Technical Report No. 28

W.A.L.R.U.S. I

Water and Land Resource Utilization Simulation

By

Allan G. Feldt

with David Moses and James Eckroad

Environmental Simulation Laboratory
School of Natural Resources
The University of Michigan

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Multidisciplinary Research in the Great Lakes

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THE UNIVERSITY OF MICHIGAN SEA GRANT PROGRAM

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ACKNOWLEDGMENTS

This version of WALRUS I is derived from the groundwork laid by Thomas E. Borton, Katherine Warner, and Richard Duke in introducing the idea of the use of operational gaming devices in Sea Grant research. At the same time, we have 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 also influenced our thinking in more subtle ways but specific further 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.

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INTRODUCTION

WALRUS I is the first in a series of three games developed for the University of Michigan Sea Grant Program to provide a basis for communication and interaction among Sea Grant personnel engaged in specialized water resources research and between such personnel and the lay public they are seeking to serve. Successive models in the series will provide gaming-simulation models of increasing complexity and sophistication, moving towards what is hoped to be a highly sophisticated and realistic simulation of human communities and their interrelationships with the environment. Development of the final stage in this series is a number of years away, but this game and a number of others are helping to prepare the way for greater use of simulation technologies and possibilities in public decision making. The second gaming-simulation model in the series, WALRUS II, is expected to be completed by the summer of 1972 and will provide a more sophisticated and detailed version of the elements and processes represented in this early, imprecise, and relatively simple gaming-simulation model.

This first game in the series is necessarily quite crude. The attempt here has been to stimulate discussion and criticism as to what the principal ingredients of an adequate simulation model dealing with water resources problems should be. To date the game has served this purpose well, and the current version contains a number of changes in content and emphasis based upon the earlier trail runs of the model with interested scientists and public officials. To personnel from the Michigan Sea Grant Program and to elected

officials and planning board members from Traverse City, Michigan, we are

easily misunderstood and is not widely known as yet, the following brief description by Robert Armstrong and Margaret Hodson is offered as a succinct and generally accepted introduction to the technique itself.

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

*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.

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), 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

(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 would be represented by human players in the computer simulation, while the three elements are present, they are represented in symbolic from 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 the 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,

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

when given variables change, can make a "prediction" of the quantitative outcome of such (a) change(s).

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

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

of an exercise, are freedom to direct the course of ... freedom to direct course

three applications, it is necessary to assess

relation to other approaches and techniques.

ssification of techniques, related to the two

to measure) and rationality (consistency of

implicit objectives). Given this classifi-

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Figure 1 provides a schematic clas

dimensions of calibration (ability

behavior in relation to stated or

cation, gaming/simulation techniqu

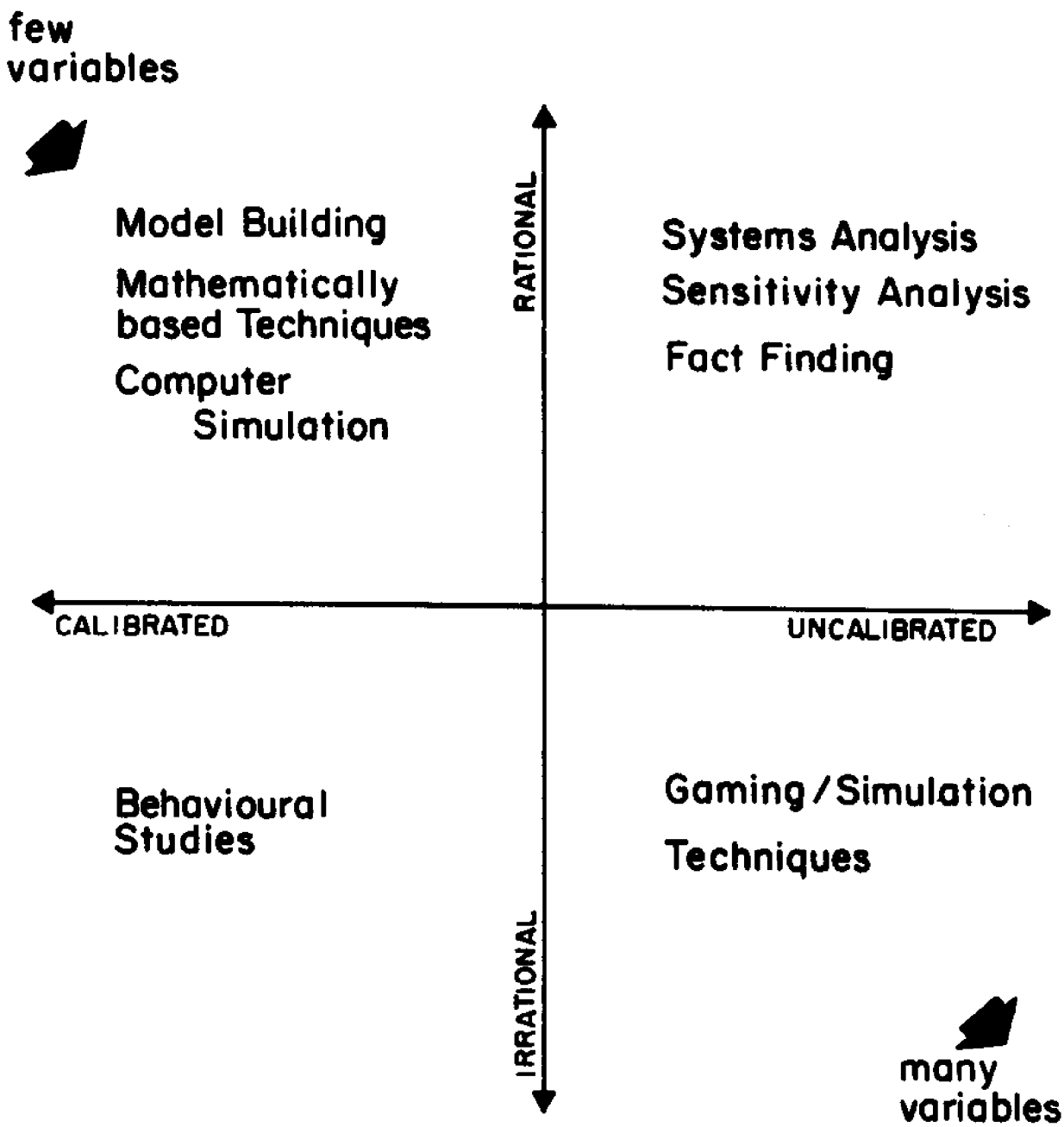

Figure 1. Schematic Classification of Techniques

the sector bounded by calibration and rationality. 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.

