 0 |
| 2.10. | Major Roads | I |
| 2.11. | Secondary Roads | II |

## IMPACT ON RESOURCE SYSTEM BY SITE TYPE

Key: 4: Threshold
3: Severe
2: Moderate
1: Compatible

| FOREST TYPE | SOIL MOISTURE 9 | 5,7 | 0,3 |
|---|---|---|---|
| 9 | X | X | Y |
| 5 | Y | Y | Z |
| 0,2 | Y | Z | Z |

X: Most Vulnerable
Y:
Z: Least Vulnerable

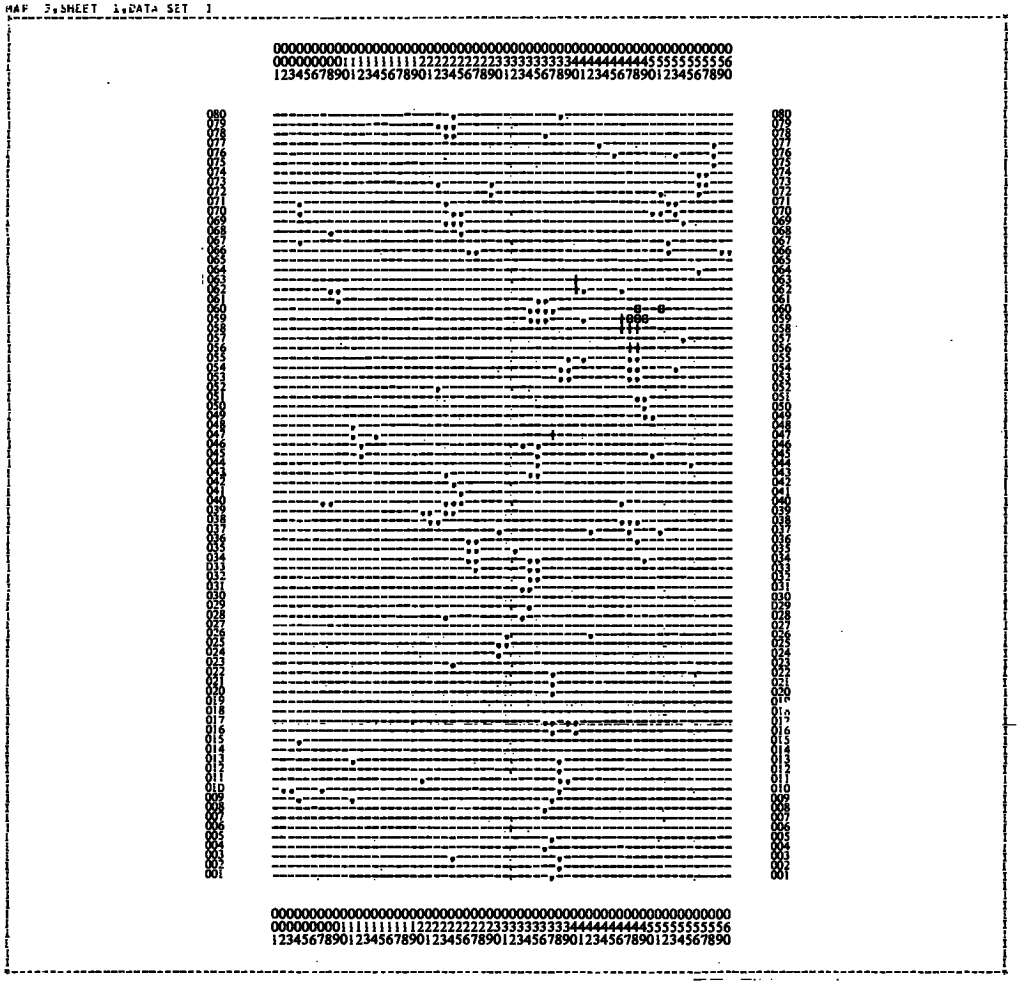
Matrix I

| | FOREST DENSITY 8 | 4,6 | 0,2 |
|---|---|---|---|
| X | 3 | 2 | 2 |
| Y | 2 | 2 | 1 |
| Z | 2 | 1 | 1 |

Matrix II

| | FOREST DENSITY 8 | 4,6 | 0,2 |
|---|---|---|---|
| X | 3 | 3 | 2 |
| Y | 3 | 2 | 2 |
| Z | 3 | 2 | 1 |

MAP 3,SHEET 1,DATA SET 1



VULNERABILITY TO FOREST FIRES

RESOURCE SYSTEM - VEGETATION

HEALY HILL CASE STUDY

THE LAND USES ARE GROUPED ON THE BASIS OF THEIR HAVING SIMILAR IMPACTS ON THIS RESOURCE SYSTEM. THE MAP SHOWS FOR EACH CELL (SITE TYPE) THE SEVEREST IMPACT AND THE GROUP OF LAND USES WITH THE LOWEST POTENTIAL DAMAGE WHICH CAUSES THAT IMPACT. IT IS ASSUMED THAT LAND USES OF HIGHER POTENTIAL IMPACT CAUSE THE SAME DAMAGE.
FOR THIS ANALYSIS IT IS ASSUMED THAT THE LEVEL OF ACTIVITY FOR EACH LAND USE DOES NOT EXCEED THE STANDARDS USED IN THIS ANALYSIS MODEL.

GROUP (0)
- PARKING
- SWIMMING
- BOATING
- AGRICULTURE
- SNOWSHOE
- CROSS COUNTRY SKIING
- SNOWMOBILE
- DOWNHILL SKIING

GROUP (1)
- BEACHES
- RESIDENTIAL(12 U/A)
- HIKING
- PRIMARY ROADS
- FISHING
- FIELD SPORTS
- HUNTING

GROUP (2)
- CAMPING
- PICNIC
- SECONDARY ROADS
- RESIDENTIAL(2 U/A)

SITE TYPE VARIABLES
- SOIL MOISTURE
- FOREST TYPE
- FOREST DENSITY

LEGEND
0 = NO IMPACT
1 = COMPATIBLE IMPACT BY GROUP 2
2 = COMPATIBLE IMPACT BY GROUPS 1,2
3 = MODERATE IMPACT BY GROUP 2
4 = MODERATE IMPACT BY GROUPS 1,2
5 = SEVERE IMPACT BY GROUP 2
6 = SEVERE IMPACT BY GROUPS 1,2
7 = THRESHOLD IMPACT BY GROUP 2
8 = THRESHOLD IMPACT BY GROUPS 1,2

Fig. V.5
Vulnerability to Forest Fires

RESOURCE SYSTEM 6: Wildlife

IMPACT: Vulnerability of Habitat (Figure V.6)

SITY TYPE VARIABLES: The variables are listed in the order by which they contribute to the definition of site types for the analysis of this resource system. The Variable Ranges are described from the most vulnerable to the least vulnerable.

| REF. | VARIABLE | REF. | RANGE | |
|---|---|---|---|---|
| 8 | Soil Moisture | 5,7 | Moist fresh | Supports more diverse plant material and more diverse soil fauna as food and source of cover. |
| | | 0,3 | Water wet | |
| | | 9 | Dry | Less diverse vegetation |
| 11 | Forest Type | 2 | Cut, regrowth | Diverse plant material provides multiple habitats; plant material more vigorous and accessible than mature forest, stump sprouting. |
| | | 5 | Decid. | |
| | | 0,9 | None, conif. | Little cover for wildlife, under story canopy and shrubs generally absent; wildlife food limited. |
| 12 | Forest Density | 2,4 | 0-50% | Maximum edge and transitional vegetation zones (ecotones). |
| | | 6,8 | 51-100% | |
| | | 0 | None | Lack of diverse wildlife food and cover. |

## RELATIVE IMPACT OF LAND USE

Key: 0: none
I: see Matrix I
II: see Matrix II

### 1. SUMMER PLAN

| | | |
|---|---|---|
| 1.1. | Hunting | I |
| 1.2. | Fishing | I |
| 1.3. | Swimming | I |
| 1.4. | Trail/Hiking | 0 |
| 1.5. | Camping | I |
| 1.6. | Picnicking | I |
| 1.7. | Boating | I |
| 1.7. | Marina | II |
| 1.8. | Residential 12u/a | II |
| 1.8. | Residential 2u/a | II |
| 1.9. | Parking | I |
| 1.10. | Major Roads | II |
| 1.11. | Secondary Roads | I |
| 1.12. | Agriculture | 0 |

### 2. WINTER PLAN

| | | |
|---|---|---|
| 2.1. | Hunting | I |
| 2.2. | Snowshoeing | 0 |
| 2.3. | X-Country Ski | 0 |
| 2.4. | Trail/Hiking | 0 |
| 2.5. | Snow Mobiling | I |
| 2.6. | Downhill Ski | 0 |
| 2.7. | Ice Skating | 0 |
| 2.8. | Residential 12u/a | II |
| 2.8. | Residential 2u/a | II |
| 2.9. | Parking | I |
| 2.10. | Major Roads | II |
| 2.11. | Secondary Roads | I |

## IMPACT ON RESOURCE SYSTEM BY SITE TYPE

Key: 4: Threshold
3: Severe
2: Moderate
1: Compatible

| FOREST TYPE | SOIL MOISTURE 5,7 | 0,3 | 9 |
|---|---|---|---|
| 2 | X | Y | Y |
| 5 | Y | Y | Z |
| 0,9 | Y | Z | Z |

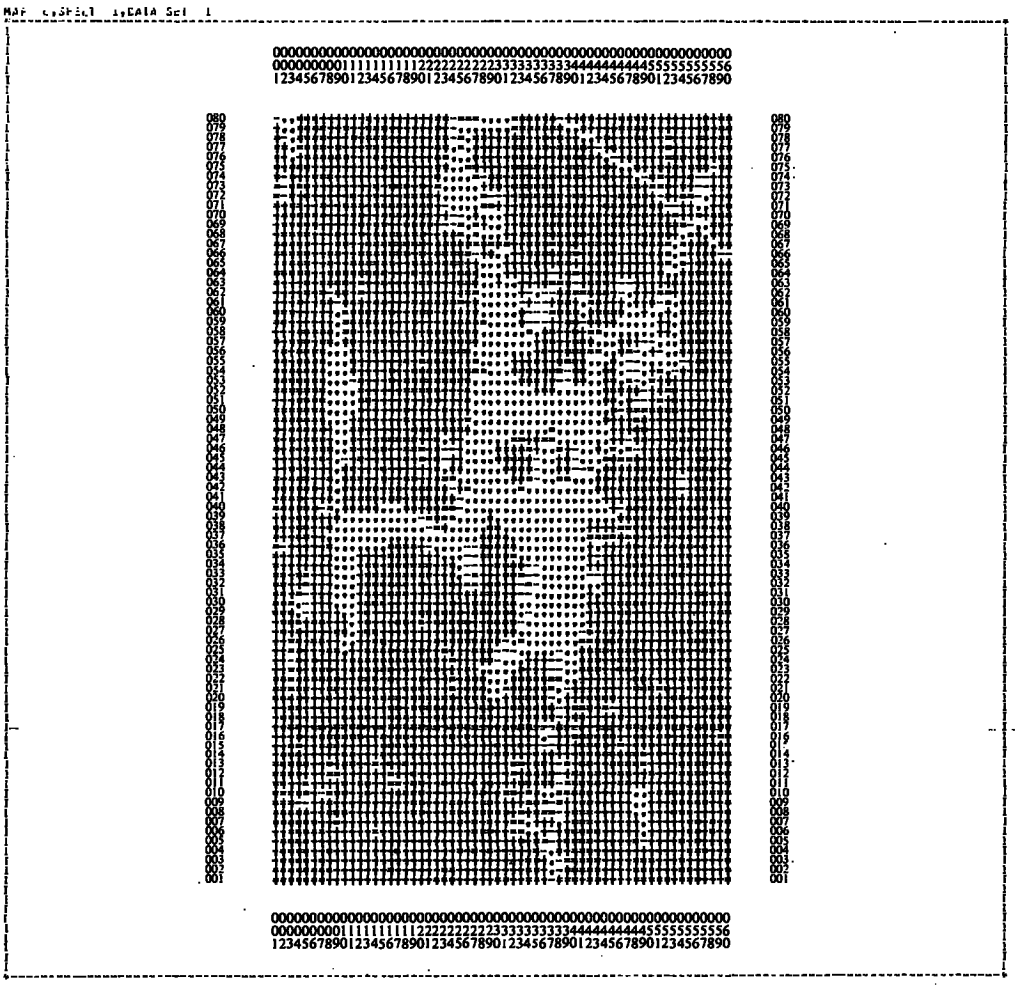
X: Most Vulnerable
Y:
Z: Least Vulnerable

Matrix I

| | FOREST DENSITY 2,4 | 6,8 | 0 |
|---|---|---|---|
| X | 2 | 2 | 1 |
| Y | 2 | 2 | 1 |
| Z | 1 | 1 | 1 |

Matrix II

| | FOREST DENSITY 2,4 | 6,8 | 0 |
|---|---|---|---|
| X | 3 | 3 | 2 |
| Y | 3 | 2 | 1 |
| Z | 2 | 1 | 1 |



VULNERABILITY TO WILDLIFE HABITAT

RESOURCE SYSTEM - WILDLIFE

HONEY HILL CASE STUDY

THE LAND USES ARE GROUPED ON THE BASIS OF THEIR HAVING SIMILAR IMPACTS ON THIS RESOURCE SYSTEM. THE MAP SHOWS FOR EACH CELL (SITE TYPE) THE SEVERESI IMPACT AND THE GROUP OF LAND USES WITH THE LOWEST POTENTIAL DAMAGE WHICH CAUSES THAT IMPACT. IT IS ASSUMED THAT LAND USES OF HIGHER POTENTIAL IMPACT CAUSE THE SAME DAMAGE.
FOR THIS ANALYSIS IT IS ASSUMED THAT THE LEVEL OF ACTIVITY FOR EACH LAND USE DOES NOT EXCEED THE STANDARDS USED IN THIS ANALYSIS MODEL.

| GROUP (0) | GROUP (1) | GROUP (2) |
|---|---|---|
| HIKING | CAMPING | MARINAS |
| (LOWHILL SKIING | BEACHES | RESIDENTIAL(12 U/A) |
| FIELD SPORTS | PARKING | RESIDENTIAL(2 U/A) |
| AGRICULTURE | PICNIC | PRIMARY ROADS |
| SNOWSHOE | SECONDARY ROADS | |
| CROSS COUNTRY SKIING | HUNTING | |
| | FISHING | |
| | SWIMMING | |
| | BOATING | |
| | SNOWMOBILE | |

SITE TYPE VARIABLES

SOIL MOISTURE
FOREST TYPE
FOREST DENSITY

LEGEND
0 = NO IMPACT
1 = COMPATIBLE IMPACT BY GROUP 2
2 = COMPATIBLE IMPACT BY GROUPS 1,2
3 = MOLERATE IMPACT BY GROUP 2
4 = MODERATE IMPACT BY GROUPS 1,2
5 = SEVERE IMPACT BY GROUP 2
6 = SEVERE IMPACT BY GROUPS 1,2
7 = THRESHOLD IMPACT BY GROUP 2
8 = THRESHOLD IMPACT BY GROUPS 1,2

| LEVELS | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|---|---|
| SYMBOLS | | | | | | | | | |
| FREQUENCY | 0 | 0 | 495 | 155 | 157 | 1818 | 1528 | 0 | 0 |

Fig. V.6
Vulnerability to Wildlife Habitat

RESOURCE SYSTEM 7: Insects

IMPACT: Vulnerability of Habitat (Figure V.7)

SITE TYPE VARIABLES: The variables are listed in the order by which they contribute to the definition of site types for the analysis of this resource system. The Variable Ranges are described from the most vulnerable to the least vulnerable.

| REF. | VARIABLE | REF. | RANGE | |
|---|---|---|---|---|
| 8 | Soil Moisture | 0,3 | Water, wet | Breeding areas favorable to many species; large variety of ground flora and fauna. |
| | | 5,7 | Moist, fresh | |
| | | 9 | Dry | Restricted breeding areas; fauna sparse |
| 12 | Forest Density | 2,4 | 0-50% | Great variety of wet and dry; light and shady situations at various levels in vegetation. |
| | | 6 | 51-80% | |
| | | 0,8 | 81-100% none | Reduction of direct light and heat; none - severe intensity of light and heat. |
| 13 | Forest Height | 1 | <20' | Shrubby material, fields; old fields and agriculture contain the highest proportion of insect population. |
| | | 3,5 | 21-60' | |
| | | 7,9,0 | 61->80' | Mature forest; small number of insect species due to uniformity of habitat; none - absence of canopy levels. |

## RELATIVE IMPACT OF LAND USE

Key: 0: none
I: see Matrix I
II: see Matrix II

### 1. SUMMER PLAN

| | | |
|---|---|---|
| 1.1. | Hunting | 0 |
| 1.2. | Fishing | 0 |
| 1.3. | Swimming | I |
| 1.4. | Trail/Hiking | 0 |
| 1.5. | Camping | II |
| 1.6. | Picnicking | I |
| 1.7. | Boating | 0 |
| 1.7. | Marina | II |
| 1.8. | Residential 12u/a | II |
| 1.8. | Residential 2u/a | II |
| 1.9. | Parking | II |
| 1.10. | Major Roads | II |
| 1.11. | Secondary Roads | I |
| 1.12. | Agriculture | II |

### 2. WINTER PLAN

| | | |
|---|---|---|
| 2.1. | Hunting | 0 |
| 2.2. | Snowshoeing | 0 |
| 2.3. | X-Country Ski | 0 |
| 2.4. | Trail/Hiking | 0 |
| 2.5. | Snow Mobiling | 0 |
| 2.6. | Downhill Ski | 0 |
| 2.7. | Ice Skating | 0 |
| 2.8. | Residential 12u/a | II |
| 2.8. | Residential 2u/a | II |
| 2.9. | Parking | II |
| 2.10. | Major Roads | II |
| 2.11. | Secondary Roads | I |

## IMPACT ON RESOURCE SYSTEM BY SITE TYPE

Key: 4: Threshold
3: Severe
2: Moderate
1: Compatible

| FOREST DENSITY | SOIL MOISTURE 0,3 | 5,7 | 9 |
|---|---|---|---|
| 2,4 | X | X | Y |
| 6 | Y | Y | Z |
| 8 | Y | Y | Z |

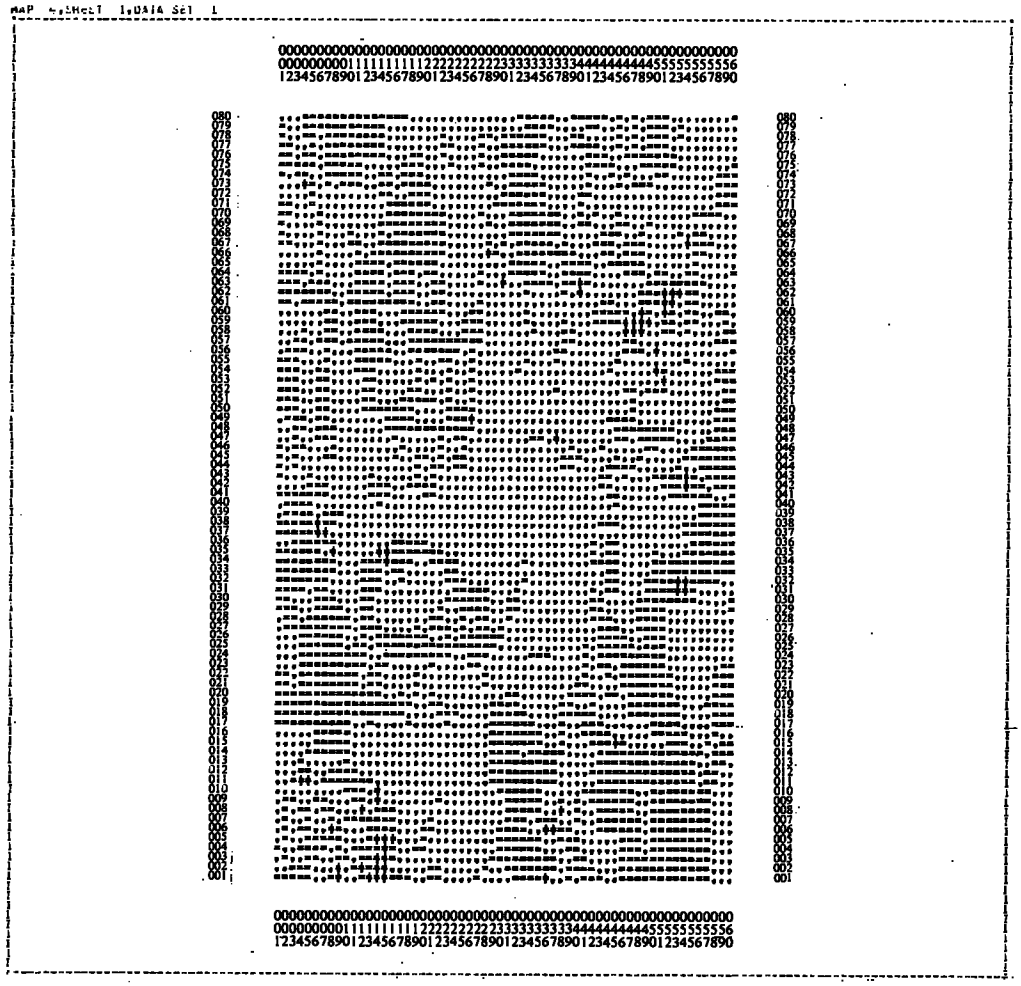
| | FOREST HEIGHT 1 | 3,5 | 7,9, 0 |
|---|---|---|---|
| X | 2 | 2 | 2 |
| Y | 2 | 1 | 1 |
| Z | 1 | 1 | 1 |

Matrix I

| | FOREST HEIGHT 1 | 3,5 | 7,9, 0 |
|---|---|---|---|
| X | 4 | 3 | 2 |
| Y | 3 | 2 | 2 |
| Z | 2 | 2 | 1 |

Matrix II

X: Most Vulnerable
Y:
Z: Least Vulnerable



VULNERABILITY TO INSECTS

RESOURCE SYSTEM - INSECTS

HONEY HILL CASE STUDY

THE LAND USES ARE GROUPED ON THE BASIS OF THEIR HAVING SIMILAR IMPACTS ON THIS RESOURCE SYSTEM. THE MAP SHOWS FOR EACH CELL (SITE TYPE) THE SEVEREST IMPACT AND THE GROUP OF LAND USES WITH THE LOWEST POTENTIAL DAMAGE WHICH CAUSES THAT IMPACT. IT IS ASSUMED THAT LAND USES OF HIGHER POTENTIAL IMPACT CAUSE THE SAME DAMAGE.
FOR THIS ANALYSIS IT IS ASSUMED THAT THE LEVEL OF ACTIVITY FOR EACH LAND USE DOES NOT EXCEED THE STANDARDS USED IN THIS ANALYSIS MODEL.

GROUP (0)

- HIKING
- FISHING
- BOATING
- SNOWSHOE
- CROSS COUNTRY SKIING
- SNOWMOBILE
- HUNTING
- DOWNHILL SKIING

GROUP (1)

- PICNIC
- SECONDARY ROADS
- FIELD SPORTS
- SWIMMING

GROUP (2)

- CAMPING
- BEACHES
- MARINAS
- PARKING
- RESIDENTIAL(12 U/A)
- RESIDENTIAL(2 U/A)
- PRIMARY ROADS
- AGRICULTURE

SITE TYPE VARIABLES

- SOIL MOISTURE
- FOREST DENSITY
- FOREST HEIGHT

LEGEND

0 = NO IMPACT
1 = COMPATIBLE IMPACT BY GROUP 2
2 = COMPATIBLE IMPACT BY GROUPS 1,2
3 = MODERATE IMPACT BY GROUP 2
4 = MODERATE IMPACT BY GROUPS 1,2
5 = SEVERE IMPACT BY GROUP 2
6 = SEVERE IMPACT BY GROUPS 1,2
7 = THRESHOLD IMPACT BY GROUP 2
8 = THRESHOLD IMPACT BY GROUPS 1,2

| LEVELS | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|---|---|
| SYMBOLS | | | | | | | | | |
| FREQUENCY | 0 | 0 | 3114 | 0 | 2022 | 0 | 63 | 0 | 0 |

Fig. V.7
Vulnerability to Insects

RESOURCE SYSTEM 8: Potential Scientific Resources

IMPACT Vulnerability (Figure V.8)

SITE TYPE VARIABLES: The variables are listed in the order by which they contribute to the definition of site types for the analysis of this resource system. The Variable Ranges are described from the most vulnerable to the least vulnerable.

| REF. | VARIABLE | REF. | RANGE | |
|---|---|---|---|---|
| 10 | Water | 0-5 | Wetlands small streams 1st order streams ponds | Constitute headwaters of stream system; often unpolluted; good fish and wildlife habitat. |
| | | 7,8 | Minor rivers, lakes | |
| | | 1,6,9 | Major rivers reser- voirs swales none | Large rivers have considerable self-cleansing capacity because of flow and volume. |
| 11 | Forest Type | 5,9 | Decid. Conif. | Good botanical variety and support of wildlife. |
| | | 2 | Cut, Regrowth | |
| | | 0 | None | Usually agricultural land. |
| 13 | Forest Height | 7,9 | 61->80' | Age and successional history of significant scientific interest. |
| | | 3,5 | 21-60' | |
| | | 0,1 | None, <20' | Relative abundance of youthful sites. |

## RELATIVE IMPACT OF LAND USE

Key: 0: none
I: see Matrix I
II: see Matrix II

### 1. SUMMER PLAN

| | | |
|---|---|---|
| 1.1. | Hunting | I |
| 1.2. | Fishing | I |
| 1.3. | Swimming | 0 |
| 1.4. | Trail/Hiking | I |
| 1.5. | Camping | I |
| 1.6. | Picnicking | I |
| 1.7. | Boating | I |
| 1.7. | Marina | I |
| 1.8. | Residential 12u/a | II |
| 1.8. | Residential 2u/a | II |
| 1.9. | Parking | I |
| 1.10. | Major Roads | II |
| 1.11. | Secondary Roads | I |
| 1.12. | Agriculture | I |

### 2. WINTER PLAN

| | | |
|---|---|---|
| 2.1. | Hunting | I |
| 2.2. | Snowshoeing | 0 |
| 2.3. | X-Country Ski | 0 |
| 2.4. | Trail/Hiking | I |
| 2.5. | Snow Mobiling | I |
| 2.6. | Downhill Ski | 0 |
| 2.7. | Ice Skating | 0 |
| 2.8. | Residential 12u/a | II |
| 2.8. | Residential 2u/a | II |
| 2.9. | Parking | I |
| 2.10. | Major Roads | II |
| 2.11. | Secondary Roads | I |

## IMPACT ON RESOURCE SYSTEM BY SITE TYPE

Key: 4: Threshold
3: Severe
2: Moderate
1: Compatible

| FOREST TYPE \ WATER | 0-5 | 7,8 | 1,6, 9 |
|---|---|---|---|
| 5,9 | X | Y | Z |
| 2 | Y | Y | Z |
| 0 | Z | Z | Z |

X: Most Vulnerable
Y:
Z: Least Vulnerable

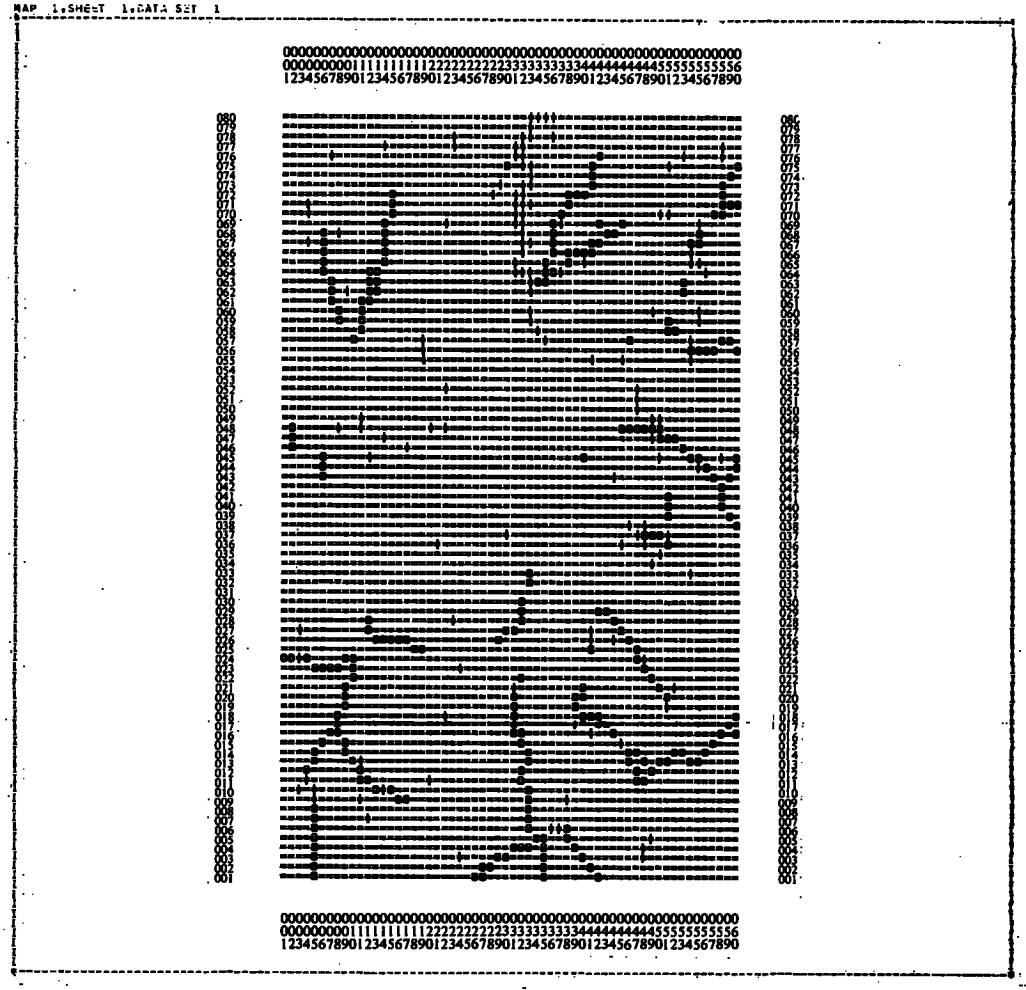
Matrix I

| | FOREST HEIGHT 7,9 | 3,5 | 0,1 |
|---|---|---|---|
| X | 3 | 2 | 2 |
| Y | 3 | 2 | 1 |
| Z | 2 | 1 | 1 |

Matrix II

| | FOREST HEIGHT 7,9 | 3,5 | 0,1 |
|---|---|---|---|
| X | 4 | 4 | 3 |
| Y | 3 | 3 | 2 |
| Z | 3 | 2 | 2 |

MAP 1.SHEET 1.DATA SET 1



VULNERABILITY TO SCIENTIFIC RESOURCES

RESOURCE SYSTEM - SCIENTIFIC RESOURCES

HONEY HILL CASE STUDY

THE LAND USES ARE GROUPED ON THE BASIS OF THEIR HAVING SIMILAR IMPACTS ON THIS RESOURCE SYSTEM. THE MAP SHOWS FOR EACH CELL (SITE TYPE) THE SEVEREST IMPACT AND THE GROUP OF LAND USES WITH THE LOWEST POTENTIAL DAMAGE WHICH CAUSES THAT IMPACT. IT IS ASSUMED THAT LAND USES OF HIGHER POTENTIAL IMPACT CAUSE THE SAME DAMAGE.
FOR THIS ANALYSIS IT IS ASSUMED THAT THE LEVEL OF ACTIVITY FOR EACH LAND USE DOES NOT EXCEED THE STANDARDS USED IN THIS ANALYSIS MODEL.

GROUP (0)
- HIKING
- SWIMMING
- SNOWSHOE
- CROSS COUNTRY SKIING
- DOWNHILL SKIING

GROUP (1)
- CAMPING
- BEACHES
- MARINAS
- PARKING
- PICNIC
- SECONDARY ROADS
- FISHING
- FIELD SPORTS
- BOATING
- AGRICULTURE
- SNOWMOBILE
- HUNTING

GROUP (2)
- RESIDENTIAL(12 U/A)
- RESIDENTIAL(2 U/A)
- PRIMARY ROADS

SITE TYPE VARIABLES
- WATER TYPE
- FOREST TYPE
- FOREST HEIGHT

LEGEND
0 = NO IMPACT
1 = COMPATIBLE IMPACT BY GROUP 2
2 = COMPATIBLE IMPACT BY GROUPS 1,2
3 = MODERATE IMPACT BY GROUP 2
4 = MODERATE IMPACT BY GROUPS 1,2
5 = SEVERE IMPACT BY GROUP 2
6 = SEVERE IMPACT BY GROUPS 1,2
7 = THRESHOLD IMPACT BY GROUP 2
8 = THRESHOLD IMPACT BY GROUPS 1,2

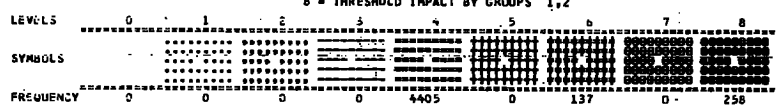



Fig. V.8
Vulnerability to Scientific Resources

RESOURCE SYSTEM 9: Visual Impact

IMPACT: Areas Vulnerable to Visual Change (Figure V.9)

SITE TYPE VARIABLES: The variables are listed in the order by which they contribute to the definition of site types for the analysis of this resource system. The Variable Ranges are described from the most vulnerable to the least vulnerable.

| REF. | VARIABLE | REF. | RANGE | |
|---|---|---|---|---|
| 12 | Forest Density | 0,2 | None, 30% | Areas of maximum visual exposure but less impact on flat ground. |
| | | 4,6 | 31-80% | Better visual closure, particularly on flat ground; exposure is still high on land with a slope >15%. |
| | | 8 | 81-100% | Visual closure excellent due to dense canopy. |
| 3&4 | Topographic Slope | 7,8,9 | 15-35+% | Presents large surface area to the viewer. |
| | | 4,5,6 | 8-15% | Medium exposure of surface area. |
| | | 0-3 | None, 0-8% | Minimal surface area exposed. |
| 27 | Proximity to Water | 8,9 | $H_2O$ in cell, nearest $H_2O$ in neighbor. cell | Maximum exposure to observer due to short distance and minimal visual interference. |
| | | 5-7 | nearest $H_2O$ 1.-.2 kms. | Increased distance reduces visual impact. |
| | | 0-4 | none w/in 6 kms., nearest $H_2O$ 6-1 km. | Highest potential of visual interference to observer. |

## RELATIVE IMPACT OF LAND USE

Key: 0: none
I: see Matrix I
II: see Matrix II

### 1. SUMMER PLAN

| | | |
|---|---|---|
| 1.1. | Hunting | 0 |
| 1.2. | Fishing | 0 |
| 1.3. | Swimming | 0 |
| 1.4. | Trail/Hiking | 0 |
| 1.5. | Camping | I |
| 1.6. | Picnicking | I |
| 1.7. | Boating | I |
| 1.7. | Marina | II |
| 1.8. | Residential 12u/a | II |
| 1.8. | Residential 2u/a | II |
| 1.9. | Parking | I |
| 1.10. | Major Roads | II |
| 1.11. | Secondary Roads | I |
| 1.12. | Agriculture | I |

### 2. WINTER PLAN

| | | |
|---|---|---|
| 2.1. | Hunting | 0 |
| 2.2. | Snowshoeing | 0 |
| 2.3. | X-Country Ski | 0 |
| 2.4. | Trail/Hiking | 0 |
| 2.5. | Snow Mobiling | 0 |
| 2.6. | Downhill Ski | I |
| 2.7. | Ice Skating | 0 |
| 2.8. | Residential 12u/a | II |
| 2.8. | Residential 2u/a | II |
| 2.9. | Parking | I |
| 2.10. | Major Roads | II |
| 2.11. | Secondary Roads | I |

## IMPACT ON RESOURCE SYSTEM BY SITE TYPE

Key: 4: Threshold
3: Severe
2: Moderate
1: Compatible

| SLOPE | FOREST DENSITY 0,2 | 4,6 | 8 |
|---|---|---|---|
| 7,8,9 | X | X | Y |
| 4,5,6 | X | Y | Z |
| 0-3 | Y | Z | Z |

| | PROXIMITY TO WATER 8,9 | 5-7 | 0-4 |
|---|---|---|---|
| X | 3 | 2 | 1 |
| Y | 3 | 2 | 1 |
| Z | 2 | 1 | 1 |

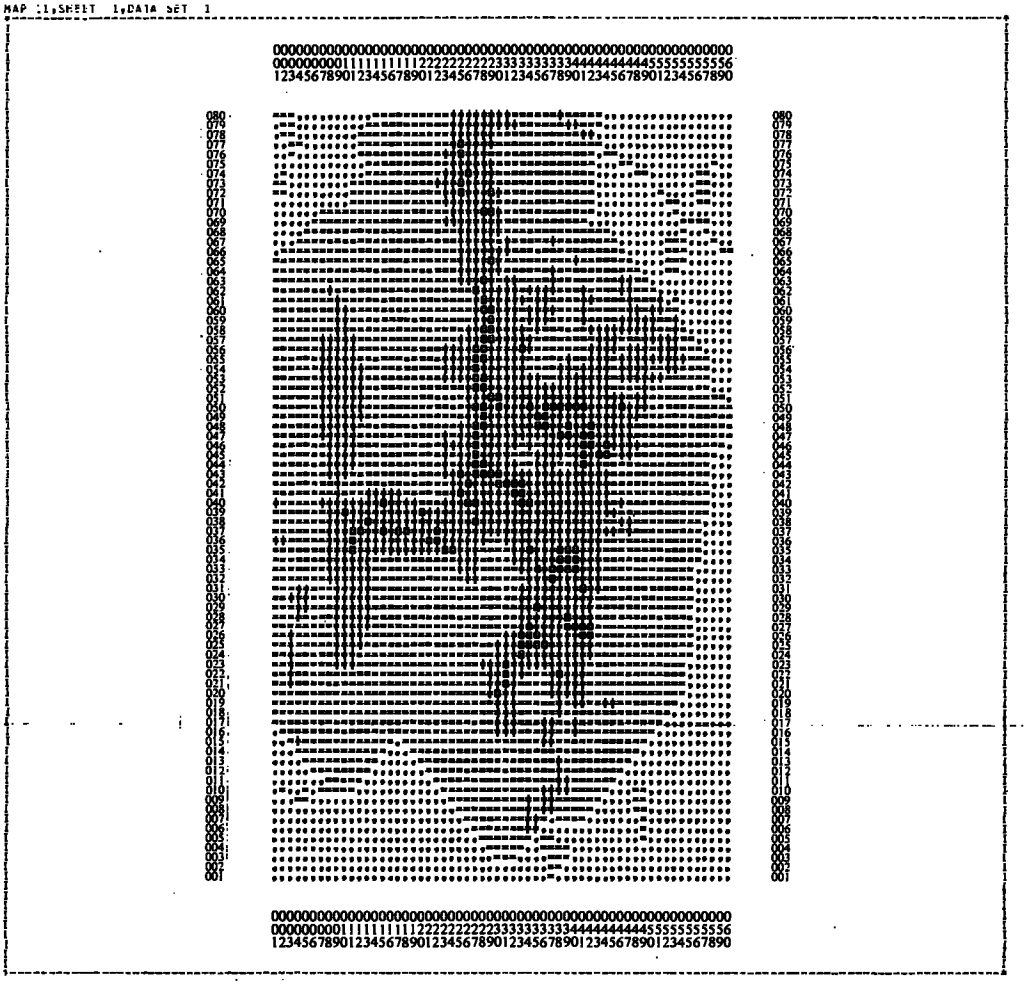
Matrix I

| | PROXIMITY TO WATER 8,9 | 5-7 | 0-4 |
|---|---|---|---|
| X | 4 | 3 | 2 |
| Y | 3 | 3 | 2 |
| Z | 3 | 2 | 1 |

Matrix II

X: Most Vulnerable
Y:
Z: Least Vulnerable

MAP 1;SHEET 1;DATA SET 1



VULNERABILITY TO SCENIC RESOURCES

RESOURCE SYSTEM - SCENIC RESOURCES

HONEY HILL CASE STUDY

THE LAND USES ARE GROUPED ON THE BASIS OF THEIR HAVING SIMILAR IMPACTS ON THIS RESOURCE SYSTEM. THE MAP SHOWS FOR EACH CELL (SITE TYPE) THE SEVEREST IMPACT AND THE GROUP OF LAND USES WITH THE LOWEST POTENTIAL DAMAGE WHICH CAUSES THAT IMPACT. IT IS ASSUMED THAT LAND USES OF HIGHER POTENTIAL IMPACT CAUSE THE SAME DAMAGE.
FOR THIS ANALYSIS IT IS ASSUMED THAT THE LEVEL OF ACTIVITY FOR EACH LAND USE DOES NOT EXCEED THE STANDARDS USED IN THIS ANALYSIS MODEL.

GROUP (0)

- HIKING
- FISHING
- SWIMMING
- BOATING
- SNOWSHOE
- CROSS COUNTRY SKIING
- SNOWMOBILE
- HUNTING

GROUP (1)

- CAMPING
- BEACHES
- MARINAS
- PARKING
- PICNIC
- SECONDARY ROADS
- FIELD SPORTS
- AGRICULTURE
- DOWNHILL SKIING

GROUP (2)

- RESIDENTIAL(2 U/A)
- RESIDENTIAL(2 U/A)
- PRIMARY ROADS

SITE TYPE VARIABLES

- TOPOGRAPHIC SLOPE
- PROXIMITY TO WATER
- FOREST HEIGHT

LEGEND
0 = NO IMPACT
1 = COMPATIBLE IMPACT BY GROUP 2
2 = COMPATIBLE IMPACT BY GROUPS 1,2
3 = MODERATE IMPACT BY GROUP 2
4 = MODERAT: IMPACT BY GROUPS 1,2
5 = SEVERE IMPACT BY GROUP 2
6 = SEVERE IMPACT BY GROUPS 1,2
7 = THRESHOLD IMPACT BY GROUP 2
8 = THRESHOLD IMPACT BY GROUPS 1,2

| LEVELS | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|---|---|
| SYMBOLS | | | | | | | | | |
| FREQUENCY | 0 | 0 | 1164 | 0 | 2433 | 0 | 1046 | 0 | 137 |

Fig. V.9
Vulnerability to Scenic Resources

RESOURCE SYSTEM 10: Dry Beach

IMPACT: Vulnerability to Water Fluctuation Damage (Figure V.10)

SITE TYPE VARIABLES: The variables are listed in the order by which they contribute to the definition of site types for the analysis of this resource system. The Variable Ranges are described from the most vulnerable to the least vulnerable.

| REF. | VARIABLE | REF. | RANGE | |
|---|---|---|---|---|
| 3&4 | Topographic Slope | 5-9 | 10-35+% | Beach susceptible to deterioration through erosional processes, generally difficult for recreational land use. |
| | | 2,4 | 4-10% | |
| | | 0,1 | 0-4%, none | Surface runoff low; satisfactory slope for water related land use. |
| 6 | Soil Type | 5,6,7 | Peats silts clays | Low bearing capacity plastic soils; when eroded will cause extensive silting and turbidity. |
| | | 2,4 | Fine gravels sands | |
| | | 0,1,3 | Coarse gravels sands | Particles not easily dislocated and transported due to their large size; drainage good. |
| 8 | Soil Moisture | 0,3,5 | Water wet moist | Heavy saturation, runoff intense even from moderate rainfall. |
| | | 7 | Fresh | |
| | | 9 | Dry | Soil can absorb periodic rainfall and water coverage. |

## RELATIVE IMPACT OF LAND USE

Key: 0: none
I: see Matrix I
II: see Matrix II

### 1. SUMMER PLAN

1.1. Hunting_____
1.2. Fishing_____
1.3. Swimming_____
1.4. Trail/Hiking_____
1.5. Camping_____
1.6. Picnicking_____
1.7. Boating_____
1.7. Marina_____
1.8. Residential 12u/a___
1.8. Residential 2u/a___
1.9. Parking_____
1.10. Major Roads_____
1.11. Secondary Roads____
1.12. Agriculture_____

### 2. WINTER PLAN

2.1. Hunting_____
2.2. Snowshoeing_____
2.3. X-Country Ski_____
2.4. Trail/Hiking_____
2.5. Snow Mobiling_____
2.6. Downhill Ski_____
2.7. Ice Skating_____
2.8. Residential 12u/a___
2.8. Residential 2u/a___
2.9. Parking_____
2.10. Major Roads_____
2.11. Secondary Roads____

NOTES:

During normal seasonal reservoir operation, the frequency of fluctuations would not cause serious effects to the site: See Matrix I.

If Reservoir operation enters daily fluctuation, the frequency would cause serious site problems and user conflicts via unpredictable depths and position of water: See Matrix II.

## IMPACT ON RESOURCE SYSTEM BY SITE TYPE

Key: 4: Threshold
3: Severe
2: Moderate
1: Compatible

| SOIL TYPE | TOPOGRAPHIC SLOPE 5-9 | 2,4 | 0,1 |
|---|---|---|---|
| 5,6,7 | X | X | Y |
| 2,4 | Y | Y | Z |
| 1,3 | Y | Z | Z |

X: Most Vulnerable
Y:
Z: Least Vulnerable

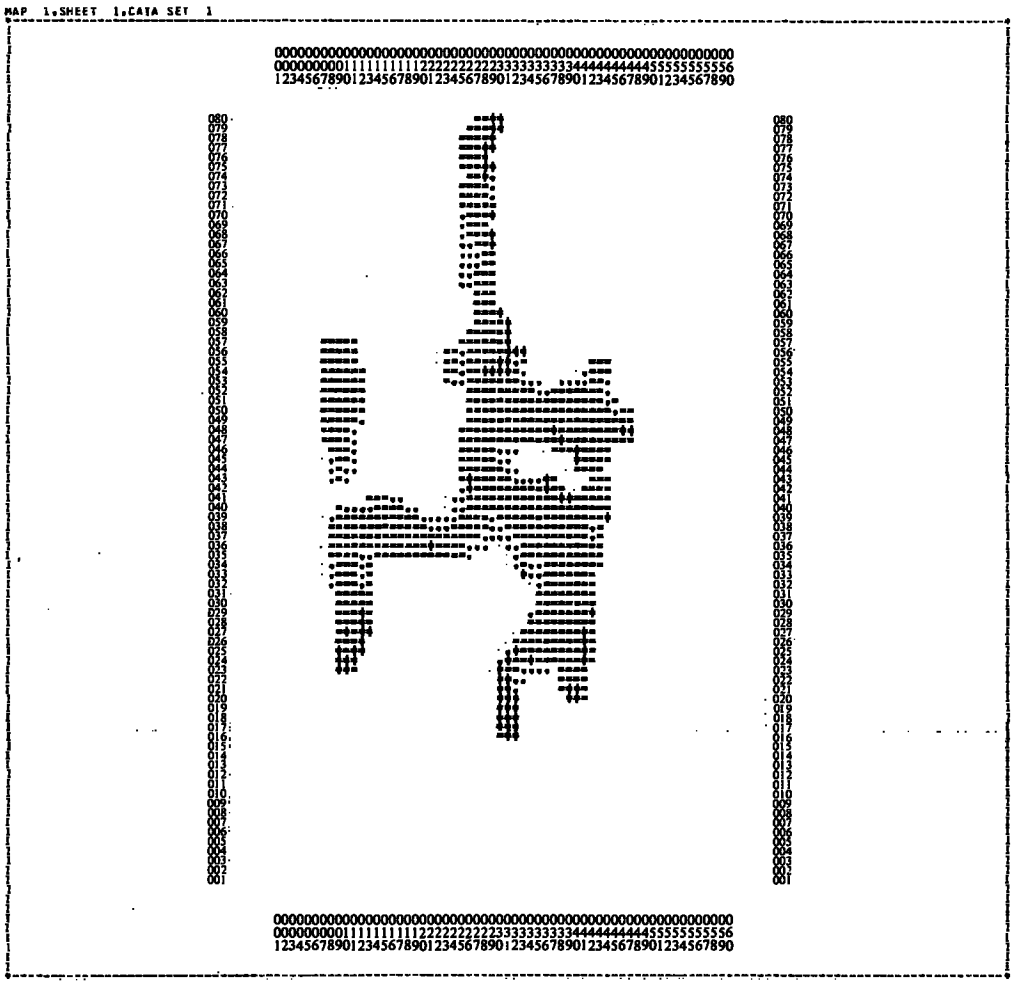
Matrix I

| | SOIL MOISTURE 0,3,5 | 7 | 9 |
|---|---|---|---|
| X | 3 | 3 | 2 |
| Y | 2 | 2 | 1 |
| Z | 1 | 1 | 1 |

Matrix II

| | SOIL MOISTURE 0,3,5 | 7 | 9 |
|---|---|---|---|
| X | 3 | 3 | 3 |
| Y | 3 | 2 | 2 |
| Z | 2 | 2 | 1 |

MAP 1,SHEET 1,DATA SET 1



VULNERABILITY TO WATER FLUCTUATION DAMAGE

RESOURCE SYSTEM - DRY BEACH

HONEY HILL CASE STUDY

THE LAND USES ARE GROUPED ON THE BASIS OF THEIR HAVING SIMILAR IMPACTS ON THIS RESOURCE SYSTEM. THE MAP SHOWS FOR EACH CELL (SITE TYPE) THE SEVEREST IMPACT AND THE GROUP OF LAND USES WITH THE LOWEST POTENTIAL DAMAGE WHICH CAUSES THAT IMPACT. IT IS ASSUMED THAT LAND USES OF HIGHER POTENTIAL IMPACT CAUSE THE SAME DAMAGE.
FOR THIS ANALYSIS IT IS ASSUMED THAT THE LEVEL OF ACTIVITY FOR EACH LAND USE DOES NOT EXCEED THE STANDARDS USED IN THIS ANALYSIS MODEL.

| GROUP (0) | GROUP (1) | GROUP (2) |
|---|---|---|
| CAMPING | (RESERVOIR(PROJECTED) | RESERVOIR(FLUCT) |
| BEACHES | | |
| MARINAS | | |
| PARKING | | |
| PICNIC | | |
| RESIDENTIAL(12 U/A) | | |
| RESIDENTIAL(2 U/A) | | |
| MIXING | | |
| PRIMARY ROADS | | |
| SECONDARY ROADS | | |
| FISHING | | |
| FIELD SPORTS | | |
| SWIMMING | | |
| BOATING | | |
| AGRICULTURE | | |
| SNOWSHOE | | |
| CROSS COUNTRY SKIING | | |
| SNOWMOBILE | | |
| HUNTING | | |
| DOWNHILL SKIING | | |

SITE TYPE VARIABLES

TOPOGRAPHIC SLOPE
SOIL TYPE
SOIL MOISTURE

LEGEND
0 = NO IMPACT
1 = COMPATIBLE IMPACT BY GROUP 2
2 = COMPATIBLE IMPACT BY GROUPS 1,2
3 = MODERATE IMPACT BY GROUP 2
4 = MODERATE IMPACT BY GROUPS 1,2
5 = SEVERE IMPACT BY GROUP 2
6 = SEVERE IMPACT BY GROUPS 1,2
7 = THRESHOLD IMPACT BY GROUP 2
8 = THRESHOLD IMPACT BY GROUPS 1,2

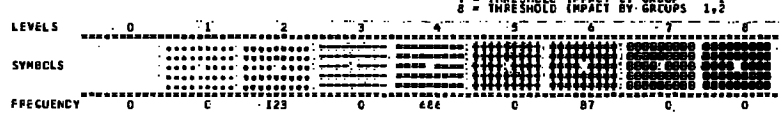



Fig. V.10
Vulnerability to Water Fluctuation Damage - Dry Beach

RESOURCE SYSTEM 11: Wet Beach

IMPACT: Vulnerability to Water Fluctuation Damage (Figure V.11)

SITE TYPE VARIABLES: The variables are listed in the order by which they contribute to the definition of site types for the analysis of this resource system. The Variable Ranges are described from the most vulnerable to the least vulnerable.

| REF. | VARIABLE | REF. | RANGE | |
|---|---|---|---|---|
| 3&4 | Topographic Slope | 0,5-9 | None, 10-35+% | Slope not useful for bathing, highly erodible. |
| | | 2,4 | 4-10% | |
| | | 1 | 0-4% | Slope best adapted to recreational use; erosion slight. |
| 6 | Soil Type | 0,5, 6,7 | Peat, silts, clays | Easily disturbed, stay in suspension in water; turbid water and muddy bottom unsatisfactory for bathing. |
| | | 1,3 | Coarse gravel sands | |
| | | 2,4 | Fine gravel sands | Not as conducive to plant growth. Ideal for bathing purposes. |

## RELATIVE IMPACT OF LAND USE

Key: 0: none
I: see Matrix I
II: see Matrix II

### 1. SUMMER PLAN

1.1. Hunting_____
1.2. Fishing_____
1.3. Swimming_____
1.4. Trail/Hiking_____
1.5. Camping_____
1.6. Picnicking_____
1.7. Boating_____
1.7. Marina_____
1.8. Residential 12u/a___
1.8. Residential 2u/a___
1.9. Parking_____
1.10. Major Roads_____
1.11. Secondary Roads____
1.12. Agriculture_____

### 2. WINTER PLAN

2.1. Hunting_____
2.2. Snowshoeing_____
2.3. X-Country Ski_____
2.4. Trail/Hiking_____
2.5. Snow Mobiling_____
2.6. Downhill Ski_____
2.7. Ice Skating_____
2.8. Residential 12u/a___
2.8. Residential 2u/a___
2.9. Parking_____
2.10. Major Roads_____
2.11. Secondary Roads____

NOTE A:

During normal seasonal reservoir operation, the frequency of fluctuation would not cause serious effects to the site; See Matrix I.

If reservoir operation enters daily fluctuation, the frequency would cause serious site problems and user conflicts via unpredictable depths and position of water: See Matrix II.

## IMPACT ON RESOURCE SYSTEM BY SITE TYPE

Key: 4: Threshold
3: Severe
2: Moderate
1: Compatible

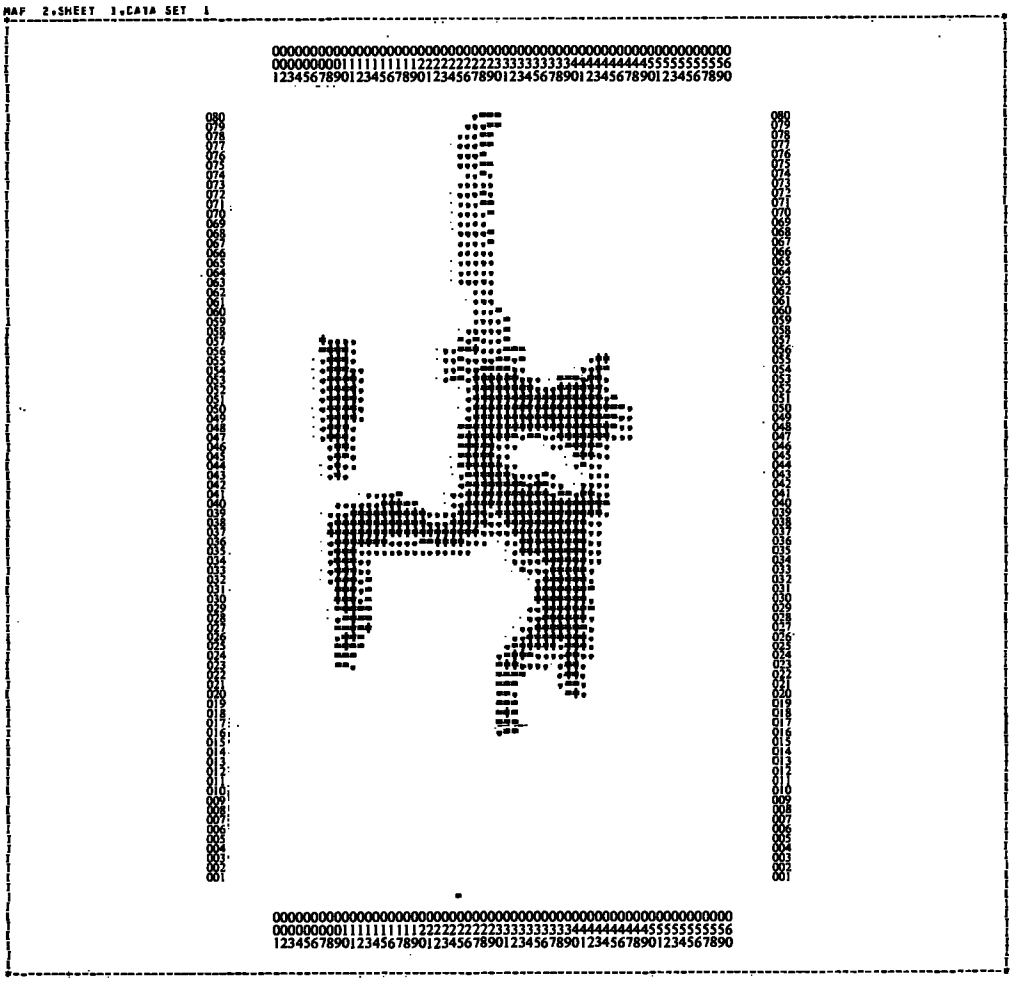
| SOIL TYPE \ TOPOGRAPHIC SLOPE | 0 | 2,4 | 5-9, 1 |
|---|---|---|---|
| 5,6,7 | 3 | 2 | 2 |
| 1,3 | 2 | 1 | 1 |
| 2,4 | 1 | 1 | 1 |

Matrix I

| TOPOGRAPHIC SLOPE | 0 | 2,4 | 5-9, 1 |
|---|---|---|---|
| | 3 | 3 | 3 |
| | 3 | 2 | 1 |
| | 2 | 1 | 1 |

Matrix II

MAP 2,SHEET 1,DATA SET 1



VULNERABILITY TO WATER FLUCTUATION DAMAGE

RESOURCE SYSTEM - WET BEACH

HONEY HILL CASE STUDY

THE LAND USES ARE GROUPED ON THE BASIS OF THEIR HAVING SIMILAR IMPACTS ON THIS RESOURCE SYSTEM. THE MAP SHOWS FOR EACH CELL (SITE TYPE) THE SEVEREST IMPACT AND THE GROUP OF LAND USES WITH THE LOWEST POTENTIAL DAMAGE WHICH CAUSES THAT IMPACT. IT IS ASSUMED THAT LAND USES OF HIGHER POTENTIAL IMPACT CAUSE THE SAME DAMAGE.
FOR THIS ANALYSIS IT IS ASSUMED THAT THE LEVEL OF ACTIVITY FOR EACH LAND USE DOES NOT EXCEED THE STANDARDS USED IN THIS ANALYSIS MODEL.

GROUP (0)

CAMPING
BEACHES
MARINAS
PARKING
PICNIC
RESIDENTIAL(12 U/A)
RESIDENTIAL(2 U/A)
HIKING
PRIMARY ROADS
SECONDARY ROADS
FISHING
FIELD SPORTS
SWIMMING
BOATING
AGRICULTURE
SNOWSHOE
CROSS COUNTRY SKIING
SNOWMOBILE
HUNTING
DOWNHILL SKIING

GROUP (1)

RESERVOIR(PROJECTED)

GROUP (2)

RESERVOIR(FLUCT)

SITE TYPE VARIABLES

TOPOGRAPHIC SLOPE
SOIL TYPE

LEGEND
0 = NO IMPACT
1 = COMPATIBLE IMPACT BY GROUP 2
2 = COMPATIBLE IMPACT BY GROUPS 1,2
3 = MODERATE IMPACT BY GROUP 2
4 = MODERATE IMPACT BY GROUPS 1,2
5 = SEVERE IMPACT BY GROUP 2
6 = SEVERE IMPACT BY GROUPS 1,2
7 = THRESHOLD IMPACT BY GROUP 2
8 = THRESHOLD IMPACT BY GROUPS 1,2

| LEVELS | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|---|---|
| SYMBOLS | | | | | | | | | |
| FREQUENCY | 0 | 0 | 134 | 0 | 130 | 0 | 432 | 0 | 0 |

Fig. V.11
Vulnerability to Water Fluctuation Damage - Wet Beach

## CHAPTER VI: THE EFFECTS OF ACTIVITIES ON THE SITE RESOURCE SYSTEMS: "IMPACT"

### A. TOTAL IMPACT

The models described in the previous chapter have defined the potential impact of each activity on each site resource system on each cell. These could be mapped separately so as to show the relative potential damage to each resource system of locating each activity. The model as stored in the computer retains this detailed level of information. We find it convenient, however, to summarize these potential impacts across all the site resource systems for each activity. The concept of "total impact" must be clearly understood to be indefensible, since it combines with equal importance such diverse evaluations as visual quality, insect habitat, and surface water pollution. Clearly these cannot be so simplistically combined (if at all). Rather, we see the total impact maps as being a necessary and convenient short cut to a "quick and dirty" evaluation of the relative potential damage of locating the activities.

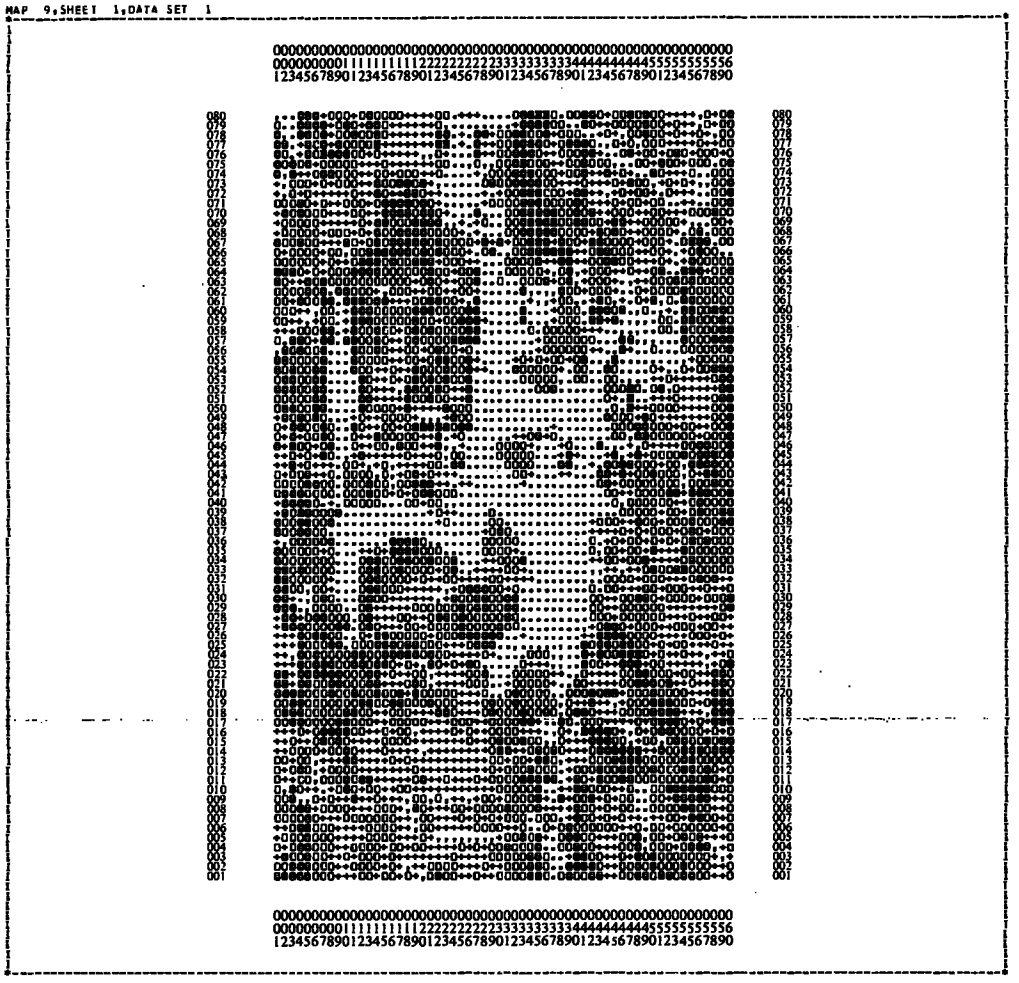
In order to produce these maps, the impacts of each activity were evaluated for each system on a scale of 1 (none) to 4 (threshhold) and the values generated by the models in the previous chapter were simply added. Thus, on the figures in this chapter, one should be very cautious in ascribing real meaning to the graphic symbols. Rather, the figures should be read as, at best, indicating the relative probability of high impact on the vulnerable site resource systems. In reading the following figures, the darker symbolism represents the greatest potential impact on the site resource systems of locating the specific activity being mapped. The lightest symbols are probably the safer locations.

The following Figures, VI.1 through VI.25, show the total impact of the potential project activities. A detailed description of the impacts of one activity, major roads, is then presented as an example of the use of models in Figures VI.26 through VI.36.

### B. THE IMPACTS OF HIGHWAYS ON THE SITE RESOURCE SYSTEMS

This section describes the application of the resource system vulnerability models in evaluating the potential impact of one example activity, major roads.

MAP 9,SHEET 1,DATA SET 1



WINTER LAND USE ACTIVITY - HUNTING

TOTAL IMPACT ON 11 RESOURCE SYSTEMS

HONEY HILL CASE STUDY

THIS ANALYSIS SHOWS THE TOTAL IMPACT ON ALL RESOURCE SYSTEMS CAUSED BY THIS LAND USE ACTIVITY.

LEGEND
0 = AREAS OF LEAST IMPACT
TO
9 = AREAS OF MOST IMPACT

DATA MAPPED IN 10 LEVELS BETWEEN EXTREME VALUES OF 3.00 AND 8.00

ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| MINIMUM | 3.00 | 3.50 | 4.00 | 4.50 | 5.00 | 5.50 | 6.00 | 6.50 | 7.00 | 7.50 |
| MAXIMUM | 3.50 | 4.00 | 4.50 | 5.00 | 5.50 | 6.00 | 6.50 | 7.00 | 7.50 | 8.00 |

PERCENTAGE OF TOTAL ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

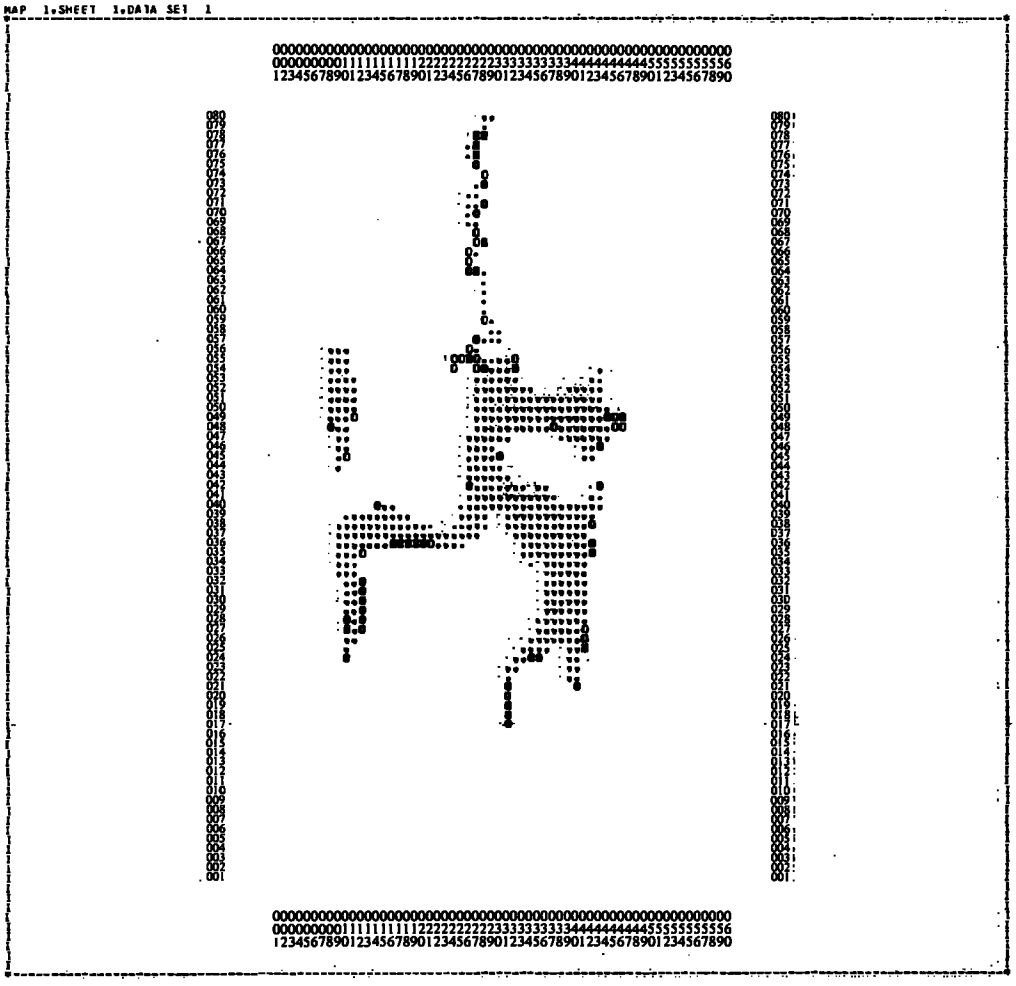
| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 |

FREQUENCY DISTRIBUTION OF DATA POINT VALUES IN EACH LEVEL

| LEVELS | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|---|
| SYMBOLS | | | | | | | | | | |
| FREQUENCY | 781 | 155 | 0 | 1077 | 0 | 1872 | 0 | 851 | 0 | 24 |

Fig. VI.1
Total Impact: Hunting

MAP 1.SHEET 1.DATA SET 1



SUMMER LAND USE ACTIVITY - FISHING

TOTAL IMPACT ON 11 RESOURCE SYSTEMS

HONEY HILL CASE STUDY

THIS ANALYSIS SHOWS THE TOTAL IMPACT ON ALL RESOURCE SYSTEMS CAUSED BY THIS LAND USE ACTIVITY.

LEGEND
0 = AREAS OF LEAST IMPACT
TO
9 = AREAS OF MOST IMPACT

DATA MAPPED IN 10 LEVELS BETWEEN EXTREME VALUES OF 5.00 AND 9.00

ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| MINIMUM | 5.00 | 5.40 | 5.80 | 6.20 | 6.60 | 7.00 | 7.40 | 7.80 | 8.20 | 8.60 |
| MAXIMUM | 5.40 | 5.80 | 6.20 | 6.60 | 7.00 | 7.40 | 7.80 | 8.20 | 8.60 | 9.00 |

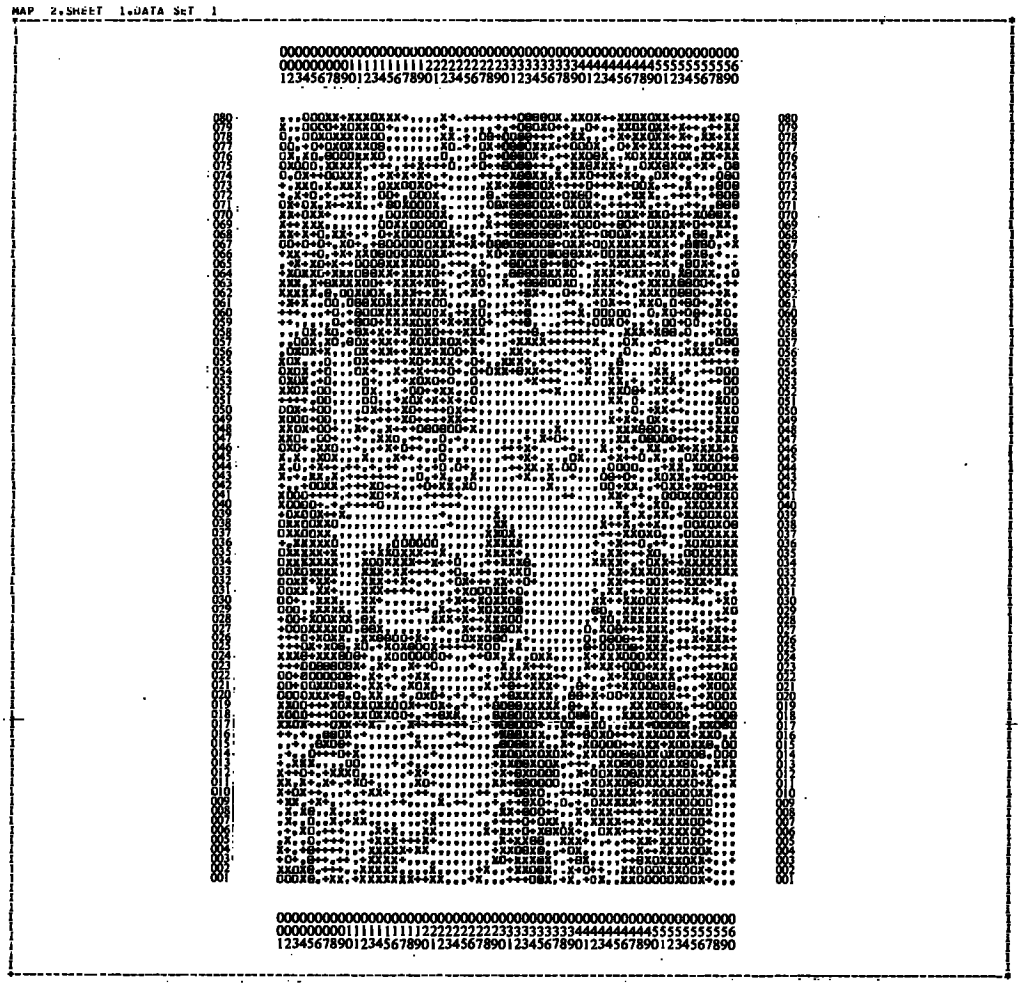
PERCENTAGE OF TOTAL ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 |

FREQUENCY DISTRIBUTION OF DATA POINT VALUES IN EACH LEVEL

| LEVELS | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|---|
| SYMBOLS | | | | | | | | | | |
| FREQUENCY | 34 | 0 | 414 | 0 | 0 | 24 | 0 | 34 | 0 | 14 |

Fig. VI.2
Total Impact: Fishing




SUMMER LAND USE ACTIVITY - BEACHES

TOTAL IMPACT ON 11 RESOURCE SYSTEMS

MONEY HILL CASE STUDY

THIS ANALYSIS SHOWS THE TOTAL IMPACT ON ALL RESOURCE SYSTEMS CAUSED BY THIS LAND USE ACTIVITY.

LEGEND
0 = AREAS OF LEAST IMPACT
TO
9 = AREAS OFMOST IMPACT

DATA MAPPED IN 10 LEVELS BETWEEN EXTREME VALUES OF 0.00 AND 18.00

ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| MINIMUM | 8.00 | 9.00 | 10.00 | 11.00 | 12.00 | 13.00 | 14.00 | 15.00 | 16.00 | 17.00 |
| MAXIMUM | 9.00 | 10.00 | 11.00 | 12.00 | 13.00 | 14.00 | 15.00 | 16.00 | 17.00 | 18.00 |

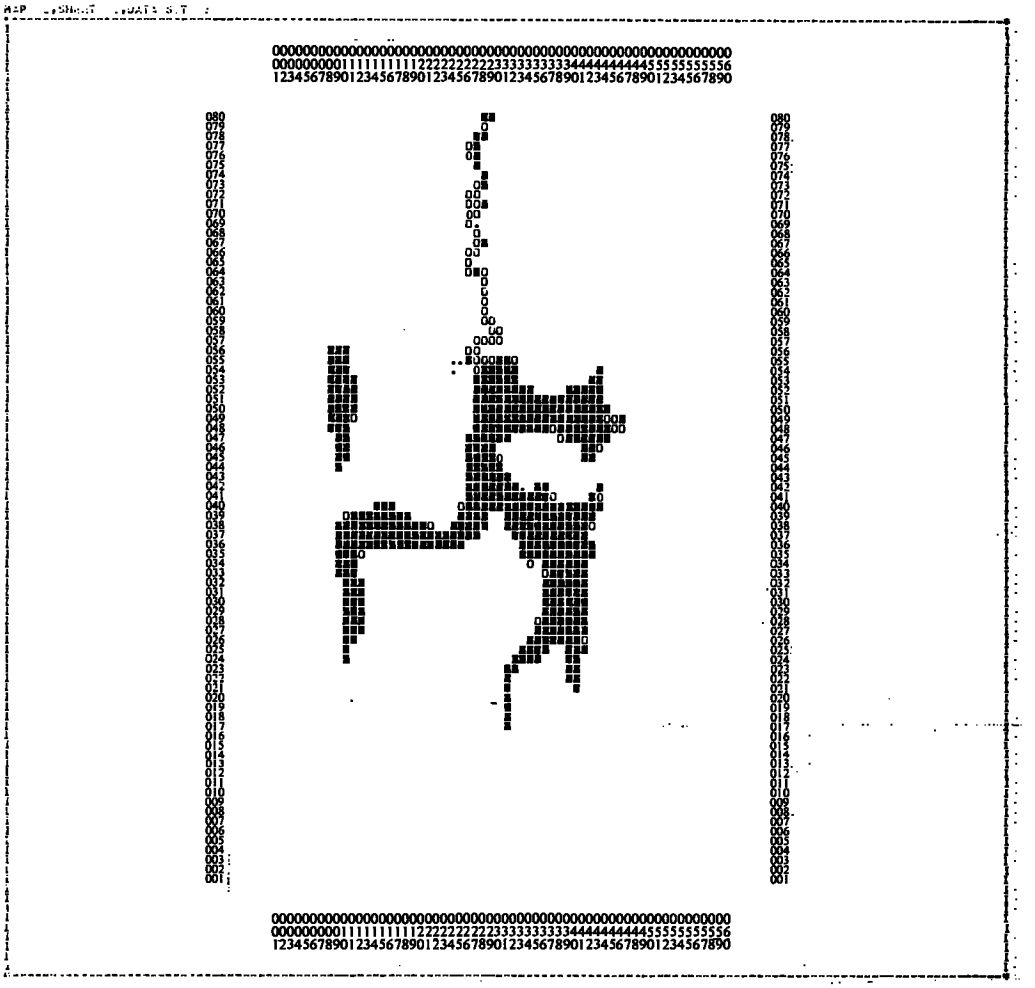
PERCENTAGE OF TOTAL ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 |

FREQUENCY DISTRIBUTION OF DATA POINT VALUES IN EACH LEVEL

| LEVELS | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|---|
| SYMBOLS | | | | | | | | | | |
| FREQUENCY | 47 | 868 | 664 | 1011 | 1234 | 765 | 176 | 33 | 1 | 1 |

Fig. VI.3
Total Impact: Swimming (Beach)



SUMMER LAND US. ACTIVITY - SWIMMING

TOTAL IMPACT ON 12 RESOURCE SYSTEMS

HONEY HILL CASE STUDY

THIS ANALYSIS SHOWS THE TOTAL IMPACT ON ALL RESOURCE SYSTEMS CAUSED BY THIS LAND USE ACTIVITY.

LEGEND
0 = AREAS OF LEAST IMPACT
TO
9 = AREAS OF MOST IMPACT

DATA MAPPED IN 10 LEVELS BETWEEN EXTREME VALUES OF 3.00 AND 5.00 MEAN = 4.87 ST. DEV. = 6.50

ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| MINIMUM | 3.00 | 3.20 | 3.40 | 3.60 | 3.80 | 4.00 | 4.20 | 4.40 | 4.60 | 4.80 |
| MAXIMUM | 3.20 | 3.40 | 3.60 | 3.80 | 4.00 | 4.20 | 4.40 | 4.60 | 4.80 | 5.00 |

PERCENTAGE OF TOTAL ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

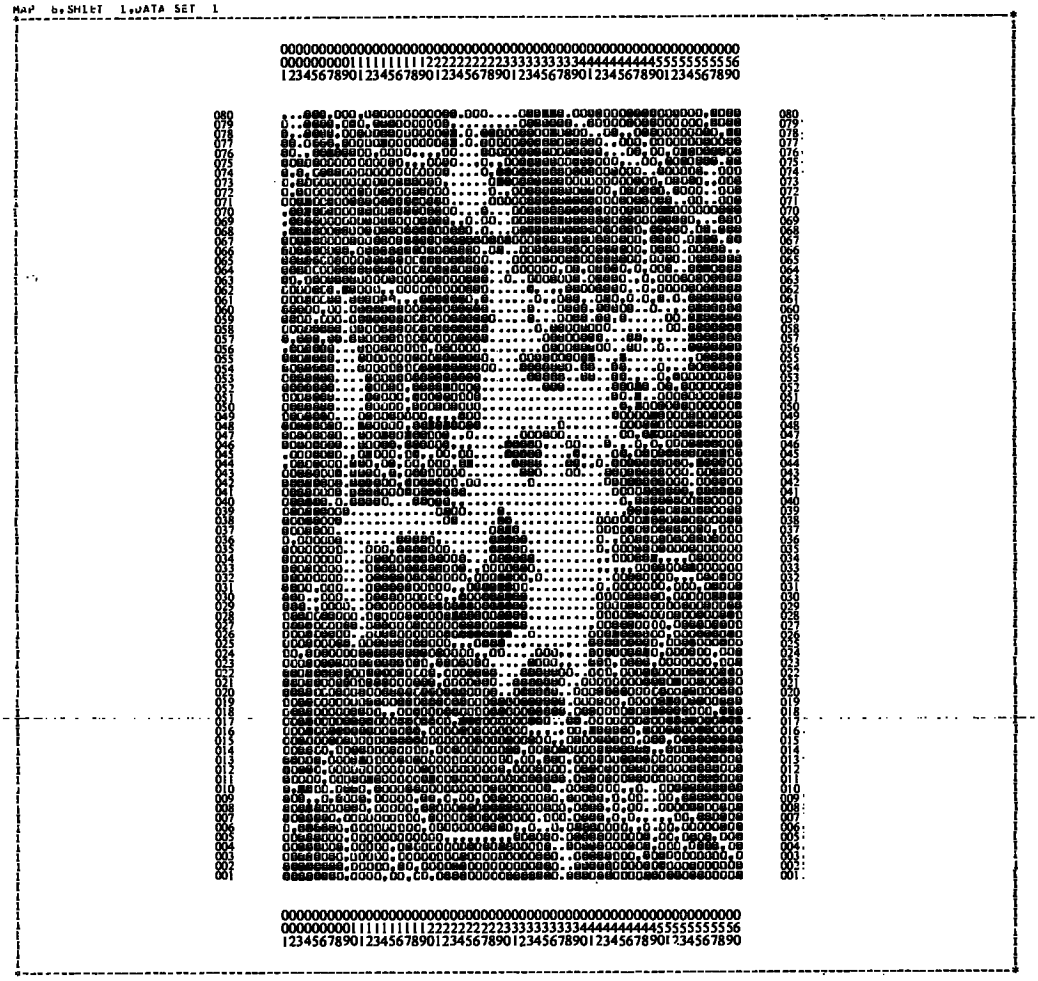
| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 |

FREQUENCY DISTRIBUTION OF DATA POINT VALUES IN EACH LEVEL

| LEVELS | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|---|
| SYMBOLS | ..... | ..... | ..... | ..... | ++++ ++++ | XXXX XXXX | 0000 0000 | 0000 0000 | ▒▒▒▒ ▒▒▒▒ | ▒▒▒▒ ▒▒▒▒ |
| FREQUENCY | 0 | 0 | 0 | 0 | 0 | 57 | 0 | 0 | 0 | 456 |

Fig. VI.4
Total Impact: Swimming (Water)

MAP 6,SHEET 1,DATA SET 1



SUMMER LAND USE ACTIVITY - HIKING

TOTAL IMPACT ON 11 RESOURCE SYSTEMS

HONEY HILL CASE STUDY

THIS ANALYSIS SHOWS THE TOTAL IMPACT ON ALL RESOURCE SYSTEMS CAUSED BY THIS LAND USE ACTIVITY.

