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WALRUS I
WATER AND LAND RESOURCE UTILIZATION
SIMULATION
(Revised)

by
David O. Moses and Allan G. Feldt
with
Barbara Darnton

School of Natural Resources
The University of Michigan

June 1975

Sea Grant Report No. MICHU-75-602

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THE MICHIGAN SEA GRANT PROGRAM

ACKNOWLEDGMENTS

The April 1972 version of WALRUS I was derived from the groundwork laid by Thomas E. Borton, Katherine Warner, and Richard Duke, who introduced the idea of the use of operational gaming devices in Sea Grant research. We also borrowed heavily from a number of existing games for some of the components and operating properties of this game. Specifically we are indebted to ideas taken from PPOM and CLUG by Allan Feldt, to COGG by David Povey, to "Urban Dynamics" by Urbandyne, Inc., and to "Marbles" by Fred Goodman. Doubtless, other games have influenced our thinking in more subtle ways but further specific acknowledgments are not possible.

To these intellectual sources we are indebted for ideas, concepts, and suggestions. To the Sea Grant staff at The University of Michigan and officials from Traverse City, we are indebted for cooperation, understanding, and support.

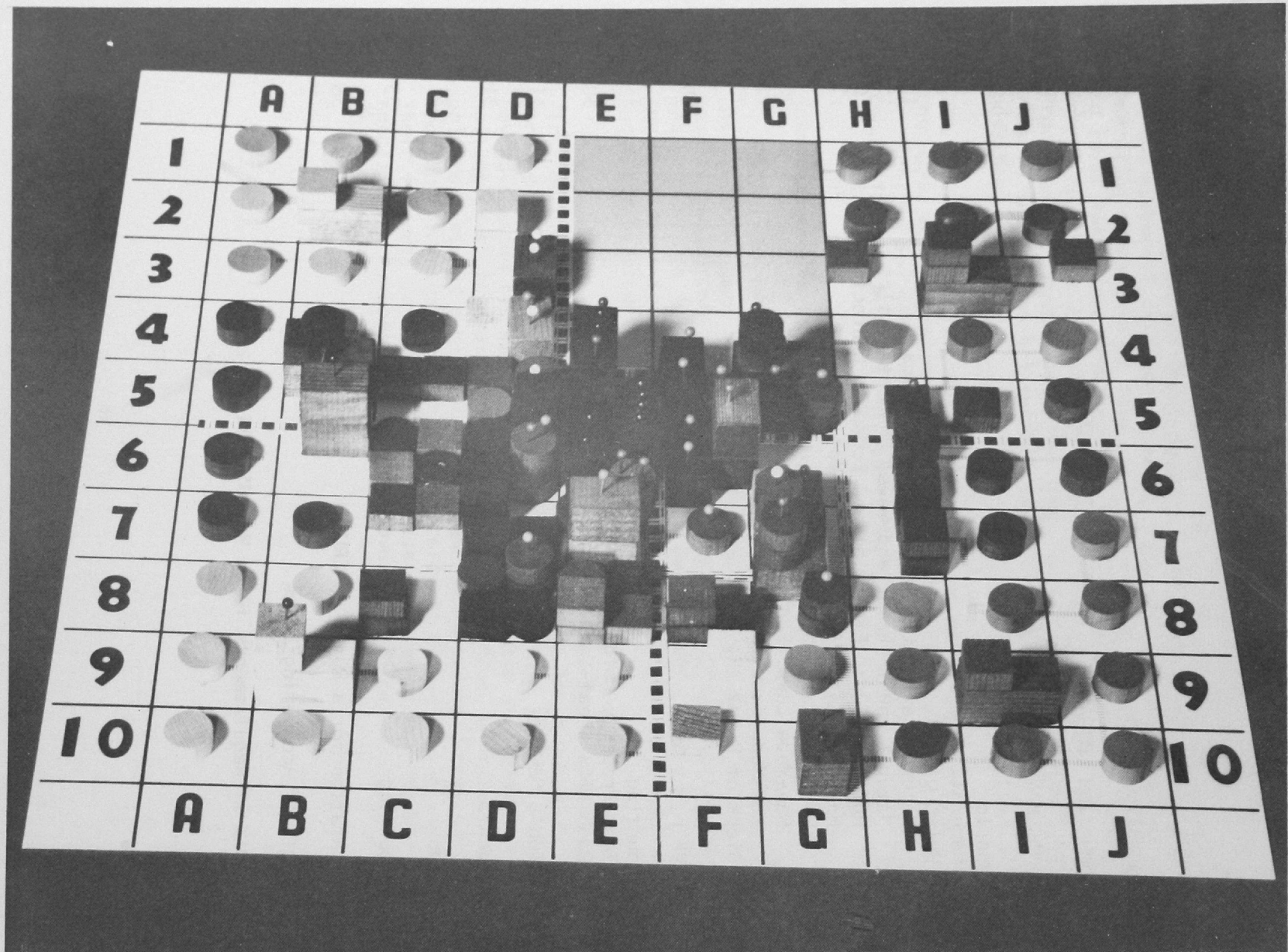
Acknowledgements to the 1975 revision.

Since WALRUS I was first introduced, several thousand persons have used the game in a wide variety of contexts both in this country and abroad. Many of these users have offered criticisms and suggestions for revisions to the basic model. The current revision reflects our own experiences plus changes introduced or suggested by others.

We continue our acknowledged debt to those mentioned in the first version. Additionally, we would like to thank the many persons who have used the game over the past four years and who have discussed its strengths and weaknesses with us. These include colleagues at several other American universities, officials from universities and public planning agencies in several other countries, and many students here at The University of Michigan. We appreciate their interest in the game and its use and acknowledge without specificity the contribution they have made to this revision.

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INTRODUCTION

WALRUS I was originally developed in 1971 by the University of Michigan Sea Grant Program as part of an attempt to improve communication of information and ideas among Sea Grant scientists and between them and the general public they were seeking to serve. It proved quite popular among its intended audiences as well as with students in a number of courses at the university. Subsequently, the game has been used rather extensively in course work at many universities and in a number of planning agencies both in this country and in several foreign countries.

The game has been modified and changed a number of times to meet the needs of particular audiences and applications, and a number of significant improvements in the basic game are now available. This revision of the original rules seeks to incorporate some of the more important changes and simplifications and to provide a much more clearly written description of the game itself. At the same time, the price of plastic has made the further use of LEGO playing pieces prohibitively expensive. A revision of the game components has been developed using wooden playing blocks rather than plastic ones. The current rules describe operation of the game using such pieces, although its operation with plastic playing pieces is still feasible. A list of the required components is provided in Appendix II.

WALRUS I accomplished its basic purpose rather early after its first introduction. Its continued use beyond that purpose has been gratifying and somewhat disconcerting since it has forced a responsibility upon the designers for continued development of the game and advice on its use which we had not intended to undertake. Our basic task under Sea Grant funding for the past several years has been to develop more sophisticated forms of gaming/simulation models suitable for direct application in local planning and public decision making efforts. Thus far, we have been successful in these attempts and are currently working with local officials on the adaptation of some of our developments in local planning efforts. These efforts are reported elsewhere in various professional and technical papers written for the Sea Grant Program.

A computerized version of WALRUS I, called WALRUS II, has also been developed for those users who find computer assistance in running the game desirable or helpful. A copy of the computer program for WALRUS II is available through the Michigan Sea Grant Program. Potential users of WALRUS II should be advised, however, that the computer program does not substitute for understanding of the basic WALRUS game. Full familiarity with the contents of this manual describing the manual version of the game is considered necessary to satisfactory utilization of the computer version of WALRUS.

As in the first version of WALRUS I, it is still appropriate to begin discussion of the game with a general introduction to the meaning and use of gaming simulation devices. The brief article by Robert Armstrong and Margaret Hobson of the University of Birmingham which follows still provides the clearest and most succinct introduction to this subject matter available.

INTRODUCTION TO GAMING/SIMULATION TECHNIQUES*

Historical Development

Gaming/simulation techniques are of long standing; such games as *chess*, *go*, and *Shogi* having been developed from war games used in the Indian subcontinent, China, and Japan some thousands of years ago. Modern war-gaming dates from the latter part of the eighteenth century, when the Prussian military establishment became conscious of the need to revise the training of combat officers.** Whilst in the last thirty years the training element has remained important, gaming techniques have been employed in such areas as strategic planning - e.g., the Japanese attack on Pearl Harbor; tactical operations planning - e.g., "hunt and kill" patterns for submarine search; weapon use and development - e.g., analysis of air and ground combat; and the attempt to define the characteristics and implications of new weapons systems - e.g., the pattern of deployment of nuclear weapons by NATO in Europe.

Although primarily a postwar development, "crisis" games designed to allow examination of aspects of international relations began to be developed during the interwar period. These are role-playing exercises set in a scenario related to an actual or imaginary crisis situation. They owe much in terms of their form to the "free-play" *kriegspiel*, which developed out of the Prussian war-game exercises mentioned above.

It was not until 1956 that the American Management Association, in cooperation with I.B.M., began to develop "business war-games." Since then the growth of business-gaming, mainly for training purposes, has been rapid. As in the military field, there have been extensions with games being used to examine aspects of operational problems, e.g., stock-control, though such developments have not been as prolific as the military equivalents.

Applications to problems of public administration and land use planning date from 1960 (Hendricks - POGE), though the two best-known examples, CLUG (Allan Feldt) and METRO (Richard Duke), and are both post-1963 developments, and to date, the extent of the use of gaming techniques in this area is still limited.

Thus, paradoxically, the use of games as training and planning devices is both ancient and novel, but in all the applications of gaming certain common elements can be found. These are:

*Reprinted from *Gaming/Simulation Techniques: An Introductory Exercise, Management by Objectives*, by Robert H. Armstrong and Margaret Hobson, Institute of Local Government Studies, University of Birmingham, Birmingham, England, with the permission of the authors.

**Extensions of the Prussian "method" were later developed by the Russians, British, and Americans.

- (i) people playing roles - which do not necessarily correspond to those they assume in the real-life situation.
- (ii) a scenario - defining a problem area or a given "state of the system"
- (iii) an accounting system designed to keep track of events and their consequences during play

Different games will place the emphasis on different elements. Thus, some games are almost entirely role-playing exercises, whilst at the other extreme the use of elaborate computer simulations reduces the people to a secondary role and emphasizes the "accounting" system.

Computer Simulations

At this point it may be useful to distinguish a gaming/simulation exercise from a computer or machine simulation. Gaming/simulations will always employ all three elements - roles, scenario, and accounting - and at least the major roles will be represented by human players. In the computer simulation, while the three elements are present, they are represented in symbolic form within a model. Thus the relatively "free" decisions taken by role-players in a gaming/simulation exercise are replaced in the computer or machine simulation by programmed responses* to a series of alternatives.

Gaming/simulations which use a computer use it as part of the accounts system. Even where a "sophisticated" model is employed, its purpose is to do no more than process information and responses generated by human players. Hence the emphasis is not placed upon the logical or inner consistency of the model used, but upon either or both the relationships

- (i) between the roles represented by human players
- (ii) between the players and the model

This characteristic of gaming/simulation means that its main purpose cannot be "predictive" in the sense in which that term is used by the operations research scientist. The presence of human players means that there will always be opportunities for the absurd to happen and the irrational to dominate. Conditions of play will vary from exercise to exercise, not the least important variable being the personalities of the players. However, computer simulations, when given variables change, can make a "prediction" of the quantitative outcome of such (a) change(s).

*This is still true where the programmed responses are deliberately designed to be "random."

The differences in outcome from gaming/simulation and computer simulation approaches do not mean that they are "opposed" approaches. Each draws on different techniques, which in turn influence the structure and the type of result which can be expected or anticipated.

Gaming/Simulation Techniques

Within each of the elements of role-playing, scenario construction, and accounting system development, a number of techniques can be employed.

1. *Role Playing*

There are three aspects to be considered in relation to roles:

- (i) role definition
- (ii) role allocation
- (iii) adjuncts to role playing

Roles may be defined to correspond with their real-life counterparts or may be an amalgam of certain interest groups which have selected characteristics in common. Either approach may be used in a gaming/simulation exercise or the two may be combined. The objective, whichever the approach adopted, is to introduce into the exercise what are seen as the "key" decision-making groups. The definition itself can be stated either in minimum terms, so as to allow for development of the role during the exercise, or in terms of stated objectives to be pursued by those playing the role. This definition can be accompanied by a statement of activities considered (in)appropriate to the role.