[illegible] insights gained [illegible]

[illegible] urse of an exercise or they may arise as the con- [illegible] or individually during the co

[illegible] uations, not necessarily immediately following [illegible] sequence of postexercise eval

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n which there appear to be few positive outcomes, [illegible] There may be occasions o

following play. However, individuals often "rec- [illegible] either during or immediately

ities with the game situation over a large period [illegible] ognize" in real life, similar

lt is important that the circumstances arising [illegible] of time. In this connection

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 ever-growing but [illegible] extension of ancient war-gaming.

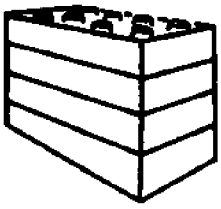
THE BASIC GAME

Playing Board and Pieces

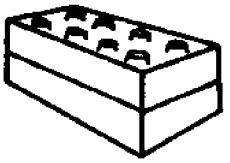
WALRUS I is played on a 50-knob by 50-knob Lego board marked off into 4-knob by 4-knob cells, which in turn are separated by single-knob divider strips. Each knob represents approximately 10 acres of land area, the distance between five knobs approximates one kilometer, the distance between four knobs approximates one-half mile, and each cell approximates one-quarter square mile. Divider strips are used to represent public rights of way between cells and are the location of any roads, sewer lines, or water lines provided during the game.

Playing pieces in WALRUS I either represent one of the basic types of land uses allowed in the model or are used to designate presence of water lines, sewer lines, highways, land ownership, or employment. Major land uses in the game and the combinations of Lego blocks used to represent them are given in Figures 2 and 3. The color of the piece indicates the team which owns that particular land use, with clear colored pieces used for municipal ownership. Cylindrical pieces are used to indicate ownership of a cell or an individual knob when the ownership is not already clearly indicated by the color of buildings occupying the site. Single-knob square pieces are used to designate employment place of residential units, the residence taking a block with the same color and letter as the employer.

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



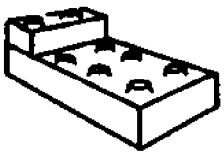
Heavy Industry



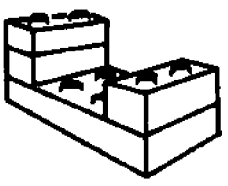
Light Industry

Private Recreation

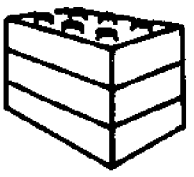
Employer-Employee Affiliation (in white & clear)



Agriculture I



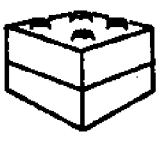
Agriculture II



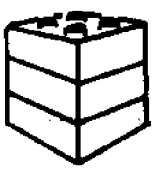
Retail

Ownership of Vacant Land

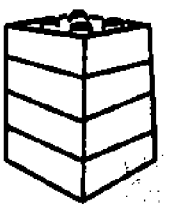
Residential I



Residential II



Residential III



Residential IV

MUNICIPAL PROPERTIES (in clear color only)

Water Facility additional blocks indicate type (treatment)

Sewage Facility additional blocks indicate type (treatment)

School

Municipal Service

Figure 2. WALRUS I Lego Components

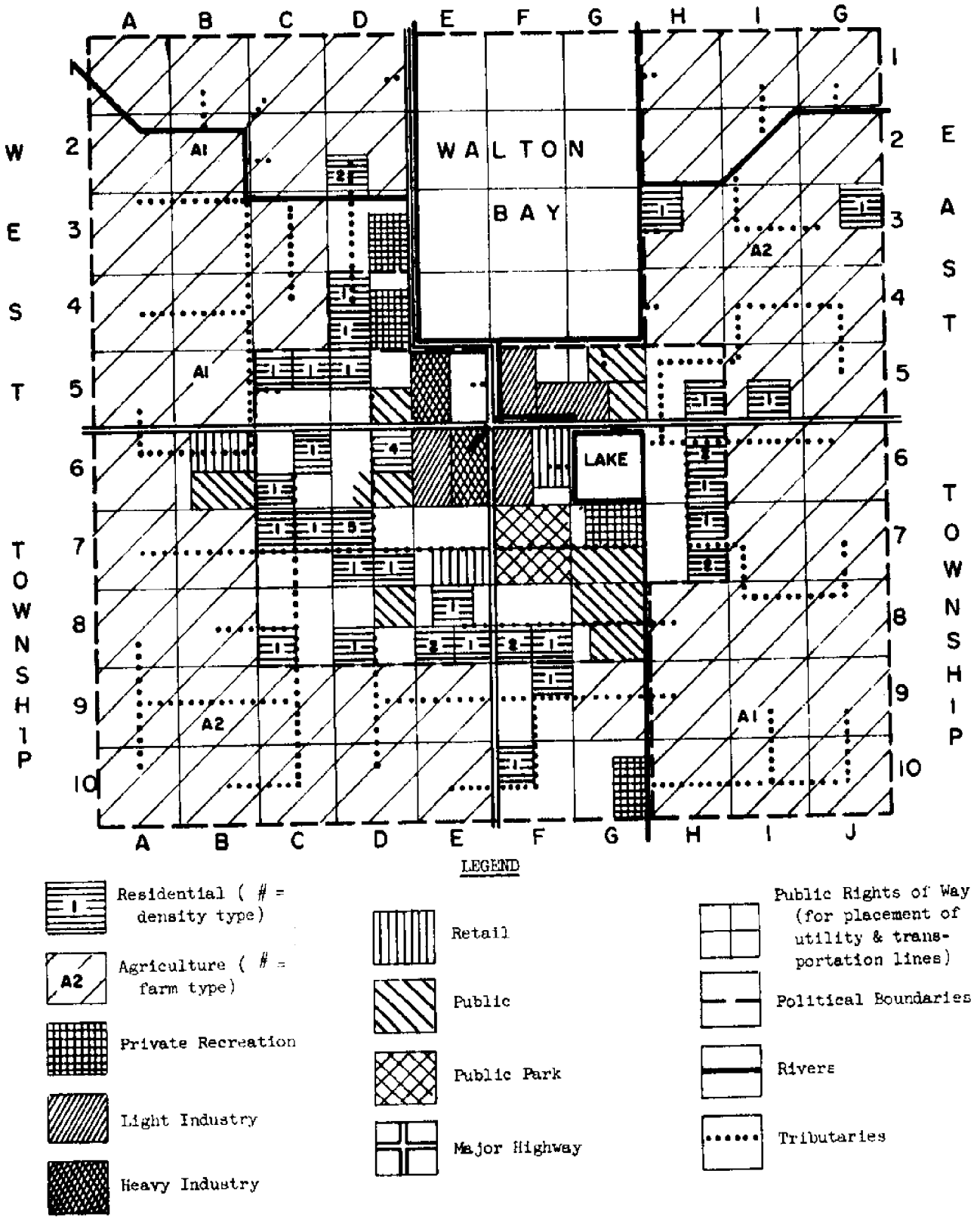


Figure 3. The Walton Region

Teams and Governments

Players are assigned to private business teams in groups of two or three per team. Each of the five teams represent a particular set of business and geographic interests and players will probably play in a manner representing those interests. Such "role-playing" activity is not required, however, and players may make decisions and play the game in any number in any manner they wish within the constraints imposed by the game rules and steps of play.