LEGEND
0 = AREAS OF LEAST IMPACT
TO
9 = AREAS OFMOST IMPACT

DATA MAPPED IN 10 LEVELS BETWEEN EXTREME VALUES OF 2.00 AND 6.00

ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| MINIMUM | 2.00 | 2.40 | 2.80 | 3.20 | 3.60 | 4.00 | 4.40 | 4.80 | 5.20 | 5.60 |
| MAXIMUM | 2.40 | 2.80 | 3.20 | 3.60 | 4.00 | 4.40 | 4.80 | 5.20 | 5.60 | 6.00 |

PERCENTAGE OF TOTAL ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

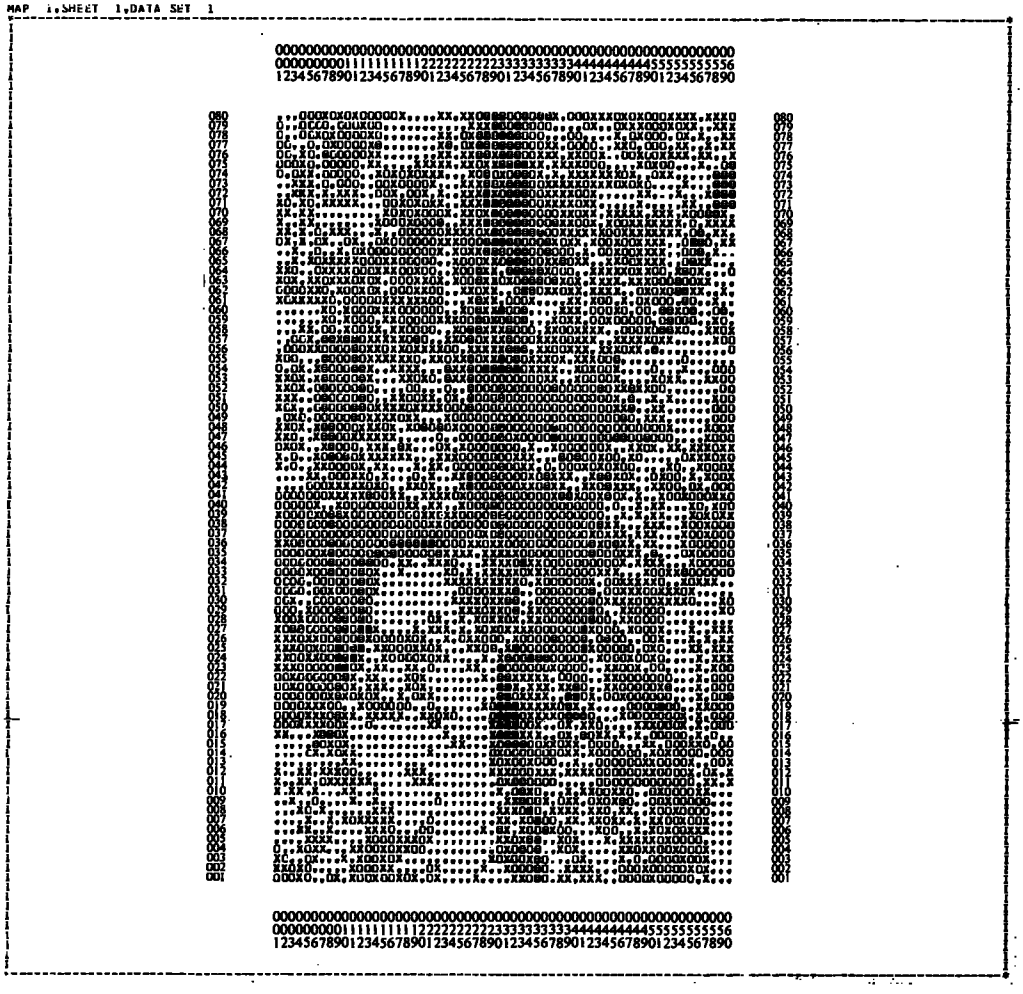
| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 12.00 | 12.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 |

FREQUENCY DISTRIBUTION OF DATA POINT VALUES IN EACH LEVEL

| LEVELS | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|---|
| SYMBOLS | | | | | | | | | | |
| FREQUENCY | 756 | 0 | 266 | 0 | 0 | 1948 | 0 | 1719 | 0 | 49 |

Fig. VI.5
Total Impact: Hiking

MAP 1,SHEET 1,DATA SET 1



SUMMER LAND USE ACTIVITY - CAMPING

TOTAL IMPACT ON 11 RESOURCE SYSTEMS

HONEY HILL CASE

THIS ANALYSIS SHOWS THE TOTAL IMPACT ON ALL RESOURCE SYSTEMS CAUSED BY THIS LAND USE ACTIVITY.

LEGEND
0 = AREAS OF LEAST IMPACT
TO
9 = AREAS OFMOST IMPACT

DATA MAPPED IN 10 LEVELS BETWEEN EXTREME VALUES OF 10.00 AND 17.00

ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| MINIMUM | 10.00 | 10.70 | 11.40 | 12.10 | 12.80 | 13.50 | 14.20 | 14.90 | 15.60 | 16.30 |
| MAXIMUM | 10.70 | 11.40 | 12.10 | 12.80 | 13.50 | 14.20 | 14.90 | 15.60 | 16.30 | 17.00 |

PERCENTAGE OF TOTAL ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

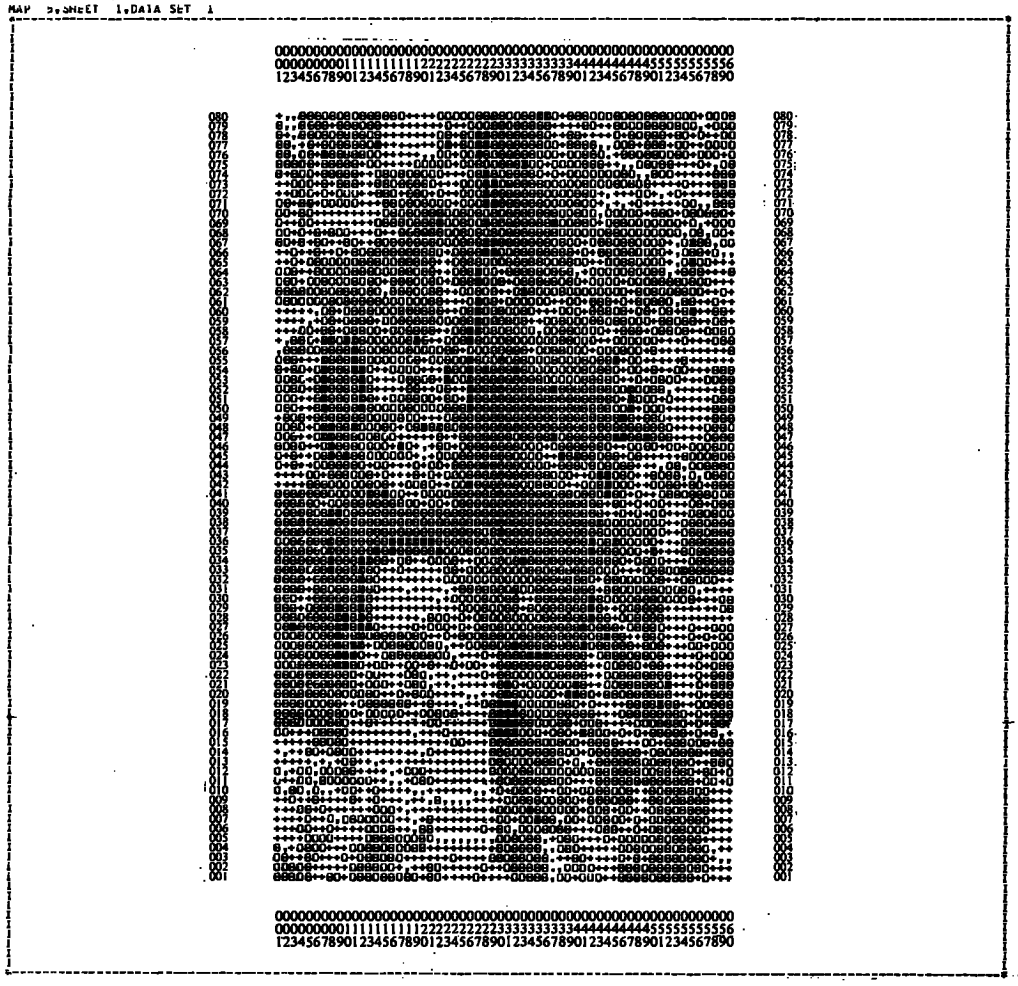
| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 |

FREQUENCY DISTRIBUTION OF DATA POINT VALUES IN EACH LEVEL

| LEVELS | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|---|
| SYMBOLS | . | . | . | + | X | 0 | 8 | # | M | W |
| FREQUENCY | 13 | 134 | 1201 | 0 | 1351 | 1738 | 0 | 275 | 46 | 2 |

Fig. VI.6
Total Impact: Camping

MAP 5,SHEET 1,DATA SET 1



SUMMER LAND USE ACTIVITY - PICNICKING

TOTAL IMPACT ON 11 RESOURCE SYSTEMS

HONEY HILL CASE STUDY

THIS ANALYSIS SHOWS THE TOTAL IMPACT ON ALL RESOURCE SYSTEMS CAUSED BY THIS LAND USE ACTIVITY.

LEGEND
0 = AREAS OF LEAST IMPACT
10
9 = AREAS OFMOST IMPACT

DATA MAPPED IN 10 LEVELS BETWEEN EXTREME VALUES OF 8.00 AND 14.00

ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| MINIMUM | 8.00 | 8.80 | 9.60 | 9.80 | 10.40 | 11.00 | 11.60 | 12.20 | 12.80 | 13.40 |
| MAXIMUM | 8.80 | 9.20 | 9.80 | 10.40 | 11.00 | 11.60 | 12.20 | 12.80 | 13.40 | 14.00 |

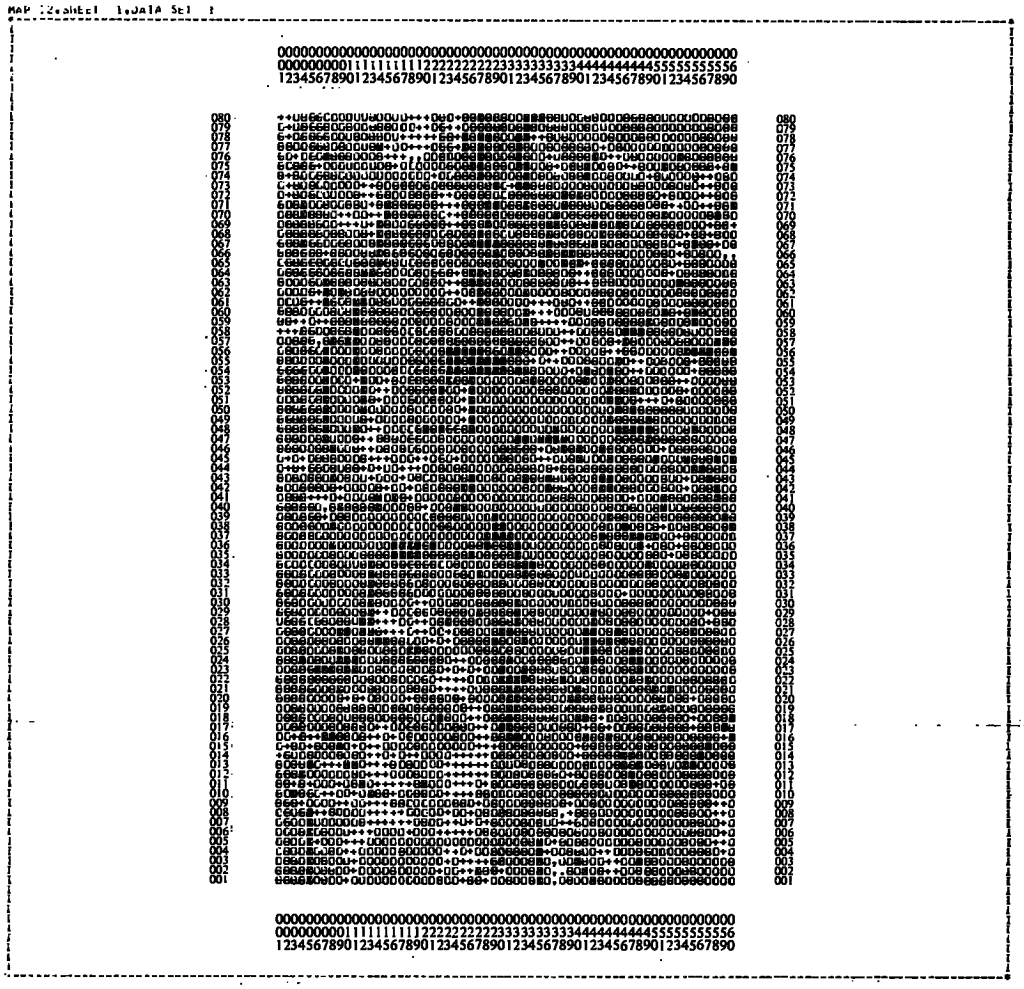
PERCENTAGE OF TOTAL ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 |

FREQUENCY DISTRIBUTION OF DATA POINT VALUES IN EACH LEVEL

| LEVELS | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|---|
| SYMBOLS | | | | | | | | | | |
| FREQUENCY | 3 | 115 | 0 | 1161 | 0 | 1470 | 1814 | 0 | 171 | 6 |

Fig. VI.7
Total Impact: Picnicking



SUMMER,LAND USE ACTIVITY - FIELD SPORTS

TOTAL IMPACT ON 11 RESOURCE SYSTEMS

HONEY HILL CASE STUDY

THIS ANALYSIS SHOWS THE TOTAL IMPACT ON ALL RESOURCE SYSTEMS CAUSED BY THIS LAND USE ACTIVITY.

LEGEND
0 = AREAS OF LEAST IMPACT
(0)
9 = AREAS OFMOST IMPACT

DATA MAPPED IN 10 LEVELS BETWEEN EXTREME VALUES OF 6.00 AND 12.00

ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| MINIMUM | 6.00 | 6.40 | 7.20 | 7.80 | 8.40 | 9.00 | 9.60 | 10.20 | 10.80 | 11.40 |
| MAXIMUM | 6.40 | 7.20 | 7.80 | 8.40 | 9.00 | 9.60 | 10.20 | 10.80 | 11.40 | 12.00 |

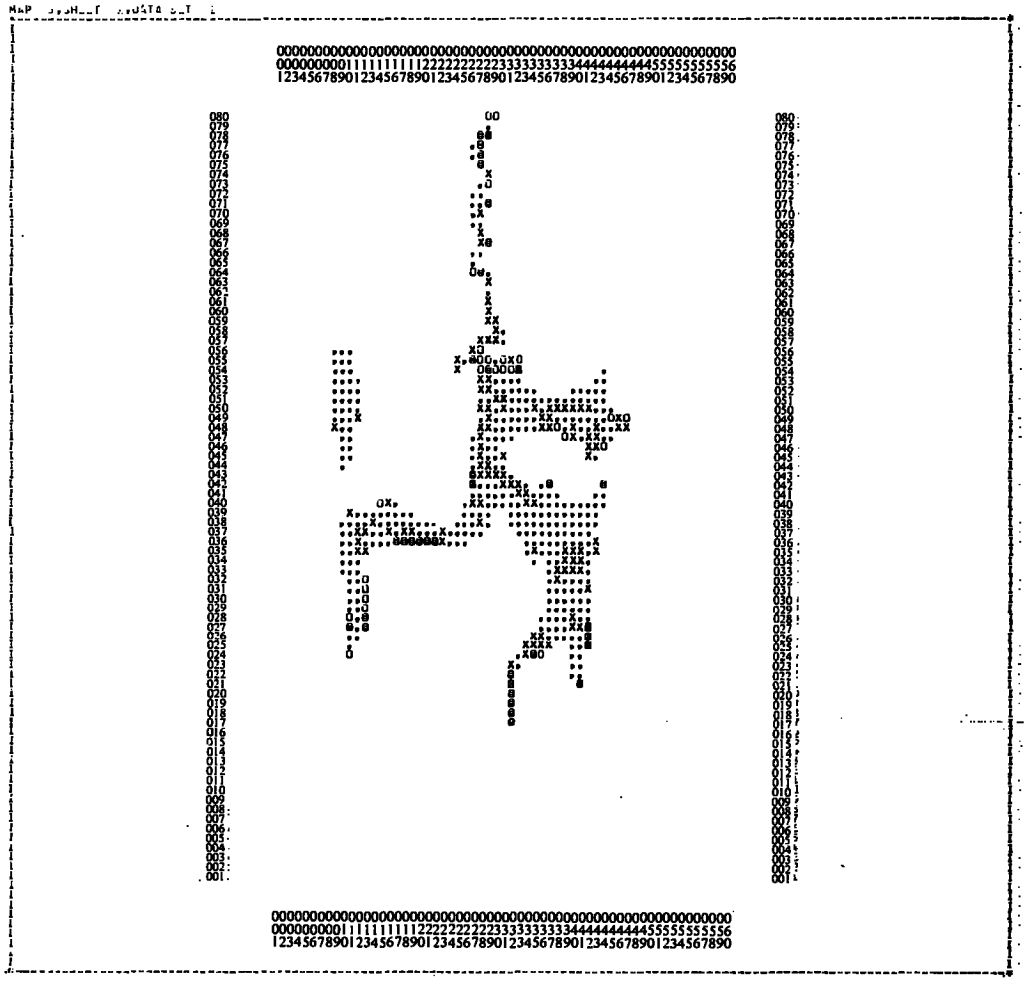
PERCENTAGE OF TOTAL ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 |

FREQUENCY DISTRIBUTION OF DATA POINT VALUES IN EACH LEVEL

| LEVELS | 2 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|---|
| SYMBOLS | ..... | ..... | ..... | ++++++++ | XXXXXXXX | 00000000 | 00000000 | 00000000 | ..... | ..... |
| | ..... | ..... | ..... | ++++++++ | XXXXXXXX | 00000000 | 00000000 | 00000000 | ..... | ..... |
| | ..... | ..... | ..... | ++++ ++++ | XXXX XXXX | 0000 0000 | 0000 0000 | 0000 0000 | ..... | ..... |
| | ..... | ..... | ..... | ++++++++ | XXXXXXXX | 00000000 | 00000000 | 00000000 | ..... | ..... |
| | ..... | ..... | ..... | ++++++++ | XXXXXXXX | 00000000 | 00000000 | 00000000 | ..... | ..... |
| FREQUENCY | 1 | 16 | 0 | 499 | 0 | 2246 | 1742 | 3 | 381 | 11 |

Fig. VI.8
Total Impact: Field Sports



SUMMER LAND USE ACTIVITY - MARINA

TOTAL IMPACT ON ALL RESOURCE SYSTEMS

HONEY HILL CASE STUDY

THIS ANALYSIS SHOWS THE TOTAL IMPACT ON ALL RESOURCE SYSTEMS CAUSED BY THIS LAND USE ACTIVITY.

LEGEND
0 = AREAS OF LEAST IMPACT TO
9 = AREAS OF MOST IMPACT

DATA MAPPED IN 10 LEVELS BETWEEN EXTREME VALUES OF 15.00 AND 22.00 MEAN = 17.52 ST. DEV. = 24.30

ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| MINIMUM | 15.00 | 15.70 | 16.40 | 17.10 | 17.80 | 18.50 | 19.20 | 19.90 | 20.60 | 21.30 |
| MAXIMUM | 15.70 | 16.40 | 17.10 | 17.80 | 18.50 | 19.20 | 19.90 | 20.60 | 21.30 | 22.00 |

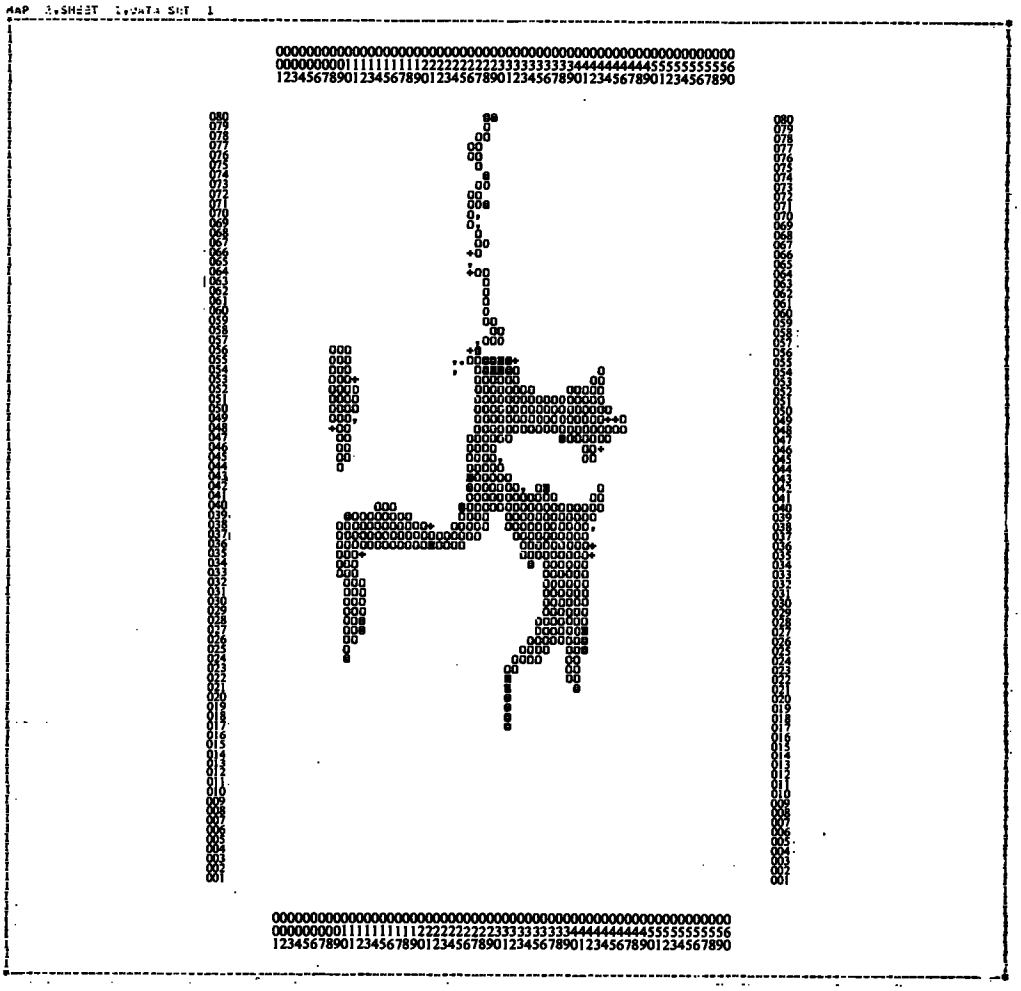
PERCENTAGE OF TOTAL ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 |

FREQUENCY DISTRIBUTION OF DATA POINT VALUES IN EACH LEVEL

| LEVELS | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|---|
| SYMBOLS | . | , | : | + | X | O | @ | # | = | * |
| FREQUENCY | 1 | 3 | 341 | 0 | 112 | 26 | 0 | 27 | 7 | 1 |

Fig. VI.9
Total Impact: Marinas



SUMMER LAND USE ACTIVITY - BOATING

TOTAL IMPACT ON 11 RESOURCE SYSTEMS

HONEY HILL CASE STUDY

THIS ANALYSIS SHOWS THE TOTAL IMPACT ON ALL RESOURCE SYSTEMS CAUSED BY THIS LAND USE ACTIVITY.

LEGEND
0 = AREAS OF LEAST IMPACT
TO
9 = AREAS OF MOST IMPACT

DATA MAPPED IN 10 LEVELS BETWEEN EXTREME VALUES OF 9.00 AND 14.00 MEAN = 12.00 ST. DEV. = 1.00

ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| MINIMUM | 9.00 | 9.50 | 10.00 | 10.50 | 11.00 | 11.50 | 12.00 | 12.50 | 13.00 | 13.50 |
| MAXIMUM | 9.50 | 10.00 | 10.50 | 11.00 | 11.50 | 12.00 | 12.50 | 13.00 | 13.50 | 14.00 |

PERCENTAGE OF TOTAL ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

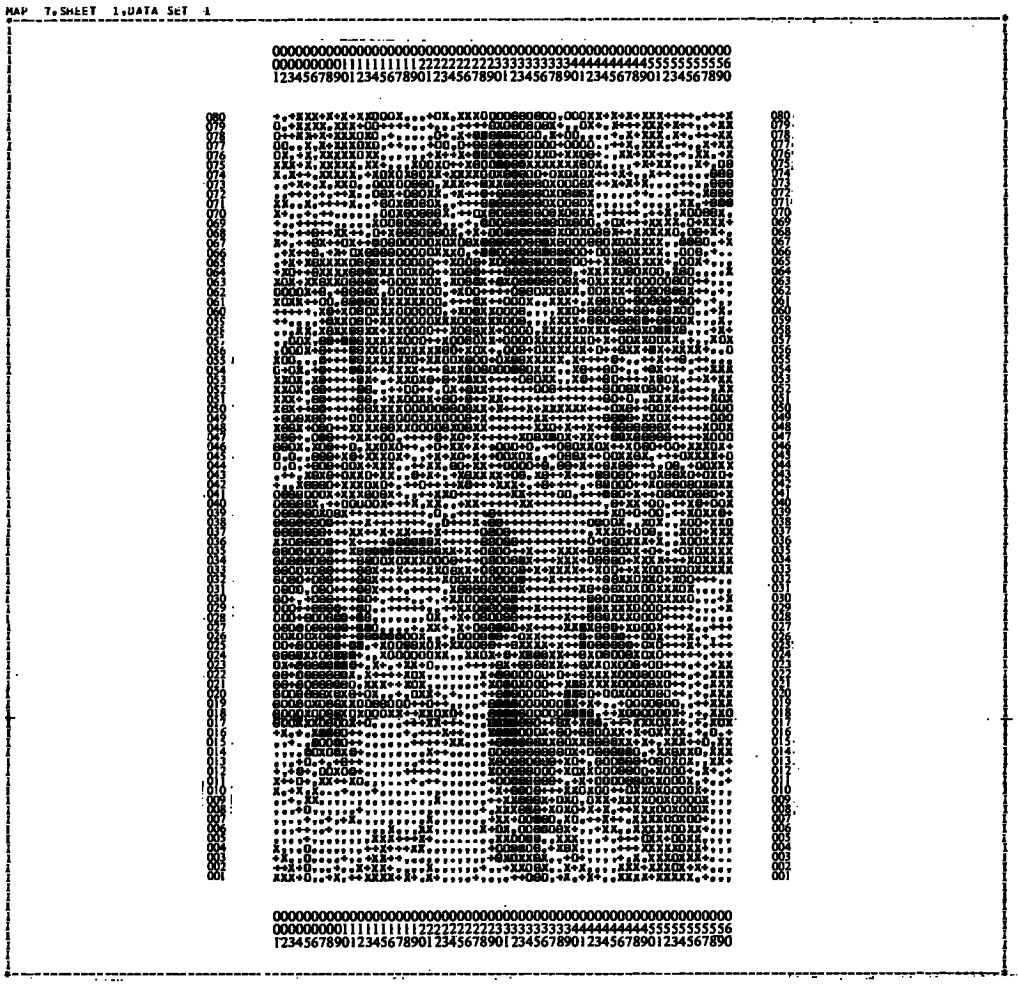
| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 |

FREQUENCY DISTRIBUTION OF DATA POINT VALUES IN EACH LEVEL

| LEVELS | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|---|
| SYMBOLS | ..... | ..... | ..... | +++++++++ | XXXXXXXXX | 000000000 | 888888888 | ********* | ######### | ######### |
| FREQUENCY | 1 | 10 | 0 | 13 | 0 | 452 | 0 | 25 | 0 | 9 |

Fig. VI.10
Total Impact: Boating

MAP 7, SHEET 1, DATA SET 1



SUMMER LAND USE ACTIVITY - RESIDENTIAL 12 UNITS/ACRE1

TOTAL IMPACT ON 11 RESOURCE SYSTEMS

HONEY HILL CASE STUDY

THIS ANALYSIS SHOWS THE TOTAL IMPACT ON ALL RESOURCE SYSTEMS CAUSED BY THIS LAND USE ACTIVITY.

LEGEND
0 = AREAS OF LEAST IMPACT
TO
9 = AREAS OFMOST IMPACT

DATA MAPPED IN 10 LEVELS BETWEEN EXTREME VALUES OF 15.00 AND 25.00

ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| MINIMUM | 15.00 | 16.00 | 17.00 | 18.00 | 19.00 | 20.00 | 21.00 | 22.00 | 23.00 | 24.00 |
| MAXIMUM | 16.00 | 17.00 | 18.00 | 19.00 | 20.00 | 21.00 | 22.00 | 23.00 | 24.00 | 25.00 |

PERCENTAGE OF TOTAL ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 |

FREQUENCY DISTRIBUTION OF DATA POINT VALUES IN EACH LEVEL

| LEVELS | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|---|
| SYMBOLS | | | | | | | | | | |
| FREQUENCY | 27 | 224 | 575 | 1179 | 1115 | 887 | 562 | 179 | 46 | 6 |

Fig. VI.11
Total Impact: Residential (2 Units/Acre)

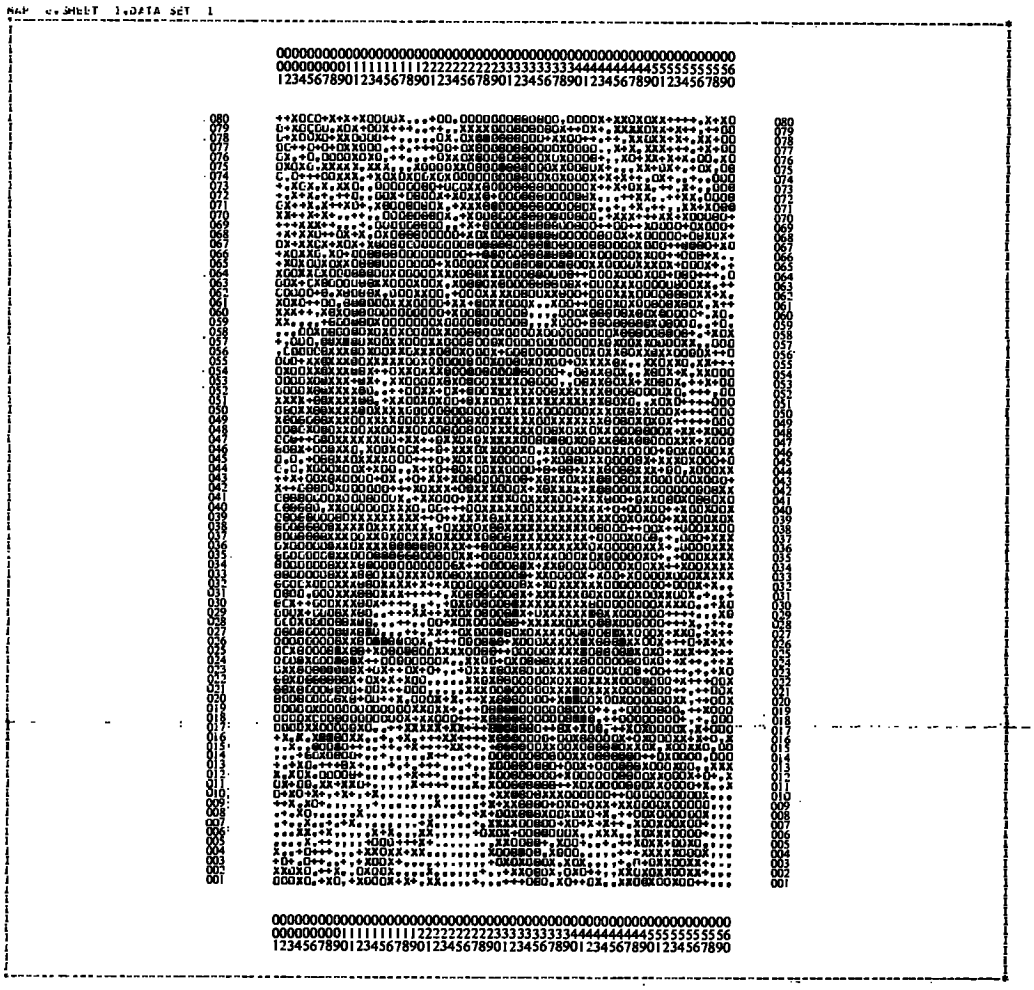
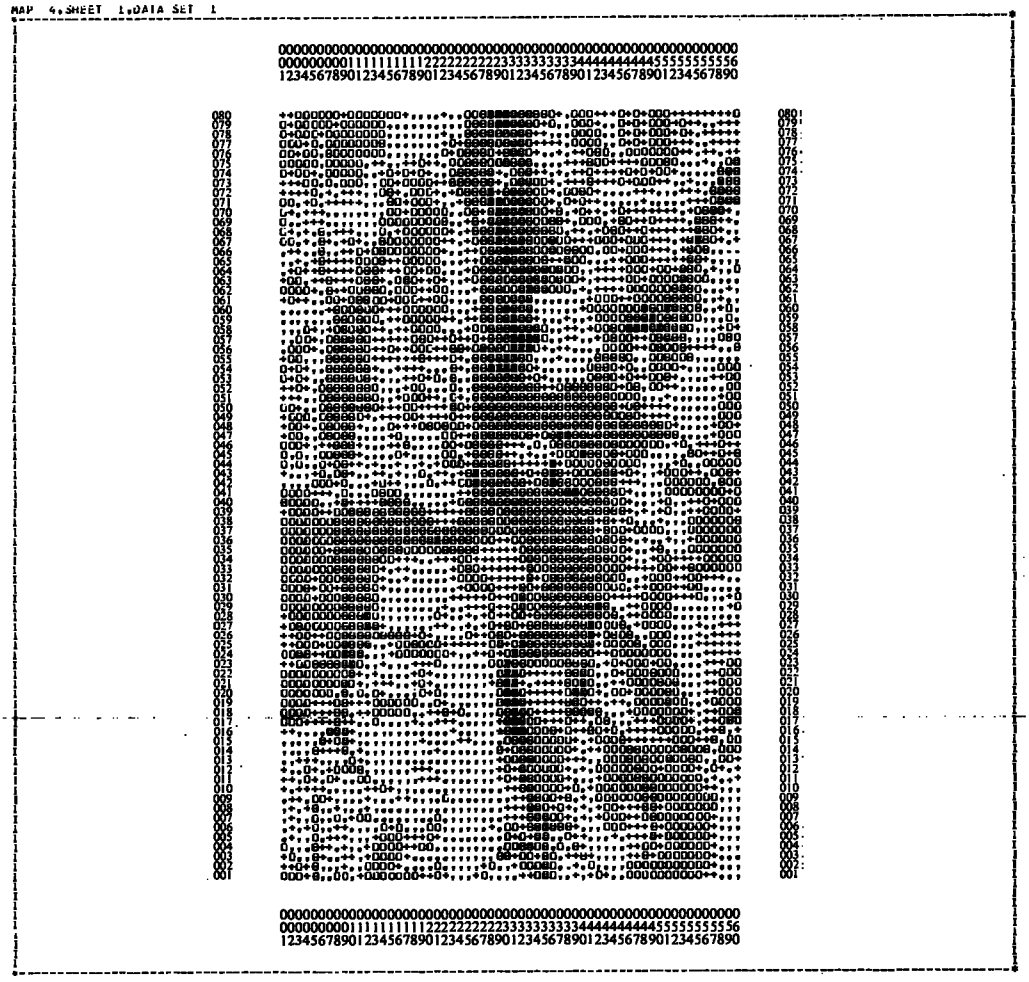



Fig. VI.12
Total Impact: Residential (12 Units/Acre)




SUMMER LAND USE ACTIVITY - PARKING

TOTAL IMPACT ON 11 RESOURCE SYSTEMS

HONEY HILL CASE STUDY

THIS ANALYSIS SHOWS THE TOTAL IMPACT ON ALL RESOURCE SYSTEMS CAUSED BY THIS LAND USE ACTIVITY.

LEGEND
0 = AREAS OF LEAST IMPACT
TO
9 = AREAS OFMOST IMPACT

DATA MAPPED IN 10 LEVELS BETWEEN EXTREME VALUES OF 9.00 AND 17.00

ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| MINIMUM | 9.00 | 9.80 | 10.60 | 11.40 | 12.20 | 13.00 | 13.80 | 14.60 | 15.40 | 16.20 |
| MAXIMUM | 9.80 | 10.60 | 11.40 | 12.20 | 13.00 | 13.80 | 14.60 | 15.40 | 16.20 | 17.00 |

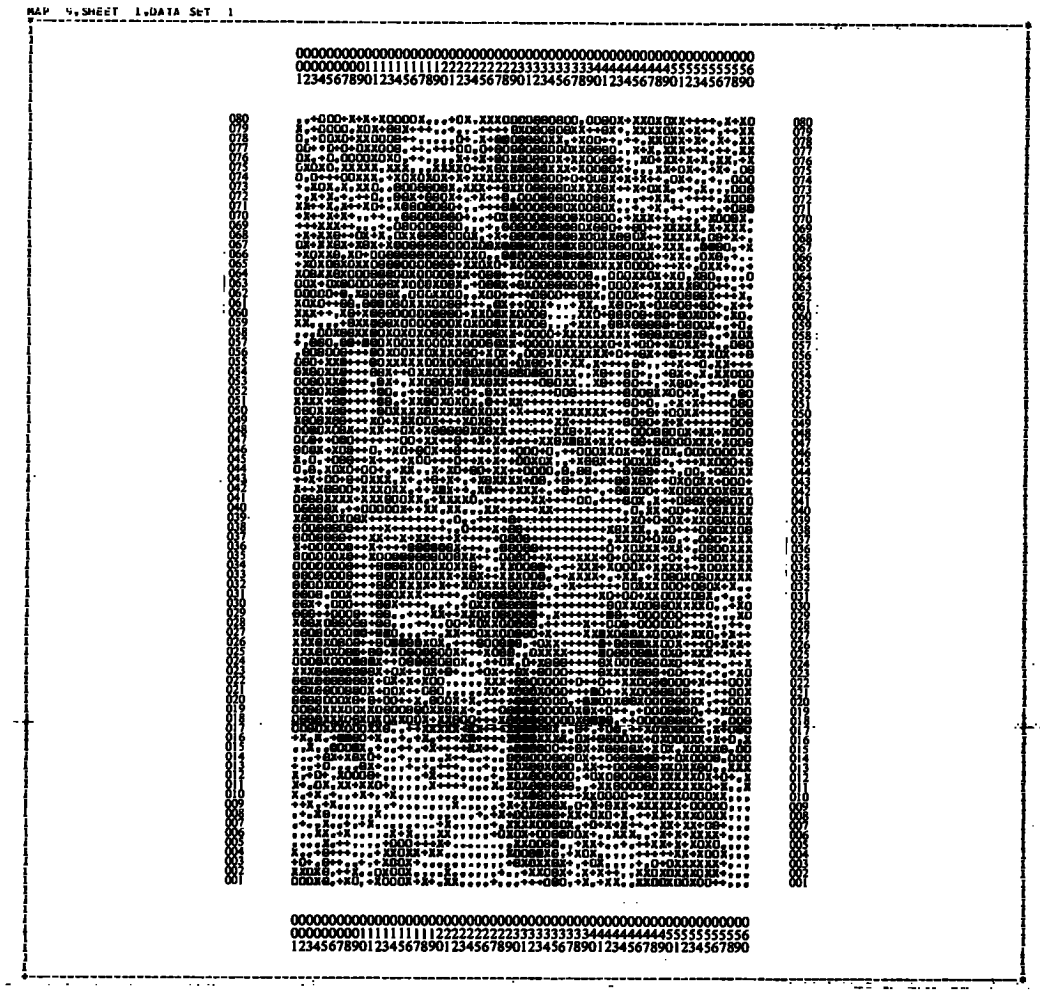
PERCENTAGE OF TOTAL ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 |

FREQUENCY DISTRIBUTION OF DATA POINT VALUES IN EACH LEVEL

| LEVELS | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|---|
| SYMBOLS | ++++++++ | XXXXXXXX | OOOOOOOO | 88888888 | | | | | | |
| FREQUENCY | 3 | 448 | 754 | 1080 | 0 | 1447 | 844 | 152 | 53 | 19 |

Fig. VI.13
Total Impact: Parking




SUMMER LAND USE ACTIVITY - PRIMARY ROADS

TOTAL IMPACT ON 11 RESOURCE SYSTEMS

HONEY HILL CASE STUDY

THIS ANALYSIS SHOWS THE TOTAL IMPACT ON ALL RESOURCE SYSTEMS CAUSED BY THIS LAND USE ACTIVITY.

LEGEND
0 = AREAS OF LEAST IMPACT
TO
9 = AREAS OFMOST IMPACT

DATA MAPPED IN 10 LEVELS BETWEEN EXTREME VALUES OF 14.00 AND 25.00

ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| MINIMUM | 14.00 | 15.10 | 16.20 | 17.30 | 18.40 | 19.50 | 20.60 | 21.70 | 22.80 | 23.90 |
| MAXIMUM | 15.10 | 16.20 | 17.30 | 18.40 | 19.50 | 20.60 | 21.70 | 22.80 | 23.90 | 25.00 |

PERCENTAGE OF TOTAL ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

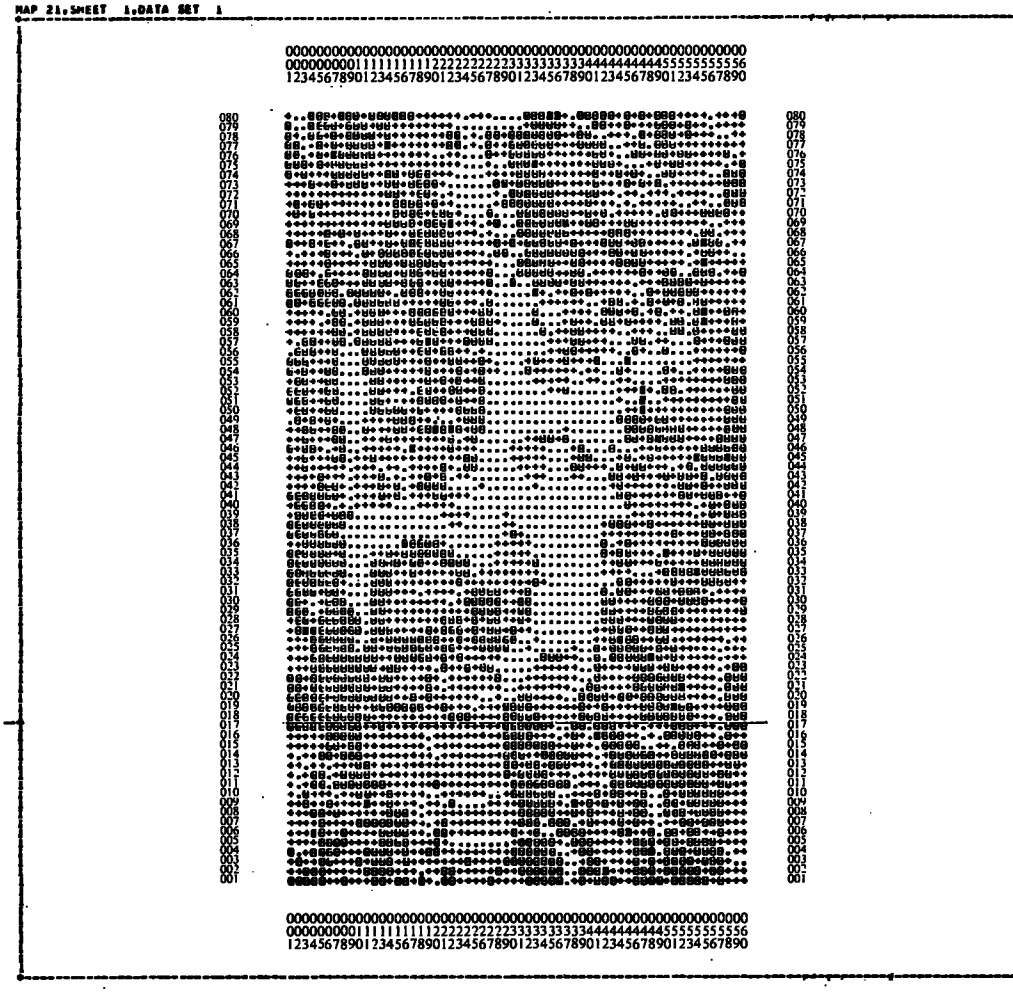
| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 |

FREQUENCY DISTRIBUTION OF DATA POINT VALUES IN EACH LEVEL

| LEVELS | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|---|
| SYMBOLS | | | | | | | | | | |
| FREQUENCY | 25 | 145 | 451 | 1167 | 1173 | 1034 | 585 | 148 | 28 | 4 |

Fig. VI.14
Total Impact: Primary Roads

MAP 21.SHEET 1.DATA SET 1



WINTER LAND USE ACTIVITY - SNOW SHOEING

TOTAL IMPACT ON 11 RESOURCE SYSTEMS

HONEY HILL CASE STUDY

THIS ANALYSIS SHOWS THE TOTAL IMPACT ON ALL RESOURCE SYSTEMS CAUSED BY THIS LAND USE ACTIVITY.

LEGEND
0 = AREAS OF LEAST IMPACT
TO
9 = AREAS OFMOST IMPACT

DATA MAPPED IN 10 LEVELS BETWEEN EXTREME VALUES OF 2.00 AND 5.00

ABSOLUTE VALUE RANGE APPLYING TO EACH LIVEL

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| MINIMUM | 2.00 | 2.30 | 2.60 | 2.90 | 3.20 | 3.50 | 3.80 | 4.10 | 4.40 | 4.70 | 5.00 |
| MAXIMUM | 2.30 | 2.60 | 2.90 | 3.20 | 3.50 | 3.80 | 4.10 | 4.40 | 4.70 | 5.00 | |

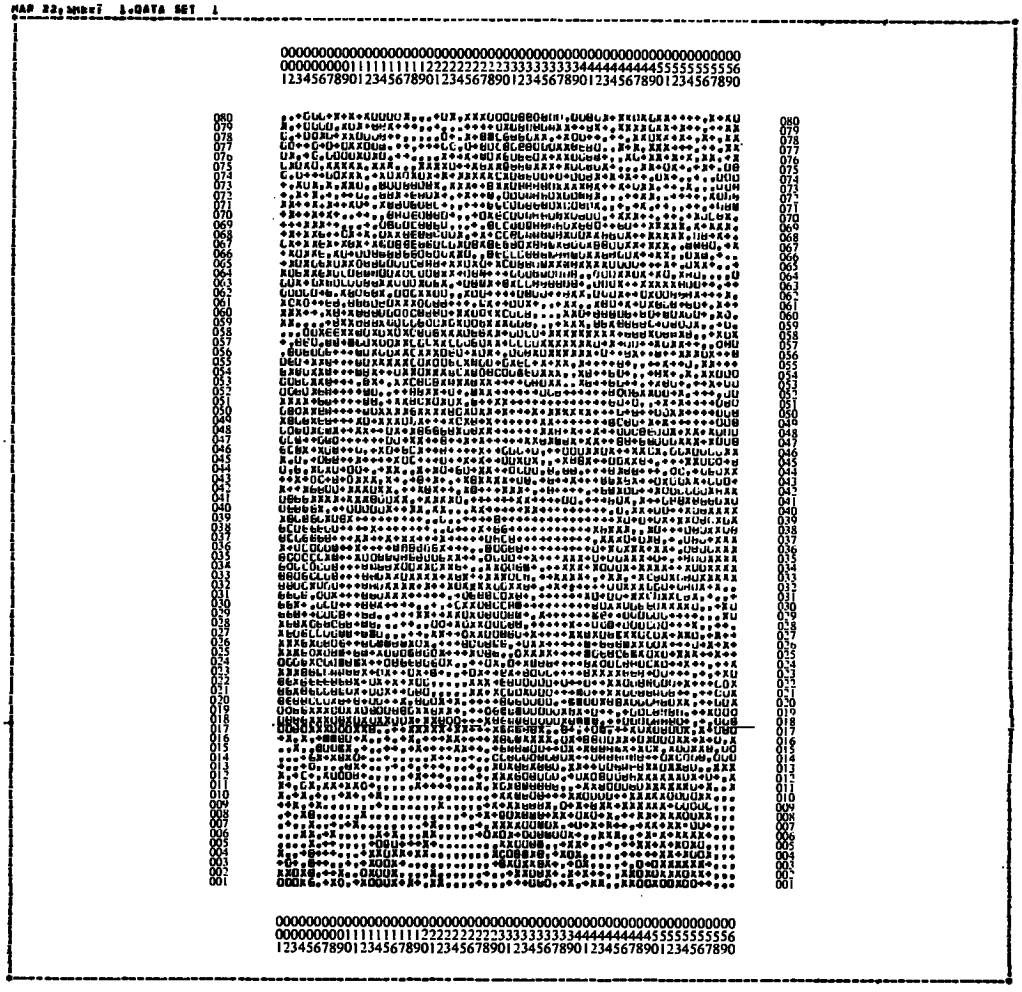
PERCENTAGE OF TOTAL ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 |

FREQUENCY DISTRIBUTION OF DATA POINT VALUES IN EACH LEVEL

| LEVELS | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|---|
| SYMBOLS | ..... | ..... | ..... | ++++++ | XXXXXXX | 00000000 | ..... | ..... | ..... | ..... |
| | ..... | ..... | ..... | ++++++ | XXXXXXX | 00000000 | ..... | ..... | ..... | ..... |
| | .... .... | .... .... | .... .... | ++++ ++++ | XXXX XXXX | 0000 0000 | .... .... | .... .... | .... .... | .... .... |
| | ..... | ..... | ..... | ++++++ | XXXXXXX | 00000000 | ..... | ..... | ..... | ..... |
| | ..... | ..... | ..... | ++++++ | XXXXXXX | 00000000 | ..... | ..... | ..... | ..... |
| FREQUENCY | 928 | 0 | 0 | 2041 | 0 | 0 | 1796 | 0 | 0 | 38 |

Fig. VI.15
Total Impact: Snow Shoeing



WINTER LAND USE ACTIVITY - CROSS COUNTRY SKIING

TOTAL IMPACT ON 11 RESOURCE SYSTEMS

HONEY HILL CASE STUDY

THIS ANALYSIS SHOWS THE TOTAL IMPACT ON ALL RESOURCE SYSTEMS CAUSED BY THIS LAND USE ACTIVITY.

LEGEND
0 = AREAS OF LEAST IMPACT
TO
9 = AREAS UPMOST IMPACT

DATA MAPPED IN 10 LEVILS BETWEEN EXTREME VALUES UP 14.00 AND 25.00

ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| MINIMUM | 14.00 | 15.10 | 16.20 | 17.30 | 18.40 | 19.50 | 20.60 | 21.70 | 22.80 | 23.90 |
| MAXIMUM | 15.10 | 16.20 | 17.30 | 18.40 | 19.50 | 20.60 | 21.70 | 22.80 | 23.90 | 25.00 |

PERCENTAGE OF TOTAL ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

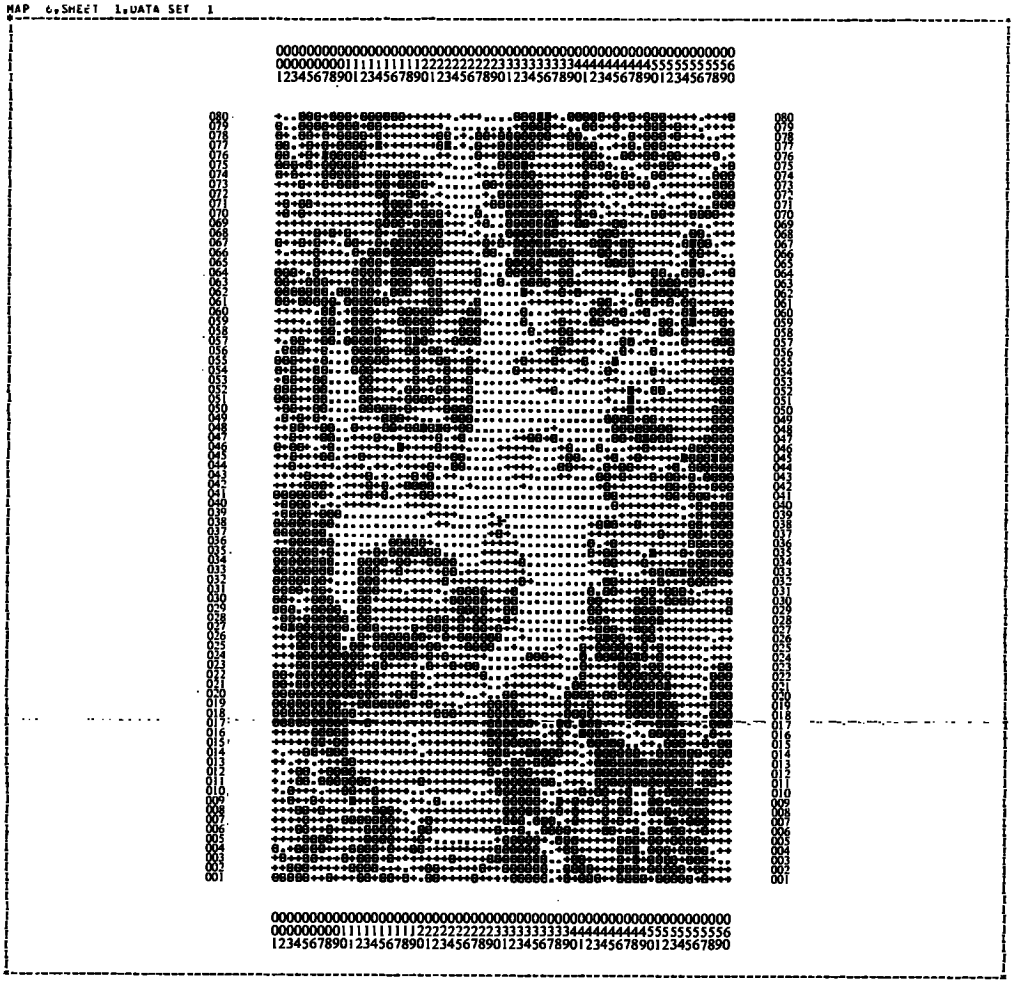
| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 |

FREQUENCY DISTRIBUTION OF DATA POINT VALUES IN EACH LEVEL

| LEVELS | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|---|
| SYMBOLS | | | | | | | | | | |
| FREQUENCY | 25 | 145 | 491 | 1167 | 1173 | 1034 | 585 | 148 | 28 | 4 |

Fig. VI.16
Total Impact: Cross Country Skiing

MAP 6,SHEET 1,DATA SET 1



WINTER LAND USE ACTIVITY - SNOWMOBILING

TOTAL IMPACT ON 11 RESOURCE SYSTEMS

HONEY HILL CASE STUDY

THIS ANALYSIS SHOWS THE TOTAL IMPACT ON ALL RESOURCE SYSTEMS CAUSED BY THIS LAND USE ACTIVITY.

LEGEND
0 = AREAS OF LEAST IMPACT
TO
9 = AREAS OF MOST IMPACT

DATA MAPPED IN 10 LEVELS BETWEEN EXTREME VALUES OF 2.00 AND 5.00

ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| MINIMUM | 2.00 | 2.30 | 2.60 | 2.90 | 3.20 | 3.50 | 3.80 | 4.10 | 4.40 | 4.70 |
| MAXIMUM | 2.30 | 2.60 | 2.90 | 3.20 | 3.50 | 3.80 | 4.10 | 4.40 | 4.70 | 5.00 |

PERCENTAGE OF TOTAL ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

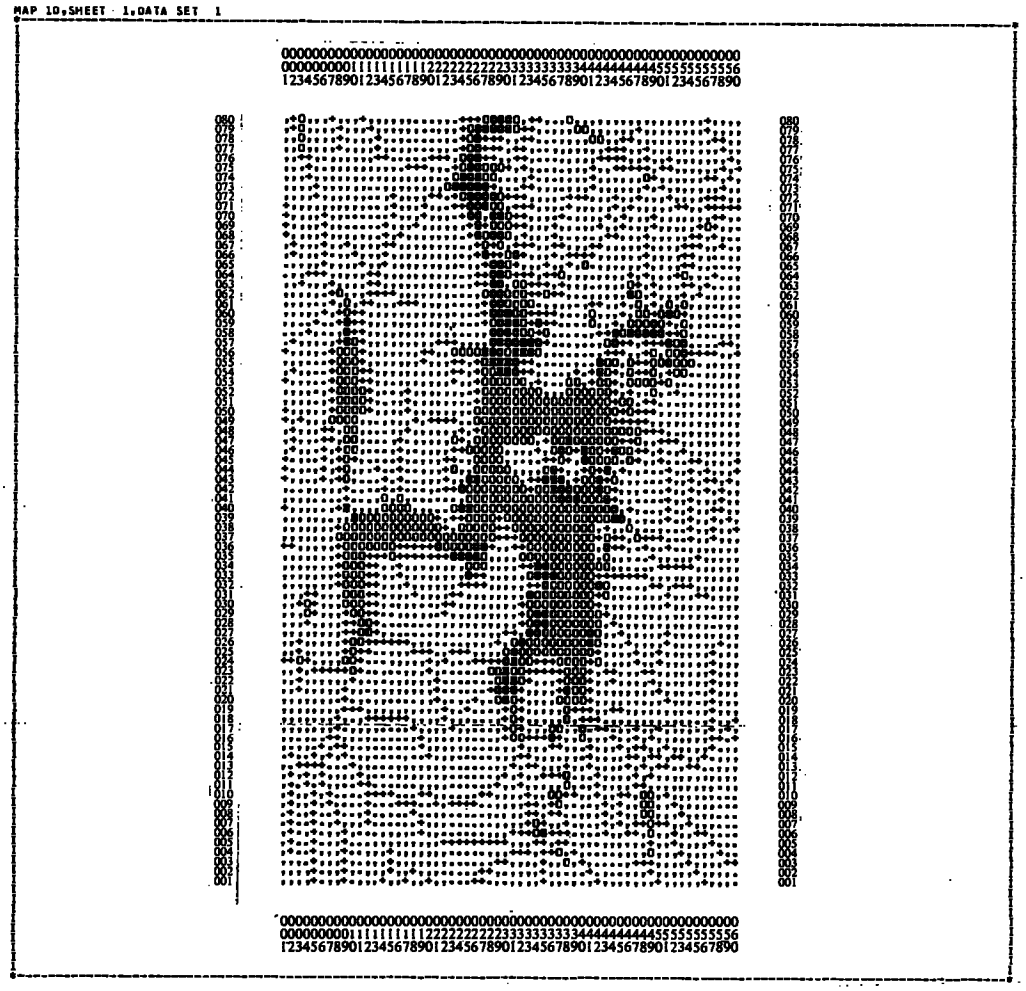
| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 |

FREQUENCY DISTRIBUTION OF DATA POINT VALUES IN EACH LEVEL

| LEVELS | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|---|
| SYMBOLS | | | | | | | | | | |
| FREQUENCY | 928 | 0 | 0 | 2041 | 0 | 0 | 1796 | 0 | 0 | 35 |

Fig. VI.17
Total Impact: Snowmobiling

MAP 10,SHEET 1,DATA SET 1



WINTER LAND USE ACTIVITY - DOWNHILL SKIING

TOTAL IMPACT ON 11 RESOURCE SYSTEMS

HONEY HILL CASE STUDY

THIS ANALYSIS SHOWS THE TOTAL IMPACT ON ALL RESOURCE SYSTEMS CAUSED BY THIS LAND USE ACTIVITY.

LEGEND
0 = AREAS OF LEAST IMPACT
TO
9 = AREAS OF MOST IMPACT

DATA MAPPED IN 10 LEVELS BETWEEN EXTREME VALUES OF 3.00 AND 8.00

ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| MINIMUM | 3.00 | 3.50 | 4.00 | 4.50 | 5.00 | 5.50 | 6.00 | 6.50 | 7.00 | 7.50 |
| MAXIMUM | 3.50 | 4.00 | 4.50 | 5.00 | 5.50 | 6.00 | 6.50 | 7.00 | 7.50 | 8.00 |

PERCENTAGE OF TOTAL ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 |

FREQUENCY DISTRIBUTION OF DATA POINT VALUES IN EACH LEVEL

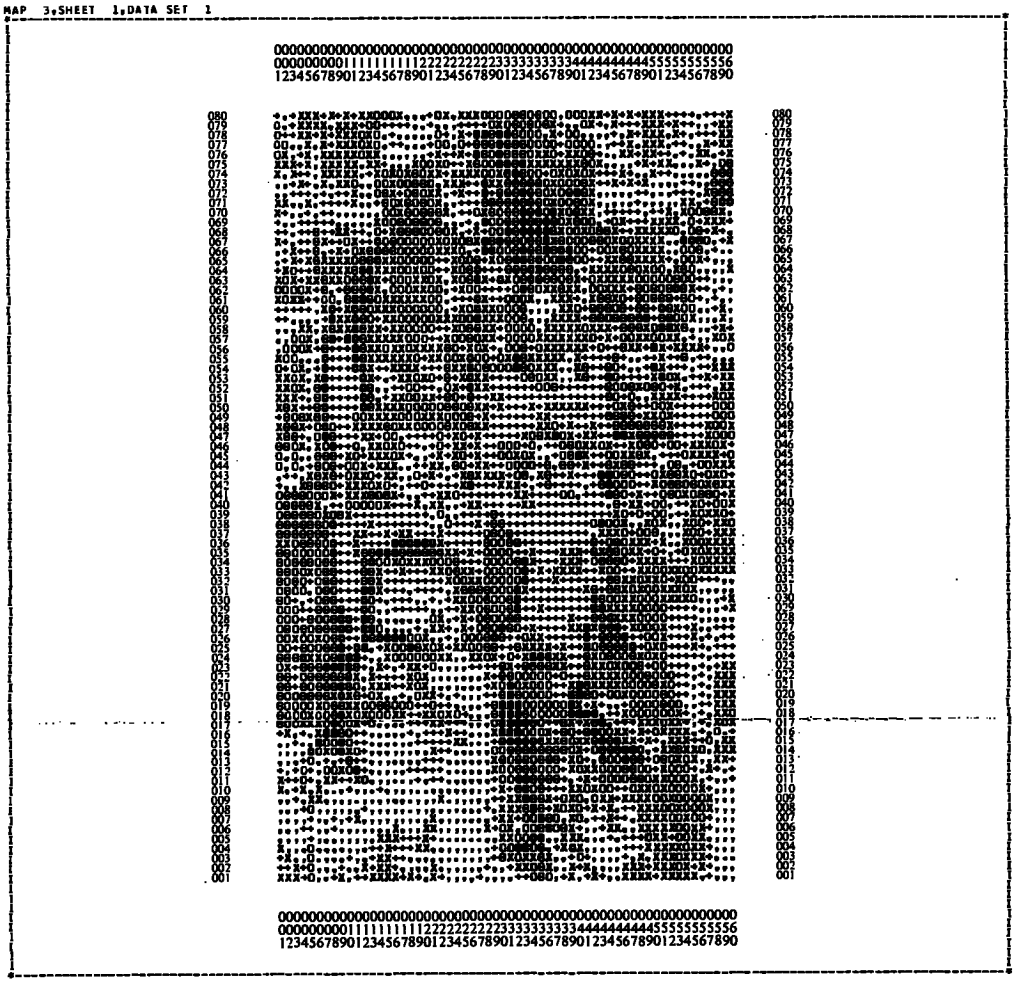
| LEVELS | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|---|
| SYMBOLS | ..... | ..... | ..... | +++++ | XXXXX | 00000 | ..... | ..... | ..... | ..... |
| | ..... | ..... | ..... | +++++ | XXXXX | 00000 | ..... | ..... | ..... | ..... |
| | .... | .... | .... | ++++ | XXXX | 0000 | .... | .... | .... | .... |
| | ..... | ..... | ..... | +++++ | XXXXX | 00000 | ..... | ..... | ..... | ..... |
| | ..... | ..... | ..... | +++++ | XXXXX | 00000 | ..... | ..... | ..... | ..... |
| FREQUENCY | 675 | 2317 | 0 | 977 | 0 | 664 | 0 | 144 | 0 | 23 |

Fig. VI.18
Total Impact: Downhill Skiing

See Fig. III.36 for that area
in which ice skating can occur.

Fig. VI.19
Total Impact: Ice Skating

MAP 3,SHEET 1,DATA SET 1



WINTER LAND USE ACTIVITY - RESIDENTIAL (2 UNITS/ACRE)

TOTAL IMPACT ON 11 RESOURCE SYSTEMS

HONEY HILL CASE STUDY

THIS ANALYSIS SHOWS THE TOTAL IMPACT ON ALL RESOURCE SYSTEMS CAUSED BY THIS LAND USE ACTIVITY.

LEGEND
0 = AREAS OF LEAST IMPACT
TO
9 = AREAS OF MOST IMPACT

DATA MAPPED IN 10 LEVELS BETWEEN EXTREME VALUES OF 15.00 AND 25.00

ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| MINIMUM | 15.00 | 16.08 | 17.00 | 18.00 | 19.00 | 20.00 | 21.00 | 22.00 | 23.00 | 24.00 |
| MAXIMUM | 16.00 | 17.00 | 18.00 | 19.00 | 20.00 | 21.00 | 22.00 | 23.00 | 24.00 | 25.00 |

PERCENTAGE OF TOTAL ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

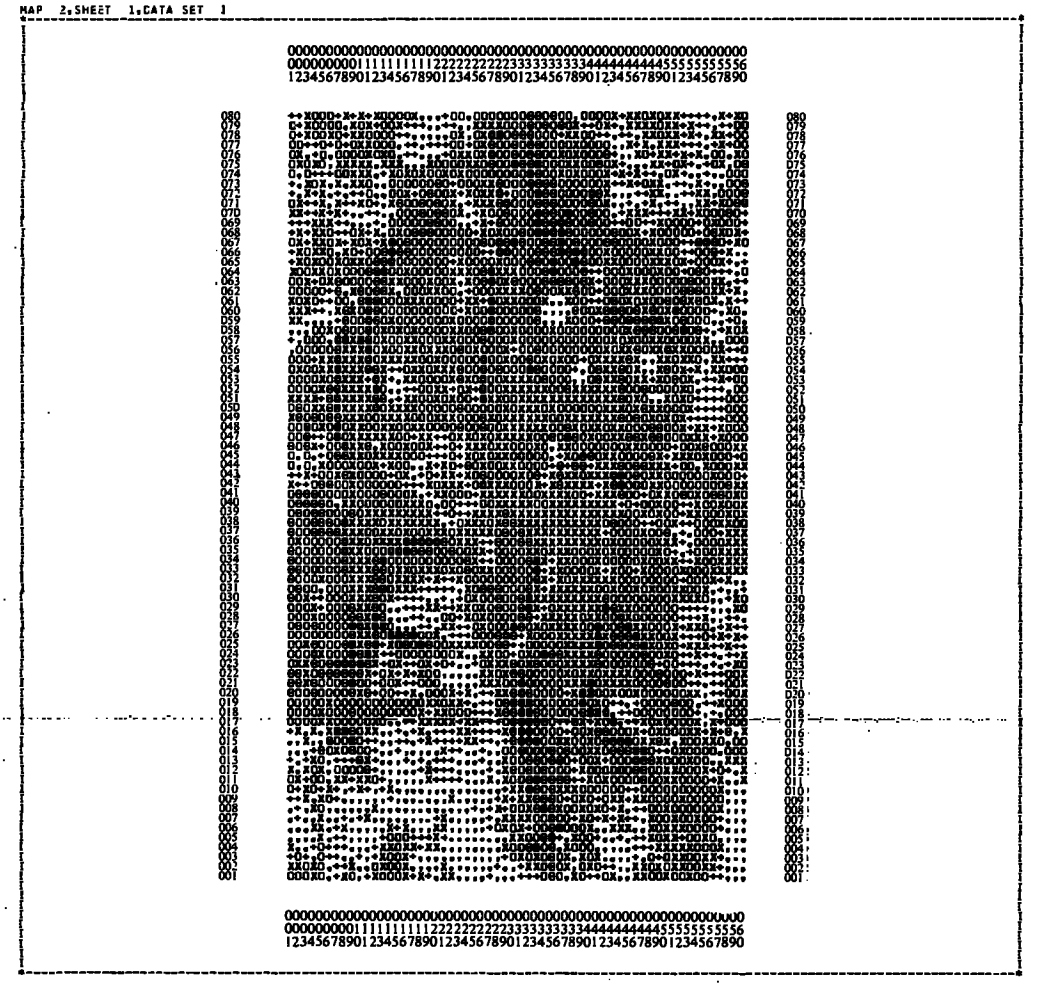
| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 |

FREQUENCY DISTRIBUTION OF DATA POINT VALUES IN EACH LEVEL

| LEVELS | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|---|
| SYMBOLS | | | | | | | | | | |
| FREQUENCY | 27 | 224 | 575 | 1179 | 1115 | 087 | 562 | 179 | 46 | 6 |

Fig. VI.20
Total Impact: Residential (2 Units/Acre)

MAP 2,SHEET 1,CATA SET 1



WINTER LAND USE ACTIVITY - RESIDENTIAL (12 UNITS/ACRE)

TOTAL IMPACT ON 11 RESOURCE SYSTEMS

HONEY HILL CASE STUDY

THIS ANALYSIS SHOWS THE TOTAL IMPACT ON ALL RESOURCE SYSTEMS CAUSED BY THIS LAND USE ACTIVITY.

LEGEND
0 = AREAS OF LEAST IMPACT
TO
9 = AREAS OF MOST IMPACT

DATA MAPPED IN 10 LEVELS BETWEEN EXTREME VALUES OF 14.00 AND 26.00

ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| MINIMUM | 14.00 | 15.20 | 16.40 | 17.60 | 18.80 | 20.00 | 21.20 | 22.40 | 23.60 | 24.80 |
| MAXIMUM | 15.20 | 16.40 | 17.60 | 18.80 | 20.00 | 21.20 | 22.40 | 23.60 | 24.80 | 26.00 |

PERCENTAGE OF TOTAL ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

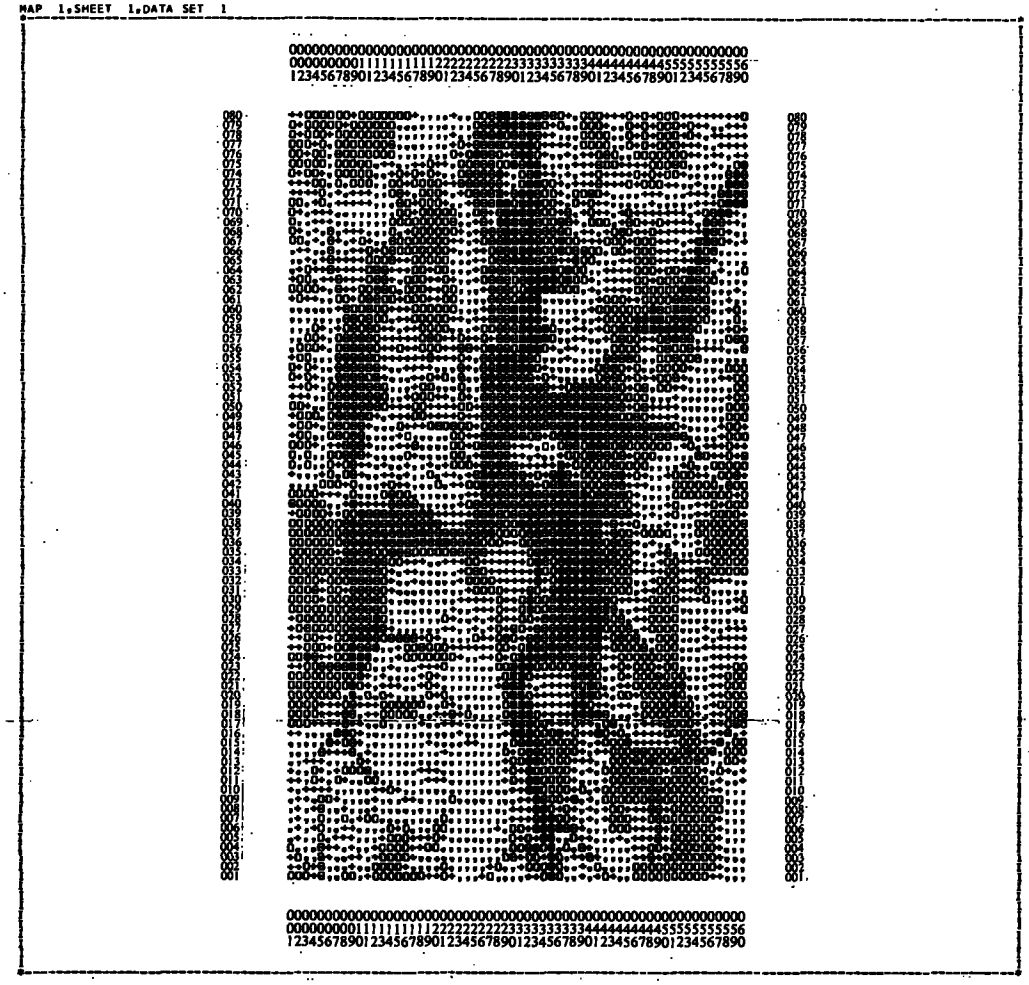
| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 |

FREQUENCY DISTRIBUTION OF DATA POINT VALUES IN EACH LEVEL

| LEVELS | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|---|
| SYMBOLS | | | | | | | | | | |
| FREQUENCY | 16 | 112 | 402 | 619 | 1270 | 1804 | 410 | 135 | 28 | 4 |

Fig. VI.21
Total Impact: Residential (12 Units/Acre)

MAP 1,SHEET 1,DATA SET 1



WINTER LAND USE ACTIVITY - PARKING

TOTAL IMPACT ON 11 RESOURCE SYSTEMS

HONEY HILL CASE STUDY

THIS ANALYSIS SHOWS THE TOTAL IMPACT ON ALL RESOURCE SYSTEMS CAUSED BY THIS LAND USE ACTIVITY.

LEGEND
0 = AREAS OF LEAST IMPACT
TO
9 = AREAS OF MOST IMPACT

DATA MAPPED IN 10 LEVELS BETWEEN EXTREME VALUES OF 9.00 AND 17.00

ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| MINIMUM | 9.00 | 9.80 | 10.60 | 11.40 | 12.20 | 13.00 | 13.80 | 14.60 | 15.40 | 16.20 |
| MAXIMUM | 9.80 | 10.60 | 11.40 | 12.20 | 13.00 | 13.80 | 14.60 | 15.40 | 16.20 | 17.00 |

PERCENTAGE OF TOTAL ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

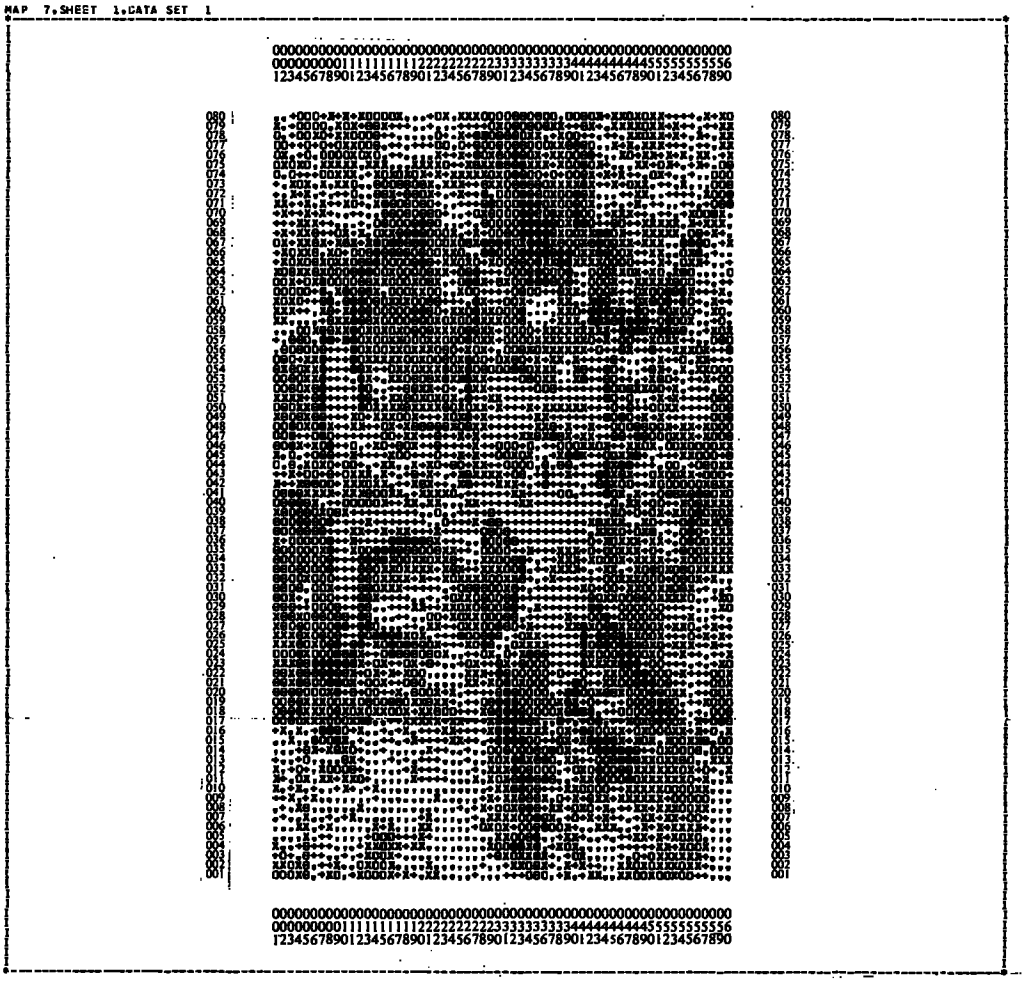
| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 |

FREQUENCY DISTRIBUTION OF DATA POINT VALUES IN EACH LEVEL

| LEVELS | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|---|
| SYMBOLS | | | | | | | | | | |
| FREQUENCY | 3 | 448 | 754 | 1080 | 0 | 1447 | 844 | 152 | 53 | 19 |

Fig. VI.22
Total Impact: Parking

MAP 7.SHEET 1.DATA SET 1



WINTER LAND USE ACTIVITY - PRIMARY ROADS

TOTAL IMPACT ON 11 RESOURCE SYSTEMS

HONEY HILL CASE STUDY

THIS ANALYSIS SHOWS THE TOTAL IMPACT ON ALL RESOURCE SYSTEMS CAUSED BY THIS LAND USE ACTIVITY.

LEGEND
0 = AREAS OF LEAST IMPACT
TO
9 = AREAS OF MOST IMPACT

DATA MAPPED IN 10 LEVELS BETWEEN EXTREME VALUES OF 14.00 AND 25.00

ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| MINIMUM | 14.00 | 15.10 | 16.20 | 17.30 | 18.40 | 19.50 | 20.60 | 21.70 | 22.80 | 23.90 |
| MAXIMUM | 15.10 | 16.20 | 17.30 | 18.40 | 19.50 | 20.60 | 21.70 | 22.80 | 23.90 | 25.00 |

PERCENTAGE OF TOTAL ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

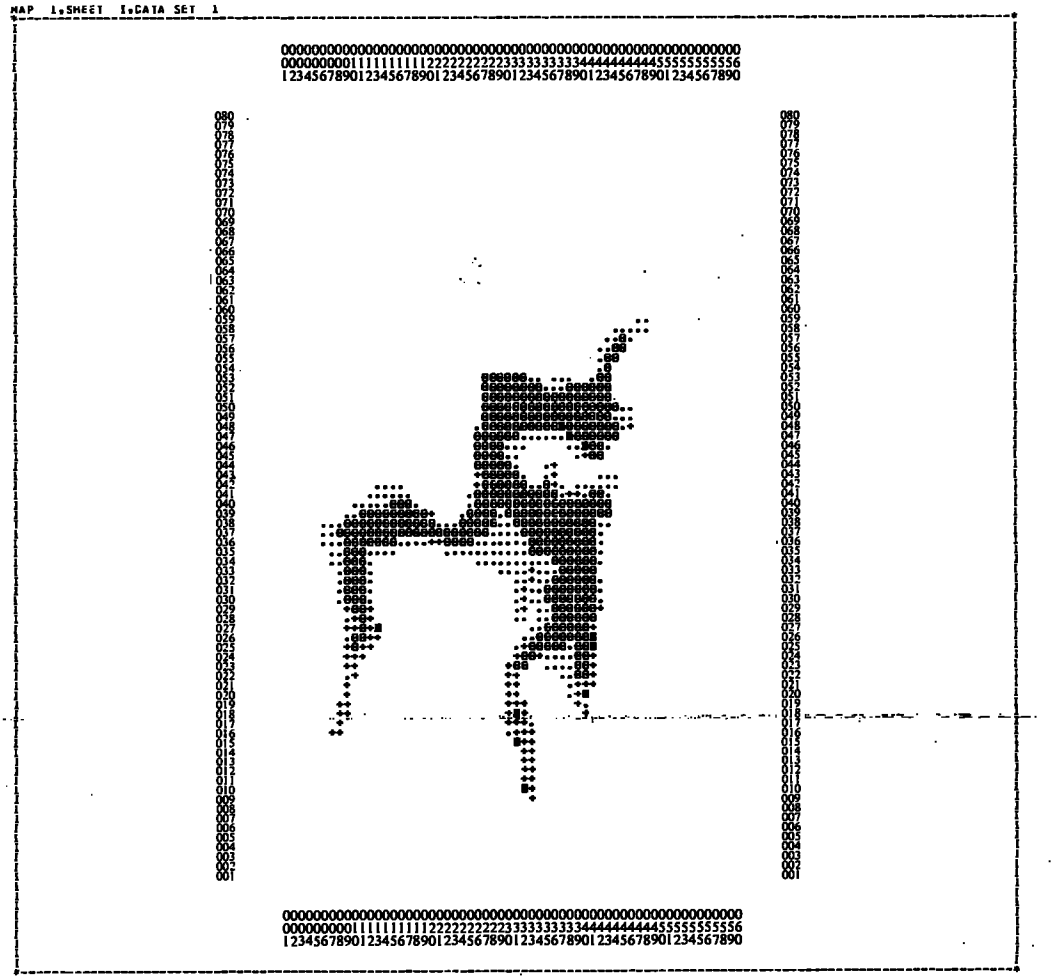
| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 |

FREQUENCY DISTRIBUTION OF DATA POINT VALUES IN EACH LEVEL

| LEVELS | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|---|
| SYMBOLS | | | | | | | | | | |
| FREQUENCY | 25 | 145 | 491 | 1167 | 1173 | 1034 | 585 | 148 | 28 | 4 |

Fig. VI.23
Total Impact: Primary Roads

MAP 1.SHEET 1.DATA SET 1



SUMMER LAND USE ACTIVITY - RESERVOIR OPERATION (AS PLANNED)

TOTAL IMPACT ON 11 RESOURCE SYSTEMS

HONEY HILL CASE STUDY

THIS ANALYSIS SHOWS THE TOTAL IMPACT ON ALL RESOURCE SYSTEMS CAUSED BY THIS LAND USE ACTIVITY.

LEGEND
0 = AREAS OF LEAST IMPACT
10
9 = AREAS OF MOST IMPACT

DATA MAPPED IN 10 LEVELS BETWEEN EXTREME VALUES OF 2.00 AND 5.00

ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| MINIMUM | 2.00 | 2.30 | 2.60 | 2.90 | 3.20 | 3.50 | 3.80 | 4.10 | 4.40 | 4.70 |
| MAXIMUM | 2.30 | 2.60 | 2.90 | 3.20 | 3.50 | 3.80 | 4.10 | 4.40 | 4.70 | 5.00 |

PERCENTAGE OF TOTAL ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

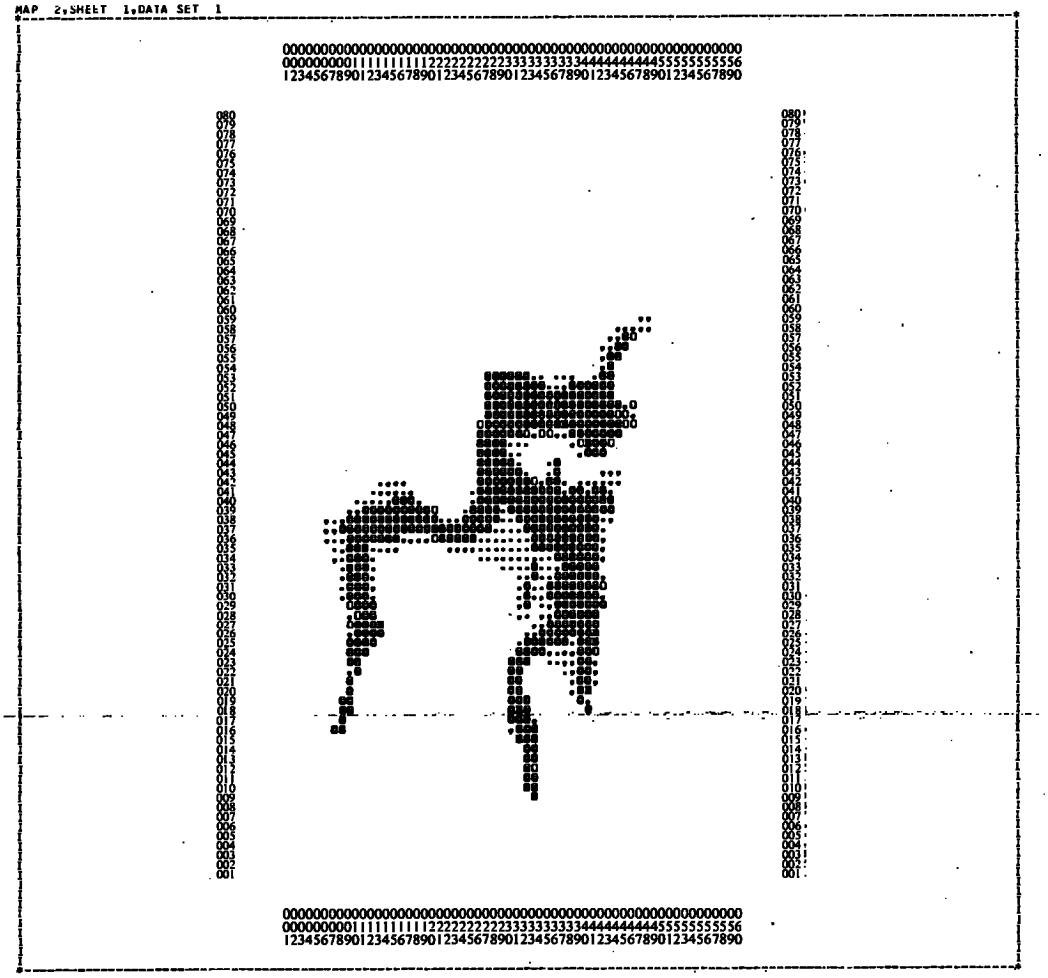
| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 |

FREQUENCY DISTRIBUTION OF DATA POINT VALUES IN EACH LEVEL

| LEVELS | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|---|
| SYMBOLS | ..... | ..... | ..... | +++++++++ | XXXXXXXXX | 000000000 | @@@@@@@@@ | ######### | ######### | ######### |
| FREQUENCY | 209 | 0 | 0 | 88 | 0 | 0 | 384 | 0 | 0 | 10 |

Fig. VI.24
Total Impact: Reservoir Operation
(As Planned)

MAP 2,SHEET 1,DATA SET 1



SUMMER LAND USE ACTIVITY - RESERVOIR OPERATION (DAILY FLUCT)

TOTAL IMPACT ON 11 RESOURCE SYSTEMS

HONEY HILL CASE STUDY

THIS ANALYSIS SHOWS THE TOTAL IMPACT ON ALL RESOURCE SYSTEMS CAUSED BY THIS LAND USE ACTIVITY.