Once definitions have been decided upon, the allocation of roles to players can be undertaken in a number of ways. A player may take a role that matches or is closely akin to his own real-life role. Opposite to this is the "role-reversal" approach, where a player is deliberately put in a role other than his real-life one. Where roles correspond to individual decision-makers in real-life situations some attempt may be made to match players' personality characteristics to those of the persons whose positions they will be playing (e.g., in the attempts to game/simulate the outbreak of World War I, separate runs were undertaken with "matched" and "unmatched" personalities). Other attempts to simulate more recent crises by one of the great powers have suffered from the lack of well informed Chinese communist leaders.

At certain stages during play it may be necessary to introduce some additional elements into the exercise in order to evoke or record the response of roles to precise circumstances. Those may be fairly elementary, e.g., to record voting patterns, or at the other end of the spectrum be more sophisticated, e.g., in order to establish and record changing "weight" of influence accorded to roles of "equal standing" by the players taking these roles. Whatever the specific purpose of these adjuncts,

the general aim is to provide linkages between roles, and between roles and the scenario or accounting system within the "abstract" environment of a gaming/simulation exercise. Without such linkages there is always the danger of role-playing becoming introspective, lacking force and hence not providing any dynamic elements within the exercise.

2. *Scenario Construction*

The scenario in a gaming/simulation exercise defines the situation presented to the roles at the start of play. The scenario is normally given in two parts - one being provided as a framework for the exercise as a whole, and the other providing, often in greater detail, points of reference for the individual roles.

The scenario provides information. This may be in the form of written reports, diagrams, maps, physical models, statistical information, and financial statements. Normally several of these methods are used in combination, and the information may be provided in manual form, displayed in the area where the exercise is to be held, or made available to roles on specific request.

The scenario may relate to a past, present, or future situation, thus the attempt to simulate the outbreak of World War I is situated in the past, the N.E. Corridor Transportation study in the present, and many weapons systems simulations some twenty years in the future. In addition, a "scenario" set in the present can contain information relating to the past, and also forecasts of the future. Given the scenario at the start of the play, the dynamic element introduced by role-playing (whatever the interpretation put on this by the players) leads to changes in the definition or type of situation confronted by players.

It is the function of the "accounting system" to monitor and process the activities of the roles and update the scenario. The "new" information which is generated by the models may be available to all roles, to select roles, or on specific request.

3. *The Accounting System*

The accounting system may present

- (i) a series of cumulative totals for the exercise as a whole
- (ii) a series of cumulative totals for the individual items
- (iii) an autonomous model which processes the individual items of information or cumulative totals. This is the only "model"* - using the term in its strictest sense - which is employed in the exercise, in that

*The term "controlling model(s)" is often used to cover all three aspects of the accounting system. Here the word "model" is being used loosely.

it contains in-built assumptions relating to behavior and response. In both manually operated accounting systems and computer-based accounting systems, the assumptions are open to challenge and discussion. Any changes proposed by the players (and normally a degree of consensus is required) can be relatively easily substituted in the manually operated system. In the computer-based system, the proposed changes normally require a rewriting of parts of the program.

In practice, the three elements of role-playing, scenario, and accounting can be more closely interrelated than is suggested in the above account. It is, in fact, possible to combine certain or all aspects in one "presentation." The greater the degree of combination, the more abstract the exercise becomes. Thus in many recreational games, representation becomes symbolic: in "gaming/simulations" an attempt is made to move away from abstraction whilst still employing fundamentally similar techniques.

Uses and Applications of Gaming/Simulation Techniques

Validation of the effectiveness of gaming/simulation can be discussed only in relation to the purposes for which it is used. Suffice it to say here that the subject is a controversial one, though no more so than that of validating the effectiveness of many other educational and decision-making aids.

There are four main areas in which gaming/simulation is commonly used:

- (i) education and training
- (ii) decision-making and policy formulation
- (iii) research
- (iv) operational investigations

The considerations determining its use in the first of these four areas are different from those applying to the other three. In an educational setting the object is to create an environment within which students may learn about the "total" situation through the medium of their own activities. With young, inexperienced students a substitute for "experience" is being provided, and as the aim may be to teach particular lessons, the exercises used may be highly structured. By contrast, where "experienced" professionals are taking part the aim is not so much to teach specific lessons as to provide an opportunity for exploration of and experimentation with situations with which they are familiar. In these cases, the exercises are less structured, players having more freedom to direct the course of an exercise.

In considering the remaining three applications, it is necessary to assess the relevance of this approach in relation to other approaches and

techniques. Figure 1 provides a schematic classification of techniques, related to the two dimensions of calibration (ability to measure) and rationality (consistency of behavior in relation to stated or implicit objectives). Given this classification, gaming/simulation techniques are seen as making their contribution in the sector bounded by non-calibration and irrationality. Exploration of an area by the use of gaming/simulation techniques may lead to the clearer definition of the key elements in a given situation, and ultimately the employment of the quantitative techniques. Such clearer definition may stem from "results" obtained in one or more of the following areas:

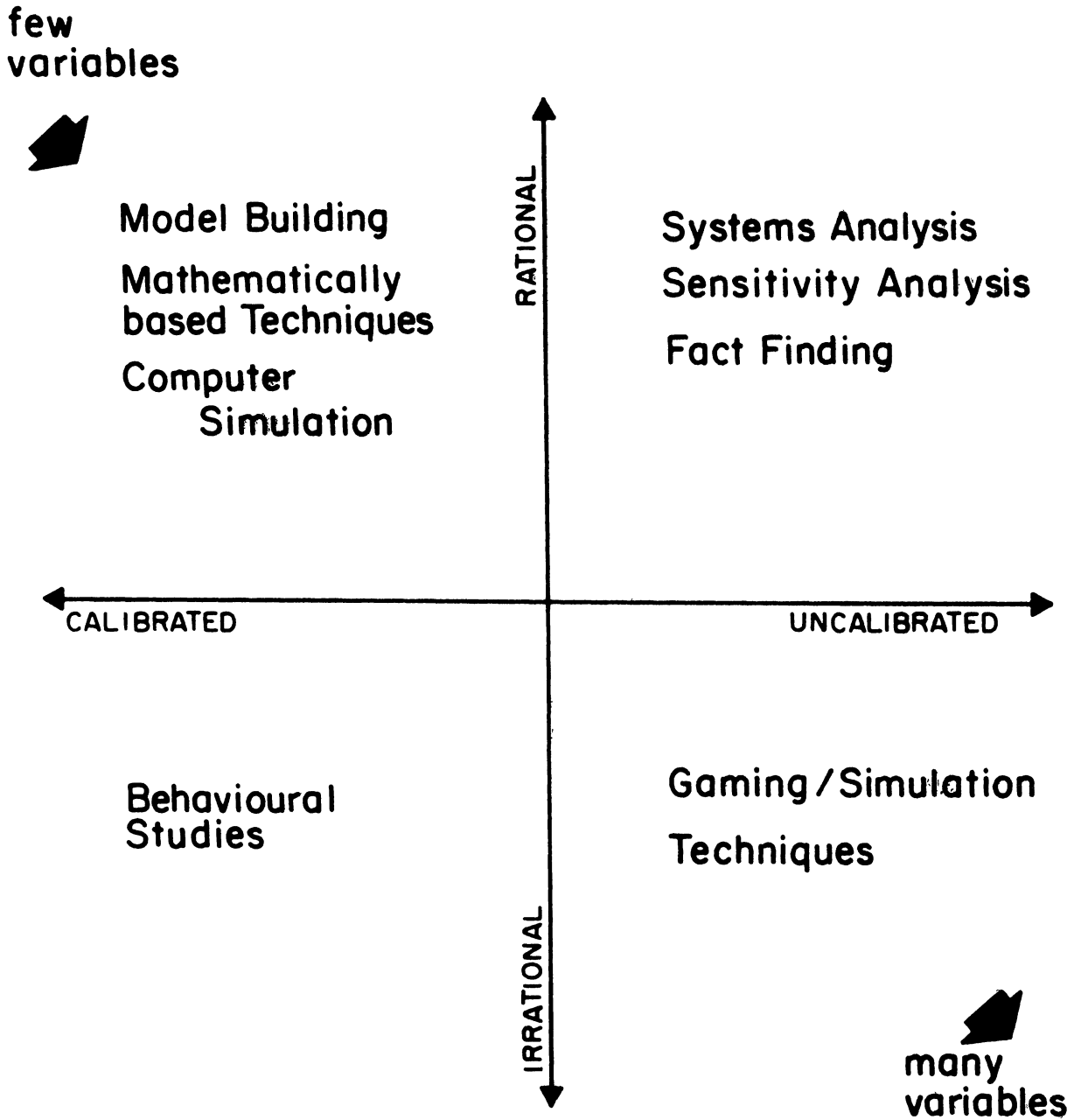
- (i) Identification and understanding of the interactions between two or more roles, e.g., initiation of contacts, their timing and purpose, leading to an evaluation of the resulting opportunities for cooperation or likelihood of conflict.
- (ii) Identification of information requirements and the use of information by the roles.
- (iii) Identification of the problem/opportunity areas created by complexes of decisions which may not always be the direct concern of the roles represented in the exercise.
- (iv) Exposure of the assumptions underlying the decision-making behavior of key groups in a situation.

These types of results may be obtained from "insights" gained collectively or individually during the course of an exercise or they may arise as the consequence of postexercise evaluations, not necessarily immediately following play. (In some cases the results may be obtained by using an exercise on a number of occasions.) It should be emphasized that results may not always have the same significance for all players. Different players may take part in successive runs of the exercise or the same players may participate in the same or different roles.

There may be occasions on which there appear to be few positive outcomes, either during or immediately following play. However, individuals often "recognize" in real life, similarities with the game situation over a large period of time. In this connection it is important that the circumstances arising during play are treated as a yardstick and the attempt to transpose game experience directly into real-life situations is resisted.

In this introduction the emphasis has been upon the construction and use of gaming/simulation exercises. There are many situations in which the techniques employed can be abstracted from an exercise and used for such purposes as structuring a discussion, displaying information and presenting new concepts. Their application in these latter areas is an even newer, but rapidly growing extension of ancient war-gaming.

Figure 1. Schematic Classification of Techniques



PLAYER'S MANUAL

The purpose of this section is to acquaint the players with the basic game and its operation. The use of this section during the play of the game will become that of a reference manual. As such, this section has three major divisions. The Scenario sub-section provides a description of the environment or situation that the players will be working in. The Roles sub-section describes the nature of the interests the players will be representing in the scenario. Finally, the Accounting sub-section describes those accounts kept by the players which monitor and process the activities of the roles and update the scenario.

SCENARIO

GENERAL

The playing board used with WALRUS I represents a 25 square mile geographic area divided into a grid of 1/4 square mile units called cells. The dividing lines represent public rights of way between cells and locate any highways, sewer lines, or water lines in use during the game. The highways, sewer lines, or water lines are indicated by tape of different sizes and colors. Also indicated on the playing board is Walton Bay, the three rivers flowing into the bay, and the drainage tributaries flowing into the rivers. The above information is summarized in Figure 2.

The shape of the playing pieces placed on the WALRUS I board represent either land ownership, one of the ten basic types of land use, or employment affiliation. (See Figure 3). The color of the pieces indicates which of the five teams owns that particular use, with the brown pieces indicating public ownership. The colored push-pins, placed on the top of those pieces which *employ*, indicate which of the five teams the workers are from. A push-pin placed on top of a residential piece indicates that a worker is unemployed. Figure 4 presents the existing land use pattern at the start of play.