Red and yellow teams are primarily agricultural in orientation and are each in political control of one of the suburban townships, East Township and West Township respectively. They have a limited amount of direct poli-power and influence within the city itself although their monolithic status in the townships often makes them important to city players. The interests and goals of these teams might be similar, although they can readily diverge into two antithetical directions. Limiting growth in the township and seek to maximize return from agricultural investments is one direction and requi care in matters of zoning and land sales within each jurisdiction. Convers re-zoning agricultural land to residential, commerical, 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 develo ment by other teams might, of course, result in loss of the political power enjoyed by the original teams in each township. Provision of adequate wate and sewer services for these developments is a continuous problem and usual gets the developing township into issues of annexation to the city, purchas

of services from the city, or independent provision of services by either the township or private investors. Major alternatives involve either requiring a region-wide water and sewer authority or requiring no services at all for development, thus letting each investor solve his own problems and protect his own interests. At the beginning of the game, both townships have a very low level of taxation and virtually no capital or operating expenses.

The ebony team is primarily involved in industrial holdings within the city. It also represents one of the major voting blocks within the city. As the major employer, the ebony team receives a substantial number of influents and is generally regarded as being crucial supporter for most city programs. 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., the ebony team may follow a policy of industrial expansion either within the city or in the townships or may 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 industries' own ideological conceptions of how they ought to behave.

The blue team is engaged primarily in recreational industries such as hotels, campgrounds, ski resorts, marinas, etc. The poltical strength of the blue team within the city is equal to that of the ebony 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. Diversification of the type of commercial holdings owned by the blue team is one form of protection against environmental impacts, but care and consideration on environmental policy issues is even more important.

The white team holds a virtual monopoly of retail services in the cities and towns and has a fairly important share of political power in the city. As the only retailer in the city, the white team may, in the short run, reap exorbitant profits from all other players by raising prices to the upper limit allowed. Such an action is almost certain to result in other teams entering retailing as quickly as possible, resulting in substantial losses in both customers and trust to the white team. General growth and expansion of the city is basically in the interests of the white 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 white team 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 secondary and longer term interests in the problems of environmental degradation which worry other teams more directly.

Rules of Play

The game is controlled by two sets of rules, one set called "man-made laws" and one set called "natural laws." The man-made laws exist in three sets, one for each of the three political jurisdictions. Yet a fourth set is used which is not written down but which reflects the general constitutional and legal restraints imposed on all activities by county, state, and federal legislation and precedent. Man-made laws may be changed by majority vote of the governing body of each jurisdiction and more may be added within reasonable limits of existing state and national legislation.

Natural laws are representations of what are seen to be the major environmental and economic constraints affecting behavior and development. The laws are stated in rather crude terms appropriate to the level of complexity and detail appropriate for the game-simulation model. Natural laws may be changed 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 operation of this game.

Man-made laws for each of the three jurisdictions and natural laws for the entire game are given on the following pages.

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 has the power to appoint city officials such as tax collector and public health officer, subject to approval of Common Council.

2. Votes: One vote in Common Council is received for each residential cell in which a team has a majority of the residential units.

3. Zoning: The existing zoning map for the city 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 in opposition. All changes in zoning must be announced and posted on the zoning map. All zoning categories are mutually exclusive

4. Welfare: Any residential unit without employment ma tax collector for welfare payments in lieu of income. The cu payment is $3,000 per round per residential unit.

5. Water and Sewer Services: No construction is allowe in any cell which is not serviced with an adequate level of w services. Provision of these services from existing capacity bility of Common Council but may be delegated to some other c septic beds are allowed within the city limits. Only publicl supplies may be used within the city limits, i.e., no direct ri water sources may be used.

6. Extension of City Services: Municipally owned city an

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.

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 the 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.

9. Taxation: Taxes are based on land use and are currently at the following rates: Full Industry, $20,000 per round; Light Industry, $10,000 per round; Recreation Industry, $7,000 per round; Retail Stores, $7,000 per round; 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 participations so made must be paid for from public funds. Approval of an application constitutes an agreement to

encumber the city for the necessary proportional payment of the project immediately upon winning the grant.

11. Rights of Way: Sale or lease of a public right of way to a private team or permission to build upon such right of way requires approval of the Common Council. Rights of way bordering two jurisdictions require approval of both governing bodies.

Man-Made Laws: West Township

1. Appointments: The chairman has power to appoint employees in township-owned services and to negotiate wage rates for these employees. The chairman 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 r cell in which a team has a majority of the residential units.

3. Zoning: The existing zoning map for the town shall be en the chairman or his appointee. Changes in zoning may be enacted b vote of the Town Board acting upon a petition presented to the Boa ject to one round delay in order to allow dissenting interests to their arguments in opposition. All changes in zoning must be anno posted on the zoning map. All zoning categories are mutually excl

4. Welfare: Any residential unit without employment may app tax collector for welfare payments in lieu of income. The current

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 rate and method of compensation. Creation of special-purpose districts, user charges, normal taxation, or other methods may be employed as desired by a majority of the Town Board. Services may not be extended within 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 fol-

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 to encumber the town for the necessary proportional payment of the project immediately upon winning the grant.