LEGEND
0 = AREAS OF LEAST IMPACT
TO
9 = AREAS OF MOST IMPACT

DATA MAPPED IN 10 LEVELS BETWEEN EXTREME VALUES OF 2.00 AND 6.00

ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| MINIMUM | 2.00 | 2.40 | 2.80 | 3.20 | 3.60 | 4.00 | 4.40 | 4.80 | 5.20 | 5.60 |
| MAXIMUM | 2.40 | 2.80 | 3.20 | 3.60 | 4.00 | 4.40 | 4.80 | 5.20 | 5.60 | 6.00 |

PERCENTAGE OF TOTAL ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 |

FREQUENCY DISTRIBUTION OF DATA POINT VALUES IN EACH LEVEL

| LEVELS | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|---|
| SYMBOLS | | | | | | | | | | |
| FREQUENCY | 91 | 0 | 108 | 0 | 0 | 21 | 0 | 461 | 0 | 10 |

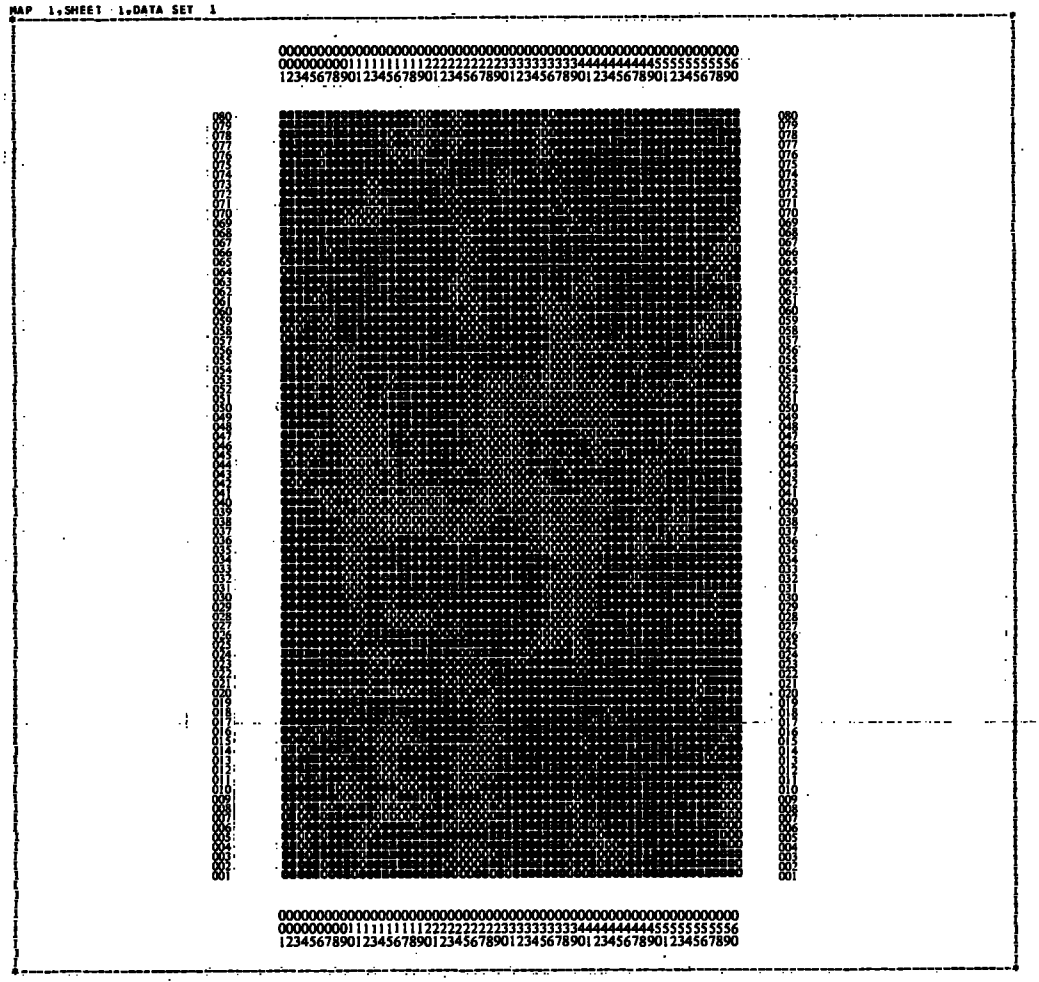
Fig. VI.25
Total Impact: Reservoir Operation
(Daily Fluctuation)

The impacts of highways on the site resource system are primarily a function of the design standards used in the initial layout or location of the road. The character and quality of the construction of the facility is the second most significant point. After the facility has been installed on the site, there are two other factors which cause varying degrees of site impact. These are the maintenance of the facility which includes its management practices, and the user impact itself.

## 1. IMPACT OF HIGHWAYS ON SURFACE WATER POLLUTION (Figure VI.26)

In order to reduce the potential damage of the surface water system by pollution or degradation, the road should have as little contact as possible with wetlands, the first order streams and ponds in the headwaters of the watersheds. This location and design consideration alone will greatly reduce the long term effects of a change in the quantity and quality of the surface water. Cut and fill operations with their ancillary storm drainage ditches could greatly modify both the pattern of surface water runoff and in some cases intercept and redirect the subsurface water movements. In this landscape these areas are also very susceptible to sheet or gulley soil erosion, due to the fact that these water features are generally in upland situations having steeper slope gradients.

Other sensitive areas, and those which would display the fastest rate of change would be downstream from the point where the facility would cross a stream. This is primarily due to the cut and fill operations necessary to cross these features and also the installation of structures. Unless silting basins are installed below these crossing points the immediate condition of silting in the stream channel itself would occur. One could expect this to cause a number of more long term effects to the surface water regime. The bottom characteristics of the streams would be changed, there would be a decrease in water depth, and the water temperatures would also probably rise. Consequently, the fish and flora of those areas would be modified. Because of future periods of seasonal high flow, a portion of the bedload would be transported into other wetlands, ponds, or reservoirs creating an abnormal increase of sediment in those areas. Two other factors influencing the water quality would be the surface runoff into swales and streams from fresh bituminous surfaces carrying various finishing oils, and the effects of salts used in winter maintenance programs.




IMPACT OF PRIMARY HIGHWAYS ON SURFACE WATER POLLUTION

RESOURCE SYSTEM - :SURFACE WATER

HONEY HILL CASE STUDY

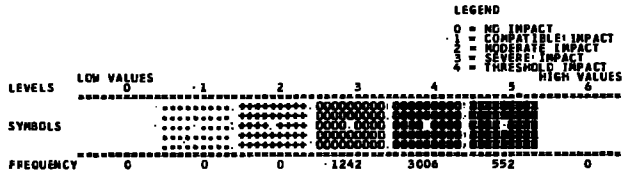



Fig. VI.26
Total Impact: Primary Highways on Surface Water Pollution

## 2. IMPACT OF HIGHWAYS ON AQUIFER POLLUTION (Figure VI.27)

The most serious threat to the pollution of surface aquifers in this area would probably be the build-up of salt concentrations in the subsurface water supply due to winter road maintenance programs. It is difficult at the present time to make any exact projections as to the degree of pollution or the time required for the build-up of these concentrations. As can be seen from the map, the areas most susceptible to aquifer pollution are generally those of 0-8% slope, thus giving longer periods of time for the infiltration of pollutants. They are also generally in the flood plain which has a fairly high water table, thus allowing pollutants to reach the subsurface water regime more quickly.

## 3. IMPACT OF HIGHWAYS ON SHORELINE EROSION AND TURBIDITY (Figure VI.28)

The significance of this impact on shoreline erosion and turbidity is directly related to the proximity of the facility to the reservoir. Current horizontal and vertical design standards for a primary highway facility are of such a nature that they generally cannot take into consideration the subtle configurations of a natural shoreline. The road design is further limited in its response to land features by the engineering considerations of its road base and restrictions associated with its maintenance, design speed and safety factors.

The most critical period of impact is during the construction of the facility. It is during this period that heavy construction equipment is operating within the right-of-way--clearing, grubbing, and rough grading. Because these areas have been stripped of their vegetative cover, the process of dislocation and transportation of soil particles by precipitation will be accelerated. The more erodible the soil and the steeper the slope, the greater the extent of soil transport.

If the topography adjacent to the shoreline of the reservoir is steep and if the center line of the road is in close proximity to the shoreline, there will undoubtedly have to be large fill areas in order to hold the proper road gradients above. Such activity will not only cause siltation in the shoreline of the reservoir but will create a new shore whose gradient will be in the vicinity of a 1:3 or a 1:4 slope, thus generating new erosion and maintenance problems. Much of the fill generally used is

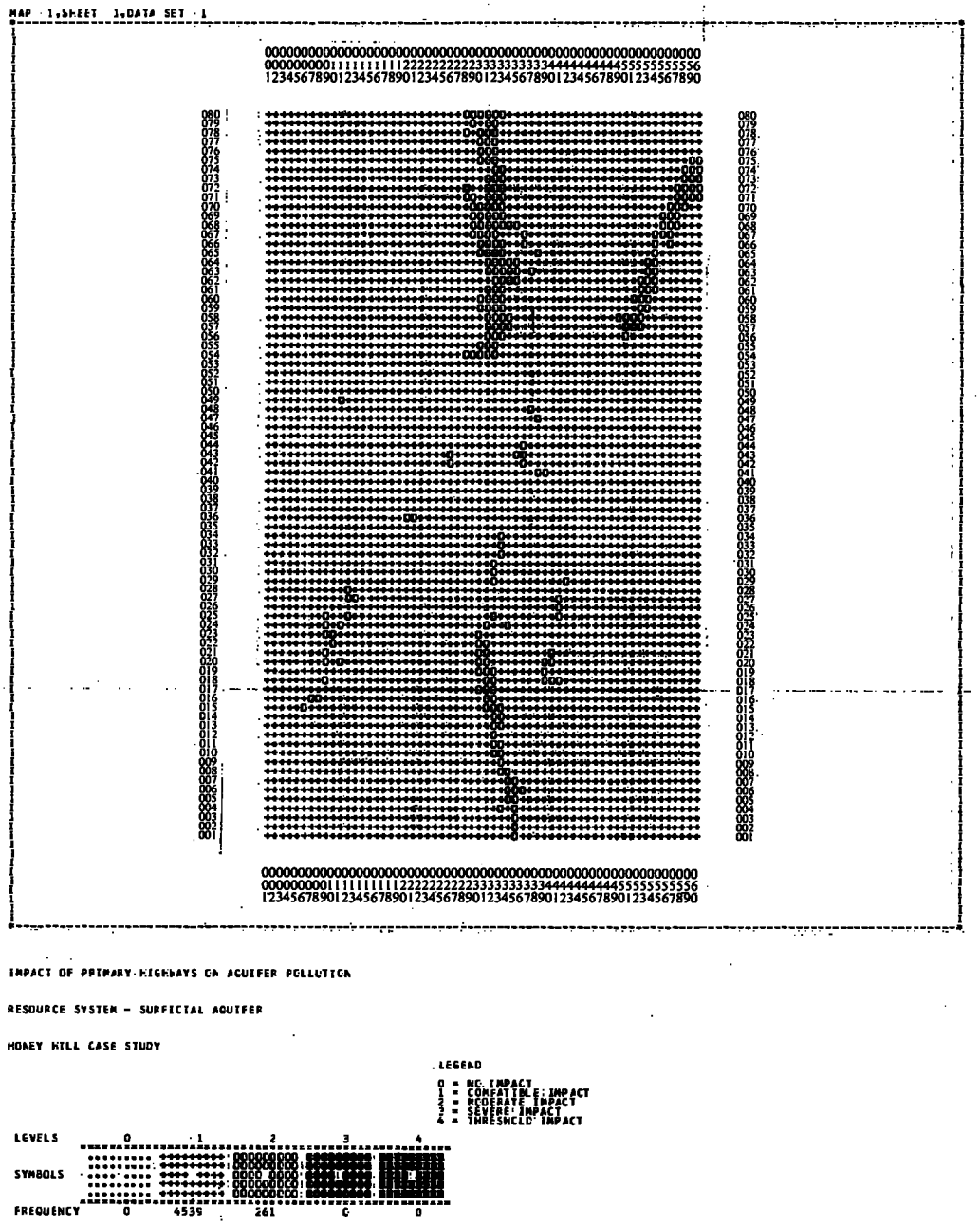
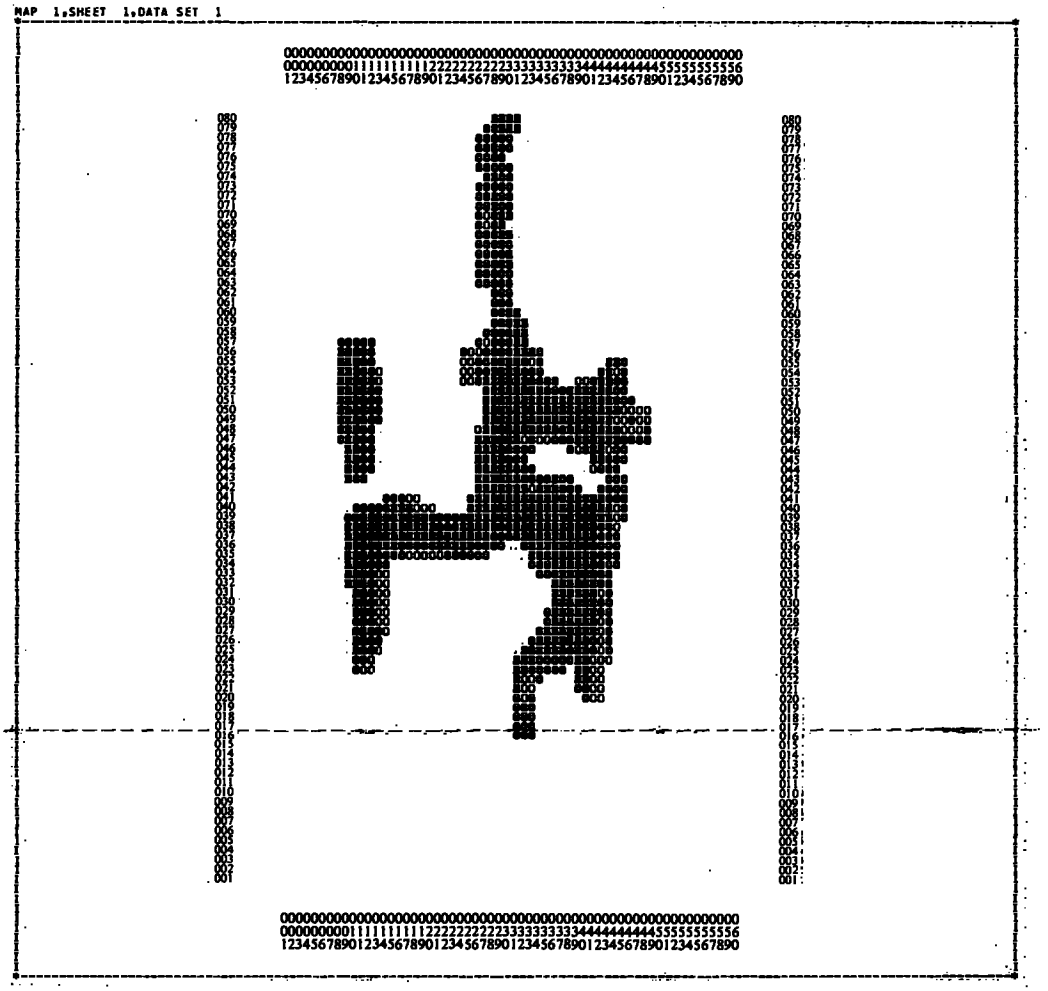



Fig. VI.27
Total Impact: Primary Highways on Aquifer Pollution




IMPACT OF PRIMARY HIGHWAYS ON EROSION AND TURBIDITY

RESOURCE SYSTEM - SHORELINE

HONEY HILL CASE STUDY

LEGEND

0 = NO IMPACT
1 = COMPATIBLE IMPACT
2 = MODERATE IMPACT
3 = SEVERE IMPACT
4 = THRESHOLD IMPACT

| LEVELS | 0 | 1 | 2 | 3 | 4 |
|---|---|---|---|---|---|
| SYMBOLS | ..... | +++++ | 00000 | ##### | ##### |
| FREQUENCY | 0 | 0 | 87 | 347 | 462 |

Fig. VI.28
Total Impact: Primary Highways on Erosion and Turbidity

of a mixed gravel with particle sizes ranging from pebbles to fine sands. This material would be very susceptible to slumping because of wave action from the free water surface and will create an area of high turbidity along its length unless the toe of the slope at its point of entry into the reservoir is faced with stone riprap.

4. IMPACT OF HIGHWAYS ON SOIL EROSION (Figure VI.29)

During the construction of the road, the right-of-way is generally cleared and grubbed and the vegetation is removed from the right-of-way for the operation of equipment and the establishment of grades. It is the removal of this vegetative cover, the regrading, and the use of heavy equipment, during the construction phase that cause the impact on erosion.

5. IMPACT OF HIGHWAYS ON FOREST FIRE VULNERABILITY (Figure VI.30)

The primary impact in this case would not occur during the construction and maintenance periods but would stem from the use of the facility. This would occur both from the traffic operating on the road and from rest stops or scenic overviews. Fires caused, for example, by cigarettes thrown from autos, are rather difficult to control, but can be lessened by the location of the road. If the facility traversed a dry, dense coniferous or mixed coniferous and deciduous stand of trees with a very heavy canopy, it would seem appropriate to clear the secondary canopy and shrubby material near the ground in order to reduce the fire hazard. It would be advisable to locate rest areas or turnouts in those areas which are designated as compatible being minimally vulnerable to forest fires. These sites would probably have moist soil conditions, some deciduous or cut and regrowth areas, and a forest density of less than 30% tree coverage. Such locations would assist in limiting the spread of fire.

6. IMPACT OF HIGHWAYS ON WILDLIFE HABITAT (Figure VI.31)

Other than the direct taking of areas for an activity facility, there are several secondary impacts which are equally important. The most significant factors relate to the spatial location of the road in creating barriers to the movements of larger game species to and from areas of food and cover. This includes the reduction

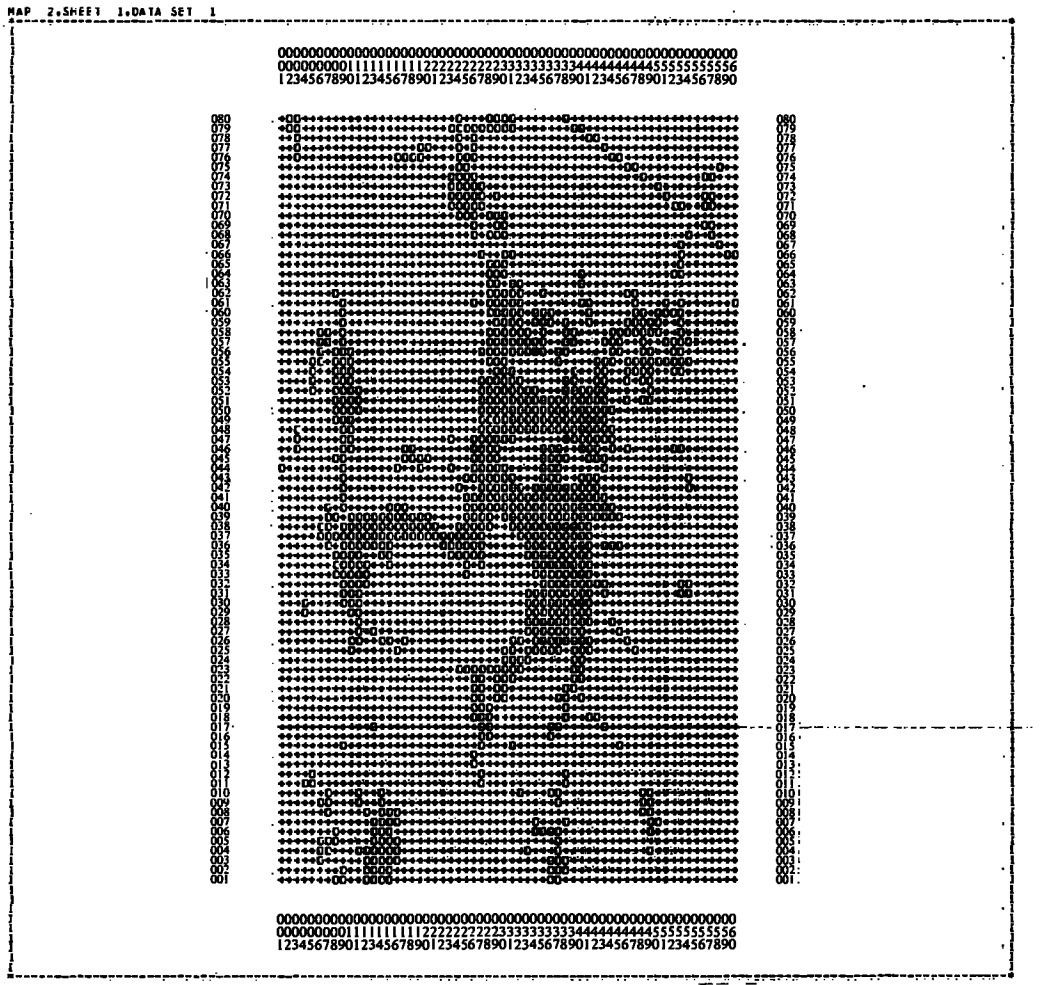
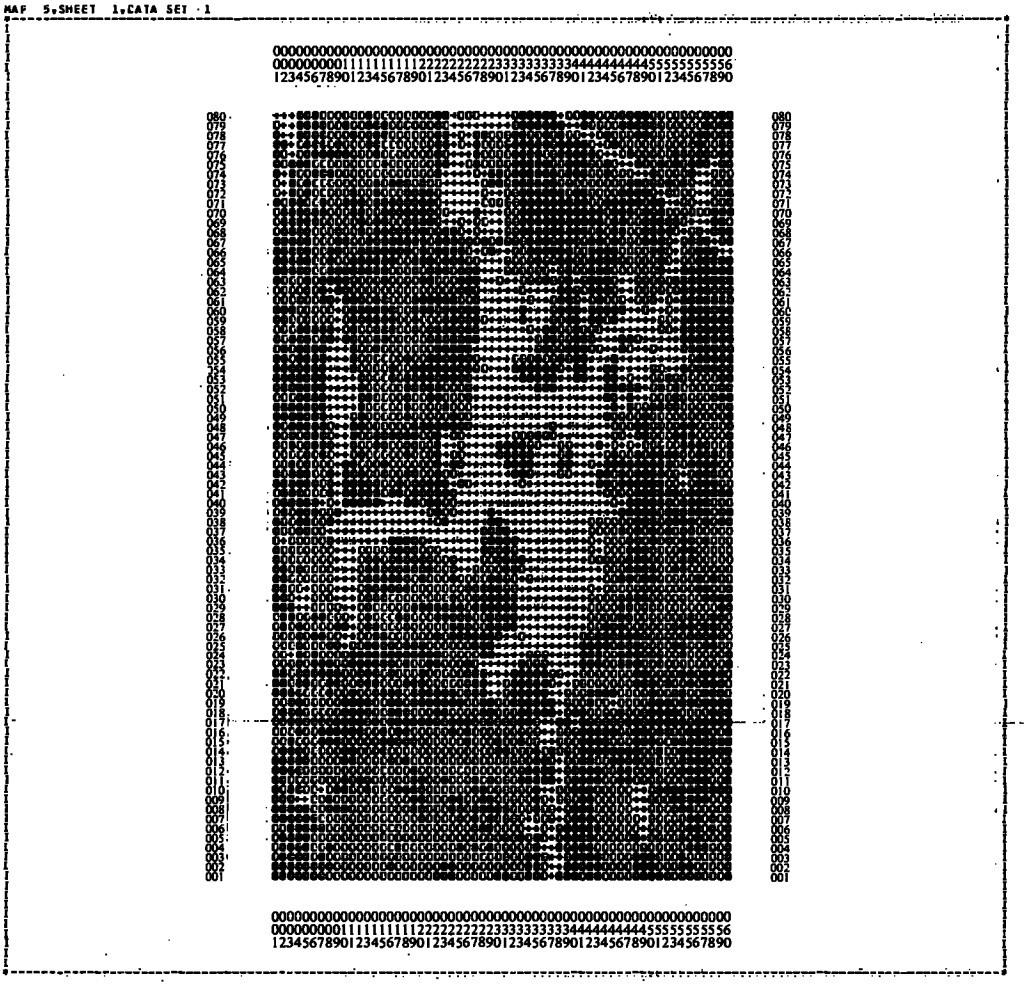



Fig. VI.29
Total Impact: Primary Highways on Soil Erosion




IMPACT OF PRIMARY HIGHWAYS ON FOREST FIRE VULNERABILITY

RESOURCE SYSTEM - VEGETATION

HONEY HILL CASE STUDY

LEGEND

0 = NO IMPACT
1 = COMPATIBLE IMPACT
2 = MODERATE IMPACT
3 = SEVERE IMPACT
4 = THRESHOLD IMPACT

| LEVELS | 0 | 1 | 2 | 3 | 4 |
|---|---|---|---|---|---|
| SYMBOLS | | | | | |
| FREQUENCY | 0 | 857 | 2615 | 1928 | 0 |

Fig. VI.30
Total Impact: Primary Highways on Forest Fire

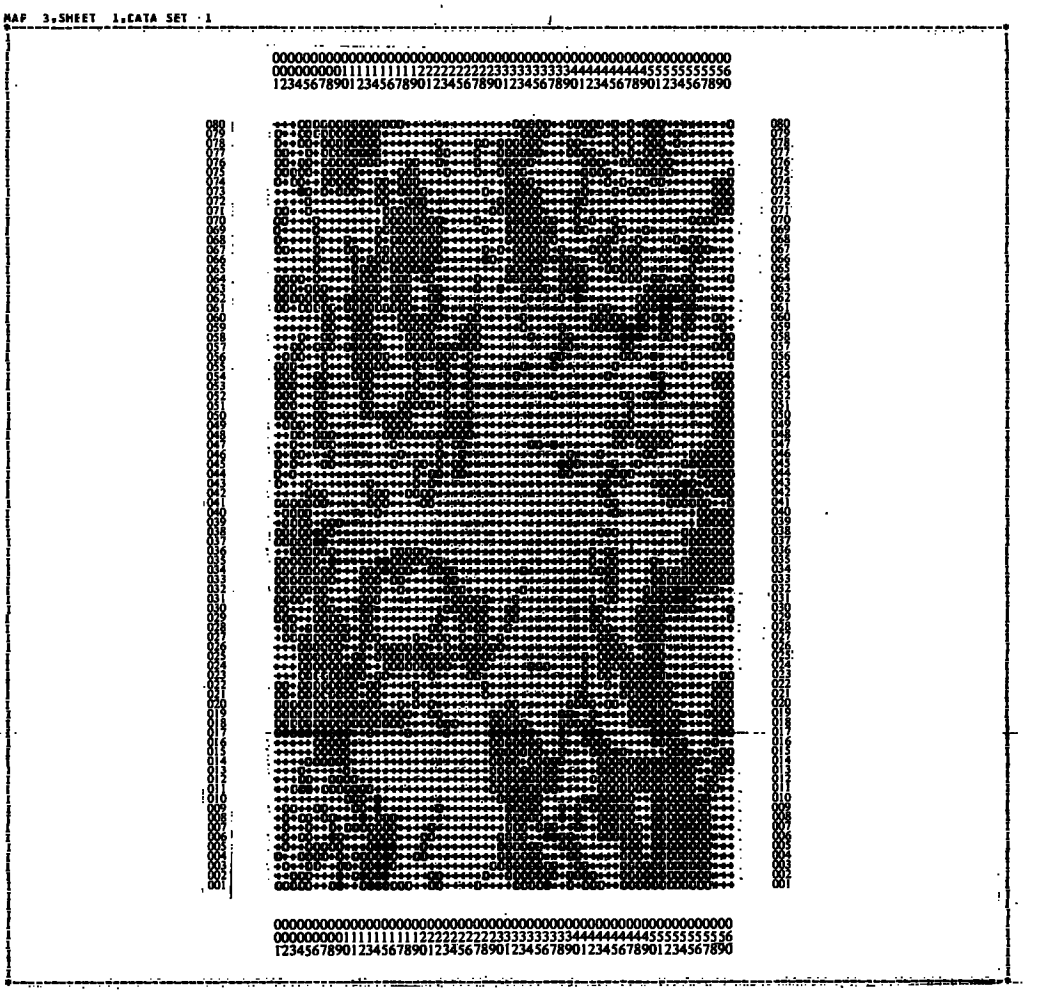



Fig. VI.31
Total Impact: Primary Highways on Wildlife Habitat

of large, diverse areas of vegetation into smaller compartments which are unusable for larger game species, and the audial and visual encroachment of the traffic. It is true that a cleared right-of-way does provide additional browsing areas for some larger game species. At the same time, however, it also creates a potentially hazardous situation from the standpoint of the presence of wildlife on the pavement or of people stopping to observe.

7. IMPACT OF HIGHWAYS ON INSECT HABITAT (Figure VI.32)

Because of the importance of insect habitat for the support of wildlife, the road should not be allowed to indiscriminently take those sites which are indicated as having potentially severe impact. Damage related to the highway could be caused by construction, by maintenance spraying to prevent woody or shrubby material from reestablishing itself in the clear cut right-of-way, and salt runoff to wet and swampy areas into which streams drain.

8. IMPACT OF HIGHWAYS ON SCIENTIFIC RESOURCES (Figure VI.33)

The site resources of potential scientific value which might be affected by a road are spatially well defined. A critical factor is that the resources under consideration create networks or linear patterns in the landscape which are primarily due to the surface water systems (wetlands, small streams, first order streams, and ponds). The type and size of structures needed to cross these features are a major area of concern. Another is the time of year that construction takes place and the precautions taken during the period of construction. If the installation of a culvert takes place during the spring, which is a period of high runoff, and no precautions are taken to capture silt and other debris which normally occurs during back filling and the movement of equipment in the stream channel, then one can expect extensive silting and sedimentation downstream from that point of crossing. Needless to say, if construction is started during this period and is delayed due to heavy precipitation and peak runoff, extensive silting and sedimentation will take place downstream from that point of crossing, and in many cases, permanent damage can occur to the stream biota. Potential impacts on scientific resources could be caused by the salting of roads due to icing conditions. Salt or other chemicals used in winter road maintenance programs are generally collected in swales paralleling the road and then discharged into surface water streams. These

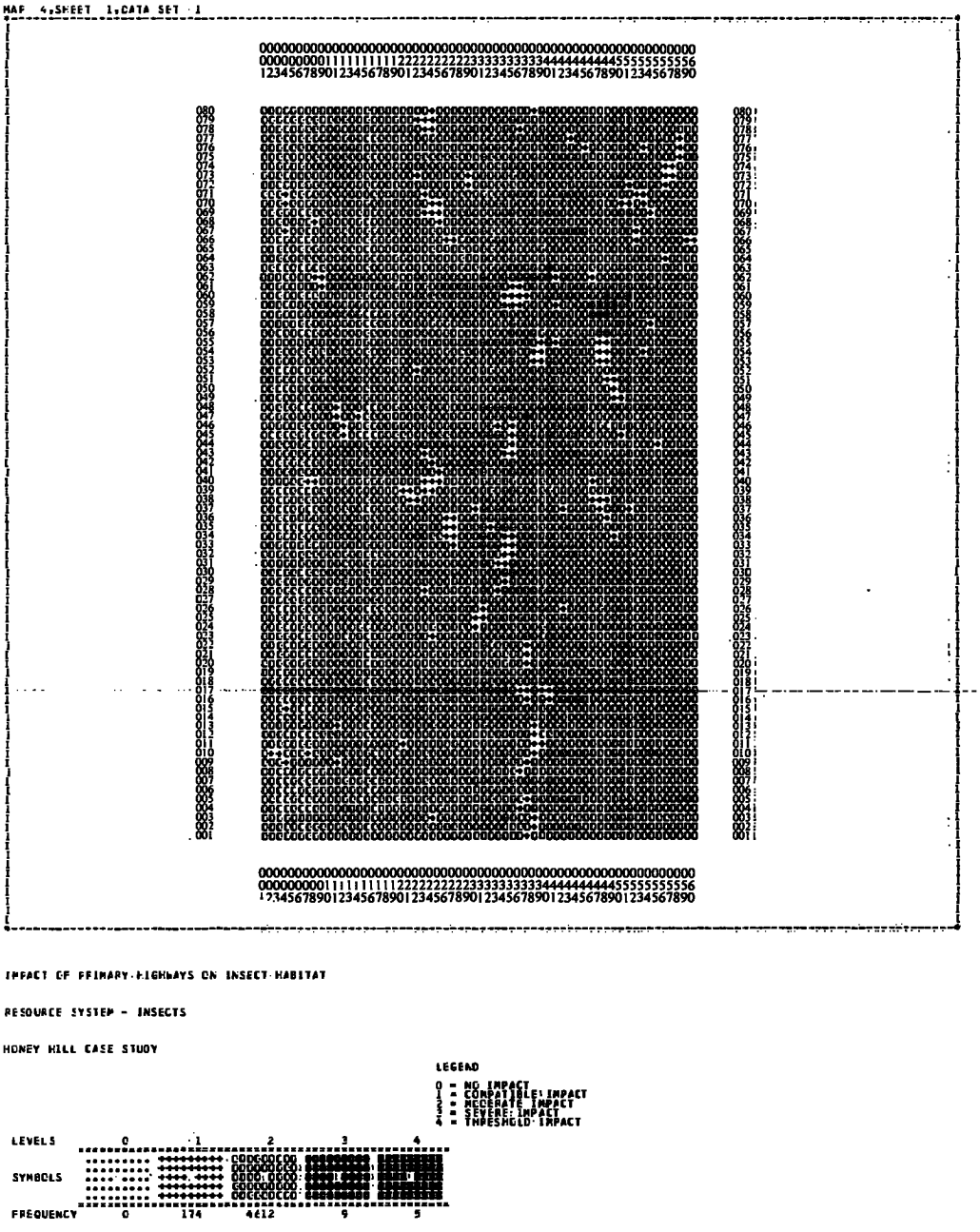
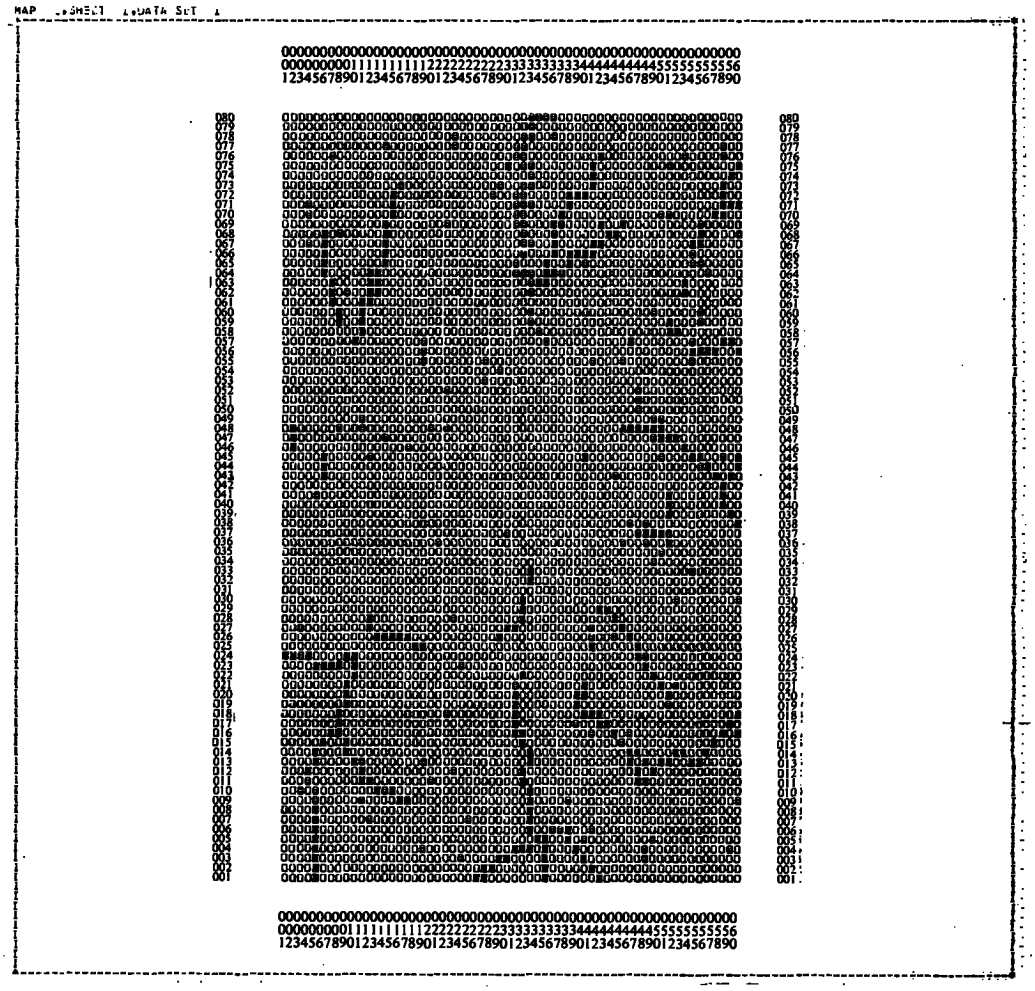



Fig. VI.32
Total Impact: Primary Highways on Insect Habitat



IMPACT OF PRIMARY HIGHWAYS ON SCIENTIFIC RESOURCES

RESOURCE SYSTEM - SCIENTIFIC RESOURCES

HONEY HILL CASE STUDY

LEGEND

0 = NO IMPACT
1 = COMPATIBLE IMPACT
2 = MODERATE IMPACT
3 = SEVERE IMPACT
4 = THRESHOLD IMPACT

| LEVELS | 0 | 1 | 2 | 3 | 4 |
|---|---|---|---|---|---|
| SYMBOLS | ..... | +++++++ | 00000000 | @@@@@@@@ | ######## |
| | ..... | +++++++ | 00000000 | @@@@@@@@ | ######## |
| | .... .... | ++++ ++++ | 0000 0000 | @@@@ @@@@ | #### #### |
| | ..... | +++++++ | 00000000 | @@@@@@@@ | ######## |
| | ..... | +++++++ | 00000000 | @@@@@@@@ | ######## |
| FREQUENCY | 0 | 0 | 4405 | 137 | 258 |

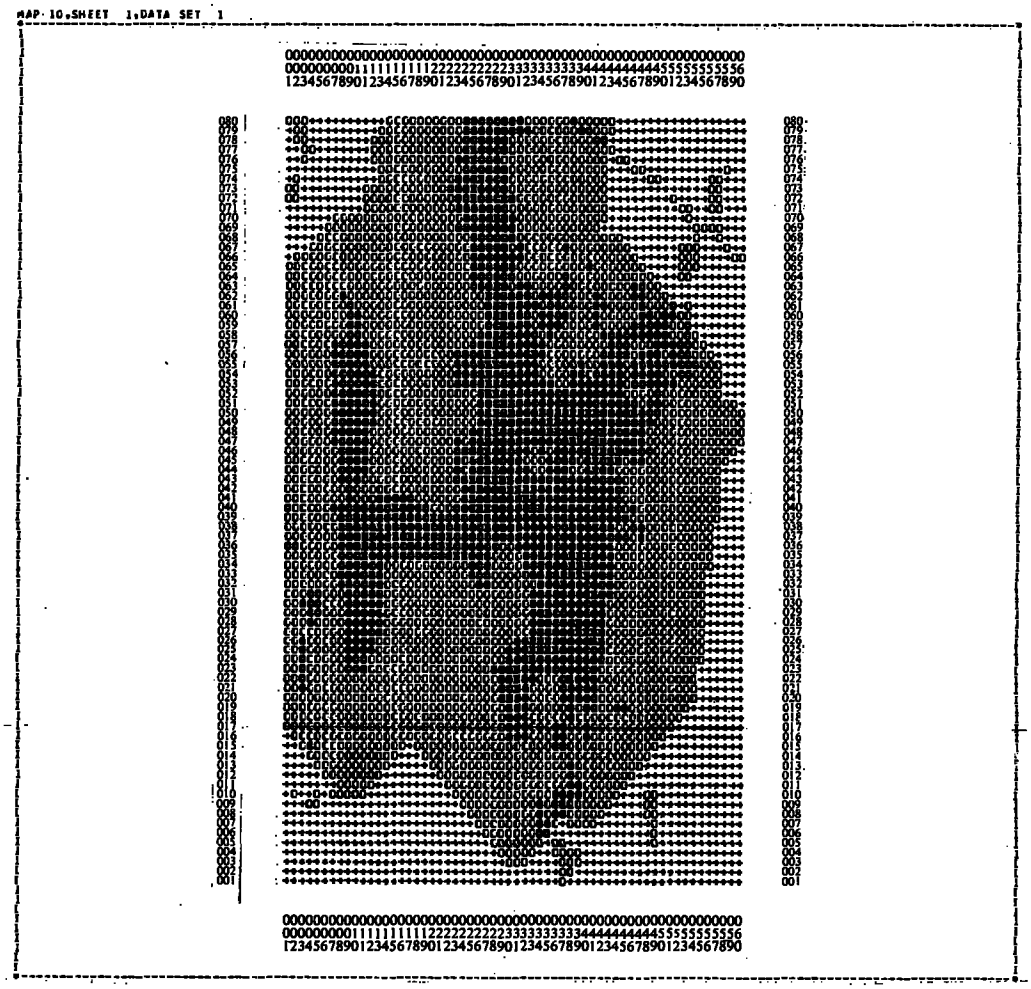
Fig. VI.33
Total Impact: Primary Highways on Scientific Resources

salt concentrations not only disrupt and permanently change these small stream corridors but also build up larger concentrations in lakes and reservoirs into which these streams flow.

## 9. IMPACT OF HIGHWAYS ON SCENIC RESOURCES (Figure VI.34)

A new primary facility installed in those areas which indicate susceptibility to severe visual change will be felt very nearly throughout the entire recreation area. The most intense visual encroachment will occur on that side of the reservoir where the road would be located. Visual impact would affect any activity taking place on the surface of the reservoir such as boating, swimming, fishing, water skiing, etc. An intense encroachment would be felt on the opposite shoreline for if the road is located very near to the shoreline, its visual presence is intensified by the noise generated by the operation of motor vehicles on it since there would be no absorption of the sound across the surface of the water.

A facility could traverse areas projecting a moderate impact without causing any significant visual change to the site. This could best be accomplished by not clear cutting the entire right-of-way in areas of moderately dense vegetation and by keeping the facility off broad areas of steeply sloping topography. The visual impacts of extensive cuts and fill on both sides of the road (in order to maintain and hold acceptable gradients) could thus be minimized.




IMPACT OF PRIMARY HIGHWAYS ON SCENIC RESOURCES

RESOURCE SYSTEM - SCENIC RESOURCES

HONEY HILL CASE STUDY

LEGEND

0 = NO IMPACT
1 = COMPATIBLE IMPACT
2 = MODERATE IMPACT
3 = SEVERE IMPACT
4 = THRESHOLD IMPACT

| LEVELS | 0 | 1 | 2 | 3 | 4 |
|---|---|---|---|---|---|
| SYMBOLS | . | + | C | O | |
| FREQUENCY | 0 | 1164 | 2452 | 1044 | 137 |

Fig. VI.34
Total Impact: Primary Highways on Scenic Resources

## CHAPTER VII: DEMANDS

Aside from the models which predict the impact of locating each of the activities on the site areas, two other categories of information are required in order to accomplish the evaluations proposed in the research. The first of these is estimates of the demand for the various activities; the second is estimates of the dollar costs of providing facilities for these activities and the income to be locally and regionally derived from different levels of participation. While these data are necessary for the conduct of the research, their acquisition has not been considered a prime focus of our effort. Rather, we have used the best available information and,where necessary to develop quantitative estimates without available data, we have made what must be considered reasonable guesses.

The purpose of the demand studies was to estimate, for any given consumer population, the relative propensity to consume the recreation and other activities afforded by the site. Two variables were selected for the definition of consumer sub-groups. These were: income and the distance between the site and the person's place of residence.

Income sub-groups were defined by effective buying income. Effective buying income is defined by Market Statistics, Inc. in its Guide for Marketing Executives, 1968, p. 10. It is a concept equivalent to "U.S. Disposable Personal Income." This is "personal income - wages, salaries, interest, dividends, profits and property income, minus federal, state and local taxes. This includes: 1) net cash income, plus 2) income in kind - payments in noncash goods and services, such as food and housing, and 3) imputed income - food consumed on the farm that produces it and imputed rent of owner-occupied housing. Effective Buying Income is equivalent to the Government's 'disposal personal income.' Money gifts are not counted as income. Effective Buying Income totals are bulk measurements of potential. They indicate the general ability to buy and are plainly essential in comparing, selecting and grouping markets on that basis." Data are available for 1968 by county for the following effective buying sub-groups: 0-$3000/year, 3-5000, 5-8000, 8-10000, 10,000+.

Distance to the site, which was considered to be equivalent to time from the site, was estimated in terms of 50 mile

rings drawn concentrically around the study area (see Figure VII.1). These rings were considered equivalent to one hour driving zones.

Four time-distance zones were defined: 0-1 hour, 1-2, 2-3, 3-4 hours from the site. After identifying the counties within each zone, the population by time-distance and income groups was calculated. The number of households by income and time-distance to site are presented in Table VII.1. For the purposes of simplification, the twenty sub-groups identified in Table VII.1 were collapsed into nine sub-groups. These nine sub-groups were based upon three income categories: 0-5000/year, $5000-10,000/year, and $10,000+; and three time-distance groups: 0-1 hours, 1-3 hours, and 3-4 hours. The number of households by income and distance in the nine sub-groups which were used throughout the rest of the research are presented in Table VII.2.

There were virtually no locally reliable data on the participation in recreation activities available for the Monadnock Region of New Hampshire. The few reported studies are based upon inconsistent income groupings and small samples. As a result, no site-specific demand estimates could be made for the Honey Hill project.

The best available data were those reported for the Northeast Region in the Outdoor Recreation Resources Review Commission Study Reports #19 - National Recreation Survey. Tables are presented by activity, on the percent of persons 12 years and over participating, days of activity per person, and days of activity per participant during quarterly seasons in 1960 for the United States and major regions. Data are reported by selected socio-economic characteristics including locale of residents and family income. The consumer participation in terms of days per person provided a comparative base for all the selected activities. The nine income-distance sub-groups were created by aggregating the reported family income data into the three desired groupings and by selecting among the residents' locale data. Because of the location of the Honey Hill study area, it could be assumed that the 0-1 hour zone could be characterized as rural non-farm, that the 1-3 hour zone could be considered urban, and that the 3-4 hour zone was primarily SMA over 1,000,000. Appropriate data were derived from the column reporting the Northeast United States. Table VII.3 reports the propensities of activity participation by income and time-distance to the site. Each activity is reported in the appropriate summer or winter season and since the data are based upon days per person, they can be considered as a ratio.

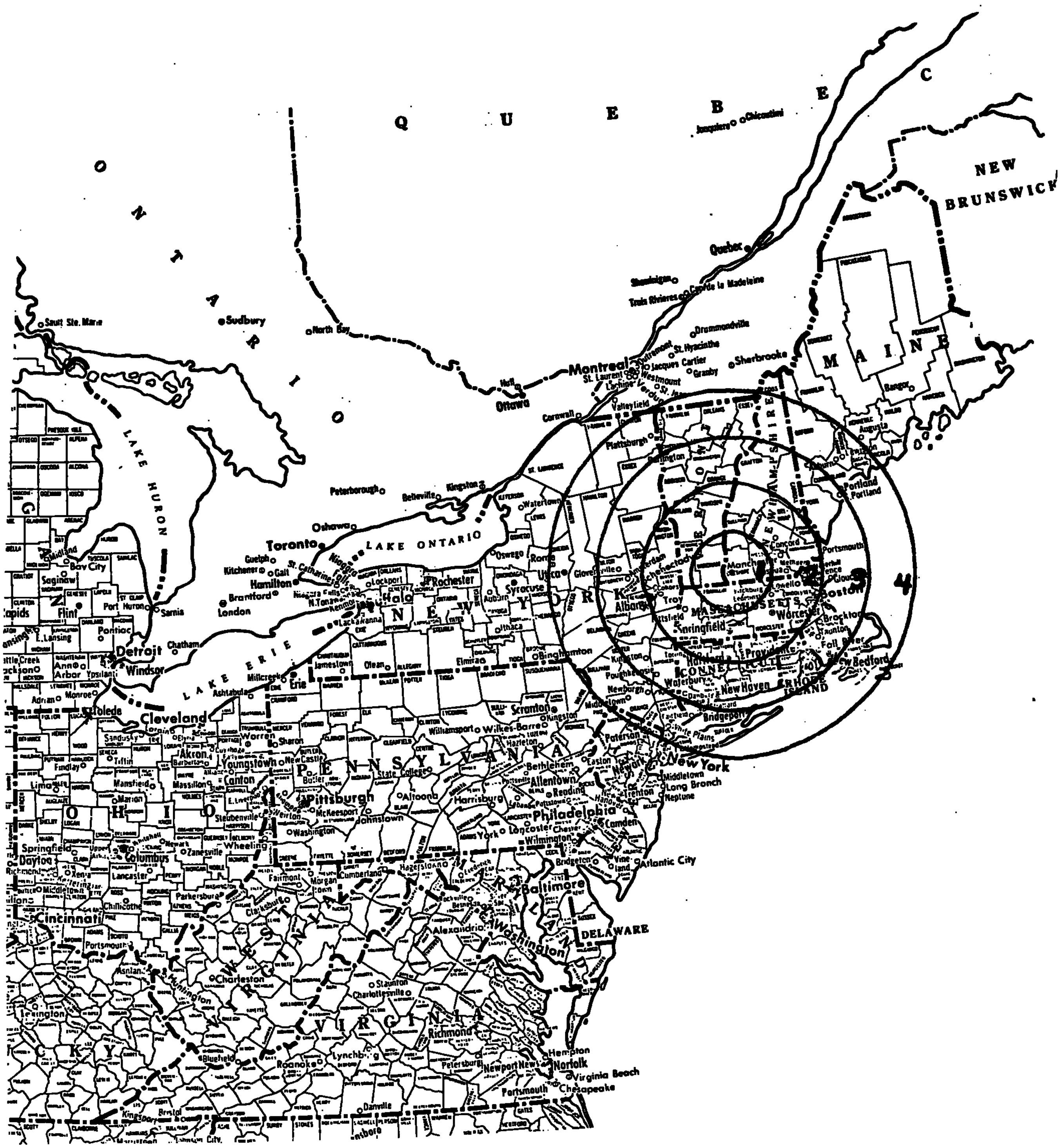



Fig. VII.1
One Hour Time-distance Zones to Site

The propensity for activity participation was then combined with the population in each of the nine sub-groups. The resulting Table VII.4, displays the number of first choice activity participants by season per 1000 cars by income and distance of travel to site. The figures reported on Table VII.4 are used in the research, and in particular in the simulation model, as the basis for the number of people who are assumed to be desiring participation in the various activity facilities provided in each of the proposed plans.

TABLE VII.1

NUMBER OF HOUSEHOLDS BY INCOME AND TIME-DISTANCE TO SITE (x1000)
Source: Sales Management, June 1968

| TIME-DISTANCE TO SITE: | INCOME: $0-3000/yr | $3-5000/yr | $5-8000/yr | $8-10,000/yr | $10,000+/yr |
|---|---|---|---|---|---|
| 0-1 hr. | 4 | 3 | 7 | 4 | 5 |
| 1-2 hr. | 41 | 48 | 119 | 57 | 72 |
| 2-3 hr. | 293 | 278 | 654 | 631 | 593 |
| 3-4 hr. | 212 | 189 | 458 | 267 | 499 |

TOTAL: 4,165(000)

TABLE VII.2

NUMBER OF HOUSEHOLDS BY INCOME AND TIME-DISTANCE TO SITE, AGGREGATED, (x1000)

| TIME-DISTANCE TO SITE: | INCOME: $0-5000/yr | $5-10,000/yr | $10,000+/yr |
|---|---|---|---|
| 0-1 hr. | 7 | 11 | 5 |
| 1-3 hr. | 660 | 1191 | 72 |
| 3-4 hr. | 401 | 725 | 499 |

TOTAL: 4,165(000)

TABLE VII.3

DEMAND: PROPENSITIES OF ACTIVITY PARTICIPATION, IN DAYS PER PERSON, BY SEASON, BY INCOME AND TIME-DISTANCE TO SITE

Source: Analysis of Tables in ORRRC #19

| | | INCOME: $0-5,000/yr | $5-10,000/yr | $10-15,000/yr |
|---|---|---|---|---|
| TIME-DISTANCE TO SITE | 0-1 hr | | | |
| | 1-3 hr | | | |
| | 3+ hr | | | |

SUMMER ACTIVITIES

| | | | |
|---|---|---|---|
| | 0.217 | 0.216 | 0.192 |
| 1.1 Hunting | 0.084 | 0.083 | 0.074 |
| | 0.047 | 0.046 | 0.041 |
| | 0.217 | 0.216 | 0.192 |
| 1.2 Fishing | 0.084 | 0.083 | 0.074 |
| | 0.047 | 0.046 | 0.041 |
| | 0.107 | 0.138 | 0.180 |
| 1.3 Swimming | 0.070 | 0.090 | 0.118 |
| | 0.075 | 0.097 | 0.126 |
| | 0.050 | 0.042 | 0.112 |
| 1.4 Trail hiking | 0.135 | 0.112 | 0.301 |
| | 0.061 | 0.051 | 0.136 |
| | 0.216 | 0.160 | 0.293 |
| 1.5 Camping | 0.051 | 0.038 | 0.069 |
| | 0.056 | 0.042 | 0.076 |
| | 0.129 | 0.184 | 0.190 |
| 1.6 Picnicking | 0.057 | 0.082 | 0.084 |
| | 0.070 | 0.100 | 0.103 |

TABLE VII.3
(Continued)

| | | | |
|---|---|---|---|
| | 0.090 | 0.096 | 0.246 |
| 1.7 Boating | 0.054 | 0.058 | 0.149 |
| | 0.064 | 0.068 | 0.175 |
| 1.8 Residential | (limited) | | |
| 1.9 Parking | (all) | | |
| 1.10 Major roads | (all) | | |

WINTER ACTIVITIES

| | | | |
|---|---|---|---|
| | 0.425 | 0.242 | 0.074 |
| 2.1 Hunting | 0.098 | 0.056 | 0.017 |
| | 0.050 | 0.029 | 0.009 |
| | 0.033 | 0.059 | 0.011 |
| 2.2 Snowshoeing | 0.097 | 0.172 | 0.032 |
| | 0.192 | 0.339 | 0.064 |
| | 0.035 | 0.055 | 0.010 |
| 2.3 Cross-country skiing | 0.105 | 0.165 | 0.030 |
| | 0.210 | 0.330 | 0.060 |
| | 0.050 | 0.042 | 0.112 |
| 2.4 Hiking | 0.135 | 0.112 | 0.301 |
| | 0.061 | 0.051 | 0.136 |
| | 0.345 | 0.152 | 0.061 |
| 2.5 Snowmobiling | 0.189 | 0.083 | 0.034 |
| | 0.085 | 0.037 | 0.015 |
| | 0.035 | 0.055 | 0.010 |
| 2.6 Downhill Skiing | 0.105 | 0.165 | 0.030 |
| | 0.210 | 0.330 | 0.060 |
| | 0.035 | 0.221 | 0.170 |
| 2.7 Ice skating | 0.037 | 0.233 | 0.180 |
| | 0.010 | 0.064 | 0.049 |
| 2.8 Residential | (limited) | | |
| 2.9 Parking | (all) | | |
| 2.10 Major roads | (all) | | |

TABLE VII.4

DEMAND: NUMBER OF FIRST CHOICE ACTIVITY PARTICIPANTS BY SEASON PER N=1000 CARS (3250 PERSONS) BY INCOME AND TIME-DISTANCE TO SITE

| TIME-DISTANCE TO SITE | INCOME: $0-5,000/yr | $5-10,000/yr | $10-15,000/yr |
|---|---|---|---|
| 0-1 hr | | | |
| 1-3 hr | | | |
| 3+ hr | | | |

SUMMER ACTIVITIES

| | | | |
|---|---|---|---|
| | 58.072 | 57.558 | 51.391 |
| 1.1 Hunting | 22.356 | 22.158 | 19.784 |
| | 12.434 | 12.324 | 11.004 |
| | 58.072 | 57.558 | 51.391 |
| 1.2 Fishing | 22.356 | 22.158 | 19.784 |
| | 12.434 | 12.324 | 11.004 |
| | 100.144 | 129.617 | 169.186 |
| 1.3 Swimming | 65.293 | 84.510 | 110.309 |
| | 69.906 | 90.480 | 118.101 |
| | 2.134 | 1.778 | 4.765 |
| 1.4 Trail hiking | 5.727 | 4.773 | 12.791 |
| | 2.583 | 2.152 | 5.768 |
| | 9.521 | 7.064 | 12.899 |
| 1.5 Camping | 2.240 | 1.662 | 3.035 |
| | 2.464 | 1.828 | 3.339 |
| | 51.475 | 73.210 | 75.688 |
| 1.6 Picnicking | 22.819 | 32.454 | 33.552 |
| | 27.913 | 39.699 | 41.043 |
| | 15.983 | 17.160 | 43.910 |
| 1.7 Boating | 9.656 | 10.368 | 26.529 |
| | 11.321 | 12.155 | 31.103 |

TABLE VII.4
(Continued)

| | | | |
|---|---|---|---|
| 1.8 Residential | (limited) | | |
| 1.9 Parking | (all) | | |
| 1.10 Major roads | (all) | | |

WINTER ACTIVITIES

| | | | |
|---|---|---|---|
| | 142.126 | 80.979 | 24.789 |
| 2.1 Hunting | 32.582 | 18.564 | 5.683 |
| | 16.853 | 9.602 | 2.939 |
| | 5.589 | 9.889 | 1.863 |
| 2.2 Snowshoeing | 16.338 | 28.906 | 5.446 |
| | 32.247 | 57.052 | 10.749 |
| | 9.527 | 14.971 | 2.722 |
| 2.3 Cross-country skiing | 28.580 | 44.912 | 8.166 |
| | 57.161 | 89.824 | 16.332 |
| | 2.134 | 1.778 | 4.765 |
| 2.4 Hiking | 5.727 | 4.773 | 12.791 |
| | 2.583 | 2.152 | 5.768 |
| | 160.672 | 70.696 | 28.564 |
| 2.5 Snowmobiling | 87.965 | 38.705 | 15.638 |
| | 39.495 | 17.378 | 7.021 |
| | 47.634 | 74.854 | 13.610 |
| 2.6 Downhill skiing | 142.902 | 224.560 | 40.829 |
| | 285.804 | 449.121 | 81.658 |
| | 14.715 | 92.971 | 71.567 |
| 2.7 Ice skating | 15.505 | 97.962 | 75.410 |
| | 4.247 | 26.830 | 20.654 |
| 2.8 Residential | (limited) | | |
| 2.9 Parking | (all) | | |
| 2.10 Major roads | (all) | | |

## CHAPTER VIII: DOLLAR COSTS AND BENEFITS

Since one of the major purposes of the research was to evaluate the dollar costs and benefits of any proposal for the Honey Hill Study area, it was necessary to have data on the income generated locally and regionally by the participants in the various activities and it was also necessary to be able to develop estimates of the cost of providing the facilities. As was the case in the estimation of demands, no locally reliable data were available on expenditures and costs.

### A. COSTS

Estimates of the cost of construction for various activity facilities were developed by persons familiar with typical local practice in the Honey Hill Area and from the preliminary cost estimating procedures used by the U.S. Army Corps of Engineers. These costs are reported for each activity in Table VIII.1.

### B. LOCAL AND REGIONAL INCOME

No locally reliable data were available on the expenditure patterns of recreation participants in the Honey Hill region. It was necessary for us to have estimates of the amounts of money spent locally by a participant, and of the regional effects of that expenditure for each of the activities. A search was made of available literature and on the basis of these findings estimates were developed which were used by the research team. These values are reported on Table VIII.2. Direct local income and its regional multiplier by activity by participant day were used in the estimates of local and regional benefits in the simulation model and in the definition of the objective function in the linear program. They can only be considered estimates and their reliability is certainly subject to question. This category of information is so central to the evaluation of alternative plan proposals that we can only urge that a substantial effort be made in the future on the development of accurate local estimates of consumer expenditures and their regional multiplier effects.

TABLE VIII.1

COSTS OF ACTIVITY FACILITIES PER CELL (2.5 ACRES)

Source: 1) Corps of Engineers
2) Research Team
/c = per cell (2.5 acres)

A. CAPITAL COSTS

| | | |
|---|---|---|
| 1. | Summer | |
| 1.1 | Hunting | None |
| 1.2 | Fishing | None |
| 1.3 | Swimming: $1.75/sq. yd. | 21,175/c[1] |
| 1.4 | Trail hiking: $80/acre | 200/c[2] |
| 1.5 | Camping: $2,500/site @ 4/acre | 25,000/c[1] |
| 1.6 | Picnicking: $175/site @ 10/acre | 4,375/c[1] |
| 1.7 | Marina: $3,000/ramp @ 2/cell | 6,000/c[1] |
| 1.8 | Residential: est. 25,000/unit @ 6/acre | 300,000/c[2] |
| 1.9 | Parking: $3.25/sq. yd. | 39,325/c[1] |
| 1.10 | Roads @ 24': $33,000/linear mile | 2,040/c[1] |
| 2. | Winter | |
| 2.1 | Hunting | None |
| 2.2 | Snowshoeing | None |
| 2.3 | Cross-country skiing | None |
| 2.4 | Trail hiking: $80/acre | 200/c[2] |
| 2.5 | Snowmobiling | None |
| 2.6 | Downhill skiing: $6,000/c clearing & grading; $50,000/25c lifts | 8,000/c[2] |
| 2.7 | Ice skating | None |
| 2.8 | Residential | As above |
| 2.9 | Parking | As above |
| 2.10 | Roads | As above |

B. MAINTENANCE COSTS

| | |
|---|---|
| Per visitor day | $ .35[1] |
| Plus, per man day camping | .75[1] |
| Plus, per man day downhill skiing | 2.00[2] |

TABLE VIII.2

DIRECT LOCAL INCOME AND REGIONAL MULTIPLIER
BY ACTIVITY, BY PARTICIPANT DAY

| Activity | Direct Local Income | Regional Multiplier |
|---|---|---|
| 1. Summer | | |
| 1.1 Hunting | 6.12 | 1.98 |
| 1.2 Fishing | 7.22 | 2.76 |
| 1.3 Swimming | 2.30 | 2.76 |
| 1.4 Trail Hiking | 5.80 | 1.98 |
| 1.5 Camping | 5.80 | 1.98 |
| 1.6 Picnicking | 5.80 | 1.98 |
| 1.7 Boating | 6.14 | 2.76 |
| 1.8 Residential | 3.25 | 1.98 |
| 1.9 Parking | - | - |
| 1.10 Major roads | - | - |
| 2. Winter | | |
| 2.1 Hunting | 6.12 | 1.98 |
| 2.2 Snowshoeing | 5.80 | 1.98 |
| 2.3 Cross-country skiing | 5.80 | 1.98 |
| 2.4 Trail hiking | 5.80 | 1.98 |
| 2.5 Snowmobiling | 5.80 | 1.98 |
| 2.6 Downhill skiing | 16.97 | 2.76 |
| 2.7 Ice skating | 5.80 | 1.98 |
| 2.8 Residential | 3.25 | 1.98 |
| 2.9 Parking | - | - |
| 2.10 Major roads | - | - |

## CHAPTER IX: THE SIMULATION MODEL

A simulation model was prepared to evaluate the performance of the plans made for the Honey Hill project. It was designed to operate at the scale of the individual grid cell. The model had as its purpose the evaluation of any plans developed for the study area in terms of its social, fiscal, and/or environmental consequences.

The model has the following general framework:

1. The season of year is established and the population arriving at the site on a given day is fixed by establishing a parameter, N, equal to the number of car units. This number is translated into people by applying the multiplier 3.25 persons/car. In this research project, the model was run for two seasons, summer and winter, and a range of N in increments of 500, from 1000-3000. This allowed us to identify the points at which a given plan for the site became overcrowded, exhibited rapidly increasing environmental damage, and/or began to decline in potential dollar income.

2. Activity participation rates in terms of man days per season per activity are then defined. These rates are normalized and relative activity preference weights are generated. The activity preferences by income-time group are calculated and the demands associated with the given population size are established.

Table IX.1 shows the normalized participation rates for the summer activities by income-time group. Table IX.2 shows the demands associated with the summer N=3000 demand population. Tables IX.3 and IX.4 show the equivalent tables for winter activities. The model makes the assumption that each participant will take part in three summer activities per day or two winter activities, and that these will be combined in the order of their overall relative preference weights. The identification of activity preferences by income-time group allow for the evaluation of the extent to which the various groups are served by a given plan.

3. Space standards for each activity in terms of person/acre are defined. These space standards are derived from research described in Chapter IV and are used to measure the degree to which an activity location is overcrowded. Crowding is used as the primary measure of the quality of

the experience for the participant. Table IX.5 presents the standards used in the model.

4. The daily local dollar income and the regional multiplier are then defined in terms of dollars per activity per person day. These figures allow the model to estimate the local and regional income of the plan (see Table VIII.2).

5. The next input to the model is the attractiveness scores for each activity on each cell location as previously defined in Chapter IV and as stored in the data bank.

6. A plan specifying the allocation of activities to cells is then read.

7. The population is then allocated to the site by activity preference on the basis of the relative attractiveness of all the cells available for the activity. For example, for a given incoming population, the total number of campers is allocated to all camping sites on the basis of the relative attractiveness of each of the camping sites designated in the plan.

8. Usage level categories are constructed as percentages of the space standards previously defined and the cells allocated by the plan are sorted into the usage level categories. Five levels of usage are identified: 0-75% of standard, 75-100%, 100-125%, 125-150%, and over 150% of standard. It is assumed in the model that this last category would result in people being turned away from participation in that activity, thus also losing potential income.

Two alternative output formats were developed for the model and can be requested of the program. The first identifies the coordinates of each activity-cell for the degree of crowding as shown in Table IX.6. The second option suppresses the cell by cell evaluation and has as its output the summary table as shown in Table IX.7.

9. The number of people by activity by usage level (crowding) is then calculated and summarized as shown in Table IX.8.

10. The dollar income accruing to the local area and the region is then calculated for each activity and summed. These are based upon the previously defined data expenditures per person per activity and their regional multipliers. An output table is generated as shown in Table IX.9.

11. The next output of the simulation model is the mean site attractiveness, by activity of the cells proposed by plan. These are summarized as shown in Table IX.10.

12. The impact of the plan is then determined for each of the eleven site resource systems in terms of the number of null, compatible, moderate, severe and threshold conditions which are caused by the proposed activity locations in the plan. A mean impact value is also calculated for each system. Table IX.11 shows the output table generated by this step.

13. The capital costs of constructing the plan are then calculated on the basis of the number of facility cells provided by the plan and data previously defined on the costs per activity-cell. These are summed by season, as shown in Table IX.12. In interpreting this table, it must be kept in mind that the seasonal costs of the residential, parking and roads components are not repetitive. In addition, no distinction is made in the model as to the assignment of costs among the various project participants.

Table IX.13 presents the program as developed for the simulation for steps 1 through 9. Table IX.14 presents the program

As described in Chapters X and XI, the simulation model was used to evaluate the proposals made for the Honey Hill project. It was also used to test the capacity of the plans through a series of evaluations made under varying demand conditions. In the plan improvement processes which the research team developed, its ability to identify the relative deficiency and/or excess of activity facilities provided an important check on the adequacy of the initial estimated program requirements. Lastly, it allowed us to evaluate comparatively the alternative proposals for the project.

SUMMER
PROPENSITIES OF ACTIVITY CONSUMPTION

| | | | |
|---|---|---|---|
| ACTIVITY 1 | | | |
| | 0.217 | 0.216 | 0.192 |
| | 0.084 | 0.083 | 0.074 |
| | 0.047 | 0.046 | 0.041 |
| ACTIVITY 2 | | | |
| | 0.217 | 0.216 | 0.192 |
| | 0.084 | 0.083 | 0.074 |
| | 0.047 | 0.046 | 0.041 |
| ACTIVITY 3 | | | |
| | 0.107 | 0.138 | 0.180 |
| | 0.070 | 0.090 | 0.118 |
| | 0.075 | 0.097 | 0.126 |
| ACTIVITY 4 | | | |
| | 0.090 | 0.096 | 0.246 |
| | 0.054 | 0.058 | 0.149 |
| | 0.064 | 0.068 | 0.175 |
| ACTIVITY 5 | | | |
| | 0.216 | 0.160 | 0.293 |
| | 0.051 | 0.038 | 0.069 |
| | 0.056 | 0.042 | 0.076 |
| ACTIVITY 6 | | | |
| | 0.129 | 0.184 | 0.190 |
| | 0.057 | 0.082 | 0.084 |
| | 0.070 | 0.100 | 0.103 |
| ACTIVITY 7 | | | |
| | 0.090 | 0.096 | 0.246 |
| | 0.054 | 0.058 | 0.149 |
| | 0.064 | 0.068 | 0.175 |
| ACTIVITY 8 | | | |
| | 0.0 | 0.0 | 0.0 |
| | 0.0 | 0.0 | 0.0 |
| | 0.0 | 0.0 | 0.0 |
| ACTIVITY 9 | | | |
| | 0.0 | 0.0 | 0.0 |
| | 0.0 | 0.0 | 0.0 |
| | 0.0 | 0.0 | 0.0 |

Table IX.1
Summer Propensities of Activity Consumption

SUMMER
RATES OF ACTIVITY CONSUMPTION N =3000

| | | | |
|---|---|---|---|
| ACTIVITY 1 | | | |
| | 249.428 | 247.221 | 220.733 |
| | 96.021 | 95.172 | 84.975 |
| | 53.408 | 52.936 | 47.264 |
| ACTIVITY 2 | | | |
| | 249.428 | 247.221 | 220.733 |
| | 96.021 | 95.172 | 84.975 |
| | 53.408 | 52.936 | 47.264 |
| ACTIVITY 3 | | | |
| | 430.136 | 556.729 | 726.686 |
| | 280.447 | 362.985 | 473.796 |
| | 300.259 | 388.628 | 507.267 |
| ACTIVITY 4 | | | |
| | 68.648 | 73.707 | 188.602 |
| | 41.475 | 44.531 | 113.947 |
| | 48.626 | 52.209 | 133.593 |
| ACTIVITY 5 | | | |
| | 40.894 | 30.341 | 55.405 |
| | 9.622 | 7.139 | 13.036 |
| | 10.584 | 7.853 | 14.340 |
| ACTIVITY 6 | | | |
| | 221.097 | 314.449 | 325.094 |
| | 98.012 | 139.395 | 144.114 |
| | 119.894 | 170.515 | 176.288 |
| ACTIVITY 7 | | | |
| | 68.648 | 73.707 | 188.602 |
| | 41.475 | 44.531 | 113.947 |
| | 48.626 | 52.209 | 133.593 |
| ACTIVITY 8 | | | |
| | 0.0 | 0.0 | 0.0 |
| | 0.0 | 0.0 | 0.0 |
| | 0.0 | 0.0 | 0.0 |
| ACTIVITY 9 | | | |
| | 0.0 | 0.0 | 0.0 |
| | 0.0 | 0.0 | 0.0 |
| | 0.0 | 0.0 | 0.0 |

Table IX.2
Summer Rates of Activity Consumption
(N=3000)

WINTER
PROPENSITIES OF ACTIVITY CONSUMPTION

ACTIVITY 1

| | | |
|---|---|---|
| 0.425 | 0.242 | 0.074 |
| 0.098 | 0.056 | 0.017 |
| 0.050 | 0.029 | 0.009 |

ACTIVITY 2

| | | |
|---|---|---|
| 0.033 | 0.059 | 0.011 |
| 0.097 | 0.172 | 0.032 |
| 0.192 | 0.339 | 0.064 |

ACTIVITY 3

| | | |
|---|---|---|
| 0.035 | 0.055 | 0.010 |
| 0.105 | 0.165 | 0.030 |
| 0.210 | 0.330 | 0.060 |

ACTIVITY 4

| | | |
|---|---|---|
| 0.090 | 0.096 | 0.246 |
| 0.054 | 0.058 | 0.149 |
| 0.064 | 0.068 | 0.175 |

ACTIVITY 5

| | | |
|---|---|---|
| 0.345 | 0.152 | 0.061 |
| 0.189 | 0.083 | 0.034 |
| 0.085 | 0.037 | 0.015 |

ACTIVITY 6

| | | |
|---|---|---|
| 0.035 | 0.055 | 0.010 |
| 0.105 | 0.165 | 0.030 |
| 0.210 | 0.330 | 0.060 |

ACTIVITY 7

| | | |
|---|---|---|
| 0.0 | 0.0 | 0.0 |
| 0.0 | 0.0 | 0.0 |
| 0.0 | 0.0 | 0.0 |

ACTIVITY 8

| | | |
|---|---|---|
| 0.0 | 0.0 | 0.0 |
| 0.0 | 0.0 | 0.0 |
| 0.0 | 0.0 | 0.0 |

ACTIVITY 9

| | | |
|---|---|---|
| 0.0 | 0.0 | 0.0 |
| 0.0 | 0.0 | 0.0 |
| 0.0 | 0.0 | 0.0 |

Table IX.3
Winter Propensities of Activity Consumption

WINTER
RATES OF ACTIVITY CONSUMPTION N = 3000

| | | | |
|---|---|---|---|
| ACTIVITY 1 | | | |
| | 430.980 | 245.559 | 75.171 |
| | 98.802 | 56.294 | 17.233 |
| | 51.104 | 29.118 | 8.914 |
| ACTIVITY 2 | | | |
| | 16.949 | 29.987 | 5.650 |
| | 49.544 | 87.655 | 16.515 |
| | 97.784 | 173.003 | 32.595 |
| ACTIVITY 3 | | | |
| | 28.889 | 45.397 | 8.254 |
| | 86.667 | 136.190 | 24.762 |
| | 173.333 | 272.381 | 49.524 |
| ACTIVITY 4 | | | |
| | 166.950 | 179.251 | 458.672 |
| | 100.865 | 108.298 | 277.115 |
| | 118.256 | 126.970 | 324.893 |
| ACTIVITY 5 | | | |
| | 487.217 | 214.375 | 86.616 |
| | 266.744 | 117.368 | 47.421 |
| | 119.763 | 52.696 | 21.291 |
| ACTIVITY 6 | | | |
| | 144.444 | 226.984 | 41.270 |
| | 433.333 | 680.952 | 123.809 |
| | 866.666 | 1361.904 | 247.619 |
| ACTIVITY 7 | | | |
| | 0.0 | 0.0 | 0.0 |
| | 0.0 | 0.0 | 0.0 |
| | 0.0 | 0.0 | 0.0 |
| ACTIVITY 8 | | | |
| | 0.0 | 0.0 | 0.0 |
| | 0.0 | 0.0 | 0.0 |
| | 0.0 | 0.0 | 0.0 |
| ACTIVITY 9 | | | |
| | 0.0 | 0.0 | 0.0 |
| | 0.0 | 0.0 | 0.0 |
| | 0.0 | 0.0 | 0.0 |

Table IX.4
Winter Rates of Activity Consumption
(N=3000)

TABLE IX.5

SPACE STANDARDS BY ACTIVITY, PERSONS PER ACRE

| Activity | Persons/Acre |
|---|---|
| 1. SUMMER | |
| 1.1 Hunting | 8 p/a |
| 1.2 Fishing | 2 p/a |
| 1.3 Swimming (beach) | 540 p/a |
| 1.4 Trail hiking | 3 p/a |
| 1.5 Camping | 16 p/a |
| 1.6 Picnicking | 40 p/a |
| 1.7 Boating | 80 p/a |
| 1.8 Residential | - |
| 1.9 Parking | 150 p/a |
| 1.10 Major roads | - |
| 2. WINTER | |
| 2.1 Hunting | 8 p/a |
| 2.2 Snowshoeing | 3 p/a |
| 2.3 Cross-country skiing | 3 p/a |
| 2.4 Trail hiking | 3 p/a |
| 2.5 Snowmobiling | 1.5 p/a |
| 2.6 Downhill skiing | 30 p/a |
| 2.7 Ice skating | 100 p/a |
| 2.8 Residential | - |
| 2.9 Parking | 150 p/a |
| 2.10 Major roads | - |

OUTPUT FOR PLAN 1

ACTIVITY 1

| LT .75 | LT STD | LT 1.25X | LT 1.50X |
|---|---|---|---|

ACTIVITY 2

| LT .75 | LT STD | LT 1.25X | LT 1.50X |
|---|---|---|---|
| | | | 28 33 |
| | | | 29 36 |
| | | 31 25 | |
| | | 36 24 | |
| | 43 21 | | |
| | | | 44 29 |
| | 47 35 | | |
| | | 49 33 | |
| | | | 61 11 |
| | | 62 39 | |

ACTIVITY 3

| LT .75 | LT STD | LT 1.25X | LT 1.50X |
|---|---|---|---|

ACTIVITY 4

| LT .75 | LT STD | LT 1.25X | LT 1.50X |
|---|---|---|---|
| 39 41 | | | |
| 39 42 | | | |
| 39 43 | | | |
| 40 13 | | | |
| 40 14 | | | |
| 40 15 | | | |
| 40 16 | | | |
| 40 17 | | | |
| 40 39 | | | |
| 40 40 | | | |
| 40 43 | | | |
| 41 13 | | | |
| 41 14 | | | |

Table IX.6
Crowding by Activity, Evaluation by Cell

PLAN 2 SUMMER N= 3000

Table IX.7
Number of Cells/Activity/Crowding

| ACT. # | 0-75% | 75-100% | 100-125% | 125-150% |
|---|---|---|---|---|
| 1 | 0.0 | 0.0 | 0.0 | 0.0 |
| 2 | 0.0 | 0.0 | 5.0 | 5.0 |
| 3 | 10.0 | 8.0 | 9.0 | 106.0 |
| 4 | 14.0 | 0.0 | 0.0 | 0.0 |
| 5 | 0.0 | 0.0 | 0.0 | 2.0 |
| 6 | 0.0 | 0.0 | 0.0 | 0.0 |
| 7 | 0.0 | 0.0 | 0.0 | 0.0 |
| 8 | 0.0 | 4.0 | 0.0 | 0.0 |
| 9 | 175.0 | 0.0 | 0.0 | 0.0 |
| TOTAL | 199.0 | 12.0 | 14.0 | 113.0 |

Table IX.8
Number of People/Activity/Crowding

| ACT. # | 0-75% | 75-100% | 100-125% | 125-150% | TURNED AWAY |
|---|---|---|---|---|---|
| 1 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 2 | 0.0 | 0.0 | 1483.4 | 1858.1 | 34.2 |
| 3 | 53.8 | 58.2 | 78.5 | 1211.5 | 1.4 |
| 4 | 8437.9 | 0.0 | 0.0 | 0.0 | 0.0 |
| 5 | 0.0 | 0.0 | 0.0 | 1462.7 | 140.9 |
| 6 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 7 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 8 | 0.0 | 396.5 | 0.0 | 0.0 | 0.0 |
| 9 | 343.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| TOTAL | 8834.7 | 454.6 | 1561.9 | 4532.3 | 176.5 |

Table IX.9
Income/Activity

| ACT. # | LOCAL | REGIONAL |
|---|---|---|
| 1 | 0.0 | 0.0 |
| 2 | 19380.7 | 38373.7 |
| 3 | 10122.2 | 27937.3 |
| 4 | 19407.1 | 53563.7 |
| 5 | 10561.0 | 29148.3 |
| 6 | 0.0 | 0.0 |
| 7 | 0.0 | 0.0 |
| 8 | 2299.5 | 4553.1 |
| 9 | 1989.6 | 3939.5 |
| TOTAL | 63760.2 | 157515.4 |

PLAN # 2 SUMMARY

Table IX.10
Attractiveness Summary

SUMMER PLAN ATTRACTIVENESS

| ACTIVITY | # OF CELLS | MEAN |
|---|---|---|
| 1 | 41 | 34.98 |
| 2 | 39 | 66.15 |
| 3 | 12 | 81.67 |
| 4 | 71 | 94.37 |
| 5 | 13 | 75.46 |
| 6 | 10 | 68.00 |
| 7 | 2 | 90.00 |
| 8 | 62 | 68.47 |
| 9 | 9 | 64.44 |
| 10 | 242 | 3.69 |
| TOTAL | 501 | 38.43 |

WINTER PLAN ATTRACTIVENESS

| ACTIVITY | # OF CELLS | MEAN |
|---|---|---|
| 11 | 41 | 34.98 |
| 12 | 0 | 0.0 |
| 13 | 0 | 0.0 |
| 14 | 71 | 94.37 |
| 15 | 269 | 68.18 |
| 16 | 55 | 49.75 |
| 17 | 0 | 0.0 |
| 18 | 62 | 68.47 |
| 19 | 9 | 64.44 |
| 20 | 242 | 3.69 |
| TOTAL | 749 | 46.63 |

Table IX.11
Plan Impact

TOTAL IMPACT = 7370.

| SYSTEM | NULL | COMPAT. | MODERATE | SEVERE | TERMINAL | MEAN |
|---|---|---|---|---|---|---|
| 1 | 443 | 36 | 98 | 218 | 30 | 1.219 |
| 2 | 485 | 301 | 39 | 0 | 0 | 0.459 |
| 3 | 432 | 302 | 91 | 0 | 0 | 0.587 |
| 4 | 126 | 560 | 130 | 9 | 0 | 1.027 |
| 5 | 475 | 65 | 281 | 3 | 1 | 0.776 |
| 6 | 333 | 149 | 156 | 187 | 0 | 1.239 |
| 7 | 436 | 11 | 122 | 253 | 3 | 1.244 |
| 8 | 0 | 0 | 0 | 0 | 0 | 0.0 |
| 9 | 0 | 0 | 0 | 0 | 0 | 0.0 |
| 10 | 55 | 454 | 303 | 4 | 9 | 1.343 |
| 11 | 432 | 90 | 151 | 142 | 10 | 1.040 |
| TOTAL | 3217 | 1968 | 1371 | 816 | 53 | 0.993 |

Table IX.12
Capital Costs of Plan

| ACTIVITY # | SUMMER | WINTER |
|---|---|---|
| 1 | 0 0 | 0 0 |
| 2 | 0 0 | 0 0 |
| 3 | 254 10 | 0 0 |
| 4 | 14 20 | 14 20 |
| 5 | 325 00 | 0 0 |
| 6 | 43 75 | 440 00 |
| 7 | 12 00 | 0 0 |
| 8 | 18600 00 | 18600 00 |
| 9 | 353 92 | 353 92 |
| 10 | 493 68 | 493 68 |
| TOTAL | 20096065 | 19901080 |

```
//C096150  JOB  'HARVARD COMPUTING CENTER',
//     (920800,321,'SIM'),SINTON,RET=LCG,UNIT=2314,TIME=5
//  EXEC  LARCHB,PROGRAM=GRDUM,DATA12=NEWPLN18,
//     DATA13=NRMACT10,REGION.RUN=150K
XX    PROC  PROGRAM=GRIDSET,LDISC=LARCH3,PROG=LARCH,                    00000000
XX          DATA12=NULLFI,DATA13=NULLFI,ARRAY=NULLFI,DATA14=NULLFI      00000010
XXFORT  EXEC  PGM=G,REGION=150K                                         00000020
XXSYSPRINT  DD  SYSOUT=A,DCB=(LRECL=120,RECFM=FBA,BLKSIZE=7200)         00000030
XXSYSPUNCH  DD  SYSOUT=B,SPACE=(TRK,(1,3),RLSE,CONTIG),                 00000040
XX          DCB=(RECFM=FB,LRECL=80,BLKSIZE=3200)                        00000050
XXSYSLIN  DD  DSNAME=&LOADSET,DISP=(MOD,PASS),UNIT=SYSQUE,              00000060
XX            SPACE=(TRK,(1,3)),DCB=(LRECL=80,RECFM=FB,BLKSIZE=3200)    00000070
//FORT.SYSIN  DD *
IEF236I ALLOC. FOR C096150  FORT
IEF237I 233   ALLOCATED TO SYSPRINT
IEF237I 233   ALLOCATED TO SYSPUNCH
IEF237I 233   ALLOCATED TO SYSLIN
IEF237I 232   ALLOCATED TO SYSIN
```

Table IX.13
The Simulation Model Steps 1-9

```
0001              DIMENSION ACT(9,6), TACT(9),PACT(9,3,3), SP(10), RMUL(9)
0002              DIMENSION RACT(9,3,3), PLAN(80,60), IPLAN(80,60) , DINC(9)
0003              DIMENSION TOT(9),TAT(9)
0004              DIMENSION SUM( 9,5)
0005              DIMENSION TSUM(5)
0006              DIMENSION PSUM(9,5),PEO(9)
0007              INTEGER*2 IA(18)
0008              REAL A(80,60), B(18)
0009              READ(5,4501) NHOLD
0010        4501  FORMAT(I1)
            C  N IS SET AS A MULTIPLE OF COUNTER NK
0011              DO 9876 NK=6,7
0012              N=500*NK
            C  CODE EQUALS ONE FOR WINTER, ZERO FOR SUMMER
0013              CODE=0.
            C  INPUT ACTIVITY RATES (ALONG EACH AXIS)
0014        721   DO 2 I=1,9
0015              TACT(I)=0.
0016              READ(5,1) (ACT(I,J), J=1,6)
0017        1     FORMAT (6F5.2)
0018              DO 3 J=1,6
0019        3     TACT(I)=TACT(I)+ACT(I,J)
0020        2     CONTINUE
            C  GENERATE PROPENSITIES OF ACTIVITY CONSUMPTION
0021              DO 4 I=1,9
0022              X=0.
0023              Y=0.
0024              DO  5 J=1,3
0025        5     X=X+ACT(I,J)
0026              IF(X.EQ.0.0) GO TO 1237
0027              DO 6 J=4,6
0028        6     Y=Y+ACT(I,J)
0029              DO 7 J=1,3
0030        7     ACT(I,J)=ACT(I,J)/X
0031              DO 8 J=4,6
0032        8     ACT(I,J)=ACT(I,J)/Y
0033              GO TO 4
0034        1237  DO 1238 J=1,6
0035        1238  ACT(I,J)=0.
0036        4     CONTINUE
0037        1239  DO 9 I=1,9
0038              DO 10 J=1,3
0039              DO 11 K=1,3
0040        11    PACT(I,J,K)=ACT(I,K)*ACT(I,J+3)
0041        10    CONTINUE
0042        9     CONTINUE
0043              IF(CODE.EQ.1.) GO TO 975
0044              WRITE (6,933)
0045        933   FORMAT(///,25H SUMMER SIMULATION OUTPUT,///)
0046        975   Q=0.
0047              WRITE (6,3300)
0048        3300  FORMAT(///,37H PROPENSITIES OF ACTIVITY CONSUMPTION)
0049              DO 12 I=1,9
0050              WRITE (6,13) I
0051        13    FORMAT (///,10H ACTIVITY ,I2)
0052              WRITE (6,14) ((PACT(I,J,K),K=1,3), J=1,3)
0053        14    FORMAT(/,10X,3F15.3)
0054        12    CONTINUE
```