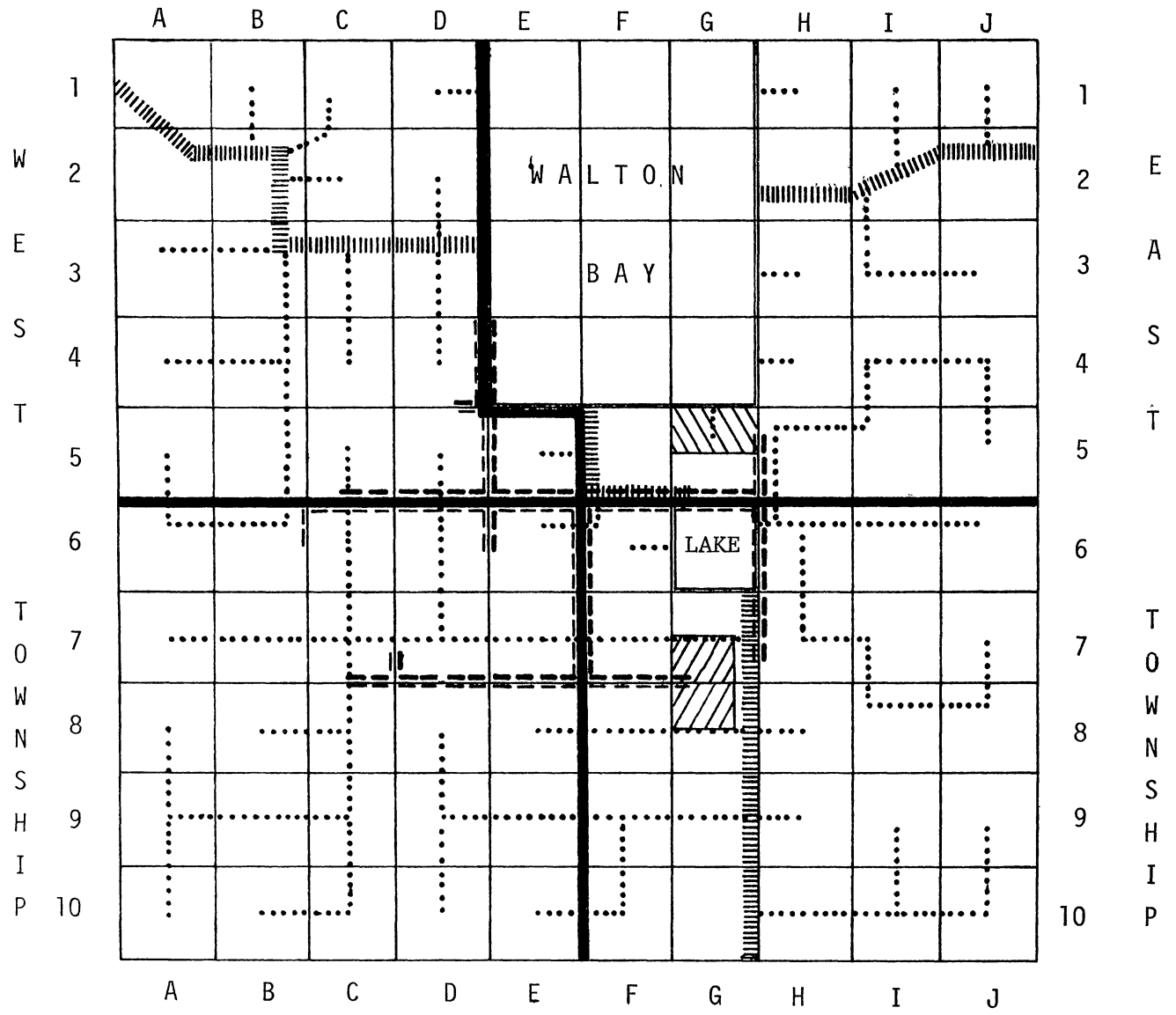
Together, the playing pieces and the playing board represent an area containing Walton, a small city of 12,000 people, and two adjacent semi-rural townships.

RULES OF PLAY

The game is controlled by two sets of rules, called "natural laws" and "man-made laws". Natural laws are representations of what are seen to be the major land use, environmental, economic, and political constraints affecting behavior and development in the Walton Region. The natural laws may be challenged by any player presenting a reasonable argument and/or documentation of another natural law which is more valid with respect to the real world and which is reducible to the simplistic format required for the operation of this game.

The man-made laws set the legal and historical precedent for the operation of each of the three jurisdictions - Walton, East Township,

Figure 2. Existing Drainage & Utility System of the Walton Region

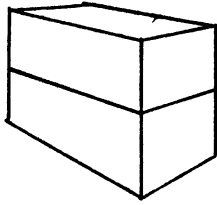


Legend

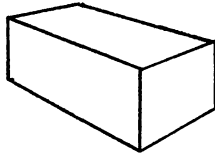
- | | | | |
|--|----------------------|--|-------------------|
| | Rivers | | Sewer lines (63K) |
| | Drainage Streams | | Water lines (67K) |
| | Major Highways | | Sewer Plant |
| | Public Rights of Way | | Water Plant |

Figure 3. WALRUS I Playing Pieces

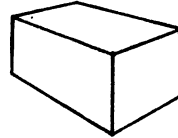
PRIVATE LAND USES (by team in red, blue, ebony, green, yellow)



Heavy Industry



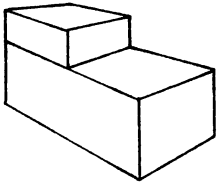
Light Industry



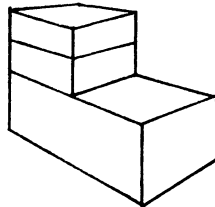
Private Recreation



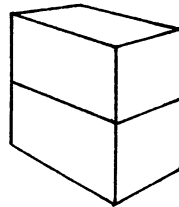
Employment Affiliation



Agriculture I



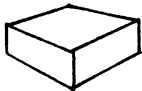
Agriculture II



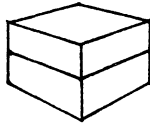
Retail



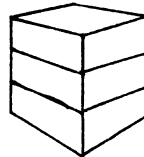
Ownership of Vacant land (in brown also)



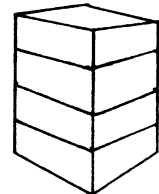
Residential I



Residential II

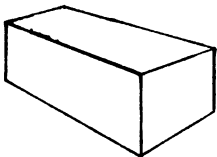


Residential III

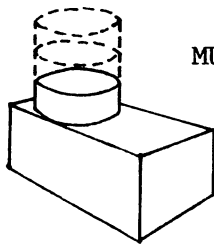


Residential IV

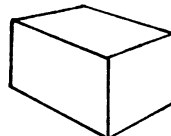
MUNICIPAL LAND USES (in brown)



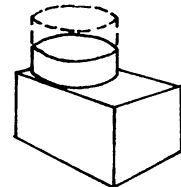
Sewage Plant I



Sewage Plant II(III,&IV)



Water Plant I



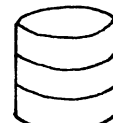
Water Plant II (III)



Park

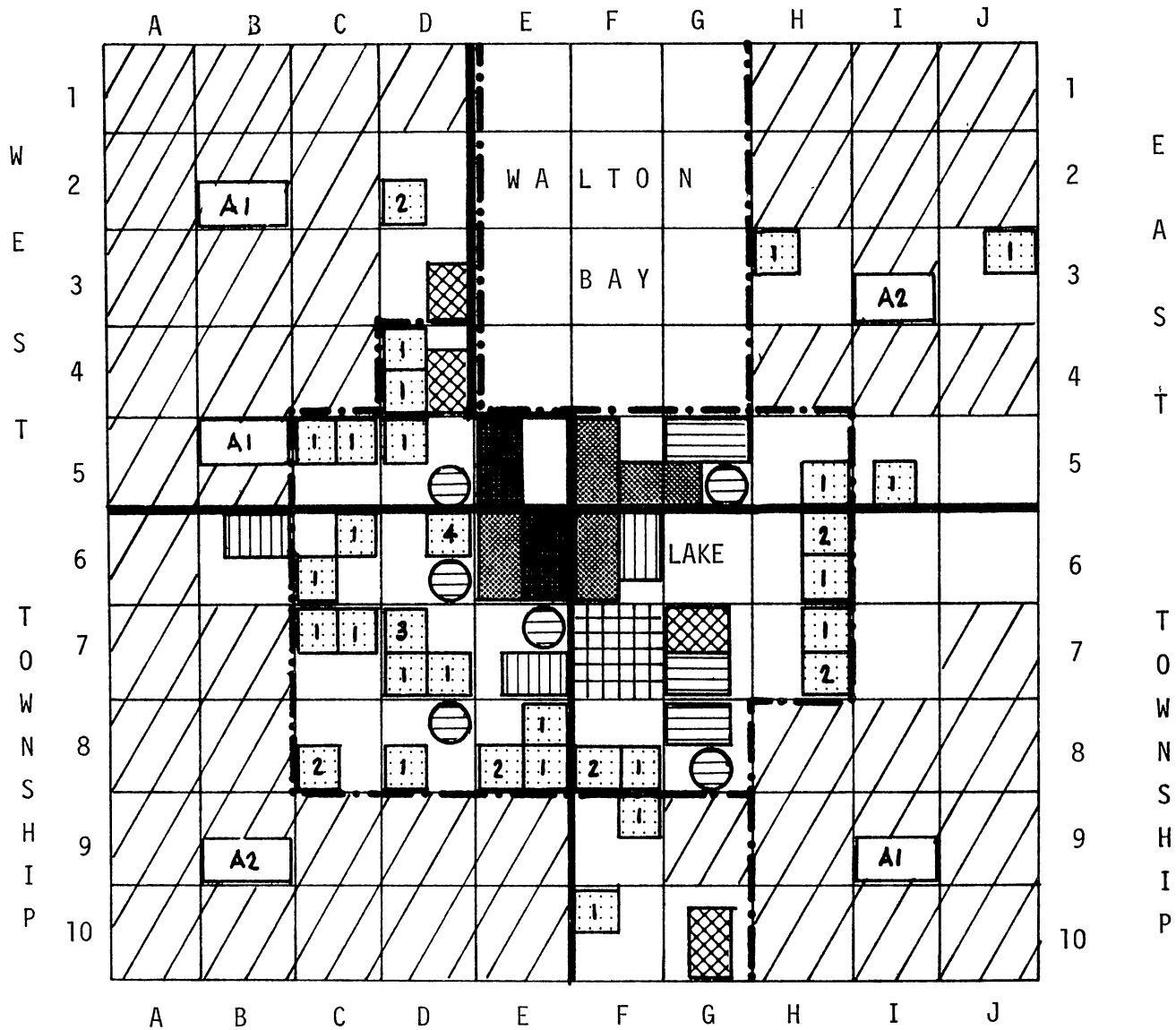


Municipal Service


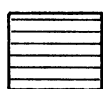
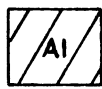
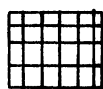
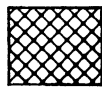

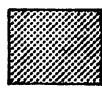
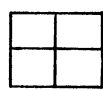

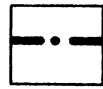
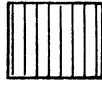



School

Figure 4. The Walton Region Land Use Map



Legend

- | | | | |
|--|-------------------------------|---|----------------------|
|  | Residential (#= density type) |  | Public |
|  | Agriculture (#= farm type) |  | Public Park |
|  | Private Recreation |  | Major Highway |
|  | Light Industry |  | Public Rights of Way |
|  | Heavy Industry |  | Political Boundaries |
|  | Retail |  | Vacant |

and West Township. These laws may be changed by majority vote of the governing body of each of the jurisdictions and more may be added within reasonable limits of existing state and national legislation and precedent.

The natural laws governing the play of the game and the man-made laws for each of the three jurisdictions are given below.

Natural Laws: Land Use Characteristics

Land uses in WALRUS are restricted to those listed in the basic components table (see Figure 5) which follows. The basic components table also provides the initial construction cost for each type of use, the number of employees required for operation, the water and sewer requirements, and appropriate information on gross income. For public land uses, capacity and operating costs are also reported. The following additional characteristics for particular land uses also apply:

1. *Heavy and light industry and retail stores* may only locate in a cell adjacent to a major highway.
2. *Residences, retail stores, and municipalities* receive their incomes from other players in the form of wages, welfare, food payments, or taxes. All other incomes come from the outside world and are paid by the operator each round.
3. *Recreation industries* may only locate on cells adjacent to a major river or the bay. As pollution levels in the adjacent body of water rise, its income is decreased according to the following schedule:

<u>Pollution Reading of River or Bay Cell</u>	<u>Decrease in Basic Income</u>
10K*	25%
20K	50%
30K	100%

4. Each *residential unit* must "consume" one food unit (represented by a paper clip) each round by submitting it to the operator at the end of the round. The food unit must be purchased from a retail store at the current price. Residential units may not locate more than three cells from a major highway.
5. Each *retail store* may purchase up to twenty food units (represented by paper clips) from the operator each round at a wholesale price determined by the operator. Initial price is \$2,000/unit. He may sell these to his customers at a price not exceeding 200% of the wholesale price.

*See page 15 for explanation of the unit "K".