11. Rights of Way: Sale or lease of a public right of way to a private

ission to build upon such right of way requires approval of the team or perm

Rights of way bordering two jurisdictions require approval of both Town Board.

odies. governing bo

Man-Made Laws: East Township

1. Appointments: The chairman has power to appoint employees in township-

wage rates for these employees, the chairman [illegible] power to negotiate

ip officials such as tax collector and public [illegible] has the power to appoint townsh

roval of the Town Board. [illegible] health officer, subject to appr

e Town Board is received for each residential

rity of the residential units.

zoning map for the town shall be enforced by

Changes in zoning may be enacted by majority

pon a petition presented to the Board and sub-

r to allow dissenting interests to present

All changes in zoning must be announced and

zoning categories are mutually exclusive.

ial unit without employment may apply to the

nts in lieu of income. The current level of

residential unit.

es: No residential unit, retail store, or rec-

or bay water which is at a pollution level

enforced by the chairman or his appointed offi-

red for construction and use of groundwater or

rmissible. Sewage may be dumped directly into

ng the cell in question to the river or bay

Either water or sewage treatment plants may

2. Votes: One vote on th

cell in which a team has a majo

3. Zoning: The existing

the chairman or his appointee.

vote of the Town Board acting u

ject to one round delay in orde

their arguments in opposition.

posted on the zoning map. All

4. Welfare: Any resident

tax collector for welfare payme

payment is $3,000 per round per

5. Water and Sewer Servic

reation industry may use river

greater than 4K. This limit is

cial. No septic beds are requi

nonpolluted surface water is pe

the appropriate stream connecti

system.

6. Provision of Services:

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 rate and method of compensation. Creation of special-purpose districts, user charges, normal taxation, or other methods may be employed as desired by a majority of the Town Board. Services may not be extended within 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 [illegible] of at least $5,000 per [illegible]

on land use and are currently at the fol-
00 per unit per round; Agriculture I,
,000 per round. Changes in tax rates or
mple majority vote of Town Board. Any
st make provision for necessary accounting
. All changes in level or type of taxation
taking effect.
ons to apply for federal or state aid must

9. Taxation: Taxes are based
lowing rates: Residential Units, $5
$1,000 per round; Agriculture II, $2
in system of taxation are made by si
changes in the system of taxation mu
procedures by the town tax collector
must be announced one round prior to

10. Federal/State Aid: Decisi

receive majority approval of the Town Board and application fees must be paid from public funds. Approval of an application constitutes an agreement to encumber the town for the necessary proportional payment of the project immediately upon winning the grant.

11. Rights of Way: Sale or lease of a public right of way to a private team or permission to build upon such right of way requires approval of the Town Board. Rights of way bordering two jurisdictions require approval of both governing bodies.

Natural Laws

(Can be changed by successfully challenging the basic model or submodel.)

Land Use Characteristics

Land uses in WALRUS are restricted to those listed in the basic components section which follows. The basic components section 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 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:

Pollution Reading of River or Bay Cell	Decrease in Basic Income
10K	25%
20K	50%
30K	100%

4. Each residential unit must "consume" one food unit 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 price currently being asked.

5. Each retail store may purchase up to twenty food units from the operator each round at a wholesale price determined by the operator. He may sell these to his customers at a price not exceeding 200% of the wholesale price. Unused food units may be carried as inventory from round to round.

6. A municipal service unit services its own cell plus the eight immediately 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 has a maximum capacity of serving 25 residential units. If the total capacity of all schools on the board is exceeded by the total number of residences on the board, a 10% reduction in all external incomes to all land uses will be charged for each 10 excess residential units.

Basic Component Characteristics

Land Use Type	Construction Cost	No. of Employees	Water Needs	Effluent	Capacity/ Gross Income/ 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 Cust.)	0
Agriculture I	25,000 (plus land)	1 (self)	1	2	10,000/9 cells (± 10% for ≷ 9)	0
Agriculture II	50,000* (plus land)	2 (self + 1)	3	5	25,000/9 cells (± 10% for ≷ 9)	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 Units	8,000
Municipal Services	25,000	1	1	1	9 Adj. Cells	4,000
Water Plant I	10,000	1	0	0	5K	1,000
Water Plant II	25,000	1	0	0	20K	5,000
Water Plant III	50,000	1	0	0	50K	15,000
Septic Bed I	5,000	0	0	0	1K	0
Sewage Plant II	20,000	1	0	0	15K	5,000
Sewage Plant III	40,000	1	0	0	40K	10,000
Sewage Plant IV	75,000	1	0	0	100K	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.

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, the amount of water required by a particular land use or a given cell, and the amount of sewage generated by a particular land use or cell. The capacity of water or sewer plant and the lines available for extension along public rights of way is further indicated, respectively, by a clear or ebony 1 x 1 x 1/2 Lego block which is placed on the right of way to indicate a water or sewer extension.

1. 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.

2. Water from a bay or river cell may be used directly without appreciable treatment cost as long as the pollution level is below 5K per cell 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.

3. The installed capacity of water and sewer services to any cell is measured by the number of knobs of clear or ebony Lego placed on any adjacent public right of way, not counting corners. The same installed capacity may be counted towards

ct to any re-
ning the lines

straints on use imposed by the municipality ow
and connected treatment plants.

normally 80%,
tants are dis-
y be raised once
g costs of the

4. The efficiency of a sewage treatment plant is r
e.g., for 100K of sewage treated, 20K of pollut
charged into the bay or a river. Efficiency m
by an additional 10% by increasing the operatir
plant by 25%.

5. 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.

Financial and Economic Properties

Financial payments are made between players according to agreements between themselves and between players and the operator according to the costs and incomes indicated for particular land uses and other requirements. It is the responsibility of each municipality to levy and collect its taxes from the appropriate players.

1. Transportation costs for journey to work and to shop are charged each residential unit each round and are paid to the operator. The charge is $500 for each cell traversed along the public right of way and is counted from nearest corner of origin to nearest corner of destination. Travel between any two points connected by a major highway is counted as zero cost.

2. 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

3. 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.

Influents and Votes

Voting power of each team in any jurisdiction is based upon the distribution of its residential 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 earned by a team as follows:

   a. One influent for each employee from another team.

   b. One influent for each [illegible] residential

   c. One influent for each public office held in any municipality. No more than three such offices may be established in any municipality.

units living in a cell
at a pollution level
bordering on a major river or bay
below 5K.

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.

GAME PROCEDURES

Money, Votes, Influents, and Pollutants

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 units controlled or owned within each appropriate political jurisdiction. Personal status or prestige is measured by poker chips representing influents, which are awarded on the basis of public office, position as an economic dominant in the economy, or owning residential units in prestige locations in the area. No single goal is provided for all players to attempt to optimize and any given player may choose as his own criteria for winning the game any one or more of these factors in any personally meaningful combination. Other aspects of the game, aside from those discussed here, may also be selected as goals. Nothing in the nature of the game or the manner in which it is played requires consensus on the 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.

Pollutants in the game are measured according to the number of units of effluents which accumulate in the bay and river system according to the land uses in existence and the type of treatment provided for effluents under varying conditions. When operated on a manual basis, the operator simply keeps a record of how many effluents are emitted from each land use on the board and notes where it enters a river or the bay. 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 "natural" decay. The greater the amount of development, the greater 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 possible on WALRUS. Such control requires money, understanding of the problem, and carefully developed political cooperation in order to be successfully accomplished.