Table IX.13 (cont.)
The Simulation Model Steps 1-9

```
C   INPUT SPACE STANDARDSIN PEOPLE PER ACRE
      READ (5,50)  (SP(I),I=1,10)
50    FORMAT (10F7.2)
C   INPUT DAILY DOLLAR LOCAL INCOME AND REGIONAL MULTIPLIER @ACTIVITY
      DO 52  I=1,9
      READ  (5,51) DINC(I),RMUL(I)
51    FORMAT (2F5.2)
52    CONTINUE
      X=N
      Z=0.
C   CALCULATE ACTIVITY RATES
      DO 60 I=1,9
60    Z=Z+TACT(I)
      IF(CODE.EQ.1.) GO TO 1401
      DO 61 I=1,9
      TACT(I)=TACT(I)/Z
C   THERE ARE 3.25 PERSONS PER CAR
61    TACT(I)=X*3.25*TACT(I)*3.
      DO 62 I=1,9
      DO 63 J=1,3
      DO 64 K=1,3
64    RACT(I,J,K)=PACT(I,J,K)*TACT(I)/3.
63    CONTINUE
62    CONTINUE
      GO TO 1402
1401  DO 1403 I=1,9
      TACT(I)=TACT(I)/Z
1403  TACT(I)=X*3.25*TACT(I)*2.
      DO 1404 I=1,9
      DO 1405 J=1,3
      DO 1406 K=1,3
1406  RACT(I,J,K)=PACT(I,J,K)*TACT(I)/2.
1405  CONTINUE
1404  CONTINUE
1402  WRITE(6,1240)
1240  FORMAT(//,30H RATES OF ACTIVITY CONSUMPTION,//)
      DO 65 I=1,9
      WRITE (6,13) I
      WRITE(6,14) ((RACT(I,J,K),K=1,3),J=1,3)
65    CONTINUE
C   COUNTER NN DESIGNATES THOSE PLANS TO BE TESTED
      DO 1111 NN=16,18
C   READ A PLAN
5001  DO 66 I=1,80
      DO 67 J=1,60
      READ (12) IA
      IPLAN(I,J)=IA(NN)
67    CONTINUE
66    CONTINUE
      IF(CODE.EQ.1.) GO TO 722
      DO 25 J=1,80
      DO 26 K=1,60
      A(J,K)=0.
C   REINITIALIZE PLAN CODES
      IF(IPLAN(J,K).EQ.01) IPLAN(J,K)=2
      IF(IPLAN(J,K).EQ.63) IPLAN(J,K)=2
      IF(IPLAN(J,K).EQ.80) IPLAN(J,K)=1
      IF(IPLAN(J,K).EQ.33) IPLAN(J,K)=1
```

Table IX.13 (cont.)
The Simulation Model Steps 1-9

```
0106                IF(IPLAN(J,K).EQ.64) IPLAN(J,K)=3
0107                IF(IPLAN(J,K).EQ.71) IPLAN(J,K)=4
0108                IF(IPLAN(J,K).EQ.43) IPLAN(J,K)=4
0109                IF(IPLAN(J,K).EQ.44) IPLAN(J,K)=4
0110                IF(IPLAN(J,K).EQ.62) IPLAN(J,K)=5
0111                IF(IPLAN(J,K).EQ.61) IPLAN(J,K)=6
0112                IF(IPLAN(J,K).EQ.93) IPLAN(J,K)=7
0113                IF(IPLAN(J,K).EQ.65) IPLAN(J,K)=7
0114                IF(IPLAN(J,K).EQ.88) IPLAN(J,K)=10
0115          26    CONTINUE
0116          25    CONTINUE
0117                IF(CODE.EQ.0.) GO TO 723
0118          722   DO 727 J=1,80
0119                DO 728 K=1,60
0120                A(J,K)=0.
0121                IF(IPLAN(J,K).EQ.80) IPLAN(J,K)=1
0122                IF(IPLAN(J,K).EQ.33) IPLAN(J,K)=1
0123                IF(IPLAN(J,K).EQ.32) IPLAN(J,K)=2
0124                IF(IPLAN(J,K).EQ.42) IPLAN(J,K)=2
0125                IF(IPLAN(J,K).EQ.31) IPLAN(J,K)=3
0126                IF(IPLAN(J,K).EQ.41) IPLAN(J,K)=3
0127                IF(IPLAN(J,K).EQ.71) IPLAN(J,K)=4
0128                IF(IPLAN(J,K).EQ.43) IPLAN(J,K)=4
0129                IF(IPLAN(J,K).EQ.44) IPLAN(J,K)=4
0130                IF(IPLAN(J,K).EQ.51) IPLAN(J,K)=5
0131                IF(IPLAN(J,K).EQ.52) IPLAN(J,K)=6
0132          728   CONTINUE
0133          727   CONTINUE
0134                IF(CODE.EQ.1.) GO TO 724
              C  INPUT ATTRACTIVENESS SCORES FOR DESIGNATED PLAN
0135          723   DO 19 J=1,80
0136                DO 20 K=1,60
0137                READ (13) (B(I), I=1,18)
0138                B(1)=B(3)
0139                B(2)=B(15)
0140                B(3)=B(11)
0141                B(4)=B(18)
0142                B(5)=B(17)
0143                B(6)=B(8)
0144                B(7)=B(12)
0145                B(10)=B(14)
0146                JJ=IPLAN(J,K)
0147                IF(JJ.LE.10) A(J,K)=B(JJ)
0148          20    CONTINUE
0149          19    CONTINUE
0150                IF(CODE.EQ.0.) GO TO 831
0151          724   DO 725 J=1,80
0152                DO 726 K=1,60
0153                READ(13) (B(I),I=1,18)
0154                B(1)=B(3)
0155                B(2)=B(6)
0156                B(3)=B(7)
0157                B(6)=B(4)
0158                B(4)=B(18)
0159                JJ=IPLAN(J,K)
0160                IF(JJ.LE.7) A(J,K)=B(JJ)
0161          726   CONTINUE
0162          725   CONTINUE
```

Table IX.13 (cont.)
The Simulation Model Steps 1-9

```
0163        831   Q=0.
0164              REWIND 13
0165              DO 30 I=1,9
0166              COUNT=0.
0167              DO 31 J=1,80
0168              DO 32 K=1,60
0169              IF(IPLAN(J,K).NE.I) GO TO 32
0170              IF(A(J,K).LE.0.) A(J,K)=0.
0171              COUNT=COUNT+A(J,K)
0172        32    CONTINUE
0173        31    CONTINUE
0174              IF(COUNT.EQ.0.) COUNT=1.
0175              DO 33 J=1,80
0176              DO 34 K=1,60
0177              IF(IPLAN(J,K).NE.I) GO TO 34
            C  ALLOCATE PEOPLE TO PLANS
0178              PLAN(J,K)=(A(J,K)/COUNT)*TACT(I)
0179        34    CONTINUE
0180        33    CONTINUE
0181        30    CONTINUE
0182              X=0.
0183              IF(CODE.EQ.1.) GO TO 1242
0184              DO 35 J=1,80
0185              DO 36 K=1,60
0186              IF(IPLAN(J,K).EQ.10) X=A(J,K)+X
0187        36    CONTINUE
0188        35    CONTINUE
0189              DO 37 J=1,80
0190              DO 38 K=1,60
0191              IF(IPLAN(J,K).EQ.10) PLAN(J,K)=A(J,K)/X*N
0192        38    CONTINUE
0193        37    CONTINUE
0194        1242  DO 801 I=1,9
0195              PEO(I)=0.
0196              DO 802 J=1,5
0197              PSUM(I,J)=0.
0198              SUM(I,J)=0.
0199        802   CONTINUE
0200        801   CONTINUE
0201              IF(NHDLD.EQ.1) GO TO 4502
            C  GENERATE USAGE LEVEL CATEGORIES
0202              DO 102 I=1,9
0203              SP(I)=SP(I)*2.5
0204              WRITE (6,13) I
0205              WRITE (6,3000)
0206        3000  FORMAT(//,10H  LT .75  ,10H  LT STD  ,10H LT 1.25X ,10H LT 1.50X
0207              X1=SP(I)*.75
0208              X2=SP(I)*1.25
0209              X3=SP(I)*1.50
0210              DO 100 J=1,80
0211              DO 101 K=1,60
0212              IF(IPLAN(J,K).NE.I) GO TO 101
0213              IF(PLAN(J,K).LE.X1) GO TO 104
0214              IF(PLAN(J,K).LE.SP(I)) GO TO 105
0215              IF(PLAN(J,K).LE.X2) GO TO 106
0216              IF(PLAN(J,K).LE.X3) GO TO 107
0217              IF(PLAN(J,K).GT.X3) GO TO 108
0218        104   WRITE(6,109) J,K
```

Table IX.13 (cont.)
The Simulation Model Steps 1-9

```
0219        109   FORMAT(2I3)
0220              SUM(I,1)=SUM(I,1)+1
0221              PSUM(I,1)=PSUM(I,1)+PLAN(J,K)
0222              GO TO 101
0223        105   WRITE(6,110) J,K
0224        110   FORMAT(10X,2I3)
0225              SUM(I,2)=SUM(I,2)+1
0226              PSUM(I,2)=PSUM(I,2)+PLAN(J,K)
0227              GO TO 101
0228        106   WRITE(6,111) J,K
0229        111   FORMAT(20X,2I3)
0230              SUM(I,3)=SUM(I,3)+1
0231              PSUM(I,3)=PSUM(I,3)+PLAN(J,K)
0232              GO TO 101
0233        107   WRITE(6,112) J,K
0234        112   FORMAT(30X,2I3)
0235              SUM(I,4)=SUM(I,4)+1
0236              PSUM(I,4)=PSUM(I,4)+PLAN(J,K)
0237              GO TO 101
0238        108   WRITE(6,112) J,K
0239              SUM(I,5)=PLAN(J,K)-X3
0240              PLAN(J,K)=X3
0241              PSUM(I,4)=PSUM(I,4)+PLAN(J,K)
0242              SUM(I,4)=SUM(I,4)+1
0243              GO TO 101
0244        101   CONTINUE
0245        100   CONTINUE
0246        102   CONTINUE
0247              GO TO 4503
0248        4502  DO 4504 I=1,9
0249              SP(I)=SP(I)*2.5
0250              X1=SP(I)*.75
0251              X2=SP(I)*1.25
0252              X3=SP(I)*1.50
0253              DO 4505 J=1,80
0254              DO 4506 K=1,60
0255              IF(IPLAN(J,K).NE.I) GO TO 4506
0256              IF(PLAN(J,K).LE.1.) GO TO 4506
0257              IF(PLAN(J,K).LE.X1) GO TO 4508
0258              IF(PLAN(J,K).LE.SP(I)) GO TO 4509
0259              IF(PLAN(J,K).LE.X2) GO TO 4510
0260              IF(PLAN(J,K).LE.X3) GO TO 4511
0261              IF(PLAN(J,K).GT.X3) GO TO 4512
0262        4508  SUM(I,1)=SUM(I,1)+1
0263              PSUM(I,1)=PSUM(I,1)+PLAN(J,K)
0264              GO TO 4506
0265        4509  SUM(I,2)=SUM(I,2)+1
0266              PSUM(I,2)=PSUM(I,2)+PLAN(J,K)
0267              GO TO 4506
0268        4510  SUM(I,3)=SUM(I,3)+1
0269              PSUM(I,3)=PSUM(I,3)+PLAN(J,K)
0270              GO TO 4506
0271        4511  SUM(I,4)=SUM(I,4)+1
0272              PSUM(I,4)=PSUM(I,4)+PLAN(J,K)
0273              GO TO 4506
0274        4512  SUM(I,5)=PLAN(J,K)-X3
0275              PLAN(J,K)=X3
0276              PSUM(I,4)=PSUM(I,4)+PLAN(J,K)
```

Table IX.13 (cont.)
The Simulation Model Steps 1-9

```
0277              SUM(I,4)=SUM(I,4)+1
0278              GO TO 4506
0279        4506  CCNTINUE
0280        4505  CONTINUE
0281        4504  CONTINUE
0282        4503  REWIND 12
0283              IF(CODE.EQ.1.) GO TO 4515
0284              WRITE(6,3002) NN,N
0285        3002  FORMAT(1H1,///,6H PLAN ,I2,8H SUMMER ,4H N= ,I4)
0286              GO TO 4517
0287        4515  WRITE(6,4516) NN,N
0288        4516  FORMAT(1H1,///,6H PLAN ,I2,8H WINTER ,4H N= ,I4)
0289        4517  WRITE(6,4518)
0290        4518  FORMAT(40H TABLE 1 :  NO. CELLS/ACTIVITY/CROWDING ,/)
0291              WRITE(6,4519)
0292        4519  FORMAT(47H ACT. #        0-75%  75-100% 100-125% 125-150% )
0293              DO 4521 I=1,9
0294              WRITE(6,4520) I,(SUM(I,J),J=1,4)
0295        4520  FORMAT(I7,3X,4F9.1)
0296        4521  CONTINUE
0297              DO 4524 J=1,5
0298        4524  TSUM(J)=0.
0299              DO 4522 I=1,9
0300              DO 4523 J=1,4
0301        4523  TSUM(J)=SUM(I,J)+TSUM(J)
0302        4522  CONTINUE
0303              WRITE(6,4525) (TSUM(J),J=1,4)
0304        4525  FORMAT(10H TOTAL     ,4F9.1,///)
0305              WRITE(6,4526)
0306        4526  FORMAT(40H TABLE 2 : NO. PEOPLE/ACTIVITY/CROWDING ,//)
0307              WRITE(6,4527)
0308        4527  FORMAT(47H ACT. #        0-75%  75-100% 100-125% 125-150% ,13H T
                 $ED AWAY )
0309              DO 3003 I=1,9
0310              WRITE(6,3005) I, (PSUM(I,J),J=1,4), SUM(I,5)
0311        3005  FORMAT(I7,3X,5F9.1)
0312        3003  CONTINUE
0313              DO 4530 J=1,5
0314        4530  TSUM(J)=0.
0315              DO 4531 I=1,9
0316              DO 4532 J=1,4
0317        4532  TSUM(J)=TSUM(J)+PSUM(I,J)
0318        4531  TSUM(5)=TSUM(5)+SUM(I,5)
0319              WRITE(6,4533) (TSUM(J),J=1,5)
0320        4533  FORMAT(10H TOTAL     ,5F9.1,///)
            C    CALCULATE INCOME
0321              DO 701 I=1,9
0322              DO 446 J=1,4
0323        446   PEO(I)=PEO(I)+PSUM(I,J)
0324              TOT(I)=DINC(I)*PEO(I)
0325        701   TAT(I)=RMUL(I)*PEO(I)*DINC(I)
0326              X=0.
0327              Y=0.
0328              DO 704 I=1,9
0329              X=X+TOT(I)
0330        704   Y=Y+TAT(I)
0331              WRITE(6,4540)
0332        4540  FORMAT(27H TABLE 3 : INCOME/ACTIVITY )
```

Table IX.13 (cont.)
The Simulation Model Steps 1-9

```
0333              WRITE(6,4550)
0334        4550  FORMAT(//,38H ACT. #        LOCAL          REGIONAL )
0335              DO 705 I=1,9
0336              WRITE(6,4551) I,TOT(I),TAT(I)
0337        4551  FORMAT(I7,3X,F9.1,9X,F9.1)
0338        705   CONTINUE
0339              WRITE(6,4552) X,Y
0340        4552  FORMAT(10H TOTAL     ,F9.1,9X,F9.1)
0341        1111  CONTINUE
0342              IF(CODE.EQ.1.) GO TO 720
0343              CODE=1.
0344              GO TO 721
0345        720   Q=0.
0346        9876  CONTINUE
0347              STOP
0348              END
```

Table IX.13 (cont.)
The Simulation Model Steps 1-9

```
//C042175  JOB  'HARVARD COMPUTING CENTER',
//    (434899,321,'HYPL'),SINTON,RET=LCG,UNIT=2314,TIME=5
//    EXEC   FORTGCLG,
//    REGICN.GO=150K,OUTPUT=NOBLOCK
XX  PRCC PROG=MAIN,OUTPUT=BLOCK,CALCOMP=NULLFILE,SC4020=NULLFILE          00000000
XXFORT    EXEC  PGM=G,REGION=150K                                          00000010
XXSYSPRINT DD SYSOUT=A,DCB=(LRECL=120,RECFM=FBA,BLKSIZE=7200) 60/TK        00000020
XXSYSPUNCH DD  SYSOUT=B,SPACE=(TRK,(1,3),RLSE,CONTIG),                    &00000030
XX             DCB=(LRECL=80,RECFM=FB,BLKSIZE=3200)                        00000040
XXSYSLIN    DD  DSNAME=&LOADSET,DISP=(MOD,PASS),UNIT=SYSQUE,              &00000050
XX             SPACE=(TRK,(1,3)),DCB=(LRECL=80,RECFM=FB,BLKSIZE=3200)     00000060
//FORT.SYSIN  DD  *
IEF236I ALLOC. FOR C042175  FORT
IEF237I 233   ALLOCATED TO SYSPRINT
IEF237I 233   ALLOCATED TO SYSPUNCH
IEF237I 233   ALLOCATED TO SYSLIN
IEF237I 230   ALLOCATED TO SYSIN
```

Table IX.14
The Simulation Model Steps 10-13

```
0001          DATA NL,NS,NP/20,11,15/,II,JJ/80,60/
0002          INTEGER*2 IB(27,11),IC(15),ID(49)
0003          REAL IA(18)
0004          DIMENSICN NAT(25,30),NAS(25,30),ATS(25)
0005          REAL NIS(25)
0006          INTEGER*2 NIM(25,30,5),MIM(5)
0007          DATA NAS,NAT/1500*0/,ATS,NIS/50*0.0/,NIM/3750*0/
0008          DIMENSICN ACST(20)
0009          DATA ACST/0.,0.,21175.,200.,25000.,4375.,6000.,300000.,39325.,
             "2040.,3*0.,200.,0.,8000.,0.,300000.,39325.,2040./
0010          INTEGER*2 LUC(100),LUK(2,20)
0011          DATA LUC/100*0/
0012       71 READ(5,70) N,IM
0013          IF(N.GT.100 .CR. N.LT.1) GO TO 75
0014          LUC(N)=IM
0015          GO TO 76
0016       75 WRITE(6,77) N
0017       77 FORMAT('  ***ERROR AT',I5)
0018       76 CONTINUE
0019          IF(N-99) 71,72,72
0020       72 READ(5,70) LUK
0021       70 FORMAT(2I2)
0022       74 FORMAT(20I4)
0023       73 FORMAT(50I2)
0024          WRITE(6,73) LUC
0025          WRITE(6,74) ((LUK(I,J),J=1,20),I=1,2)
0026          DO 100 I=1,II
0027          DO 100 J=1,JJ
0028          READ(12) IA
0029          READ(13) IB
0030          READ(14) IC
0031          READ(15) ID
0032          DO 101 IP=1,NP
0033          IG=IC(IP)
0034          IF(IG.GT.100 .OR. IG.LT.0) GO TO 105
0035          IF(IC(18).GT.4) IG=89
0036          IF(IG.EQ.0) GC TO 101
0037          IL=LUC(IG)
0038          IF(IL.EQ.0) GO TO 101
0039          JA=LUK(1,IL)
0040          JI=LUK(2,IL)
0041          NAT(IP,IL)=NAT(IP,IL)+1
0042          NAS(IP,IL)=NAS(IP,IL)+IA(JA)
0043          TIMP=0
0044          DO 102 IS=1,NS
0045          IF(IS.EQ.8) GC TO 102
0046          IF(IS.EQ.9) GC TO 102
0047          M=IB(JI,IS)/10+1
0048          NIM(IP,IS,M)=NIM(IP,IS,M)+1
0049      103 TIMP=TIMP+IB(JI,IS)/10
0050      102 CONTINUE
0051          NIS(IP)=NIS(IP)+TIMP
0052          GO TO 101
0053      105 WRITE(6,106) I,J,IP,IG
0054      106 FORMAT(4I10)
0055      101 CONTINUE
0056      100 CONTINUE
0057          NL=NL/2
```

Table IX.14 (cont.)
The Simulation Model Steps 10-13

```
0058          DO 200 IP=1,NP
0059          WRITE(9,201) IP
0060      201 FORMAT('1',' PLAN #',I4,'  SUMMARY')
0061          WRITE(9,218)
0062      218 FORMAT(///' TABLE # 4')
0063          DO 220 K=1,2
0064          IF(K.EQ.1) GO TO 225
0065          WRITE(9,221)
0066      221 FORMAT(///' WINTER PLAN ATTRACTIVENESS')
0067          NAT(IP,11)=NAT(IP,1)
0068          NAT(IP,14)=NAT(IP,4)
0069          NAT(IP,18)=NAT(IP,8)
0070          NAT(IP,19)=NAT(IP,9)
0071          NAT(IP,20)=NAT(IP,10)
0072          NAS(IP,20)=NAS(IP,10)
0073          NAS(IP,19)=NAS(IP,9)
0074          NAS(IP,18)=NAS(IP,8)
0075          NAS(IP,14)=NAS(IP,4)
0076          NAS(IP,11)=NAS(IP,1)
0077          GO TO 227
0078      225 WRITE(9,226)
0079      226 FORMAT(///' SUMMER PLAN ATTRACTIVENESS')
0080      227 CONTINUE
0081          WRITE(9,202)
0082      202 FORMAT('   ACTIVITY   # OF CELLS          MEAN')
0083          MAT=0
0084          MAS=0
0085          DO 203 KL=1,NL
0086          IL=KL+10*(K-1)
0087          MAS=MAS+NAS(IP,IL)
0088          MAT=MAT+NAT(IP,IL)
0089          YAS=0
0090          IF(NAT(IP,IL).EQ.0) GO TO 203
0091          YAS=NAS(IP,IL)
0092          YAT=NAT(IP,IL)
0093          YAS=YAS/YAT
0094      203 WRITE(9,204) IL,NAT(IP,IL),YAS
0095      204 FORMAT(I8,7X,I6,8X,F8.2)
0096          XMAS=MAS
0097          XMAT=MAT
0098          ATS(IP)=XMAS/XMAT
0099          WRITE(9,211) MAT,ATS(IP)
0100      211 FORMAT('   TOTAL',7X,I6,8X,F8.2)
0101      220 CONTINUE
0102          WRITE(9,205) NIS(IP)
0103      205 FORMAT(/////' TABLE # 5  PLAN IMPACT',10X,'TOTAL IMPACT ='F10.0/)
0104          WRITE(9,206)
0105      206 FORMAT(' SYSTEM      NULL   COMPAT.  MODERATE    SEVERE  TERMINAL
            C     MEAN')
0106          DO 212 M=1,5
0107      212 MIM(M)=0
0108          SX=0
0109          DO 207 IS=1,NS
0110          XN=0
0111          XM=0
0112          DO 208 M=1,5
0113          MIM(M)=MIM(M)+NIM(IP,IS,M)
0114          MM=M-1
```

Table IX.14 (cont.)
The Simulation Model Steps 10-13

```
0115          XN=XN+NIM(IP,IS,M)*MM
0116      208 XM=XM+NIM(IP,IS,M)
0117          IF(XM.EQ.0.) GO TO 207
0118          XN=XN/XM
0119          SX=SX+XM
0120      207 WRITE(9,209) IS,(NIM(IP,IS,M),M=1,5),XN
0121      209 FORMAT(I7,5I10,F10.3)
0122          NIS(IP)=NIS(IP)/SX
0123          WRITE(9,213) (MIM(M),M=1,5),NIS(IP)
0124      213 FORMAT('  TOTAL',5I10,F10.3)
0125          WRITE(9,230)
0126      230 FORMAT(/////' TABLE # 6  CAPITAL COSTS OF PLAN'/)
0127          WRITE(9,231)
0128      231 FORMAT(' ACTIVITY #     SUMMER     WINTER')
0129          WSM=0
0130          SSM=0
0131          DO 232 KL=1,10
0132          SM=NAT(IP,KL)*ACST(KL)/1000.
0133          WM=NAT(IP,KL+10)*ACST(KL+10)/1000.
0134          WSM=WSM+WM
0135          SSM=SSM+SM
0136      232 WRITE(9,233) KL,SM,WM
0137      233 FORMAT(I11,2F10.2)
0138          WRITE(9,234) SSM,WSM
0139      234 FORMAT('       TOTAL',2F10.2)
0140      200 CONTINUE
0141          WRITE(6,399)
0142      399 FORMAT('1'///'  *********** FINISHED ********')
0143          STOP
0144          END
```

Table IX.14 (cont.)
The Simulation Model Steps 10-13

# CHAPTER X: MAKING PLANS: BEST PROFESSIONAL JUDGMENT

## A. TWO APPROACHES TO MAKING PLANS

Having described the fiscal, social, and environmental framework within which site development proposals could be made and evaluated, the research team then developed two principal approaches to making plans. These can be characterized as "best professional judgment" and "mathematical programming." Plans generated by these approaches were evaluated for their fiscal, social and environmental consequences by the simulation model. This chapter describes the approach used to generate and improve the professional judgment plans. The linear programming analytic model is presented in Chapter XI. The plans which were generated and the approaches are comparatively evaluated in Chapter XII.

The problem to which the plan making and evaluation exercises was addressed had two alternative basic assumptions. Each of these resulted in a complete set of plans and evaluations. The first of these, the "A" plans, assumed that all of the development to be proposed for the Honey Hill area was to be within the borders of the reservoir, the Federal, and the State land holdings (see Figure III.36). The second set of plans, the "B" plans, assumed that the equivalent development could be placed anywhere in the study area encompassed by the data bank. These alternatives represent the possibility of incorporating into the planning-design process the identification of those lands which should be incorporated into a project.

Even though the research team had been given a map of previously identified and proposed landholdings for the project, we felt that the ability to use an analysis procedure which itself could identify the appropriate site borders was a potentially valuable expansion of our initial purpose. Thus, among other questions the "A" schemes can be characterized as proposing solutions for the question: "Given a site area and given a demand - what goes where?" The "B" schemes ask "Given a demand - what site shall we acquire and what goes where?" Since the processes of making, evaluating and improving plans in both the professional judgment and analytic model approaches are identical for the "A" and "B" assumptions, with the exception of the pre-defined site border, the discussion in the following chapters will be based upon the more

typical "A" assumption. That is to say, all proposed activities shall be located within the previously determined State and Federal land areas.

## B. THE PROFESSIONAL JUDGMENT PLANS: INITIAL PROPOSALS

The professional judgment schemes were developed in two stages. The first was an exercise conducted by five members of the research team. It had as its purpose the generation of initial proposals which could be used as a basis for the clarification of various research issues and for the preliminary design of the simulation model. The second phase of improving the professional judgment schemes involved taking one set of these previously made plans, those by Murray, and utilizing the various parts of the analysis procedure and the simulation model to improve the initial proposal.

Five members of the research team, Messrs. Murray, Steinitz, Toth, and Way and Miss Peacock, prepared initial plans for both the "A" and "B" assumptions. The overriding objective in developing these initial proposals was to identify the value judgments which were made by different individuals in the conceptualization of the proposals and to provide a clearer idea of the issues to which the simulation model should be addressed. In particular, these were the activity location factors and the criteria for the environmental quality aspects of the simulation model. The development of these plans served to highlight potential conflicts among the proposed land uses. The exercise also provided the research group with the opportunity to describe their initial reactions to the scope of the problem and its potential for solution.

A program for the exercise was developed and each individual was asked to make an "A" plan which located the entire program requirements in the proposed Federal and State land holding and a "B" program which required the allocation for these activities to be within the area described in the data bank. The quantities required in the program were initial estimates made by the research team. Since the second round of making professional judgment plans would be based upon an evaluation of the initial proposals via the simulation model, it was possible for us to make plans using an estimated program with the knowledge that the revised plans would be based upon a more accurate definition of the quantities likely to be required. Aside from the basic requirements which distinguish the "A" and

"B" schemes, there were two additional constraints which were consistently adopted in the proposals. The first was the previously identified location and elevations of the reservoir. The second constant was the acceptance of the major road relocation proposed in initial documents by the New Hampshire State Department of Public Works. Thus, the plans do not consider the location and elevation of the reservoir or the relocation of the primary road network as a variable in the making of the plans. Table X.1 describes the program used for the making of the initial proposals.

The initial proposals were prepared by team members who had previously made visits to the study area. Having been given a base map prepared from the U.S.G.S. mpa (Figure III.5), the maps produced from the data inventory (Figures III.6 thru III.48) and the program, each participant in the exercise was asked to prepare a drawing in scale with the base map of his planned activity locations for the "A" and "B" assumptions. He was also asked to describe his major design concepts and to list for each activity the principal considerations which influenced his plan choices. The "product" of this exercise consisted of the drawn plan of activity locations, a statement of the major concepts in the proposal and a listing of the value judgments, concepts, criteria, etc., that influenced the location of each of the activities.

Table X.2 presents a selection of the items listed as locational criteria in the professional judgment schemes. It should be noted that there are inconsistencies among the judgments both in terms of the priorities of criteria and the actual criteria themselves. In all cases, the number of aspects considered was substantially smaller than the number that could have been considered. It turns out that in preparing initial proposals, each of the designers tended to simplify the problem to a substantial degree. As a result, the solutions exhibited much more variation than would have resulted had there been a careful, systematic analysis of the locational criteria for each of the activities. Indeed, in discussion among the team members subsequent to the initial plan making, several of the proposed locations were conceded to be debatable. The list of criteria provided a useful check on the completeness of the data inventory and of the activity site attractiveness analyses. Table X.2a presents the criteria which form the design concept of the Murray plans.

The plan which resulted from the exercise was a line and color drawing as shown in Figure X.1. The drawing outlined

TABLE X.1

PROFESSIONAL JUDGMENT PLANS
INITIAL DEVELOPMENT PROGRAM

| Activity | Program Requirement |
|---|---|
| 1. Summer | |
| 1.1 Hunting | No specified area |
| 1.2 Fishing | Identify shoreline positions<br>No specified area |
| 1.3 Swimming | 2 separate areas of 6 cells each for beach |
| 1.4 Trail hiking | No specified area |
| 1.5 Camping | 5 separated cells |
| 1.6 Picnicking | 10 separated cells |
| 1.7 Boating | 1 cell launching facility<br>1 cell rental facility |
| 1.8 Residential | Total 61 cells |
| 1.8.1 Water view | 35 cells |
| 1.8.2 Wood view | 10 cells |
| 1.8.3 Farmstead | 5 areas of 2 cells each |
| 1.8.4 Condominium | 6 adjacent cells |
| 1.9 Parking | 5 cells |
| 1.10 Major roads | As given |
| 2. Winter | |
| 2.1 Hunting | No specified area |
| 2.2 Snowshoeing | No specified area |
| 2.3 Cross country skiing | No specified area |

TABLE X.1
(Continued)

| Activity | Program Requirement |
|---|---|
| 2.4 Trail hiking | No specified area<br>Can combine with 2.2 and 2.3 in multi-use trail system |
| 2.5 Snowmobiling | No specified area |
| 2.6 Downhill skiing | No specified area<br>Probably 1-2 tow system<br>1 cell base facilities |
| 2.7 Ice skating | No specified area |
| 2.8 Residential | As 1.8 |
| 2.9 Parking | As 1.9 |
| 2.10 Major roads | As 1.10 |

TABLE X.2

PROFESSIONAL JUDGMENT PLANS: INITIAL SITE CRITERIA

| Activity | Plans | Criteria |
|---|---|---|
| 1. Summer | | |
| 1.1 Hunting: | Steinitz: | May ban or limit to outside areas |
| | Toth: | Isolation, topo variation, near farmsteads, near campsites |
| | Way: | Follow state regulations |
| | Peacock: | In passive areas except ski area |
| 1.2 Fishing: | Murray: | Water - not specific |
| | Steinitz: | All over but limit access |
| | Toth: | Near stream entrees, diverse shoreline (no waterskiing) |
| | Way: | Boat rental at condominium, fishing anywhere except swim areas |
| | Peacock: | Accessible to camp areas |
| 1.3 Swimming: | Murray: | South facing areas - away from boating - near picnicking |
| | Steinitz: | Near town, near shops, near parking, near camping |
| | Toth: | S. orientation, dec. trees, <4% slope, near housing |
| | Way: | Natural sandy areas, low subsurface slope, S. orientation. |
| | Peacock: | Near water viewlots and campsite |
| 1.4 Hiking Trails: | Murray: | Ridges, views - connections |
| | Steinitz: | Variation in views - sloping and flat topo |

TABLE X.2
(Continued)

| Activity | Plans | Criteria |
|---|---|---|
| 2. Winter | | |
| 2.2 Snowshoeing: | Way: | Anywhere |
| | Peacock: | Unpopulated areas |
| 2.3 Cross-Country Skiing: | Murray: | Same as hiking trails |
| | Way: | Follows upland trail system |
| | Peacock: | Unpopulated areas |
| 2.5 Snowmobiles: | Murray: | Lake and trails |
| | Steinitz: | Ban in area |
| | Way: | Around lake only |
| | Peacock: | May ban |
| 2.6 Downhill Skiing: | Murray: | SW-NW slopes (small area) |
| | Steinitz: | SW slope, steepness but varied |
| | Toth: | SE slope, near housing, access |
| | Way: | NW-N-SW orientation, 400-700' drop, >25% slope |
| | Peacock: | Highest elevation and largest area available |
| 2.7 Ice Skating: | Murray: | Near activity center |
| | Steinitz: | Near town and all over |
| | Toth: | All lake |
| | Way: | Anywhere - maintained at condominium and ski facility |
| | Peacock: | Access, next to boat facility, view from ski slope |

TABLE X.2
(Continued)

| Activity | | Plans | Criteria |
|---|---|---|---|
| 1.8.1 | Water View Lots: | Steinitz: | Water view, access, utilities, trees, SE-SW orientation |
| | | Toth: | Dec. trees, >10' to rock, kame terraces, S-SE slopes, <8% slope, sand and gravel |
| | | Way: | View to water, walking access, good septic soils, S-SE orientation, back from shore |
| | | Peacock: | Elevated view of water, view to east |
| 1.8.2 | Wood View Lots: | Steinitz: | Trees, utilities, access, SE-SW orientation |
| | | Toth: | Veg. enclosure, SE slope, >10' to rock, kame-sand-gravel, <8% slope |
| | | Way: | Dense evergreens (internal char.), good septic soild, visually separate from lake, water table >5' |
| | | Peacock: | In trees, away from water, not next to water related activities |
| 1.8.3 | Farmsteads: | Steinitz: | Trees, water view, SE-SW slopes, access, utilities |
| | | Toth: | Open fields, <8% slope, flood plain, lake view, screened from road |
| | | Way: | Preserve open pastures, put structure above crest, >5' to water table, good septic soils |
| 1.8.4 | Condominium: | Steinitz: | Trees, water view, SE-SW slopes, access, utilities |
| | | Toth: | Dec. trees, >10' rock, kame terraces, SE slope, sand-gravel, <8% slope |
| | | Way: | Access to water, peninsula because of existing infrastructure, good septic tank |
| | | Peacock: | Access to water, accessible to skiing |

TABLE X.2
(Continued)

| Activity | Plans | Criteria |
|---|---|---|
| 1.4 Hiking Trails: (Cont'd) | Toth: | High points and shoreline |
| | Way: | Links unique and prominent view areas and features - runs ridges and around lake |
| | Peacock: | In trees, away from water, not next to water related activities |
| 1.5 Camping: | Murray: | Near water and views; away from housing and activity |
| | Steinitz: | 2 types, crowded and isolated |
| | Toth: | Dec. trees, isolation from housing, <15% slope, water edge |
| | Way: | Unique features, many assoc. to water, provide diversity, views |
| | Peacock: | Access, separate from housing |
| 1.6 Picnicking: | Murray: | Near water, not near camping, flat areas, good views |
| | Steinitz: | Quiet areas, water view, near fishing, road access, trees |
| | Toth: | Dec.-Con. mix, near water, access, isolation from farms and Res., near swimming |
| | Way: | Near unique features - coves, terraces, cliffs, providing diversity |
| 1.7 Waterskiing: | Steinitz: | Zones in an active area |
| | Toth: | OK, not zoned |
| | Way: | OK, not zoned |
| 1.8 Residential: | | |

TABLE X.2a

PROFESSIONAL JUDGMENT PLANS:
INITIAL SITE CRITERIA: MURRAY

| Activity | Criteria |
|---|---|
| 1. Summer | |
| 1.2 Fishing | Water - not specific |
| 1.3 Swimming | South facing areas - away from boating - near picnicking |
| 1.4 Hiking trails | Ridges, views - connections |
| 1.5 Camping | Near water and views; away from housing and activity |
| 1.6 Picnicking | Near water, not near camping, flat areas, good views |
| 1.8 Residential (all) | Trees, utilities, access, SE-SW orientation |
| 2. Winter | |
| 2.3 Cross-Country Skiing | Same as hiking trails |
| 2.5 Snowmobiles | Lake and trails |
| 2.6 Downhill skiing | SW-NW slopes (small area) |
| 2.7 Ice skating | Near activity center |

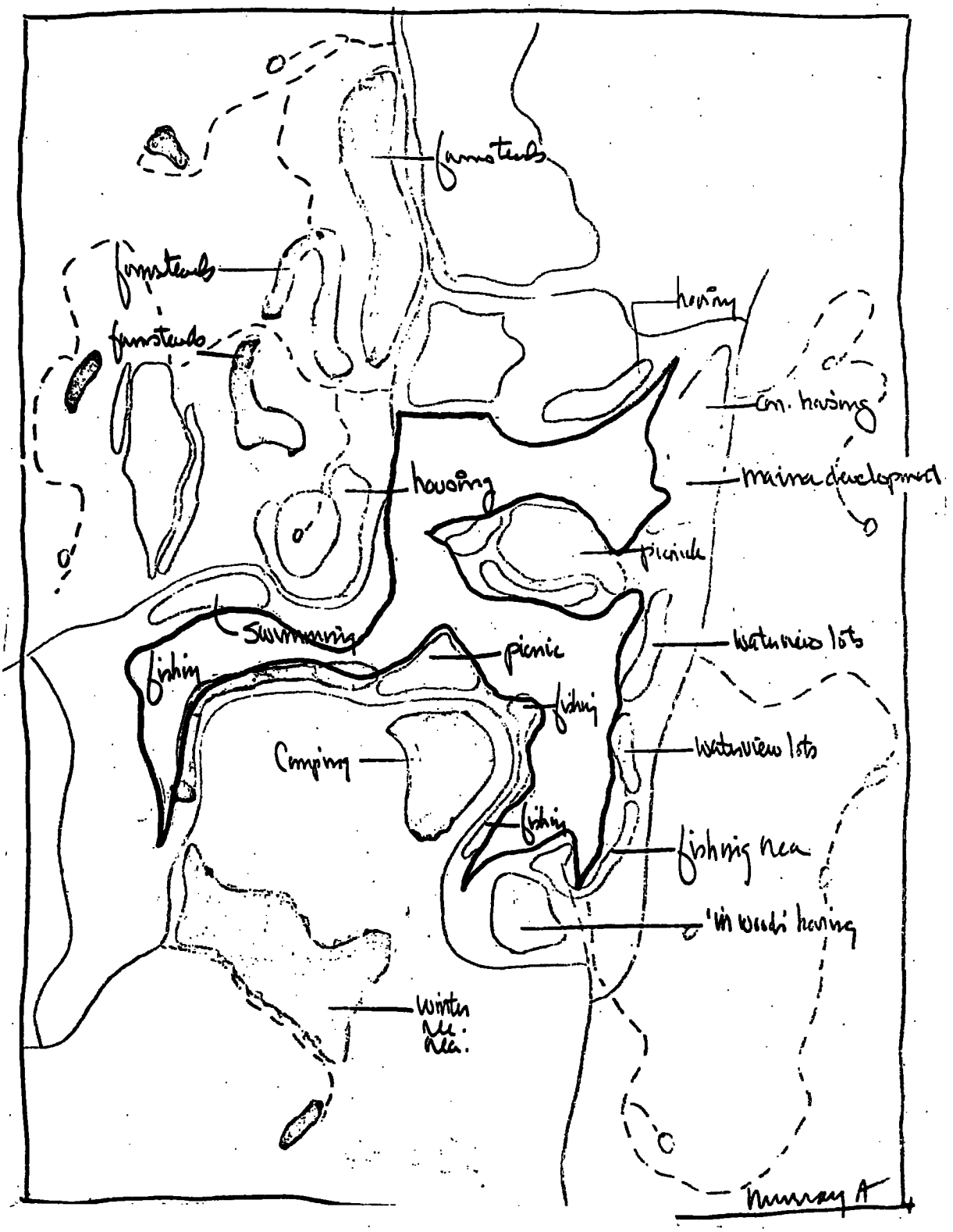



Fig. X.1
Areas of Required Activity Locations

or pinpointed areas which were the activity locations required in the program. This drawing was then converted to a cell by cell map using a coding key developed for the activity data bank (Table X.3). Each activity was located in the appropriate grid cells and identified by its two-digit code. Figure X.2 shows the grid coding of a plan at the worksheet stage. The worksheet was then given to a keypuncher who prepared a set of records of the values for the coded plans. These records were stored in the data files and two maps made by the GRID program (Appendix L). The first is the summer plan component of the proposal and the second is the winter plan component. Figures X.3 and X.4 show the summer and winter plans for the "A" scheme made by Timothy Murray.

## C. EVALUATING THE INITIAL PLANS

The activity allocations made in these plans were then evaluated against the attractiveness and impact models previously described. Figure X.5 shows the attractiveness for the planned activities in the Murray "A" plan.

The "total impact" of the plan on the eleven site resource systems is shown in Figure X.6. The impacts were then mapped for the individual systems, as illustrated by Figure X.7, Impact on Surface Water System, and Figure X.8, Impact on Wildlife Habitat. Note particularly the severe and threshold impacts caused by the plan through the allocation of residential development to the South and East facing slopes of Honey Hill.

The plan was then evaluated for its environmental, social, and fiscal consequences as defined in the simulation model. Tables X.4 through X.12 demonstrate the simulation model evaluations of the Murray "A" plan at N=3000.

Each of the initial plan proposals was evaluated by the simulation model under a range of demands established by setting the number of cars to 1000, 1500, 2000, 2500, and 3000. Thus, each of the schemes was also evaluated to determine the point at which the proposed activity locations became so overcrowded so as to turn away potential consumers, therefore, both crowding those that remain and possibly losing potential local and regional dollar income.

Table X.13 summarizes the performance of the Murray "A" plan under these different demand conditions.

TABLE X.3

ACTIVITY CODE

| Code | Activity |
|---|---|
| 00 | WATER AREA |
| 01 | fishing |
| 02 | canoeing |
| 03 | boating |
| 04 | multi-use |
| 10 | SWIMMING |
| 20 | WATER SPECIAL |
| 21 | motorboating |
| 22 | waterskiing |
| 30 | WINTER AREA LAND |
| 31 | cross-country skiing |
| 32 | snowshoeing |
| 33 | hunting |
| 34 | ice skating |
| 40 | WINTER LINEAR LAND |
| 41 | cross-country skiing |
| 42 | snowshoeing |
| 43 | hiking trail |
| 44 | multi-use trails |
| 50 | WINTER SPECIAL |
| 51 | snow mobile - including lakes |
| 52 | downhill skiing |
| 60 | SUMMER AREA LAND |
| 61 | picnic |
| 62 | camping |
| 63 | fishing |
| 64 | swimming beach |
| 65 | launch area |
| 70 | SUMMER LINEAR LAND |
| 71 | hiking |
| 80 | HUNTING |

TABLE X.3
(Continued)

| Code | Activity |
|---|---|
| 90 | RESIDENTIAL AND OTHER STRUCTURES |
| 91 | trail shelter |
| 92 | ski shelter |
| 93 | marina |
| 94 | skating shelter |
| 95 | water view homes |
| 96 | wood view homes |
| 97 | condominium homes |
| 98 | farmsteads |
| 99 | group lodge |

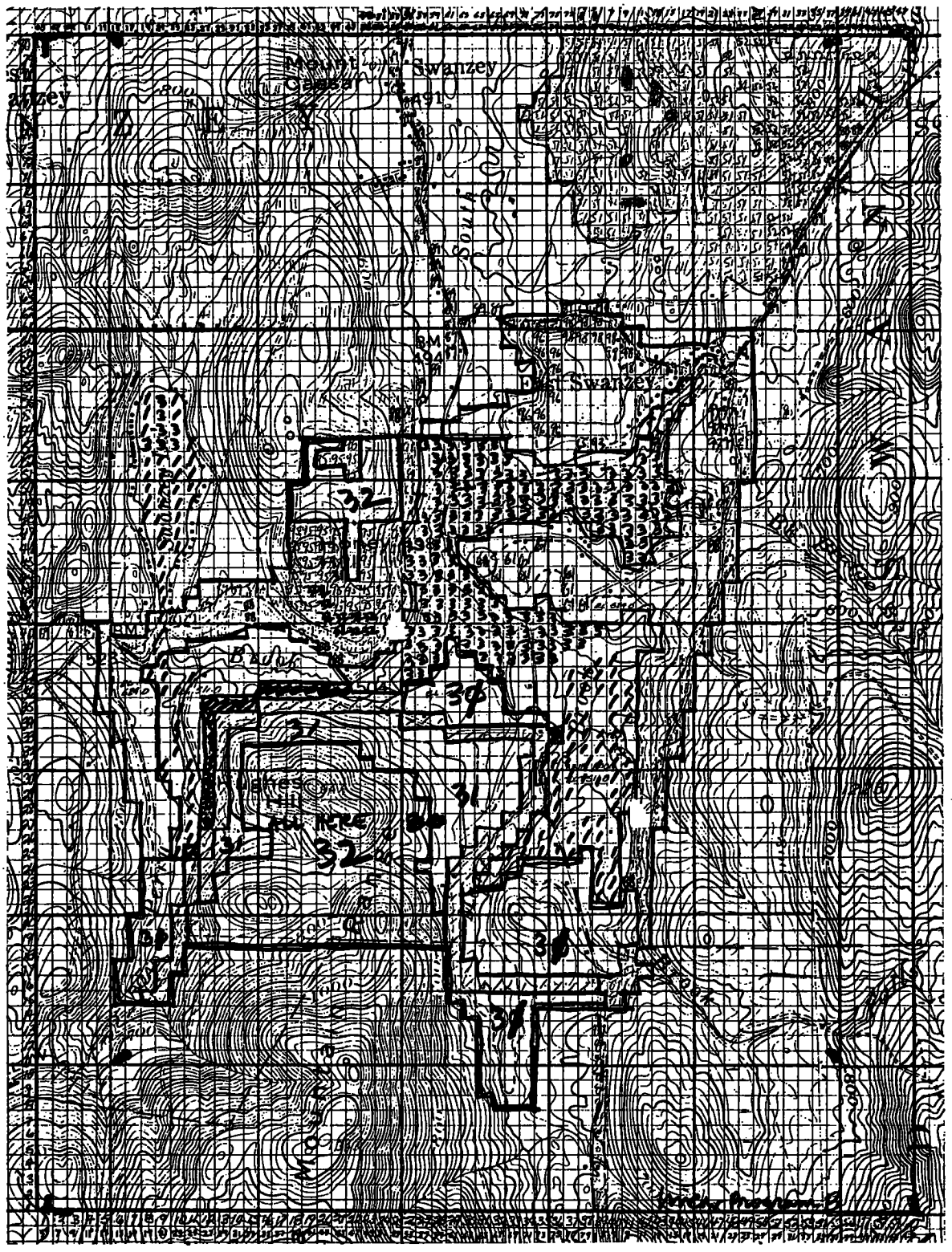



Fig. X.2
Grid Coding of a Plan at the Worksheet Stage

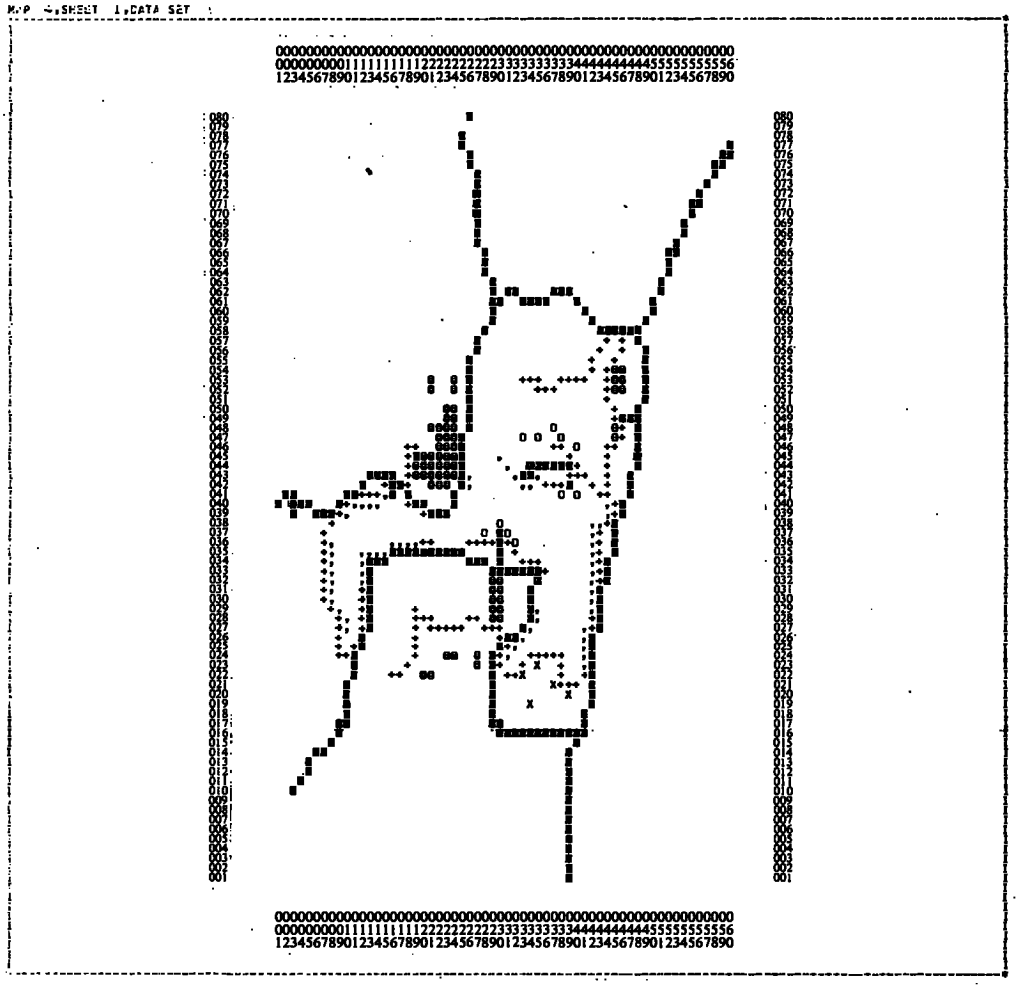
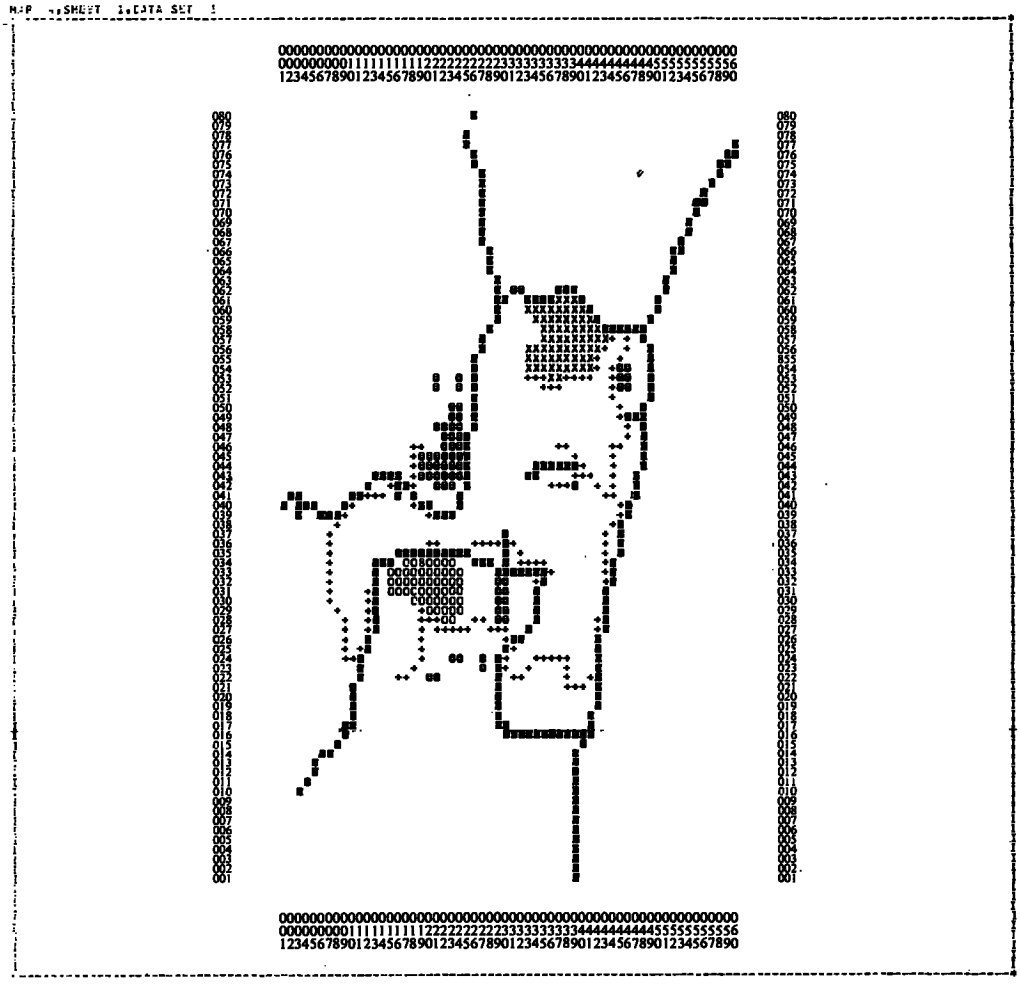



Fig. X.3
Murray "A": Summer Plan

MAP 1, SHEET 1, DATA SET 1



PLAN 1 - WINTER

PROFESSIONAL JUDGEMENT - MURRAY

HENRY HILL CASE STUDY

LEGEND
1 = HUNTING
2 = SNOW SHOEING
3 = CROSS COUNTRY SKIING
4 = TRAILS
5 = SNOW MOBILING
6 = DOWNHILL SKIING
7 = ICE SKATING
8 = RESIDENTIAL
9 = PARKING
10 = MAJOR ROADS

DATA MAPPED IN 10 LEVELS BETWEEN EXTREME VALUES OF 0.50 AND 10.50

ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| MINIMUM | 0.50 | 1.50 | 2.50 | 3.50 | 4.50 | 5.50 | 6.50 | 7.50 | 8.50 | 9.50 |
| MAXIMUM | 1.50 | 2.50 | 3.50 | 4.50 | 5.50 | 6.50 | 7.50 | 8.50 | 9.50 | 10.50 |

PERCENTAGE OF TOTAL ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

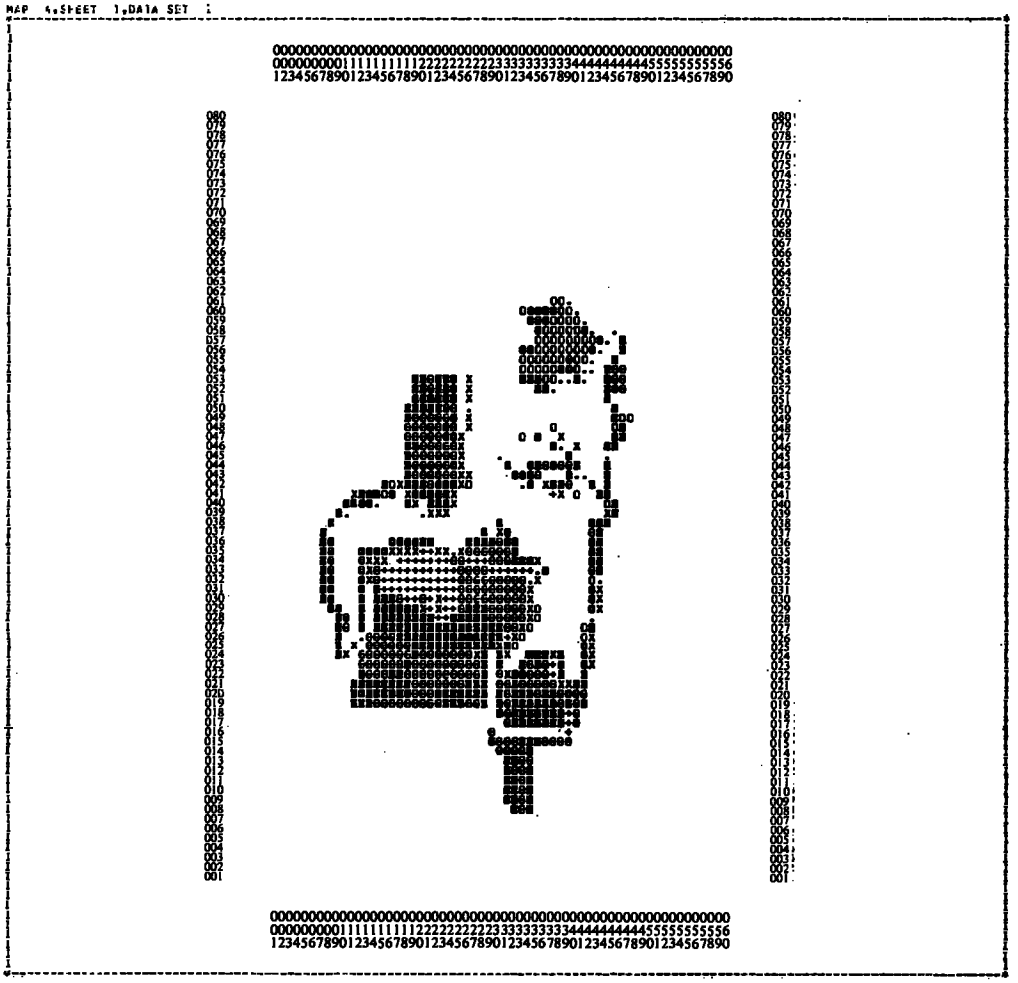
| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 |

FREQUENCY DISTRIBUTION OF DATA POINT VALUES IN EACH LEVEL

| LEVELS | LOW VALUES 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | HIGH VALUES 11 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SYMBOLS | | | | | | | | | | | | |
| FREQUENCY | 3194 | 0 | 0 | 0 | 144 | 66 | 51 | 0 | 61 | 5 | 254 | 0 |

Fig. X.4
Murray "A": Winter Plan

MAP 4,SHEET 1,DATA SET 1



ATTRACTIVENESS EVALUATION - PLAN A

PROFESSIONAL JUDGEMENT - MURRAY

HONEY HILL CASE STUDY

THIS ANALYSIS SHOWS THE NORMALIZED ATTRACTIVENESS VALUES FOR EACH OF THE PLANNED ACTIVITIES.

LEGEND

0 = LEAST ATTRACTIVE AREAS FOR PLANNED ACTIVITIES
9 = MOST ATTRACTIVE AREAS FOR PLANNED ACTIVITIES

DATA MAPPED IN 10 LEVELS BETWEEN EXTREME VALUES OF 0.0 AND 100.00

| ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| MINIMUM | 0.0 | 10.00 | 20.00 | 30.00 | 40.00 | 50.00 | 60.00 | 70.00 | 80.00 | 90.00 |
| MAXIMUM | 10.00 | 20.00 | 30.00 | 40.00 | 50.00 | 60.00 | 70.00 | 80.00 | 90.00 | 100.00 |

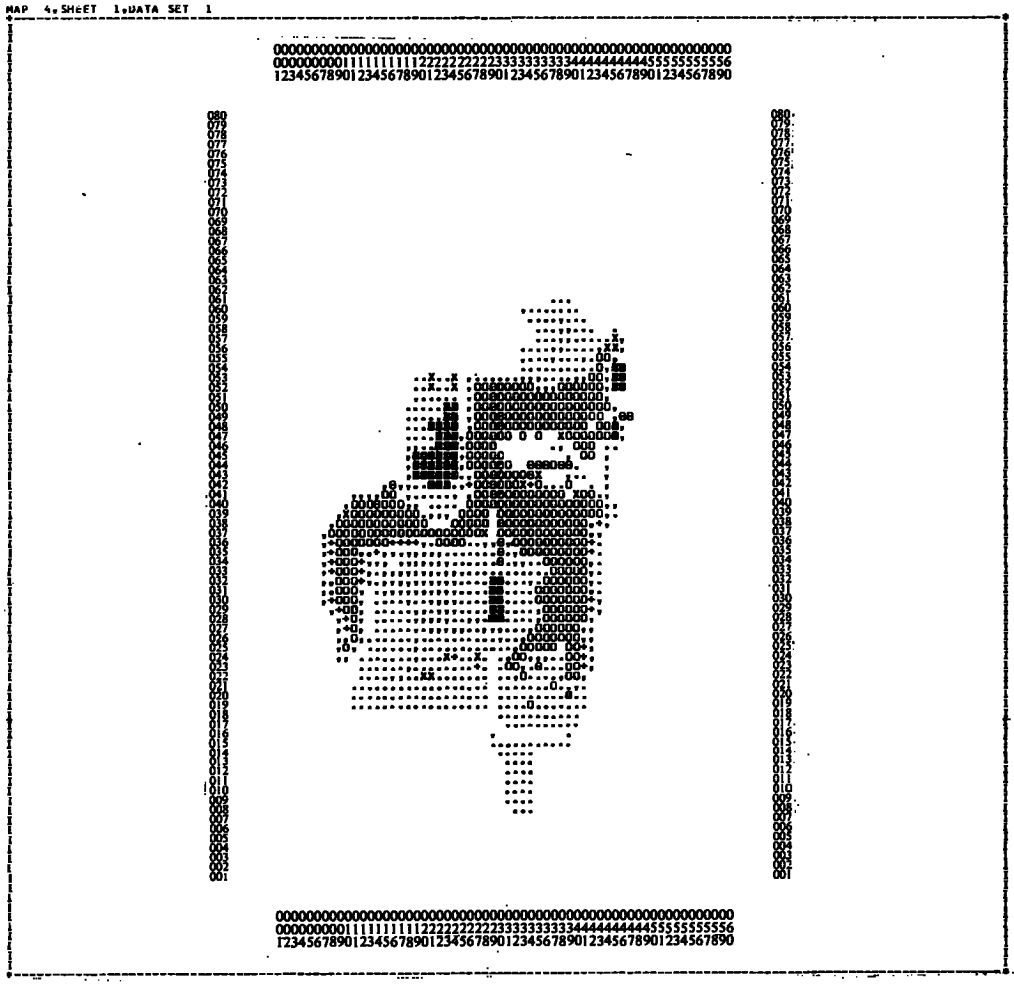
| PERCENTAGE OF TOTAL ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 |

FREQUENCY DISTRIBUTION OF DATA POINT VALUES IN EACH LEVEL

| LEVELS | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|---|
| SYMBOLS | ..... | ..... | ..... | +++++++ | XXXXXXXX | 00000000 | 00000000 | ..... | ..... | ..... |
| FREQUENCY | 20 | 0 | 0 | 65 | 66 | 63 | 232 | 44 | 35 | 291 |

Fig. X.5
Murray "A": Attractiveness Evaluation

MAP 4, SHEET 1, DATA SET 1



EVALUATION OF PLAN A - MURRAY

TOTAL IMPACT ON ALL RESOURCE SYSTEMS

HONEY HILL CASE STUDY

THIS ANALYSIS SHOWS THE TOTAL IMPACT OF THIS PLAN ON ALL RESOURCE SYSTEMS.

LEGEND
0 = LEAST IMPACT CAUSED BY PLANNED LAND USE
10
9 = GREATEST IMPACT CAUSED BY PLANNED LAND USE

DATA MAPPED IN 10 LEVELS BETWEEN EXTREME VALUES OF 1.00 AND 22.00

ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| MINIMUM | 1.00 | 3.10 | 5.20 | 7.30 | 9.40 | 11.50 | 13.60 | 15.70 | 17.80 | 19.90 |
| MAXIMUM | 3.10 | 5.20 | 7.30 | 9.40 | 11.50 | 13.60 | 15.70 | 17.80 | 19.90 | 22.00 |

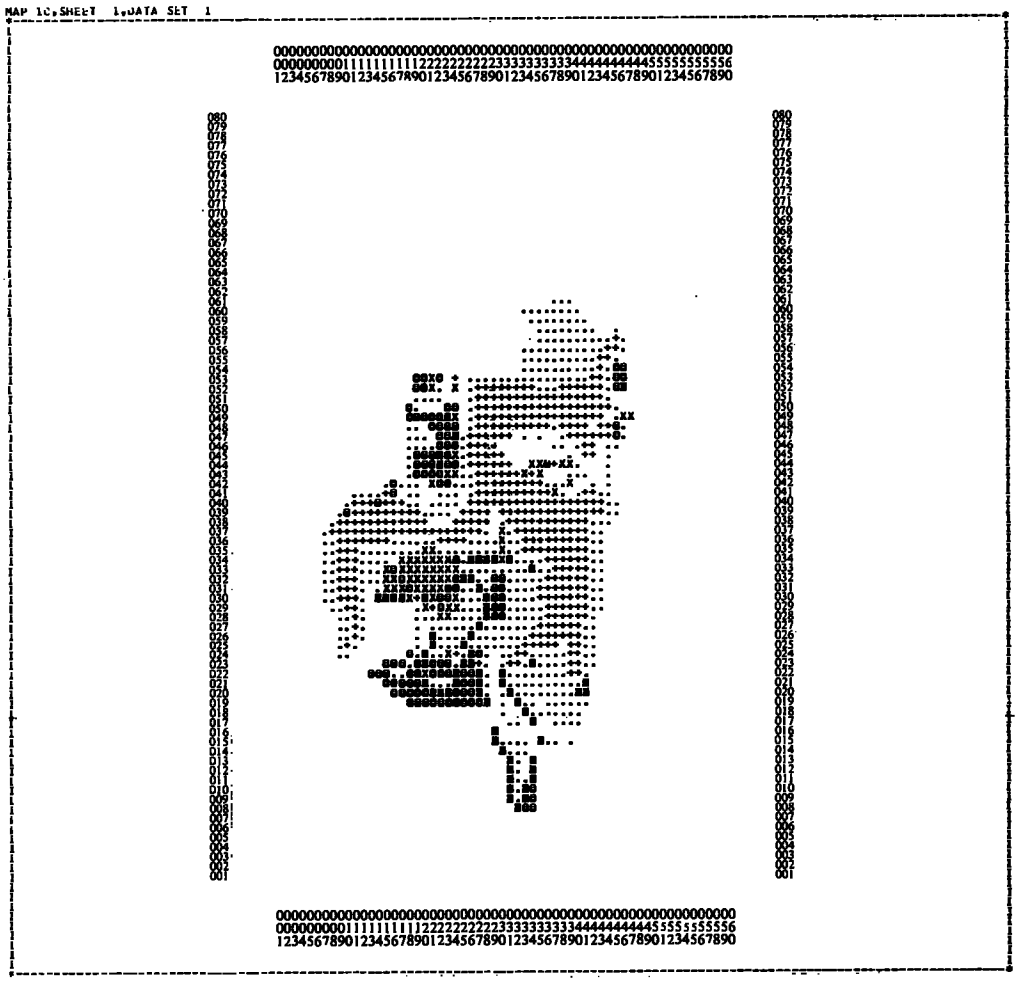
PERCENTAGE OF TOTAL ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 13.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 |

FREQUENCY DISTRIBUTION OF DATA POINT VALUES IN EACH LEVEL

| LEVELS | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|---|
| SYMBOLS | | | | | | | | | | |
| FREQUENCY | 474 | 207 | 19 | 28 | 17 | 396 | 14 | 2 | 19 | 33 |

Fig. X.6
Murray "A": Total Impact on Resource Systems




PLAN A - IMPACT ON SURFACE WATER SYSTEM

PROFESSIONAL JUDGEMENT - MURRAY

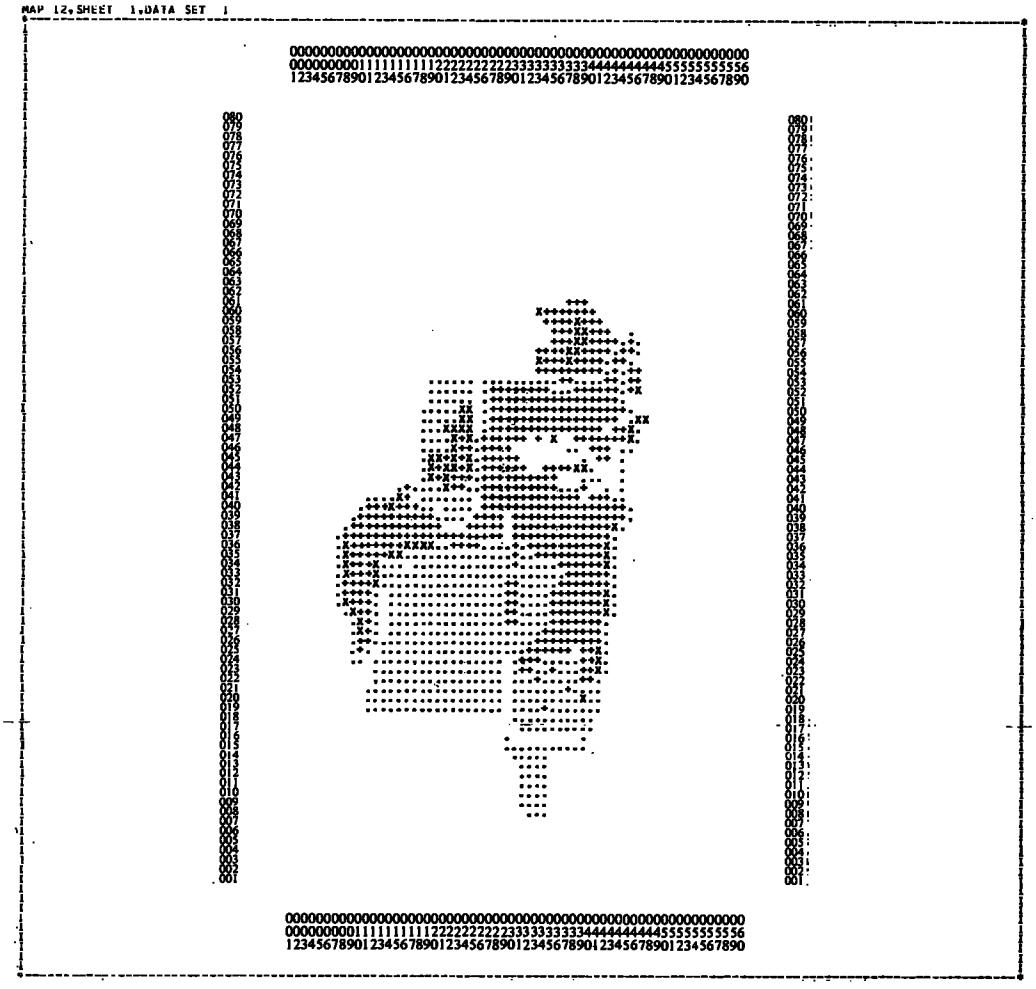
MUNCY HILL CASE STUDY

LEGEND
0 = NO IMPACT
1 = COMPATIBLE IMPACT
2 = MODERATE IMPACT
3 = SEVERE IMPACT
4 = THRESHOLD IMPACT

THIS ANALYSIS SHOWS THE RELATIVE IMPACT OF THIS PLAN ON THIS RESOURCE SYSTEM.

| LEVELS | 0 | 1 | 2 | 3 | 4 |
|---|---|---|---|---|---|
| SYMBOLS | | | | | |
| FREQUENCY | 488 | 391 | 65 | 116 | 68 |

Fig. X.7
Murray "A": Impact on Surface Water System




PLAN A - IMPACT ON WILDLIFE HABITAT

PROFESSIONAL JUDGEMENT - MURRAY

HONEY HILL CASE STUDY

LEGEND
0 = NO IMPACT
1 = COMPATIBLE IMPACT
2 = MODERATE IMPACT
3 = SEVERE IMPACT
4 = THRESHOLD IMPACT

THIS ANALYSIS SHOWS THE RELATIVE IMPACT OF THIS PLAN ON THIS RESOURCE SYSTEM.

| LEVELS | 0 | 1 | 2 | 3 | 4 |
|---|---|---|---|---|---|
| SYMBOLS | ..... | +++++++ | XXXXXXXX | 00000000 | ■■■■■■■■ |
| | ..... | +++++++ | XXXXXXXX | 00000000 | ■■■■■■■■ |
| | .... .... | +++ +++ | XXXX XXXX | 0000 0000 | ■■■■ ■■■■ |
| | ..... | +++++++ | XXXXXXXX | 00000000 | ■■■■■■■■ |
| | ..... | +++++++ | XXXXXXXX | 00000000 | ■■■■■■■■ |
| FREQUENCY | 620 | 519 | 76 | 0 | 0 |

Fig. X.8
Murray "A": Impact on Wildlife Habitat

Table X.4
Murray "A": Initial Plan
Summer N=3000
No. Cells/Activity/Crowding

| ACT. # | 0-75% | 75-100% | 100-125% | 125-150% |
|---|---|---|---|---|
| 1 | 0.0 | 0.0 | 0.0 | 0.0 |
| 2 | 202.0 | 33.0 | 0.0 | 0.0 |
| 3 | 8.0 | 0.0 | 0.0 | 0.0 |
| 4 | 55.0 | 120.0 | 0.0 | 0.0 |
| 5 | 5.0 | 0.0 | 0.0 | 0.0 |
| 6 | 6.0 | 5.0 | 0.0 | 0.0 |
| 7 | 0.0 | 0.0 | 0.0 | 1.0 |
| 8 | 0.0 | 0.0 | 0.0 | 0.0 |
| 9 | 0.0 | 0.0 | 0.0 | 0.0 |
| TOTAL | 276.0 | 158.0 | 0.0 | 1.0 |

Table X.5
Murray "A": Initial Plan
Summer N=3000
No. People/Activity/Crowding

| ACT. # | 0-75% | 75-100% | 100-125% | 125-150% | TURNED AWAY |
|---|---|---|---|---|---|
| 1 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 2 | 2613.8 | 827.7 | 0.0 | 0.0 | 0.0 |
| 3 | 12080.8 | 0.0 | 0.0 | 0.0 | 0.0 |
| 4 | 428.1 | 1867.9 | 0.0 | 0.0 | 0.0 |
| 5 | 567.6 | 0.0 | 0.0 | 0.0 | 0.0 |
| 6 | 2168.9 | 2957.6 | 0.0 | 0.0 | 0.0 |
| 7 | 0.0 | 0.0 | 0.0 | 1875.0 | 421.0 |
| 8 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 9 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| TOTAL | 17859.2 | 5653.3 | 0.0 | 1875.0 | 421.0 |

Table X.6
Murray "A": Initial Plan
Summer N=3000
Income/Activity

| ACT. # | LOCAL | REGIONAL |
|---|---|---|
| 1 | 0.0 | 0.0 |
| 2 | 24847.3 | 68578.5 |
| 3 | 27785.8 | 76688.8 |
| 4 | 16577.2 | 45753.0 |
| 5 | 3292.3 | 6518.8 |
| 6 | 29734.1 | 58873.5 |
| 7 | 13537.5 | 37363.5 |
| 8 | 0.0 | 0.0 |
| 9 | 0.0 | 0.0 |
| TOTAL | 115774.0 | 293775.9 |

Table X.7
Murray "A": Initial Plan
Winter N=3000
No. Cells/Activity/Crowding

| ACT. # | 0-75% | 75-100% | 100-125% | 125-150% |
|---|---|---|---|---|
| 1 | 0.0 | 0.0 | 0.0 | 0.0 |
| 2 | 266.0 | 0.0 | 0.0 | 0.0 |
| 3 | 0.0 | 0.0 | 0.0 | 0.0 |
| 4 | 55.0 | 0.0 | 0.0 | 120.0 |
| 5 | 0.0 | 0.0 | 0.0 | 61.0 |
| 6 | 52.0 | 0.0 | 0.0 | 0.0 |
| 7 | 0.0 | 0.0 | 0.0 | 0.0 |
| 8 | 0.0 | 0.0 | 0.0 | 0.0 |
| 9 | 0.0 | 0.0 | 0.0 | 0.0 |
| TOTAL | 373.0 | 0.0 | 0.0 | 181.0 |

Table X.8
Murray "A": Initial Plan
Winter = 3000
No. People/Activity/Crowding

| ACT. # | 0-75% | 75-100% | 100-125% | 125-150% | TURNED AWAY |
|---|---|---|---|---|---|
| 1 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 2 | 1019.4 | 0.0 | 0.0 | 0.0 | 0.0 |
| 3 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 4 | 694.0 | 0.0 | 0.0 | 3028.5 | 0.0 |
| 5 | 0.0 | 0.0 | 0.0 | 2144.5 | 7.5 |
| 6 | 8253.9 | 0.0 | 0.0 | 0.0 | 0.0 |
| 7 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 8 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 9 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| TOTAL | 9967.3 | 0.0 | 0.0 | 5173.0 | 7.5 |

Table X.9
Murray "A": Initial Plan
Winter N=3000
Income/Activity

| ACT. # | LOCAL | REGIONAL |
|---|---|---|
| 1 | 0.0 | 0.0 |
| 2 | 5912.5 | 11706.7 |
| 3 | 0.0 | 0.0 |
| 4 | 26876.7 | 74179.6 |
| 5 | 12438.3 | 24627.8 |
| 6 | 140068.8 | 386589.7 |
| 7 | 0.0 | 0.0 |
| 8 | 0.0 | 0.0 |
| 9 | 0.0 | 0.0 |
| TOTAL | 185296.1 | 497103.7 |

Table X.10
Murray "A": Initial Plan
Attractiveness Summary

SUMMER PLAN ATTRACTIVENESS

| ACTIVITY | # OF CELLS | MEAN |
|---|---|---|
| 1 | 0 | 0.0 |
| 2 | 49 | 1.63 |
| 3 | 12 | 55.83 |
| 4 | 150 | 82.67 |
| 5 | 5 | 77.40 |
| 6 | 11 | 70.91 |
| 7 | 2 | 45.00 |
| 8 | 62 | 67.40 |
| 9 | 5 | 68.00 |
| 10 | 254 | 3.71 |
| TOTAL | 550 | 36.13 |

WINTER PLAN ATTRACTIVENESS

| ACTIVITY | # OF CELLS | MEAN |
|---|---|---|
| 11 | 0 | 0.0 |
| 12 | 0 | 0.0 |
| 13 | 0 | 0.0 |
| 14 | 150 | 82.67 |
| 15 | 66 | 60.30 |
| 16 | 50 | 34.02 |
| 17 | 0 | 0.0 |
| 18 | 62 | 67.40 |
| 19 | 5 | 68.00 |
| 20 | 254 | 3.71 |
| TOTAL | 587 | 40.11 |

Table X.11
Murray "A": Initial Plan
Plan Impact TOTAL IMPACT = 7875.

| SYSTEM | NULL | COMPAT. | MODERATE | SEVERE | TERMINAL | MEAN |
|---|---|---|---|---|---|---|
| 1 | 281 | 11 | 96 | 247 | 31 | 1.604 |
| 2 | 326 | 291 | 49 | 0 | 0 | 0.584 |
| 3 | 277 | 307 | 82 | 0 | 0 | 0.707 |
| 4 | 200 | 288 | 169 | 9 | 0 | 0.980 |
| 5 | 315 | 54 | 293 | 3 | 1 | 0.980 |
| 6 | 121 | 137 | 198 | 210 | 0 | 1.746 |
| 7 | 266 | 7 | 133 | 256 | 4 | 1.587 |
| 8 | 0 | 0 | 0 | 0 | 0 | 0.0 |
| 9 | 0 | 0 | 0 | 0 | 0 | 0.0 |
| 10 | 50 | 73 | 327 | 41 | 175 | 2.327 |
| 11 | 277 | 67 | 172 | 140 | 10 | 1.308 |
| TOTAL | 2113 | 1235 | 1519 | 906 | 221 | 1.314 |

Table X.12
Murray "A": Initial Plan
Capital Costs of Plan

| ACTIVITY # | SUMMER | WINTER |
|---|---|---|
| 1 | 0 0 | 0 0 |
| 2 | 0 0 | 0 0 |
| 3 | 254 10 | 0 0 |
| 4 | 30 00 | 30 00 |
| 5 | 125 00 | 0 0 |
| 6 | 48 13 | 400 00 |
| 7 | 12 00 | 0 0 |
| 8 | 18600 00 | 18600 00 |
| 9 | 196 63 | 196 63 |
| 10 | 518 16 | 518 16 |
| TOTAL | 19784000 | 19744078 |

TABLE X.13

MURRAY "A": INITIAL PLAN
SUMMARY UNDER DEMANDS N=1000 THROUGH N=3000

| | N=1000 | N-1500 | N=2000 | N=2500 | N=3000 |
|---|---|---|---|---|---|
| 1. SUMMER PLAN | | | | | |
| Attractiveness (mean mean) | 36.13 | 36.13 | 36.13 | 36.13 | 36.13 |
| Impact (mean mean) | 1.314 | 1.314 | 1.314 | 1.314 | 1.314 |
| No. of people crowded | 234 | 234 | 234 | 234 | 1,875 |
| No. of people turned away | 283 | 484 | 684 | 884 | 421 |
| $ local income | 24,308 | 35,616 | 46,925 | 58,233 | 115,774 |
| $ regional income | 60,517 | 88,440 | 116,363 | 144,287 | 293,775 |
| $ capital cost | 19,784,000 | 19,784,000 | 19,784,000 | 19,784,000 | 19,784,000 |
| $ capital cost w/o res. | 1,184,000 | 1,184,000 | 1,184,000 | 1,184,000 | 1,184,000 |
| 2. WINTER PLAN | | | | | |
| Attractiveness (mean mean) | 40.11 | 40.11 | 40.11 | 40.11 | 40.11 |
| Impact (mean mean) | 1.314 | 1.314 | 1.314 | 1.314 | 1.314 |
| No. of people crowded | 234 | 234 | 234 | 234 | 5,173 |
| No. of people turned away | 112 | 225 | 340 | 454 | 7 |
| $ local income | 55,246 | 82,014 | 108,788 | 135,562 | 185,296 |
| $ regional income | 146,723 | 217,752 | 288,778 | 359,805 | 497,104 |
| $ capital cost | 19,744,078 | 19,744,078 | 19,744,078 | 19,744,078 | 19,744,078 |
| $ capital cost w/o res. | 1,144,078 | 1,144,078 | 1,044,078 | 1,144,078 | 1,144,078 |

The initial plans made by the research team for the "A" assumptions are shown with their summary evaluations in Appendix H.

The initial plans made by the research team for the "B" assumption are shown with their summary evaluations in Appendix I. These were made and evaluated by a process identical with that described for the "A" plans.

## D. IMPROVING THE PLANS

Improvements to the initial proposal could be defined in terms of increasing its activity attractiveness, decreasing its site resource systems impacts, decreasing its overcrowding and its facility under-utilization, decreasing its dollar costs and increasing its dollar benefits.

Three strategies for improving the initial plans were developed. These are 1) incorporating the "vulnerability" and "impact" analyses into the design process, 2) incorporating the "attractiveness" analysis, and 3) incorporating the simulation model evaluations, particularly those which might alter the quantitative program. These strategies were tested sequentially.

In practice, however, these methods of improving the initial plan could be undertaken simultaneously or in any other sequence. Furthermore, it is not always necessary to map and evaluate any but the initial and final proposals.

The plans made by Murray were selected as the test case in a series of attempts to use the analysis procedures and the simulation model in order to improve the plan.