Basic Component Characteristics Table

Land Use Type	Construction Cost	No. of Employees	Water Needs	Effluent	Capacity/or Gross Income/or Service Area	Operating Cost/Round (excl. wages)
Heavy Industry	\$100,000*	4 R Units	4K	8K	\$50,000	0
Light Industry	50,000	2	2	2	25,000	0
Recreation Ind.	25,000	2	3	3	25,000 max.	0
Retail Store	25,000	1	2	2	(Price x # of Cust.)	0
Agriculture I	25,000 (plus land)	1 (self)	1	2	10,000/9 Cells (+ 10% for \geq 9 Cells)	0
Agriculture II	50,000* (plus land)	2 (self + 1)	3	5	25,000/9 cells (+ 10% for \geq 9 Cells)	0
R1 Residence	10,000	---	1	1	4-8,000	0
R2 Residence	25,000*	---	2	2	Twice R1	0
R3 Residence	40,000*	---	3 x R1	3 x R1	3 x R1	0
R4 Residence	60,000*	---	4 x R1	4 x R1	4 x R1	0
Rn Residence	n x 15,000*	---	n x R1	n x R1	n x R1	0
Public Park	10,000/cell	1	1	1	---	\$ 2,000
Public School	40,000	2	2	2	25 R or Ag. Units	8,000
Municipal Services	25,000	1	1	1	9 Adj. Cells	4,000
Water Plant I	10,000	1	0	0	4K	1,000
Water Plant II	25,000	1	0	0	16K	5,000
Water Plant III	50,000	1	0	0	40K	15,000
Septic Bed I	5,000	0	0	0	1K	0
Sewage Plant II	20,000	1	0	0	12K	5,000
Sewage Plant III	40,000	1	0	0	32K	10,000
Sewage Plant IV	75,000	1	0	0	80K	20,000

*Cost given is for new construction only. If the land use is upgraded from a lower intensity use, only the difference in construction cost need be paid.

FIGURE 5

Unused food units may be carried as inventory from round to round.

6. A *municipal service unit* services its own cell plus the eight adjacent surrounding cells. Any cell containing more than two residential units must be within the service area of a municipal service unit.
7. A *school* can serve a maximum of 25 residential or agricultural units. If school enrollment (as measured by total numbers of residential and agricultural units on the board) exceeds the total capacity of all schools on the board, a 10% reduction in all external incomes to all land uses will be charged for each 10 excess residential units. At the start of the game, the two schools in the city have an enrollment of 47 residential and agricultural units. At a per unit school enrollment charge of \$1,000 the west township transfers \$7,000 to the city and the east township transfers \$5,000.

Natural Laws: Water and Sewer Characteristics

The quantity and quality of both water and sewage are measured by an index called K. This index is used to describe the capacity of water and sewer plants, the pollution level of a river or bay cell, and the amount of sewage generated by a particular land use or cell. The number of water or sewer lines associated with a particular plant is indicated by the shape and size of the playing piece representing that plant and the label affixed to it.

1. The *installed capacity* (in "Ks") of water and sewer services to any cell is measured by the number of "dashes" of orange or green tape. This capacity may be counted toward cells on either side of the right of way subject to restraints imposed by the municipality owning the lines and treatment plants. Unused lines (not placed on the playing board) are held by officials of the jurisdiction owning the plant.
2. The *efficiency of a sewage treatment plant* is normally 80%, e.g., for 100K of sewage treated, 20K of pollutants are discharged into the bay or a river. Efficiency may be raised once an additional 10% by increasing the operating costs of the plant by 25%
3. The *capacity of a water or sewer plant* may be increased up to four times by the payment of an additional 10% of the initial construction cost for each 5% increase in capacity.
4. *Groundwater* is available to each cell at the rate of 1K per cell. Such water is available for use

in its own cell or in any adjacent cell at the rate of 1K per round and is not subject to pollution. Land in agricultural use is assumed to use the groundwater of the cell occupied. Such water may be used only once each round and may not be used for industrial purposes.

5. *Water from a bay or river cell* may be used directly without appreciable treatment cost as long as the pollution level is 5K or less in the cell from which the water is drawn. Water at greater than 5K level of pollution may not be used without passing through a treatment plant.

Natural Laws: Financial and Economic Characteristics

Financial payments are made between players according to agreements among themselves and between players and the operator on the basis of costs and incomes associated with a particular land use and other requirements. It is the responsibility of each municipality to levy and collect its taxes from the appropriate teams.

1. *Federal or state aid* for any specified public use may be applied for by any municipality. The cost for an application is \$10,000 per application. Such aid will cover 75% of the total cost of any approved public project, exclusive of land acquisition costs. The probability of receiving approval is normally 25% but may be increased by the payment of influents to the operator. Ten influents will increase the probability by 5%. When an application is submitted in one round, the dice are rolled in the next round and the funds become available in the following round.

PROBABILITIES OF OBTAINING FEDERAL GRANTS

Probability of Winning	Winning Dice Numbers	Probability of Winning	Winning Dice Numbers
25%	2, 7, 11	65%	5, 6, 7, 8, 9
30%	2, 7, 9	70%	2, 5, 6, 7, 8, 9
35%	3, 7, 8	75%	4, 5, 6, 7, 8, 9
40%	4, 7, 8	80%	3, 4, 5, 6, 7, 8, 9
45%	6, 7, 8	85%	3, 4, 5, 6, 7, 8, 9, 11
50%	3, 6, 7, 8	90%	3, 4, 5, 6, 7, 8, 9, 10
55%	5, 6, 7, 8	95%	3, 4, 5, 6, 7, 8, 9, 10, 11
60%	4, 6, 7, 8, 10	100%	2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12

2. Loans from the operator may be obtained at 10% interest per round. The maximum available to any team is 25% of the value of its total assets. The rate of repayment is at 10% of the principal plus any accrued interest each round. Loans to municipalities are automatically granted upon the appearance of a deficit in the budget. The rate of interest on municipal loans is 5% and the maximum indebtedness available in any round is equal to the size of the operating budget in the preceding round.

Natural Laws: Influent and Votes

Voting power of each team in any jurisdiction is based upon the distribution of its residential and agricultural units in that jurisdiction according to the representation formula established by appropriate man-made laws. Voting power may be increased for any given vote by paying the appropriate number of influents to the operator.

1. *Influents are represented by influent cards and earned by a team as follows:*
 - a. one influent for each employee from another team.
 - b. one influent for each residential unit in a cell bordering on a major river or bay at a pollution level below 10K.
 - c. one influent for each public office held in any municipality. No more than three such offices may be established in any municipality.
2. *Influents may be expended as follows:*
 - a. five influents may purchase one additional vote on any issue through payment to the operator.
 - b. five influents may purchase one line of "newspaper space."
 - c. ten influents may be paid to the operator to purchase a 5% increase in the probability of receiving federal or state aid.

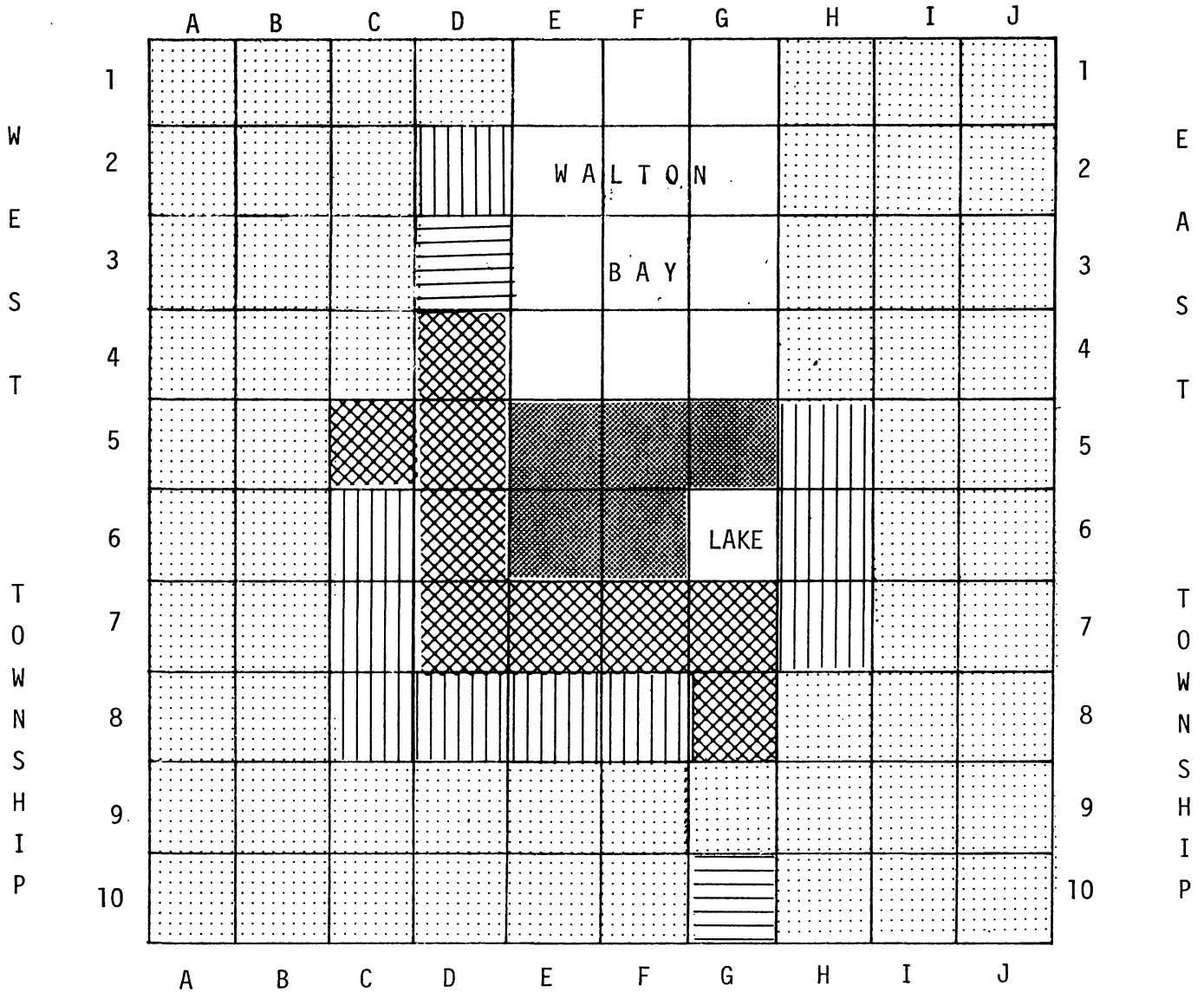
Man-Made Laws: Walton

1. *Appointments:* The mayor has the power to appoint employees in municipally owned services and to negotiate wage rates for these employees. The mayor also has the power to appoint city officials such as tax collector and public health officer, again at his/her own discretion and subject to approval of Common Council.
2. *Votes:* One vote in Common Council is received for each residential cell or agricultural unit in which

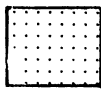


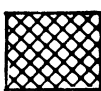

a team has a majority of the residential units.

3. *Zoning:* The existing hierarchical zoning map for the city (see Figure 6) shall be enforced by the mayor or his appointee. Changes in zoning may be enacted by majority vote of Common Council acting upon a petition presented to Council and subject to one round delay in order to allow dissenting interests to present their arguments. All changes in zoning must be announced and posted on the zoning map.
4. *Welfare:* Any residential unit without employment may apply to the tax collector for welfare payments in lieu of income. The current level of payment is \$3,000 per round per residential unit.
5. *Water and Sewer Services:* No construction is allowed within the city in any cell which is not serviced with an adequate level of water and sewer services. Provision of these services from existing capacity is the mandated responsibility of Common Council but may be delegated to some other city official. No septic beds are allowed within the city limits. Only publicly treated water supplies may be used within the city limits, i.e., no direct river or groundwater sources may be used.
6. *Extension of City Services:* Municipally owned city and water services may not be extended to users outside the city limits without annexation. If this provision is rescinded, Council must publicly post a schedule of costs for installation of services and per-round rates for use by users outside the city limits. (Prior to the passage of this law, an agreement between the city and west township was in force stipulating the payment of \$2,000 to the city for the provision of 2K water service to cell B6 in west township.)
7. *Annexation:* Annexation of all or any part of a surrounding jurisdiction requires majority approval of both governing bodies as well as approval of the teams owning the land to be annexed. All annexed land must be adjacent to land already within the city limits.
8. *Condemnation:* Condemnation of privately owned land for public good may be enacted by a two-thirds majority of Common Council with appropriate compensation for private owners directly affected. Compensation is to be between 75% and 125% of the initial construction cost of any building and at the rate of at least \$20,000 per cell of land.