Steps of Play

Play of WALRUS 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 and transportation 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 chairman
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. 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.

Accounting Forms

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 location, its employment coding letter, and appropriate information on its operating income and costs. These are coded so as to indicate gross income payments for wages and salaries to employees, taxes to one or another jurisdiction, transportation costs, other payments such as for retail goods, and the net profit or loss on the property 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 listing of the same properties and commitments order by the team or jurisdiction with whom each 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 income from the outside world. Similar updating of this account as changes are made in successive rounds is also the responsibility of each team.

Another accounting form is provided to each of the three municipalities, giving a list of its holdings and operating costs, its tax payments due from each team, and its overall cash position in the first round. 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 assistant. These are open to inspection by any interested player at any time.

Team SAMPLE Date

CASH FLOW SHEET

To/From	Purpose	Description	Amount	Cycle 2	Cycle 3	Cycle 4	Cycle 5
CITY	wages	R	+12,000				
	taxes		-23,000				
W.Tsp.	taxes		- 2,000				
RED	wages	E	-12,000				
	goods	A,B,B,C	+12,000				
BLUE	wages	E	- 6,000				
	goods	C,D	+ 6,000				
EBONY	wages	O	+ 6,000				
	goods	F,F,G	+ 9,000				
WHITE	goods	H,M,O	- 9,000				
	goods	I,J,J,K	+12,000				
BANK	goods	$2,000/unit	-30,000				
	trans.	Ag.(I3)-store	- 1,500				
SELF	wages	M	± 6,000				
	goods	R,R	+ 6,000				

WALRUS I
Team SAMPLE

Date _____

TEAM PROPERTY HOLDINGS

Land Use Type	Size	Location	Letter	Gross Income	Total Wages	To or From	Taxes	To	Transp.	Other Payments	To or From	Net Profit
Heavy Industry												
Heavy Industry												
Light Industry		G5	E	25,000	-12,000	Red	-10,000	City				3,000
Light Industry												
Agriculture I												
Agriculture II	12	I3	H	32,500	-6,000	Blue	-2,000	W.T.	-1,500	-3,000	White	20,000
Retail		E7	M	45,000	-6,000	Self	-7,000	City		-30,000	Bank	2,000
Retail												
Recreation												
Recreation												
Recreation												
Residence I		I6	N	6,000		Self	-1,500	City		-3,000	White	1,500
Residence II		D5	RR	12,000		City	-3,000	City		-6,000	Self	3,000
Residence I		C6	O	6,000		Ebony	-1,500	City		-3,000	White	1,000
Residence												
Residence												
Residence												
Residence												
Vacant	10K	E7										31,000

APPENDIX I. LEGO COMPONENTS FOR WALRUS I PLAYING KITS

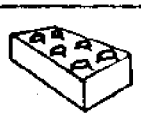
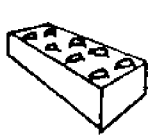
The following two pages indicate the kinds and quantities of Lego blocks generally used in a WALRUS game as we have designed it and discussed it here. Appropriate substitutes may be made if ready access to enough kinds of blocks is not possible locally. Using materials other than Lego is, of course, possible although we have generally found these children's blocks to be very inconvenient to employ. All the above description of the game is based on using Lego components.

Lego blocks may be purchased in most toy stores, although in this country specific pieces may not be purchased individually, only prepackaged kits of defined contents being available. An arrangement to buy particular pieces may be possible through a local dealer. At this writing a private consulting firm has undertaken to purchase Lego at wholesale and to package the components needed for several academic games in kits which may be purchased directly from them. They have agreed to provide kits for WALRUS I as well and a set of Lego components may be purchased directly from this company: Urbex Affiliates, Inc., 474 Thurston Road, Rochester, N.Y. 14619. Similar Lego kits for WALRUS I may also become available from Learning A & M, Environmental Simulation Laboratory, The University of Michigan, Ann Arbor, Michigan 48104.

Other components needed are paper clips for food units, a pair of dice, and a supply of play money.

WALRUS I: LEGO REQUIREMENTS FOR KIT

One 50x50 knob playing board plus the following pieces.

Piece	Description	Colors	Purpose	Quantity
	1/2 high 1x1	clear ebony red	Water lines Sewer lines Major highways	250 each
	regular 1x1	white clear	Employer-employee identification	75 each
	round 1x1	red white blue ebony yellow clear	Ownership/knob	30 each
	regular 1x2	yellow white red blue ebony	Agriculture—farm type	6 each
	regular 2x2	yellow white red blue ebony	Residences	25 each
		clear	Municipal services	12
	regular 2x3	yellow white red blue ebony	Recreation industries	5 each
		clear	Water plants, schools	42
	regular 2x4	yellow white red blue	Industries, farms	12 each
		ebony	Industries	30
		clear	Sewage plants	34

WALRUS I: KIT REQUIREMENTS BY TEAM AND LAND USE

Land Use	Team					
	Red	White	Ebony	Yellow	Blue	Clear
Heavy industries	2	2	5	2	2	-
Light industries	2	2	5	2	2	-
Recreation industries	4	4	4	4	5	-
Agriculture I	1	1	1	1	1	-
Agriculture II	1	1	1	1	1	-
Retail	2	4	2	2	2	-
Residential I	10	10	10	10	10	-
idential II	2	2	2	2	2	-
idential III	2	2	2	2	2	-
idential IV	1	1	1	1	1	-
icipal services	-	-	-	-	-	6
ools	-	-	-	-	-	3
er plants						
	-	-	-	-	-	10
I	-	-	-	-	-	7
II	-	-	-	-	-	4
age plants						
	-	-	-	-	-	10
I	-	-	-	-	-	5
II	-	-	-	-	-	2
V	-	-	-	-	-	2

Res
Res
Res
Muni
Scho
Wate
I
II
II
Sewa
I
II
II
IV

APPENDIX II. WALRUS I INITIATING CONDITIONS

The following forms give the basic parameters for initiating a WALRUS I game at the conditions described in the preceding rules and instructions. Many other initiating conditions and community configurations, of course, may be employed. These are provided primarily to allow the new user to gain initial experience with the model in a mode similar to that generally employed by the authors and reflecting the descriptions of the game encompassed previously.

These records involve a pollution record chart completed to round zero prior to the beginning of play and a blank record pollution chart suitable for copying and use in computing pollution in each successive round. Completion of this form for each round is quite simple and becomes self-explanatory upon inspection of the chart. The effluent from each cell is determined by the land use in existence in that cell with all effluent from agricultural uses assumed to flow from the cell containing the agricultural building. Each cell is connected to one of the rivers or the bay by the water courses indicated on the land use map. The effluents a

re added to the three rivers as appropriate with one K of pollution subtracted for each cell the river traverses. The total effluents into the bay from the three rivers is determined and additional effluents flowing directly into the bay from particular cells are also noted.