The first basic way in which the plans can be improved is to introduce the site resource systems models described in Chapter V into the design process. These models, which evaluate the vulnerability of the various locations to activities and which predict the degree of impact which would result, can be used in the selection of sites so that locations with minimal impacts are selected. The use of the impact models involves a cell by cell analysis of the plan, aimed at identifying alternative locations for those activities which a previous evaluation shows to have caused high degrees of impact. An example in the Murray "A" plan is the housing on Honey Hill. If areas are unavailable within the basic design concept which would lessen the impact of activities, it may well be that a

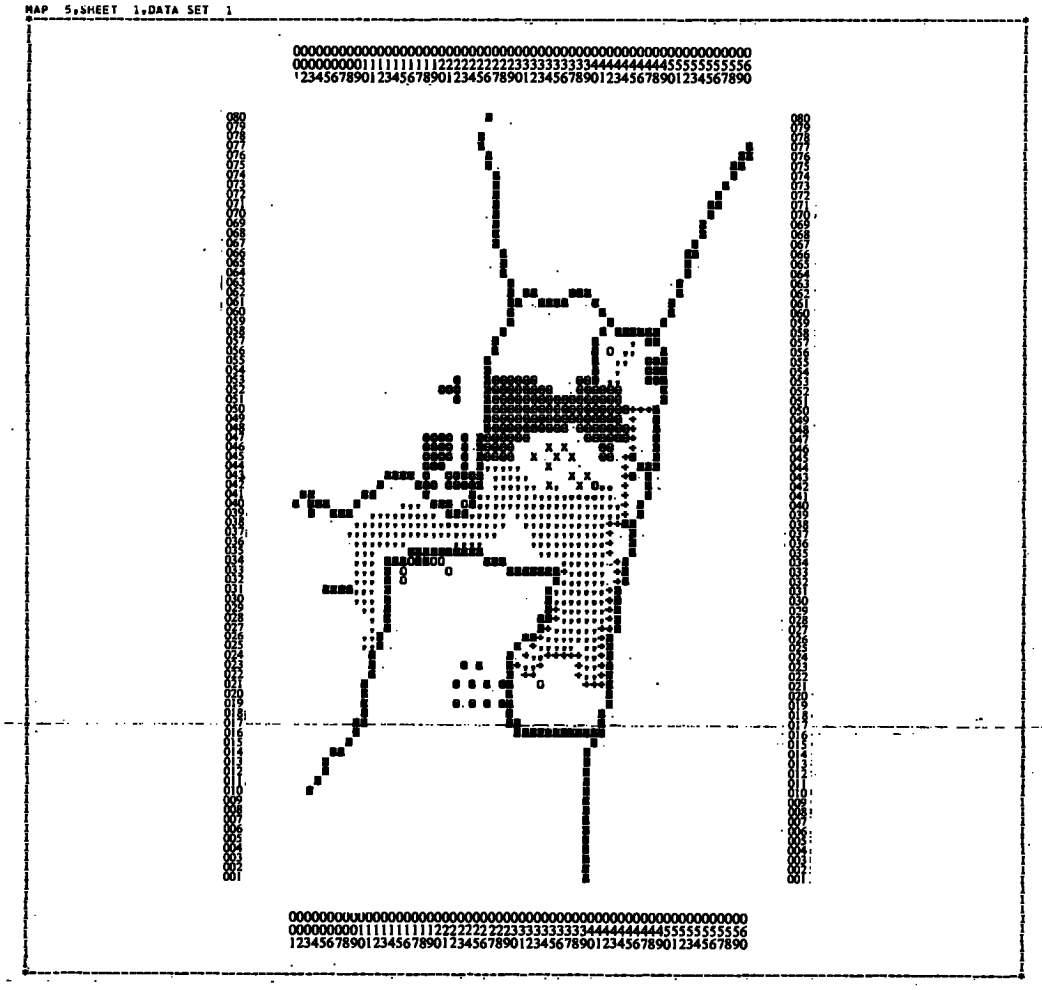
major shift in location is necessary, thus altering the basic concept.

In the process of using the vulnerability maps, (Figures V.1 through V.11), to test the plans, occasions may arise in which a proposed shift in location in order to achieve a lesser impact will also result in a lesser attractiveness. This is an area in which judgments on the part of the designer are unavoidable. A reasonable rule in using the maps is to compromise attractiveness for those activities which the simulation model has identified as under-utilized, and to compromise impact for those activities which are financially lucrative. An important caveat for the latter should be that in any case, one would seek to eliminate the severe and threshold impacts.

Figures X.9 through X.12 and Tables X.14 through X.22 present the Murray "A" plan after the introduction of the impact model into the design process. The expectation is that this plan will result in a lower degree of site resource system impact than the previously evaluated proposals, and it is hoped that its attractiveness, social and fiscal consequences would not be worse.

The second basis of improving the initial plans is to introduce the site attractiveness evaluations as described in Chapter IV into the design process. From the attractiveness evaluation of the second Murray "A" plan (Figure X.11) the locations with relatively low attractiveness evaluations could be identified. The activities represented could be identified from the plans (Figures X.9 and X.10) as was the case with the introduction of the impact evaluations. The procedure involves a search, by activity, for sites with higher potential attractiveness values. Where possible, and within the basic design concept of the plan, activities would be relocated from lower to higher value cells.

If, however, there are no such potential improvements, a general search is more of the appropriate activity attractiveness maps for alternative areas which would improve the plan. While a major shift in activity location may alter the basic design concept, this is a price which must be considered in order to achieve the improvement sought. Having attempted to improve the attractiveness of each of the activities incorporated in the plan, a new keypunching worksheet could be made, and a plan keypunched, mapped and evaluated against the attractiveness, impact, social and fiscal aspects of the simulation model. Figures X.13 through X.16 and Tables




MURRAY A + IMPACT EVALUATIONS

SUMMER PLAN

HONEY HILL CASE STUDY

LEGEND
1 = HUNTING
2 = FISHING AND CANOEING
3 = SWIMMING BEACH
4 = HIKING
5 = CAMPING
6 = PICNICKING
7 = MARINA AND BOATING
8 = RESIDENTIAL
9 = PARKING
10= MAJOR ROADS

DATA MAPPED IN 10 LEVELS BETWEEN EXTREME VALUES OF 0.50 AND 10.50

ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| MINIMUM | 0.50 | 1.50 | 2.50 | 3.50 | 4.50 | 5.50 | 6.50 | 7.50 | 8.50 | 9.50 |
| MAXIMUM | 1.50 | 2.50 | 3.50 | 4.50 | 5.50 | 6.50 | 7.50 | 8.50 | 9.50 | 10.50 |

PERCENTAGE OF TOTAL ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

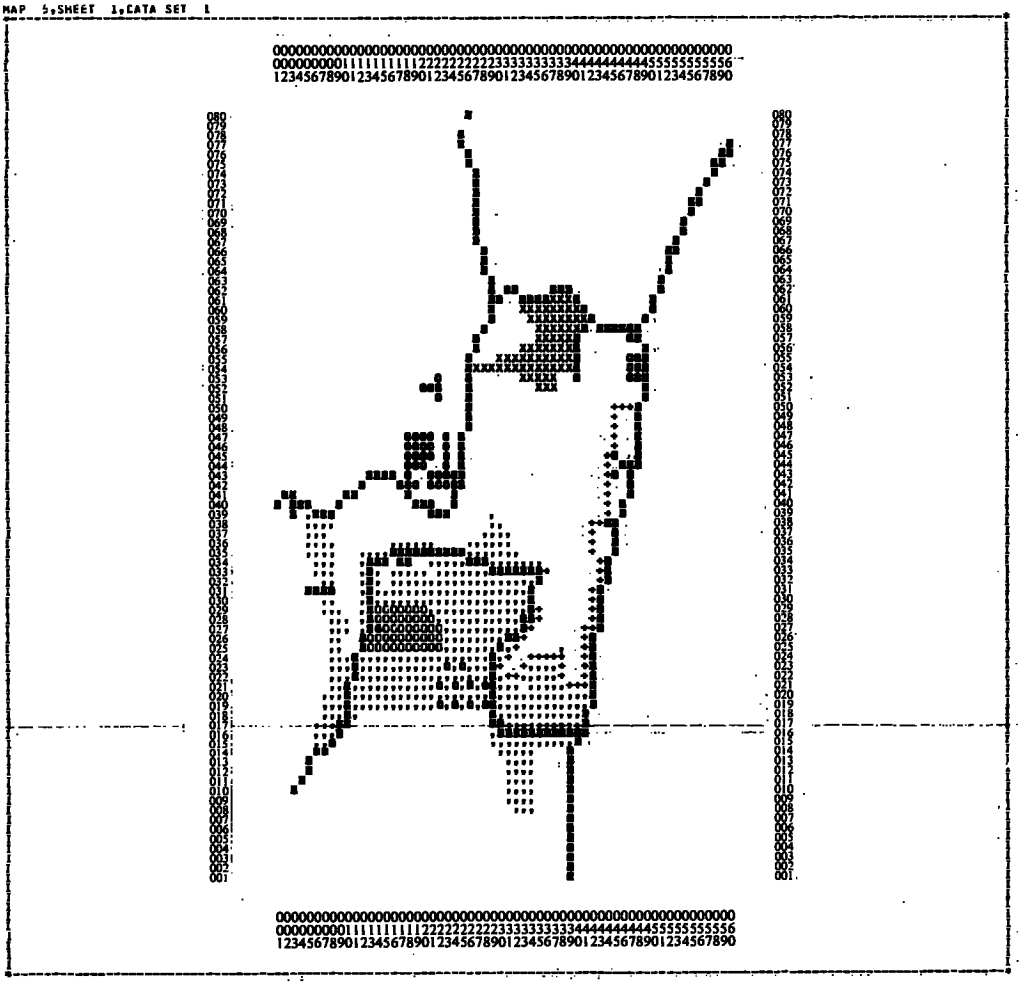
| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 |

FREQUENCY DISTRIBUTION OF DATA POINT VALUES IN EACH LEVEL

| LEVELS | LOW VALUES 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | HIGH VALUES 11 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SYMBOLS | | | | | | | | | | | | |
| FREQUENCY | 4013 | 0 | 273 | 12 | 54 | 18 | 10 | 115 | 51 | 10 | 252 | 0 |

Fig. X.9
Murray "A" + Impact Evaluations - Summer Plan

MAP 5,SHEET 1,CATA SET 1



MURRAY A + IMPACT EVALUATIONS

WINTER PLAN

HONEY HILL CASE STUDY

LEGEND
1 = HUNTING
2 = SNOW SHOEING
3 = CROSS COUNTRY SKIING
4 = TRAILS
5 = SNOW MOBILING
6 = DOWNHILL SKIING
7 = ICE SKATING
8 = RESIDENTIAL
9 = PARKING
10 = MAJOR ROADS

DATA MAPPED IN 10 LEVELS BETWEEN EXTREME VALUES OF 0.50 AND 10.50

ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| MINIMUM | 0.50 | 1.50 | 2.50 | 3.50 | 4.50 | 5.50 | 6.50 | 7.50 | 8.50 | 9.50 |
| MAXIMUM | 1.50 | 2.50 | 3.50 | 4.50 | 5.50 | 6.50 | 7.50 | 8.50 | 9.50 | 10.50 |

PERCENTAGE OF TOTAL ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

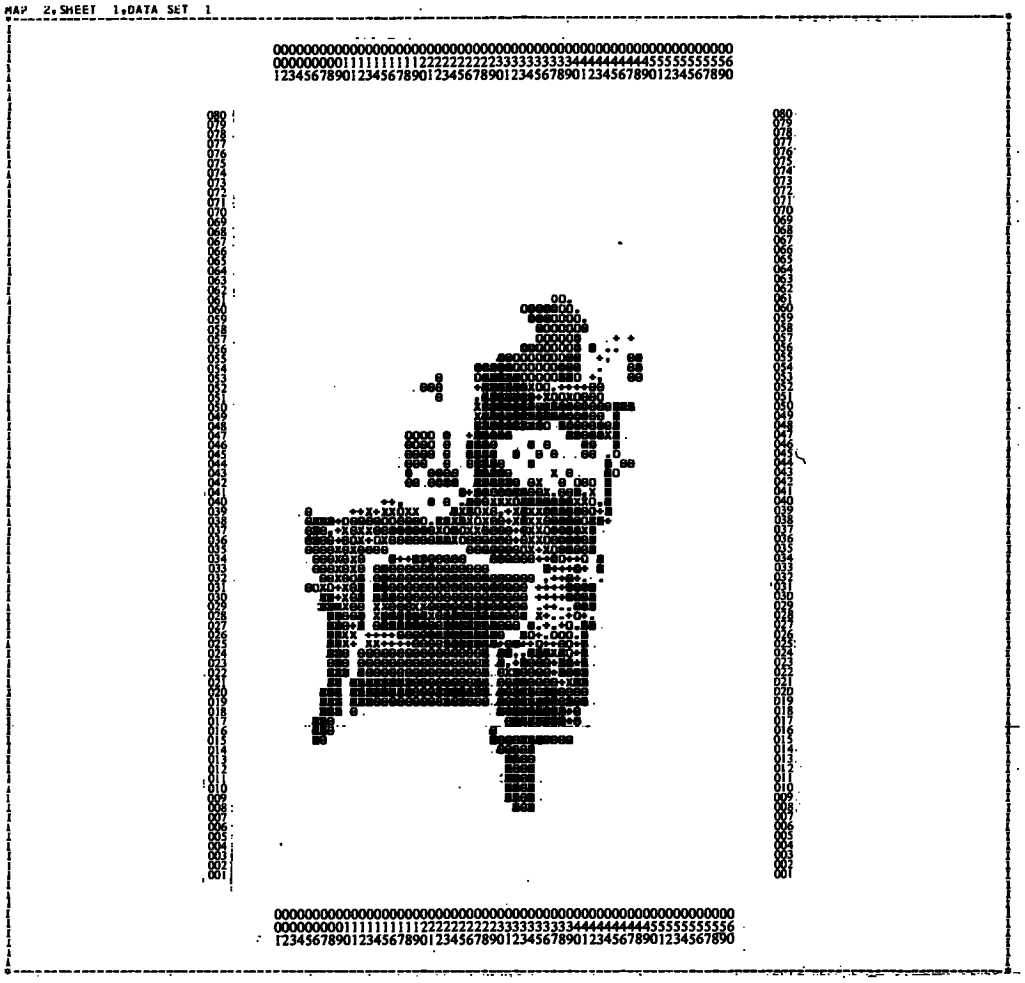
| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 |

FREQUENCY DISTRIBUTION OF CATA POINT VALUES IN EACH LEVEL

| LEVELS | LOW VALUES 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | HIGH VALUES 11 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SYMBOLS | | | | | | | | | | | | |
| FREQUENCY | 3880 | 0 | 441 | 0 | 54 | 68 | 43 | 0 | 52 | 10 | 252 | 0 |

Fig. X.10
Murray "A" + Impact Evaluations - Winter Plan

MAP 2,SHEET 1,DATA SET 1



MURRAY - A WITH IMPACT EVALUATION

ATTRACTIVENESS EVALUATION

HONEY HILL CASE STUDY

THIS ANALYSIS SHOWS THE NORMALIZED ATTRACTIVENESS VALUES FOR EACH OF THE PLANNED ACTIVITIES.

LEGEND

0 = LEAST ATTRACTIVE AREAS FOR PLANNED ACTIVITIES
TO
9 = MOST ATTRACTIVE AREAS FOR PLANNED ACTIVITIES

DATA MAPPED IN 10 LEVELS BETWEEN EXTREME VALUES OF 0.0 AND 100.00

ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| MINIMUM | 0.0 | 10.00 | 20.00 | 30.00 | 40.00 | 50.00 | 60.00 | 70.00 | 80.00 | 90.00 |
| MAXIMUM | 10.00 | 20.00 | 30.00 | 40.00 | 50.00 | 60.00 | 70.00 | 80.00 | 90.00 | 100.00 |

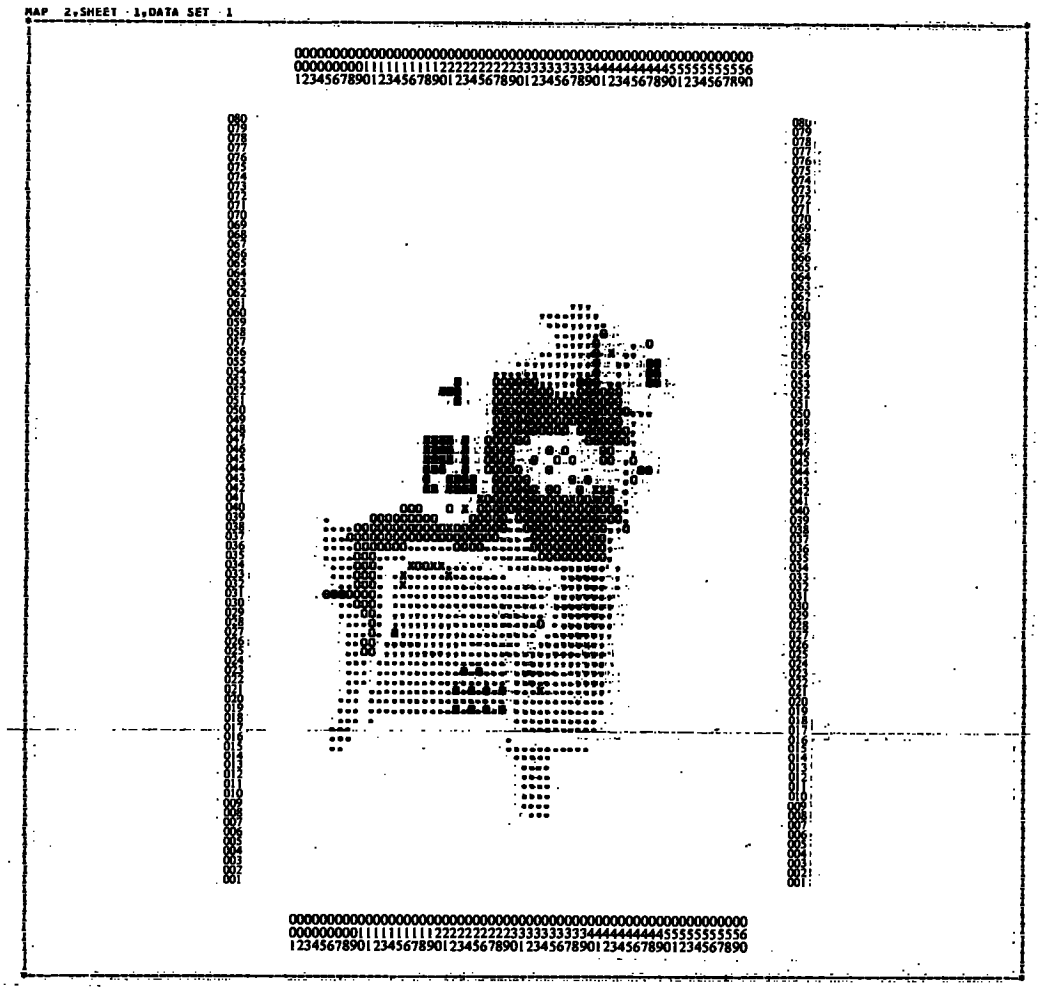
PERCENTAGE OF TOTAL ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 |

FREQUENCY DISTRIBUTION OF DATA POINT VALUES IN EACH LEVEL

| LEVELS | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|---|
| SYMBOLS | ..... | ..... | ..... | +++++++ | XXXXXXX | 000000 | ..... | ..... | ..... | ..... |
| FREQUENCY | 22 | 9 | 5 | 83 | 73 | 96 | 381 | 85 | 70 | 275 |

Fig. X.11
Murray "A" with Impact Evaluation:
Attractiveness Evaluation




MURRAY - A WITH IMPACT EVALUATION

TOTAL IMPACT ON ALL RESOURCE SYSTEMS

HONEY HILL CASE STUDY

THIS ANALYSIS SHOWS THE TOTAL IMPACT OF THIS PLAN ON ALL RESOURCE SYSTEMS.

LEGEND
0 = LEAST IMPACT CAUSED BY PLANNED LAND USE
TO
9 = GREATEST IMPACT CAUSED BY PLANNED LAND USE

DATA MAPPED IN 10 LEVELS BETWEEN EXTREME VALUES OF 0.0 AND 21.00

ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| MINIMUM | 0.0 | 2.10 | 4.20 | 6.30 | 8.40 | 10.50 | 12.60 | 14.70 | 16.80 | 18.90 |
| MAXIMUM | 2.10 | 4.20 | 6.30 | 8.40 | 10.50 | 12.60 | 14.70 | 16.80 | 18.90 | 21.00 |

PERCENTAGE OF TOTAL ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 |

FREQUENCY DISTRIBUTION OF DATA POINT VALUES IN EACH LEVEL

| LEVELS | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|---|
| SYMBOLS | | | | | | | | | | |
| FREQUENCY | 469 | 120 | 99 | 0 | 16 | 324 | 15 | 4 | 20 | 32 |

Fig. X.12
Murray "A" with Impact Evaluations: Total Impact on Resources with Impact Evaluations

Table X.14
Murray "A" + Impact Evaluations
Summer N=3000
No. Cells/Activity/Crowding

| ACT. # | 0-75% | 75-100% | 100-125% | 125-150% |
|---|---|---|---|---|
| 1 | 0.0 | 0.0 | 0.0 | 0.0 |
| 2 | 236.0 | 0.0 | 0.0 | 0.0 |
| 3 | 9.0 | 0.0 | 0.0 | 0.0 |
| 4 | 50.0 | 0.0 | 0.0 | 0.0 |
| 5 | 10.0 | 0.0 | 0.0 | 0.0 |
| 6 | 10.0 | 0.0 | 0.0 | 0.0 |
| 7 | 2.0 | 0.0 | 0.0 | 0.0 |
| 8 | 0.0 | 0.0 | 0.0 | 0.0 |
| 9 | 0.0 | 0.0 | 0.0 | 0.0 |
| TOTAL | 317.0 | 0.0 | 0.0 | 0.0 |

Table X.15
Murray "A" + Impact Evaluations
Summer N=3000
No. People/Activity/Crowding

| ACT. # | 0-75% | 75-100% | 100-125% | 125-150% | TURNED AWAY |
|---|---|---|---|---|---|
| 1 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 2 | 3441.4 | 0.0 | 0.0 | 0.0 | 0.0 |
| 3 | 12080.8 | 0.0 | 0.0 | 0.0 | 0.0 |
| 4 | 2296.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 5 | 567.6 | 0.0 | 0.0 | 0.0 | 0.0 |
| 6 | 5126.6 | 0.0 | 0.0 | 0.0 | 0.0 |
| 7 | 2296.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 8 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 9 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| TOTAL | 25808.5 | 0.0 | 0.0 | 0.0 | 0.0 |

Table X.16
Murray "A" + Impact Evaluations
Summer N=3000
Income/Activity

| ACT. # | LOCAL | REGIONAL |
|---|---|---|
| 1 | 0.0 | 0.0 |
| 2 | 24847.2 | 68578.3 |
| 3 | 27785.8 | 76688.8 |
| 4 | 16577.2 | 45753.0 |
| 5 | 3292.3 | 6518.8 |
| 6 | 29734.1 | 58873.5 |
| 7 | 16577.2 | 45753.1 |
| 8 | 0.0 | 0.0 |
| 9 | 0.0 | 0.0 |
| TOTAL | 118813.7 | 302165.3 |

Table X.17
Murray "A" + Impact Evaluations
Winter N=3000
No. Cells/Activity/Crowding

| ACT. # | 0-75% | 75-100% | 100-125% | 125-150% |
|---|---|---|---|---|
| 1 | 0.0 | 0.0 | 0.0 | 0.0 |
| 2 | 192.0 | 0.0 | 0.0 | 0.0 |
| 3 | 113.0 | 0.0 | 0.0 | 0.0 |
| 4 | 50.0 | 0.0 | 0.0 | 0.0 |
| 5 | 64.0 | 0.0 | 0.0 | 0.0 |
| 6 | 43.0 | 0.0 | 0.0 | 0.0 |
| 7 | 0.0 | 0.0 | 0.0 | 0.0 |
| 8 | 0.0 | 0.0 | 0.0 | 0.0 |
| 9 | 0.0 | 0.0 | 0.0 | 0.0 |
| TOTAL | 462.0 | 0.0 | 0.0 | 0.0 |

Table X.18
Murray "A" + Impact Evaluations
Winter N=3000
No. People/Activity/Crowding

| ACT. # | 0-75% | 75-100% | 100-125% | 125-150% | TURNED AWAY |
|---|---|---|---|---|---|
| 1 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 2 | 1019.4 | 0.0 | 0.0 | 0.0 | 0.0 |
| 3 | 1650.8 | 0.0 | 0.0 | 0.0 | 0.0 |
| 4 | 3722.5 | 0.0 | 0.0 | 0.0 | 0.0 |
| 5 | 2827.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 6 | 8253.9 | 0.0 | 0.0 | 0.0 | 0.0 |
| 7 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 8 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 9 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| TOTAL | 17473.6 | 0.0 | 0.0 | 0.0 | 0.0 |

Table X.19
Murray "A" + Impact Evaluations
Winter N=3000
Income Activity

| ACT. # | LOCAL | REGIONAL |
|---|---|---|
| 1 | 0.0 | 0.0 |
| 2 | 5912.4 | 11706.5 |
| 3 | 11506.0 | 31756.4 |
| 4 | 26876.7 | 74179.6 |
| 5 | 16396.5 | 32465.0 |
| 6 | 140069.0 | 386590.3 |
| 7 | 0.0 | 0.0 |
| 8 | 0.0 | 0.0 |
| 9 | 0.0 | 0.0 |
| TOTAL | 200760.4 | 536697.7 |

Table X.20
Murray "A" + Impact Evaluations
Attractiveness Summary

SUMMER PLAN ATTRACTIVENESS

| ACTIVITY | # OF CELLS | MEAN |
|---|---|---|
| 1 | 0 | 0.0 |
| 2 | 81 | 42.22 |
| 3 | 12 | 61.67 |
| 4 | 54 | 88.89 |
| 5 | 10 | 66.60 |
| 6 | 10 | 85.00 |
| 7 | 2 | 90.00 |
| 8 | 52 | 66.21 |
| 9 | 10 | 57.00 |
| 10 | 252 | 3.54 |
| TOTAL | 483 | 32.22 |

WINTER PLAN ATTRACTIVENESS

| ACTIVITY | # OF CELLS | MEAN |
|---|---|---|
| 11 | 0 | 0.0 |
| 12 | 0 | 0.0 |
| 13 | 0 | 0.0 |
| 14 | 54 | 88.89 |
| 15 | 68 | 62.35 |
| 16 | 43 | 62.42 |
| 17 | 0 | 0.0 |
| 18 | 52 | 66.21 |
| 19 | 10 | 57.00 |
| 20 | 252 | 3.54 |
| TOTAL | 479 | 34.72 |

Table X.21
Murray "A" + Impact Evaluations
Plan Impact TOTAL IMPACT = 7342.

| SYSTEM | NULL | COMPAT. | MODERATE | SEVERE | TERMINAL | MEAN |
|---|---|---|---|---|---|---|
| 1 | 223 | 29 | 95 | 221 | 26 | 1.660 |
| 2 | 256 | 309 | 29 | 0 | 0 | 0.618 |
| 3 | 215 | 291 | 88 | 0 | 0 | 0.786 |
| 4 | 97 | 361 | 127 | 9 | 0 | 1.081 |
| 5 | 246 | 61 | 283 | 3 | 1 | 1.077 |
| 6 | 121 | 188 | 146 | 139 | 0 | 1.510 |
| 7 | 165 | 13 | 107 | 304 | 5 | 1.951 |
| 8 | 0 | 0 | 0 | 0 | 0 | 0.0 |
| 9 | 0 | 0 | 0 | 0 | 0 | 0.0 |
| 10 | 43 | 131 | 213 | 39 | 168 | 2.266 |
| 11 | 215 | 76 | 157 | 136 | 10 | 1.411 |
| TOTAL | 1581 | 1459 | 1245 | 851 | 210 | 1.373 |

Table X.22
Murray "A" + Impact Evaluations
Capital Costs of Plan

| ACTIVITY # | SUMMER | WINTER |
|---|---|---|
| 1 | 0 0 | 0 0 |
| 2 | 0 0 | 0 0 |
| 3 | 254 10 | 0 0 |
| 4 | 10 80 | 10 80 |
| 5 | 250 00 | 0 0 |
| 6 | 43 75 | 344 00 |
| 7 | 12 00 | 0 0 |
| 8 | 15600 00 | 15600 00 |
| 9 | 393 25 | 393 25 |
| 10 | 514 08 | 514 08 |
| TOTAL | 17077058 | 16862013 |

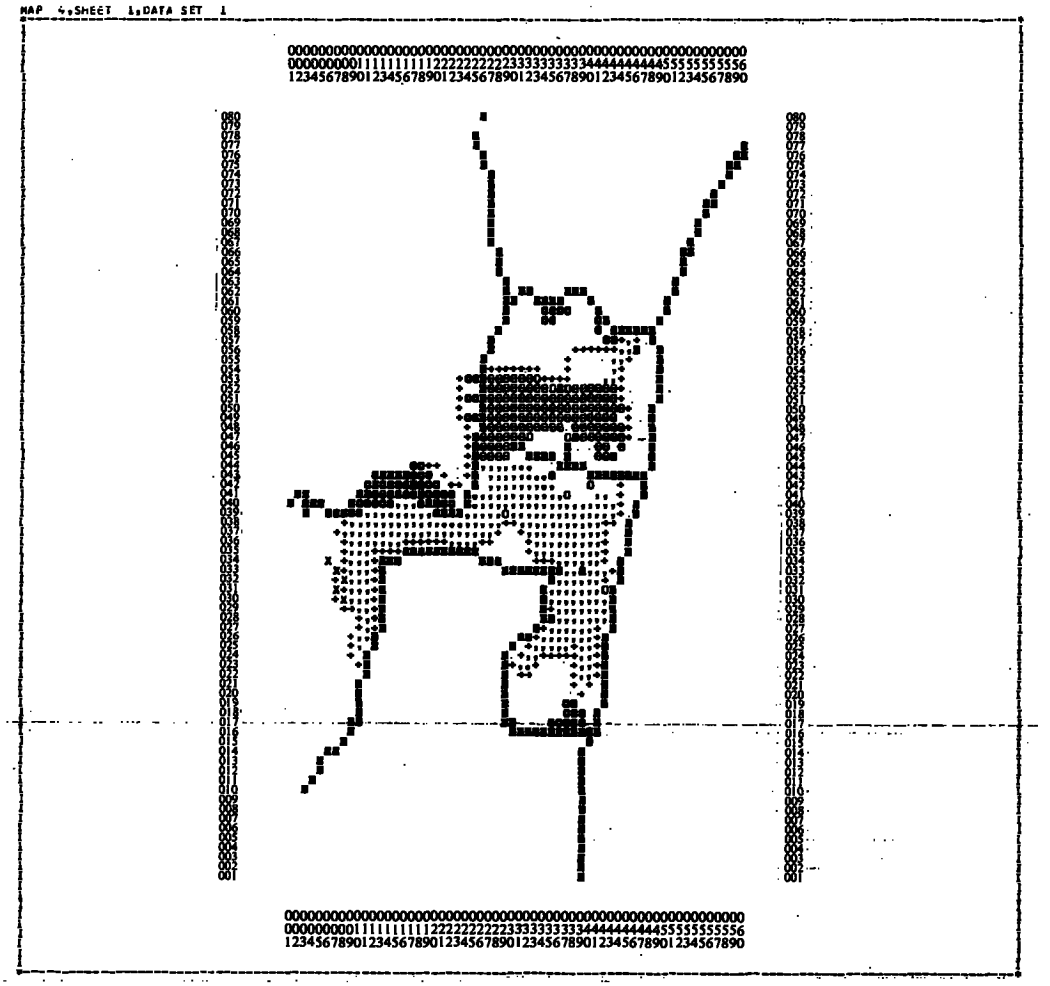
X.23 through X.31 show the Murray "A" plan as altered and evaluated via the introduction of the attractiveness analyses. The expectation in this category of plan improvement is that the new plan will result in an increase in the attractiveness for each of the activity components of the plan. It is hoped that the site resource system impacts and the social and fiscal evaluations also would improve. It is again conceivable, however, that conflicts will occur between improving the attractiveness of an activity location and the possible increase of a site resource system impact. These must be resolved by the designer as previously discussed.

The third major stage in the improvement of the plan is the introduction of the social and fiscal aspects of the simulation model into the design process. In particular, the simulation model identifies those activities which are being under-utilized for a given demand. Having run the simulation model for varying degrees of demand, and having identified the range at which a general site capacity can be established for the proposal (in the case of Murray "A", this is around N=3000), the tabular output can identify those activities for which additional site allocations are required, so as to reduce crowding and retain the financial benefits. It can also identify those activities which are in oversupply and which can be partially removed, thus decreasing the costs of the plan and its resource system impacts without losing any of the financial benefits. The procedure consists of estimating of the number of cells to be added to or taken away from each activity. Having identified these numbers, the plan is then analyzed and the appropriate number of cells eliminated on the basis of taking away those which are the least attractive and/or cause the greatest impacts.

For those activity locations which must be added to the plan, the same design process utilizing the attractiveness and vulnerability analyses is used. Figures X.17 through X.22 and Tables X.32 through X.40 show the Murray "A" scheme after the incorporation of the simulation evaluations into the design process. The expectation is that this scheme will have resulted in a lower dollar cost, a greater dollar benefit, and an improvement in attractiveness and impact. This plan is substantially the best that can be expected within the basic concept of the Murray "A" scheme.

Table X.41 shows the degree to which the various summary evaluations of the Murray "A" plan were improved during the

MAP 4, SHEET 1, DATA SET 1



MURRAY A + ATTRACTIVENESS EVALUATIONS

SUMMER PLAN

HONEY HILL CASE STUDY

LEGEND
1 = HUNTING
2 = FISHING AND CANOEING
3 = SWIMMING BEACH
4 = HIKING
5 = CAMPING
6 = PICNICKING
7 = MARINA AND BOATING
8 = RESIDENTIAL
9 = PARKING
10= MAJOR ROADS

DATA MAPPED IN 10 LEVELS BETWEEN EXTREME VALUES OF 0.50 AND 10.50

ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| MINIMUM | 0.50 | 1.50 | 2.50 | 3.50 | 4.50 | 5.50 | 6.50 | 7.50 | 8.50 | 9.50 |
| MAXIMUM | 1.50 | 2.50 | 3.50 | 4.50 | 5.50 | 6.50 | 7.50 | 8.50 | 9.50 | 10.50 |

PERCENTAGE OF TOTAL ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

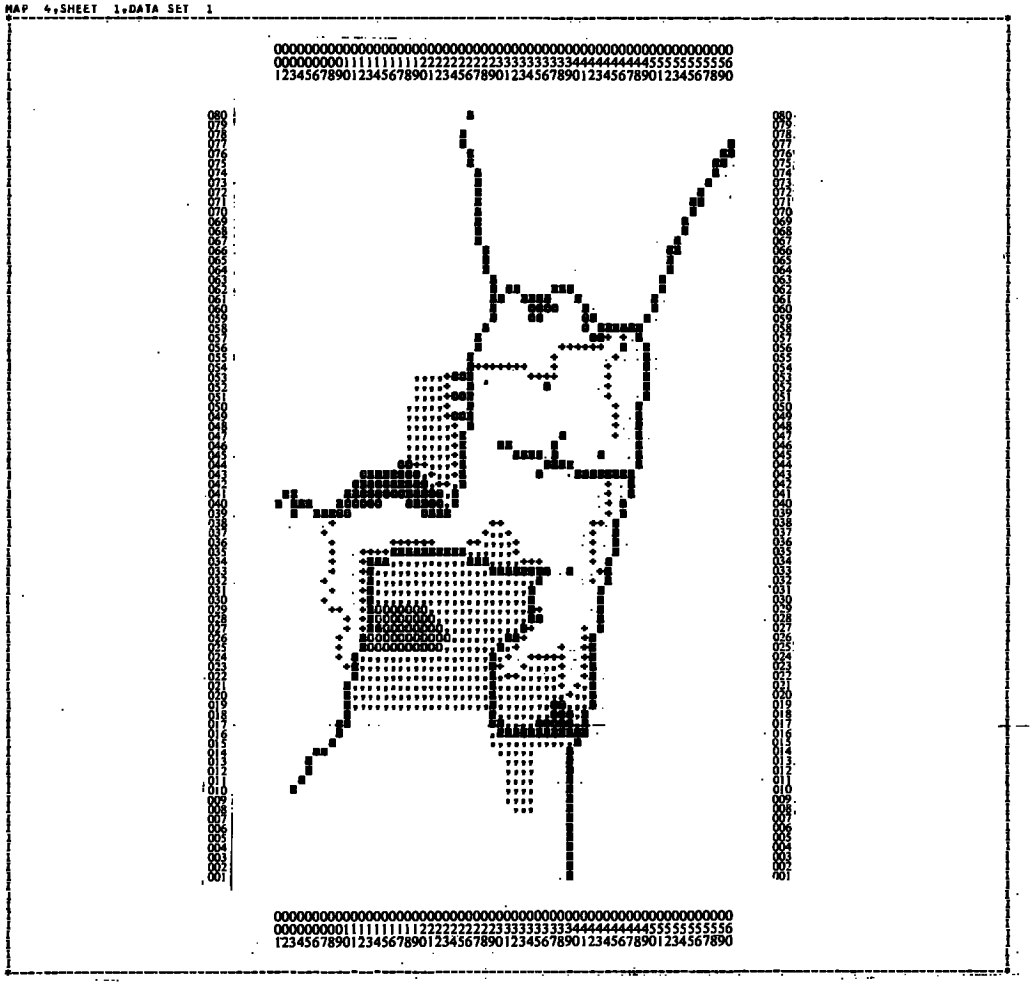
| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 |

FREQUENCY DISTRIBUTION OF DATA POINT VALUES IN EACH LEVEL

| LEVELS | LOW VALUES 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | HIGH VALUES 11 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SYMBOLS | | | | | | | | | | | | |
| FREQUENCY | 3925 | 0 | 275 | 12 | 130 | 5 | 9 | 114 | 61 | 9 | 260 | 0 |

Fig. X.13
Murray "A" + Attractiveness Evaluations:
Summer Plan

MAP 4,SHEET 1,DATA SET 1



MURRAY A + ATTRACTIVENESS EVALUATIONS

WINTER PLAN

HONEY HILL CASE STUDY

LEGEND
1 = HUNTING
2 = SNOW SHOEING
3 = CROSS COUNTRY SKIING
4 = TRAILS
5 = SNOW MOBILING
6 = DOWNHILL SKIING
7 = ICE SKATING
8 = RESIDENTIAL
9 = PARKING
10 = MAJOR ROADS

DATA MAPPED IN 10 LEVELS BETWEEN EXTREME VALUES OF 0.50 AND 10.50

ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| MINIMUM | 0.50 | 1.50 | 2.50 | 3.50 | 4.50 | 5.50 | 6.50 | 7.50 | 8.50 | 9.50 |
| MAXIMUM | 1.50 | 2.50 | 3.50 | 4.50 | 5.50 | 6.50 | 7.50 | 8.50 | 9.50 | 10.50 |

PERCENTAGE OF TOTAL ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

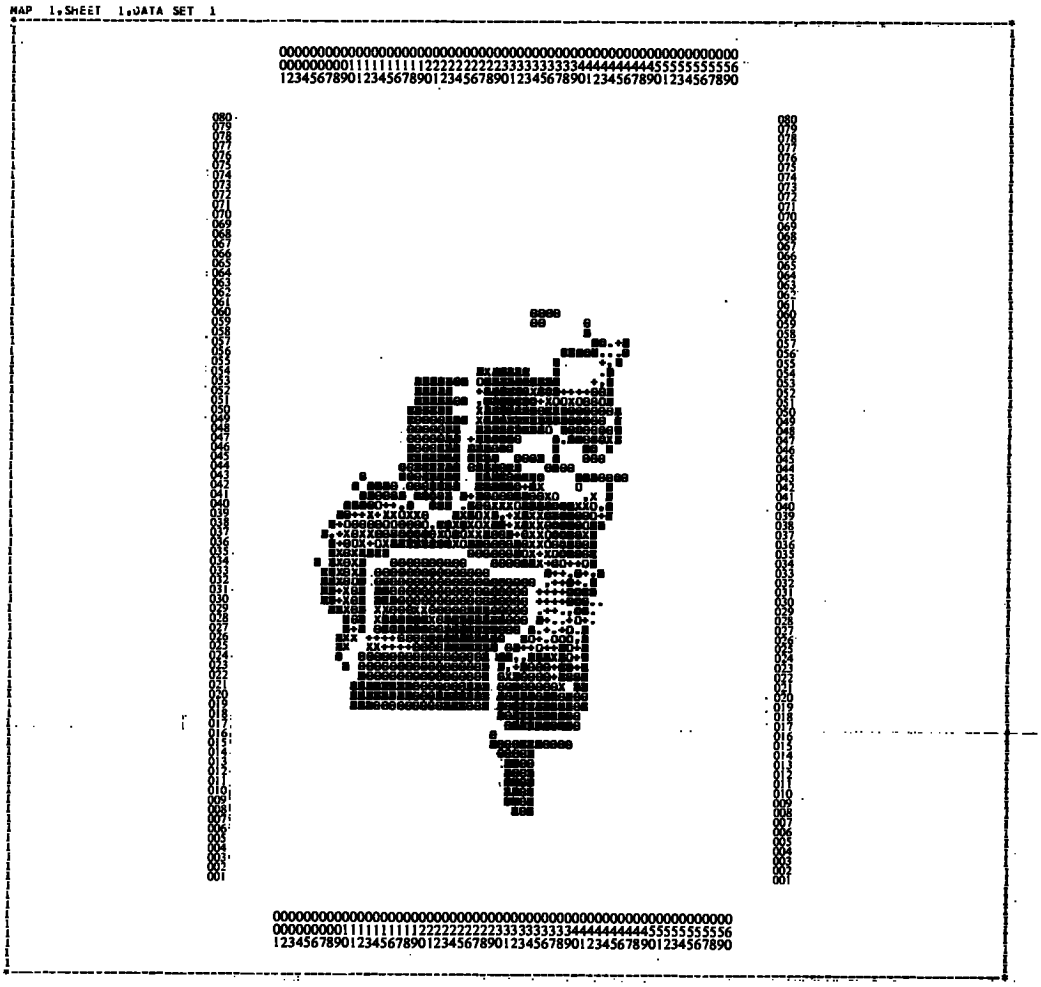
| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 |

FREQUENCY DISTRIBUTION OF DATA POINT VALUES IN EACH LEVEL

| LEVELS | LOW VALUES 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | HIGH VALUES 11 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SYMBOLS | | ..... | ..... | ..... | +++++ | XXXXX | 00000 | 00000 | ..... | ..... | ..... | |
| FREQUENCY | 3888 | 0 | 407 | 0 | 130 | 0 | 44 | 0 | 62 | 9 | 260 | 0 |

Fig. X.14
Murray "A" + Attractiveness Evaluations:
Winter Plan

MAP 1,SHEET 1,DATA SET 1



MURRAY - A WITH ATTRACTIVENESS EVALUATION

ATTRACTIVENESS EVALUATION

HONEY HILL CASE STUDY

THIS ANALYSIS SHOWS THE NORMALIZED ATTRACTIVENESS VALUES FOR EACH OF THE PLANNED ACTIVITIES.

LEGEND

0 = LEAST ATTRACTIVE AREAS FOR PLANNED ACTIVITIES
TO
9 = MOST ATTRACTIVE AREAS FOR PLANNED ACTIVITIES

DATA MAPPED IN 10 LEVELS BETWEEN EXTREME VALUES OF 0.0 AND 100.00

ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| MINIMUM | 0.0 | 10.00 | 20.00 | 30.00 | 40.00 | 50.00 | 60.00 | 70.00 | 80.00 | 90.00 |
| MAXIMUM | 10.00 | 20.00 | 30.00 | 40.00 | 50.00 | 60.00 | 70.00 | 80.00 | 90.00 | 100.00 |

PERCENTAGE OF TOTAL ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

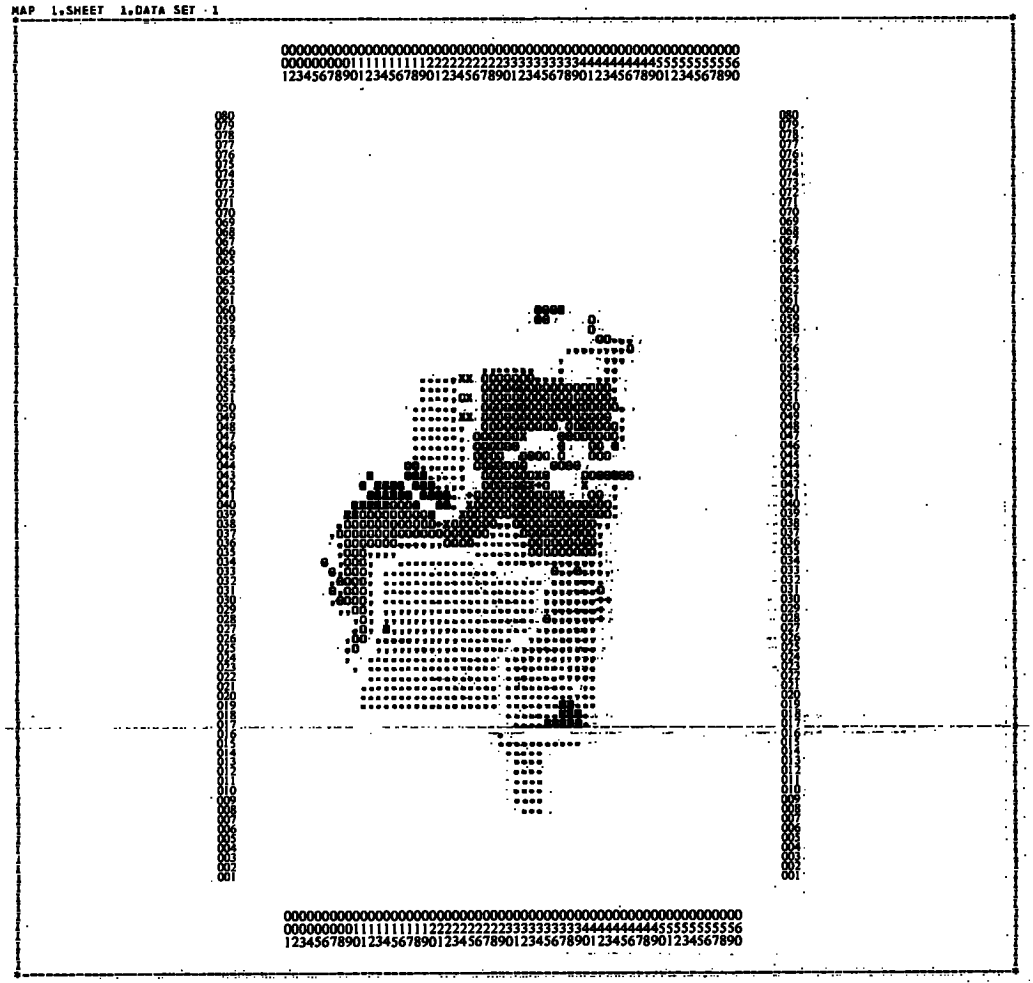
| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 |

FREQUENCY DISTRIBUTION OF DATA POINT VALUES IN EACH LEVEL

| LEVELS | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|---|
| SYMBOLS | ..... | ..... | ..... | +++++++++ | XXXXXXXXX | 000000000 | 000000000 | 000000000 | 000000000 | 000000000 |
| | ..... | ..... | ..... | +++++++++ | XXXXXXXXX | 000000000 | 000000000 | 000000000 | 000000000 | 000000000 |
| | .... | .... | .... | ++++ ++++ | XXXX XXXX | 0000 0000 | 0000 0000 | 0000 0000 | 0000 0000 | 0000 0000 |
| | ..... | ..... | ..... | +++++++++ | XXXXXXXXX | 000000000 | 000000000 | 000000000 | 000000000 | 000000000 |
| | ..... | ..... | ..... | +++++++++ | XXXXXXXXX | 000000000 | 000000000 | 000000000 | 000000000 | 000000000 |
| FREQUENCY | 22 | 9 | 6 | 72 | 72 | 42 | 337 | 73 | 101 | 352 |

Fig. X.15
Murray "A" + Attractiveness Evaluations:
Attractiveness

MAP 1,SHEET 1,DATA SET 1



MURRAY - A WITH ATTRACTIVENESS EVALUATION

TOTAL IMPACT ON ALL RESOURCE SYSTEMS

HONEY HILL CASE STUDY

THIS ANALYSIS SHOWS THE TOTAL IMPACT OF THIS PLAN ON ALL RESOURCE SYSTEMS.

LEGEND
0 = LEAST IMPACT CAUSED BY PLANNED LAND USE
TO
9 = GREATEST IMPACT CAUSED BY PLANNED LAND USE

DATA MAPPED IN 10 LEVELS BETWEEN EXTREME VALUES OF 0.0 AND 23.00

ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| MINIMUM | 0.0 | 2.30 | 4.60 | 6.90 | 9.20 | 11.50 | 13.80 | 16.10 | 18.40 | 20.70 |
| MAXIMUM | 2.30 | 4.60 | 6.90 | 9.20 | 11.50 | 13.80 | 16.10 | 18.40 | 20.70 | 23.00 |

PERCENTAGE OF TOTAL ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 |

FREQUENCY DISTRIBUTION OF DATA POINT VALUES IN EACH LEVEL

| LEVELS | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|---|
| SYMBOLS | | | | | | | | | | |
| FREQUENCY | 424 | 110 | 128 | 7 | 13 | 329 | 24 | 10 | 20 | 21 |

Fig. X.16
Murray "A" + Attractiveness Evaluation:
Total Impact

Murray "A" + Attractiveness Evaluation
Table X.23: "Summer N=3000"
No. Cells/Activity/Crowding

| ACT. # | 0-75% | 75-100% | 100-125% | 125-150% |
|---|---|---|---|---|
| 1 | 0.0 | 0.0 | 0.0 | 0.0 |
| 2 | 235.0 | 0.0 | 0.0 | 0.0 |
| 3 | 10.0 | 0.0 | 0.0 | 0.0 |
| 4 | 127.0 | 0.0 | 0.0 | 0.0 |
| 5 | 5.0 | 0.0 | 0.0 | 0.0 |
| 6 | 9.0 | 0.0 | 0.0 | 0.0 |
| 7 | 1.0 | 0.0 | 0.0 | 0.0 |
| 8 | 0.0 | 0.0 | 0.0 | 0.0 |
| 9 | 0.0 | 0.0 | 0.0 | 0.0 |
| TOTAL | 387.0 | 0.0 | 0.0 | 0.0 |

Murray "A" + Attractiveness Evaluation
Table X.24: "Summer N=3000"
No. People/Activity/Crowding

| ACT. # | 0-75% | 75-100% | 100-125% | 125-150% | TURNED AWAY |
|---|---|---|---|---|---|
| 1 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 2 | 3441.5 | 0.0 | 0.0 | 0.0 | 0.0 |
| 3 | 12080.8 | 0.0 | 0.0 | 0.0 | 0.0 |
| 4 | 2296.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 5 | 567.6 | 0.0 | 0.0 | 0.0 | 0.0 |
| 6 | 5126.6 | 0.0 | 0.0 | 0.0 | 0.0 |
| 7 | 2296.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 8 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 9 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| TOTAL | 25808.4 | 0.0 | 0.0 | 0.0 | 0.0 |

Murray "A" + Attractiveness Evaluation
Table X.25: "Summer N=3000"
Income/Activity

| ACT. # | LOCAL | REGIONAL |
|---|---|---|
| 1 | 0.0 | 0.0 |
| 2 | 24847.3 | 68578.5 |
| 3 | 27785.8 | 76688.7 |
| 4 | 16577.0 | 45752.6 |
| 5 | 3292.3 | 6518.8 |
| 6 | 29734.1 | 58873.5 |
| 7 | 16577.2 | 45753.1 |
| 8 | 0.0 | 0.0 |
| 9 | 0.0 | 0.0 |
| TOTAL | 118813.6 | 302165.1 |

Murray "A" + Attractiveness Evaluations
Table X.26: "Winter N=3000"
No. Cells/Activity/Crowding

| ACT. # | 0-75% | 75-100% | 100-125% | 125-150% |
|---|---|---|---|---|
| 1 | 1.0 | 0.0 | 2.0 | 2.0 |
| 2 | 247.0 | 0.0 | 0.0 | 0.0 |
| 3 | 113.0 | 0.0 | 0.0 | 0.0 |
| 4 | 127.0 | 0.0 | 0.0 | 0.0 |
| 5 | 0.0 | 0.0 | 0.0 | 0.0 |
| 6 | 44.0 | 0.0 | 0.0 | 0.0 |
| 7 | 0.0 | 0.0 | 0.0 | 0.0 |
| 8 | 0.0 | 0.0 | 0.0 | 0.0 |
| 9 | 0.0 | 0.0 | 0.0 | 0.0 |
| TOTAL | 532.0 | 0.0 | 2.0 | 2.0 |

Murray "A" + Attractiveness Evaluation
Table X.27: "Winter N=3000"
No. People/Activity/Crowding

| ACT. # | 0-75% | 75-100% | 100-125% | 125-150% | TURNED AWAY |
|---|---|---|---|---|---|
| 1 | 225.1 | 0.0 | 675.4 | 937.5 | 94.1 |
| 2 | 1019.4 | 0.0 | 0.0 | 0.0 | 0.0 |
| 3 | 1650.8 | 0.0 | 0.0 | 0.0 | 0.0 |
| 4 | 3722.5 | 0.0 | 0.0 | 0.0 | 0.0 |
| 5 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 6 | 8253.9 | 0.0 | 0.0 | 0.0 | 0.0 |
| 7 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 8 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 9 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| TOTAL | 14871.8 | 0.0 | 675.4 | 937.5 | 94.1 |

Murray "A" + Attractiveness Evaluations
Table X.28: "Winter N=3000"
Income/Activity

| ACT. # | LOCAL | REGIONAL |
|---|---|---|
| 1 | 11249.2 | 31047.7 |
| 2 | 5912.3 | 11706.3 |
| 3 | 11506.0 | 31756.4 |
| 4 | 26876.7 | 74179.7 |
| 5 | 0.0 | 0.0 |
| 6 | 140069.3 | 386591.1 |
| 7 | 0.0 | 0.0 |
| 8 | 0.0 | 0.0 |
| 9 | 0.0 | 0.0 |
| TOTAL | 195613.3 | 535281.1 |

Murray "A" + Attractiveness Evaluations
Table X.29: Summary

SUMMER PLAN ATTRACTIVENESS

| ACTIVITY | # OF CELLS | MEAN |
|---|---|---|
| 1 | 0 | 0.0 |
| 2 | 84 | 40.24 |
| 3 | 12 | 77.50 |
| 4 | 130 | 95.77 |
| 5 | 5 | 90.00 |
| 6 | 9 | 81.11 |
| 7 | 1 | 90.00 |
| 8 | 62 | 77.98 |
| 9 | 9 | 66.67 |
| 10 | 260 | 3.57 |
| TOTAL | 572 | 42.65 |

WINTER PLAN ATTRACTIVENESS

| ACTIVITY | # OF CELLS | MEAN |
|---|---|---|
| 11 | 0 | 0.0 |
| 12 | 56 | 89.68 |
| 13 | 0 | 0.0 |
| 14 | 130 | 95.77 |
| 15 | 0 | 0.0 |
| 16 | 44 | 62.89 |
| 17 | 0 | 0.0 |
| 18 | 62 | 77.98 |
| 19 | 9 | 66.67 |
| 20 | 260 | 3.57 |
| TOTAL | 561 | 47.42 |

Murray "A" + Attractiveness Evaluations
Table X.30: Plan Impact

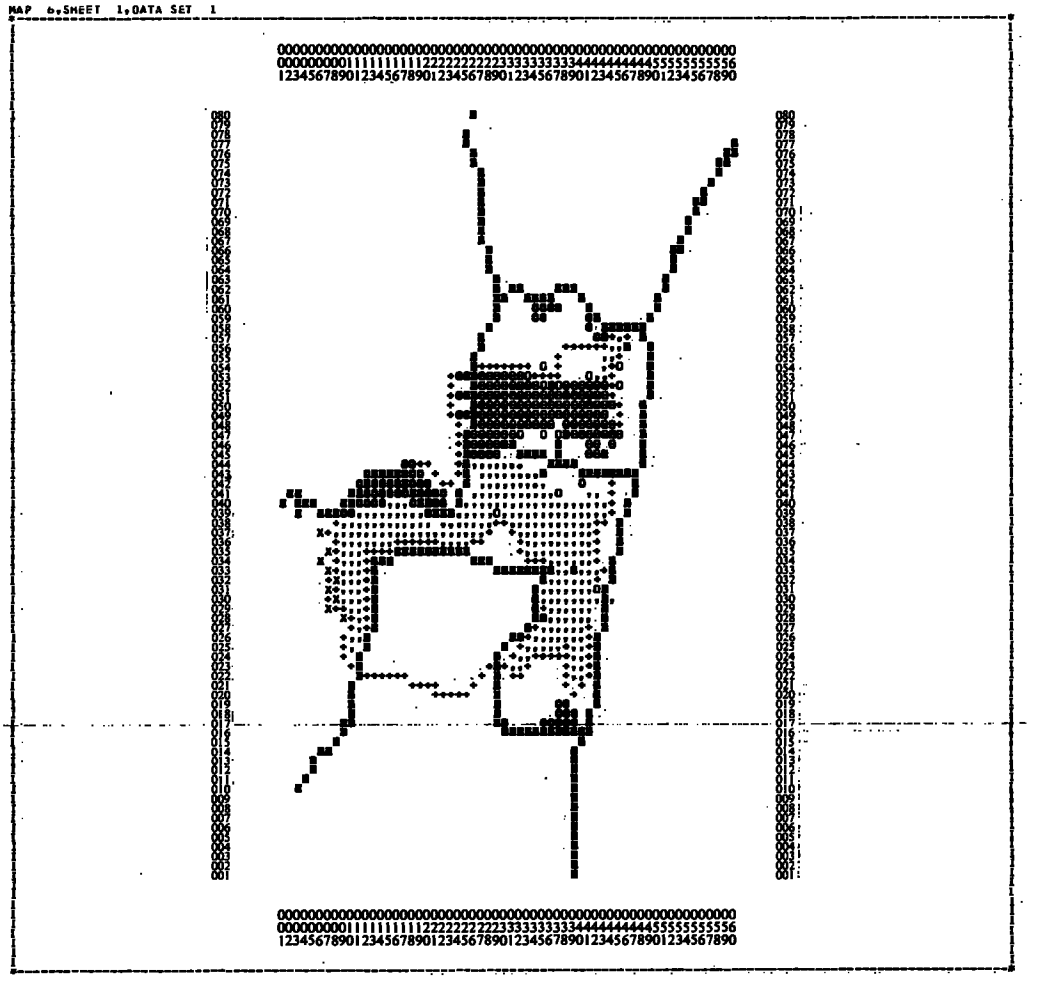
TOTAL IMPACT = 7851.

| SYSTEM | NULL | COMPAT. | MODERATE | SEVERE | TERMINAL | MEAN |
|---|---|---|---|---|---|---|
| 1 | 284 | 34 | 104 | 224 | 26 | 1.515 |
| 2 | 323 | 286 | 62 | 1 | 0 | 0.615 |
| 3 | 282 | 290 | 100 | 0 | 0 | 0.729 |
| 4 | 230 | 301 | 132 | 9 | 0 | 0.881 |
| 5 | 314 | 59 | 295 | 3 | 1 | 0.985 |
| 6 | 109 | 193 | 178 | 192 | 0 | 1.674 |
| 7 | 230 | 3 | 98 | 337 | 4 | 1.824 |
| 8 | 0 | 0 | 0 | 0 | 0 | 0.0 |
| 9 | 0 | 0 | 0 | 0 | 0 | 0.0 |
| 10 | 100 | 119 | 237 | 36 | 180 | 2.115 |
| 11 | 282 | 65 | 149 | 163 | 13 | 1.345 |
| TOTAL | 2154 | 1350 | 1355 | 965 | 224 | 1.298 |

Murray "A" + Attractiveness Evaluations
Table X.31: Capital Costs of Plan

| ACTIVITY # | SUMMER | WINTER |
|---|---|---|
| 1 | 0 0 | 0 0 |
| 2 | 0 0 | 0 0 |
| 3 | 254 10 | 0 0 |
| 4 | 26 00 | 26 00 |
| 5 | 125 00 | 0 0 |
| 6 | 39 38 | 352 00 |
| 7 | 6 00 | 0 0 |
| 8 | 18600 00 | 18600 00 |
| 9 | 353 92 | 353 92 |
| 10 | 530 40 | 530 40 |
| TOTAL | 19934079 | 19862032 |

MAP 6,SHEET 1,DATA SET 1



MURRAY A + ATTRACT EVAL + IMPACT EVAL + SIMULATION EVAL IN=3000I

SUMMER PLAN

HONEY HILL CASE STUDY

LEGEND
1 = HUNTING
2 = FISHING AND CANOEING
3 = SWIMMING BEACH
4 = HIKING
5 = CAMPING
6 = PICNICKING
7 = MARINA AND BOATING
8 = RESIDENTIAL
9 = PARKING
10= MAJOR ROADS

DATA MAPPED IN 10 LEVELS BETWEEN EXTREME VALUES OF 0.50 AND 10.50

ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| MINIMUM | 0.50 | 1.50 | 2.50 | 3.50 | 4.50 | 5.50 | 6.50 | 7.50 | 8.50 | 9.50 |
| MAXIMUM | 1.50 | 2.50 | 3.50 | 4.50 | 5.50 | 6.50 | 7.50 | 8.50 | 9.50 | 10.50 |

PERCENTAGE OF TOTAL ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

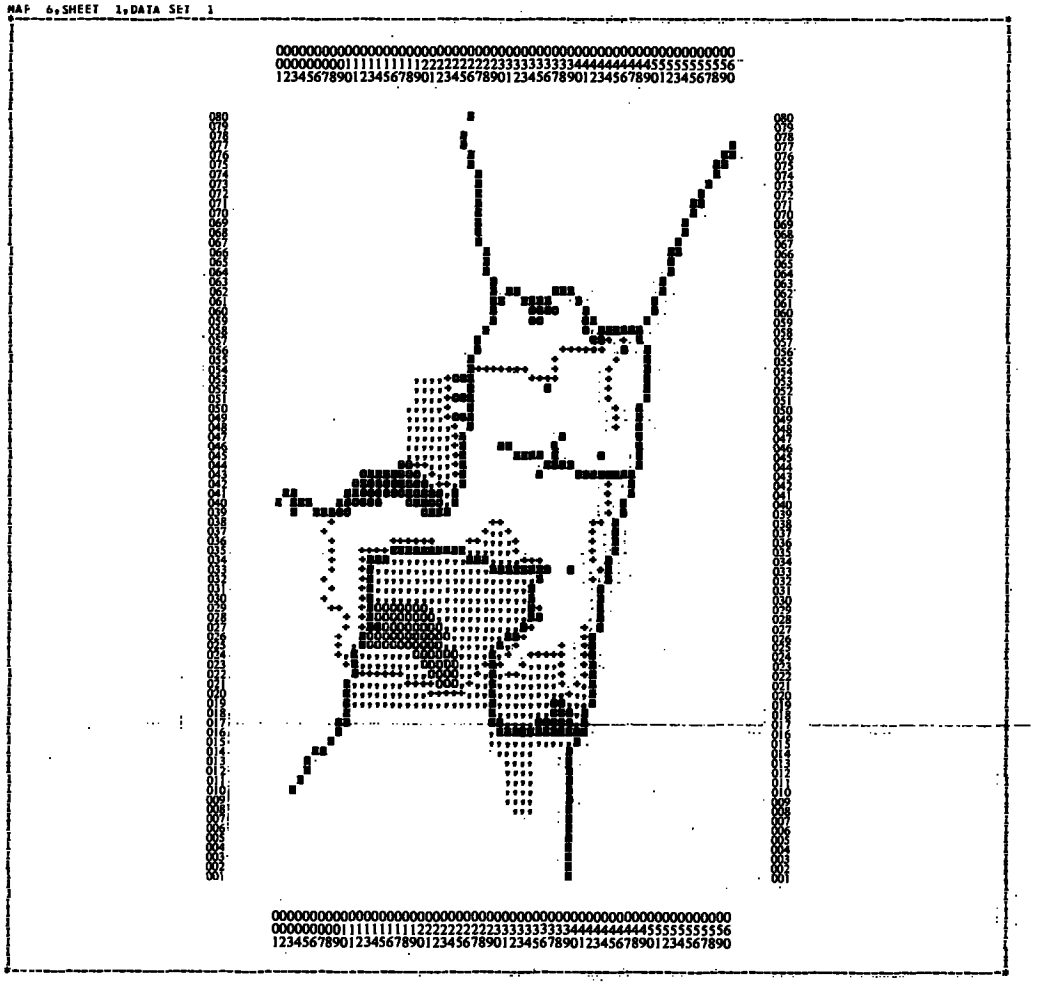
| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 |

FREQUENCY DISTRIBUTION OF DATA POINT VALUES IN EACH LEVEL

| LEVELS | LOW VALUES 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | HIGH VALUES 11 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SYMBOLS | | | | | | | | | | | | |
| FREQUENCY | 3901 | 0 | 214 | 10 | 147 | 9 | 14 | 115 | 61 | 9 | 260 | 0 |

Fig. X.17
Murray "A" + Attractiveness Evaluation + Impact Evaluation + Simulation Evaluation (N=3000) - Summer Plan

MAP 6,SHEET 1,DATA SET 1



MURRAY A + ATTRACT EVAL + IMPACT EVAL + SIMULATION EVAL (N=3000)

WINTER PLAN

HONEY HILL CASE STUDY

LEGEND
1 = HUNTING
2 = SNOW SHOEING
3 = CROSS COUNTRY SKIING
4 = TRAILS
5 = SNOW MOBILING
6 = DOWNHILL SKIING
7 = ICE SKATING
8 = RESIDENTIAL
9 = PARKING
10 = MAJOR ROADS

DATA MAPPED IN 10 LEVELS BETWEEN EXTREME VALUES OF 0.50 AND 10.50

ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| MINIMUM | 0.50 | 1.50 | 2.50 | 3.50 | 4.50 | 5.50 | 6.50 | 7.50 | 8.50 | 9.50 |
| MAXIMUM | 1.50 | 2.50 | 3.50 | 4.50 | 5.50 | 6.50 | 7.50 | 8.50 | 9.50 | 10.50 |

PERCENTAGE OF TOTAL ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

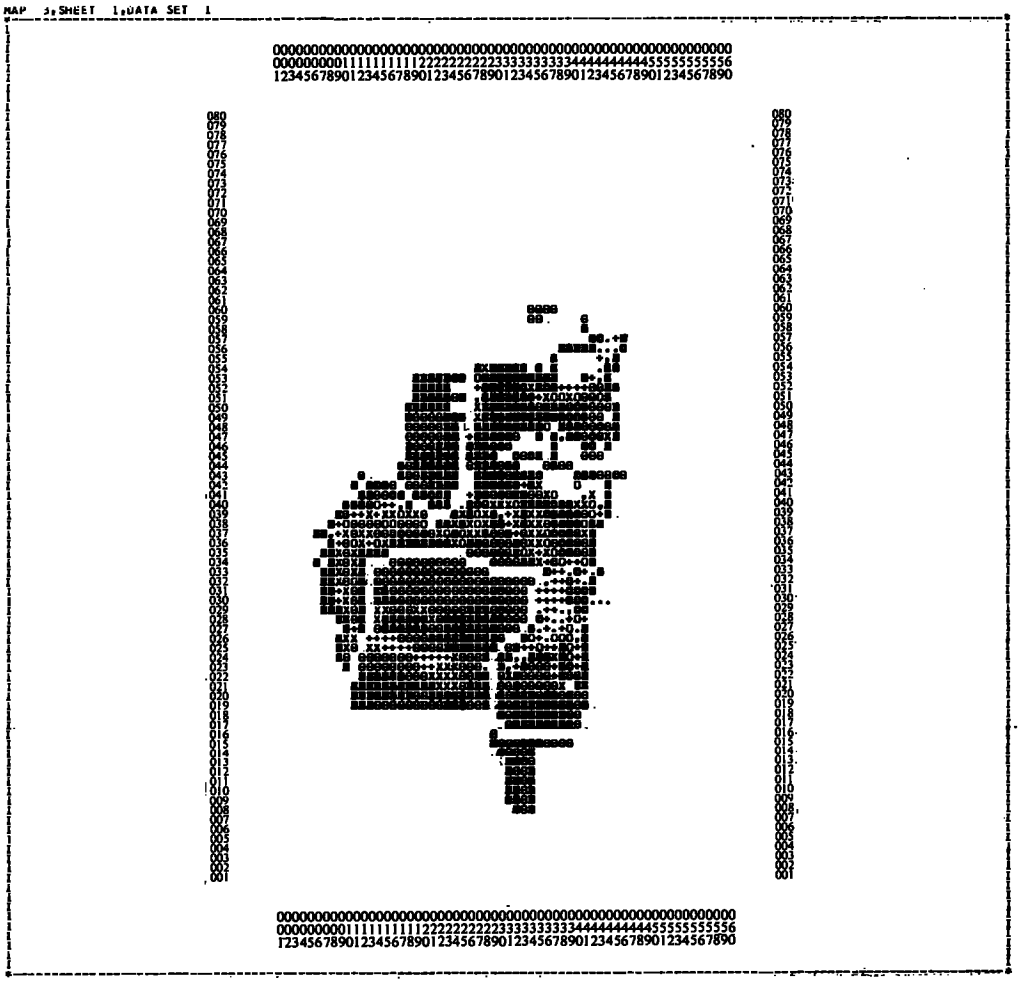
| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 |

FREQUENCY DISTRIBUTION OF DATA POINT VALUES IN EACH LEVEL

| | LOW VALUES | | | | | | | | | | HIGH VALUES |
|---|---|---|---|---|---|---|---|---|---|---|---|
| LEVELS | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| SYMBOLS | | | | | | | | | | | |
| FREQUENCY | 3887 | 0 | 373 | 0 | 147 | 0 | 62 | 0 | 62 | 9 | 260 | 0 |

Fig. X.18
Murray "A" + Attractiveness Evaluation + Impact Evaluation + Simulation Evaluation (N=3000) - Winter Plan

MAP 3, SHEET 1, DATA SET 1



MURRAY - A WITH ATTRACTIVENESS AND IMPACT EVAL + SIMULAIION EVAL

ATTRACIIVENESS EVALUATION

HONEY HILL CASE STUDY

THIS ANALYSIS SHOWS THE NORMALIZED ATTRACTIVENESS VALUES FOR EACH OF THE PLANNED ACTIVITIES.

LEGEND

0 = LEAST ATTRACTIVE AREAS FOR PLANNED ACTIVITIES
TO
9 = MOST ATTRACTIVE AREAS FOR PLANNED ACTIVITIES

DATA MAPPED IN 10 LEVELS BETWEEN EXTREME VALUES OF 0.0 AND 100.00

ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| MINIMUM | 0.0 | 10.00 | 20.00 | 30.00 | 40.00 | 50.00 | 60.00 | 70.00 | 80.00 | 90.00 |
| MAXIMUM | 10.00 | 20.00 | 30.00 | 40.00 | 50.00 | 60.00 | 70.00 | 80.00 | 90.00 | 100.00 |

PERCENTAGE OF TOTAL ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

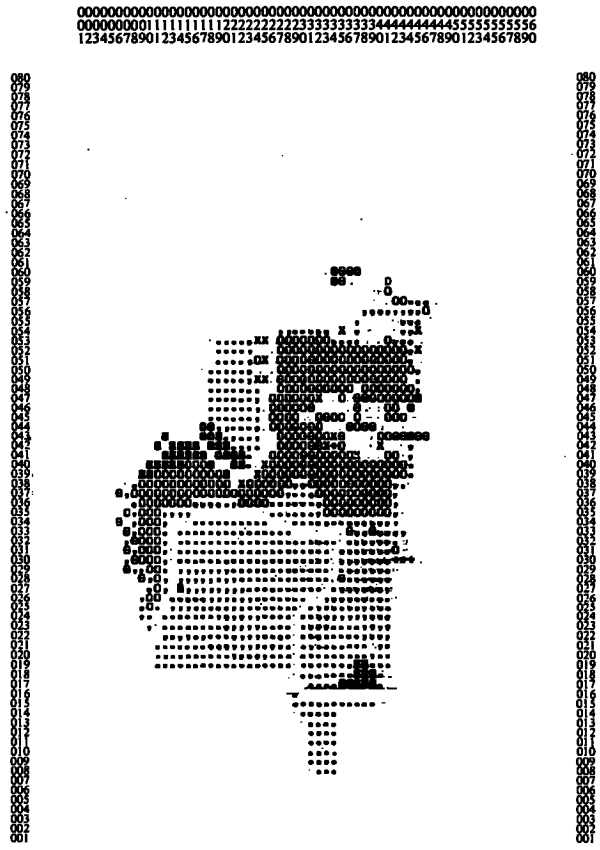
| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 |

FREQUENCY DISTRIBUTION OF DATA POINT VALUES IN EACH LEVEL

| LEVELS | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|---|
| SYMBOLS | ..... | ..... | ..... | +++++++ | XXXXXXXX | 00000000 | @@@@@@@@ | ######## | ######## | ######## |
| FREQUENCY | 21 | 9 | 6 | 79 | 83 | 42 | 311 | 73 | 105 | 365 |

Fig. X.19
Murray "A" with Attractiveness & Impact Evaluation + Simulation Evaluation

MAP 3,SHEET 1,DATA SET 1



MURRAY - A WITH ATTRACTIVENESS AND IMPACT EVAL + SIMULATION EVAL

TOTAL IMPACT ON ALL RESOURCE SYSTEMS

HONEY HILL CASE STUDY

THIS ANALYSIS SHOWS THE TOTAL IMPACT OF THIS PLAN ON ALL RESOURCE SYSTEMS.

LEGEND
0 = LEAST IMPACT CAUSED BY PLANNED LAND USE
TO
9 = GREATEST IMPACT CAUSED BY PLANNED LAND USE

DATA MAPPED IN 10 LEVELS BETWEEN EXTREME VALUES OF 0.0 AND 23.00

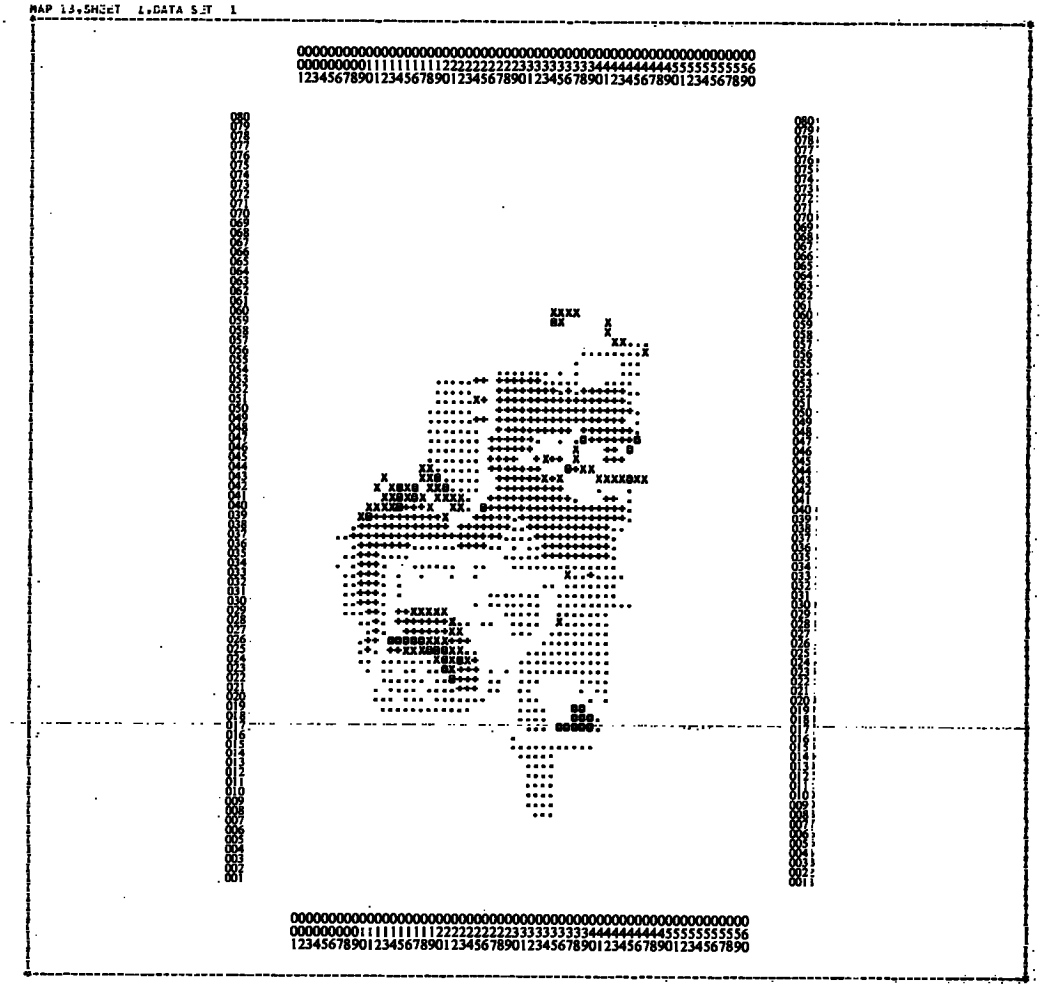
| ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| MINIMUM | 0.0 | 2.30 | 4.60 | 6.90 | 9.20 | 11.50 | 13.80 | 16.10 | 18.40 | 20.70 |
| MAXIMUM | 2.30 | 4.60 | 6.90 | 9.20 | 11.50 | 13.80 | 16.10 | 18.40 | 20.70 | 23.00 |

| PERCENTAGE OF TOTAL ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 |

FREQUENCY DISTRIBUTION OF DATA POINT VALUES IN EACH LEVEL

| LEVELS | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|---|
| SYMBOLS | | | | | | | | | | |
| FREQUENCY | 391 | 128 | 144 | 4 | 16 | 332 | 27 | 10 | 21 | 21 |

Fig. X.20
Murray "A" with Attractiveness & Impact + Simulation Evaluation - Total Impact on All Resource Systems



MURRAY A + ATTRACTIVENESS + SIMULATION EVALUATION

IMPACT ON SURFACE WATER SYSTEM

HONEY HILL CASE STUDY

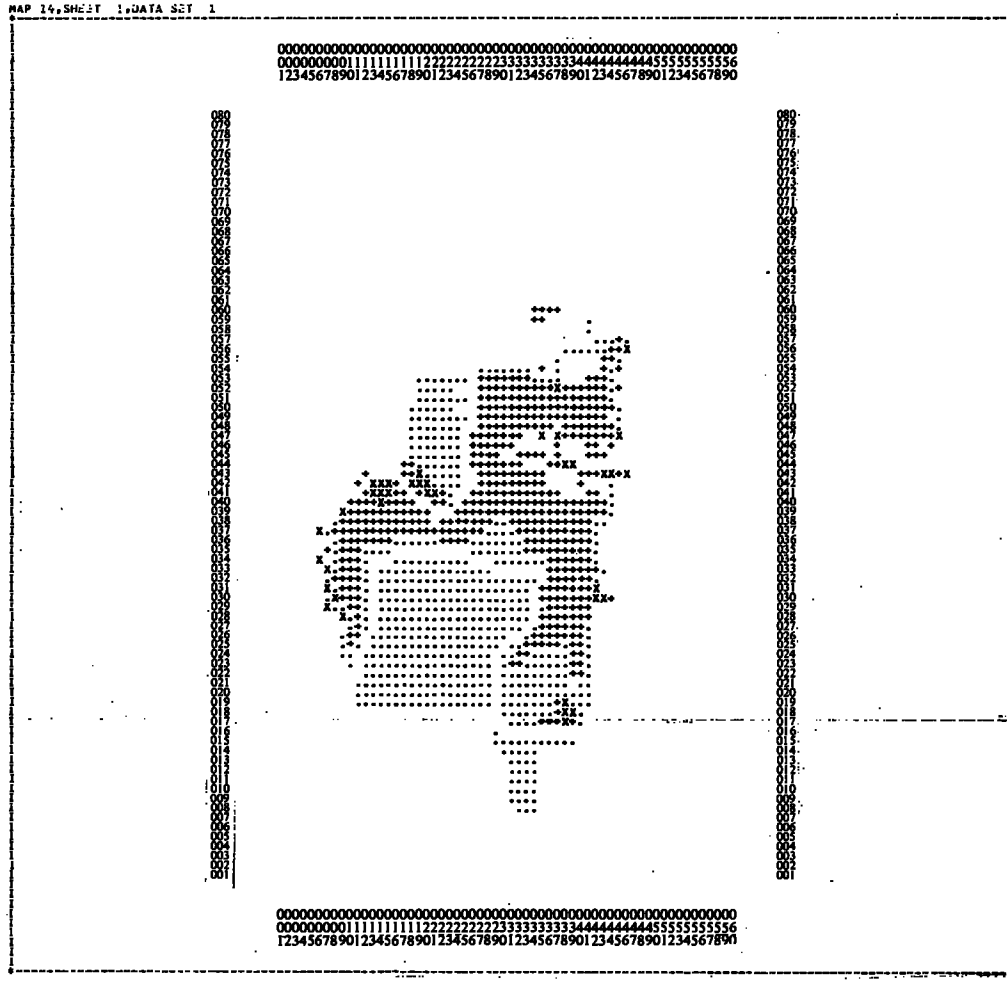
LEGEND
0 = NO IMPACT
1 = COMPATIBLE IMPACT
2 = MODERATE IMPACT
3 = SEVERE IMPACT
4 = THRESHULD IMPACT

THIS ANALYSIS SHOWS THE RELATIVE IMPACT OF THIS PLAN ON THIS RESOURCE SYSTEM.

| LEVELS | 0 | 1 | 2 | 3 | 4 |
|---|---|---|---|---|---|
| SYMBOLS | ..... | +++++++++ | XXXXXXXXX | 00000000 | ######## |
| | ..... | +++++++++ | XXXXXXXXX | 00000000 | ######## |
| | ..... | +++++++++ | XXXX XXXX | 0000 0000 | #### #### |
| | ..... | +++++++++ | XXXXXXXXX | 00000000 | ######## |
| | ..... | +++++++++ | XXXXXXXXX | 00000000 | ######## |
| FREQUENCY | 483 | 356 | 73 | 37 | 0 |

Fig. X.21
Murray "A" + Attractiveness + Simulation Evaluation - Impact on Surface Water System

MAP 14,SHEET 1,DATA SET 1



MURRAY 'A' + ATTRACTIVENESS + SIMULATION EVALUATION

IMPACT ON WILDLIFE HABITAT

HONEY HILL CASE STUDY

LEGEND
0 = NO IMPACT
1 = COMPATIBLE IMPACT
2 = MODERATE IMPACT
3 = SEVERE IMPACT
4 = THRESHOLD IMPACT

THIS ANALYSIS SHOWS THE RELATIVE IMPACT OF THIS PLAN ON THIS RESOURCE SYSTEM.

| LEVELS | 0 | 1 | 2 | 3 | 4 |
|---|---|---|---|---|---|
| SYMBOLS | ..... | +++++++ | XXXXXXXX | 00000000 | ■■■■■■■■ |
| FREQUENCY | 593 | 463 | 38 | 0 | 0 |

Fig. X.22
Murray "A" + Attractiveness + Simulation Evaluation - Impact on Wildlife Habitat

Murray "A" + Simulation Evaluation
Table X.32: "Summer N=3000"
No. Cells/Activity/Crowding

| ACT. # | 0-75% | 75-100% | 100-125% | 125-150% |
|---|---|---|---|---|
| 1 | 0.0 | 0.0 | 0.0 | 0.0 |
| 2 | 235.0 | 0.0 | 0.0 | 0.0 |
| 3 | 9.0 | 0.0 | 0.0 | 0.0 |
| 4 | 143.0 | 0.0 | 0.0 | 0.0 |
| 5 | 9.0 | 0.0 | 0.0 | 0.0 |
| 6 | 14.0 | 0.0 | 0.0 | 0.0 |
| 7 | 2.0 | 0.0 | 0.0 | 0.0 |
| 8 | 0.0 | 0.0 | 0.0 | 0.0 |
| 9 | 0.0 | 0.0 | 0.0 | 0.0 |
| TOTAL | 412.0 | 0.0 | 0.0 | 0.0 |

Murray "A" + Simulation Evaluation
Table X.33: "Summer N=3000"
No. People/Activity/Crowding

| ACT. # | 0-75% | 75-100% | 100-125% | 125-150% | TURNED AWAY |
|---|---|---|---|---|---|
| 1 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 2 | 3441.5 | 0.0 | 0.0 | 0.0 | 0.0 |
| 3 | 12080.8 | 0.0 | 0.0 | 0.0 | 0.0 |
| 4 | 2296.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 5 | 567.6 | 0.0 | 0.0 | 0.0 | 0.0 |
| 6 | 5126.6 | 0.0 | 0.0 | 0.0 | 0.0 |
| 7 | 2296.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 8 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 9 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| TOTAL | 25808.4 | 0.0 | 0.0 | 0.0 | 0.0 |

Murray "A" + Simulation Evaluation
Table X.34: "Summer N=3000"
Income/Activity

| ACT. # | LOCAL | REGIONAL |
|---|---|---|
| 1 | 0.0 | 0.0 |
| 2 | 24847.3 | 68578.5 |
| 3 | 27785.8 | 76688.7 |
| 4 | 16577.0 | 45752.6 |
| 5 | 3292.3 | 6518.8 |
| 6 | 29734.1 | 58873.5 |
| 7 | 16577.2 | 45753.1 |
| 8 | 0.0 | 0.0 |
| 9 | 0.0 | 0.0 |
| TOTAL | 118813.6 | 302165.1 |

Murray "A" + Simulation Evaluation
Table X.35: "Winter N=3000"
No. Cells/Activity/Crowding

| ACT. # | 0-75% | 75-100% | 100-125% | 125-150% |
|---|---|---|---|---|
| 1 | 4.0 | 0.0 | 0.0 | 0.0 |
| 2 | 247.0 | 0.0 | 0.0 | 0.0 |
| 3 | 113.0 | 0.0 | 0.0 | 0.0 |
| 4 | 143.0 | 0.0 | 0.0 | 0.0 |
| 5 | 0.0 | 0.0 | 0.0 | 0.0 |
| 6 | 62.0 | 0.0 | 0.0 | 0.0 |
| 7 | 0.0 | 0.0 | 0.0 | 0.0 |
| 8 | 0.0 | 0.0 | 0.0 | 0.0 |
| 9 | 0.0 | 0.0 | 0.0 | 0.0 |
| TOTAL | 569.0 | 0.0 | 0.0 | 0.0 |

Murray "A" + Simulation Evaluation
Table X.36: "Winter N=3000"
No. People/Activity/Crowding

| ACT. # | 0-75% | 75-100% | 100-125% | 125-150% | TURNED AWAY |
|---|---|---|---|---|---|
| 1 | 2026.3 | 0.0 | 0.0 | 0.0 | 0.0 |
| 2 | 1019.4 | 0.0 | 0.0 | 0.0 | 0.0 |
| 3 | 1650.8 | 0.0 | 0.0 | 0.0 | 0.0 |
| 4 | 3722.5 | 0.0 | 0.0 | 0.0 | 0.0 |
| 5 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 6 | 8253.9 | 0.0 | 0.0 | 0.0 | 0.0 |
| 7 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 8 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 9 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| TOTAL | 16672.9 | 0.0 | 0.0 | 0.0 | 0.0 |

Murray "A" + Simulation Evaluation
Table X.37: "Winter N=3000
Income/Activity

| ACT. # | LOCAL | REGIONAL |
|---|---|---|
| 1 | 12401.2 | 34227.4 |
| 2 | 5912.3 | 11706.3 |
| 3 | 11506.0 | 31756.4 |
| 4 | 26876.7 | 74179.5 |
| 5 | 0.0 | 0.0 |
| 6 | 140068.1 | 386587.9 |
| 7 | 0.0 | 0.0 |
| 8 | 0.0 | 0.0 |
| 9 | 0.0 | 0.0 |
| TOTAL | 196764.3 | 538457.5 |

Murray "A" + Simulation Evaluation
Table X.38: Summary

SUMMER PLAN ATTRACTIVENESS

| ACTIVITY | # OF CELLS | MEAN |
|---|---|---|
| 1 | 0 | 0.0 |
| 2 | 83 | 40.72 |
| 3 | 10 | 84.00 |
| 4 | 147 | 95.58 |
| 5 | 9 | 90.00 |
| 6 | 14 | 84.29 |
| 7 | 2 | 90.00 |
| 8 | 62 | 77.98 |
| 9 | 9 | 66.67 |
| 10 | 260 | 3.57 |
| TOTAL | 596 | 44.97 |

WINTER PLAN ATTRACTIVENESS

| ACTIVITY | # OF CELLS | MEAN |
|---|---|---|
| 11 | 0 | 0.0 |
| 12 | 56 | 89.68 |
| 13 | 0 | 0.0 |
| 14 | 147 | 95.58 |
| 15 | 0 | 0.0 |
| 16 | 62 | 57.23 |
| 17 | 0 | 0.0 |
| 18 | 62 | 77.98 |
| 19 | 9 | 66.67 |
| 20 | 260 | 3.57 |
| TOTAL | 596 | 48.63 |

Murray "A" + Simulation Evaluation
Table X.39: Plan Impact TOTAL IMPACT = 8100.

| SYSTEM | NULL | COMPAT. | MODERATE | SEVERE | TERMINAL | MEAN |
|---|---|---|---|---|---|---|
| 1 | 309 | 42 | 108 | 229 | 26 | 1.469 |
| 2 | 362 | 289 | 62 | 1 | 0 | 0.583 |
| 3 | 296 | 318 | 100 | 0 | 0 | 0.725 |
| 4 | 265 | 305 | 135 | 9 | 0 | 0.843 |
| 5 | 348 | 62 | 300 | 3 | 1 | 0.945 |
| 6 | 127 | 192 | 181 | 214 | 0 | 1.675 |
| 7 | 265 | 3 | 106 | 336 | 4 | 1.735 |
| 8 | 0 | 0 | 0 | 0 | 0 | 0.0 |
| 9 | 0 | 0 | 0 | 0 | 0 | 0.0 |
| 10 | 118 | 120 | 260 | 36 | 180 | 2.056 |
| 11 | 296 | 89 | 152 | 164 | 13 | 1.312 |
| TOTAL | 2386 | 1420 | 1404 | 992 | 224 | 1.261 |

Murray "A" + Simulation Evaluation
Table X.40: Capital Costs of Plan

| ACTIVITY # | SUMMER | WINTER |
|---|---|---|
| 1 | 0 0 | 0.0 |
| 2 | 0 0 | 0.0 |
| 3 | 211 75 | 0.0 |
| 4 | 29 40 | 29.40 |
| 5 | 225.00 | 0 0 |
| 6 | 61 25 | 496.00 |
| 7 | 12 00 | 0.0 |
| 8 | 18600 00 | 18600.00 |
| 9 | 353 92 | 353.92 |
| 10 | 530.40 | 530 40 |
| TOTAL | 20023072 | 20009072 |

process of introducing the impact, attractiveness, and simulation evaluations into the design process. Since the initial proposals were presented in generalized drawings that are the typical style of initial site plan presentations, the areas identified for activities in the initial plans were consistently coarser than those which resulted after the various improvement strategies were introduced. Some improvements were due to the finer spatial scale of the impact and attractiveness evaluations, which resulted in more locationally specific activity selections.

