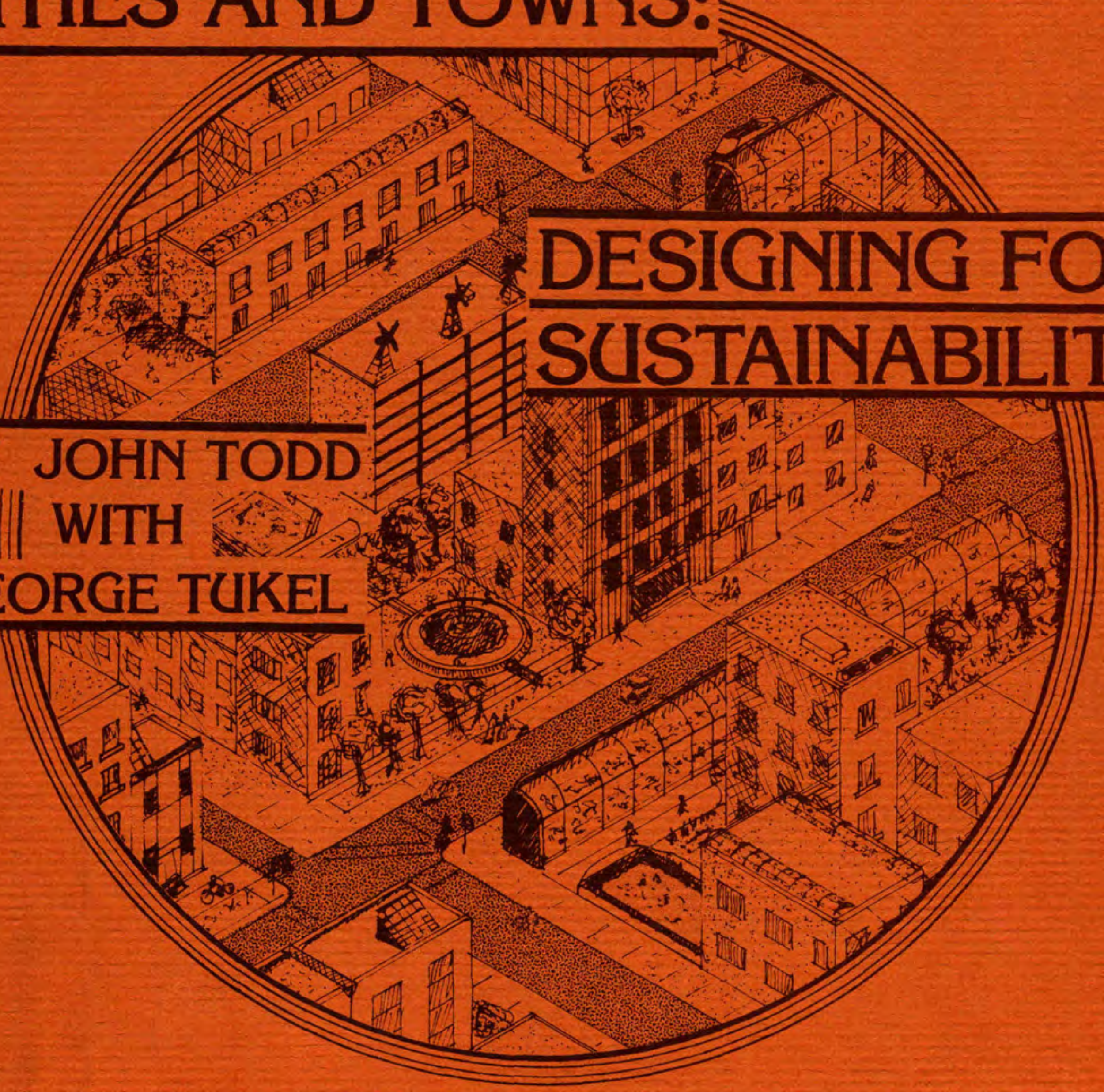
REINHABITING CITIES AND TOWNS: DESIGNING FOR SUSTAINABILITY



BY JOHN TODD
WITH
GEORGE TUKEL

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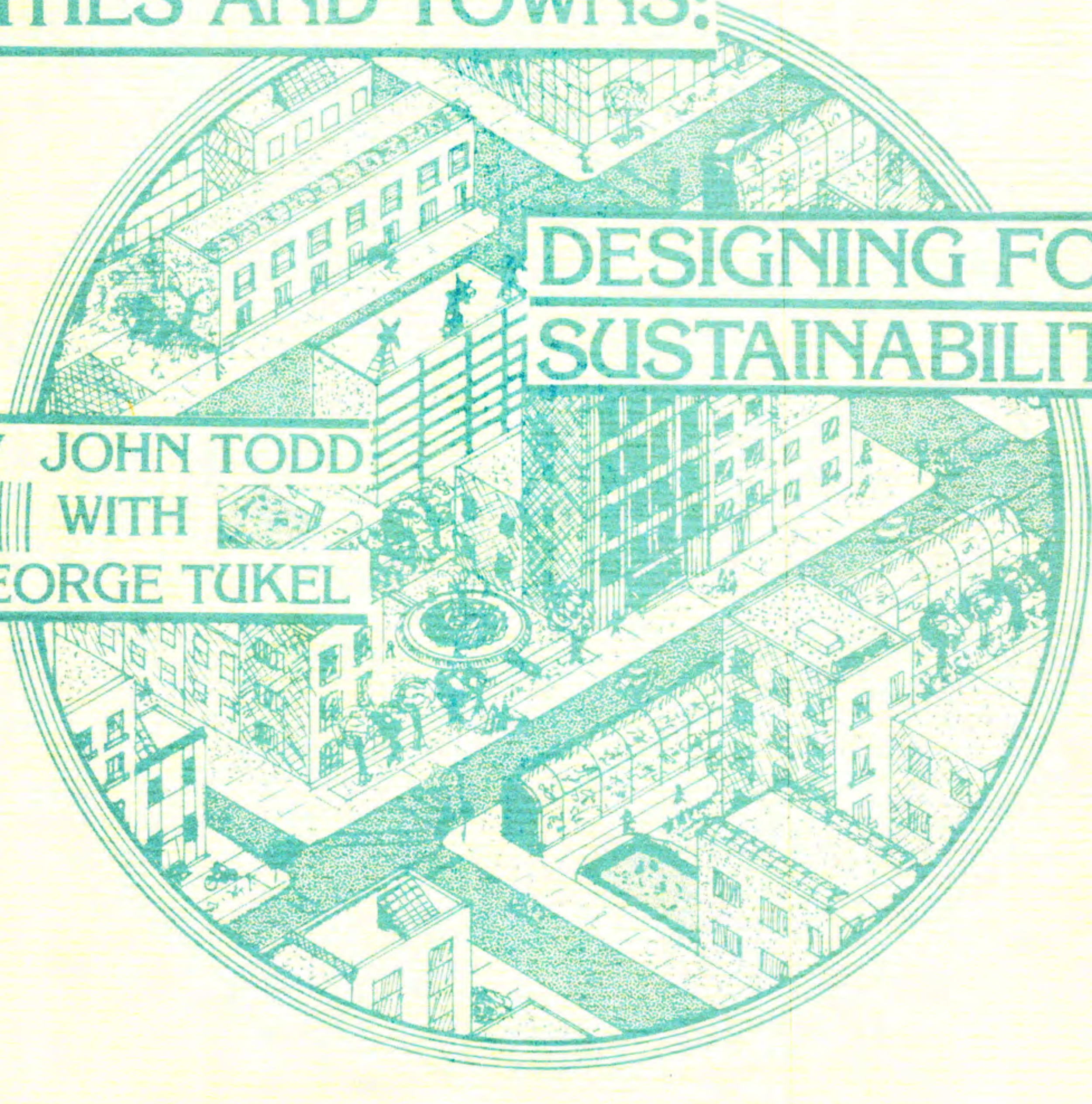

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John Todd

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TABLE OF CONTENTS

Part I
How natural systems unfold: The ecological and biological basis for the design of human services 5

Patterns in nature 6
Succession 9

Part II
Knowing a place is the first step in the evolution of bioregionally based design practices 13

Biogeography and History 14
Community structure 19

Part III
Community sustainability: The intersection of human need, the logic of succession and technology 25

Water 26
Housing 32
Food production 43
Transportation 55
Community energy systems 57

INTRODUCTION

There is news for us in nature. Its teachings can be used in myriad ways to help build and sustain human communities. Principles, strategies and even ways of thinking, derived from a biological perspective, will allow us to make the transition to a solar-based society. By mirroring function in nature, agriculture, landscapes, waste treatment, energy supply and use systems, water use and recycling, architecture, neighborhoods, villages, towns and even cities can be built or transformed. Designed with nature, such systems require less energy. The integration of support components on a local or community level leads to stability and to immunity from supply disruptions; as a result, the human landscape becomes more coherent and civilized. There may be psychological benefits as well. In such a community we may come to remember forgotten knowledge; namely, our ancient and profound partnership with other life. For 99.9 percent or several million years of (our) history, *Homo sapiens* lived in the wild, often very well. This association with the wild, both secular and sacred, has left its mark on our psyches and on our behavior. Vestiges linger in hunting, fishing, birdwatching, nature photography and gardening. Caged in skyscrapers and in box architecture we sense a loss, yet we know not what.