Figure 6. The Walton Region Zoning Ordinance



Legend

-  R-1 1. R1 residences or agricultural uses
-  R-2 1. Any use permitted in R-1 districts.
2. R2 residences
3. Municipal services, parks
-  C-1 1. Any use permitted in R-2 districts
2. R3 residences
3. Recreation Industries
-  C-2 1. Any use permitted in C-1 districts
2. R4 residences (or larger)
3. Retail stores
4. Utilities, schools
-  M 1. Any use permitted in C-2 districts
2. All Industrial uses

9. *Taxation:* Taxes are based on land use and are currently at the following rates:
 - a. Heavy Industry, \$20,000 per round
 - b. Light Industry, \$10,000 per round
 - c. Recreation Industry, \$7,000 per round
 - d. Retail Stores, \$7,000 per round
 - e. Residential Units, \$1,500 per unit per round

Changes in tax rates or in the system of taxation are made by simple majority vote of Council. Any changes in the system of taxation must make provision for necessary accounting procedures by the city tax collector. All changes in level or type of taxation must be announced one round prior to taking effect.

10. *Federal/State Aid:* Decisions to apply for federal or state aid must receive majority approval of Common Council and application fees must be paid for from public funds. Approval of an application constitutes an agreement by the city to provide the necessary proportional payment of the project immediately upon winning the grant.

Man-Made Laws: East Township

1. *Appointments:* The chairperson has power to appoint employees in township-owned services at his/her discretion and to negotiate wage rates for these employees. The chairperson also has the power to appoint township officials such as tax collector and public health officer, subject to approval of the Town Board.
2. *Votes:* One vote on the Town Board is received for each residential cell or agricultural unit in which a team has a majority of the residential units.
3. *Zoning:* The existing hierarchical zoning map for the town (see Figure 6) shall be enforced by the chairperson or his/her appointee. Changes in zoning may be enacted by majority vote of the Town Board acting upon a petition presented to the Board and subject to one round delay in order to allow dissenting interests to present their arguments. All changes in zoning must be announced and posted on the zoning map.
4. *Welfare:* Any residential unit without employment may apply to the tax collector for welfare payments in lieu of income. The current level of payment is \$3,000 per round per residential unit.

5. *Water and Sewer Services:* No residential unit, retail store, or recreation industry may use river or bay water which is at a pollution level greater than 5K. This limit is enforced by the chairperson or his/her appointed official. No septic beds are required for construction and use of groundwater or nonpolluted surface water is permissible. Sewage is dumped directly into the appropriate drainage stream connecting the cell in question to the river or bay system.
6. *Provision of Services:* Either water or sewage treatment plants may be built at public or private expense without any legal constraint. Services thus provided may be extended to any user desiring them upon agreement on some mutually satisfactory method and rate of compensation. Such methods as creation of special-purpose districts, user charges, normal taxation, etc. may be employed as desired by a majority of the Town Board. Services may not be extended into the jurisdiction of another public body without the consent of that body.
7. *Annexation:* Annexation of all or any part of a surrounding jurisdiction requires majority approval of both governing bodies as well as approval of the teams owning the land to be annexed. All annexed land must be adjacent to land already within the township limits.
8. *Condemnation:* Condemnation of privately owned land for the public good may be enacted by a two-thirds majority of the Town Board with appropriate compensation for private owners directly affected. Compensation is to be between 75% and 125% of the initial construction cost of any buildings and at the rate of at least \$5,000 per cell of land.
9. *Taxation:* Taxes are based on land use and are currently at the following rates:
 - a. Residential Units, \$800 per unit per round
 - b. Agriculture I, \$1,000 per round
 - c. Agriculture II, \$2,000 per round

Changes in tax rates or in the system of taxation are made by simple majority vote of the Town Board. Any changes in the system of taxation must provide for necessary accounting procedures by the town tax collector. All changes in level or type of taxation must be announced one round prior to taking effect.

10. *Federal/State Aid:* Decisions to apply for federal or state aid must receive majority approval of the Town Board and application fees must be paid from public

funds. Approval of an application constitutes an agreement by the town to provide the necessary proportional payment of the project immediately upon winning the grant.

Man-Made Laws: West Township

1. *Appointments:* The chairperson has power to appoint employees in township-owned services at his/her discretion and to negotiate wage rates for these employees. The chairperson also has the power to appoint township officials such as tax collector and public health officer, subject to approval of the Town Board.
2. *Votes:* One vote on the Town Board is received for each residential cell or agricultural unit in which a team has a majority of the residential units.
3. *Zoning:* The existing hierarchical zoning map for the town (see Figure 6) shall be enforced by the chairperson or his/her appointee. Changes in zoning may be enacted by majority vote of the Town Board acting upon a petition presented to the Board and subject to one round delay in order to allow dissenting interests to present their arguments. All changes in zoning must be announced and posted on the zoning map.
4. *Welfare:* Any residential unit without employment may apply to the tax collector for welfare payments in lieu of income. The current level of payment is \$3,000 per round per residential unit.
5. *Water and Sewer Services:* No residential unit, retail store, or recreation industry may use river or bay water which is at a pollution level greater than 5K.* This limit is enforced by the chairperson or his/her appointed official. No septic beds are required for construction and use of groundwater or nonpolluted surface water is permissible. Sewage is dumped directly into the appropriate drainage stream connecting the cell in question to the river or bay system.
6. *Provision of Services:* Either water or sewage treatment plants may be built at public or private expense without any legal constraint. Services thus provided may be extended to any user desiring them upon agreement on some mutually satisfactory method and rate of compensation. Such methods as creation of special-purpose districts, user charges, normal taxation, etc.

*K is an index of the quantity and quality of both water and sewage.

may be employed as desired by a majority of the Town Board. Services may not be extended into the jurisdiction of another public body without the consent of that body.

7. *Annexation:* Annexation of all or any part of a surrounding jurisdiction requires majority approval of both governing bodies as well as approval of the teams owning the land to be annexed. All annexed land must be adjacent to land already within the township limits.
8. *Condemnation:* Condemnation of privately owned land for the public good may be enacted by a two-thirds majority of the Town Board with appropriate compensation for private owners directly affected. Compensation is to be between 75% and 125% of the initial construction cost of any buildings and at the rate of at least \$5,000 per cell of land.
9. *Taxation:* Taxes are based on land use and are currently at the following rates:
 - a. Recreation Industry, \$7,000 per round
 - b. Retail Stores, \$3,000 per round
 - c. Residential Units, \$500 per unit per round
 - d. Agriculture I, \$1,000 per round
 - e. Agriculture II, \$2,000 per round

Changes in tax rates or in system of taxation are made by simple majority vote of the Town Board. Any changes in the system of taxation must provide for necessary accounting procedures by the town tax collector. All changes in level or type of taxation must be announced one round prior to taking effect.

10. *Federal/State Aid:* Decisions to apply for federal or state aid must receive majority approval of the Town Board and application fees must be paid from public funds. Approval of an application constitutes an agreement by the town to provide the necessary proportional payment of the project immediately upon winning the grant.

STEPS OF PLAY

Play of WALRUS I occurs in a series of four stages within a round. At the completion of the fourth stage, the next round begins with another repetition of the same four stages based now upon the new status derived from the previous round. The four principal stages and the kinds of activities carried out in each are as follows:

Stage I. *Results of Previous Round Decisions*

- 1 Receive income
- 2 Pay employees
- 3 Pay shopping costs and receive goods
- 4 Pay operating costs
- 5 Pay taxes
- 6 Receive influents
- 7 Confirm current voting strength

Stage II. *Current Private Sector Decisions*

- 1 Buy or sell land
- 2 Construction of new buildings
- 3 Make or change shopping and employment commitments
- 4 File requests for public action
- 5 Elect new representatives

Stage III. *Current Public Sector Decisions*

- 1 Petitions and hearings before Council or Board
- 2 Financial and other status reports
- 3 Elect mayor or chairperson
- 4 Appoint new public officials
- 5 Vote on changes in man-made laws
- 6 New construction or development
- 7 Process applications for federal grants
- 8 Set taxes for next round
- 9 Old business
- 10 New business

Stage IV. *Challenges and Status Evaluation*

- 1 Announcement and discussion of public actions and programs
- 2 Operator commentary
- 3 Questions and discussion on game components and models
- 4 Proposed changes in natural laws

Begin next round . . .

Insofar as possible, the sequence of play will follow approximately this order, although Stages II and III may overlap. Governing bodies may meet continuously if necessary, but when Stage III is announced, they must set aside time for public hearings as requested, with time limits being determined by the governing officer. The operator has final discretion on announcing the completion of any one of the stages, and at that time any further decisions or actions to be taken must be deferred until the appropriate stage in the next round.

ROLES

Players are assigned to five teams in groups of three to five per team. Each of the teams represents a particular set of geographic, economic, and political interests within the three major municipalities in the game. Players will most likely want to play in a manner representing those interests. Such "role playing" activity is not required, however, and players may make decisions in any manner they wish as long as they stay within the constraints imposed by the game rules and steps of play.

RED and *YELLOW* teams are primarily agricultural in orientation and are in political control of the suburban townships, East Township (red) and West Township (yellow). They have only a limited amount of direct political power and influence within the city itself although their influential status in the townships often makes them important to city players. The interests and goals of these teams may be similar, although they can readily diverge into opposing directions. The concerns of the red and yellow team include such areas as: growth in the townships; agricultural investments; zoning of agricultural land to residential, commercial or industrial uses; land values and property taxes; adequate water and sewage services; and shifts in political power as a consequence of changes in these conditions.

The *BLUE* team is engaged primarily in recreational industries such as hotels, campgrounds, ski resorts, marinas, etc. The political strength of the blue team within the city is equal to that of the green team, and like the ebony team, also provides a fairly important segment of the employment base of both the city and the townships. The game is designed in such a manner that the blue team would be one of the first to feel an impact from high levels of environmental degradation, although this impact would be fairly quickly passed along to other players in terms of reduced employment, loss of shopping, increased welfare, and slower rates of growth. Care and consideration on environmental policy issues is of primary importance to the blue team.

The *EBONY* team is primarily involved in industrial holdings within the city and represents one of its major voting blocks. As the major employer, the ebony team receives a substantial number of influents, (tokens representing personal status or prestige). It is generally regarded as being the crucial supporter for most city programs. The interests of the ebony team revolve around such matters as zoning changes required for industrial expansion either within the city or in the townships, sewer services for new developments, new investments, and the relevant issues of pollution.

The *GREEN* team holds a virtual monopoly of retail services in the city and towns. It is politically in a swing position in terms of city politics, offering enough votes to make cooperation with any other team very attractive, but not enough to give any other single team a majority position. Tax rates in the city plus a rapid rate of development are immediate concerns, with only a secondary and longer term interest in the problems of environmental degradation which affect other teams more directly. As the only retailer in the city, the green team is also concerned with prices and the gain and loss of customers and trust due to general growth and expansion in the city and entrance of other teams into retailing.

During play of the game, players attempt to control, and possibly optimize, their own position and the status of the region with respect to any one or more of four basic elements: economic strength, political strength, personal status and prestige, and overall environmental quality of the water resources. Each of these dimensions is represented by an element in the game. Play money is exchanged according to relatively straightforward rules analogous to the major elements of a local economy. Political strength is based upon the number of residential or agricultural units owned within each appropriate political jurisdiction. Personal status or prestige is measured by influent cards which are awarded on the basis of public office, position as an economic dominant in the economy, or owning residential units in prestigious locations in the area.

Pollutants in the game are measured according to the number of effluents which accumulate in the bay and river system according to the land uses in existence and the type of sewage treatment provided. The effluents, measured in units of "K", decay slightly over each round but gradually build up in the bay at a rate faster than the rate of deposition of such effluents into the aquatic system. The rate and amount of deposition may be decreased by providing sewer lines and sewage treatment facilities of varying capacities and efficiencies in various locations in the region. The number and effectiveness of such facilities matched against their cost and the political responsibility for providing them constitutes the basic attempt at control over environmental degradation which is possible in *WALRUS I*. Such control requires money, understanding of the problem, and carefully developed political cooperation in order to be successfully accomplished.

No single goal is provided for all players to optimize and any given player may choose his own criteria for winning the game from one or more of these elements. Other aspects of the game, aside from those discussed here, may form the basis for goals chosen. Indeed, the lack of consensus among possible goals is probably one of the more realistic aspects of this simple form of simulation model.