Improvements also resulted because the specific impact evaluations and attractiveness evaluations were able to encompass a wider range of factors in a greater degree of spatial detail and in more levels of evaluation than the designers could account for in preparing their initial plans. The process of using these evaluations was reasonably simple, involving a search, activity by activity and location by location, of an ordered sequence of maps. While judgments were necessary in the use of these evaluations, the conditions under which the judgments were to be made were clearly identified.

In summary, the improvement shown between the evaluations of the initial Murray "A" plan and those of its final version are major. Important improvements are shown for both the summer and winter plans in greater attractiveness, less impact, less crowding, a smaller number of people turned away, increased local dollar income and increased regional dollar income. The capital cost of the final Murray "A" plan is greater but would seem to be more than offset by the almost doubling of local and regional dollar income. In short, an important improvement was demonstrated for what was a more than adequate plan in the first place.

A parallel set of plan improvement exercises was conducted for the Murray "B" scheme. The initial proposal was made and evaluated. Then the impact models were introduced and the plan was reevaluated. The attractiveness models were then introduced and the plan was again reevaluated. Finally, the simulation model results were incorporated and the plan was adjusted and evaluated. The final proposal was considered to be the best within the concept. These plans and their evaluations are shown in Appendix J.

TABLE X.41

MURRAY "A" PLAN: IMPROVEMENTS, N=3000

| | Initial Plan | + Impact Evaluations | + Attractiveness Evaluations | + Simulation Evaluations |
|---|---|---|---|---|
| 1. SUMMER PLAN | | | | |
| Attractiveness (mean mean) | 36.13 | 32.22 | 42.65 | 44.97 |
| Impact (mean mean) | 1.314 | 1.373 | 1.298 | 1.261 |
| No. of people crowded | 234 | 0 | 0 | 0 |
| No. of people turned away | 1,084 | 0 | 0 | 0 |
| $ local income | 69,541 | 118,814 | 118,814 | 118,814 |
| $ regional income | 172,211 | 302,165 | 302,165 | 302.165 |
| $ capital cost | 19,784,000 | 17,077,098 | 19,934,079 | 20,023,072 |
| $ capital cost w/o res. | 1,184,000 | 1,477,098 | 1,334,079 | 1,423,072 |
| 2. WINTER PLAN | | | | |
| Attractiveness (mean mean) | 40.11 | 34.72 | 47.42 | 48.63 |
| Impact (mean mean) | 1.314 | 1.373 | 1.298 | 1.261 |
| No. of people crowded | 234 | 0 | 936 | 0 |
| No. of people turned away | 568 | 0 | 94 | 0 |
| $ local income | 162,336 | 200,760 | 195,613 | 196.764 |
| $ regional income | 430,833 | 536,698 | 535,281 | 538,458 |
| $ capital cost | 19,744,078 | 16,862,013 | 19,962,032 | 20,009,072 |
| $ capital cost w/o res. | 1,144,078 | 1,262,013 | 1,262,032 | 1,409,072 |

# CHAPTER XI: MAKING PLANS: A LINEAR PROGRAMMING ANALYTIC MODEL

## A. INTRODUCTION TO THE LINEAR PROGRAMMING MODEL

A second basic approach to making plans was explored through the development of a linear programming analytic model. It was our contention that such a model to "solve" the Honey Hill problem could be constructed and made operational even under the very restrictive assumption of the formal mathematics of linear programming. Therefore this section of our report deals more with the construction of methodology and not so much with the details of current recreation planning procedures. In a later section of this chapter we show the results of the application of this model to the specific case of multiple use planning for the proposed Honey Hill impoundment in southern New Hampshire.

It is not our purpose here to introduce the reader to linear programming as a technique of Systems Analysis and Operations Research. This has been done definitively by Dantzig [ 117 ] and other writers. We shall, however, use in our discussions some of the technical concepts of linear programming and will give brief footnote explanations wherever applicable. Basically linear programming is an extension of the classical theory of constrained optimization in which both the maximand and the constraints upon the maximand are restricted to be linear functions of the unknown variables. To persons unfamiliar with linear programming this may appear to be a tremendous restriction on the use of the technique to model complex social/economic/physical systems. It turns out, however, that by judicious selection of variables and some steps which enable non-linear functions to be approximated by piecewise linear functions, many successful applications have been made in complex economic/engineering planning for transportation and water resources development.

In part B of this chapter a formal presentation of the linear programming model is made. The formal model is perfectly generalizable to any multiple use reservoir development scheme and as such is a major methodological contribution of the report. The third section, section C, deals with the specific data and the application of the model to Honey Hill. Section D develops "A" and "B" plans from the linear program solution.

Before proceeding, some general comments may help the reader to understand and appreciate what follows. The most important comment is that while it turned out to be relatively straightforward to formulate, the application to Honey Hill turned out to be quite difficult from the point of view of data and of cost of computation. Both of these obstacles could of course be overcome by committing more resources to this aspect of planning studies. This was, however, not within the scope of the resources made available to this particular research study. As will be noted later the major trade-offs in computational and data management costs for the model are between the number of homogeneous land or water zones, the number of recreation activities, and the number of seasons or time intervals to be considered. Ideally we would like to consider many small homogeneous zones (in the Honey Hill case about 150 were suggested and 23 were used), a large number of choices for recreation (in our example we considered 6 summer and 2 winter activities) and a weekly time interval (we were forced to consider only two seasons or time intervals of 6 months each). Even with the reduced size of our problem we were faced with a 194 rows and 151 variable linear programming model. While this is not considered a "large" problem by systems analysts it was almost too expensive for our computer budget and our data organizing resources. In a Corps of Engineers District Office, however, we believe that models of two to three times this size could be fairly easily set up and solved--provided that the data were organized along with the rest of the data necessary for project feasibility studies.[1] Moreover, it would become even more tractable if model studies are to be made for the sizing of the engineering installations.

A further comment relates to the use of various objective functions. Linear programming is an ideal tool to rapidly investigate multiple objectives. One merely has to replace the objective functions,[2] keeping the remainder of the constraints the same. Unfortunately, due to the highly abstracted form that we have been forced to use in the actual application, the choice of objective functions, whether local or national makes no difference in the actual levels

---

[1] A "feasible solution" is a solution to a linear program in which all of the constraints are satisfied but this is not the best of the feasible solutions which is called the "optimal solution."

[2] The objective function is the linear function of the variables which is to be maximized. In our case it represents the net benefits accruing to the project.

of the activities[3] although it of course affects the value of the objective function. We, therefore, had reluctantly to ignore this aspect of the analysis in our computed solutions to the model. This in no way diminishes our belief that such analyses should be made in future developments of this type of model.

## B. THE LINEAR PROGRAMMING MODEL

### 1. OVERVIEW

A schematic diagram of the proposed mathematical model is shown in Figure XI.1. This diagram demonstrates how the more formal economics of revenue maximization for the reservoir project is tied together with sets of system constraints derived from the physical and ecological quality conditions of the local environment and also consumer demand estimates for recreation, power, and water supply utilization. There are primarily eleven groups of constraints, as follows:

(1) pollution control standards for reservoir water,

(2) power targets on water releases,

(3) flood control water surface levels,

(4) low flow augmentation,

(5) water intake needs for municipalities and industry,

(6) recreational demand for local activities,

(7) capacity limitations on recreation,

(8) visual quality or esthetic standards,

(9) preservation or management of wildlife in the project area,

(10) preservation or management of forested regions,

(11) restrictions on parking space and transportation access.

---

[3] In l.p. we refer to the variables as activities in reference to an earlier name for l.p. -- "activity analysis."

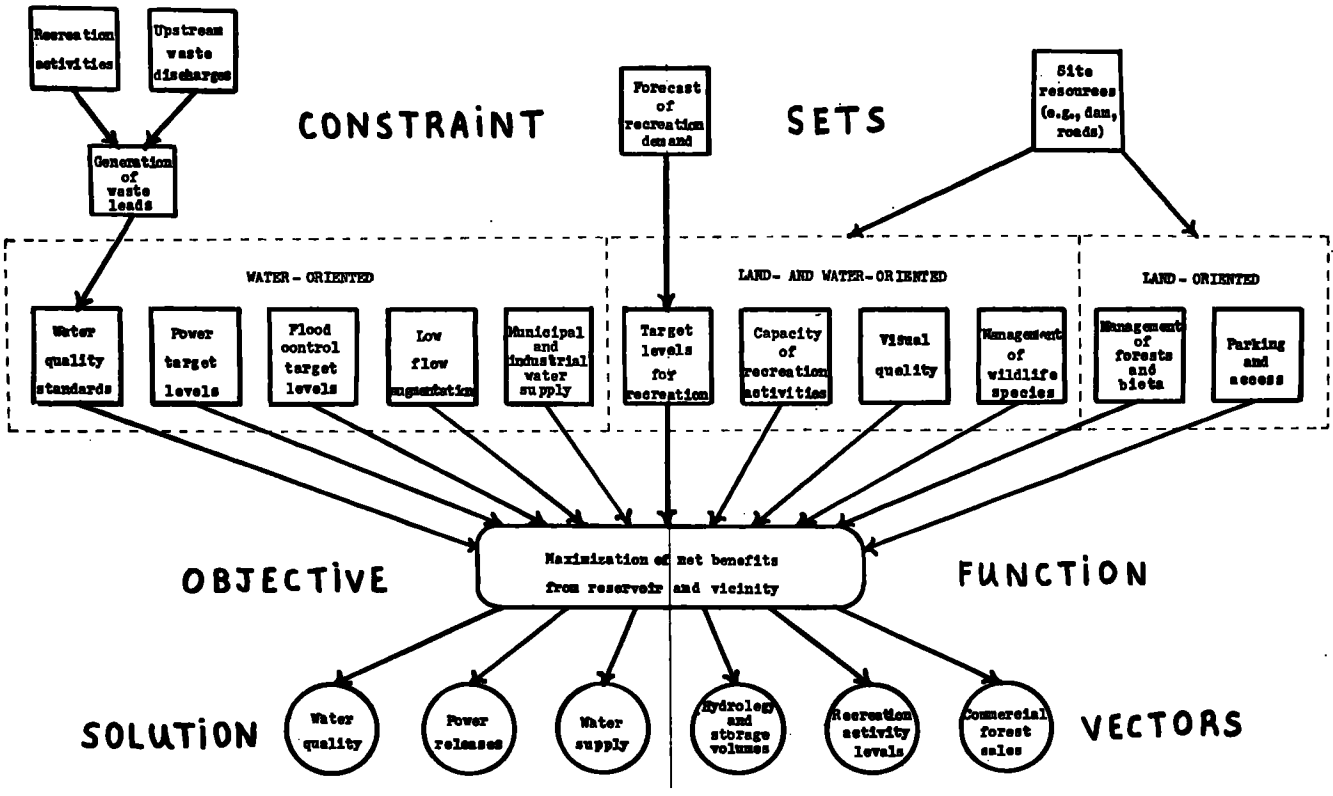



Fig. XI.1
Schematic Diagram of the Proposed Mathematical Model

The maximization of the objective function--the value of direct monetary net benefits from construction and utilization of the reservoir development over a specified time horizon--implies a particular set of values for such decision variables as power releases, water supply levels, recreation activity accommodations, forest and wildlife density levels, concentrations of water pollutants, and storage requirements of the reservoir. The net benefit objective function, labelled VALUE, which is shown schematically in Figure XI.2, equals the algebraic sum of benefits minus costs of the project, i.e.,

$$\text{VALUE} = \text{BENEFITS} - \text{COSTS} \qquad (1)$$

Seasonal operation and maintenance expenditures are required for these activities:

(1) upkeep of dam and reservoir,

(2) operation of power plant,

(3) maintenance of recreational facilities,

(4) operation, maintenance, and repair of waste control equipment,

(5) management of fish and wildlife,

(6) cultivation of forests and biota.

These are shown schematically in Figure XI.3.

Installation expenses are assumed given, and seasonal outlays for the dam, reservoir, and pollution abatement are not formulated in the objective function since these are assumed to be independent of activity level. Aggregate costs in the model are thus expressed as,

$$\text{COSTS} = \text{Cost}_p + \text{Cost}_R + \text{Cost}_s + \text{Cost}_f \qquad (2)$$

A computer compatible breakdown of variables is selected for the model. It is assumed that the project area is separated into R sub-regions; the time horizon covers T seasons[4];

[4] However, this model is static in the context of long-term investments (exceeding one-year periods). In the parlance of systems analysis, this is a "snapshot" model that can be applied to a dynamic situation by starting at the planning horizon and working backwards. See for example Smith [ 157 ].

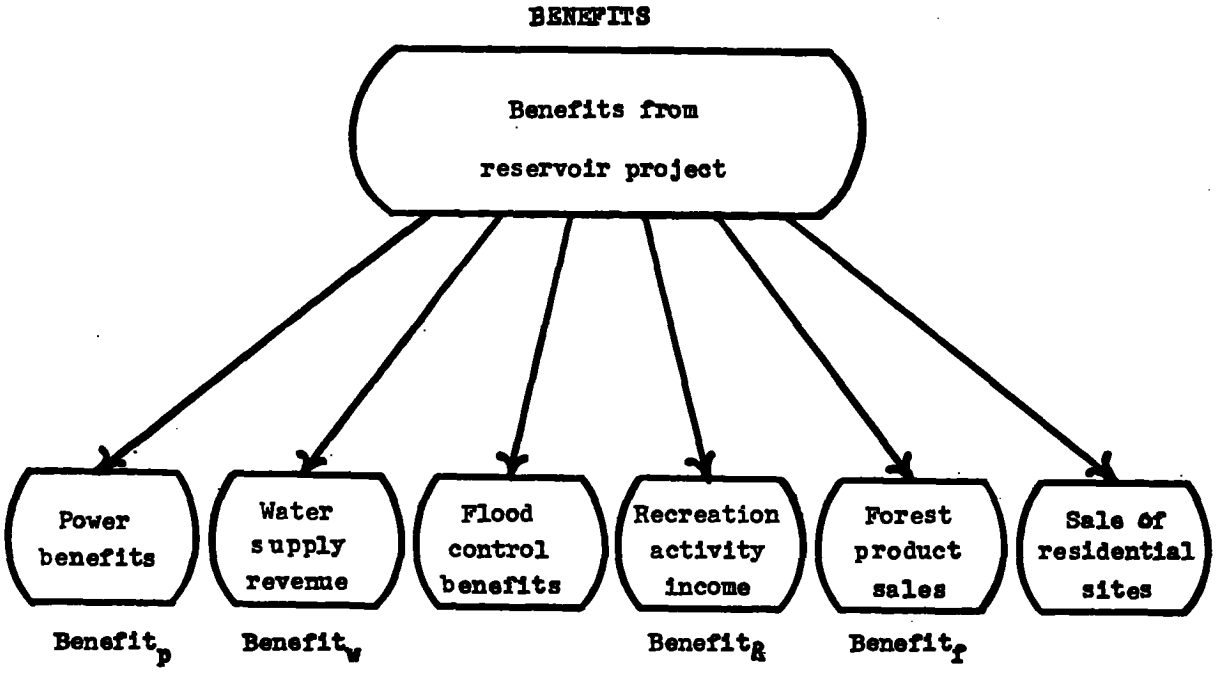



Fig. XI.2
Schematic Diagram of Net Benefit

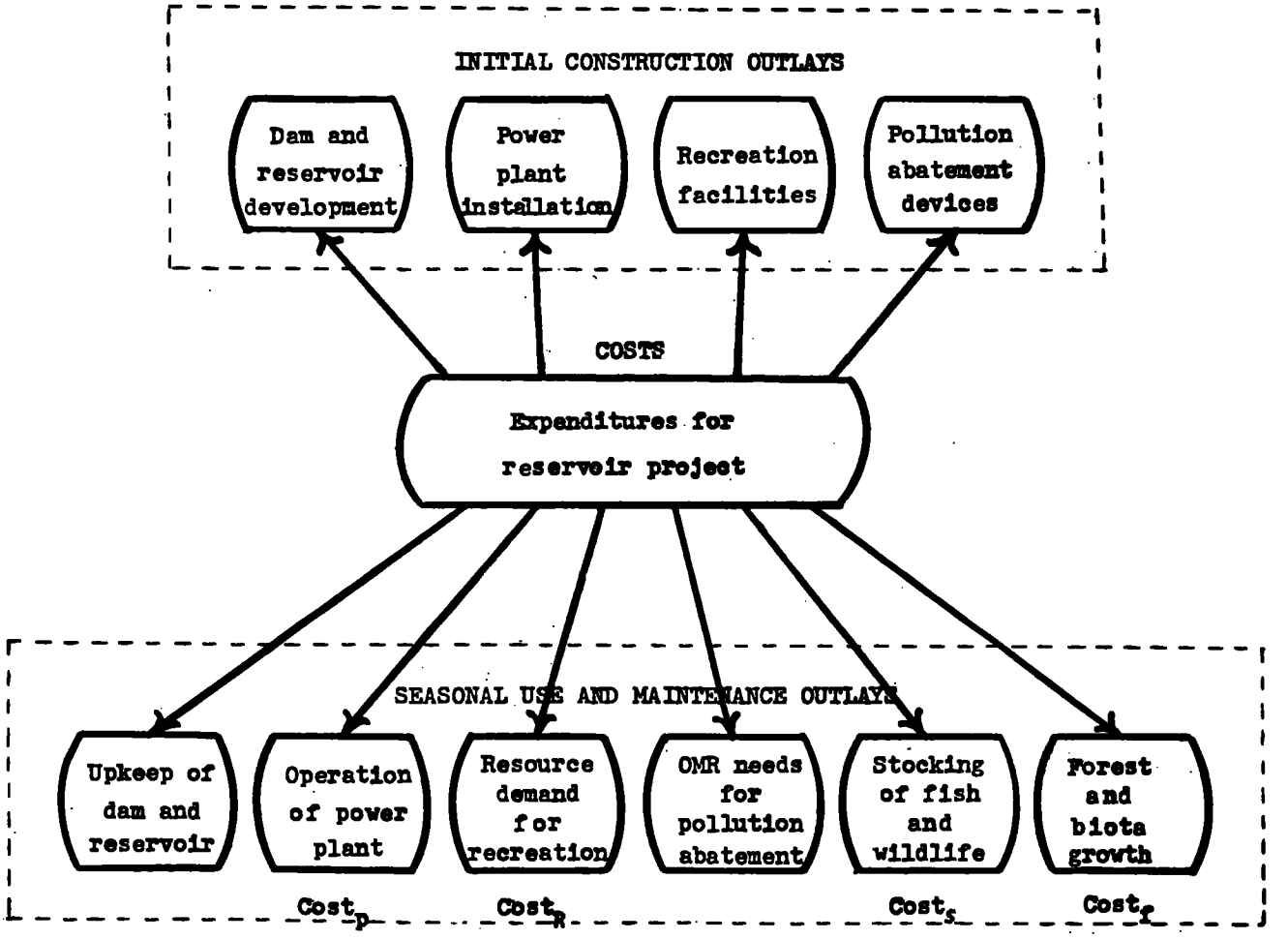



Fig. XI.3
Schematic Diagram of Initial Construction Costs

$J_t$ classes of recreation are stipulated in season t; and C conservative and N non-conservative pollutants are measured in the water bodies. Effects of silt and land pollution are not analyzed in this presentation of the model. Table XI.1 introduces symbols or variables that are used in the model.

## 2. CONSTRAINTS ON THE SYSTEM

The sets of constraints graphically represented in Figure XI.1 are formulated in the following mathematical notation.

(1) Water quality standards....

The concentration of water pollutants generated by recreational activities and upstream waste discharges (ignoring effects of conservation and sedimentation) is assumed directly proportional to intensity of recreation and waste load emissions and inversely proportional to the storage volume of the reservoir. For non-conservative wastes, n=1,...,N, an average concentration $\rho_{nt}$ is permitted over season t; that is,

$$P_{nt} + \sum_j \sum_r p_{nj} X_{jrt} \leq \rho_{nt} S_t, \quad t=1,\ldots,T, \qquad (3)$$

where $P_{nt}$ represents total load of waste n discharged upstream; $p_{nj}$, the waste load generated per unit level of activity j; $X_{jrt}$, the intensity of recreation activity j in region r; and $S_t$, the volume of storage in the reservoir during season t. The concentration of conservative pollutants is dependent upon storage conditions over the entire horizon; consequently,

| SYMBOL | INTERPRETATION |
|---|---|
| $r$ | regional index in project area |
| $j$ | recreational activity index |
| $t$ | seasonal time index |
| $T$ | terminal seasonal time index |
| $R$ | total regions in project area |
| $J_t$ | total recreational activities during season t |
| $c$ | conservative pollutant index |
| $n$ | non-conservative pollutant index |
| $C$ | total number of conservative pollutants |
| $N$ | total number of non-conservative pollutants |
| $X_{jrt}$ | level of recreational activity j in region r during season t |
| $\underline{D}_{jt}$ | total demand for recreational activity j during season t |
| $r_t$ | water release for power during season t |
| $P$ | total power target over T seasons |
| $\alpha_{pt}$ | proportion of total power target demanded during season t |
| $\xi_{pt}$ | unit price of power per K.W.H. during season t |
| $\bar{\gamma}_{pt}$ | unit dump energy price of power during season t |
| $\underline{\gamma}_{pt}$ | unit shortage cost of power during season t |

Table XI.1
List of Symbols in the Environmental Quality Model

Table XI.1(continued)

| SYMBOL | INTERPRETATION |
|---|---|
| $S_t$ | storage volume in reservoir during season t |
| $\bar{S}_t$ | storage volume at maximally allowed capacity |
| $F_t$ | minimal requirement of storage volume buffer during season t |
| $I_t$ | volume of inflows into reservoir during season t |
| $R_t$ | total volume of releases from reservoir during season t |
| $w_t$ | water release for downstream water consumption during season t |
| W | total demand for downstream water consumption over T seasons |
| $\alpha_{wt}$ | proportion of total water utilization demanded during season t |
| $\xi_{wt}$ | unit income for water supplied during season t |
| $\underline{\gamma}_{wt}$ | unit loss for water supply shortage during season t |
| $LF_t$ | minimal water release for low flow augmentation during season t |
| $H_{jrt}$ | maximal intensity of recreational activity j in region r to preserve wildlife during season t |
| $f_r$ | area of commercially forestable land in region r |
| $\underline{f}$ | minimal area of land devoted to the conservation of forests in project area |
| $k_j^{(w)}$ | water surface area required per unit of recreational activity j |

Table XI.1(continued)

| SYMBOL | INTERPRETATION |
|---|---|
| $b_r$ | intercept of reservoir storage — surface area graph (see Figure 3) in region r |
| $\beta_r$ | slope of linear segment of storage — surface area graph (see Figure 3) in region r |
| $k_j^{(L)}$ | land surface area required per unit of recreational activity j |
| $L_{rt}$ | total land area availability in region r during season t |
| $A_{rt}$ | total water surface area availability in region r during season t |
| $a_{jrt}$ | physical limitations for level of recreational activity j in region r during season t |
| $\eta_j$ | parking space requirements per unit level of recreational activity j |
| $\bar{\eta}_{rt}$ | total parking space availability in region r during season t |
| $p_{nj}$ | load of non-conservative waste n generated per unit level of recreational activity j |
| $\rho_{nt}$ | maximum allowable concentration of non-conservative pollutant n during season t |
| $\tilde{p}_{cj}$ | load of conservative waste c generated per unit level of recreational activity j |
| $\rho_c$ | maximum allowable concentration of conservative pollutant c over the time horizon |
| $\xi_{ft}$ | unit profit from forest products during season t at demand level |
| $\bar{\gamma}_{ft}$ | unit profit from surplus of forest products during season t |

Table XI.1(continued)

| SYMBOL | INTERPRETATION |
|---|---|
| $\underline{\gamma}_{ft}$ | unit loss from shortage of forest products during season t |
| $\underline{\xi}_{Rjt}$ | net direct income per unit level of recreational activity j during season t |
| $\underline{\gamma}_{Rjt}$ | unit loss from shortage of level of recreational activity j demanded during season t |
| $\Lambda_{pt}$ | unit cost for power plant operation during season t |
| $\Lambda_{ft}$ | unit cost for management of forested acres during season t |
| $\Lambda_{st}$ | unit cost for management of wildlife habitat during season t |
| $\Lambda_{Rjt}$ | unit cost for use and maintenance of facilities for recreational activity j during season t |
| $Benefit_p$ | aggregate benefits from power supply |
| $Benefit_w$ | aggregate benefits from water supply |
| $Benefit_R$ | aggregate benefits from recreation |
| $Benefit_f$ | aggregate benefits from forest management |
| $Cost_p$ | aggregate maintenance costs for power plant |
| $Cost_R$ | aggregate maintenance costs for recreation |
| $Cost_s$ | aggregate costs for wildlife management |
| $Cost_f$ | aggregate costs for forest management |
| BENEFITS | aggregate benefits in objective function |
| COSTS | aggregate costs in objective function |
| VALUE | total net benefits from income or expenditure sources in the reservoir development |

$$\tilde{P}_c + \sum_j \sum_r \sum_t \tilde{p}_{cj} x_{jrt} \leq \frac{1}{T} \rho_c \sum_t^T s_t, \tag{4}$$

such that $\tilde{P}_c$ is the sum of initial and upstream loads of waste c; $\tilde{p}_{ct}$ measures the quantity of waste c produced per unit of activity j; and $\rho_c$ is the maximum allowable concentration. The technology of water releases can affect pollution levels but is not considered in this formulation.

(2) Power supply targets....

Given a total power target P over the time horizon and the proportion $\alpha_t$ released in season t, actual water release $r_t$ must satisfy target levels, i.e.,[5]

$$r_t \geq \alpha_t P, \quad t=1,\ldots,T. \tag{5}$$

If water is released under a contractual agreement, constraint (5) then becomes an equality.

(3) Flood control storage....

During each season t the difference between maximal and actual volumes of storage in the reservoir must be adequate to hold flood waters temporarily,

$$\bar{S}_t - S_t \geq F_t, \quad t=1,\ldots,T, \tag{6}$$

---

[5] It is assumed that a linear relationship exists between power production and flow releases. The average head for each season is used as a constant, and the term $\alpha_t P$ is therefore in flow units with the average head conversion factor being embedded in $\alpha_t$.

in which $\overline{S}_t$ is the known volume at full capacity and $F_t$ is the minimally required storage buffer. Furthermore, the actual storage volume $S_t$ must at least equal level $\underline{S}_t$ during season t,

$$S_t \geqslant \underline{S}_t, \quad t=1,\ldots,T. \tag{7}$$

A final group of hydrology constraints expresses the identity that initial storage $S_t$, inflows $I_t$, and total releases $R_t$ during one season equal storage $S_{t+1}$ at the beginning of the next season; that is,[6]

$$S_t + I_t - R_t = S_{t+1}, \quad t=1,\ldots,T. \tag{8}$$

Since total releases are comprised of releases for power $r_t$ and water supply $w_t$, or equivalently,

$$R_t = r_t + w_t, \quad t=1,..,T, \tag{9}$$

substitution of this expression into (4) implies,

$$S_t + I_t - r_t - w_t = S_{t+1}, \quad t=1,..,T. \tag{10}$$

(4) Low flow augmentation....

Water release $r_t$ must be at least target level $LF_t$ to augment low flow during season t, or

---

[6] In the model it is assumed that season T precedes season 1 over the annual cycle of seasons and that $S_{T+1}$ is a given target level. Moreover, a steady state deterministic hydrology is incorporated into the formulation.

$$r_t \geqslant LF_t, \quad t=1,..,T. \tag{11}$$

(5) Municipal and industrial water needs....

If W is the total demand for reservoir water over the time horizon and $\alpha_{wt}$ is the proportion allocated to season t, then

$$w_t \geqslant \alpha_{wt}W, \quad t=1,..,T, \tag{12}$$

in which $w_t$ is the quantity of water released to supply these needs.

(6) Recreational demand constraints....

Accommodations for activity j in all sub-regions during season t are not greater than $\underline{D}_{jt}$ where $\underline{D}_{jt}$ is based upon exogenous estimates of maximum levels of peak Sunday demand to be provided in season t; that is,

$$\sum_r X_{jrt} \geqslant \underline{D}_{jt}, \quad j=1,...,J_t; \quad t=1,...,T. \tag{13}$$

For parks within reach of large population centers, constraints on minimal activity levels may not be necessary. To reduce the number of unknowns in the model, demand level $\underline{D}_{jt}$ can be used to estimate total recreational needs in all sub-regions, and variable $X_{jrt}$ is eliminated from the formulation.

7) Capacity for recreation....

Spatial limitations of the park constrain the intensity and distribution of water-related recreational programs,

$$\sum_j k_j^{(w)} X_{jrt} \leq A_{rt}, \quad r=1,..,R; \quad t=1,..,T, \qquad (14)$$

where $A_{rt}$ is the surface area of water bodies in region r, and $k_j^{(w)}$ converts recreational participation rate $X_{jrt}$ into water surface requirements.[7] The index r is summed over all regions which contain water bodies while index j pertains to water-related sports.

The surface area $A_{rt}$ is calculated as a function of storage $S_t$ according to Figure XI.4. If storage levels vary between bounds $\underline{S}_t$ and $\overline{S}_t$, then the following relationship holds,

$$A_{rt} = b_r + \beta_r S_t, \quad r=1,..,R; \quad r=1,..,T. \qquad (15)$$

Substituting this identity into the above inequality (14) yields,

$$\sum_j k_j^{(w)} X_{jrt} \leq b_r + \beta_r S_t, \quad r=1,..,R; \; t=1,..,T. \qquad (16)$$

Similarly, limitations on land area around the reservoir imply the following constraints on land-based recreation activities and forest regions,

$$\sum_j k_j^{(L)} X_{jrt} + f_r \leq L_{rt}, \quad r=1,..,R; \; t=1,..,T, \qquad (17)$$

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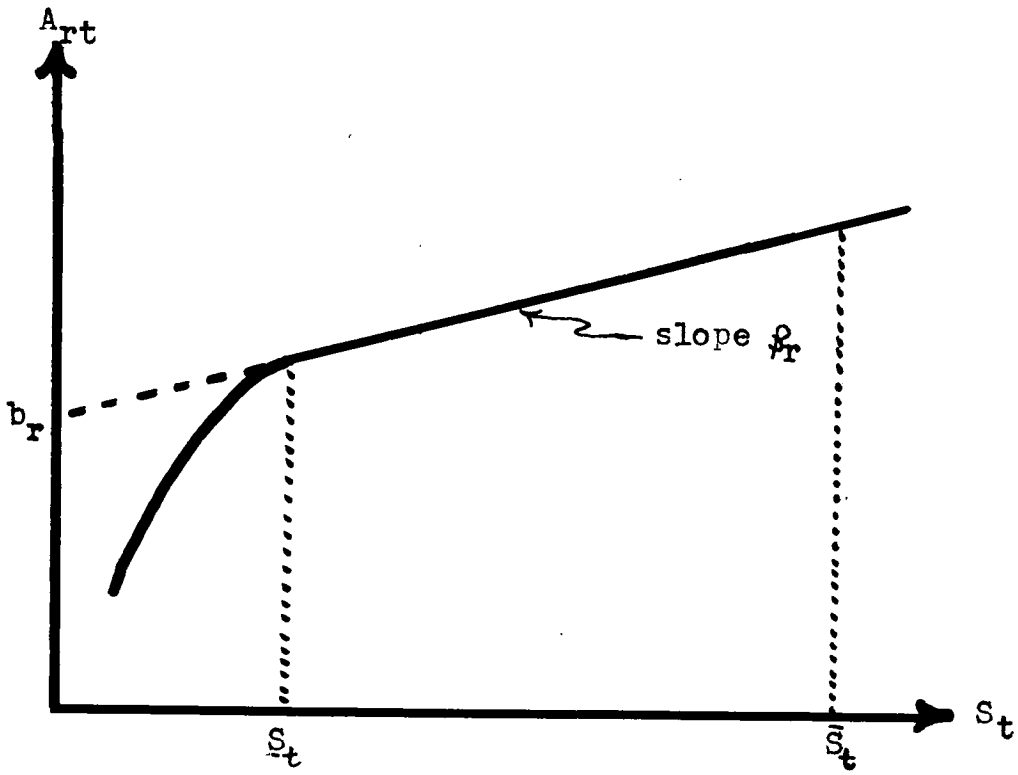
[7] For instance, a recent study by Ellis [ 118 ], Part III, Report No. 12, pp. 104-118, estimates capacity requirements for recreation, such as water skiing, which utilizes 15-40 acres per boat.




$$A_{rt} = b_r + \rho_r S_t, \quad \underline{S}_t \leq S_t \leq \bar{S}_t.$$

Fig. XI.4
Relationship Between Storage & Surface Area of Reservoir

where $k_j^{(L)}$ converts participation rates for land-oriented activity j into corresponding land requirements; $L_{rt}$ is the availability of land area in region r for season t.

There are also restrictions or bounds $a_{jrt}$ on the degree of recreation participation within each region,

$$X_{jrt} \leq a_{jrt}, \quad j=1,\ldots,J_t; \quad r=1,\ldots,R; \quad t=1,\ldots,T, \tag{18}$$

Swimming and fishing, for example, may not be permitted within the same region. This implies an either/or type of constraint and integer programming would be required. We have made these choices exogenous to the model.

(8) Visual quality and esthetics....

Visual quality and esthetic standards can be formulated in terms of land use intensities as suggested by Jacobs and Way [101.1], however, no detailed study was made of the Honey Hill site and so these constraints were not incorporated.

(9) Management of wildlife....

Wildlife habitat is improved by limiting the intensity of recreation activities in various sections of the project area,

$$X_{jrt} \leq H_{jrt}, \quad j=1,\ldots,J_t; \quad r=1,\ldots,R; \quad t=1,\ldots,T, \tag{19}$$

where $H_{jrt}$ is an upper bound on recreational pursuit j in region r during season t. Ecological relations among wildlife, fish, and environment, such as density of forests or rate of water releases and drawdown, are not formulated in this model.

(10) Management of forested acres....

The minimal amount of land devoted exclusively to foresting is $\underline{f}$, so that

$$\sum_r f_r \geq \underline{f}, \tag{20}$$

such that $f_r$ is the area of commercially forestable land in region r. Reduction of the model size can be accomplished by eliminating this constraint and unknowns $f_r$ and then treating $\underline{f}$ as variable.

(11) Parking restrictions and access....

Capacity bounds on parking lot areas limit the number of automobile transported visitors to each region; that is,

$$\sum_j \eta_j X_{Jrt} \leq \bar{\eta}_{rt}, \quad r=1,\ldots,R; \quad t=1,\ldots,T, \tag{21}$$

in which $\eta_j$ estimates requirements for parking space per unit of activity j while $\bar{\eta}_{rt}$ denotes parking space availability in region r during season t. Constraints on the access of the reservoir development and its sub-regions could be developed as a function of the capacity of access roads.

## 3. OBJECTIVE FUNCTION

The objective of the optimization problem is the maximization of aggregate direct monetary net benefits from the reservoir development. Benefit components chosen from Figure XI.2 include power, water supply, and lumber sales revenues as well as income from tourists and visitors. A typical benefit function associated with each of these income sources is depicted in Figure XI.5. According to this graph, total benefit from sales level b of variable x is,

$$\text{Benefit}_x = \begin{cases} \xi B + \bar{\gamma}(b-B), & b \geq B, \\ \xi B - \underline{\gamma}(B-b), & b < B, \end{cases} \tag{22}$$

given B as the demand for product x.

Cost components in the objective function are selected from Figure XI.3 to cover expenditures for power plant operation, maintenance of recreation facilities, and management of wildlife and forests. A typical cost function is assumed linear with respect to activity level and is graphed in Figure XI.6. The cost associated with level b of variable x equals,

$$\text{Cost}_x = \Lambda b. \tag{23}$$

The objective function VALUE is symbolically expressed as,

$$\text{VALUE} = \text{BENEFITS} - \text{COSTS}, \tag{24}$$

where the right-hand side elements are partitioned into,

$$\text{BENEFITS} = \text{Benefit}_p + \text{Benefit}_w + \text{Benefit}_R + \text{Benefit}_f \tag{25}$$

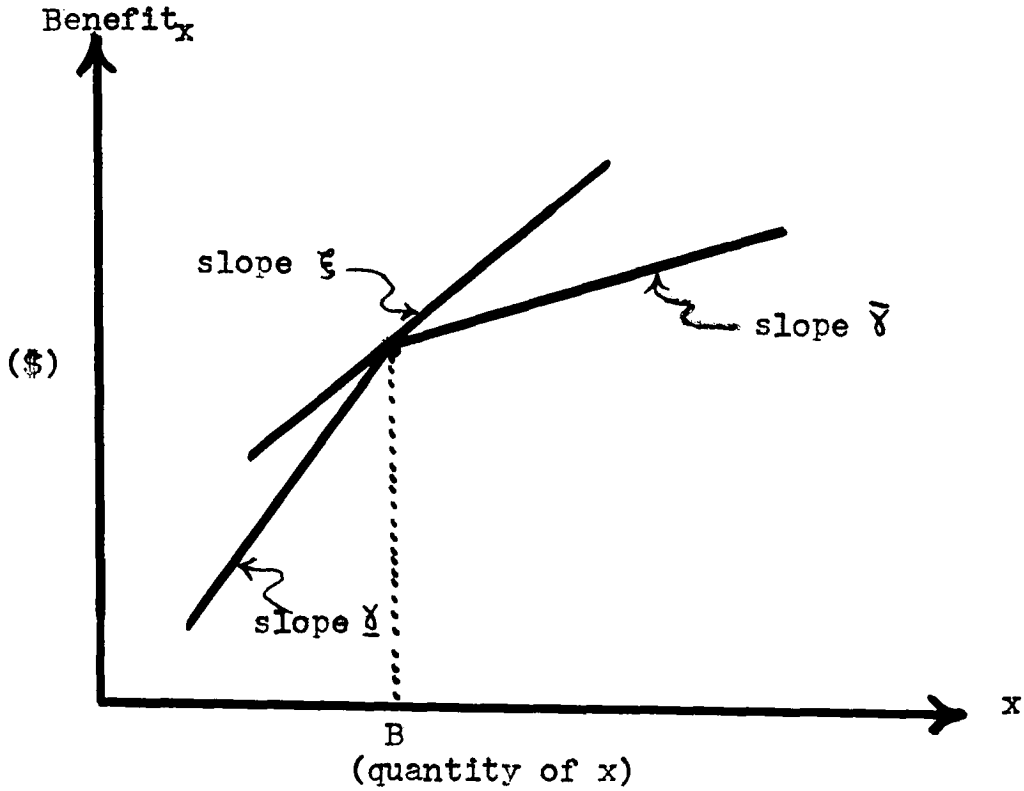
and

$$\text{COSTS} = \text{Cost}_p + \text{Cost}_R + \text{Cost}_s + \text{Cost}_f \tag{26}$$

Specific benefit and cost formulations in the objective function are presented below.

(1) Power benefits and costs....

The relation in Figure XI.7 represents benefits in the form of income from the distribution of power. Given P as




B = target level of x,

b = actual level of x,

$\xi$ = unit value of target level of x,

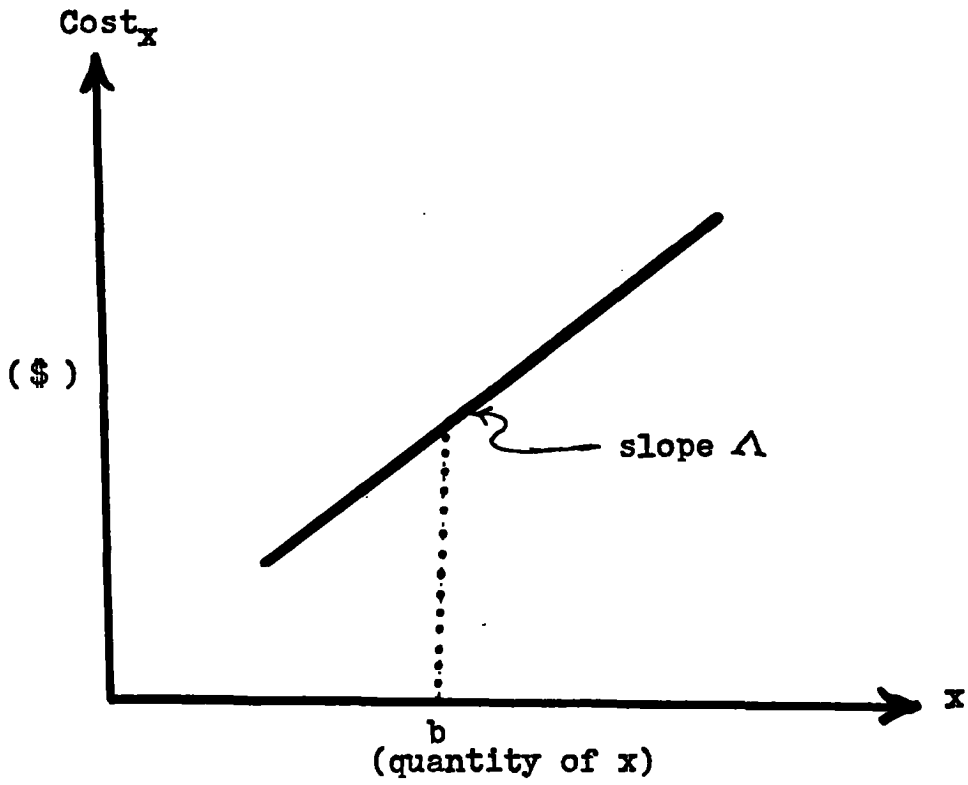
$\bar{\gamma}$ = unit value of surplus of x,

$\underline{\gamma}$ = unit value of deficiency of x,

$$y^+ = \begin{cases} y \text{ if } y > 0, \\ 0 \text{ otherwise.} \end{cases}$$

$$\text{Benefit}_x = \xi B + \bar{\gamma}(b-B)^+ - \underline{\gamma}(B-b)^+ .$$

Fig. XI.5
Typical Benefit Function in the Model




b = actual level of x,

Λ = unit cost of variable x.

$Cost_x = \Lambda b$.

Fig. XI.6
Typical Cost Function in the Model

Fig. XI.7
Power Benefits in the Model

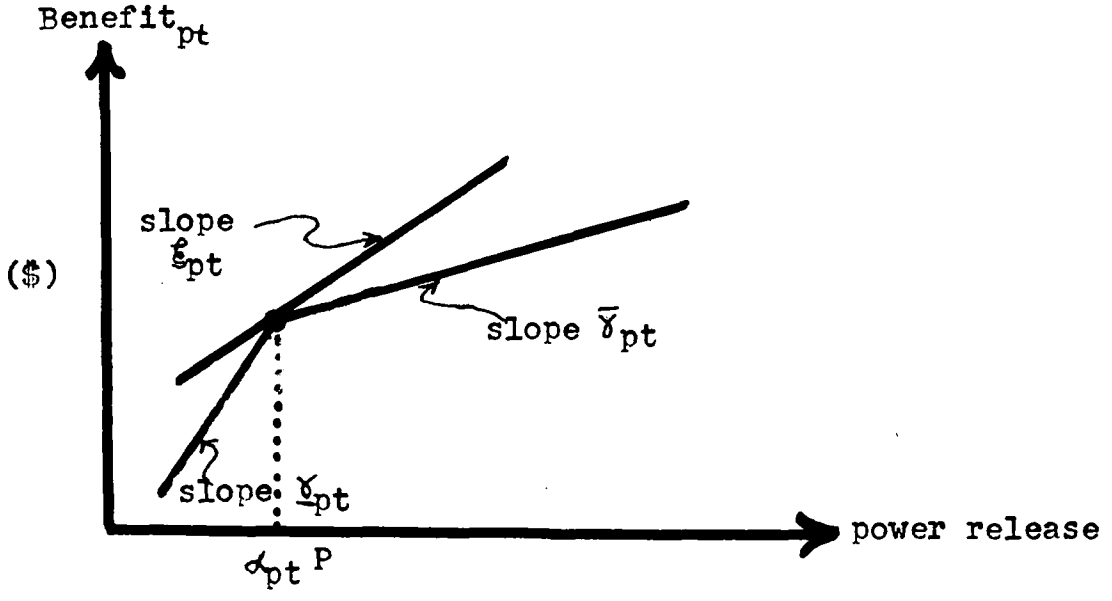
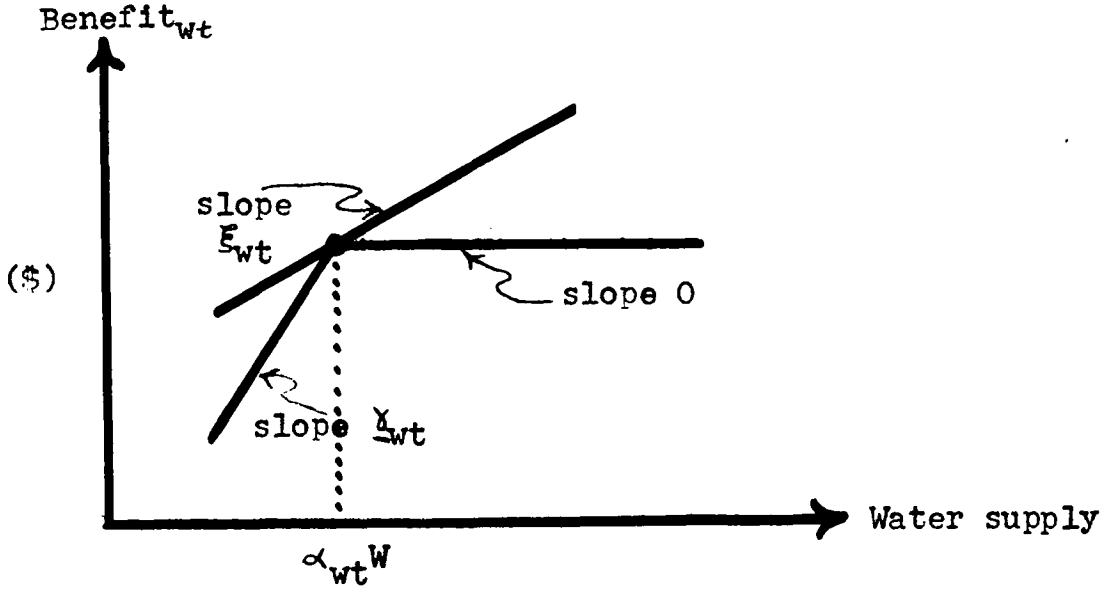



Fig. XI.8
Water Supply Benefits in the Model



the power target (K.W.H. per year[8]); $\xi_p$, the unit price per K.W.H.; $\bar{\gamma}_{pt}$, the unit dump energy price; $\underline{\gamma}_{pt}$, the unit shortage cost for energy; and $\alpha_{pt}$, the allocation of demand over time, power benefits over the time horizon are expressed as,

$$\text{Benefit}_p = \sum_t^T \{\alpha_{pt}\xi_p P + \bar{\gamma}_{pt}(r_t - \alpha_{pt}P)^+ - \underline{\gamma}_{pt}(\alpha_{pt}P - r_t)^+\}. \tag{27}$$

If the unit cost for the distribution of power is $\Lambda_{pt}$ during each season t, then power costs over the time span are,

$$\text{Cost}_p = \sum_t^T \Lambda_{pt} r_t. \tag{28}$$

(2) Water supply income....

Figure XI.8 demonstrates benefits from the sale of reservoir water to municipal and industrial sectors; the total benefits over the time horizon are thus given as,

$$\text{Benefit}_w = \sum_t^T \{\alpha_{wt}\xi_w W - \underline{\gamma}_{wt}(\alpha_{wt}W - w_t)^+\}, \tag{29}$$

such that $\xi_w$ equals the unit net income from the release of water; $\alpha_{wt}$ denotes the fraction of target W supplied during season t; and $\underline{\gamma}_{wt}$ is the unit shortage

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8 Converted to flow units via the fixed head assumption.

cost. Note in this expression that excess water supply is not consumed and thus does not contribute additional income.

(3) Direct recreational benefits and costs....

Direct benefits resulting from expenditures by tourists and visitors include overnight accommodation needs, food purchases, gasoline sales, costs for fishing, boating, and hunting licenses, camping rentals, etc. Figure XI.9 indicates benefits resulting from participation in recreational pastimes. The aggregate income anticipated from recreational activities is,

$$\text{Benefit}_R = \sum_t^T \left\{ \sum_j^{J_t} \left[ \xi_{Rjt} \underline{D}_{jt} - \underline{\gamma}_{Rjt} (\underline{D}_{jt} - \sum_r X_{jrt})^+ \right] \right\}, \tag{30}$$

where $\xi_{Rjt}$ is the income per unit of activity j, and $\underline{\gamma}_{Rjt}$ estimates unit losses by not satisfying public demand for this activity in season t. The line segment with 0 slope means that a surplus of recreational opportunity in excess of public needs does not contribute income to the region. If element $\underline{D}_{jt}$ is unknown, then only the first product term in identity (30) is included in the benefit function.

Given $\Lambda_{Rjt}$ as the unit cost for use and maintenance of recreational facilities, the total expenditures over the time horizon are,

$$\text{Cost}_R = \sum_t^T \sum_j^{J_t} \left\{ \Lambda_{Rjt} \sum_r X_{jrt} \right\}. \tag{31}$$

Fig. XI.9
Direct Recreational Benefits in the Model

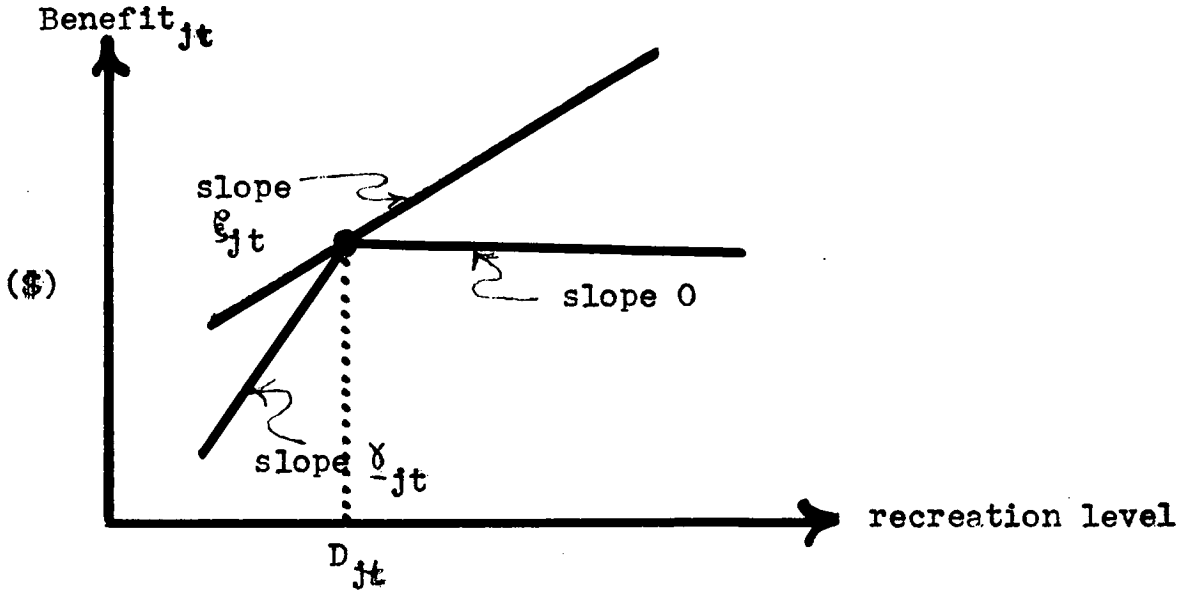
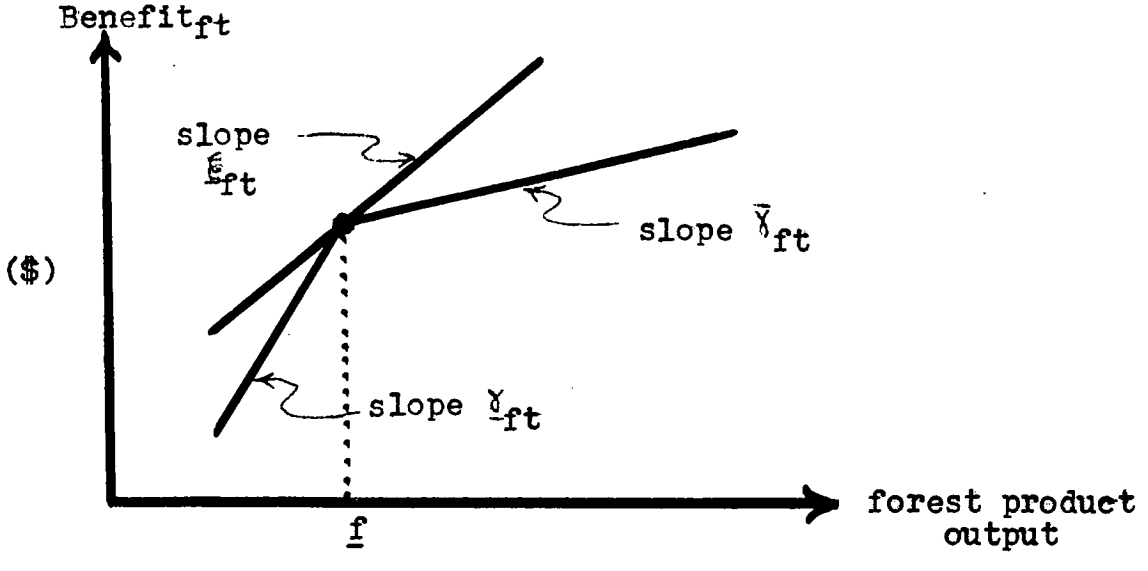



Fig. XI.10
Forest Product Benefits in the Model



If $\underline{D}_{jt}$ were variable rather than exogenously given, then the rightmost summation in (31) is replaced by this parameter.

(4) Lumber sales and expenditures....

Income from the sale of lumber in commercially forestable regions is based upon the graph in Figure XI.10. Total income over all seasons equals,

$$\text{Benefit}_f = \sum_t^T \left\{ \xi_{ft}\, \underline{f} + \bar{\gamma}_{ft}\left(\sum_r f_r - \underline{f}\right)^+ - \underline{\gamma}_{ft}\left(\underline{f} - {}_r\ f_r\right)^+ \right\}, \qquad (32)$$

such that $\xi_{ft}$ is the unit income from selling lumber at demand level; $\bar{\gamma}_{ft}$, the unit income for surplus supplies, and $\underline{\gamma}_{ft}$, the unit loss for deficiencies. Only the first product term is written in brackets in (32) when $\underline{f}$ is considered unknown.

The cost of replacing and growing trees in a unit area of forested region is $\Lambda_{ft}$ during season t; therefore, expenses for the management of forests total,

$$\text{Cost}_f = \sum_t^T \left\{ \Lambda_{ft} \sum_r f_r \right\}. \qquad (32)$$

The second summation in (32) is replaced by $\underline{f}$ if this latter parameter is part of the solution set.

(5) Management costs for wildlife....

Given $\Lambda_{st}$ as the unit cost to stock wildlife or

fish in the reservoir project area, total expenditures for the management of these programs is,

$$\text{Cost}_s = \sum_t^T \Lambda_{st} \left\{ \sum_j^{J_t} \sum_r w_j X_{jrt} \right\}, \tag{33}$$

where coefficient $w_j$ estimates the impact of recreation activity j upon the reduction of wildlife densities.

Summing previously derived sources of income and costs gives the objective function for the environmental quality model,

$$\begin{aligned}
\text{VALUE} = \sum_t^T \Big\{ & \alpha_{pt} \xi_{pt} P + \bar{\gamma}_{pt}(r_t - \alpha_{pt} P)^+ - \underline{\gamma}_{pt}(\alpha_{pt} P - r_t)^+ + \\
& \alpha_{wt} \xi_{wt} W - \underline{\gamma}_{wt}(\alpha_{wt} W - w_t)^+ + \sum_j^{J_t} [\xi_{Rjt} D_{jt} - \\
& \underline{\gamma}_{Rjt}(D_{jt} - \sum_r X_{jrt})^+] + \xi_{ft} \underline{f} + \\
& \bar{\gamma}_{ft}(\sum_r f_r - \underline{f})^+ \underline{\gamma}_{ft}(\underline{f} - \sum_r f_r)^+ - \Lambda_{pt} r_t - \\
& \sum_j^{J_t} [\Lambda_{Rjt} \sum_r X_{jrt}] - \Lambda_{ft} \sum_r f_r - \\
& \Lambda_{st} \sum_j^{J_t} \sum_r [w_j X_{jrt}] \Big\}.
\end{aligned} \tag{34}$$

If parameters $\underline{D}_{jt}$ and $\underline{f}$ are treated as part of the solution vector, then the above objective function becomes,

$$\begin{aligned}
\text{VALUE} = \sum_t^T \Big\{ & \alpha_{pt} \xi_{pt} P + \bar{\gamma}_{pt}(r_t - \alpha_{pt} P)^+ \underline{\gamma}_{pt}(\alpha_{pt} P - r_t)^+ + \\
& \alpha_{wt} \xi_{wt} W - \underline{\gamma}_{wt}(\alpha_{wt} W - w_t)^+ + \sum_j^{J_t} \xi_{Rjt} D_{jt} +
\end{aligned}$$

(continued on next page)

$$\xi_{ft}\,\underline{f} - \Lambda_{pt} r_t - \sum_j^{J_t} \Lambda_{Rjt}\, D_{jt} - \Lambda_{ft}\underline{f} -$$

$$\Lambda_{st} \sum_j^{J_t} w_j \; D_{jt}\Big\}. \qquad (35)$$

## 4. OTHER CONSIDERATIONS REGARDING RESERVOIR DEVELOPMENT OBJECTIVES

The objective function of the model evaluates the economic impact resulting from the utilization of recreation facilities, distribution of power supply, and other income and cost factors in the reservoir development and vicinity. Optimal programs implied from model solutions should be consistent with the interests of beneficiaries of the park system. Economic gains or benefits derived from specific activities are distinguished according to their relevance to particular decision-making bodies or units which weigh the values of development proposals. Failure to differentiate these benefit sources in the model formulation results in incomplete and improper recognition of important economic interests, and, consequently, the policy choices and planning programs indicated under optimal conditions inadequately reflect the worth of resource allocation and consumption within the reservoir project.

To assure maximum utility and optimum distribution of resources, one should categorize the various decision-making groups and then weight their corresponding benefits in the objective function. For the particular (Honey Hill) development under consideration, there are four principal decision-makers, as described in Figure XI.11:

1. the Corps of Engineers,
2. state park management,
3. regional conservation groups, and
4. regional chamber of commerce.

Benefits sought by these groups vary according to the geographic extent of their impact on local or regional economies. For example, an objective of the Corps of Engineers is the maximization of global economic efficiency,

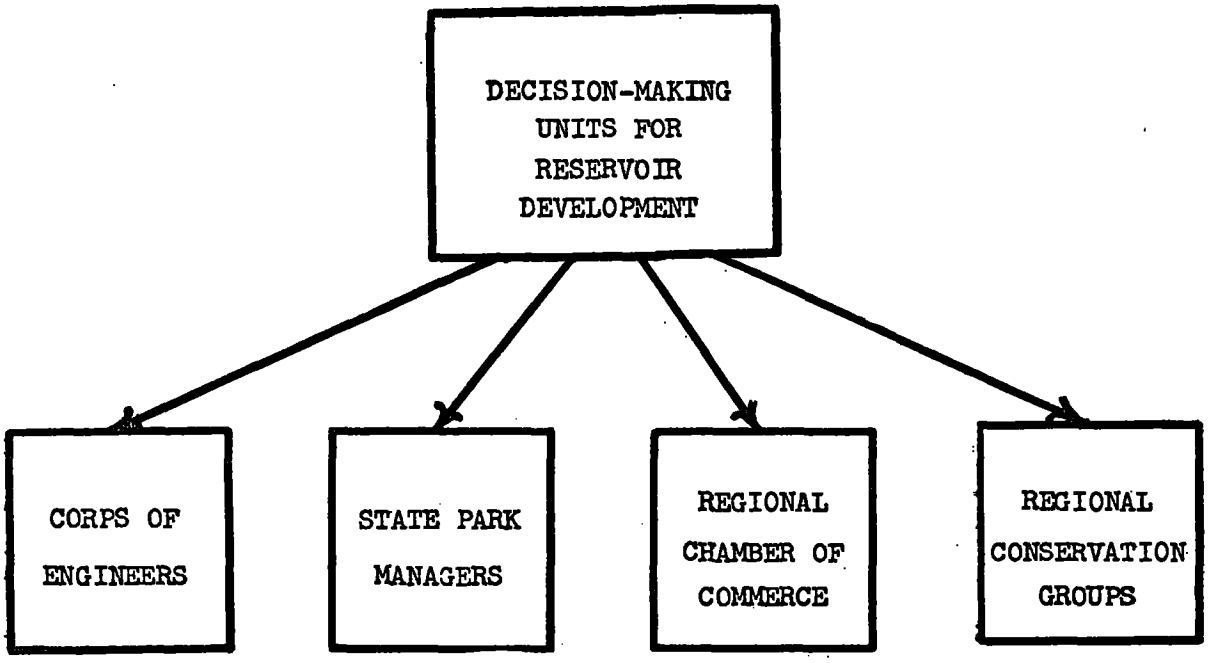



Fig. XI.11
Objective Priorities in the Model Formulation

or equivalently, the largest possible increment to national income or GNP which results from the maintenance of reservoir site facilities. On the other hand, other agencies listed above are more concerned with local implications. Managers of state parks attempt to optimize recreational benefits by making park features accessible to as many tourists and visitors as possible; the operating schedules for water supply and power production are assumed exogenous and thus without variability during each season for this decision group. The primary goal of conservationists is the preservation of plant growths and wildlife refuges in the reservoir area and thus the minimization of those activities which impair or degrade the quality of environment. (Since aesthetics is difficult to quantify in economic terms, standards on visual quality, wildlife species densities, etc., can be incorporated within the constraint matrix.) Finally, local and state businessmen and chambers of commerce emphasize the gain in revenue from tourist expenditures and other income sources in the vicinity of the reservoir, and these benefits are expressed in the objective function as the value added or income generated from activities in this region. A portion of the direct income and profits resulting from expenditures in the immediate neighborhood of the park remains in the local economy and is again spent for regional products and services. Some of this generated revenue, in turn, is expended locally, and this process of re-spending continues at successive stages. Thus, the original income obtained directly from reservoir developments constitutes a substantial, but not the entire, source of commercial gains. Aggregate benefits to the regional economy are estimated by adjusting direct income with suitable multiplier factors which account for overall spending patterns.[9]

## 5. SUMMARY

The recreation planning model is formulated as a linear programming problem, in which the linear net benefit calculation (34) or (35) is the objective function to be maximized subject to sets of linear constraints derived above. Table XI.2 enumerates unknown variables in the optimization problem and computes their total number to be,

$$2\sum_{t}^{T} J_t R + 6T + 2R,$$

[9] Refer to M. Clawson and J.L. Knetsch [ 113 ], pp. 241-4, for examples of multipliers for specific recreational pursuits.

Table XI.2
Number of Unknowns in Optimization Problem

| SYMBOL | INTERPRETATION | NUMBER OF UNKNOWNS | |
|---|---|---|---|
| | | Set A | Set B |
| * $X_{jrt}$, $j=1,\ldots,J_t; r=1,\ldots,R; t=1,\ldots,T.$ | level of recr. activity j in region r for season t | $2\sum_{t}^{J_t} J_t R$ | -- |
| $D_{jt}$, $j=1,\ldots,J_t; t=1,\ldots,T.$ | level of recr. activity j in all regions for sea. t | -- | $\sum_{t=1}^{J_t} J_t$ |
| * $r_t$, $t=1,\ldots,T.$ | water release for power supply during season t | 2 T | 2 T |
| $S_t$, $t=1,\ldots,T.$ | storage volume in reservoir for season t | T | T |
| $I_t$, $t=1,\ldots,T.$ | inflow into reservoir during season t | T | T |
| * $w_t$, $t=1,\ldots,T.$ | water release for water supply during season t | 2 T | 2 T |
| * $f_r$, $r=1,\ldots,R.$ | acreage of forested land in region r | 2 R | -- |
| $\underline{f}$ | acreage of forested land in all regions | -- | 1 |
| *The number of these variables is doubled if benefit fns. similar to Figure 4 are formulated. | TOTAL | $2\sum_{t=1}^{T} J_t R + 6T + 2R$ | $\sum_{t=1}^{T} J_t + 6T + 1$ |

with benefit function (34) or,

$$\sum_{t}^{T} J_t + 6T + 1,$$

with function (35) under listings Set A and Set B, respectively. Table XI.3 counts constraints for these two formulations of the model. Under Set A there are,

$$\sum_{t}^{T} 3\ J_t R + (3R+N+8)\ T + C + 2$$

constraints and under Set B,

$$\sum_{t}^{T} J_t R + (3R+N+8)\ T + C.$$

The objective function chosen in this formulation maximizes a particular set of regional benefits minus certain costs directly relevant to the reservoir development. Other objective functions could include amortized construction costs of facilities, seasonal OMR expenditures for pollution control, maintenance costs for the dam and reservoir, and consider the actual size of the installation as variable rather than given.

## C. INPUT DATA FOR THE HONEY HILL PROJECT

The 12,000 acre area considered in our studies were divided into 23 "homogeneous" zones. As mentioned earlier, to have zones which are truly homogeneous with respect to vegetation, topography, land forms, water types, etc., approximately 150 zones were initially suggested. Since this was too many to handle in his model for reasons mentioned earlier, an aggregation into the 23 zones shown in Figure XI.12 was made. The first 9 zones are land areas outside of the proposed State Park land takings. The 10th zone is Swanzey Lake and its shoreline. Zones 11 through 15 are various parts of the proposed Honey Hill Reservoir and its shoreline. The remaining 8 zones, 16 through 23, are the land areas within the State Park land takings. Table XI.4 gives a summary of each of the zones.

The activities considered by the model were:

i) swimming (summer)

ii) boating (summer)

Table XI.3
Number of Constraints in Optimization Problem

| CLASSIFICATION | FORMULATION | NUMBER | |
|---|---|---|---|
| | | SET A | SET B |
| * Recreational demand (6) | $\sum_r X_{jrt} \geq D_{jt}$, $j=1,..,J_t$; $r=1,..,R$; $t=1,..,T$ | $2\sum_t^T J_t R$ | 0 |
| * Power supply (2) | $r_t \geq \alpha_{pt} P$, $t=1,..,T$ | 2T | 2T |
| Flood control (3) | $S_t \geq \underline{S}$, $t=1,..,T$ | T | T |
| | $\bar{S} - S_t \geq F_t$, $t=1,..,T$ | T | T |
| | $S_t + I_t - r_t - w_t = S_{t+1}$, $t=1,..,T$ | T | T |
| Low flow augmentation (4) | $r_t \geq LF_t$, $t=1,..,T$ | T | T |
| * Water supply (5) | $w_t \geq \alpha_{wt} W$, $t=1,..,T$ | 2T | 2T |
| Wildlife conservation (9) ** | $X_{jrt} \leq \min(H_{jrt}, a_{jrt})$, $j=1,..,J_t$; $r=1,..,R$; $t=1,..,T$ | $\sum_t^T J_t R$ | $\sum_t^T J_t R$ |
| * Forest conservation (10) | $\sum_r f_r \geq \underline{f}$ | 1 | 0 |
| Recreation capacity (7) ** | $\sum_j k_j^{(W)} X_{jrt} \leq b_r + \beta_r S_t$ | RT | RT |
| | $\sum_j k_j^{(L)} X_{jrt} + f_r \leq L_{rt}$ | RT | RT |
| | $r=1,..,R$; $t=1,..,T$ | | |
| Parking availability (11) | $\sum_j \lambda_j X_{jrt} \leq \eta_{rt}$, $r=1,..,R$; $t=1,..,T$ | RT | RT |
| Pollution control (1) | $p_{nt} + \sum_j \sum_r p_{nj} X_{jrt} \leq \rho_{nt} S_t$, $n=1,..,N$; $t=1,..,T$ | NT | NT |
| | $\tilde{p}_c + \sum_j \sum_r \sum_t \tilde{p}_{cj} X_{jrt} \leq \frac{1}{T} \rho_{ct} \sum_t S_t$, $c=1,..,C$ | C | C |
| * The number of constraints is doubled if benefit fns. similar to Figure 4 are formulated. | TOTAL | $C+\sum_t^T 3J_t R + (3R+N+8)T+2$ | $C+\sum_t^T J_t R + (3R+N+8)T$ |

**The recreation capacity constraints $X_{jrt} \leq a_{jrt}$ are combined with the wildlife conservation constraints $X_{jrt} \leq H_{jrt}$ in (9).

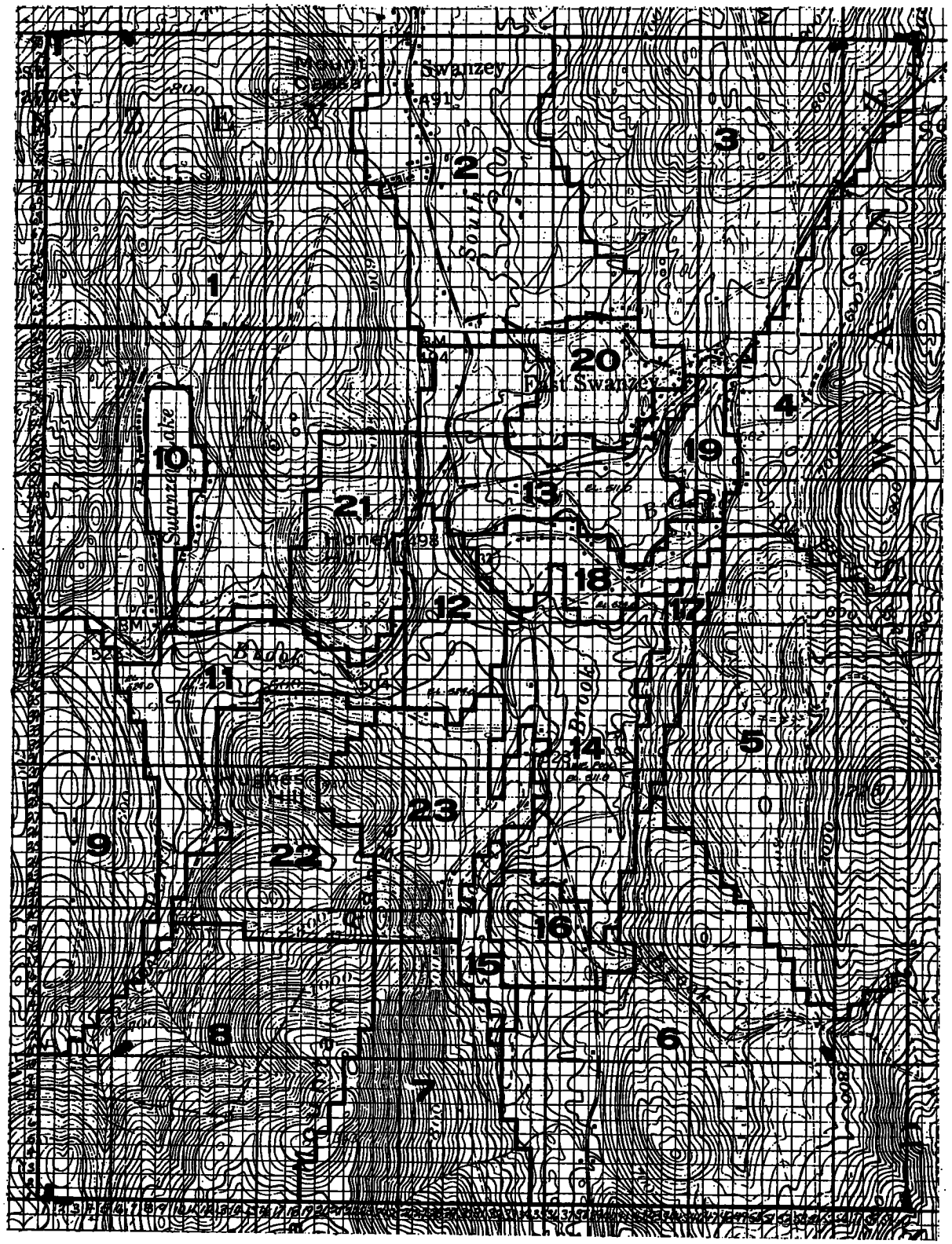



Fig. XI.12
Layout of Zones for Linear Programming Model

| Zone | Type | Area (acres) | Predominant type | |
|---|---|---|---|---|
| 1 | L and | 2000 | hills surrounding zone 10 | |
| 2 | L | 680 | river bottom, down from dam | |
| 3 | L | 1080 | large hill, S. E. ex. | |
| 4 | L | 790 | 1/2 flat, 1/2 hilly, W. exposure | |
| 5 | L | 1030 | hilly, W. exposure | |
| 6 | L | 1300 | hilly, N. exposure | |
| 7 | L | 480 | steep side of hill, E. exposure | |
| 8 | L | 830 | side of hill, W. exposure | |
| 9 | L | 405 | hilly, E. exposure | |
| 10 | Water/shore | 110 | Swanzey Lake & shore [private] | |
| 11 | W/shore | 370 | small branch of lake | Reservoir |
| 12 | W/shore | 200 | main body of lake | Reservoir |
| 13 | W/shore | 420 | N. main lake | Reservoir |
| 14 | W/shore | 455 | E. main lake | Reservoir |
| 15 | W/shore | 70 | small branch of lake | Reservoir |
| 16 | L | 137 | small hill | State-Park |
| 17 | L | 100 | side of hill, W. exposure | State-Park |
| 18 | L | 180 | penensula in lake (flat) | State-Park |
| 19 | L | 83 | slight slope, W. exposure | State-Park |
| 20 | L | 187 | S. expo. - plateau, new dam | State-Park |
| 21 | L | 270 | Honey Hill, E. & S. expo. | State-Park |
| 22 | L | 430 | Hughes Hill, N. exposure | State-Park |
| 23 | L | 400 | E. expo. of Hughes Hill | State-Park |
| | | 12,007 | | |

L = land

W = water

Table XI.4
Zones for Honey Hill

| | | |
|---|---|---|
| iii) | hiking | (summer) |
| iv) | camping | (summer) |
| v) | fishing | (summer) |
| vi) | snowmobiling | (winter) |
| vii) | downhill skiing | (winter) |
| viii) | hunting | (summer) |

Table XI.5 outlines all of the possible recreation activities for the 23 zones. By specifying the possible activities in this way we avoid the necessity of including all of the $x_{jrt}$ or (8 activities x 23 zones x 2 time periods) 368 activities. As we can see from Table XI.5, the actual number of possible combinations is only 90. This is a great saving in variables and hence computation time.

The formal statement of the linear programming model given in part II above is in vector notation as follows:

$$\text{maximize } cx$$

$$\text{subject to} \qquad A\,x \leq b$$

$$x \geq o$$

where c is the vector of net benefits, b is the resource constraint vector (called the RHS) and A is the "detached coefficient" matrix. The A matrix relates the activities to each of the constraints. In conventional linear programming usage of the A matrix is expanded by one row to include the objective function as the first row. Figure XI.13 shows the computer tabulated version of the matrix.[10] Unfortunately with such a large matrix it is not possible to fit it all onto one reasonably sized piece of paper. The output is therefore broken down by blocks of 55 variables and 45 rows of the augmented A matrix. Moreover, since the matrix has many zeroes in its elements the computer only prints those blocks which report non-zero elements. In some cases this

[10] Throughout this study we have used the MPS/360 programming package provided by IBM. For further details on the output consult the relevant IBM publication.