The count of pollutants into the bay is taken systematically around the edge of the bay from the northwest corner to the northwest corner, as indicated. The flow from the sewage treatment plant is 76K, based upon the total number of cells connected to the sewage lines at the beginning of the game.

Treatment at 80% efficiency reduces this flow to only 15K entering the bay at G5, adjacent to the sewage plant. The total load in the bay is 10K at the beginning. The new pollutant inputs are added to this number and the new total pollution of the bay is reduced by 10% for outflow of pollutants and by 12K for its own self-cleansing processes. The final total is the new total pollution load on the bay for the next round and the homogeneous distribution of pollution in each bay cell is this figure divided by 12, the number of bay cells. Finally, the average pollution per bay cell is used as the origin pollution of each of the three rivers, two rounds in the future. The intake level of pollution to the bay can be increased by the game operator if this seems desirable for pedantic purposes.

Initial layout of water and sewer lines within the city can be handled in any reasonable fashion which will ensure that each cell is provided with the necessary water and sewer capacity for initial operation. No water or sewer lines are provided initially beyond the city boundaries. Generally, surplus capacity of 20-30K in both water and sewer is available at the beginning of the game and such surplus capacity is stored by stacking the extra units of water and sewage capacity (indicated by clear and ebony 1 x 1 x 1/2 Lego units, respectively) on top of the water and sewer plants.

The next item in this appendix is a form for recording the number of influents and votes awarded to each team in each round with the first round entries plus prior status already recorded. Changes of status in successive rounds may be recorded on the same form.

Following this are three sets of municipal budget sheets for each of the three jurisdictions, giving their initial land holdings, employment affiliations, operating costs, and other payments plus the total taxes due. Taxes due from each team may be computed from their particular land holdings in each jurisdiction, but these figures are already given on the individual teams' property holdings forms. The forms are simple enough and should be self-explanatory upon examination.

Finally, the property holdings form and cash flow form for each of the five teams are provided, giving their initial holdings and the cash transfers required between various teams at the beginning of the game. These were explained in the body of the text and should be relatively clear upon inspection. Players generally require some explanation of the interpretation of the employment coding system used. This can be explained as simply a match-coding system, where the employee always takes the same letter as his employer, giving up the letter when he is fired or when he quits his job. Any new employment by a residential unit would then be indicated by assuming the letter code of his new employer. Subsequent changes in team holdings and status should be recorded by each team on the same form. An extra blank copy of each of these forms is provided so that additional copies can be made in the event some team may wish to completely rewrite their holdings record.

A zoning map is not included in this manual but one may be constructed which approximates the initial existing land uses and reflects the players' wishes.

WALRUS I

Round No. 0

Date of Play _____

POLLUTION RECORD CHART

	Location	K In	K Out	Net Change	Cum. Total	Comments
West River	Origin	2	0			Bay at R-2
	A1	0	-1K	1	1	
	B2	2,2,2,2	-1K	7	8	
	C3	0	-1K	-1	7	
	D3	2,3	-1K	4	11	To bay in R
South River	Origin	2	0			Bay at R-2
	G10	3,2	-1K	6	6	
	G9	1,1	-1K	1	7	
	G8	0	-1K	-1	6	
	G7	5	-1K	4	10	
	G6	1	-1K	0	10	
	F6	0	-1K	-1	9	
	F5	0	-1K	-1	8	To bay in R
East River	Origin	2	0			Bay at R-2
	J2	0	-1K	1	1	
	I2	5,1	-1K	5	6	
	H2	1	-1K	0	6	
					6	To bay in R
Bay	Prior	---	---	---	10	Bay at R-1
	Intake	2				External forces
	DL	0				
76	D3	11				West River
61	F5	8				South River
15 at 80% = 60	G5	15				City sewage
	H4	0				
	H3	0				
	H2	6			42	East River
	H1	0			52	Sum pollutants
			-12K		40	Self-cleansing
Outflow			- 4 K		36	At 10% of bay
Final Sum						
Pollution/Cell					3	Sum/12

Input pollution per cell to river origin at R + 2 = 3.
Input final sum to bay prior cum. total at R + 1 = 36.

WALRUS I

Round No._____
Date of Play_____

POLLUTION RECORD CHART

	Location	K In	K Out	Net Change	Cum. Total	Comments
West River	Origin		0			Bay at R-2
	A1		-1K			
	B2		-1K			
	C3		-1K			
	D3		-1K			To bay in R
South River	Origin		0			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			Bay at R-2
	J2		-1K			
	I2		-1K			
	H2		-1K			
						To bay in R
Bay	Prior	---	---	---		Bay at R-1
	Intake					External forces
	DL					
	D3					West River
	F5					South River
	G5					City sewage
	H4					
	H3					
	H2					East River
	H1					Sum pollutants
			-12K			Self-cleansing
Outflow			- K			At 10% of bay
Final Sum						
Pollution/Cell						Sum/12

Input pollution per cell in river origin at R-2 = ..
Input final sum to bay: prior sum...total at R-1 = ..

INFLUENTS AND VOTES ACCOUNTING SHEET

TEAM	INFLUENTS Source					VOTES		
	Prior*	Employment	Aesthetic	Officer	Total	Walton	E. Twp.	W. Twp.
Round 1								
red	2	0	2	---	4	2	4	0
yellow	4	1	7	---	12	1	0	5
blue	6	7	6	---	19	4	0	0
white	4	2	3	---	9	4	1	1
ebony	4	6	0	---	10	3	0	0
					Total	14	5	6
Round 2								
red								
yellow								
blue								
white								
ebony								
					Total			
Round 3								
red								
yellow								
blue								
white								
ebony								
					Total			
Round 4								
red								
yellow								
blue								
white								
ebony								
					Total			
Round 5								
red								
yellow								
blue								
white								
ebony								
					Total			
Round 6								
red								
yellow								
blue								
white								
ebony								
					Total			

*Note: accumulated from previous rounds—not awarded each round.