My thesis is that the loss we feel is the loss of balance between culture and the living world. No western culture has achieved this balance in historic times. But it yet may happen, through the mysterious workings of science and technologies, that for the first time in millenia, the polar opposites of culture and wilderness can now be fused. It is time for nature again to enter culture and become part of the fabric of out lives. It is more than a metaphor to think of a future city block built in the image of the forest. Such a block or neighborhood could have architectural forms, structural relationships and support elements designed after the forest and could be a beautiful, healing and inviting place to live.

J. T.

PART I

HOW NATURAL SYSTEMS UNFOLD:

THE ECOLOGICAL AND BIOLOGICAL BASIS FOR THE DESIGN OF HUMAN SERVICES

PATTERNS IN NATURE SPEAK TO THE RESHAPING OF COMMUNITY

SUCCESSION: CHANGE AS A CREATIVE FORCE

How Natural Systems Unfold

Ultimately, nature is mysterious, but at a level far beyond this discourse. On another level, the workings of the natural world are not hard to understand but quite accessible, not unlike the processes involved in cooking. The "cuisines" vary around themes just as culinary expression does for different peoples. If you can fathom the relationships in a great dish, you can comprehend how nature works. What I should like to do is to list many of the attributes of nature that will allow you to think about the environment in which your community is located and some possibilities as to what might be done there.

Nature has several billion of years to its credit as a "designer," giving it a rightness to which we should pay close attention. It should also be noted that for every "rule" in the living world, there is a notable exception, but these exceptions do not invalidate, only punctuate, the overall story that all life, in concert, has to tell.