Figure 7 shows the land and property ownership of the individual teams, and the three jurisdictions.

ACCOUNTING

Each team is provided with a set of two accounting forms, examples of which follow. Each of these forms provide the same basic information in two different formats.

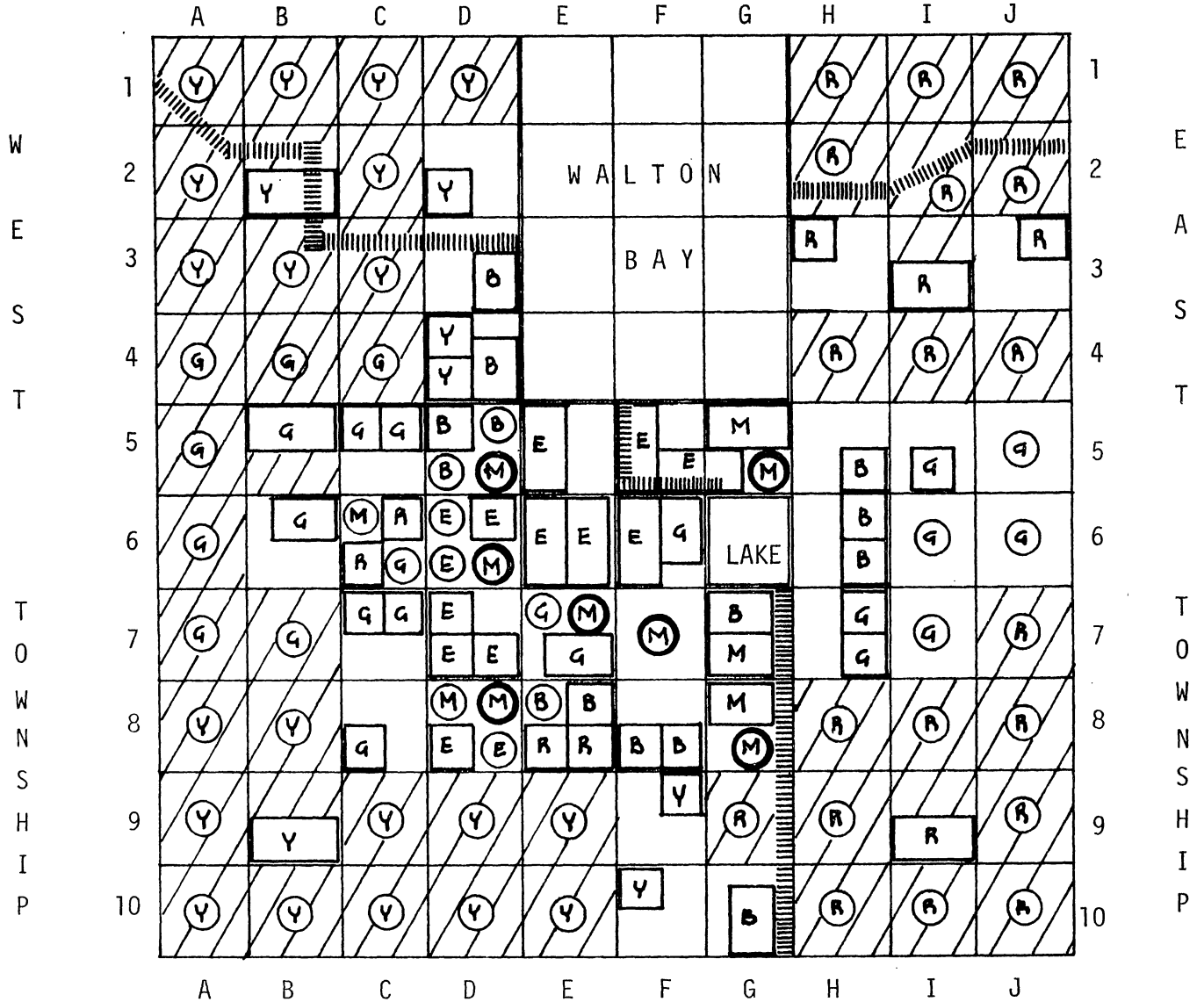
The "Team Property Holdings" account lists all of the property holdings of each team giving its size, location and appropriate information on its operating income and costs. The information given for each property includes gross income payments for wages and salaries to employees, taxes to one or another jurisdiction, other payments such as for retail goods, and the net profit or loss for the team in question. At the beginning of the game, players should look over the listing provided for their team and familiarize themselves with their holdings and their commitments to other teams and governments. Keeping these accounts up to date during successive rounds is the responsibility of each team and care should be taken to enter all new construction and any changes in commitments which occur during each round.

The second account is called the "Cash Flow Sheet" and provides a summary listing of cash flows between a team and all other teams or jurisdictions with whom that team has a current agreement. Inspection of this account should reveal that the amounts and commitments are identical to those entered on the property holding account, except for the income received from the outside world. It is again the responsibility of each team to update this account as changes are made in successive rounds.

Another account form, the "Municipal Budget Sheet", is provided to each of the three municipalities, giving a list of its holdings and operating costs, its gross tax receipts, payments for welfare, wages and loans, and its overall cash position in the first round. Each of the municipalities will also receive a "Municipal Tax Register" summarizing the taxes due from each team. The operator will provide these records to the tax collector appointed in each jurisdiction during the first round. It is then the responsibility of the tax collector to keep these records posted with current changes in each successive round.

Finally, a set of pollution records are maintained by the operator or his/her assistant. These are open to inspection by any interested player at any time.

Figure 7. Property Ownership in the Walton Region



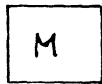
Legend



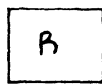
Ownership of vacant land symbol *



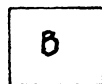
Ownership of agricultural land symbol



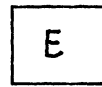
Ownership by Municipalities



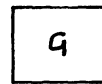
Ownership by Red Team



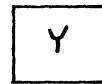
Ownership by Blue Team



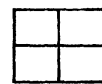
Ownership by Ebony Team



Ownership by Green Team



Ownership by Yellow Team



Public Rights of Way



River

* NOTE: In cells having developed property owned by one team only, the remaining vacant land in the cell is owned by the same team.

TEAM PROPERTY HOLDINGS

Land Use Type	Size	Location	Gross Income	Total Wages	To or From	Taxes	To	Other Payments	To or From	Net Profit
Heavy Industry										
Heavy Industry										
Light Industry		G5	25,000	-12,000	Red	10,000	City			3,000
Light Industry										
Agriculture I										
Agriculture II	12	I3	32,500	- 6,000	Blue	2,000	W.T.	3,000	Green	21,500
Retail		E7	(15*) 45,000	- 6,000	Self	7,000	City	30,000	Bank	2,000
Retail										
Recreation										
Recreation										
Recreation										
Residence	I	H6	6,000		Self	1,500	City	3,000	Green	1,500
Residence	II	D5	12,000		City	3,000	City	6,000	Self	3,000
Residence	I	C6	6,000		Ebony	1,500	City	3,000	Green	1,500
Residence										
Residence										
Residence										
Residence										
										\$32,500

* Number of customers

OPERATOR'S MANUAL

The purpose of this section is to provide the operators with the information and procedures necessary to run the game. We have generally found that three operators are required to successfully run the game, although with experience, two may be sufficient. The PLAYER'S MANUAL should be thoroughly studied before reading this section. The OPERATOR'S MANUAL has been divided, like that of the players', into Scenario, Roles, and Accounting sub-sections with the addition of a sub-section on the actual preparation necessary for a run. A format for introducing the game to the players is also suggested. Our experience has shown that a short (10-15 minute) introduction is most effective.

SCENARIO

The following is a succinct summary of the Scenario section of the PLAYER'S MANUAL. The environment the players will be working in is a watershed containing a small city and two adjacent rural townships surrounding a bay. The quality of the area's water resources has declined over time and the area is now on the verge of major pollution problems. (Refer to Figure 4, page 12 to illustrate the above). The activities in this region are ten land use types represented by the *shape* of the playing blocks (refer to Figure 3, page 11, and the playing board for examples). The "Basic Component Characteristics" table, page 14, presents the economic, employment, and water characteristics of each of the land use types.

Other behavioral constraints on these activities and the formal operation of the total environmental system are described in the remaining Natural Laws beginning on page 13. Any of the provisions in the four sections - Land Use, Water and Sewer, Financial, Inflows and Votes - may be challenged by players able to convince the operators that their alternative "law" is more "true" and equally simple.

An additional set of laws, the Man-Made Laws on pages 17-23, set the legal and historical precedents for the operation of each of the three jurisdictions - Walton, East Township, and West Township. Referring to some examples, the operators should mention that these may be changed by majority vote of the relevant governing body. Finally, as closely as possible, legislative decisions in the course of the game should not conflict with "real-world" county, state, and national laws.

ROLES

After referring the players to the role description portion of the PLAYER'S MANUAL on pages 25-27, the operator may wish to embellish those descriptions with examples of teams' property holdings, (see "Team Property Holdings" forms), and if desired, some examples of playing strategies. It should be emphasized that these are only examples, and that ultimately players may direct their team's efforts in any way they deem appropriate within the framework of the game rules and steps of play.

Strategy Comments

RED and *YELLOW* teams:

Being primarily agricultural in orientation, and in control of the suburban townships, these teams may be interested in limiting growth in the townships and seeking to maximize return from agricultural investments. This requires care in matters of zoning and land sales within each jurisdiction. Conversely, re-zoning agricultural land to residential, commercial, or industrial will encourage growth and development by other teams, escalation of land value, and a rise in property taxes. A significant increase in residential development by other teams might result in loss of the political power enjoyed by the original teams in each township. Provision of adequate water and sewer services for these developments is a continuous problem and usually gets the developing township into issues of annexation to the city, purchase of services from the city, or independent provision of services by either the township or private investors.

BLUE team:

The blue team, engaged primarily in recreational industries is one of the first to feel the impact of environmental degradation. Diversification of the type of commercial holdings owned by the blue team is one form of protection against these impacts, although as mentioned in the *PLAYER'S MANUAL*, care and consideration on environmental policy issues is even more important.

EBONY team:

With its industrial holdings, may follow a policy of industrial expansion either within the city or in the townships depending upon the levels of taxation imposed and the cooperation received from the city in terms of zoning requests, water and sewer services for new developments, etc. It may also begin to develop new investments in areas such as recreational industries or retailing. The team's stand on pollution issues and policies may be either conservative or liberal, depending upon the perceived and actual impacts such policies would have on the economic future within the community and the team's own ideological conceptions of how they ought to behave.

GREEN team:

As the only retailer in the city, the Green team could, in the short run, reap exorbitant profits from all other players by raising prices to the upper limit allowed. Such an action would almost certainly result in other teams entering retailing as quickly as possible, causing substantial losses in both customers and trust to the Green team. General growth and

expansion of the city is basically in the interest of the Green team because of its position in the retailing structure. Some diversification of holdings is also a potentially desirable strategy to avoid overdependence upon the goodwill and tolerance of customers from all other teams.

The individual team strategy chosen may result from any combination of goals associated with market/economy, power, prestige, or environmental concerns. As detailed in the PLAYER'S MANUAL, the measures of these interests in the game itself are play money, votes, influent cards, and "Ks", respectively. Information pertaining to these commodities is contained in the Natural Laws of the Player's Scenario section. As it is important that the players understand this basic information, the operators may wish to briefly review it with them.

ACCOUNTING

The status of the Walton Region and the effects of the decisions the teams make are monitored by a set of four types of accounts contained in Appendix I. Two of these, the "Pollution Record Chart" and the "Votes and Influent Accounting Sheet" are the direct responsibility of the operator to update. The other two sets - the "Team Property Holdings/Cash Flow Sheet" and the "Municipal Budget Sheet/Municipal Tax Register" - are the responsibility of the players to maintain although some assistance from the operators is initially required. The operators also have the responsibility of insuring that all the Natural Laws are adhered to although specific forms for this purpose are not provided.

Pollution Record Charts

These records include the following: 1) a pollution record chart completed for round 0 at the start of play; 2) a partially completed chart for round 1 and; 3) a blank chart suitable for copying and use in each successive round. Completion of this chart is not difficult although some initial explanation is necessary.