WAIRUS I

Name of Municipality Walton
Date of Play

MUNICIPAL BUDGET SHEET

Land Use Type	Location	Letter	Operating Costs Per Cycle 1	2	3	4	5	6	7
Mun. Serv.	G5	O	4,000						
H_2O Plt. III	G8	X	15,000						
Mun. Serv.	D5	P	4,000						
Mun. Serv.	D8	Q	4,000						
Mun. Serv.	G8	R	4,000						
School	D6	S,S	8,000						
Park	F7	V	2,000						
Sewage Plt. IV	G5	Y	20,000						
H_2O Plt. III	G7	Z	15,000						
TOTAL OPERATING COSTS			76,000						
INTEREST PAYMENTS			---						
WELFARE PAYMENTS			3,000						
OTHER PAYMENTS (WAGES)			60,000						
TOTAL EXPENDITURES			139,000						
TAXES RECEIVED			160,500						
LOANS RECEIVED			---						
OTHER TRANSFERS			---						
TOTAL INCOME			160,500						
NET BALANCE			21,500						
PREVIOUS BALANCE			---						
NEW BALANCE			21,500						

WALRUS I

Name of Municipality E. Twp.
Date of Play

MUNICIPAL BUDGET SHEET

Land Use Type	Location	Letter	Operating Costs Per Cycle						
			1	2	3	4	5	6	7
TOTAL OPERATING COSTS									
INTEREST PAYMENTS									
WELFARE PAYMENTS									
OTHER PAYMENTS									
TOTAL EXPENDITURES									
TAXES RECEIVED			4,500						
LOANS RECEIVED									
OTHER TRANSFERS									
TOTAL INCOME			4,500						
NET BALANCE			4,500						
PREVIOUS BALANCE				4,500					
NEW BALANCE			4,500						

WALRUS I

Name of Municipality W. Twp.
Date of Play

MUNICIPAL BUDGET SHEET

Land Use Type	Location	Letter	Operating Costs Per Cycle						
			1	2	3	4	5	6	7
School	B5	W,W	8,000						
TOTAL OPERATING COSTS			8,000						
INTEREST PAYMENTS			---						
WELFARE PAYMENTS			---						
OTHER PAYMENTS (WAGES)			12,000						
TOTAL EXPENDITURES			20,000						
TAXES RECEIVED			23,000						
LOANS RECEIVED									
OTHER TRANSFERS			---						
TOTAL INCOME			3,000						
NET BALANCE				3,000					
PREVIOUS BALANCE									
NEW BALANCE			3,000						

WALRUS 1
Team [illegible]

Date _____

TEAM PROPERTY HOLDINGS

Land Use Type	Size	Location	Letter	Gross Income	Total Wages	To or From	Taxes	To	Transp.	Other Payments	To or From	Net Profit
Heavy Industry		[illegible]	A	50,000	12,000 12,000	White Self	20,000	City	---	---		6,000
Heavy Industry		[illegible]	[illegible]	50,000	24,000	Self	20,000	City	---	---		6,000
Light Industry		[illegible]	C	25,000	12,000	Self	10,000	City	---	---		3,000
Light Industry		F5	D	25,000	12,000	Blue	10,000	City	---	---		3,000
Light Industry		G5	E	25,000	6,000 6,000	Blue Red	10,000	City	---	---		3,000
Light Industry		F6	F	25,000	12,000	Blue	10,000	City	---	---		3,000
Agriculture I												
Agriculture II												
Retail												
Retail												
Recreation												
Recreation												
Recreation												
Residence	IV	D6	A/A,B/B	24,000	---	Self	6,000	City	---	12,000	White	6,000
Residence	III	D7	B/B,T	12,000 6,000		White Self	4,500	City	500	9,000	White	4,000
Residence	I	D7	G	6,000		Self	1,500	City	---	3,000	White	1,500
Residence	I	D7	G	6,000		Self	1,500	City	---	3,000	White	1,500
Residence	I	D8	M	6,000		Yellow	1,500	City	500	3,000	White	1,000
Residence												
Residence												
												28,000

Team EBONY

Date

CASH FLOW SHEET

To/From	Purpose	Description	Amount	Cycle 2	Cycle 3	Cycle 4	Cycle 5
CITY	taxes		-95,000				
	wages						
	welfare						
W.Twp.	taxes						
E.Twp.	taxes						
BLUE	wages	F,F,D,D,E	-30,000				
WHITE	goods	A,A,B,B,B,B,G,G,M,T	-30,000				
	wages	A,A	-12,000				
	wages	T	+ 6,000				
YELLOW	wages	M	+ 6,000				
RED	wages	E	- 6,000				
BANK	trans.	M,T	- 1,000				
EBONY	wages	A,A,B,B,B,B,G,G	±48,000				

VALUE I
Team WHITE

Date _____

TEAM PROPERTY HOLDINGS

Land Use Type	Size	Location	Letter	Gross Income	Total Wages	To or From	Taxes	To	Transp.	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		D5	T	48,000(16)*	6,000	Ebony	3,000	W.T.	---	33,000	Bank	4,000
Retail		E5	K	48,000(16)*	6,000	Blue	7,000	City	---	32,000	Bank	3,000
Retail		F6	L	45,000(15)*	6,000	Self	7,000	City	---	30,000	Bank	2,000
Recreation												
Recreation												
Recreation												
Residence	1	C5	A	6,000		Ebony	1,500	City	---	3,000	Self	1,500
Residence	1	C5	A	6,000		Ebony	1,500	City	---	3,000	Self	1,500
Residence	1	C6	A	6,000		Blue	1,500	City	---	3,000	Self	1,500
Residence	1	C7	S	6,000		City	1,500	City	---	3,000	Self	1,500
Residence	1	J7	I	6,000		Blue	1,500	City	---	3,000	Self	1,500
Residence	1	H7	I/X	12,000		City	3,000	City	---	6,000	Self	3,000
Residence	1	I5	Y	6,000		City	500	E.T.	---	3,000	Self	1,500
Residence	1	C8	W/W	12,000		West Township	3,000	City	---	6,000	Self	3,000

*Number of customers.