TABLE XI.5

POSSIBLE RECREATION ACTIVITIES

| Zone | | Summer | Winter | Number of Activities |
|---|---|---|---|---|
| 1 | Land outside of control | 3,4,8 | 6,7 | 5 |
| 2 | | 3,4 | 6 | 3 |
| 3 | | 3,4,8 | 6,7 | 5 |
| 4 | | 3,4,8 | 6,7 | 5 |
| 5 | | 3,4,8 | 6,7 | 5 |
| 6 | | 3,4,8 | 6,7 | 5 |
| 7 | | 3,4,8 | 6,7 | 5 |
| 8 | | 3,4,8 | 6,7 | 5 |
| 9 | | 3,4,8 | 6 | 4 |
| 10 | Swanzey Lake | 1,2,5 | 6 | 4 |
| 11 | Lake | 1,2,5 | 6 | 4 |
| 12 | | 1,2,5 | 6 | 4 |
| 13 | | 1,2,5 | 6 | 4 |
| 14 | | 1,2,5 | 6 | 4 |
| 15 | | 5 | 6 | 2 |
| 16 | | 4,8 | 6 | 3 |
| 17 | State-Park | 3,4 | 8 | 3 |
| 18 | | 4 | 6 | 2 |
| 19 | | 3,4,8 | 6 | 4 |
| 20 | | 3,4 | 6 | 3 |
| 21 | | 3,4,8 | 6,7 | 5 |
| 22 | | 8 | 7 | 2 |
| 23 | | 3,4,8 | 7 | 4 |

90 activities

1) swimming
2) boating
3) hiking
4) camping
5) fishing
6) snowmobiling
7) downhill skiing
8) hunting

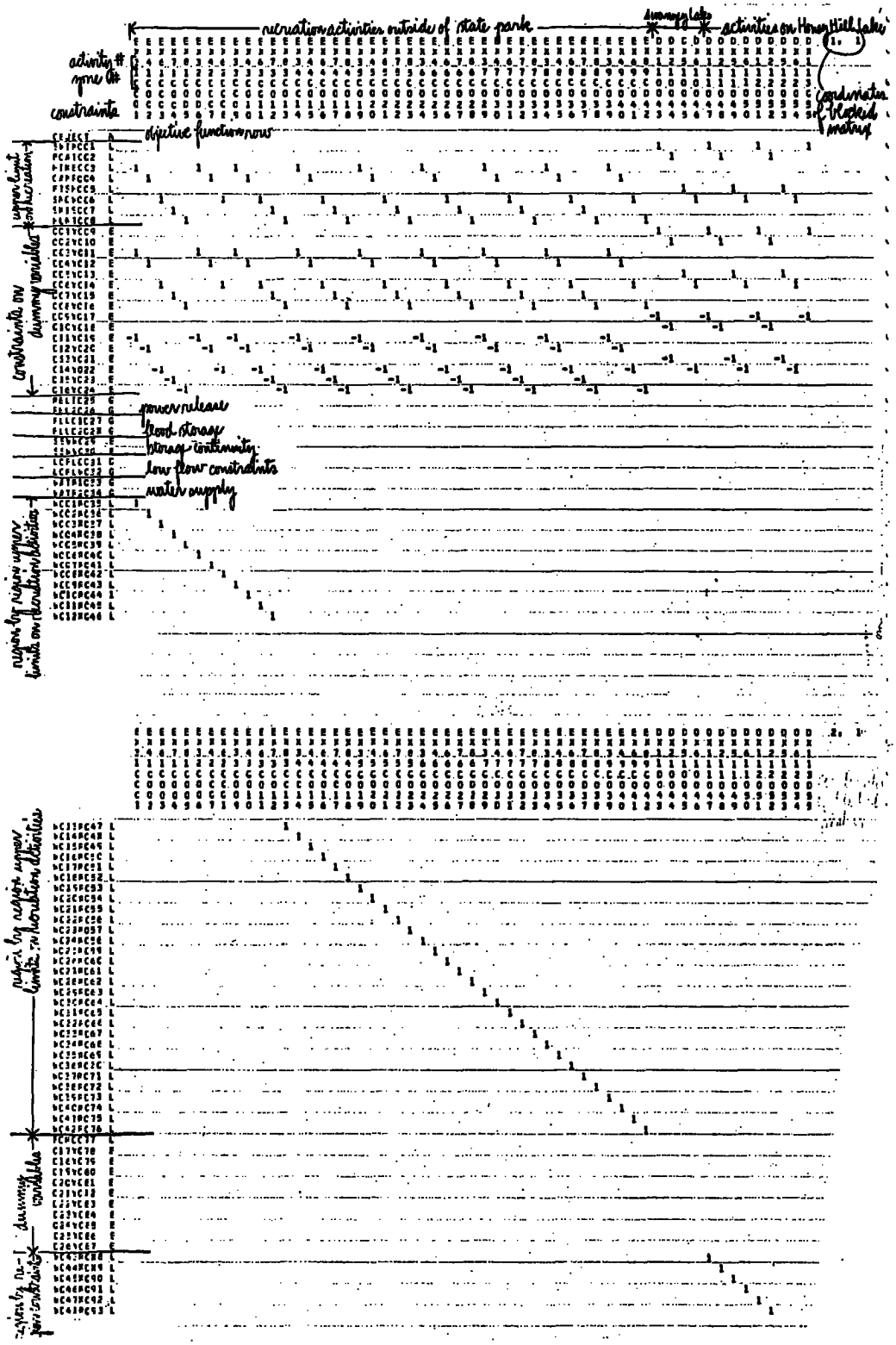



Fig. XI.13
The "A" Matrix

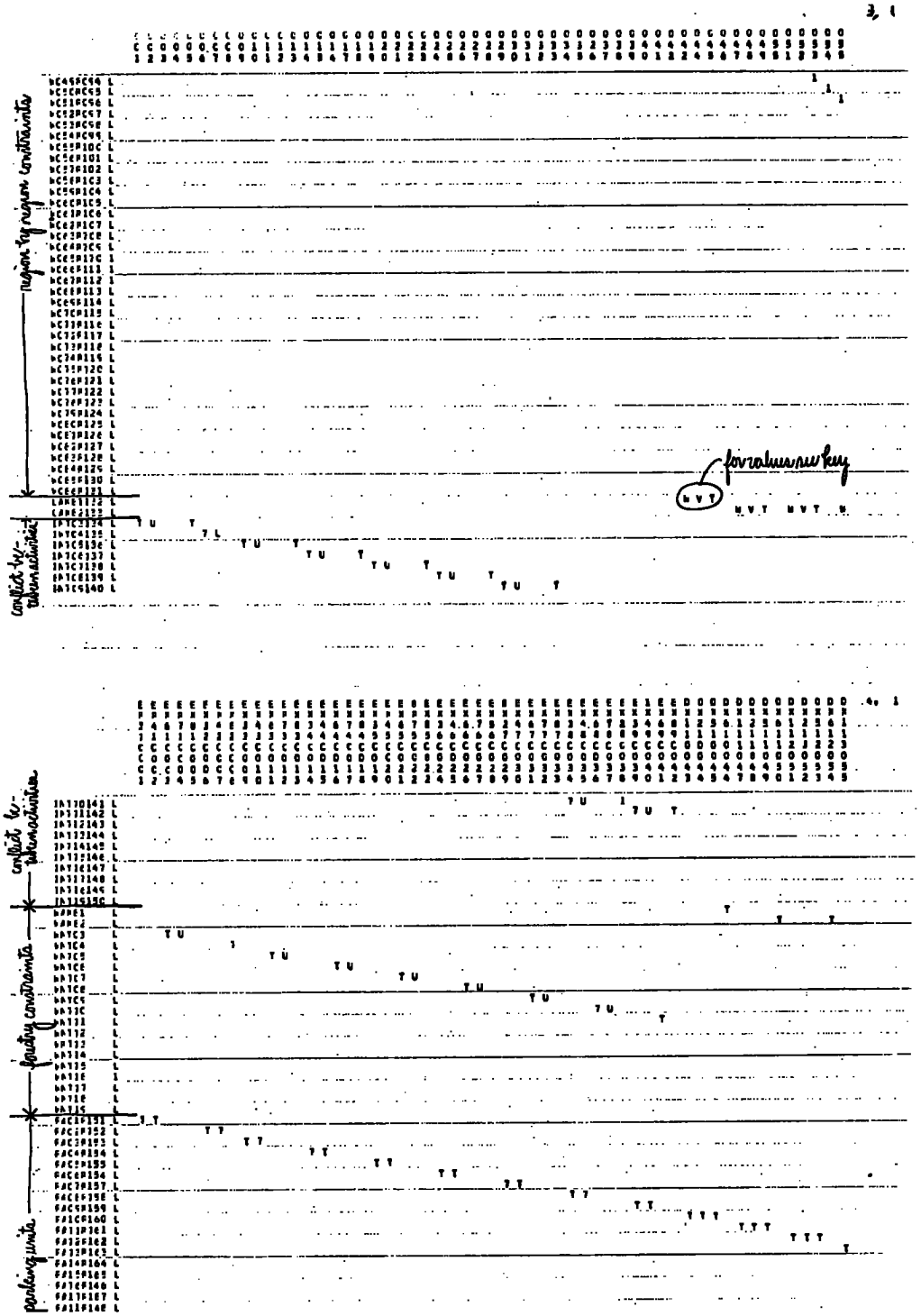



Fig. XI.13 (cont.)
The "A" Matrix

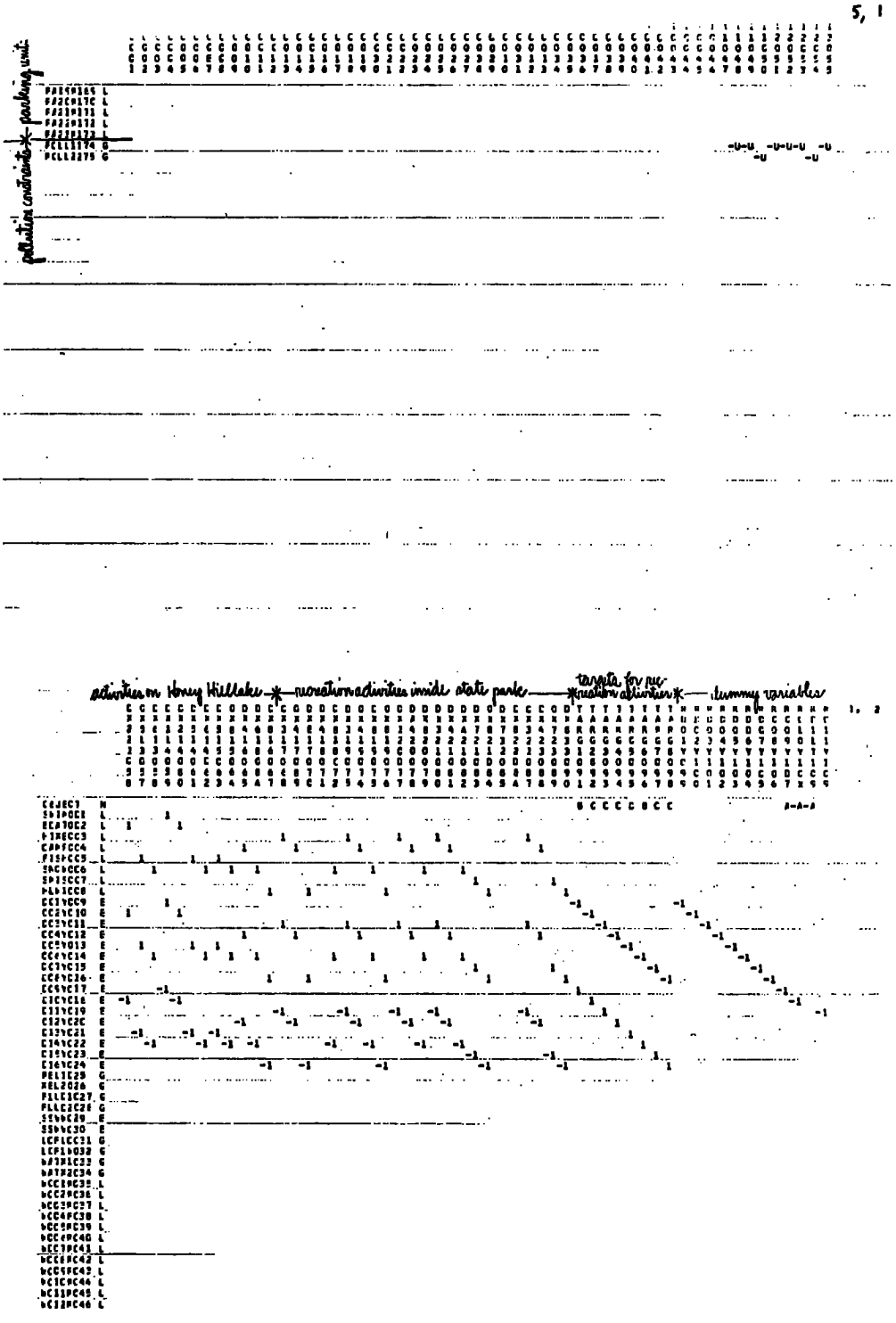
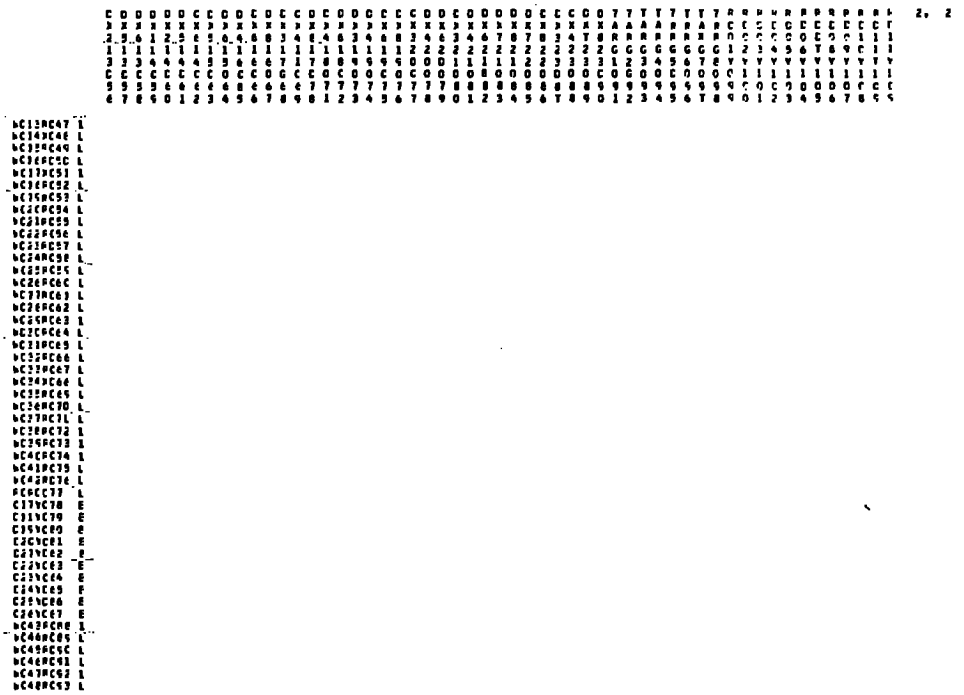



Fig. XI.13 (cont.)
The "A" Matrix



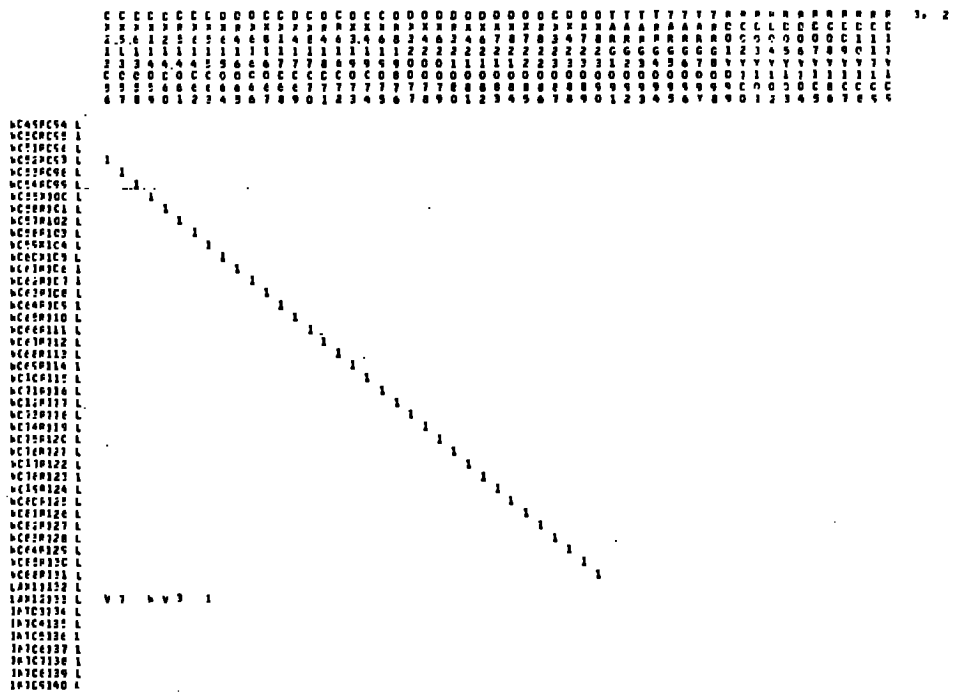
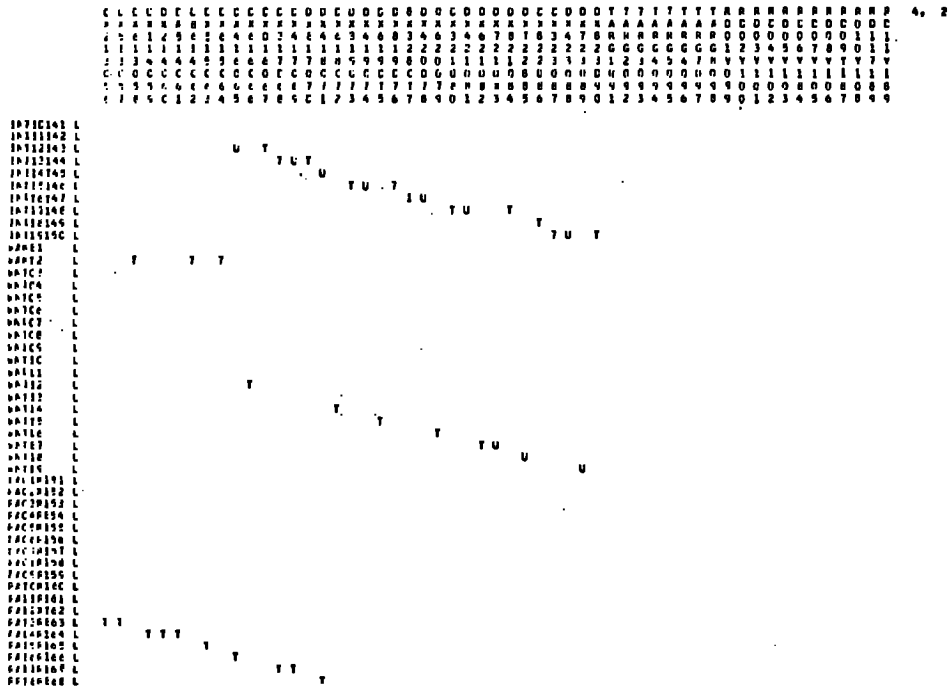


Fig. XI.13 (cont.)
The "A" Matrix



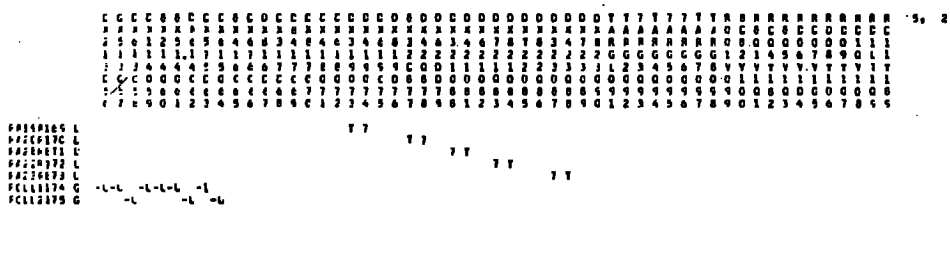
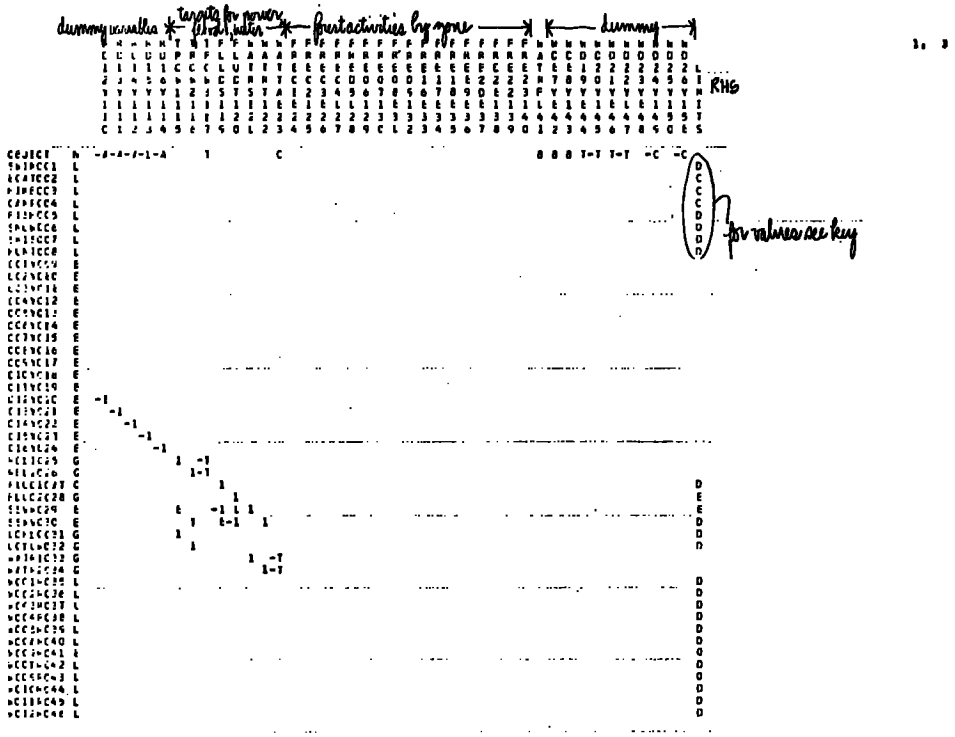


Fig. XI.13 (cont.)
The "A" Matrix



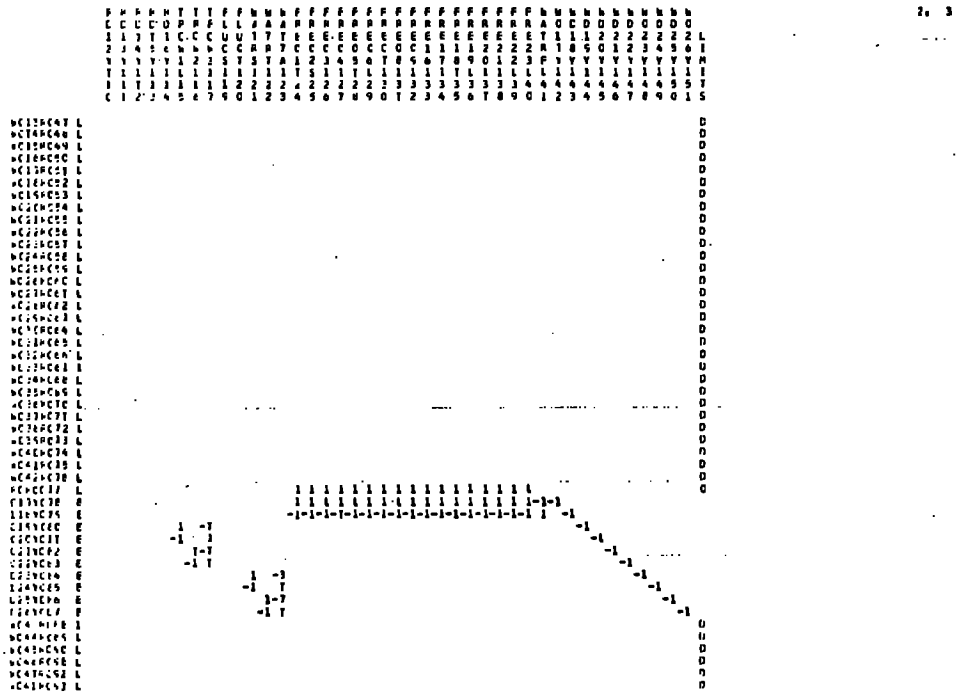
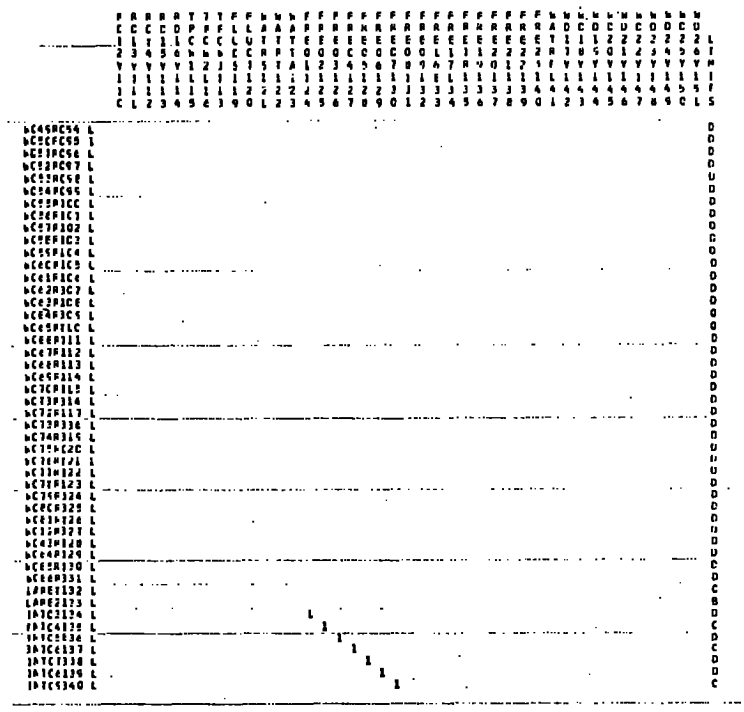



Fig. XI.13 (cont.)
The "A" Matrix



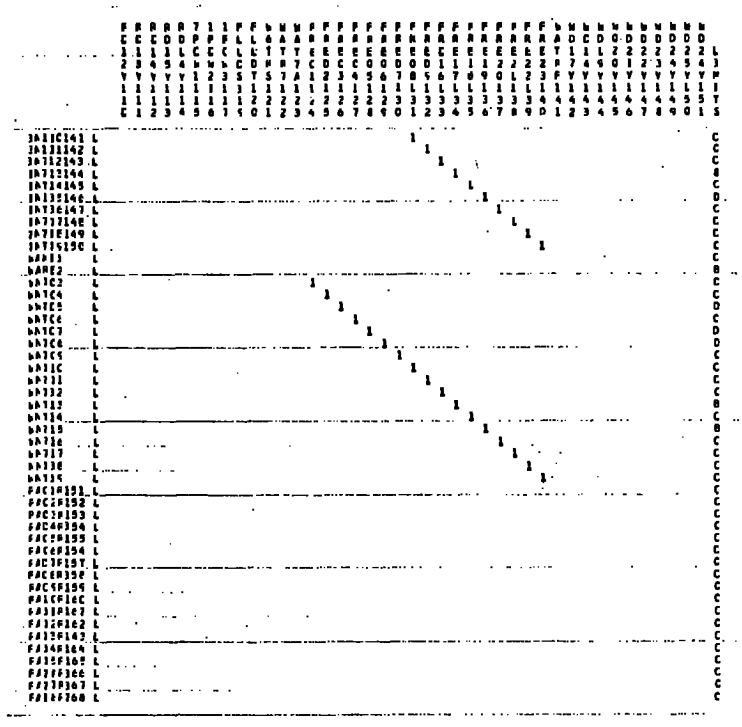


Fig. XI.13 (cont.)
The "A" Matrix

```
            A A A A A T T T F F W W W F F F F F F F F F F F F F F F F F W W W W W W W W W W W
            C C C D D P P F L L A A A A A A A A A A A A A A A A A A A A A C D D C D C D D D D
            1 1 1 1 1 C C C L U T T T E E E E E E E E E E E E E E E E E T 1 1 1 2 2 2 2 2 2 2 L
            2 3 4 5 6 W W W C C A R T C O C C O O O O O 1 1 1 1 2 2 2 2 R 7 8 9 0 1 2 3 4 5 6 I
            Y Y Y Y Y 1 2 3 S T S T A 1 2 3 4 5 6 7 8 9 6 7 8 9 D 1 2 3 F Y Y Y Y Y Y Y Y Y Y M
            1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 I
            1 1 1 1 1 1 1 1 1 2 2 2 2 2 2 2 2 2 2 3 3 3 3 3 3 3 3 3 3 4 4 4 4 4 4 4 4 4 4 5 5 T
            C 1 2 3 4 5 6 7 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 S
FA19F169 L                                                                                    C
FA20F170 L                                                                                    C
FA21F171 L                                                                                    C
FA22F172 L                                                                                    C
FA23F173 L                                                                                    C
FCL11174 G                  A                                                                 E
FCL12175 G                    A                                                               F
```

KEY TO MATRIX.

| SYMBOL | RANGE | | | COUNT (INCL.RHS) |
|---|---|---|---|---|
| Z | LESS | THAN | .000001 | |
| Y | .CCOCC1 | THRU | .COOCO9 | |
| X | .OCCC10 | | .CCCC99 | |
| W | .COO1OO | | .000999 | 5 |
| V | .CC1CCC | | .CC9999 | 5 |
| U | .01COCO | | .C99999 | 43 |
| T | .1CCCOO | | .999999 | 119 |
| 1 | 1.CCCCCC | | 1.CCCOCC | 500 |
| A | 1.000CO1 | | 1C.CCCCOO | 9 |
| B | 1C.COCCC1 | | 1CC.CCOCCC | 12 |
| C | 100.CCOCO1 | | 1.COC.COCCOC | 59 |
| D | 1,COO.CCCCC1 | | 10,00C.CCOCCC | 104 |
| E | 1C,CCO.COCCO1 | | 10C,CCC.COCCCC | 4 |
| F | 1CC,COC.CCCCC1 | | 1,CCC,CCO.CCCCCO | |
| G | GREATER | THAN | 1,CCC,CCC.CCOCCO | |

Fig. XI.13 (cont.)
The "A" Matrix

is a considerable paper-saving device. In the print-out only elements with a value of unity are printed exactly; all other non-zero elements are coded by the key attached to Figure XI.13. On the output we indicate which variables refer to the variables in the formal model.

One of the things that can be observed from Figure XI.13 is that most of the coefficients of the A matrix are either 0 or 1. This means that the number of coefficients is considerably less than the possible number (194 x 151) of coefficients. The parameters to be estimated for the linear programming model fall into the 3 categories listed below.

i) Coefficients in the A matrix.

1. Power supply, constraints number 25 and 26. We have assumed that 50% of the power is to be produced in the summer and 50% in the winter, therefore $\alpha_t = .5$.

2. Municipal water supply constraints 33 and 34. We have assumed a uniform demand of 50% per season as with power. Therefore $\alpha_{wt} = .5$.

3. Capacity for recreation constraints 134 to 150. The $k_j$ coefficients are as listed below.

| j | activity | acres per person | $k_j$ coefficient |
|---|---|---|---|
| 1 | swimming | 1/2000 | .005 |
| 2 | boating | 1/1.25 | .8 |
| 3 | hiking | 1/3 | .3333 |
| 4 | camping | 1/16 | .0625 |
| 5 | fishing | 1/2 | .5 |
| 6 | snowmobiling | 1/1.5 | .666 |
| 7 | downhill skiing | 1/30 | .033 |
| 8 | hunting | 1/8 | .125 |
| | car parking | 1/150 | $\eta_j = .0066$ |

4. Parking restrictions constraints 170 to 192 use the figure of 3.25 people per car and two activities per one parking therefore not all $\eta_j$ coefficients equal to .16.

5. Pollution constraints number 193 and 194. We have considered only the non-conservative pollutants in our model as the mechanism for build-up of conservative pollutants in lakes and reservoirs is an extremely complex process and we

were unable to get any reasonable estimates of the parameters for this constraint. For the non-conservative pollutants the process is only a little less complicated depending upon the shape of the lake (reservoir), the release schedule, the existence of density currents, etc. Moreover, we chose to consider only the "BOD" component[11] of the influent wastes. Assume the influent has the following characteristics; settled sewage with a 5 day BOD of 0.077 lbs/capita/day, or 90 mg/l, and a first day BOD of 0.029 lbs/capita/day. If the minimum dissolved oxygen (DO) to preserve fish life is 5 mg/l and the DO saturation at 20 C is 9.2 mg/l, then the required DO saturation is 100 x 5/9.2 = 54% and the critical DO deficit is 9.2 - 5 = 4.2 mg/l. In accordance with Table 17-2 of Inhoff and Fair [ 122 ], the reaeration of the reservoir will then be 20 lbs/acre/day. For the proposed reservoir of average area 970 acres this gives 19,400 lbs of oxygen daily.[12]

We have therefore chosen to use a highly simplified oxygen balance which related daily demands to daily reaeration and demands influent from outside of the system. If the reservoir is assumed to be an average of six and one-third feet deep, then the coefficients which relate storage volume to oxygen production, $P_{nt}$, is equal to 3.0. We have also assumed that there is an influent of .1 lbs of first day BOD for each man-day of recreation use of the reservoir,[13] these are the $P_{nj}$ coefficients.

ii) Right Hand Sides (RHS), Parameters.

1. Recreational demand constraints number 1 to 8. These were considered for two cases, one with 3000 cars coming to the region and one with 5000 cars. This implies capacity constraints as follows:

---

[11] BOD is the Biochemical Oxygen demand of a waste is defined by a series of chemical operations performed in the measurement of pollution. It is an indicator of the level of organic pollution in water.

[12] Incidentally, this reservoir could accommodate the water from approximately 19,400/.029 or approximately 700,000 person equivalents if the retention of water was only one day. There is apparently about 36,000 lbs BOD per day already being added to the Ashuelot River which is equivalent to 360,000 persons.

[13] This is actually closer to the 5 day BOD per capita day. But a 5 day BOD analysis would invalidate our simple steady state reaeration model.

| | | number of participants | | |
|---|---|---|---|---|
| | | 1000 cars | 3000 cars | 5000 cars |
| 1. | swimming | 937 | 2811 | 4685 |
| 2. | boating | 184 | 552 | 920 |
| 3. | hiking | 178 | 534 | 890 |
| 4. | camping | 44 | 132 | 220 |
| 5. | fishing | 266 | 798 | 1330 |
| 6. | snowmobiling | 467 | 1401 | 2335 |
| 7. | downhill skiing | 1363 | 4089 | 6815 |
| 8. | hunting | 266 | 798 | 1330 |

2. Flood control storage constraints 27 and 28. From the operating rule curve supplied by the Corps of Engineers we estimated these to be

$$F_1 = 9{,}100 \text{ acre - ft}$$

$$F_2 = 13{,}000 \text{ acre - ft}$$

3. Storage continuity constraints 29 and 30. We estimated that the inflow in period one, $I_1$, was 15,000 acre - ft (4 inches of run-off) and period two, $I_2$, was 7500 acre - ft.

4. Low flow constraints number 31 and 32. From the operating curve we estimated these as, $LF_1$ = 8,000 acre ft. and $LF_2$ = 8,000 acre ft.

5. Upper limits on recreation participation in each region constraints 35 to 76 and 88 through 131. In the absence of any detailed analyses zone by zone we arbitrarily set these at 2000 man-days of each activity except for downhill skiing which was set at 8000 man-days, and swimming at 5000 man-days. This reflects our judgment about maximum and desirable skiing and swimming developments. These sets of constraints can be used by the analyst to incorporate a lot more of his judgment into the model than is presently done by setting these upper limits so high.

6. Management of forest areas constraint 77. This constraint was arbitrarily set at a minimum of 3000 acres to sustain commercial forestry.

7. Lake area for summer activities constraint 132 and 133. From Corps of Engineers memo, Honey Hill is 970 acres and Swanzey Lake is 100 acres.

8. Capacity for recreation constraints 134 to 150. The right hand sides represent the areas of each zone as given in Figure XI.12.

9. Constraints 153 to 169 are upper limit on the 17 land zones for forest development. The values are exactly the same as in 8 above.

10. Upper limit on Parking by zone constraints 170 to 192. These were set initially to an arbitrary level of 600 cars per area but were later changed so that the amount of parking available to Swanzey Lake was restricted to 100 cars.

11. Amount of influent pollution from outside of the system constraints 193 and 194. This was set 36,000 lbs of BOD per day based upon information received from the Corps of Engineers.

iii) Objective Function Parameters.

The estimation of the parameters given in this section indicates that before placing planning importance to the results of this model--in particular--the absolute value of the objective function--much more detailed work needs to be done on improving the estimates of the objective function parameters.

1) Power. Actual variable head in power is 21 ft., however dead storage down to tail-race elevation was not given so we assumed 10 ft. This gives an average head of 20 ft. on the turbines. Now since we know that

$$E = 1.024\ Q\ h\ e \qquad \text{k.w.h.}$$

where $e$ = efficiency (85%)

$h$ = head in ft.

$Q$ = flow in acre-ft

therefore, $E = 18Q$. If we assume a price of \$.02 per k.w.h. the price per acre-ft of constant head energy will be \$.36. We assume also that dump energy is worth \$.2 ($\gamma_p$) and in an energy shortage we could but energy at \$.4 ($\gamma_p$). Also assume that the above are net of operating costs.

2) Water Supply. We have assumed that an alternative source of water would cost \$.15 per 1000 gallons or about \$205 per acre-ft. We also assume that in a shortage we could always buy water at \$300 per acre-ft. ($\gamma_{wt}$).

3) Direct Recreational Benefits. These are assumed to be net of cost of operating facilities. They are based

upon the average daily local revenue. We also have the estimates of the regional multipliers given in Table VIII.2.

| | activity | direct local income $ | regional multiplier |
|---|---|---|---|
| 1. | swimming | 2.30 | 2.76 |
| 2. | boating | 7.22 | 2.76 |
| 3. | hiking | 5.80 | 1.98 |
| 4. | camping | 5.80 | 1.98 |
| 5. | fishing | 7.22 | 2.76 |
| 6. | snowmobiling | 5.80 | 1.98 |
| 7. | downhill skiing | 16.99 | 2.76 |
| 8. | hunting | 7.22 | 2.76 |

The shortage losses $\gamma_{jt}$ for these were set at 1.3 times the $\xi_{jt}$ values.

4) Forestry Benefits. We have assumed that the net benefits for commercial forestry are $50 per acre forested. This is based upon an average yield of 50 cords of softwood per acre.

## D. RESULTS OF COMPUTATIONS

We report the results for six different runs of the model. We considered two applications for comparison; the first restricting the recreation to the reservoir and proposed State Park (type "A") and the second allowing recreation anywhere in the study area (type "B"). The cases of occupants of 3000 and 5000 cars demanding recreation at the Honey Hill site and its immediate environs were investigated for each of the "A" and "B" assumptions. On first doing this, we noticed that the major swimming developments were tending to locate on Swanzey Lake. This appeared to be an unreasonable solution so we tightened the parking and access constraints on Swanzey Lake. Hence we report two cases for the type "A" plans and four cases for the type "B" plans.

Table XI.6 represents a typical format of the output of the MPS/360 system. Each of the activities is separated in terms of participation in man-days for each activity. These figures represent man-days per average weekly peak day, except the flood, power and water supply activities which we defined in acre-ft., and the forestry activities which are defined in terms of acres.

! - COLUMNS

activity — none — participation: man days / average peak day — costs and benefits

| .COLUMN. | AT | ...ACTIVITY... | ..INPUT COST.. |
|---|---|---|---|
| EX31C001 | BS | 534.00000 | . |
| EX41C002 | LL | . | . |
| EX61C003 | LL | . | . |
| EX71C004 | LL | . | . |
| EX81C005 | LL | . | . |
| EX32C006 | LL | . | . |
| EX42C007 | BS | 132.00000 | . |
| EX62C008 | LL | . | . |
| EX33C009 | LL | . | . |
| EX43C010 | LL | . | . |
| EX63C011 | BS | 1401.00000 | . |
| EX73C012 | BS | 4098.00000 | . |
| EX83C013 | LL | . | . |
| EX34C014 | LL | . | . |
| EX44C015 | LL | . | . |
| EX64C016 | LL | . | . |
| EX74C017 | LL | . | . |
| EX84C018 | BS | 798.C0000 | . |
| EX35C019 | LL | . | . |
| EX45CC2C | LL | . | . |
| EX65C021 | LL | . | . |
| EX75C022 | LL | . | . |
| EX85C023 | LL | . | . |
| EX36CC24 | LL | . | . |
| EX46CC25 | LL | . | . |
| EX66C026 | LL | . | . |
| EX76C027 | LL | . | . |
| EX86CC28 | LL | . | . |
| EX37C029 | LL | . | . |
| EX47C030 | LL | . | . |
| EX67C031 | LL | . | . |
| EX77C032 | LL | . | . |
| EX87C033 | LL | . | . |
| EX38C034 | LL | . | . |
| EX48C035 | LL | . | . |
| EX68C036 | LL | . | . |
| EX78C037 | LL | . | . |
| EX88C038 | LL | . | . |
| EX39C039 | LL | . | . |
| EX49C040 | LL | . | . |
| EX69CC41 | LL | . | . |
| EX89C042 | LL | . | . |
| OX110043 | LL | . | . |
| DX210044 | BS | 22.22885 | . |
| DX510045 | BS | 602.77115 | . |
| DX610046 | LL | . | . |
| DX111047 | BS | 2811.C0000 | . |
| DX211048 | LL | . | . |
| DX511049 | BS | 195.22885 | . |

Table XI.6
Linear Program Output, "B" Plan, N=3000

participation: many days/average peak day

costs and benefits

activity

money

| .COLUMN. | AT | ...ACTIVITY.. | .INPUT COST.. |
|---|---|---|---|
| DX611050 | LL | . | . |
| DX112051 | LL | . | . |
| DX212052 | BS | 529.77115 | . |
| DX512053 | LL | . | . |
| DX612054 | LL | . | . |
| DX113055 | LL | . | . |
| DX213056 | LL | . | . |
| DX513057 | LL | . | . |
| DX613058 | LL | . | . |
| DX114059 | LL | . | . |
| DX214060 | LL | . | . |
| DX514061 | LL | . | . |
| DX614062 | LL | . | . |
| DX515063 | LL | . | . |
| DX615064 | LL | . | . |
| DX416065 | LL | . | . |
| DX616066 | LL | . | . |
| DX816067 | LL | . | . |
| DX317068 | LL | . | . |
| DX417069 | LL | . | . |
| DX817070 | LL | . | . |
| DX418071 | LL | . | . |
| DX618072 | LL | . | . |
| DX319073 | LL | . | . |
| DX419074 | LL | . | . |
| DX619075 | LL | . | . |
| DX819076 | LL | . | . |
| DX320077 | LL | . | . |
| DX420078 | LL | . | . |
| DX620079 | LL | . | . |
| DX321080 | LL | . | . |
| DX421081 | LL | . | . |
| DX621082 | LL | . | . |
| DX721083 | LL | . | . |
| DX821084 | LL | . | . |
| DX722085 | LL | . | . |
| DX822086 | LL | . | . |
| DX323087 | LL | . | . |
| DX423088 | LL | . | . |
| DX723089 | LL | . | . |
| DX823090 | LL | . | . |
| TARG1091 | BS | 2811.00000 | 59.50000 |
| TARG2092 | BS | 552.00000 | 187.50000 |
| TARG3093 | BS | 534.00000 | 151.00000 |
| TARG4094 | BS | 132.00000 | 151.00000 |
| TARG5095 | BS | 798.00000 | 187.50000 |
| TARG6096 | BS | 1401.00000 | 75.50000 |
| TARG7097 | BS | 4098.00000 | 220.00000 |
| TARG8098 | BS | 798.00000 | 187.00000 |
| RC01Y099 | LL | . | . |
| RD02Y100 | LL | . | . |

target variables

Table XI.6 (cont.)
Linear Program Output, "B" Plan, N=3000



Table XI.6 (cont.)
Linear Program Output, "B" Plan, N=3000

355

water release variables — participation: man days/average peak day — costs and benefits

| COLUMN. | AT | ACTIVITY | INPUT COST |
|---|---|---|---|
| R003Y101 | LL | . | . |
| R004Y102 | LL | . | . |
| R005Y103 | LL | . | . |
| R006Y104 | LL | . | . |
| R007Y105 | LL | . | . |
| R008Y106 | LL | . | . |
| R009Y107 | BS | . | 4.00000 |
| R010Y108 | LL | . | 4.50000- |
| R011Y109 | LL | . | 2.50000- |
| R011Y109 | LL | . | . |
| R012Y110 | LL | . | 3.50000- |
| R013Y111 | BS | 580.54231 | 4.00000- |
| R014Y112 | LL | . | 8.00000- |
| R015Y113 | LL | . | 19.00000- |
| R016Y114 | LL | . | 6.00000- |
| TP0W1115 | BS | 4700.00000 | . |
| TP0W2116 | BS | 4700.00000 | . |
| TP0W3117 | BS | 9400.00000 | .36000 |
| FLUDS119 | BS | 12118.60763 | . |
| FLUDT120 | BS | 13248.60763 | . |
| WATRS121 | BS | 9170.00000 | . |
| WATRT122 | BS | 3930.00000 | . |
| WATTA123 | BS | 13100.00000 | 205.00000 |
| FRE01124 | LL | . | . |
| FRE02125 | BS | 671.75000 | . |
| FRE03126 | BS | 11.70000 | . |
| FRE04127 | BS | 870.25000 | . |
| FRE05128 | BS | 1030.00000 | . |
| FRE06129 | LL | . | . |
| FRE07130 | LL | . | . |
| FRE08131 | LL | . | . |
| FRE09132 | LL | . | . |
| FRE16133 | LL | . | . |
| FRE17134 | LL | . | . |
| FRE18135 | LL | . | . |
| FRE19136 | LL | . | . |
| FRE20137 | LL | . | . |
| FRE21138 | LL | . | . |
| FRE22139 | BS | 16.30000 | . |
| FRE23140 | BS | 400.00000 | . |
| WATRF141 | BS | 3000.00000 | 50.00000 |
| WD17Y142 | LL | . | 50.00000 |
| WD18Y143 | BS | . | 50.00000 |
| WD19Y144 | BS | . | .20000 |
| WD20Y145 | LL | . | .40000- |
| WD21Y146 | LL | . | .20000 |
| WD22Y147 | BS | . | .40000- |
| WD23Y148 | LL | . | . |
| WD24Y149 | LL | . | 300.00000- |
| WD25Y150 | LL | . | . |
| WD26Y151 | LL | . | 300.00000- |

acre-ft.

acres

forest variables

acres

Table XI.6 (cont.)
Linear Program Output, "B" Plan, N=3000

The results of the two runs of the first model application (type "A") are summarized in Table XI.7. The results of type "B" models are shown in Tables XI.8 and XI.9. In Table XI.8 there was no restriction in parking at Swanzey Lake.

Table XI.7 reports the results when all of the activities were constrained to lie "within" the proposed Federal and State land holdings and the Honey Hill reservoir. In this case, the foresting activities were dropped from the model. As one would expect, the value of the benefit function drops in each case from that reported in Tables XI.8 and XI.9 in which the development is unrestricted. This always happens in mathematical programming models when the system becomes more constrained. The actual reduction in benefits of about $300,000 per annum below the case reported in Table XI.9.

What is more striking, however, is how the activities now redistribute themselves within the reservoir and State Park takings. In particular, the 5000 car case puts quite a severe tension on the system and one sees a corresponding search for additional zones within which to locate the various activities. Major changes are in the skiing and snowmobiling activities.

On first analysis the results in Tables XI.7, XI.8 and XI.9 are not very exciting. They indicate that with the given constraint set we can quite easily handle the 5000 car and 3000 car demands upon the system. The type "B" results, however, seemed to put more than a reasonable number of summer water recreation on Swanzey Lake than we would have expected. We therefore decided to "force" the solution a little by restricting access to Swanzey Lake to 100 cars during the summer months. Table XI.9 reports what happens under these circumstances. In this case one would expect a reduction in the net benefits which did in fact occur, by about $300,000 per year in the 5000 car case and only $2,000 in the 3000 car case. This indicates that, also as expected, the 5000 car case is a much more stringent demand on the system. The most important changes in activity and zone uses are the shifts from Swanzey Lake (Zone 10) to zones 11 and 13 and 13 in Honey Hill lake for the water based recreation.

In all of the six solutions presented the other resource uses of power, flood storage, water supply and forestry appear at expected levels. The only one that makes any change is the flood storage, which increases slightly in

TABLE XI.7

HONEY HILL ECONOMIC EFFICIENCY RESTRICTION TO
STATE PARK AND RESERVOIR (TYPE "A")

| Net Benefits | 5000 cars $5,268,037 | | 3000 cars $4,253,355 | |
|---|---|---|---|---|
| Activities* | | Targets | | Targets |
| 1. swim | (11,935) (12,3750) | 4,685 | (11,2811) | 2,811 |
| 2. boat | (11,920) | 920 | (11,552) | 552 |
| 3. hike | (17,171) (23,718) | 890 | (17,300) (19,233) | 534 |
| 4. camp | (16,220) | 220 | (16,132) | 132 |
| 5. fish | (11,191) | 191 | (11,195) | 195 |
| 6. snowmobile | (10,1456) (12,150) (19,42) (20,280) (21,405) | 2,335 | (10,995) (21,405) | 1,401 |
| 7. ski | (23,6815) | 6,815 | (23,4098) | 4,098 |
| 8. hunt | (16,986) (17,344) | 1,330 | (16,798) | 798 |
| Power releases** | | | | |
| 1 | 4,700 | 9,400 | 4,700 | 9,400 |
| 2 | 4,700 | | 4,700 | |
| Flood storage | | | | |
| 1 | 12,193 | | 12,118 | |
| 2 | 13,323 | | 13,248 | |
| Water supply | | | | |
| 1 | 9,170 | 13,100 | 9,170 | 13,100 |
| 2 | 3,930 | | 3,930 | |

* Zone #, # of man-days of activity.
** In acre-ft.

Honey Hill-Economic Efficiency

| | 5000 cars | | 3000 cars | |
|---|---|---|---|---|
| Net Benefits | $ 5,630,577 | | $ 4,516,206 | |
| Activity * | | Targets | | Targets |
| 1 swim | (10, 1697) (11, 2987) | 4685 | (10, 2599) (11, 211) | 2811 |
| 2 boat | (10, 920) | 920 | (10, 552) | 552 |
| 3 hike | (1, 890) | 890 | (1, 534) | 534 |
| 4 camp | (2, 220) | 220 | (2, 132) | 132 |
| 5 fish | (10, 1133) (11, 197) | 1330 | (10, 598) (11, 199) | 798 |
| 6 snowmobile | (2, 788) (5, 1546) | 2335 | (3, 1401) | 1401 |
| 7 ski | (3, 6815) | 6815 | (3, 4098) | 4098 |
| 8 hunt | 4, 1330) | 1330 | (4, 798) | 798 |
| Power ** | | | | |
| 1 | 4700 | | 4700 | |
| 2 | 4700 | | 4700 | |
| Flood storage | | | | |
| 1 | 11,870 | | 11,870 | |
| 2 | 13,000 | | 13,000 | |
| Water supply | | | | |
| 1 | 9,170 | | 9,170 | |
| 2 | 3,930 | | 3,930 | |
| Forest *** | (1, 1703) (3, 855) (4, 441) | 3000 | (2, 671) (3, 11) (4, 870) (5, 1030) (22, 16) (23, 400) | 3000 |

* (zone #, # of man days of activity)

** in acre-ft

*** (Zone #, area in acres)

Table XI.8
Honey Hill - Economic Efficiency

Honey Hill Economic Efficiency

(Restriction on Swanzey Lake-- parking to 100 cars)

| | 5000 cars | | 3000 cars | |
|---|---|---|---|---|
| Net Benefits | $5,532,724 | | $ 4,514,068 | |
| Activities * | | Targets | | Targets |
| 1. swim | (11, 935) (13, 3750) | 4685 | (11, 2811) | 2811 |
| 2. boat | (12, 920) | 920 | (10, 22) (12, 529) | 552 |
| 3. hike | ( 1, 890) | 890 | ( 1, 534) | 534 |
| 4. camp | (2, 220) | 220 | (2, 132) (11, 195) | 132 |
| 5. fish | (10, 625) (11, 192) | 816 | (10, 602) | 798 |
| 6. snowmobile | (2, 788) (5, 1546) | 2335 | (3, 1401) | 1401 |
| 7. ski | (3, 6815) | 6815 | (3, 4098) | 4098 |
| 8. hunt | (4, 1330) | 1330 | (4, 798) | 798 |
| Power releases | ** | | | |
| 1 | 4700 | 9400 | 4700 | 9400 |
| 2 | 4700 | | 4700 | |
| Flood storage | | | | |
| 1 | 12,193 | | 12,118 | |
| 2 | 13,323 | | 13,248 | |
| Water Supply | | | | |
| 1 | 9170 | 13,100 | 9170 | 13100 |
| 2 | 3930 | | 3930 | |
| Forest*** | (1, 1703) (3, 855) (4, 441) | 3000 | (2, 671) (3, 11) (4, 870) (5, 1030) (22, 16) (23, 400) | 3000 |

* (zone #, # of man-days of activity)

** in acre-ft

*** (zone #, area in acres)

Table XI.9
Honey Hill - Economic Efficiency (Restriction on Swanzey Lake -- Parking to 100 Cars)

response to increased demands for recreation during the summer months in Honey Hill reservoir. Unfortunately there appears to be little conflict between resource uses and the spatial and temporal uses of those resources in the model as it is now constituted.

## E. MAKING PLANS FROM THE LINEAR PROGRAM

The output of the linear program allocates the optimum number of man-days of each activity to the appropriate zones. It must be reiterated that the linear programming solution does not include all of the activities proposed for the Honey Hill project. Nor does it allocate those activities which it does include to the grid cells as required of the plan in order to be evaluated. Procedures were therefore developed by the research team to translate the output of the linear program into plans for both the "A" and "B" assumptions. The following discussion describes the process as applied to the "A" plan. The "B" plans are described in Appendix K.

The first stage is to translate the output of the linear program which is stated in terms of man-days of activity per zone, into the number of grid cells required. This involves the reintroduction of the space standards used in the simulation model. Table XI.10 shows the requirements developed from the linear program for the "A" scheme at N=3000.

The plans were made following the same procedures employed in the professional judgment schemes. The plan making procedure consists of selecting for each activity those cells in the appropriate zone which have the highest attractiveness and least impact for that activity. A cell by cell allocation of each activity required was made, subject to those cells lying within the appropriate zones.

As was the case in the preparation of the professional judgment schemes, this procedure occasionally involves a conflict in which the higher attractiveness cells also have more severe impacts. These judgments must be made on a case by case basis. Since the linear program only considers average values for these large zones, a further category of judgment may be required in conditions where so much activity is allocated to a zone that a literal following of the linear program demands would cause cells to be allocated which have low attractiveness and/or severe impact. In this case, a check on the maps of the

TABLE XI.10

LINEAR PROGRAM "A": PROGRAM FOR THE INITIAL PLAN, N=3000

| Activity* | Zone* | Man/days* | Persons/acre | Cells (2.5 acres) Required |
|---|---|---|---|---|
| 1. Summer | | | | |
| 1.2 Fishing | 11 | 195 | 2 | 39 |
| 1.3 Swimming | 11 | 2811 | 2000 | 1 (water)<br>12 (beach) |
| 1.4 Hiking | 17 | 300<br>233 | 3<br>3 | 40 lin.<br>31 lin. |
| 1.5 Camping | 16 | 132 | 16 | 3 |
| 1.7 Boating | 11 | 552 | 1.25 | 176 |
| 2. Winter | | | | |
| 2.1 Hunting | 16 | 798 | 8 | 40 |
| 2.5 Snowmobiling | 10<br>21 | 998<br>405 | 1.5<br>1.5 | 266<br>108 |
| 2.6 Downhill skiing | 23 | 4098 | 30 | 55 |
| 2.9 Parking | | | | 10 |
| 2.10 Major roads | | | | as given |

* Output of L.P., see Table

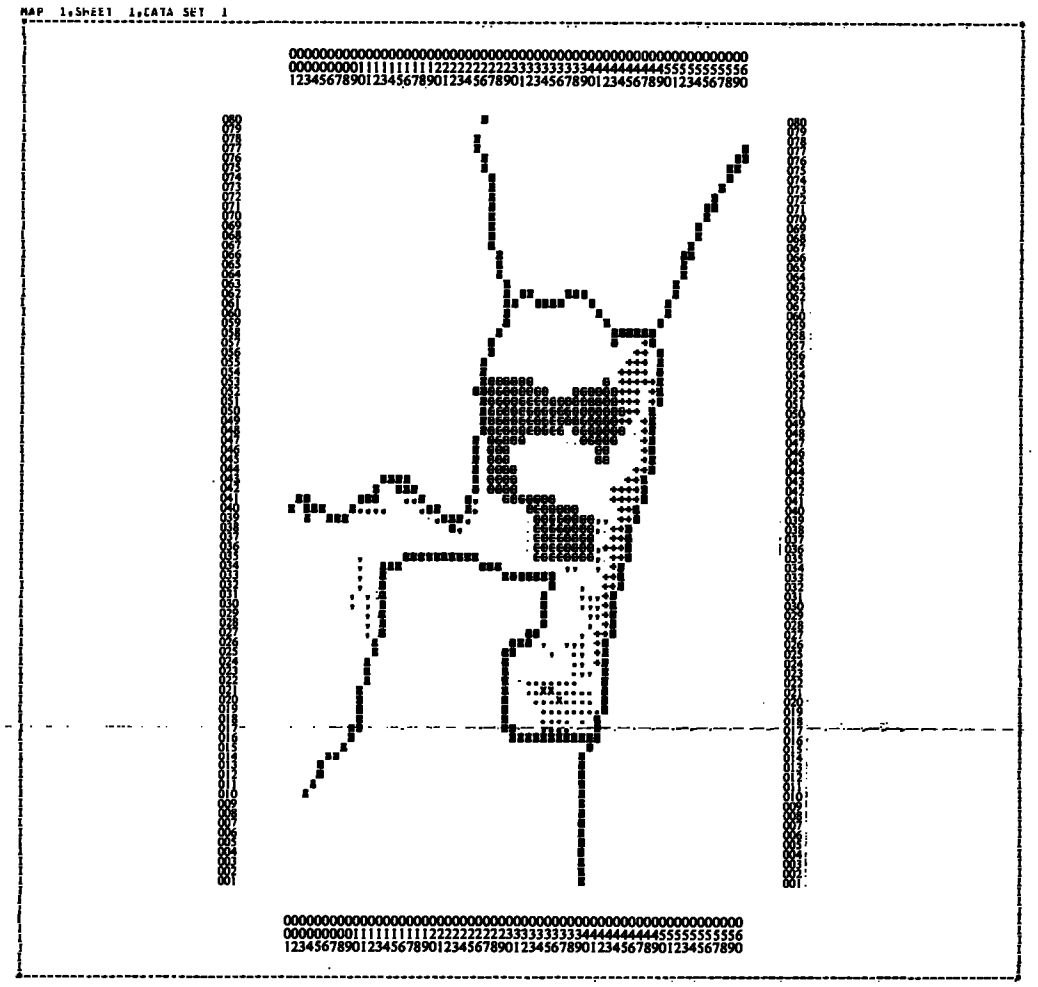
attractiveness and impact models may indicate available locations in near-by areas, but outside zones proposed by the linear program. In the plans which the research team made, this condition did arise and the designers chose to avoid unattractive and/or high impact sites. This necessitated the selection of locations in adjacent zones. Wherever possible, however, the sites selected conformed to the overall allocation concept generated by the linear program.

Sites were selected, a coding work sheet was prepared and the plans were keypunched and mapped. Figures XI.14 and XI.15 show the summer and winter plans for the linear program "A" proposal. This plan was then evaluated by the simulation model for its attractiveness, impact, social and fiscal consequences, as shown in Figures XI.16 through XI.19 and Tables XI.11 through XI.19.

## F. IMPROVING THE PLANS

Since the linear program only considered nine of the proposed activities, the next phase of plan preparation consists of the addition of these activities not previously allocated. Table XI.20 shows the activities which are indicated by the professional judgment program to be needed in addition to those specified by the linear program. These are then allocated to the sites according to their attractiveness and impact, again following the procedures previously described. Figures XI.20 through XI.23 and Tables XI.21 through XI.29 show the plans and evaluations of the scheme generated by the addition of the program "A" requirements to the linear program output. This scheme is comparable with the "A" plans produced through the use of professional judgment.

Since the previous proposal was evaluated for its attractiveness, impact, social and fiscal consequences by the simulation model, an attempt was made to improve its performance in each of these categories. The procedure employed is paralled to that described for the professional judgment schemes. First, an analysis is made of activity crowding, the purpose of which is to add facilities for those overcrowded activities and to eliminate under-utilized facilities, thus saving on capital costs. The changes proposed are shown in Table XI.30. Then, a cell by cell evaluation is made and changes proposed in order to improve the attractiveness and decrease the impact of each of the proposed allocations. Once this review is carried out, a final plan is described and mapped, as shown in Figures XI.24 and XI.25. It was evaluated by the simulation model as shown in Figures XI.26 through XI.29




LINEAR PROGRAM "A"

SUMMER PLAN

HONEY HILL CASE STUDY

LEGEND
1 = HUNTING
2 = FISHING AND CANOEING
3 = SWIMMING BEACH
4 = HIKING
5 = CAMPING
6 = PICNICKING
7 = MARINA AND BOATING
8 = RESIDENTIAL
9 = PARKING
10= MAJOR ROADS

DATA MAPPED IN 10 LEVELS BETWEEN EXTREME VALUES OF 0.50 AND 10.50

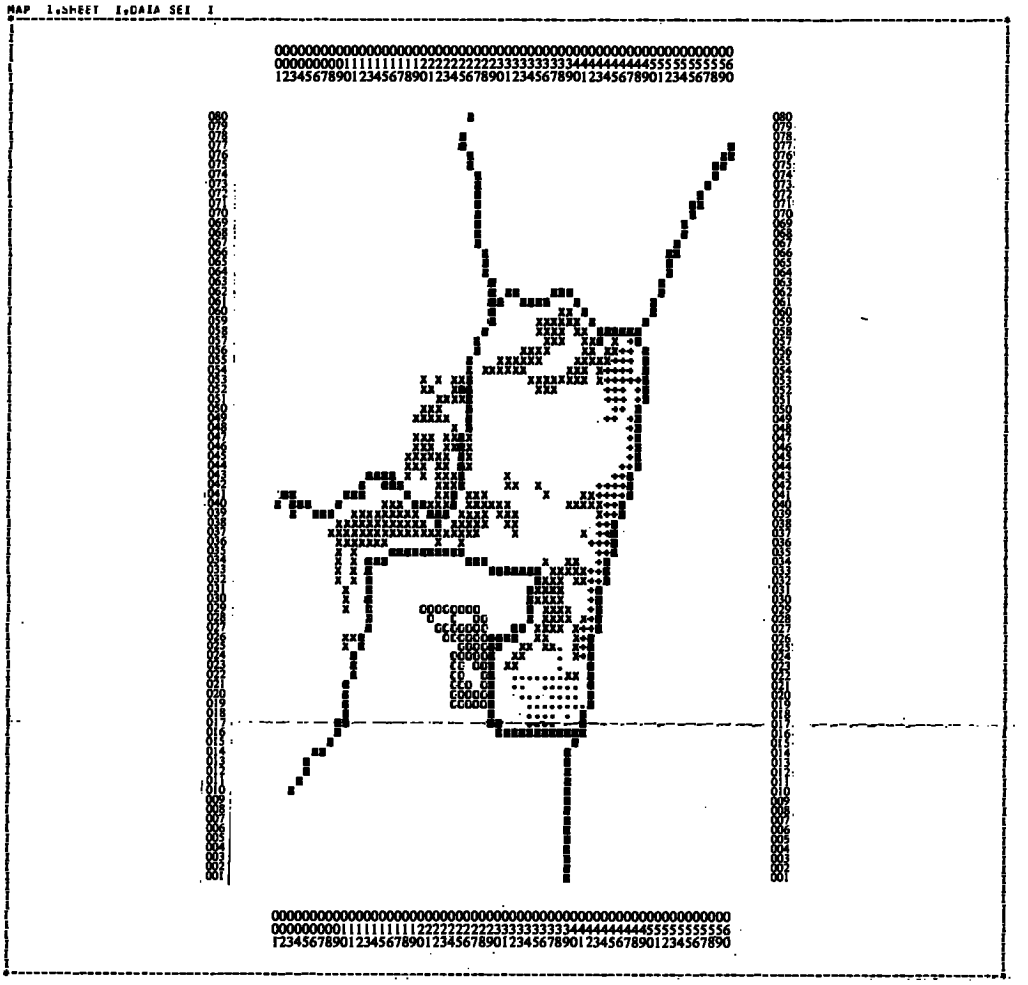
| ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| MINIMUM | 0.50 | 1.50 | 2.50 | 3.50 | 4.50 | 5.50 | 6.50 | 7.50 | 8.50 | 9.50 |
| MAXIMUM | 1.50 | 2.50 | 3.50 | 4.50 | 5.50 | 6.50 | 7.50 | 8.50 | 9.50 | 10.50 |

| PERCENTAGE OF TOTAL ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 |

FREQUENCY DISTRIBUTION OF DATA POINT VALUES IN EACH LEVEL

| LEVELS | LOW VALUES 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | HIGH VALUES 11 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SYMBOLS | | | | | | | | | | | | |
| FREQUENCY | 4207 | 41 | 35 | 12 | 71 | 3 | 0 | 176 | 0 | 9 | 242 | 0 |

Fig. XI.14
Linear Program "A": Summer Plan



LINEAR PROGRAM "A"

WINTER PLAN

HONEY HILL CASE STUDY

LEGEND
1 = HUNTING
2 = SNOW SHOEING
3 = CROSS COUNTRY SKIING
4 = TRAILS
5 = SNOW MOBILING
6 = DOWNHILL SKIING
7 = ICE SKATING
8 = RESIDENTIAL
9 = PARKING
10 = MAJOR ROADS

DATA MAPPED IN 10 LEVELS BETWEEN EXTREME VALUES OF 0.50 AND 10.50

ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| MINIMUM | 0.50 | 1.50 | 2.50 | 3.50 | 4.50 | 5.50 | 6.50 | 7.50 | 8.50 | 9.50 |
| MAXIMUM | 1.50 | 2.50 | 3.50 | 4.50 | 5.50 | 6.50 | 7.50 | 8.50 | 9.50 | 10.50 |

PERCENTAGE OF TOTAL ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

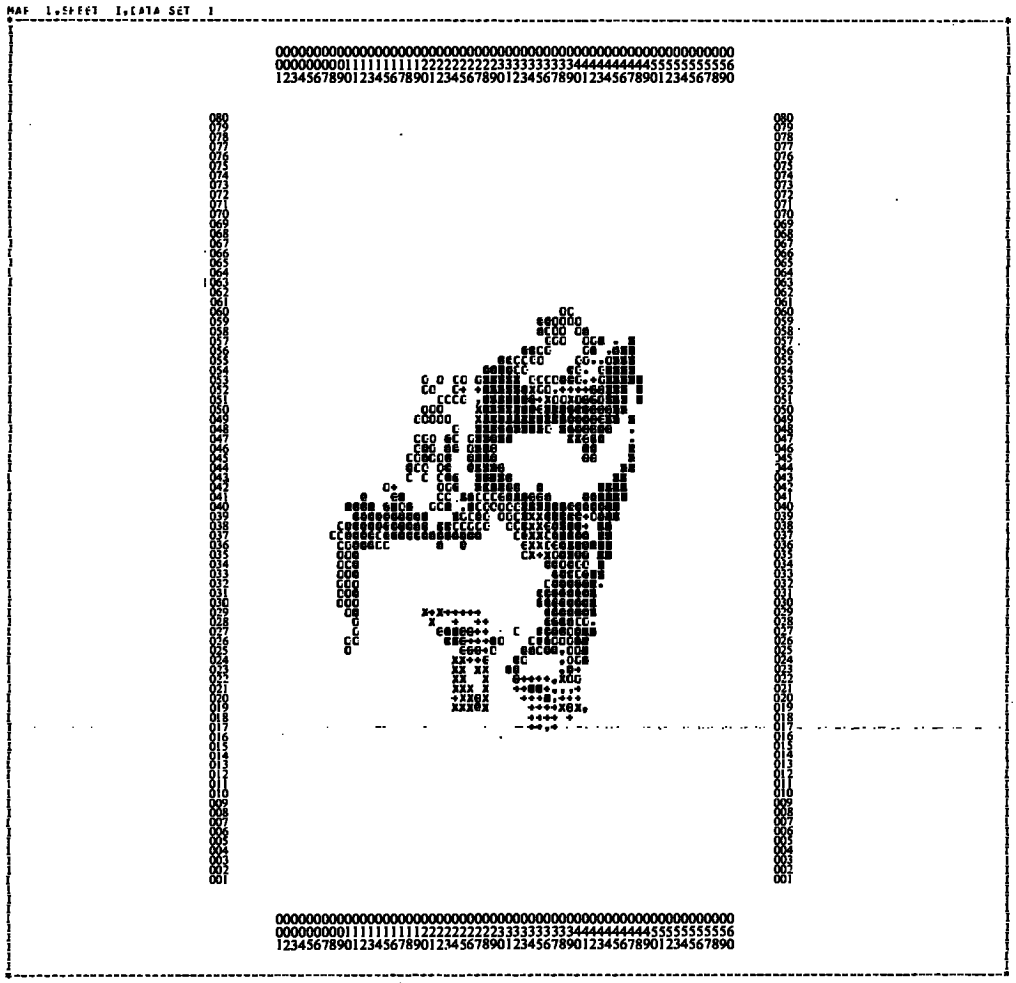
| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 |

FREQUENCY DISTRIBUTION OF DATA POINT VALUES IN EACH LEVEL

| LEVELS | LOW VALUES 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | HIGH VALUES 11 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SYMBOLS | | | | | | | | | | | | |
| FREQUENCY | 41C7 | 41 | 0 | 0 | 71 | 274 | 55 | 0 | 1 | 9 | 242 | 0 |

Fig. XI.15
Linear Program "A": Winter Plan

MAP 1,SHEET 1,DATA SET 1



LINEAR PROGRAM "A"

ATTRACTIVENESS EVALUATION

HONEY HILL CASE STUDY

THIS ANALYSIS SHOWS THE NORMALIZED ATTRACTIVENESS VALUES FOR EACH OF THE PLANNED ACTIVITIES.

LEGEND

0 = LEAST ATTRACTIVE AREAS FOR PLANNED ACTIVITIES TO
9 = MOST ATTRACTIVE AREAS FOR PLANNED ACTIVITIES

DATA MAPPED IN 10 LEVELS BETWEEN EXTREME VALUES OF 0.0 AND 100.00

ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| MINIMUM | 0.0 | 10.00 | 20.00 | 30.00 | 40.00 | 50.00 | 60.00 | 70.00 | 80.00 | 90.00 |
| MAXIMUM | 10.00 | 20.00 | 30.00 | 40.00 | 50.00 | 60.00 | 70.00 | 80.00 | 90.00 | 100.00 |

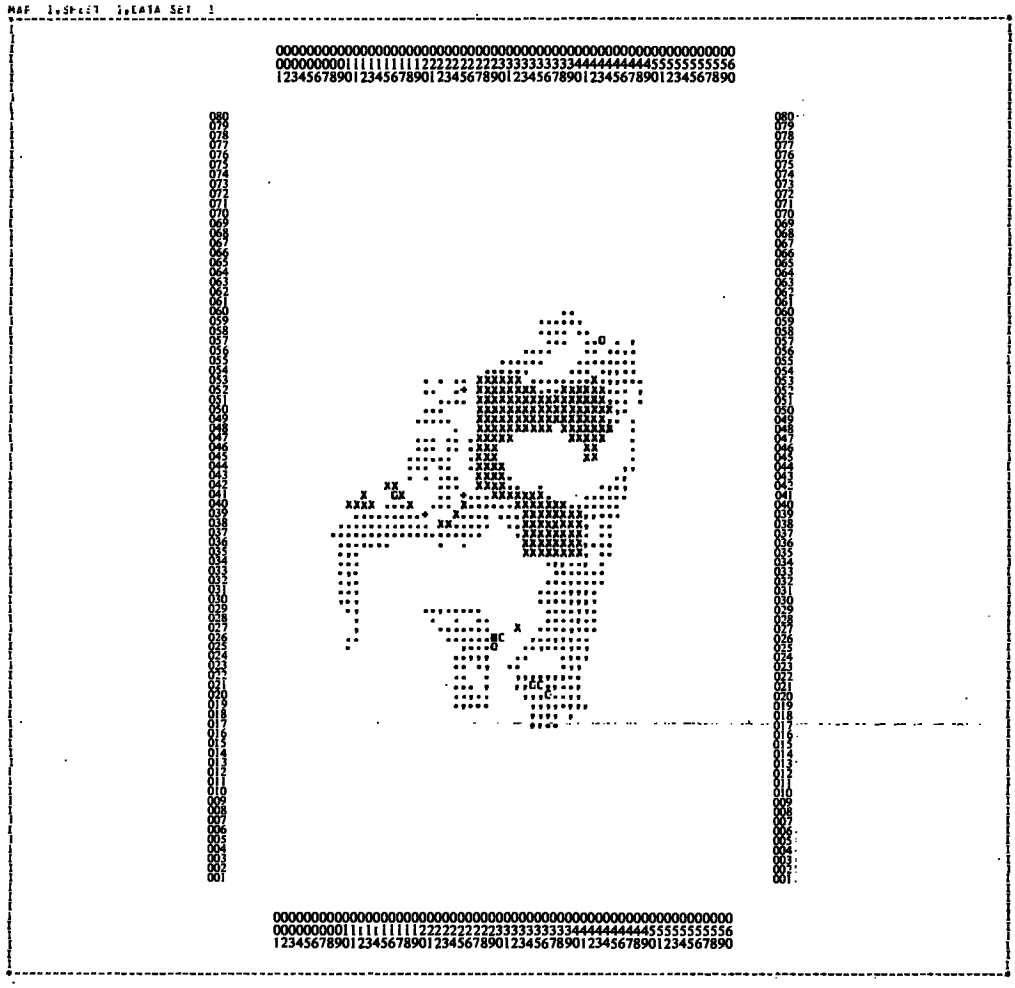
PERCENTAGE OF TOTAL ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 |

FREQUENCY DISTRIBUTION OF DATA POINT VALUES IN EACH LEVEL

| LEVELS | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|---|
| SYMBOLS | ++++++++ | ++++++++ | ++++++++ | ++++++++ | XXXXXXXX | CCCCCCCC | 00000000 | 00000000 | 00000000 | 00000000 |
| | ++++++++ | ++++++++ | ++++++++ | ++++++++ | XXXXXXXX | CCCCCCCC | 00000000 | 00000000 | 00000000 | 00000000 |
| | ++++ ++++ | ++++ ++++ | ++++ ++++ | ++++ ++++ | XXXX XXXX | CCCC CCCC | 0000 0000 | 0000 0000 | 0000 0000 | 0000 0000 |
| | ++++++++ | ++++++++ | ++++++++ | ++++++++ | XXXXXXXX | CCCCCCCC | 00000000 | 00000000 | 00000000 | 00000000 |
| | ++++++++ | ++++++++ | ++++++++ | ++++++++ | XXXXXXXX | CCCCCCCC | 00000000 | 00000000 | 00000000 | 00000000 |
| FREQUENCY | 12 | 5 | 6 | 51 | 41 | 168 | 37 | 182 | 50 | 122 |

Fig. XI.16
Linear Program "A": Attractiveness Evaluation



LINEAR PROGRAM "A"

TOTAL IMPACT ON ALL RESOURCE SYSTEMS

HONEY HILL CASE STUDY

THIS ANALYSIS SHOWS THE TOTAL IMPACT OF THIS PLAN ON ALL RESOURCE SYSTEMS.

LEGEND
0 = LEAST IMPACT CAUSED BY PLANNED LAND USE
TO
9 = GREATEST IMPACT CAUSED BY PLANNED LAND USE

DATA MAPPED IN 10 LEVELS BETWEEN EXTREME VALUES OF 2.00 AND 23.00

ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| MINIMUM | 2.00 | 4.10 | 6.20 | 8.30 | 10.40 | 12.50 | 14.60 | 16.70 | 18.80 | 20.90 |
| MAXIMUM | 4.10 | 6.20 | 8.30 | 10.40 | 12.50 | 14.60 | 16.70 | 18.80 | 20.90 | 23.00 |

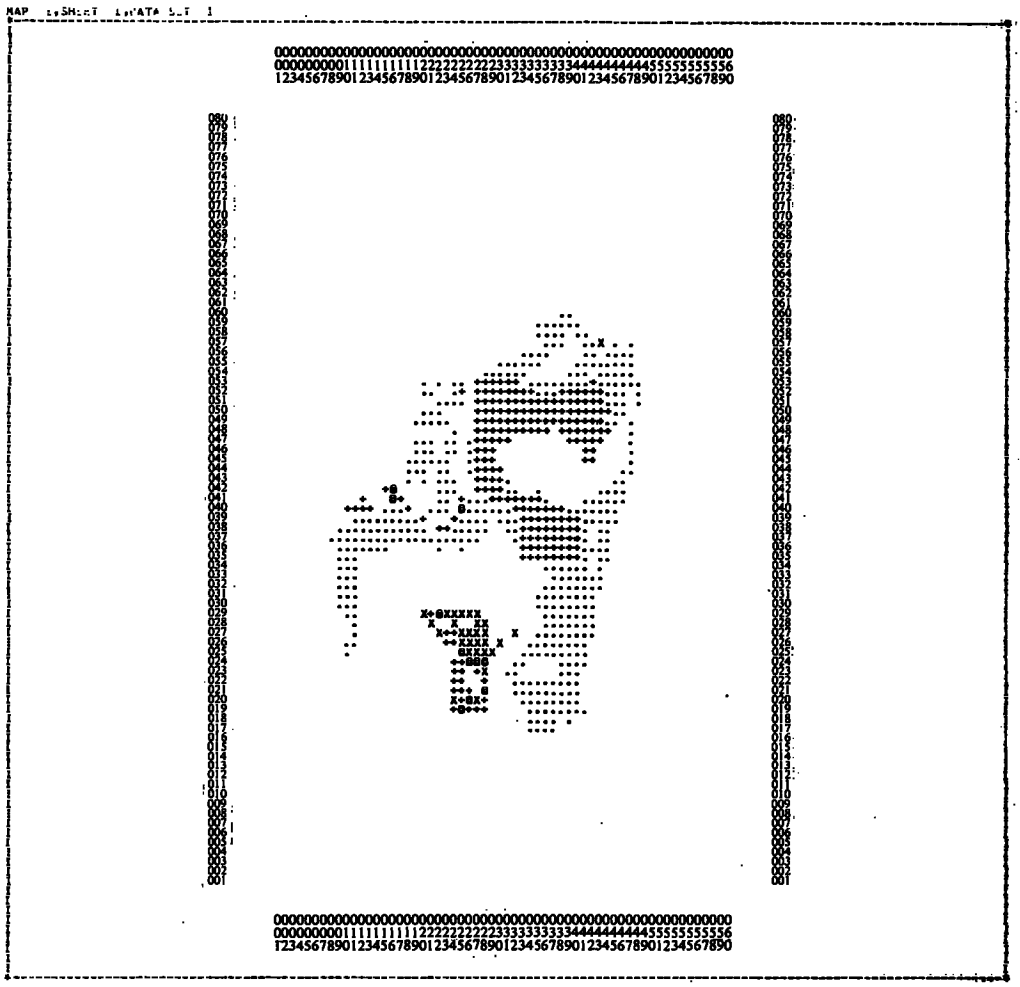
PERCENTAGE OF TOTAL ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 |

FREQUENCY DISTRIBUTION OF DATA POINT VALUES IN EACH LEVEL

| LEVELS | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|---|
| SYMBOLS | ..... | ..... | ..... | +++++++ | XXXXXXXX | CCCCCCCCC | EEEEEEEEE | ..... | ..... | ..... |
| FREQUENCY | 181 | 96 | 1 | 3 | 156 | 7 | 0 | 0 | 0 | 1 |

Fig. XI.17
Linear Program "A": Total Impact



LINEAR PROGRAM A

IMPACT ON SURFACE WATER SYSTEM

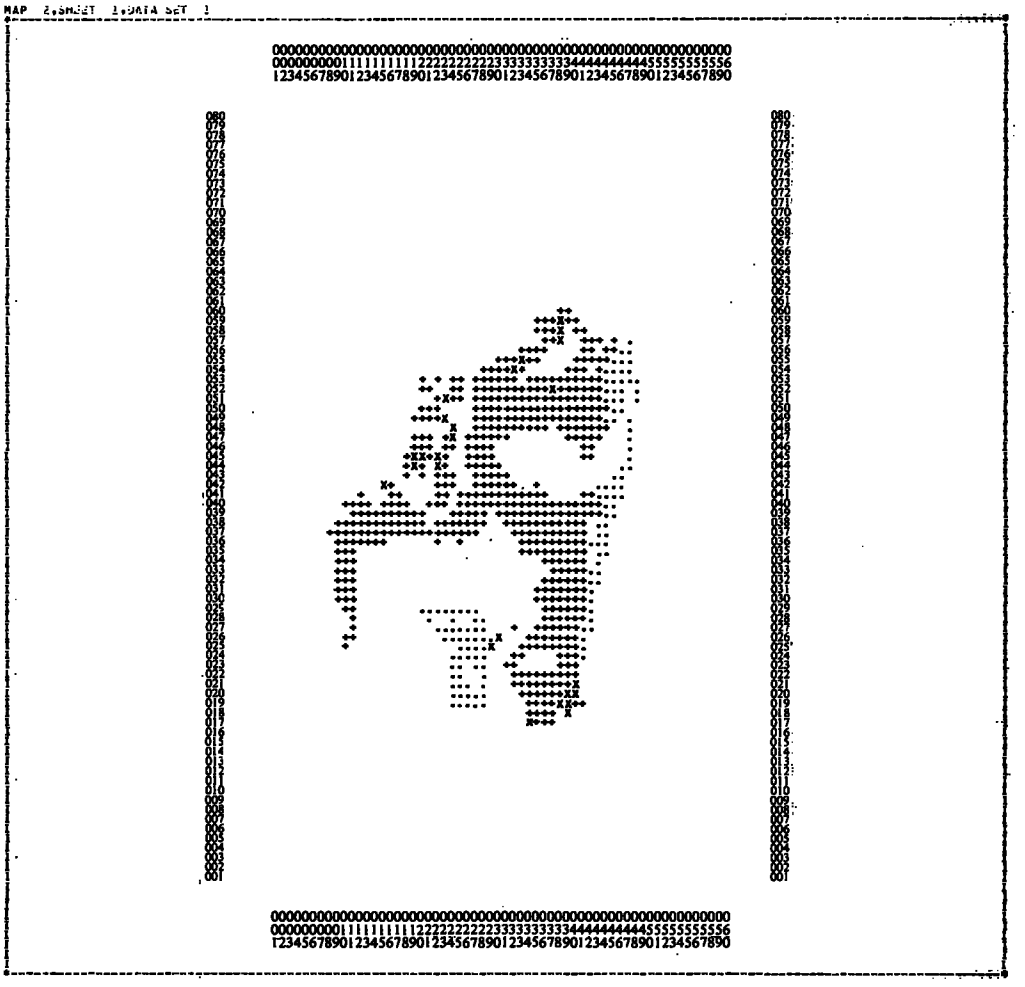
HONEY HILL CASE STUDY

LEGEND
0 = NO IMPACT
1 = COMPATIBLE IMPACT
2 = MODERATE IMPACT
3 = SEVERE IMPACT
4 = THRESHOLD IMPACT

THIS ANALYSIS SHOWS THE RELATIVE IMPACT OF THIS PLAN ON THIS RESOURCE SYSTEM.

| LEVELS | 0 | 1 | 2 | 3 | 4 |
|---|---|---|---|---|---|
| SYMBOLS | ..... | +++++++ | XXXXXXXX | 00000000 | ######## |
| | ..... | +++++++ | XXXXXXXX | 00000000 | ######## |
| | .... .... | ++++ ++++ | XXXX XXXX | 0000 0000 | #### #### |
| | ..... | +++++++ | XXXXXXXX | 00000000 | ######## |
| | ..... | +++++++ | XXXXXXXX | 00000000 | ######## |
| FREQUENCY | 428 | 212 | 29 | 11 | 0 |

Fig. XI.18
Linear Program "A": Impact on Surface Water System



LINEAR PROGRAM A

IMPACT ON WILDLIFE HABITAT

HONEY HILL CASE STUDY

LEGEND
0 = NO IMPACT
1 = COMPATIBLE IMPACT
2 = MODERATE IMPACT
3 = SEVERE IMPACT
4 = THRESHOLD IMPACT

THIS ANALYSIS SHOWS THE RELATIVE IMPACT OF THIS PLAN ON THIS RESOURCE SYSTEM.

| LEVELS | 0 | 1 | 2 | 3 | 4 |
|---|---|---|---|---|---|
| SYMBOLS | ..... | +++++++ | XXXXXXXX | ooooooooo | ||||||||| |
| FREQUENCY | 127 | 529 | 25 | 0 | 0 |

Fig. XI.19
Linear Program "A": Impact on Wildlife Habitat

Linear Program "A": Initial Plan
Table XI.11: "Summer N=3000"
No. Cells/Activity/Crowding

| ACT. # | 0-75% | 75-100% | 100-125% | 125-150% |
|---|---|---|---|---|
| 1 | 0.0 | 0.0 | 0.0 | 41.0 |
| 2 | 0.0 | 0.0 | 0.0 | 39.0 |
| 3 | 1.0 | 10.0 | 0.0 | 0.0 |
| 4 | 0.0 | 0.0 | 0.0 | 67.0 |
| 5 | 0.0 | 0.0 | 0.0 | 3.0 |
| 6 | 0.0 | 0.0 | 0.0 | 0.0 |
| 7 | 0.0 | 0.0 | 0.0 | 0.0 |
| 8 | 0.0 | 0.0 | 0.0 | 0.0 |
| 9 | 0.0 | 0.0 | 0.0 | 0.0 |
| TOTAL | 1.0 | 10.0 | 0.0 | 150.0 |

Linear Program "A": Initial Plan
Table XI.12: "Summer N=3000"
No. People/Activity/Crowding

| ACT. # | 0-75% | 75-100% | 100-125% | 125-150% | TURNED AWAY |
|---|---|---|---|---|---|
| 1 | 0.0 | 0.0 | 0.0 | 1228.7 | 59.0 |
| 2 | 0.0 | 0.0 | 0.0 | 292.5 | 45.9 |
| 3 | 862.9 | 11217.9 | 0.0 | 0.0 | 0.0 |
| 4 | 0.0 | 0.0 | 0.0 | 314.1 | 29.6 |
| 5 | 0.0 | 0.0 | 0.0 | 180.0 | 129.2 |
| 6 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 7 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 8 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 9 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| TOTAL | 862.9 | 11217.9 | 0.0 | 2015.2 | 263.7 |

Linear Program "A": Initial Plan
Table XI.13: "Summer N=3000"
Income/Activity

| ACT. # | LOCAL | REGIONAL |
|---|---|---|
| 1 | 8871.0 | 24484.0 |
| 2 | 2111.8 | 5828.7 |
| 3 | 27785.8 | 76688.6 |
| 4 | 2267.5 | 6258.4 |
| 5 | 1044.0 | 2067.1 |
| 6 | 0.0 | 0.0 |
| 7 | 0.0 | 0.0 |
| 8 | 0.0 | 0.0 |
| 9 | 0.0 | 0.0 |
| TOTAL | 42080.1 | 115326.7 |

Linear Program "A": Initial Plan
Table XI.14: "Winter N=3000"
No. Cells/Activity/Crowding

| ACT. # | 0-75% | 75-100% | 100-125% | 125-150% |
|---|---|---|---|---|
| 1 | 0.0 | 4.0 | 0.0 | 37.0 |
| 2 | 0.0 | 0.0 | 0.0 | 0.0 |
| 3 | 0.0 | 0.0 | 143.0 | 33.0 |
| 4 | 0.0 | 0.0 | 0.0 | 67.0 |
| 5 | 0.0 | 0.0 | 0.0 | 267.0 |
| 6 | 0.0 | 0.0 | 0.0 | 55.0 |
| 7 | 0.0 | 0.0 | 0.0 | 0.0 |
| 8 | 0.0 | 0.0 | 0.0 | 0.0 |
| 9 | 0.0 | 0.0 | 0.0 | 0.0 |
| TOTAL | 0.0 | 4.0 | 143.0 | 459.0 |

Linear Program "A": Initial Plan
Table XI.15: "Winter N=3000"
No. People/Activity/Crowding

| ACT. # | 0-75% | 75-100% | 100-125% | 125-150% | TURNED AWAY |
|---|---|---|---|---|---|
| 1 | 0.0 | 69.9 | 0.0 | 1110.0 | 22.4 |
| 2 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 3 | 0.0 | 0.0 | 1262.4 | 371.3 | 0.5 |
| 4 | 0.0 | 0.0 | 0.0 | 314.1 | 50.9 |
| 5 | 0.0 | 0.0 | 0.0 | 1501.9 | 3.4 |
| 6 | 0.0 | 0.0 | 0.0 | 5963.4 | 37.6 |
| 7 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 8 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 9 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| TOTAL | 0.0 | 69.9 | 1262.4 | 9260.6 | 114.8 |

Linear Program "A": Initial Plan
Table XI.16: "Winter N=3000
Income/Activity

| ACT. # | LOCAL | REGIONAL |
|---|---|---|
| 1 | 7220.8 | 19929.5 |
| 2 | 0.0 | 0.0 |
| 3 | 11386.2 | 31426.0 |
| 4 | 2267.5 | 6258.4 |
| 5 | 8710.9 | 17247.5 |
| 6 | 101198.2 | 279306.9 |
| 7 | 0.0 | 0.0 |
| 8 | 0.0 | 0.0 |
| 9 | 0.0 | 0.0 |
| TOTAL | 130783.6 | 354168.2 |

Linear Program "A": Initial Plan
Table XI.17: Summary

SUMMER PLAN ATTRACTIVENESS

| ACTIVITY | # OF CELLS | MEAN |
|---|---|---|
| 1 | 41 | 34.98 |
| 2 | 39 | 66.15 |
| 3 | 12 | 81.67 |
| 4 | 71 | 94.37 |
| 5 | 3 | 81.00 |
| 6 | 0 | 0.0 |
| 7 | 0 | 0.0 |
| 8 | 1 | 76.00 |
| 9 | 9 | 64.44 |
| 10 | 242 | 3.69 |
| TOTAL | 418 | 32.26 |

WINTER PLAN ATTRACTIVENESS

| ACTIVITY | # OF CELLS | MEAN |
|---|---|---|
| 11 | 41 | 34.98 |
| 12 | 0 | 0.0 |
| 13 | 0 | 0.0 |
| 14 | 71 | 94.37 |
| 15 | 274 | 68.39 |
| 16 | 55 | 49.75 |
| 17 | 0 | 0.0 |
| 18 | 1 | 76.00 |
| 19 | 9 | 64.44 |
| 20 | 242 | 3.69 |
| TOTAL | 693 | 44.96 |

Linear Program "A": Initial Plan
Table XI.18: Plan Impact TOTAL IMPACT = 6068.