The effluent from each cell is determined by the land uses existing in that cell (and their effluent loads from Figure 5, page 14). Effluents from agricultural uses are assumed to flow from the cell containing the agricultural building. Each cell is connected to one of the three rivers or the bay by the drainage streams as indicated on the playing board and in Figure 2. It is helpful to make a copy of Figure 2, fill in the initial effluent loads from the land uses; and overlay this with a clear sheet of plastic to record the effluent loads from any new construction or changes to the land uses serviced by sewers. The effluents from each cell are added to the rivers ("K in" column) as appropriate. One K of pollution is subtracted ("K out" column) for each cell the river traverses. This represents the natural decay and removal of effluents. The resultant "Cumulative Total" column represents the average pollution level along the rivers with respect to the adjacent land cells. Note that there

is no loss of pollution along the drainage streams.

The initial sum of the effluents into the sewage plant is 78K, based on the total land uses connected to sewage lines at the beginning of the game. Treatment at 80% efficiency reduces this flow to 16K which enters the bay at cell G-5, adjacent to the plant. The total effluent load already in the bay at the start of play is 15K. The effluents flowing into the bay from the three rivers are then noted where appropriate along with any additional effluent draining directly into the bay from adjacent cells.

The sum of these commodities is the total "raw" pollution in the bay which is then reduced by 12K for self-cleansing and then by another 10% for outflow from the bay. The homogeneous distribution of pollution in each bay cell is the "FINAL SUM" divided by 12, the number of bay cells. The "FINAL SUM" will become the new "prior" pollution load in the bay for the next round. Finally, the average pollution per bay cell is used as the "Origin" pollution for each of the three rivers and the "Intake" pollution level of the bay *two* rounds in the future (2K is used for round 1). The bay "Intake" level of pollution could be increased by the operators if desirable in order to speed up or delay a crisis situation in the game for pedantic purposes.

Influents and Votes Accounting Sheet

This chart is updated each round in accordance with the Influents and Votes section of the Natural Laws on page 17 of the Player's Manual. Changes to the initial influent values are noted by monitoring the color of the pushpins on newly-constructed employers, changes in existing employment affiliations, jurisdictional elections and appointments, and the pollution levels. Changes in voting strength are the result of new residential construction or changes to the appropriate Man-Made Laws. This chart should be posted each round.

Municipal Budget Sheets/Municipal Tax Registers

During the first round the operators should process all governmental fiscal transactions. Principally this involves the payment of wages and welfare to, and the collection of taxes from, each of the teams for each jurisdiction. The relevant amounts are recorded in the "Municipal Budget Sheets" and the "Municipal Tax Registers" respectively. All other line items on the budget sheets may be ignored, in the first round *ONLY*, with the preparation of a "Tax Coffers" envelope for each jurisdiction containing the appropriate "New Balance" amounts. The two account sheets and the tax coffers should be presented to the governmental units with their establishment later in round 1. Some explanation of the forms should be provided noting the nature of the transfer payments between jurisdictions and the retail store in B-6 (a non-conforming use) in operation before the enactment of the West Township Zoning Ordinance. In each successive round all the governmental fiscal transactions will be the responsibility of the appointed officials with the exception of the collection of "Total Operating Costs". These should be collected by the operators toward the close of each round.

Team Property Holdings/Cash Flow Sheets

Explanation of these two accounts to be maintained by the players is found in the PLAYER'S MANUAL on page 27. As the play begins, the operators should explain these forms in detail to each team (particularly the Green team).

Gross income from the "outside world" is provided by the operators at the start of each round for industrial, recreational and agricultural land uses. For those teams engaged in retailing, the proper number of food units (paper clips) are received from the operators at the start of each round. The teams sell these units to other teams and *then* make payment to the operator representing the bank, or "wholesaler", at the close of the round. At this time, an order is placed for food units for the next round. At the very end of each round, the operators must collect one food unit for each residential and agricultural unit owned by the teams.

An outline of the steps of play is presented on pages 23-24 of the PLAYER'S MANUAL. The following table suggests a division of responsibilities between three operators for a run of the game.

Posted near the government tables should be the "Votes and Influents Accounting Sheet", the Zoning Map, and a large land use map if desired. Prior to the game introduction, it is helpful to group the following materials together for each team: "Team Property Holding/Cash Flow Sheet" and the initial gross income, influents, and food units for the retailers. The "Municipal Budget Sheet/Municipal Tax Register", the "Tax Coffer", and extra sewer and water line tape where appropriate should also be assembled for each jurisdiction. A blackboard or large newsprint pad is helpful to use as a "newspaper" or to post other messages.

Tasks	Responsibility			Occurrence	All
	Operator #			of Tasks	
	1	2	3	Round I only	
General Team Descriptions	X	X	X	X	
Explain Team Accounts	X	X	X	X	
Tax collection/wage, welfare payments		X	X	X	
Distribute Influents			X		X
Distribute Exogenous Income		X			X
Sell/Collect Food Units; Bank loans	X				X
Playing Board up-to-date:					
-selling, construction		X			X
-sewer, water lines			X		X
Council/Township meetings	X				X
Accounting forms					
-team's up-to-date	X	X	X		X
-Pollution Records		X			X
-Votes/Influents			X		X
-Municipal Budget/ Tax Registers	X				X
End of round summary	X	X	X		X

PREPARATION FOR A RUN OF WALRUS I

Playing Board Set-Up

The following table presents the necessary tasks and the sources of information needed to set up the playing board for a run of the game.

TASK	SOURCE
1. Apply black dashed tape representing highways	Figure 2
2. Apply green dashed tape for sewer lines, orange dashed tape for water lines adjacent to public rights of way and on top of highway tapes. Note: 1 dash = 1 K line capacity	Figure 2
3. Set land uses:	
-type of use by shape of block	Figure 3
-specific use and location-private	Figure 4
-specific use and location-public	Figure 4-Municipal Budget
-team ownership of use	Figure 7 Sheets

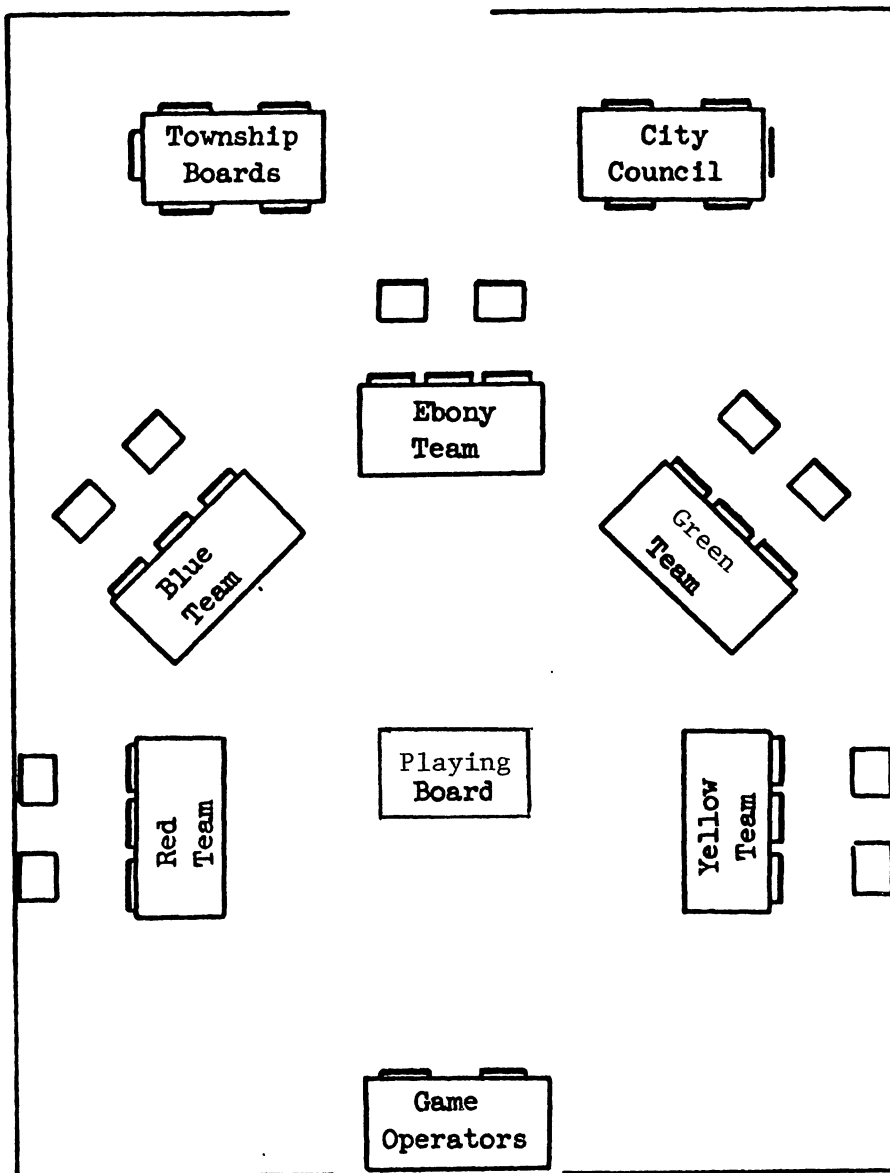
TASK

SOURCE

4. Set colored pin designating employment affiliation. The color of the pin corresponds to the color of the team employed. Unemployed residential units have a colored pin placed on the residential block. (also provides a check of step 3).

Team Property Holding Sheets

Room Set-up- The following diagram suggests appropriate seating arrangements and space needs for a run of the game with fifteen to twenty-five players.



Scale in Feet



APPENDIX I

Accounting Forms

POLLUTION RECORD CHART

Location		K In	K Out	Net Change	Cum. Total	Comments
West River	Origin	1	0			From Bay at R-2
	A1	0	-1K	1	0	
	B2	2,2,2	-1K	5	5	
	C3	0	-1K	-1	4	
	D3	2,3	-1K	4	8	To Bay in R
South River	Origin	1	0			From Bay at R-2
	G10	3,2	-1K	6	5	
	G9	1,1	-1K	1	6	
	G8	0	-1K	-1	5	
	G7	5	-1K	4	9	
	G6	1	-1K	0	9	
	F6	0	-1K	-1	8	
	F5	0	-1K	-1	7	To Bay in R
East River	Origin	1	0			From Bay at R-2
	J2	0	-1K	1	0	
	I2	5,1	-1K	5	5	
	H2	1	-1K	0	5	To Bay in R
Sewage Facility	G5	78 <u>x.20</u> 16	---	---	---	From land uses serviced 1- 80% efficiency To Bay in R
Bay	Prior Intake	15	---	---	---	From Bay FINAL SUM at R-1 From Bay at B-2
	D1	1				
	D3	0				From West River in R From South River in R From G-5 Sewage in R
	F5	8				
	G5	7				
	H4	16				From East River in R
	H3	0				
	H2	0				
	H1	5				
		0				
		<u>52</u>				Sum of Pollutants Self Cleansing At 10%= Outflow from Bay FINAL SUM * Divided by 12 cells POLLUTION/BAY CELL +
		<u>-12</u>				
		40				
	<u>- 4</u>					
	36					
	<u>÷12</u>					
	3					

R = Round number

* Input FINAL SUM to Bay Prior total in R+1=36

+ Input POLLUTION/BAY CELL to River Origins and Bay Intake R+2 =3

POLLUTION RECORD CHART

	Location	K In	K Out	Net Change	Cum. Total	Comments	
West River	Origin	2	0			From Bay at R-2	
	A1		-1K				
	B2		-1K				
	C3		-1K				
	D3		-1K				
					To Bay in R		
South River	Origin	2	0			From Bay at R-2	
	G10		-1K				
	G9		-1K				
	G8		-1K				
	G7		-1K				
	G6		-1K				
	F6		-1K				
	F5		-1K				
					To Bay in R		
East River	Origin	2	0			From Bay at R-2	
	J2		-1K				
	I2		-1K				
	H2		-1K				
					To Bay in R		
Sewage Facility	G5	<u>x.</u>	---	---	---	From land uses serviced 1- % efficiency To Bay in R	
Bay	Prior Intake	36	---	---	---	From Bay FINAL SUM at R-1 From Bay at B-2 From West River in R From South River in R From G-5 Sewage in R From East River in R Sum of Pollutants Self Cleansing At 10%= Outflow from Bay FINAL SUM * Divided by 12 cells POLLUTION/BAY CELL +	
	D1	2					
	D3						
	F5						
	G5						
	H4						
	H3						
	H2						
	H1						
			<u>-12</u>				
			<u>-</u>				
			<u>+12</u>				