Team WHITE

Date ____________

CASH FLOW SHEET

To/From	Purpose	Description	Amount	Cycle 2	Cycle 3	Cycle 4	Cycle 5
CITY	taxes		-27,500				
	wages	Y,S,X	+18,000				
	welfare						
W.Twp.	taxes		- 4,000				
	wages	W,W	+12,000				
E.Twp.	taxes		- 500				
BLUE	goods	B5 D,D,E,F,F,I,K,S	+27,000				
	wages	C,I	+12,000				
	wages	K	- 6,000				
EBONY	goods	A,A,B,B,B,B,G,G,M,T	+30,000				
	wages	A,A	+12,000				
	wages	T	- 6,000				
RED	goods	E,H,N,O,Q,R,V,Ag.(B3,B9)	+27,000				
YELLOW	goods	C,H,J,J,P,Z,Ag.(B9,B2)	+24,000				
BANK	goods-B6	A,A,C,C,F,F,H,H,I,J,J, [illegible],S,Ag.(B2,B5,B9)	-32,000				
	goods-B[illegible]	[illegible] V,W,W,Ag.(B9)	-32,000				
	goods-B6	[illegible] O,Q,S,X, [illegible]	-30,000				
	[illegible]	W,W,[illegible]					
		A,I,C	- 3,000				

WHITE goods (B5),W,W

+ 6,000

ages

WALRUS I
Team YELLOW

Date _____

TEAM PROPERTY HOLDINGS

Land Use Type	Size	Location	Letter	Gross Income	Total Wages	To or From	Taxes	To	Transp.	Other Payments	To or From	Net Profit
Heavy Industry												
Heavy Industry												
Light Industry												
Light Industry												
Agriculture I	I	D2	---	10,000			1,000	W.T.	1,000	3,000	White	5,000
Agriculture II	II	D1	M	30,000	6,000	Ebony	2,000	W.T.	1,500	3,000	White	17,500
Retail												
Retail												
Recreation												
Recreation												
Recreation												
Residence	II	D3	J/J	12,000		Blue	1,000	W.T.	---	6,000	White	5,000
Residence	I	D4	H	6,000		Blue	1,500	City	---	3,000	White	1,500
Residence	I	D4	P	6,000		City	1,500	City	---	3,000	White	1,500
Residence	II	F10	J	6,000		Blue	500	W.T.	---	3,000	White	2,500
Residence	I	F10	J	6,000		City	500	W.T.	500	3,000	White	4,000
Residence												
Residence												
												35,000

Team YELLOW

Date _____

CASH FLOW SHEET

To/From	Purpose	Description	Amount	Cycle 2	Cycle 3	Cycle 4	Cycle 5
CITY	taxes		- 3,000				
	wages	P,Z	+12,000				
W.Twp.	taxes		- 3,000				
E.Twp.							
BLUE	wages	C,H,J,J	+24,000				
EBONY	wages	M	- 6,000				
RED							
WHITE	goods	C,H,J,J,P,Z,Ag.(B9,K9)	-24,000				
BANK	trans.	Z,Ag.(B9,K9)	- 3,000				
YELLOW							

WALRUS I
Team [illegible]

Date _____

TEAM PROPERTY HOLDINGS

Land Use Type	Size	Location	Letter	Gross Income	Total Wages	To or From	Taxes	To	Transp.	Other Payments	To or From	Net Profit
Heavy Industry												
Heavy Industry												
Light Industry												
Light Industry												
Agriculture I												
Agriculture II												
Retail												
Retail												
Recreation		D3	J	25,000	12,000	Yellow Yellow	7,000	W.T.	---	---		6,000
Recreation		D4	H	25,000	12,000	Yellow Red	7,000	City	---	---		6,000
Recreation		G7	I	25,000	12,000	White Self	7,000	City	---	---		6,000
Recreation		G10	C	25,000	12,000	Yellow White	7,000	W.T.	---	---		6,000
Residence	I	D5	S	6,000		City	1,500	City	---	3,000	White	1,500
Residence	I	E8	K	6,000		White	1,500	City	---	3,000	White	1,500
Residence	II	F6	F/F	12,000		Ebony	3,000	City	---	6,000	White	3,000
Residence	I	F8	L	6,000		Self	1,500	City	---	3,000	White	1,500
Residence	II	H6	D/D	12,000		Ebony	3,000	City	---	6,000	White	3,000
Residence	I	H6	E	6,000		Ebony	1,500	City	---	3,000	White	1,500
Residence	I	H5	Unempl.	3,000		City	1,500	City	---	3,000	White	1,500
												36,000

Team BLUE

Date

CASH FLOW SHEET

To/From	Purpose	Description	Amount	Cycle 2	Cycle 3	Cycle 4	Cycle 5
CITY	taxes		-27,500				
	wages	S	+ 6,000				
	welfare	H5 Residence	+ 3,000				
W.Twp.	taxes		-14,000				
E.Twp.	taxes						
EBONY	wages	F,F,D,D,E	+30,000				
RED	wages	H	- 6,000				
YELLOW	wages	C,H,J,J	-24,000				
WHITE	goods	D,D,E,F,F,I,K,S,H5	-27,000				
	wages	C,I	-12,000				
	wages	K	+ 6,000				
BANK							
BLUE	wages	I	± 6,000				

WALRUS I
Team RED

Date

TEAM PROPERTY HOLDINGS

Land Use Type	Size	Location	Letter	Gross Income	Total Wages	To or From	Taxes	To	Transp.	Other Payments	To or From	Net Profit
Heavy Industry												
Heavy Industry												
Light Indus.r												
Light Industry												
Agriculture I	10	I?	---	11,000			1,000	E.T.	1,500	3,000	White	5,500
Agriculture II	2	I3	N	25,000	6,000	Self	2,000	E.T.	1,000	3,000	White	13,000
Retail												
Retail												
Recreation												
Recreation												
Recreation												
Residence	I	H3	E	6,000		Ebony	500	E.T.	1,500	3,000	White	1,000
Residence	I	J3	N	6,000		Self	500	E.T.	1,000	3,000	White	1,500
Residence	I	G6	H	6,000		Blue	1,500	City	---	3,000	White	1,500
Residence	I	G5	Q	6,000		City	1,500	City	---	3,000	White	1,500
Residence	I	E3	Q	6,000		City	1,500	City	---	3,000	White	1,500
Residence	II	E3	R/V	12,000		City	3,000	City	500	6,000	White	2,500
Residence												
												22,500

Team RED

Date

CASH FLOW SHEET

To/From	Purpose	Description	Amount	Cycle 2	Cycle 3	Cycle 4	Cycle 5
CITY	taxes		- 7,500				
	wages	O,Q,R,V	+24,000				
	welfare						
W.Twp.							
E.Twp.	taxes		- 4,000				
EBONY	wages	E	+ 6,000				
YELLOW							
WHITE	goods	E,N,H,O,Q,R,V,Ag.(B9, I3)	-27,000				
BLUE	wages	H	+ 6,000				
BANK	trans.	E,N,R,Ag.(F9,I3)	- 5,500				
RED	wages	N	+ 6,000				

WALRUS 1
Team_____

Date_____

TEAM PROPERTY HOLDINGS

Land Use Type	Size	Location	Letter	Gross Income	Total Wages	To or From	Taxes	To	Transp.	Other Payments	To or From	Net Profit

Team________ Date____________

CASH FLOW SHEET

To/From	Purpose	Description	Amount	Cycle 2	Cycle 3	Cycle 4	Cycle 5

APPENDIX III. SUGGESTED ROOM LAYOUT

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