| SYSTEM | NULL | COMPAT. | MODERATE | SEVERE | TERMINAL | MEAN |
|---|---|---|---|---|---|---|
| 1 | 428 | 36 | 70 | 188 | 25 | 1.124 |
| 2 | 480 | 254 | 13 | 0 | 0 | 0.375 |
| 3 | 437 | 238 | 72 | 0 | 0 | 0.511 |
| 4 | 126 | 491 | 121 | 9 | 0 | 1.017 |
| 5 | 480 | 39 | 224 | 3 | 1 | 0.669 |
| 6 | 338 | 142 | 135 | 132 | 0 | 1.082 |
| 7 | 441 | 1 | 68 | 234 | 3 | 1.139 |
| 8 | 0 | 0 | 0 | 0 | 0 | 0.0 |
| 9 | 0 | 0 | 0 | 0 | 0 | 0.0 |
| 10 | 55 | 437 | 242 | 4 | 9 | 1.297 |
| 11 | 437 | 80 | 102 | 118 | 10 | 0.908 |
| TOTAL | 3222 | 1718 | 1047 | 688 | 48 | 0.903 |

Linear Program "A": Initial Plan
Table XI.19: Capital Costs of Plan

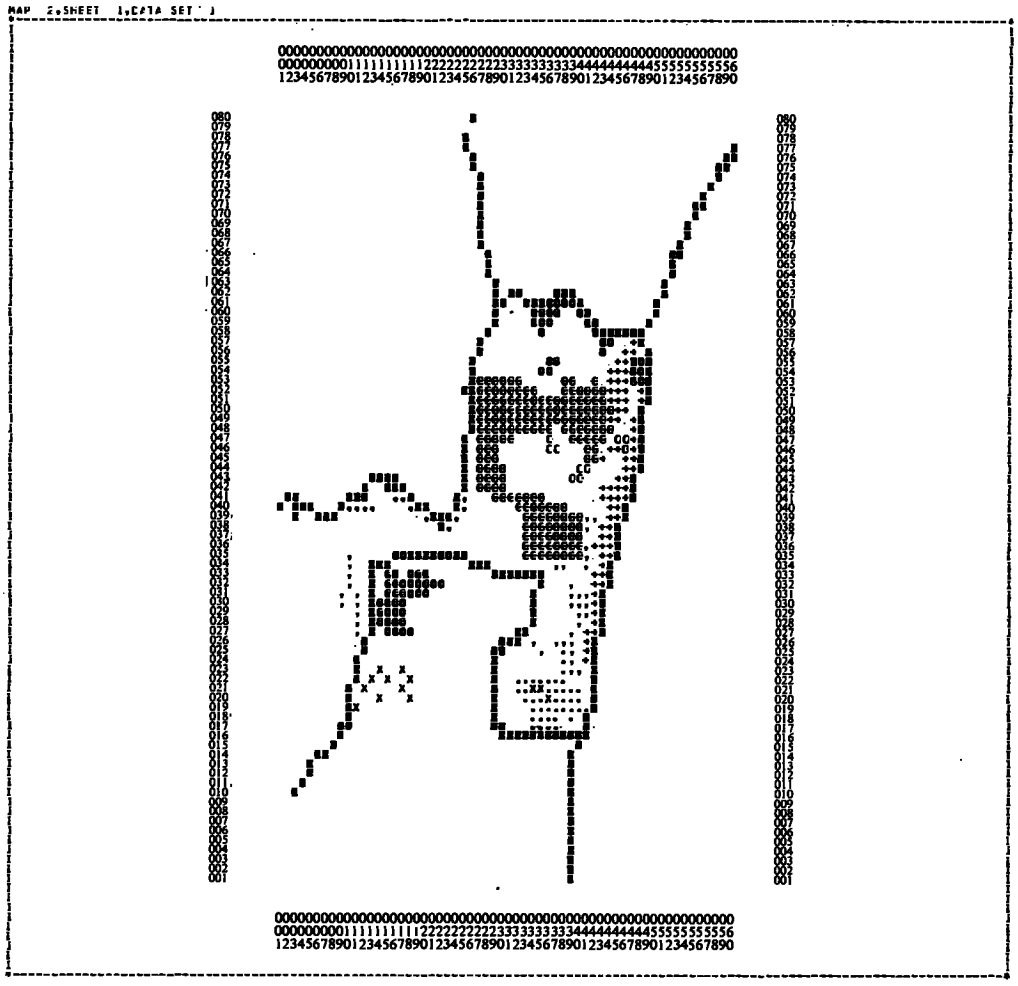
| ACTIVITY # | SUMMER | WINTER |
|---|---|---|
| 1 | 0 0 | 0 0 |
| 2 | 0 0 | 0 0 |
| 3 | 254 10 | 0 0 |
| 4 | 14 20 | 14 20 |
| 5 | 75 00 | 0 0 |
| 6 | 0 0 | 440 00 |
| 7 | 0 0 | 0 0 |
| 8 | 300 00 | 300 00 |
| 9 | 353 92 | 353 92 |
| 10 | 493 68 | 493 68 |
| TOTAL | 1490090 | 1601080 |

TABLE XI.20

LINEAR PROGRAM "A": ADDITIONAL PROGRAM REQUIREMENTS

| Activity | Additional Program Requirements |
|---|---|
| 1. Summer | |
| 1.5 Camping | 10 separated cells |
| 1.6 Picnicking | 10 separated cells |
| 1.7 Boating | 1 cell launching facility<br>1 cell rental facility |
| 1.8 Residential | Total 61 cells |
| 1.8.1 Water view | 35 cells |
| 1.8.2 Wood view | 10 cells |
| 1.8.3 Farmstead | 5 areas of 2 cells each |
| 1.8.4 Condiminium | 6 adjacent cells |

MAP 2,SHEET 1,DATA SET 1



LINEAR PROGRAM "A" + PROGRAM "A"

SUMMER PLAN

HONEY HILL CASE STUDY

LEGEND
1 = HUNTING
2 = FISHING AND CANOEING
3 = SWIMMING BEACH
4 = HIKING
5 = CAMPING
6 = PICNICKING
7 = MARINA AND BOATING
8 = RESIDENTIAL
9 = PARKING
10= MAJOR ROADS

DATA MAPPED IN 10 LEVELS BETWEEN EXTREME VALUES OF 0.50 AND 10.50

ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| MINIMUM | 0.50 | 1.50 | 2.50 | 3.50 | 4.50 | 5.50 | 6.50 | 7.50 | 8.50 | 9.50 |
| MAXIMUM | 1.50 | 2.50 | 3.50 | 4.50 | 5.50 | 6.50 | 7.50 | 8.50 | 9.50 | 10.50 |

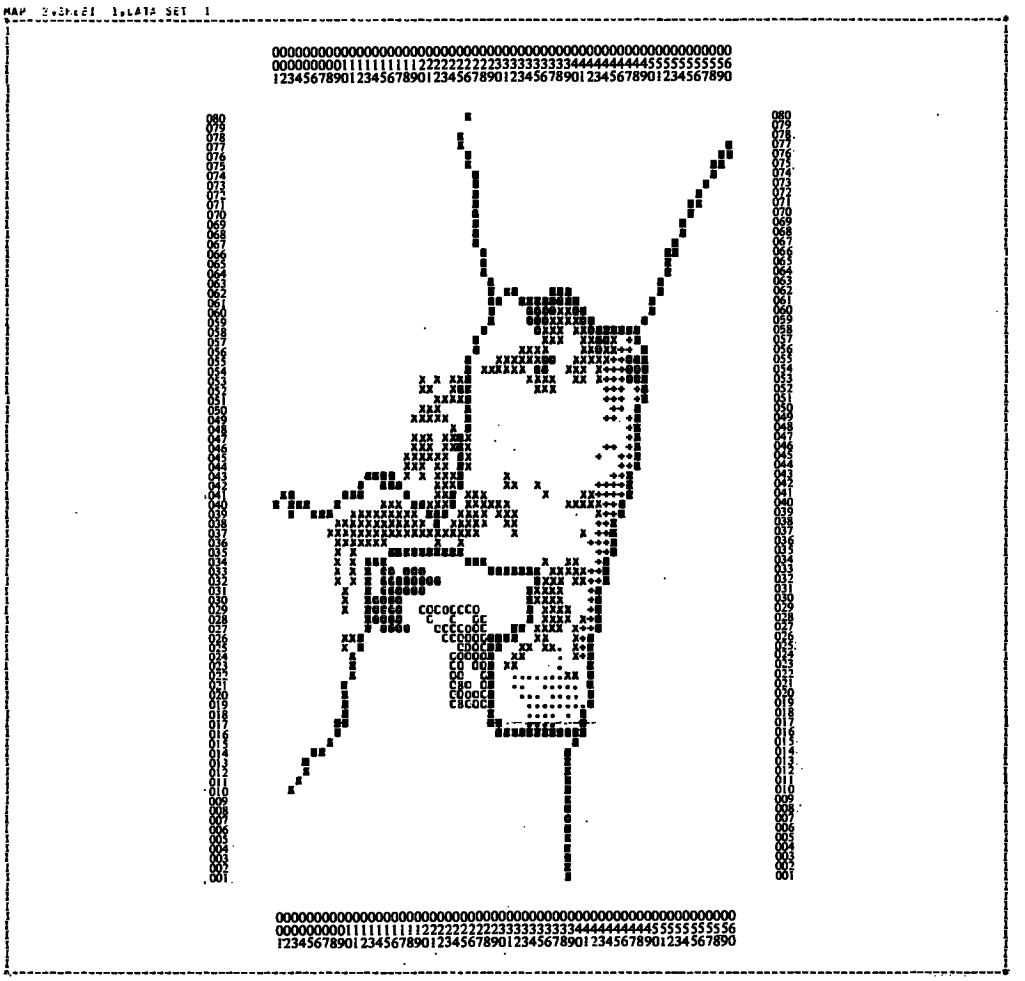
PERCENTAGE OF TOTAL ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

10.00 10.00 10.00 10.00 10.00 10.00 10.00 10.00 10.00 10.00

FREQUENCY DISTRIBUTION OF DATA POINT VALUES IN EACH LEVEL

| LEVELS | LOW VALUES 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | HIGH VALUES 11 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SYMBOLS | | | | | | | | | | | | |
| FREQUENCY | 4124 | 41 | 35 | 12 | 71 | 13 | 10 | 178 | 61 | 9 | 242 | 0 |

Fig. XI.20
Linear Program "A" + Program "A" -
Summer Plan



LINEAR PROGRAM "A" + PROGRAM "A"

WINTER PLAN

HONEY HILL CASE STUDY

LEGEND
1 = HUNTING
2 = BACK BOWING
3 = CROSS COUNTRY SKIING
4 = TRAILS
5 = BACK PEDALING
6 = DOWNHILL SKIING
7 = ICE SKATING
8 = RESIDENTIAL
9 = PARKING
10 = MAJOR ROADS

DATA MAPPED IN 10 LEVELS BETWEEN EXTREME VALUES OF 0.50 AND 10.50

ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| MINIMUM | 0.50 | 1.50 | 2.50 | 3.50 | 4.50 | 5.50 | 6.50 | 7.50 | 8.50 | 9.50 |
| MAXIMUM | 1.50 | 2.50 | 3.50 | 4.50 | 5.50 | 6.50 | 7.50 | 8.50 | 9.50 | 10.50 |

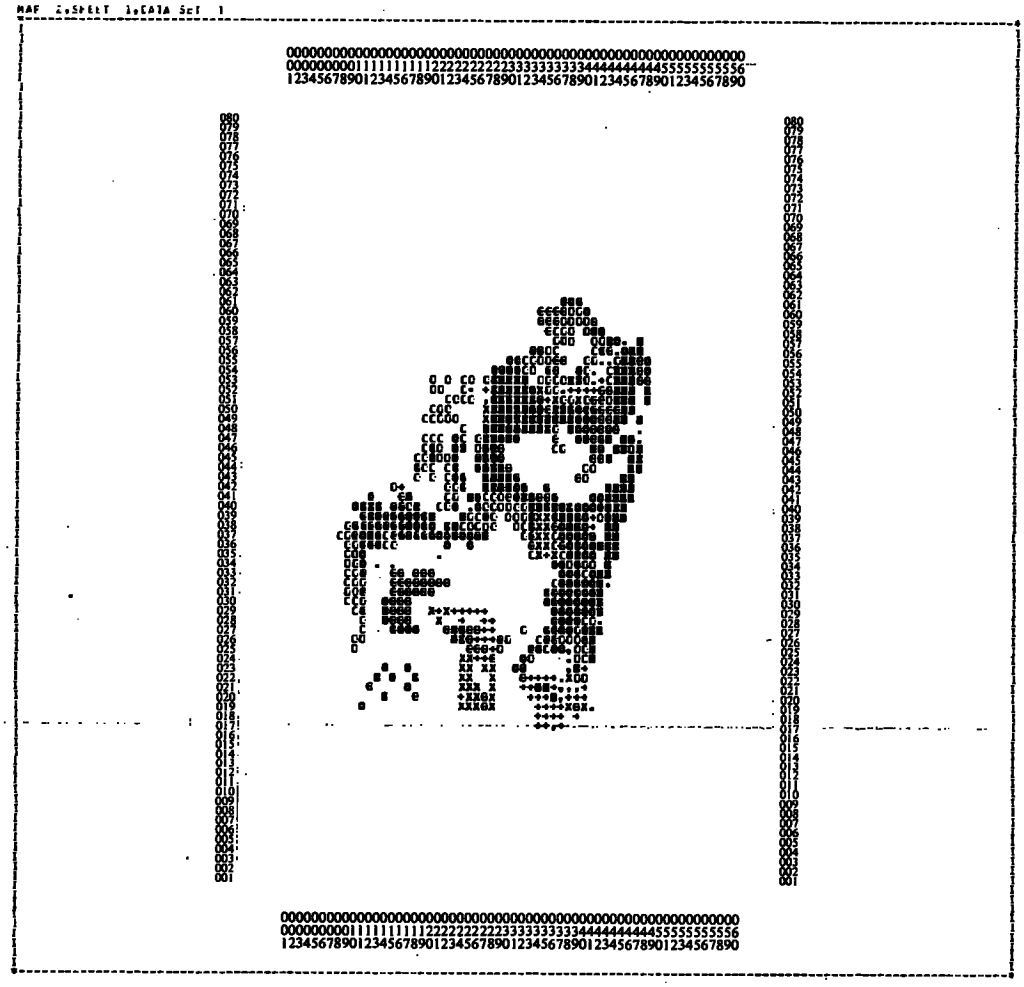
PERCENTAGE OF TOTAL ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 |

FREQUENCY DISTRIBUTION OF DATA POINT VALUES IN EACH LEVEL

| LEVELS | LOW VALUES 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | HIGH VALUES 11 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SYMBOLS | | | | | | | | | | | | |
| FREQUENCY | 4051 | 41 | 0 | 0 | 71 | 269 | 55 | 0 | 62 | 9 | 242 | 0 |

Fig. XI.21
Linear Program "A" + Program "A" -
Winter Plan



LINEAR PROGRAM "A" + PROGRAM "A"

ATTRACTIVENESS EVALUATION

HONEY HILL CASE STUDY

THIS ANALYSIS SHOWS THE NORMALIZED ATTRACTIVENESS VALUES FOR EACH OF THE PLANNED ACTIVITIES.

LEGEND

0 = LEAST ATTRACTIVE AREAS FOR PLANNED ACTIVITIES
10
9 = MOST ATTRACTIVE AREAS FOR PLANNED ACTIVITIES

DATA MAPPED IN 10 LEVELS BETWEEN EXTREME VALUES OF 0.0 AND 100.00

ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| MINIMUM | 0.0 | 10.00 | 20.00 | 30.00 | 40.00 | 50.00 | 60.00 | 70.00 | 80.00 | 90.00 |
| MAXIMUM | 10.00 | 20.00 | 30.00 | 40.00 | 50.00 | 60.00 | 70.00 | 80.00 | 90.00 | 100.00 |

PERCENTAGE OF TOTAL ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

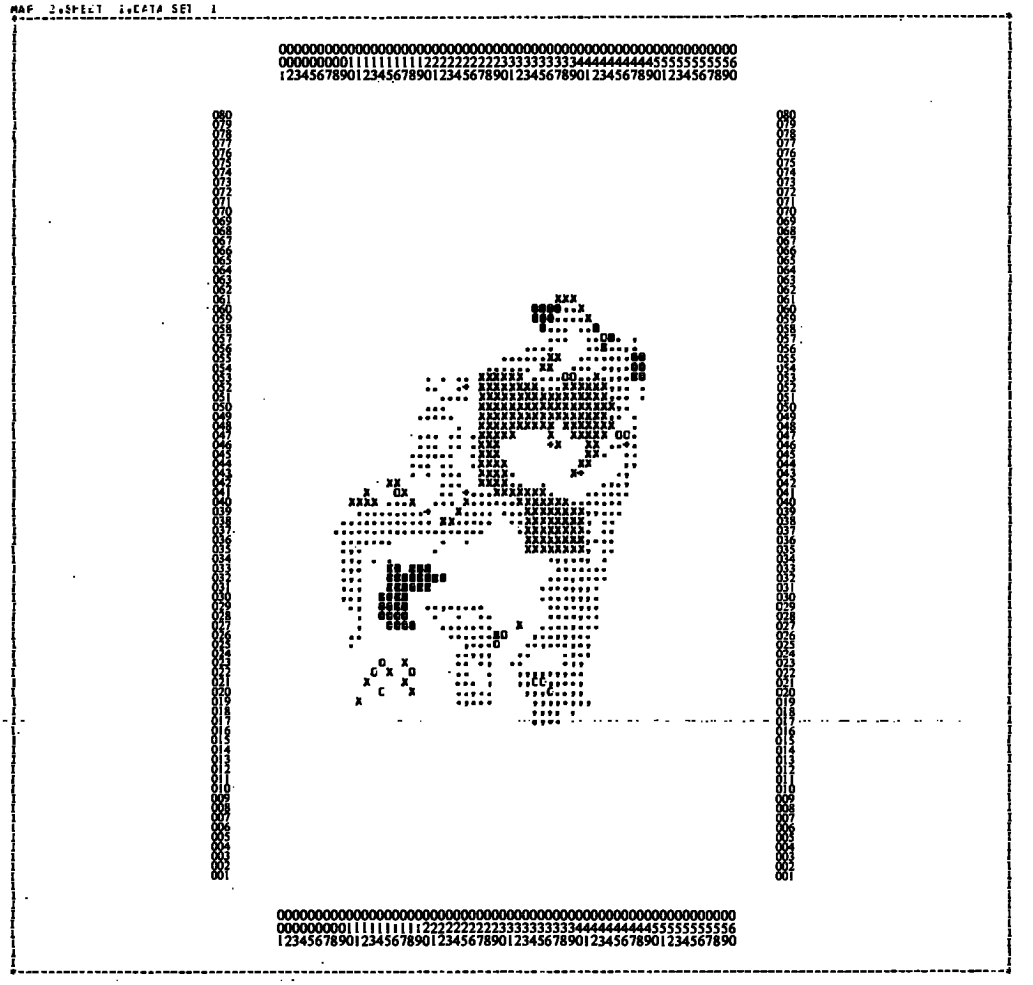
| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 |

FREQUENCY DISTRIBUTION OF DATA POINT VALUES IN EACH LEVEL

| LEVELS | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|---|
| SYMBOLS | | | | | | | | | | |
| FREQUENCY | 15 | 5 | 6 | 57 | 41 | 174 | 66 | 192 | 98 | 124 |

Fig. XI.22
Linear Program "A" + Program "A" -
Attractiveness Evaluation

MAP 2.SHEET 1.DATA SET 1



LINEAR PROGRAM "A" + PROGRAM "A"

TOTAL IMPACT ON ALL RESOURCE SYSTEMS

MONEY HILL CASE STUDY

THIS ANALYSIS SHOWS THE TOTAL IMPACT OF THIS PLAN ON ALL RESOURCE SYSTEMS.

LEGEND
0 = LEAST IMPACT CAUSED BY PLANNED LAND USE
TO
9 = GREATEST IMPACT CAUSED BY PLANNED LAND USE

DATA MAPPED IN 10 LEVELS BETWEEN EXTREME VALUES OF 2.00 AND 23.00

ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| MINIMUM | 2.00 | 4.10 | 6.20 | 8.30 | 10.40 | 12.50 | 14.60 | 16.70 | 18.80 | 20.90 |
| MAXIMUM | 4.10 | 6.20 | 8.30 | 10.40 | 12.50 | 14.60 | 16.70 | 18.80 | 20.90 | 23.00 |

PERCENTAGE OF TOTAL ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 |

FREQUENCY DISTRIBUTION OF DATA POINT VALUES IN EACH LEVEL

| LEVELS | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|---|
| SYMBOLS | | | | | XXXXXXXXX | CCCCCCCCC | GGGGGGGGG | | | |
| | | | | | XXXXXXXXX | CCCCCCCCC | GGGGGGGGG | | | |
| | | | | | XXXX XXXX | CCCC CCCC | GGGG GGGG | | | |
| | | | | | XXXXXXXXX | CCCCCCCCC | GGGGGGGGG | | | |
| | | | | | XXXXXXXXX | CCCCCCCCC | GGGGGGGGG | | | |
| FREQUENCY | 275 | 56 | 1 | 6 | 210 | 15 | 0 | 25 | 26 | 2 |

Fig. XI.23
Linear Program "A" + Program "A" -
Total Impact

Linear Program "A" + Program "A"
Table XI.21: "Summer N=3000"
No. Cells/Activity/Crowding

| ACT. # | 0-75% | 75-100% | 100-125% | 125-150% |
|---|---|---|---|---|
| 1 | 4.0 | 0.0 | 6.0 | 31.0 |
| 2 | 0.0 | 0.0 | 0.0 | 39.0 |
| 3 | 11.0 | 0.0 | 0.0 | 0.0 |
| 4 | 0.0 | 0.0 | 0.0 | 67.0 |
| 5 | 13.0 | 0.0 | 0.0 | 0.0 |
| 6 | 0.0 | 0.0 | 0.0 | 10.0 |
| 7 | 0.0 | 0.0 | 0.0 | 2.0 |
| 8 | 0.0 | 0.0 | 0.0 | 0.0 |
| 9 | 0.0 | 0.0 | 0.0 | 0.0 |
| TOTAL | 28.0 | 0.0 | 6.0 | 149.0 |

Linear Program "A" + Program "A"
Table XI.22: "Summer N=3000"
No. People/Activity/Crowding

| ACT. # | 0-75% | 75-100% | 100-125% | 125-150% | TURNED AWAY |
|---|---|---|---|---|---|
| 1 | 118.7 | 0.0 | 356.0 | 2325.0 | 14.0 |
| 2 | 0.0 | 0.0 | 0.0 | 731.3 | 34.6 |
| 3 | 12080.8 | 0.0 | 0.0 | 0.0 | 0.0 |
| 4 | 0.0 | 0.0 | 0.0 | 785.2 | 22.6 |
| 5 | 567.6 | 0.0 | 0.0 | 0.0 | 0.0 |
| 6 | 0.0 | 0.0 | 0.0 | 3750.0 | 77.3 |
| 7 | 0.0 | 0.0 | 0.0 | 1500.0 | 398.0 |
| 8 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 9 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| TOTAL | 12767.1 | 0.0 | 356.0 | 9091.4 | 546.5 |

Linear Program "A" + Program "A"
Table XI.23: "Summer N=3000"
Income/Activity

| ACT. # | LOCAL | REGIONAL |
|---|---|---|
| 1 | 20213.7 | 55789.9 |
| 2 | 5279.6 | 14571.8 |
| 3 | 27785.8 | 76688.6 |
| 4 | 5668.8 | 15646.0 |
| 5 | 3292.3 | 6518.8 |
| 6 | 21750.0 | 43065.0 |
| 7 | 10830.0 | 29890.8 |
| 8 | 0.0 | 0.0 |
| 9 | 0.0 | 0.0 |
| TOTAL | 94820.1 | 242170.6 |

Linear Program "A" + Program "A"
Table XI.24: "Winter N=3000"
No. Cells/Activity/Crowding

| ACT. # | 0-75% | 75-100% | 100-125% | 125-150% |
|---|---|---|---|---|
| 1 | 10.0 | 0.0 | 26.0 | 5.0 |
| 2 | 0.0 | 0.0 | 0.0 | 0.0 |
| 3 | 176.0 | 0.0 | 0.0 | 0.0 |
| 4 | 0.0 | 0.0 | 0.0 | 67.0 |
| 5 | 0.0 | 131.0 | 0.0 | 131.0 |
| 6 | 18.0 | 23.0 | 10.0 | 4.0 |
| 7 | 0.0 | 0.0 | 0.0 | 0.0 |
| 8 | 0.0 | 0.0 | 0.0 | 0.0 |
| 9 | 0.0 | 0.0 | 0.0 | 0.0 |
| TOTAL | 204.0 | 154.0 | 36.0 | 207.0 |

Linear Program "A" + Program "A"
Table XI.25: "Winter N=3000"
No. People/Activity/Crowding

| ACT. # | 0-75% | 75-100% | 100-125% | 125-150% | TURNED AWAY |
|---|---|---|---|---|---|
| 1 | 279.5 | 0.0 | 1362.5 | 359.6 | 12.3 |
| 2 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 3 | 1650.8 | 0.0 | 0.0 | 0.0 | 0.0 |
| 4 | 0.0 | 0.0 | 0.0 | 785.2 | 43.8 |
| 5 | 0.0 | 1211.6 | 0.0 | 1615.4 | 0.0 |
| 6 | 1800.9 | 3451.7 | 2001.0 | 1000.5 | 0.0 |
| 7 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 8 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 9 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| TOTAL | 3731.1 | 4663.2 | 3363.5 | 3760.7 | 56.2 |

Linear Program "A" + Program "A"
Table XI.26: "Winter N=3000"
Income/Activity

| ACT. # | LOCAL | REGIONAL |
|---|---|---|
| 1 | 12250.2 | 33810.4 |
| 2 | 0.0 | 0.0 |
| 3 | 11505.9 | 31756.2 |
| 4 | 5668.8 | 15646.0 |
| 5 | 16396.4 | 32464.8 |
| 6 | 140069.7 | 386592.3 |
| 7 | 0.0 | 0.0 |
| 8 | 0.0 | 0.0 |
| 9 | 0.0 | 0.0 |
| TOTAL | 185890.9 | 500269.7 |

Linear Program "A" + Program "A"
Table XI.27: Summary

SUMMER PLAN ATTRACTIVENESS

| ACTIVITY | # OF CELLS | MEAN |
|---|---|---|
| 1 | 41 | 34.98 |
| 2 | 39 | 66.15 |
| 3 | 12 | 81.67 |
| 4 | 71 | 94.37 |
| 5 | 13 | 75.46 |
| 6 | 10 | 68.00 |
| 7 | 2 | 90.00 |
| 8 | 62 | 68.47 |
| 9 | 9 | 64.44 |
| 10 | 242 | 3.69 |
| TOTAL | 501 | 38.43 |

WINTER PLAN ATTRACTIVENESS

| ACTIVITY | # OF CELLS | MEAN |
|---|---|---|
| 11 | 41 | 34.98 |
| 12 | 0 | 0.0 |
| 13 | 0 | 0.0 |
| 14 | 71 | 94.37 |
| 15 | 269 | 68.18 |
| 16 | 55 | 49.75 |
| 17 | 0 | 0.0 |
| 18 | 62 | 68.47 |
| 19 | 9 | 64.44 |
| 20 | 242 | 3.69 |
| TOTAL | 749 | 46.63 |

Linear Program "A" + Program "A"
Table XI.28: Plan Impact TOTAL IMPACT = 7370.

| SYSTEM | NULL | COMPAT. | MODERATE | SEVERE | TERMINAL | MEAN |
|---|---|---|---|---|---|---|
| 1 | 443 | 36 | 98 | 218 | 30 | 1.219 |
| 2 | 485 | 301 | 39 | 0 | 0 | 0.459 |
| 3 | 432 | 302 | 91 | 0 | 0 | 0.587 |
| 4 | 126 | 560 | 130 | 9 | 0 | 1.027 |
| 5 | 475 | 65 | 281 | 3 | 1 | 0.776 |
| 6 | 333 | 149 | 156 | 187 | 0 | 1.239 |
| 7 | 436 | 11 | 122 | 253 | 3 | 1.244 |
| 8 | 0 | 0 | 0 | 0 | 0 | 0.0 |
| 9 | 0 | 0 | 0 | 0 | 0 | 0.0 |
| 10 | 55 | 454 | 303 | 4 | 9 | 1.343 |
| 11 | 432 | 90 | 151 | 142 | 10 | 1.040 |
| TOTAL | 3217 | 1968 | 1371 | 816 | 53 | 0.993 |

Linear Program "A" + Program "A"
Table XI.29: Capital Costs of Plan

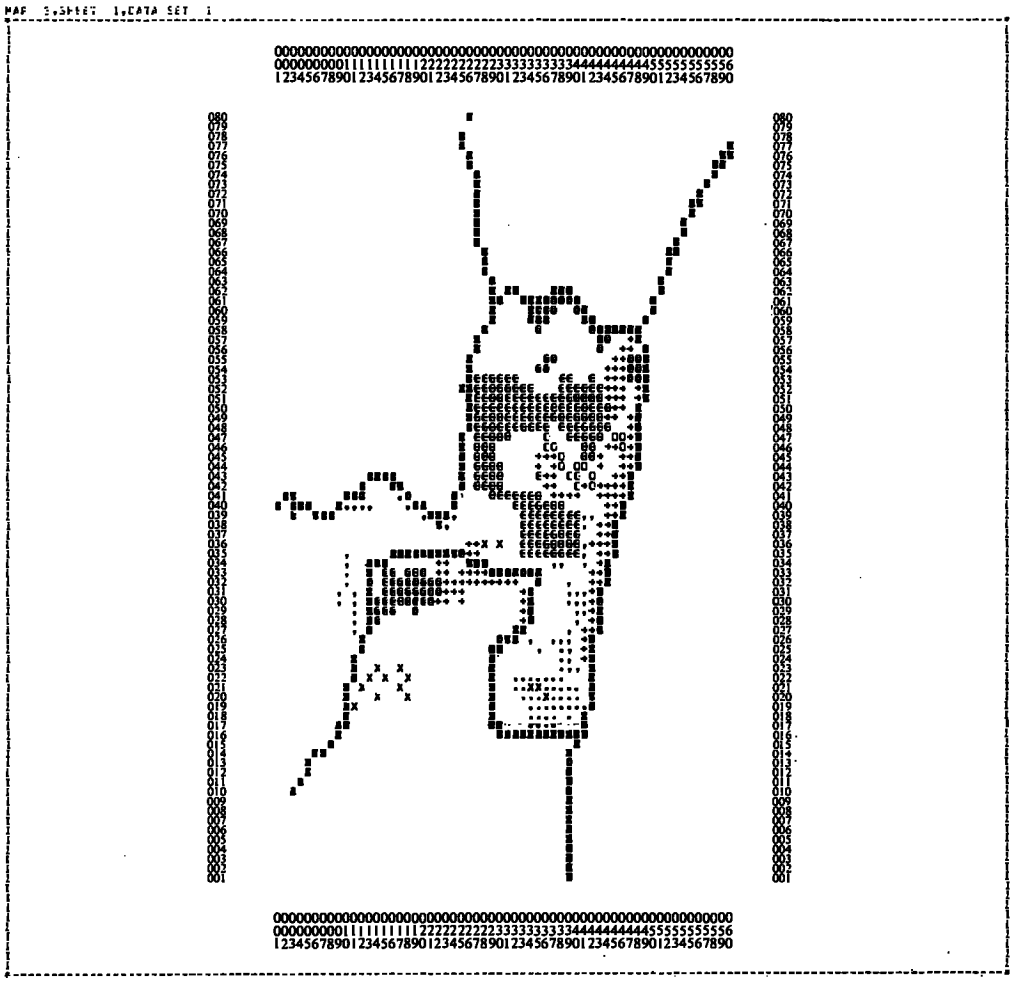
| ACTIVITY # | SUMMER | WINTER |
|---|---|---|
| 1 | 0 0 | 0 0 |
| 2 | 0 0 | 0 0 |
| 3 | 254 10 | 0 0 |
| 4 | 14 20 | 14 20 |
| 5 | 325 00 | 0 0 |
| 6 | 43 75 | 440 00 |
| 7 | 12 00 | 0 0 |
| 8 | 18600 00 | 18600 00 |
| 9 | 353 92 | 353 92 |
| 10 | 493 68 | 493 68 |
| TOTAL | 20096065 | 19901080 |

TABLE XI.30

LINEAR PROGRAM "A": PROPOSED PROGRAM CHANGES
FROM SIMULATION MODEL EVALUATION

| Activity | Proposed Change |
|---|---|
| 1. Summer | |
| 1.3 Swimming | omit 3 cells |
| 1.4 Trail hiking | add 50 cells |
| 1.5 Camping | add 4 cells |
| 1.6 Picnicking | add 5 cells |
| 1.7 Boating | add 1 cell launch area |
| 2. Winter | |
| 2.6 Downhill skiing | add 25 cells |

MAP 3,SHEET 1,DATA SET 1



LINEAR PROGRAM "A" + PROGRAM "A" + SIMULATION EVALUATION

SUMMER PLAN

HENRY HILL CASE STUDY

LEGEND
1 = HUNTING
2 = FISHING AND CANOEING
3 = SWIMMING BEACH
4 = HIKING
5 = CAMPING
6 = PICNICKING
7 = MAPPING AND BOATING
8 = RESIDENTIAL
9 = PARKING
10= MAJOR ROADS

DATA MAPPED IN 10 LEVELS BETWEEN EXTREME VALUES OF 0.50 AND 10.50

ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| MINIMUM | 0.50 | 1.50 | 2.50 | 3.50 | 4.50 | 5.50 | 6.50 | 7.50 | 8.50 | 9.50 |
| MAXIMUM | 1.50 | 2.50 | 3.50 | 4.50 | 5.50 | 6.50 | 7.50 | 8.50 | 9.50 | 10.50 |

PERCENTAGE OF TOTAL ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

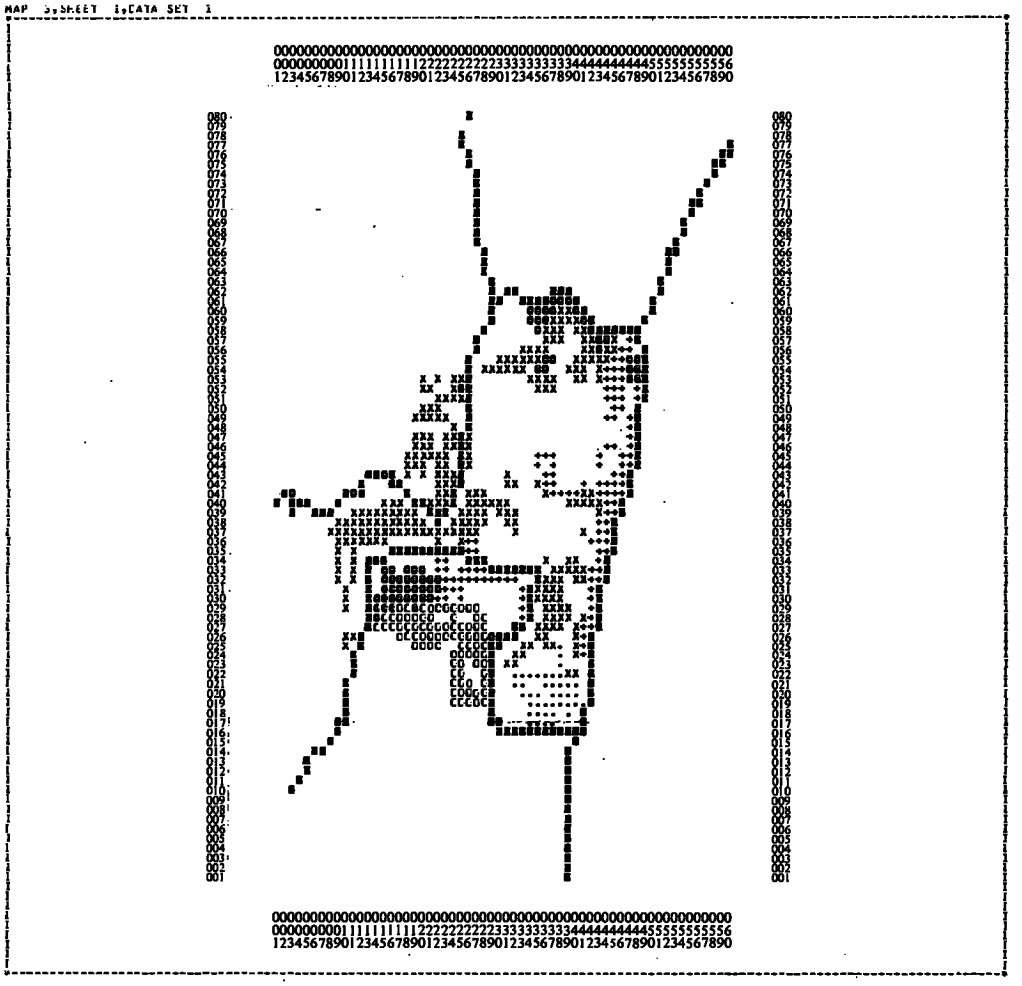
| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 |

FREQUENCY DISTRIBUTION OF DATA POINT VALUES IN EACH LEVEL

| LEVELS | LOW VALUES 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | HIGH VALUES 11 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| SYMBOLS | | | | | | | | | | | |
| FREQUENCY | 2074 | 41 | 39 | 5 | 118 | 15 | 15 | 175 | 60 | 8 | 242 | 0 |

Fig. XI.24
Linear Program "A" + Program "A" + Simulation Evaluation: Summer Plan

MAP 3,SHEET 1,DATA SET 1



LINEAR PROGRAM "A" + PROGRAM "A" + SIMULATION EVALUATION

WINTER PLAN

HONEY HILL CASE STUDY

LEGEND
1 = BOATING
2 = SNOW SHOEING
3 = CROSS COUNTRY SKIING
4 = TRAILS
5 = SNOW MOBILING
6 = DOWNHILL SKIING
7 = ICE SKATING
8 = RESIDENTIAL
9 = PARKING
10 = MAJOR ROADS

DATA MAPPED IN 10 LEVELS BETWEEN EXTREME VALUES OF 0.50 AND 10.50

ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| MINIMUM | 0.50 | 1.50 | 2.50 | 3.50 | 4.50 | 5.50 | 6.50 | 7.50 | 8.50 | 9.50 |
| MAXIMUM | 1.50 | 2.50 | 3.50 | 4.50 | 5.50 | 6.50 | 7.50 | 8.50 | 9.50 | 10.50 |

PERCENTAGE OF TOTAL ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 |

FREQUENCY DISTRIBUTION OF DATA POINT VALUES IN EACH LEVEL

| LEVELS | LOW VALUES 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | HIGH VALUES 11 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SYMBOLS | | | | | | | | | | | | |
| FREQUENCY | 3580 | 41 | 0 | 0 | 118 | 245 | 81 | 0 | 61 | 8 | 242 | 0 |

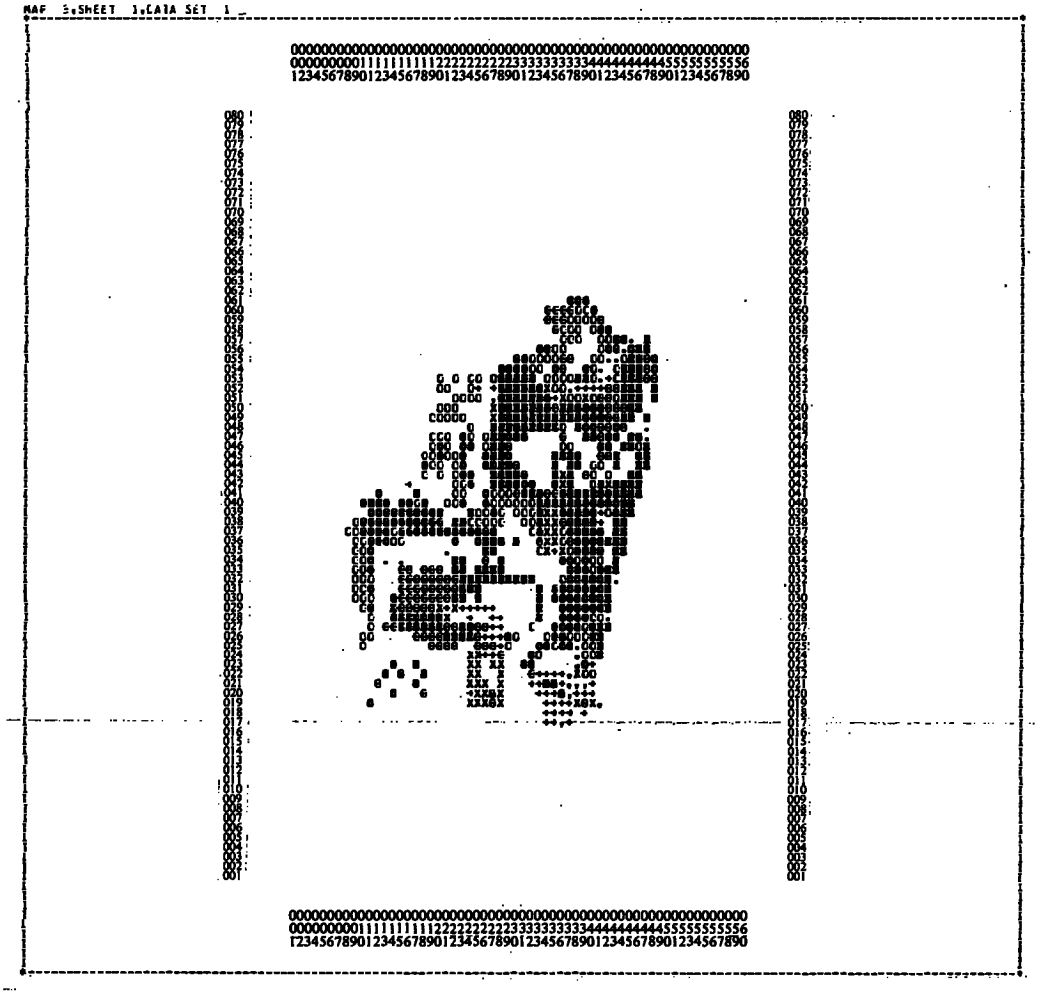
Fig. XI.25
Linear Program "A" + Program "A" + Simulation Evaluation: Winter Plan

and Tables XI.31 through XI.39. This proposal can be considered the "best" plan developable from the linear programming for a demand of N=3000 under the "A" assumption.

A parallel procedure was used for the making and evaluation of plans based upon the linear program solution for the "B" assumption. These plans and their evaluations are shown in Appendix K.

Table XI.40 shows the extent to which the initial linear program plan was improved. Since the initial plan prepared from the linear program output only allocated nine of the required activities, it is the second plan, which incorporates the requirements of the program developed for the professional judgment schemes, that must be considered the basis for comparative evaluations. The great difference between the first and second plan is the increased capital costs caused by the introduction of residential development.

There is again (as was the case in the improvement of the professional judgment schemes) a major improvement in the linear program "A" plans. In both the summer and winter plans, the attractiveness has been substantially increased while the impact of the activities has had a minor increase. The number of people crowded has declined as have the number of people turned away. Since it is desirable from a fiscal viewpoint to have the fewest possible people turned away while allowing facilities to be crowded, thus requiring fewer facilities and therefore lower capital costs, the results of the final linear program "A" plan in this category would seem to be excellent. This is reflected in a substantially larger local and regional income from the plans with a relatively small increase in capital costs. In summary, the incorporation of a full program of activities into the initial concept produced by the "optimal" allocation of the linear program, and the evaluations of that plan by the simulation model, have produced an important range of improvements.



LINEAR PROGRAM "A" + PROGRAM "A" + SIMULATION EVALUATION

ATTRACTIVENESS EVALUATION

HONEY HILL CASE STUDY

THIS ANALYSIS SHOWS THE NORMALIZED ATTRACTIVENESS VALUES FOR EACH OF THE PLANNED ACTIVITIES.

LEGEND

0 = LEAST ATTRACTIVE AREAS FOR PLANNED ACTIVITIES
TO
9 = MOST ATTRACTIVE AREAS FOR PLANNED ACTIVITIES

DATA MAPPED IN 10 LEVELS BETWEEN EXTREME VALUES OF 0.0 AND 100.00

ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| MINIMUM | 0.0 | 10.00 | 20.00 | 30.00 | 40.00 | 50.00 | 60.00 | 70.00 | 80.00 | 90.00 |
| MAXIMUM | 10.00 | 20.00 | 30.00 | 40.00 | 50.00 | 60.00 | 70.00 | 80.00 | 90.00 | 100.00 |

PERCENTAGE OF TOTAL ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

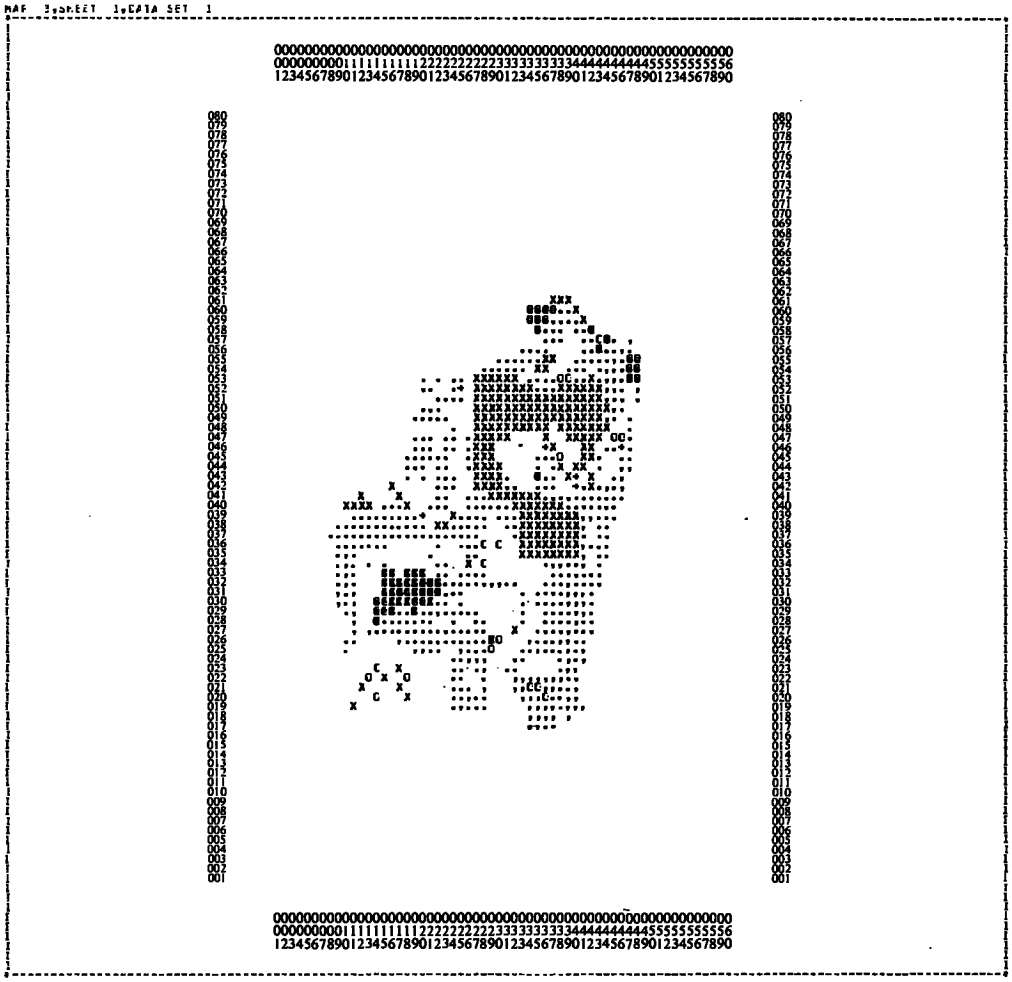
| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 |

FREQUENCY DISTRIBUTION OF DATA POINT VALUES IN EACH LEVEL

| LEVELS | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|---|
| SYMBOLS | ..... | ..... | ..... | +++++++ | XXXXXXXX | OOOOOOOO | @@@@@@@@ | ######## | ######## | ######## |
| FREQUENCY | 14 | 5 | 6 | 57 | 44 | 175 | 102 | 153 | 75 | 170 |

Fig. XI.26
Linear Program "A" + Program "A" + Simulation Evaluation: Attractiveness Evaluation

MAP 3,SHEET 1,DATA SET 1



LINEAR PROGRAM "A" + PROGRAM "A" + SIMULATION EVALUATION

TOTAL IMPACT ON ALL RESOURCE SYSTEMS

HONEY HILL CASE STUDY

THIS ANALYSIS SHOWS THE TOTAL IMPACT OF THIS PLAN ON ALL RESOURCE SYSTEMS.

LEGEND
0 = LEAST IMPACT CAUSED BY PLANNED LAND USE
10
9 = GREATEST IMPACT CAUSED BY PLANNED LAND USE

DATA MAPPED IN 10 LEVELS BETWEEN EXTREME VALUES OF 2.00 AND 23.00

ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| MINIMUM | 2.00 | 4.10 | 6.20 | 8.30 | 10.40 | 12.50 | 14.60 | 16.70 | 18.80 | 20.90 |
| MAXIMUM | 4.10 | 6.20 | 8.30 | 10.40 | 12.50 | 14.60 | 16.70 | 18.80 | 20.90 | 23.00 |

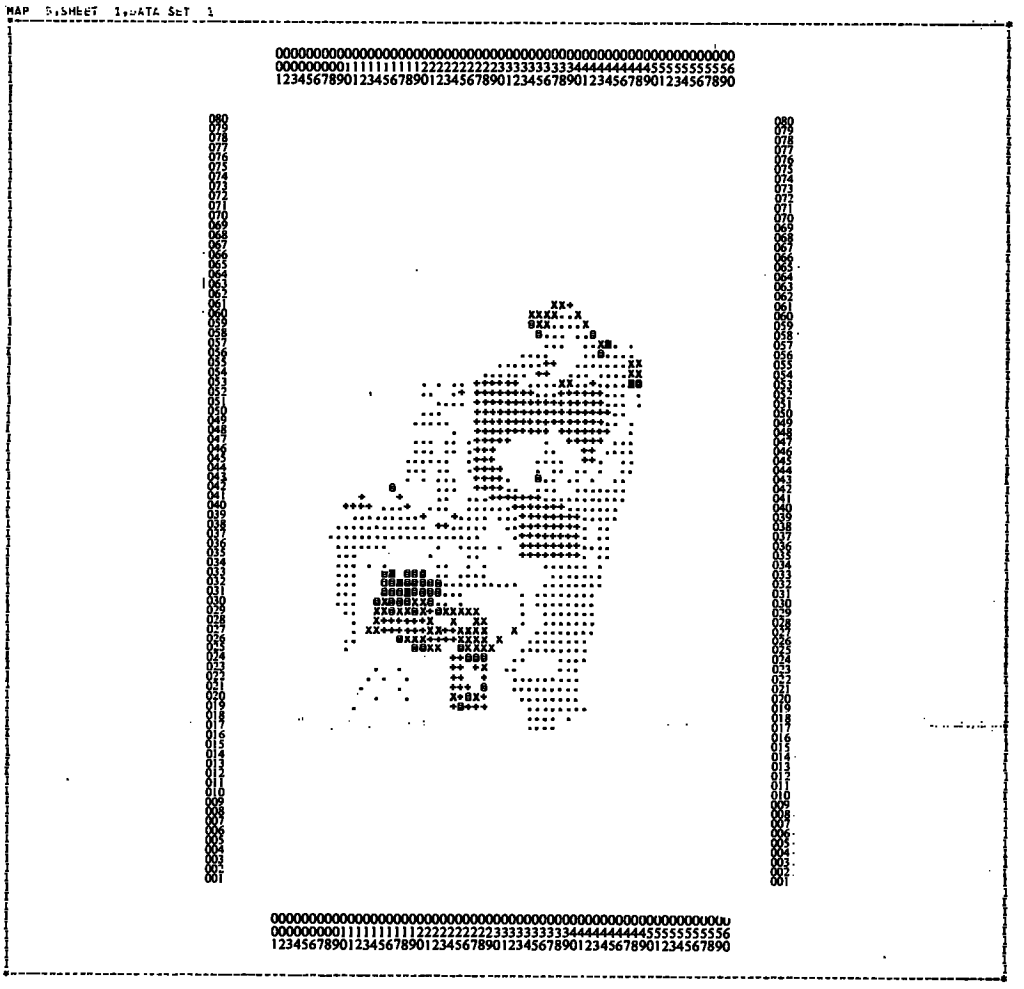
PERCENTAGE OF TOTAL ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 |

FREQUENCY DISTRIBUTION OF DATA POINT VALUES IN EACH LEVEL

| LEVELS | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|---|
| SYMBOLS | ++++++++ | XXXXXXXX | CCOOOCCCCC | BBBBBBBBBB | BBBBBBBBBB | BBBBBBBBBB | BBBBBBBBBB | BBBBBBBBBB | BBBBBBBBBB | BBBBBBBBBB |
| FREQUENCY | 447 | 104 | 1 | 6 | 212 | 16 | 0 | 21 | 20 | 2 |

Fig. XI.27
Linear Program "A" + Program "A" + Simulation Evaluation: Total Impact




LINEAR PROGRAM A + PROGRAM A + SIMULATION EVALUATION

IMPACT ON SURFACE WATER SYSTEM

HONEY HILL CASE STUDY

LEGEND
0 = NO IMPACT
1 = COMPATIBLE IMPACT
2 = MODERATE IMPACT
3 = SEVERE IMPACT
4 = THRESHOLD IMPACT

THIS ANALYSIS SHOWS THE RELATIVE IMPACT OF THIS PLAN ON THIS RESOURCE SYSTEM.

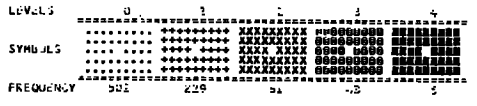
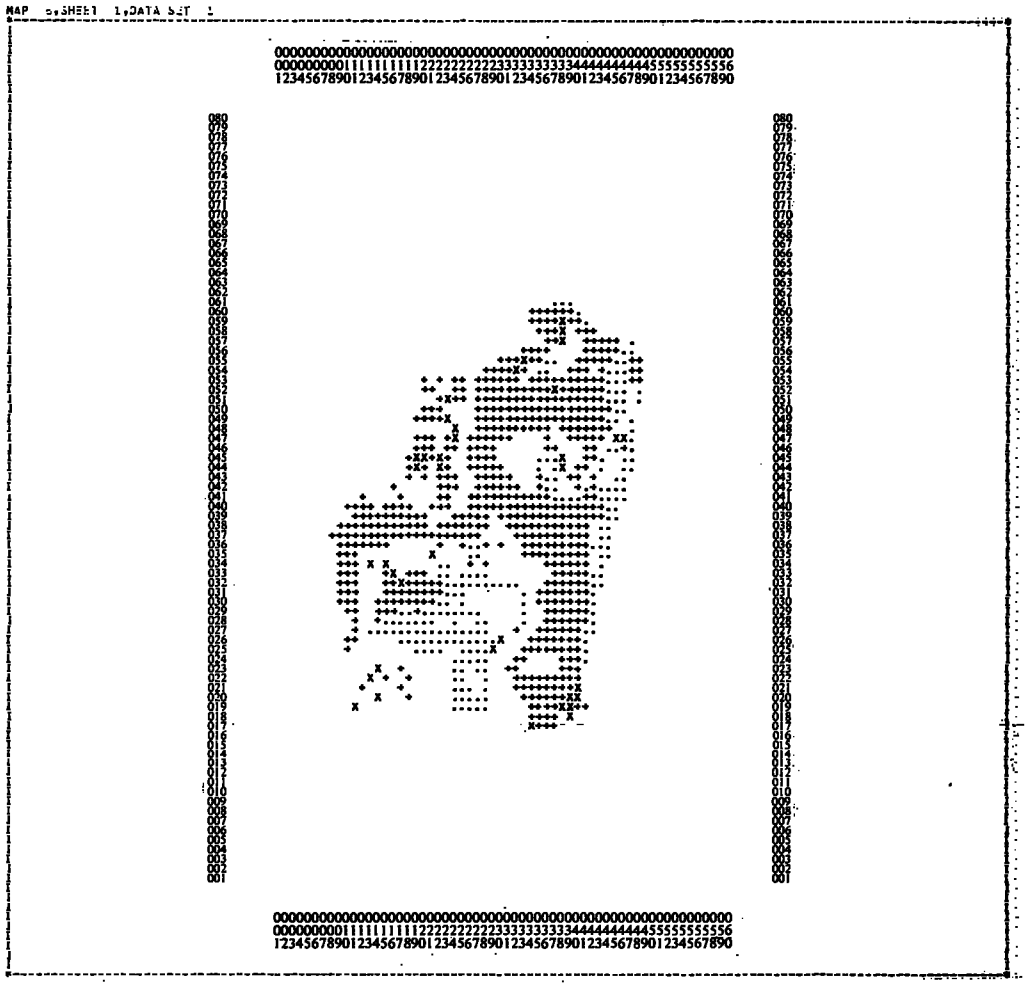



Fig. XI.28
Linear Program "A" + Program "A" + Simulation Evaluation: Impact on Surface Water System




LINEAR PROGRAM A + PROGRAM A + SIMULATION EVALUATION

IMPACT ON WILDLIFE HABITAT

HONEY HILL CASE STUDY

Pg 388

LEGEND
0 = NO IMPACT
1 = COMPATIBLE IMPACT
2 = MODERATE IMPACT
3 = SEVERE IMPACT
4 = THRESHOLD IMPACT

THIS ANALYSIS SHOWS THE RELATIVE IMPACT OF THIS PLAN ON THIS RESOURCE SYSTEM.

| LEVELS | 0 | 1 | 2 | 3 | 4 |
|---|---|---|---|---|---|
| SYMBOLS | ..... | +++++++++ | XXXXXXXXX | 000000000 | ■■■■■■■■■ |
| | ..... | +++++++++ | XXXXXXXXX | 000000000 | ■■■■■■■■■ |
| | ..... | ++++ ++++ | XXXX XXXX | 0000 0000 | ■■■■ ■■■■ |
| | ..... | +++++++++ | XXXXXXXXX | 000000000 | ■■■■■■■■■ |
| | ..... | +++++++++ | XXXXXXXXX | 000000000 | ■■■■■■■■■ |
| FREQUENCY | 210 | 594 | 37 | 0 | 0 |

Fig. XI.29
Linear Program "A" + Program "A" + Simulation Evaluation: Impact on Wildlife Habitat

Linear Program "A" + Simulation Evaluation
Table XI.31: "Summer N=3000"
No. Cells/Activity/Crowding

| ACT. # | 0-75% | 75-100% | 100-125% | 125-150% |
|---|---|---|---|---|
| 1 | 36.0 | 3.0 | 2.0 | 0.0 |
| 2 | 0.0 | 0.0 | 0.0 | 39.0 |
| 3 | 9.0 | 0.0 | 0.0 | 0.0 |
| 4 | 2.0 | 0.0 | 112.0 | 0.0 |
| 5 | 17.0 | 0.0 | 0.0 | 0.0 |
| 6 | 15.0 | 0.0 | 0.0 | 0.0 |
| 7 | 3.0 | 0.0 | 0.0 | 0.0 |
| 8 | 0.0 | 0.0 | 0.0 | 0.0 |
| 9 | 0.0 | 0.0 | 0.0 | 0.0 |
| TOTAL | 82.0 | 3.0 | 114.0 | 39.0 |

Linear Program "A" + Simulation Evaluation
Table XI.32: "Summer N=3000"
No. People/Activity/Crowding

| ACT. # | 0-75% | 75-100% | 100-125% | 125-150% | TURNED AWAY |
|---|---|---|---|---|---|
| 1 | 2788.8 | 356.0 | 296.7 | 0.0 | 0.0 |
| 2 | 0.0 | 0.0 | 0.0 | 1828.1 | 6.5 |
| 3 | 12080.8 | 0.0 | 0.0 | 0.0 | 0.0 |
| 4 | 20.3 | 0.0 | 2275.7 | 0.0 | 0.0 |
| 5 | 567.6 | 0.0 | 0.0 | 0.0 | 0.0 |
| 6 | 5126.6 | 0.0 | 0.0 | 0.0 | 0.0 |
| 7 | 2296.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 8 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 9 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| TOTAL | 22880.1 | 356.0 | 2572.4 | 1828.1 | 6.5 |

Linear Program "A" + Simulation Evaluation
Table XI.33: "Summer N=3000"
Income/Activity

| ACT. # | LOCAL | REGIONAL |
|---|---|---|
| 1 | 24847.4 | 68578.9 |
| 2 | 13199.1 | 36429.4 |
| 3 | 27785.8 | 76688.7 |
| 4 | 16577.1 | 45752.9 |
| 5 | 3292.3 | 6518.8 |
| 6 | 29734.1 | 58873.5 |
| 7 | 16577.2 | 45753.1 |
| 8 | 0.0 | 0.0 |
| 9 | 0.0 | 0.0 |
| TOTAL | 132012.9 | 338595.1 |

Linear Program "A" + Simulation Evaluation
Table XI.34: "Winter N=3000"
No. Cells/Activity/Crowding

| ACT. # | 0-75% | 75-100% | 100-125% | 125-150% |
|---|---|---|---|---|
| 1 | 41.0 | 0.0 | 0.0 | 0.0 |
| 2 | 0.0 | 0.0 | 0.0 | 0.0 |
| 3 | 176.0 | 0.0 | 0.0 | 0.0 |
| 4 | 0.0 | 2.0 | 0.0 | 112.0 |
| 5 | 262.0 | 0.0 | 0.0 | 0.0 |
| 6 | 82.0 | 0.0 | 0.0 | 0.0 |
| 7 | 0.0 | 0.0 | 0.0 | 0.0 |
| 8 | 0.0 | 0.0 | 0.0 | 0.0 |
| 9 | 0.0 | 0.0 | 0.0 | 0.0 |
| TOTAL | 561.0 | 2.0 | 0.0 | 112.0 |

Linear Program "A" + Simulation Evaluation
Table XI.35: "Winter N=3000"
No. People/Activity/Crowding

| ACT. # | 0-75% | 75-100% | 100-125% | 125-150% | TURNED AWAY |
|---|---|---|---|---|---|
| 1 | 2026.3 | 0.0 | 0.0 | 0.0 | 0.0 |
| 2 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 3 | 1650.8 | 0.0 | 0.0 | 0.0 | 0.0 |
| 4 | 0.0 | 32.9 | 0.0 | 3281.3 | 3.6 |
| 5 | 2827.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 6 | 8253.9 | 0.0 | 0.0 | 0.0 | 0.0 |
| 7 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 8 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 9 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| TOTAL | 14758.0 | 32.9 | 0.0 | 3281.3 | 3.6 |

Linear Program "A" + Simulation Evaluation
Table XI.36: "Winter N=3000"
Income/Activity

| ACT. # | LOCAL | REGIONAL |
|---|---|---|
| 1 | 12401.2 | 34227.4 |
| 2 | 0.0 | 0.0 |
| 3 | 11505.9 | 31756.2 |
| 4 | 23928.5 | 66042.5 |
| 5 | 16396.4 | 32464.8 |
| 6 | 140068.4 | 386588.9 |
| 7 | 0.0 | 0.0 |
| 8 | 0.0 | 0.0 |
| 9 | 0.0 | 0.0 |
| TOTAL | 204300.4 | 551079.8 |

Linear Program "A" + Simulation Evaluation
Table XI.37: Summary

SUMMER PLAN ATTRACTIVENESS

| ACTIVITY | # OF CELLS | MEAN |
|---|---|---|
| 1 | 41 | 34.98 |
| 2 | 39 | 66.15 |
| 3 | 9 | 91.11 |
| 4 | 118 | 95.76 |
| 5 | 15 | 76.20 |
| 6 | 15 | 68.00 |
| 7 | 3 | 90.00 |
| 8 | 61 | 67.21 |
| 9 | 8 | 65.00 |
| 10 | 242 | 3.69 |
| TOTAL | 551 | 43.70 |

WINTER PLAN ATTRACTIVENESS

| ACTIVITY | # OF CELLS | MEAN |
|---|---|---|
| 11 | 41 | 34.98 |
| 12 | 0 | 0.0 |
| 13 | 0 | 0.0 |
| 14 | 118 | 95.76 |
| 15 | 269 | 68.18 |
| 16 | 61 | 57.90 |
| 17 | 0 | 0.0 |
| 18 | 61 | 67.21 |
| 19 | 8 | 65.00 |
| 20 | 242 | 3.69 |
| TOTAL | 820 | 50.34 |

Linear Program "A" + Simulation Evaluation
Table XI.38: Plan Impact

TOTAL IMPACT = 7624.

| SYSTEM | NULL | COMPAT. | MODERATE | SEVERE | TERMINAL | MEAN |
|---|---|---|---|---|---|---|
| 1 | 497 | 48 | 102 | 224 | 30 | 1.159 |
| 2 | 563 | 298 | 40 | 0 | 0 | 0.420 |
| 3 | 476 | 329 | 96 | 0 | 0 | 0.578 |
| 4 | 199 | 562 | 131 | 9 | 0 | 0.945 |
| 5 | 548 | 68 | 281 | 3 | 1 | 0.714 |
| 6 | 358 | 176 | 175 | 192 | 0 | 1.223 |
| 7 | 509 | 11 | 127 | 251 | 3 | 1.143 |
| 8 | 0 | 0 | 0 | 0 | 0 | 0.0 |
| 9 | 0 | 0 | 0 | 0 | 0 | 0.0 |
| 10 | 81 | 505 | 302 | 4 | 9 | 1.284 |
| 11 | 476 | 117 | 153 | 145 | 10 | 0.997 |
| TOTAL | 3707 | 2114 | 1407 | 828 | 53 | 0.940 |

Linear Program "A" + Simulation Evaluation
Table XI.39: Capital Costs

| ACTIVITY # | SUMMER | WINTER |
|---|---|---|
| 1 | 0.0 | 0.0 |
| 2 | 0.0 | 0.0 |
| 3 | 190.57 | 0.0 |
| 4 | 23.60 | 23.60 |
| 5 | 375.00 | 0.0 |
| 6 | 65.63 | 648.00 |
| 7 | 18.00 | 0.0 |
| 8 | 18300.00 | 18300.00 |
| 9 | 314.60 | 314.60 |
| 10 | 493.68 | 493.68 |
| TOTAL | 19781007 | 19779088 |

TABLE XI.40

LINEAR PROGRAM "A" PLAN: IMPROVEMENTS, N=3000

| | Initial L.P. Plan | + Program "A" | + Simulation Evaluation |
|---|---|---|---|
| 1. Summer Plan | | | |
| Attractiveness (mean mean) | 32.26 | 38.43 | 43.70 |
| Impact (mean mean) | 0.903 | 0.993 | 0.940 |
| No. of people crowded | 2,015 | 9,091 | 1,828 |
| No. of people turned away | 264 | 547 | 7 |
| $ local income | 42,080 | 94,820 | 132,012 |
| $ regional income | 115,328 | 242,170 | 338,595 |
| $ capital cost | 1,490,090 | 20,496,065 | 19,781,007 |
| $ capital cost w/o res. | 1,190,090 | 1,496,065 | 1,481,007 |
| 2. Winter Plan | | | |
| Attractiveness (mean mean) | 44.96 | 46.63 | 50.34 |
| Impact (mean mean) | 0.903 | 0.993 | 0.940 |
| No. of people crowded | 9,260 | 3,760 | 3,281 |
| No. of people turned away | 115 | 56 | 7 |
| $ Local income | 130,784 | 185,891 | 204,300 |
| $ regional income | 354,168 | 500,270 | 551,080 |
| $ capital cost | 1,601,080 | 19,901,080 | 19,779,088 |
| $ capital cost w/o res. | 1,301,080 | 1,391,080 | 1,479,088 |

# CHAPTER XII: SUMMARY AND CONCLUSIONS

## A. SUMMARY

In order to summarize this research effort, we refer again to the questions which defined the problem. The overriding question was, "how can one propose a solution to a planning problem, in this case the multiple use for a reservoir site, when the activity demands on the site are unclear and when the costs and benefits to be derived from any proposal must be evaluated in terms of multiple objectives including dollar benefits and costs, environmental resource quality, and the social benefits of consumer satisfaction?" We feel that a basis for the resolution of this question has been established in the research (but that the scope of its application has not fully been tested).

With the methods that we have applied, three approaches are possible. The first would be to predefine a single objective function combining the component fiscal, social, and environmental aspects and to use the linear program to generate an "optimal" solution. The second approach would be to state formally a desirable relationship among the summary evaluations produced by the simulation model, and then to adjust the plans to the point at which they most closely conform to those predefined relationships.

Another approach to the multiple objective function is to have formal evaluation models which separately evaluate any plan in terms of the component objective function criteria. Thus, any plan could be separately evaluated for its fiscal, social and environmental consequences but these evaluations would have no formal and predetermined relationship to each other. The decision maker would review these evaluations and assess the plan for its adequacy based upon the separate evaluation scores.

Any of these approaches, that of formally predefining a relationship among the component objective functions and using the "optimizing" plan-making approach of the linear program, or the use of models to evaluate plans in terms of the separate objective functions (the approach demonstrated by our simulation model), are in our view advances over the informal and of times inconsistent procedures which are typically used to evaluate plans in "normal professional practice." That the use of models in the design and evaluation processes has resulted in "better" plans, in terms of these objective functions, has in our view been adequately demonstrated.

The second question which defines "the problem" regarded the evaluation of the "capacity" of the site. In the New England region one can almost assume that any facility provided at "reasonable" cost would be used because of the overwhelming demand in the area. The question of "how much one can develop a site before 'we kill the goose that laid the golden egg'?" is an important one and is analoguous to site capacity identification problems in land use planning and for other types of projects. The simulation model which we developed is a direct response to this question. Given the site, Honey Hill, five sketch plans were prepared for an estimated program. The first program estimate was based upon the best judgment of the research team. The simulation model was then used to evaluate these schemes in two ways. The first was to evaluate the initial program assumptions, that is, the quantities of the various activity facilities. Thus, the model identified the degree of crowding of each facility in each plan in terms of land areas and numbers of people and the program as well as the plans could be adjusted to reflect more adequately the assumptions of demand incorporated into the simulation model. The simulation model was then also used to identify the points at which the "performance" of the plan changed as a function of the number of people seeking admission to the area and wishing to participate in its recreation activities. Thus, as shown on Tables I.13, H.1.10, and H.2.10, levels of use, stated in terms of numbers of people could be identified at which the plan resulted in increased crowding, greater costs, less income, and a more severe impact on the quality of the site resources. That this value, at around N=3000, seemed to be consistent for the 5 professional judgment plans as well as for the linear program plan, indicates that there is at least one threshold or site capacity at around N=3000. That is not to say that this is a fixed number. For one thing, it is a number determined by the assumptions underlying the fiscal, social and environmental evaluations. If these assumptions were to be relaxed, in other words, if impacts were corrected for incomes higher than expected, costs lower than expected, if demand changed or standards of crowding decreased, one could probably put more people onto the site. However, even these shifts in the assumptions underlying our evaluation models could be tested for in precisely the same manner as the initial model assumptions were used. Thus, within the sub-problem of identifying site capacity one can ask and test the question, "what would the capacity be if we changed some of the design and evaluation constraints." The approach of using a simulation model to test the performance of a series of initial proposals seems to us to be a highly promising method toward resolving the question of identifying the capacity of a site.

The third problem-defining question addresses itself to methods for site development planning and design. In this research project, we have applied at a considerably finner grained grid, some of the data inventory analysis and display procedures which we previously had developed at a regional scale. These are described in the chapters which describe the data inventory and in the various technical appendices. The concept of site-attractiveness is also not a new one, being a variation of the several quality index approaches, some of which are outlined in Appendix D.

The first major innovation of the research is the model which provides the framework for evaluating the vulnerability of the various site resource systems and the impacts of the activities upon these systems. The application of a linear program to a multi-purpose development problem of the scale and content of Honey Hill is also an innovation, as is the use of a simulation model to pre-evaluate the performance of the various plans.

The most striking finding, aside from the general feasibility of using the above mentioned formal models in a design process, is that the use of these models resulted in consistently "better" plans than could be produced solely by the judgments of the qualified professionals who made up the research team. It must be emphasized that the initial plan proposals made by the members of the research team, as shown for the "A" assumption in Appendix H, and for the "B" assumption in Appendix I, would, under other circumstances, be considered adequate professional proposals. That each of these plans could be improved to a substantial degree by the evaluations and revisions generated by the use of the simulation model is of fundamental importance. Table XII.1 shows the improvements between the initial plan and the final improved plan for both the "A" and "B" assumptions and for the Murray professional judgment schemes and those produced from the linear program. When considered in the context of the degree of improvement which was actually possible, the findings shown on Table XII.1 are striking. Substantial improvements were consistently shown in increased attractiveness, decreased impact, decreased crowding and people turned away, and increased local and regional income. These improved plan qualities sometimes resulted in increased capital costs. However, these increased capital costs are apparently more than offset by the increased local and regional incomes. The output of the linear program, which was conceptually the equivalent of an initial plan, was also consistently improved in a similar manner through the use of the simulation model. In short, and simply stated,

regardless of whether the initial plan proposal was derived from the judgment of a designer or from the output of a linear program, the methods developed in our research helped to produce better plans.

The question remains, which is the best plan for Honey Hill? and which is the best strategy for achieving a best plan? Table XII.2 compares the improved plans produced by the professional judgment and linear program approaches for both the "A" and "B" assumptions. In both cases the pattern of evaluation results would seem to favor the plan whose initial concept was produced from the linear program. However, the differences in performance much more distinctly favor the linear program under the less restricted "B" assumption. This should be no surprise, and it leads to a series of observations which are less conclusions of this research than they might be hypotheses for future research. It would seem that the professional judgment--simulation model approach performs best when the problem is smaller and where the final solution is not constrained by site resource quality. Under the "A" assumption the choices for activity locations, while many when considering the number of grid cells to be allocated, are actually conceptually fewer. This is attested to by the overall similarities of several of the professional judgment "A" plans. On the other hand, under the "B" assumption, the choice of basic concepts is much wider and therefore, for any given planner or designer, much more difficult. Under these circumstances it is more likely that the linear program approach which begins with an optimization to the extent that the linear program is able to make it, would produce a superior plan. Note that both the professional judgment and linear program approaches resulted in better plans for their "B" assumptions than for their "A" assumptions. This can also be expected, since under a freer set of spatial constraints each activity could more easily seek its own "best" location, thus resulting in better summary evaluations for the plan. Even though both methods resulted in better "B" schemes, it is again not unexpected that the linear program, in comparison, would achieve a somewhat better set of evaluations.

For the practical issue of making or choosing a plan for Honey Hill, two implications can be drawn. The first is that it can be expected that the capabilities of the linear program to deal with larger numbers of constraints, to the point of producing a plan at the grid cell level, can be expected to be developed in the near future. At that point the difference between a best plan produced by professional judgments and a best plan initially developed from the linear program, will be greater.

Second, the question must be asked, "is it worth the effort?" Table XII.3 shows the amount of "effort" involved in making plans by the approaches demonstrated in the research. The table is divided into 5 basic stages: identifying the problem, data inventory and display, analysis, plan making, and plan evaluation and improvement. In this table numbers are used which represent an informal combination of time, money, manpower, etc. The numbers do not represent any particular measurement scale; they are units of "effort." As can be seen from the table, a proposal generated by the traditional professional judgment practices would be the least costly in terms of effort. The two approaches which we have developed in this research, that of professional judgment proposals evaluated and improved by a simulation model, and that of a linear program generated proposal evaluated and improved through the use of a simulation model are both somewhat more "costly." Both, however, result in substantially better plans. The larger or more complex the problem, the smaller will be the difference in effort between the computer using and the non-computer using approaches and the greater should be the improvement in quality through using the computer based approaches. Note on Table XII.3 that the major components of "effort" are constant. These are the identification of the problem, the data inventory and the analysis efforts. It is only in the procedures for making, evaluating and improving plans that the methods diverge. It is clear to us that for more complex, more constrained and larger problems the use of computers in the terms of the quality of the result is more than worth the difference in effort.

In choosing between the two computer using alternatives, that of professional judgment and the linear program with both being evaluated and improved by the simulation model, we must note that the linear program approach is slightly more "costly." Recall that the linear program produced a somewhat better plan for each of our sets of assumptions. It is not clear whether the improved plan was worth the effort, though we intuitively feel that it was. We are confident, however, that either of the alternative methods developed in this research as approaches to the Honey Hill "problem" are substantial improvements over the approaches which have been applied in the past.

## B. LIMITATIONS AND AREAS FOR FURTHER RESEARCH

There are several areas which can be identified as requiring further research. These can be divided into two categories.

The first is the obvious need for better empirical data to replace the many assumptions which the research team was forced to make. In particular, research would be required to identify accurately the appropriate estimates of demand. As was discussed in Chapter VII, the estimates which we used were based upon the 1962 ORRRC reports for the Northeast region. One would expect better data to be generated and used, possibly on the basis of metropolitan regions. Similarly, the data on expenditures and regional multipliers which we used are questionable, having been derived from diverse sources and, in some cases, being estimated by the research team. Clearly, more accurate data in this area will lead to better fiscal estimates.

While we in no way hesitate to use our best professional judgment in developing the various resource system impact models, we would prefer that careful observation experiments be undertaken to calibrate our estimates of what the vulnerability of the systems are and what the impacts of the various activities would be.

The second category of needed research would be improvements in the methodologies which we have developed. The linear program approach should clearly be expanded to the point where optimal solutions can be generated on the basis of individual grid cells and for the full range of proposed activities. Failing that, the concept of homogeneous zones which now necessarily form a basic element of this approach must be developed further. One can easily foresee the creation of homogeneous zones as a function of their intended use and being the result of a computer program which aggregates individual grid cells.

In using the linear program, we found that the space standards commonly applied in recreation planning do not give very good solutions in this type of analysis. Very intensive uses of the resources would arise if we merely used these standards. What then should be the real binding constraints upon such developments? We believe that "interactions at a distance" would bring our posited activity demands into conflict with the environment and other uses of the environment much more quickly. We believe that distant noise and visual effects should be included in the analyses. It is also apparent from our use of the model that much shorter time periods should be used if conflicts between the storage and release related water activities is to be observed. This presents no philosophical problems in formulation but would require much larger computation budgets.

The formulation of such a model also raised questions about the appropriate measures to use in the objective function. Based upon our work to date, we would like to consider multiple objective functions in which the benefits to whomsoever they accrue are kept separate. The model could be then run to identify the pay-offs to various groups under various assumptions about the nature and scale of the project. Unfortunately, due to the lack of serious conflict within the model as it is now constructed, the activity levels would be the same no matter what objective functions were used (provided of course that the coefficients of net benefits were not negative). We have done this in other resource allocation situations in which there were serious conflicts and were able to sweep out the corner solutions to a classical two person non-zero-sum game (The Prisoners' Dilemma) [152].

The simulation model could be improved in several major ways. The first would be to run the model on a seasonal or yearly basis with the "N" being selected from a distribution which itself comes from empirical observations of similar facilities. A second improvement in the simulation model would be to make the distribution of people to the various activity cells a function of the location of parking areas. Thus, while the model now assumes that everybody will park and then be distributed as a function of activity attractiveness, the program could be restructured so that everybody parks and then goes to the nearest and most attractive location. Another improvement in the simulation model would involve the evaluation of the impact of activities on site resource systems over time; in effect to attempt to simulate the "wear and tear" on a site over longer term use and as a function of repetitive crowding. The simulation model could also be revised to estimate the dollar costs and benefits of the project in terms of return on investments and also to assign the costs and benefits to the different fiscal units which would be making the project exist.

Finally, we see the possibility that a range of problem types could be approached via the procedures that we have developed. Even though they are of obvious advantage for "Honey Hill problems," we feel that they may be of even more advantage under smaller, more complex and possibly more urban conditions and for larger and possibly more complex regional watersheds. In other words, we are not at all sure that we have addressed the right problem even though we intuitively feel that we have come up with some of the right answers.

## C. CONCLUSION

Land development projects, and particularly recreational projects, in the past, have been frequently instituted without specific environmental, social and economic goals. As the demand for resource utilization continues to mount, a more rational and systematic approach is required to compare the implications inherent in the use of different policies for the intensity and distribution of leisure activities within a designated region. The importance of a modelling approach to help in defining goals for recreational programs and to relate them to other conflicting and complementary uses of the same resources can thus hardly be understated, provided that the underlying assumptions do not seriously damage the modelling of the system and that the objectives used in the models adequately represent stated goals for public investments.

We believe that the overriding purpose of building models is to help formulate the right questions. For the persons involved in constructing and using these models, some very useful insights about the nature of land resources and recreation planning were derived. In addition, we believe that there are better ways to make better plans, and that this research has been a valuable experience toward the understanding and improvement of planning and design methods.

TABLE XII.1

IMPROVEMENTS BETWEEN INITIAL AND IMPROVED PLANS

| | Professional Judgment Murray "A" | Linear Program "A" | Professional Judgment Murray "B" | Linear Program "B" |
|---|---|---|---|---|
| | FROM Table X.41 | FROM Table XI.40 | FROM Table J.4.10 | FROM Table K.3.10 |
| SUMMER PLAN | | | | |
| Attractiveness (mean, mean) | + 8.84* | + 5.27* | + 5.27* | + 3.76* |
| Impact (mean, mean) | - .053* | - .053* | - .017* | - .007* |
| No. of people crowded | - 234* | - 7,263* | 0 | 0 |
| No. of people turned away | - 1,084* | - 540* | 0 | 0 |
| $ local income | + 49,273* | + 37,192* | 0 | 0 |
| $ regional income | + 129,954* | + 96,425* | 0 | 0 |
| $ capital cost | + 239,072 | - 315,058* | + 2,385,932 | + 71,035 |
| $ capital cost w/o residence | + 239,072 | - 15,058* | + 285,932 | + 71,035 |
| WINTER PLAN | | | | |
| Attractiveness (mean, mean) | + 8.52* | + 3.71* | + 3.93* | + 21.29* |
| Impact (mean, mean) | - .053* | - .053* | - .017* | - .391* |
| No. of people crowded | - 234* | - 479* | 0 | 0 |
| No. of people turned away | - 568* | - 49* | 0 | 0 |
| $ local income | + 34,428* | + 18,409* | + 7,513* | 0 |
| $ regional income | + 107,625* | + 50,810* | + 33,521* | 0 |
| $ capital cost | + 264,994 | - 121,992* | + 2,305,982 | + 247,000 |
| $ capital cost w/o residence | + 264,994 | + 88,008 | + 205,982 | + 247,000 |

* Improvement on evaluation.

TABLE XII.2

COMPARISONS OF IMPROVED PLANS

| | Professional Judgment Murray "A" | Linear Program "A" | Professional Judgment Murray "B" | Linear Program "B" |
|---|---|---|---|---|
| SUMMER PLAN | | | | |
| Attractiveness (mean, mean) | 44.97 | 43.70 | 56.91 | 45.41 |
| Impact (mean, mean) | 1.261 | 0.940 | 1.044 | 0.699 |
| No. of people crowded | 0 | 1,828 | 0 | 0 |
| No. of people turned away | 0 | 7 | 0 | 0 |
| $ local income | 118,814 | 132,012 | 118,813 | 143,661 |
| $ regional income | 302,165 | 338,595 | 302,165 | 370,744 |
| $ capital cost | 20,023,072 | 19,781,007 | 20,051,012 | 20,084,037 |
| $ capital cost w/o residence | 1,423,072 | 1,481,007 | 1,451,012 | 1,484,037 |
| WINTER PLAN | | | | |
| Attractiveness (mean, mean) | 48.63 | 50.34 | 57.49 | 63.34 |
| Impact (mean, mean) | 1.261 | 0.940 | 1.044 | 0.699 |
| No. of people crowded | 0 | 3,281 | 0 | 0 |
| No. of people turned away | 0 | 7 | 0 | 0 |
| $ local income | 196,764 | 204,300 | 196,764 | 213,162 |
| $ regional income | 538,458 | 551,080 | 538,457 | 570,926 |
| $ capital cost | 20,009,072 | 19,779,088 | 20,771,012 | 20,182,017 |
| $ capital cost w/o residence | 1,409,072 | 1,479,088 | 2,171,012 | 1,582.017 |

TABLE XII.3

ESTIMATED "EFFORT" PER APPROACH

| | Professional Judgment Traditional | Professional Judgment Computer | Linear Program Computer |
|---|---|---|---|
| 1. Identifying the problem | 1 | 1 | 1 |
| 2. Data inventory and display | 8<br>2 | 8<br>2 | 8<br>2 |
| 3. Analysis | 3 | 3 | 3 |
| 4. Plan making | 3 | 2 | 4 |
| 5. Plan evaluation and improvement | -<br>- | 2<br>2 | 2<br>2 |
| TOTAL | 17 | 20 | 22 |

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13. ABSTRACT

The first purpose of this research was to focus attention on ways and means for measuring non-monetary social and environmental costs and benefits and comparing them with costs and benefits measurable in dollars. The second purpose was to develop better ways to plan for the multiple use of water and related land resources, with emphasis on recreation uses.

The data on the area were stored, analyzed and displayed using computer graphics techniques developed by the investigators. The study developed sets of quality indices for visual quality, ecological damage, wildlife habitat, etc. Grid areas were evaluated and ranked in terms of various uses, thus laying the basis for a planning evaluation process for site development. A simulation model was developed which allows for comparison of the effects over time of alternative recreation plans. Alternatives were developed and tested in the model utilizing both "best professional judgment plans" and alternatives derived from a mathematical programming model developed by the authors.

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| recreation planning | | | | | | |
| site resource planning | | | | | | |
| master planning | | | | | | |
| environmental resource analysis | | | | | | |
| computer graphics | | | | | | |
| simulation model | | | | | | |
| resource information | | | | | | |
| impact models | | | | | | |
| data bank | | | | | | |
| resource variable | | | | | | |
| plan evaluation | | | | | | |