R = Round number

* Input FINAL SUM to Bay Prior total in R+1=

+ Input POLLUTION/BAY CELL to River Origins and Bay Intake R+2 =

POLLUTION RECORD CHART

	Location	K In	K Out	Net Change	Cum. Total	Comments
West River	Origin		0			From Bay at R-2
	A1		-1K			
	B2		-1K			
	C3		-1K			
	D3		-1K			To Bay in R
South River	Origin		0			From Bay at R-2
	G10		-1K			
	G9		-1K			
	G8		-1K			
	G7		-1K			
	G6		-1K			
	F6		-1K			
	F5		-1K			To Bay in R
East River	Origin		0			From Bay at R-2
	J2		-1K			
	I2		-1K			
	H2		-1K			To Bay in R
Sewage Facility	G5	<u>x.</u>	---	---	---	From land uses serviced 1- % efficiency To Bay in R
Bay	Prior Intake	---	---	---	---	From Bay FINAL SUM at R-1 From Bay at B-2
	D1					
	D3					From West River in R
	F5					From South River in R
	G5					From G-5 Sewage in R
	H4					
	H3					
	H2					From East River in R
	H1					
			<u>-12</u>			
		<u>-</u>				
		<u>+12</u>				

R = Round number

* Input FINAL SUM to Bay Prior total in R+1=

+ Input POLLUTION/BAY CELL to River Origins and Bay Intake R+2 =

INFLUENTS AND VOTES ACCOUNTING SHEET

TEAM	INFLUENTS Source				Total	VOTES		
	Prior*	Employment	Aesthetic	Officer		Walton	E. Twp.	W. Twp.
<u>Round 1</u>								
red	2	0	2	---	4	2	4	0
blue	6	7	6	---	19	4	0	0
ebony	4	8	0	---	12	3	0	0
green	4	2	3	---	9	4	1	1
yellow	4	1	6	---	11	1	0	5
					Total	14	5	6
<u>Round 2</u>								
red	-							
blue	-							
ebony	-							
green	-							
yellow	-							
					Total			
<u>Round 3</u>								
red	-							
blue	-							
ebony	-							
green	-							
yellow	-							
					Total			
<u>Round 4</u>								
red	-							
blue	-							
ebony	-							
green	-							
yellow	-							
					Total			
<u>Round 5</u>								
red	-							
blue	-							
ebony	-							
green	-							
yellow	-							
					Total			

*Note: initial conditions

MUNICIPAL TAX REGISTER

TEAM	LAND USES	# ESTABLISHMENTS / TOTAL TAXES DUE				
		Cycle Number				
		1	2	3	4	5
RED	Residential Units	5/7,500				
	SUB-TOTAL	7,500				
BLUE	Recreation	2/14,000				
	Residential Units	9/13,500				
	SUB-TOTAL	27,500				
EBONY	Heavy Industry	2/40,000				
	Light Industry	4/40,000				
	Residential Units	10/15,000				
	SUB-TOTAL	95,000				
GREEN	Retail	2/14,000				
	Residential Units	2/13,500				
	SUB-TOTAL	27,500				
YELLOW	Residential Units	2/3,000				
	SUB-TOTAL	3,000				
	GRAND TOTAL	\$ 160,500				

MUNICIPAL TAX REGISTER

TEAM	LAND USES	# ESTABLISHMENTS / TOTAL TAXES DUE				
		Cycle Number				
		1	2	3	4	5
RED	Agriculture I	1/1000				
	Agriculture II	1/2000				
	Residential Units	2/1600				
	SUB-TOTAL	4600				
BLUE						
	SUB-TOTAL	-				
EBONY						
	SUB-TOTAL					
GREEN	Residential Units	1/800				
	SUB-TOTAL	800				
YELLOW						
	SUB-TOTAL	-				
	GRAND TOTAL	\$ 5400				

MUNICIPAL TAX REGISTER

TEAM	LAND USES	# ESTABLISHMENTS / TOTAL TAXES DUE				
		Cycle Number				
		1	2	3	4	5
RED						
	SUB-TOTAL	-				
BLUE	Recreation	2/14,000				
	SUB-TOTAL	14,000				
EBONY						
	SUB-TOTAL	-				
GREEN	Agriculture I	1/1,000				
	Retail	1/3,000				
	SUB-TOTAL	4,000				
YELLOW	Agriculture I	1/1,000				
	Agriculture II	1/2,000				
	Residential Units	4/2,000				
	SUB-TOTAL	5,000				
	GRAND TOTAL	\$ 23,000				

TEAM PROPERTY HOLDINGS

Land Use Type	Size	Loca- tion	Gross Income	Total Wages	To or From	Taxes	To	Other Payments	To or From	Net Profit
Heavy Industry										
Heavy Industry										
Light Industry										
Light Industry										
Agriculture I										
Agriculture II										
Retail										
Retail										
Recreation		D3	25,000	12,000	Yel., Yel.	7,000	W.T.	---		6,000
Recreation		D4	25,000	12,000	Yel., Red	7,000	City	---		6,000
Recreation		G7	25,000	12,000	Grn., Self	7,000	City	---		6,000
Recreation		G10	25,000	12,000	Yel., Grn.	7,000	W.T.	---		6,000
Residence	I	D5	6,000		City	1,500	City	3,000	Green	1,500
Residence	I	E8	6,000		Green	1,500	City	3,000	Green	1,500
Residence	II	F8	12,000		Ebony	3,000	City	6,000	Green	3,000
Residence	I	F8	6,000		Self	1,500	City	3,000	Green	1,500
Residence	II	H6	12,000		Ebony	3,000	City	6,000	Green	3,000
Residence	I	H6	6,000		Ebony	1,500	City	3,000	Green	1,500
Residence	I	H5	3,000 (unempl.)		City	1,500	City	3,000	Green	-1,500
										\$ 34,500

I-13

TEAM PROPERTY HOLDINGS

Land Use Type	Size	Location	Gross Income	Total Wages	To or From	Taxes	To	Other Payments	To or From	Net Profit
Heavy Industry		E5	50,000	12,000 12,000	Green Self	20,000	City	---		6,000
Heavy Industry		E6	50,000	24,000	Self	20,000	City	---		6,000
Light Industry		E6	25,000	12,000	Self	10,000	City	---		3,000
Light Industry		F5	25,000	12,000	Blue	10,000	City	---		3,000
Light Industry		G5	25,000	6,000 6,000	Blue Red	10,000	City	---		3,000
Light Industry		F6	25,000	12,000	Blue	10,000	City	---		3,000
Agriculture I										
Agriculture II										
Retail										
Retail										
Recreation										
Recreation										
Recreation										
Residence	IV	D6	24,000	---	Self	6,000	City	12,000	Green	6,000
Residence	III	D7	12,000 6,000		Self Green	4,500	City	9,000	Green	4,500
Residence	I	D7	6,000		Self	1,500	City	3,000	Green	1,500
Residence	I	D7	6,000		Self	1,500	City	3,000	Green	1,500
Residence	I	D8	6,000		Yellow	1,500	City	3,000	Green	1,500
Residence										
Residence										
										\$39,000

I-15

TEAM PROPERTY HOLDINGS

Land Use Type	Size	Location	Gross Income	Total Wages	To or From	Taxes	To	Other Payments	To or From	Net Profit
Heavy Industry										
Heavy Industry										
Light Industry										
Light Industry										
Agriculture I	7	B5	8,000	---		1,000	W.T.	3,000	Self	4,000
Agriculture II										
Retail		B6	48,000 [*] (16)	6,000	Ebony	3,000	W.T.	32,000	Bank	7,000
Retail		E7	48,000 [*] (16)	6,000	Blue	7,000	City	32,000	Bank	3,000
Retail		F6	45,000 [*] (15)	6,000	Self	7,000	City	30,000	Bank	2,000
Recreation										
Recreation										
Recreation										
Residence	I	C5	6,000		Ebony	1,500	City	3,000	Self	1,500
Residence	I	C5	6,000		Ebony	1,500	City	3,000	Self	1,500
Residence	I	C7	6,000		Blue	1,500	City	3,000	Self	1,500
Residence	I	C7	6,000		City	1,500	City	3,000	Self	1,500
Residence	I	H7	6,000		Blue	1,500	City	3,000	Self	1,500
Residence	II	H7	12,000		Self City	3,000	City	6,000	Self	3,000
Residence	I	I5	6,000		City	800	E.T.	3,000	Self	2,200
Residence	II	C8	12,000		City	3,000	City	6,000	Self	3,000
										\$31,700

* Number of customers

I-17

CASH FLOW SHEET

To/From	Purpose	Description	Amount	Cycle 2	Cycle 3	Cycle 4	Cycle 5
City	taxes		-27,500				
	wages	income- 5 workers	+30,000				
	welfare						
W. Twp.	taxes		- 4,000				
	wages						
E. Twp.	taxes		- 800				
Blue	goods	store # customers					
		B6 3	+ 9,000				
		E7 1	+ 3,000				
		F6 5	+15,000				
	wages	income-2 workers	+12,000				
	wages	expenditure-1 worker	- 6,000				
Ebony	goods	store # customers					
		B6 -	-				
		E7 10	+30,000				
		F6 -	-				
	wages	income-2 workers	+12,000				
	wages	expenditure-1 worker	- 6,000				
Red	goods	store # customers					
		B6 1	+ 3,000				
		E7 3	+ 9,000				
		F6 5	+15,000				
Yellow	goods	store # customers					
		B6 7	+21,000				
		E7 -	-				
		F6 1	+ 3,000				
Bank	goods	store R ^{From team} Y B E G Sum					
		B6 1 7 3 - 5 16	-32,000				
		E7 3 - 1 10 2 16	-32,000				
		F6 5 1 5 - 4 15	-30,000				
Green	goods	store # customers					
		B6 5	+15,000				
		E7 2	+ 6,000				
		F6 4	+12,000				
	wages		+ 6,000				

TEAM PROPERTY HOLDINGS

Land Use Type	Size	Location	Gross Income	Total Wages	To or From	Taxes	To	Other Payments	To or From	Net Profit
Heavy Industry										
Heavy Industry										
Light Industry										
Light Industry										
Agriculture I	9	B2	10,000			1,000	W.T.	3,000	Green	6,000
Agriculture II	11	B9	30,000	6,000	Ebony	2,000	W.T.	3,000	Green	19,000
Retail										
Retail										
Recreation										
Recreation										
Recreation										
Residence	II	D2	12,000		Blue	1,000	W.T.	6,000	Green	5,000
Residence	I	D4	6,000		Blue	1,500	City	3,000	Green	1,500
Residence	I	D4	6,000		City	1,500	City	3,000	Green	1,500
Residence	I	F9	6,000		Blue	500	W.T.	3,000	Green	2,500
Residence	I	F10	6,000		City	500	W.T.	3,000	Green	2,500
Residence										
Residence										
										\$ 38,000

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APPENDIX II

Playing Pieces for WALRUS I Kits

Playing Pieces for WALRUS I Kits

Should a person wish to construct a WALRUS I kit, the following materials would be needed:

- 1) Tokens representing: employment affiliations (pins); highways, sewer and water lines (tape); Influent (cards); and food units (paper clips).
- 2) A facsimile of the playing board
- 3) A supply of play money
- 4) A pair of dice
- 5) The land uses which may be constructed of any material convenient to the user.

The following table shows the numbers of land uses required.

Land Use	Team					
	Red	Green	Ebony	Yellow	Blue	Brown
Heavy Industries	2	2	5	2	2	-
Light Industries	2	2	5	2	2	-
Recreation Industries	4	4	4	4	5	-
Agriculture I	2	2	2	2	2	-
Agriculture II	2	2	2	2	2	-
Retail	2	4	2	2	2	-
Residential I	10	10	10	10	10	-
Residential II	2	2	2	2	2	-
Residential III	2	2	2	2	2	-
Residential IV	1	1	1	1	1	-
Municipal Services	-	-	-	-	-	6
Schools	-	-	-	-	-	4
Water Plants						
I	-	-	-	-	-	10
II	-	-	-	-	-	6
III	-	-	-	-	-	4
Sewage Plants						
I	-	-	-	-	-	5
II	-	-	-	-	-	5
III	-	-	-	-	-	4
IV	-	-	-	-	-	6
Parks	-	-	-	-	-	5

At this writing, a private firm has purchased and packaged the components needed for several academic games in kits. They have agreed to provide kits for WALRUS I as well and the complete kit may be purchased directly from: Urbex Affiliates, Inc. P.O. Box 2198, Ann Arbor, Michigan 48006

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