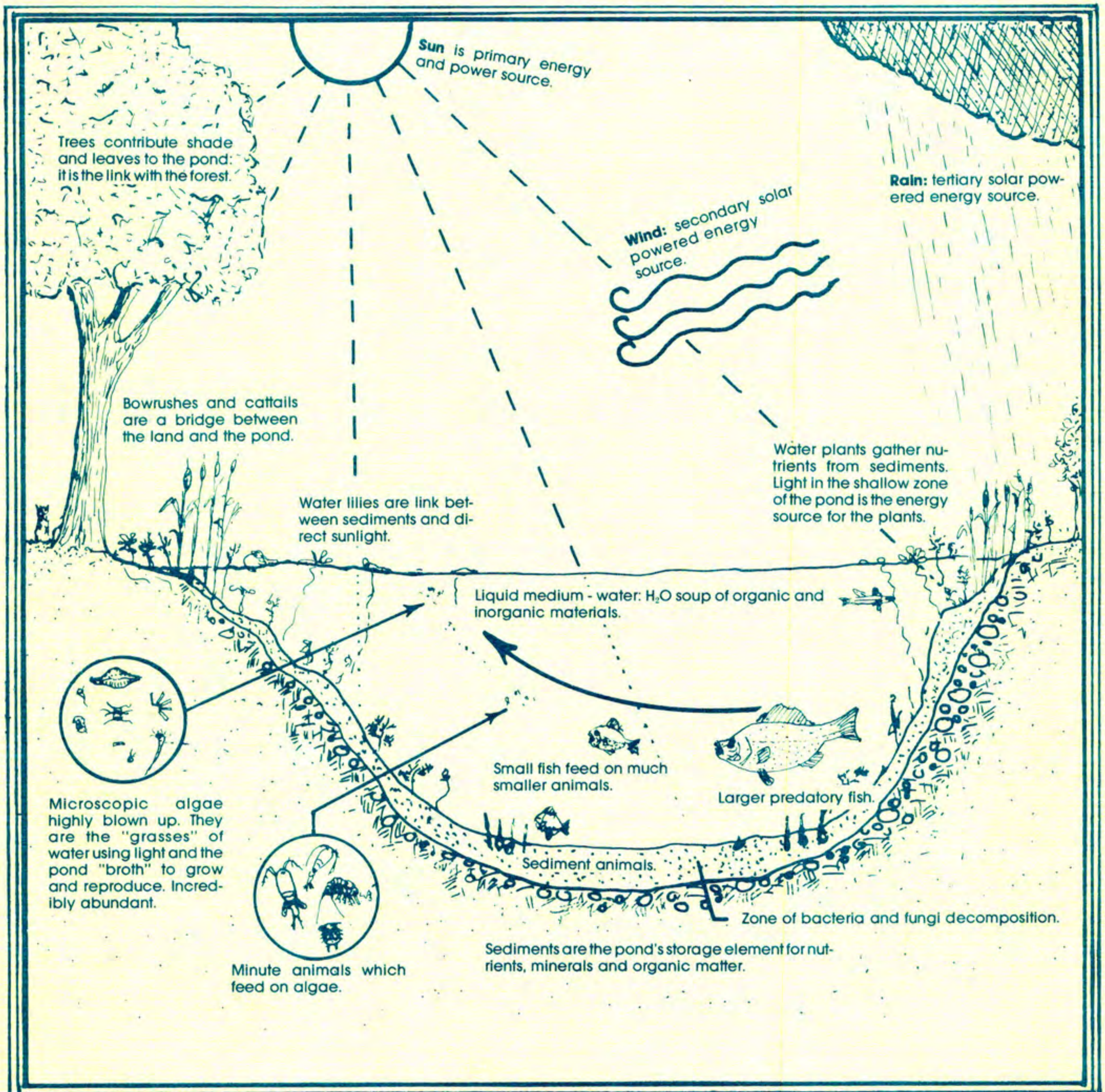
Patterns in Nature

1. The simplest and most primitive organisms are complete in themselves—whole. They carry out the basic attributes of life even at the microscopic level, including food gathering, nutrition, excretion, purification and reproduction. There is no fragmentation of function, such as occurs in technological society. To imitate nature, the subunits or "organisms" of society should be whole or complete in this same sense.

2. In the earliest history of life, evolution was triggered when a high degree of cooperation developed between unrelated organisms. Basically, different kinds of organisms "invaded" or enfolded each other to produce such composite organisms as fungi and higher plants and animals. Yet some of the older, less complex precursors like bacteria, spirochetes, and blue green algae still exist and play key ecological roles as independent entities. There is a lesson here—bringing together normally distinct types of activities can create new entities. An equivalent technological example would be the newly evolved translucent structure bioshelter which combines solar heating and cooling, wind, architectural, ecological, and agricultural functions. It is much more than a simple greenhouse although its envelope or exterior shell may be like a greenhouse skin. The bioshelter should be seen as an analog of this strategy in nature. If this process were to be extended from bioshelters to other human services, then even this co-evolutionary principle could be further developed.

3. We have seen that most organisms are complete, independent, and autonomous, and at the same time, interdependent with other life forms. This may seem a contradiction, but it is a paradox basic to life. Structure is whole and complete, yet no organism is an island unto itself. Nature depends upon connections through different levels of biological organization. The connections are always immediate and nearby. There is an unbroken continuum from cell to organisms to the ecosystem of which it is a part, to the bioregion and ultimately the whole planet.

4. Through differentiation, related cells become organisms like trees, people, and flowers. What we need to understand in this is that ancient biological connections are not abandoned, but rather are maintained



POND ECOSYSTEM

through vast reaches of time. This is the conservative side of nature. Its echo is a unity that permeates all life.

5. Ecosystems are akin to organisms. The basic difference is that the boundaries are less distinct, the length of the connections between the components are longer, and the couplings looser.

Organisms are defined outwardly by a particular structure or architecture and a surface such as bark, skin, or fur. Topographically, ecosystems are defined by the outer limits of the relationships. Whereas in the case of a pond, definition of boundaries is made easy by the banks. Some ecosystems blend into others and the boundaries are harder to see.

My view of ecosystems is a little unorthodox. I see them not just as sympatico collections of creatures, but as "beings" or metaorganisms, although I do not deny differences between organisms and ecosystems. For example, relationships in animals are defined and expressed by the central nervous system whereas a pond expresses its relationships as a "gestalt," or as the sum of its parts acting in a dynamic harmony.

6. Nature is not static. Left to itself in a wooded area, an abandoned lawn reverts to a meadow and then, within brief decades, to a woods. During this period, technically termed ecological succession, structural changes take place, and the landscape becomes more diverse, stable, and often less vulnerable to perturbations. Most human systems indicate a frame of mind that could be called early successional. Structural relationships are defined and fixed at the outset and the pattern is hard to change as conditions change. Nature has mastered change, whereas we humans tend to build, destroy, rebuild, destroy, and rebuild again. Often we lock ourselves into inflexible designs that inhibit maturation of a given society or community.

7. Beyond the ecosystem, the next over-riding structural unit is the watershed. A cluster of ecosystems arranged topographically and climatically to produce a distinct region, this organization of natural communities is easy to recognize but hard to define. It can be framed by a great river valley, mountain ranges or a coast. Usually it is categorized by distinctive vegetation and climate. This progression from local ecosystems to watersheds blends outward to join with others to comprise a biographical province. The hardwood forested land east of the Great Plains extending southward from southern Canada almost to the Gulf of Mexico is one such great province. Such provinces in turn blend to form the earth's canopy.

Made up of watershed tiers and comprising biographical provinces, there is another geographical area known for its distinctive climate, landforms, and plant and animal life. Known as a bioregion, it differs from a watershed or province in that it is a terrain for human consciousness to see itself as a part of. The specifics of this possibility—reinhabitation or learning to live in place—finds its actualization in preserving the bioregion as a life-place while recognizing the uniqueness of the human species in its material and cultural forms.

8. An ancient notion of the earth as an organism or being has been resurrected recently by two space scientists, Drs. Lynn Margulis and James Lovelock. They call their theory the Gaia hypothesis. They have found that the earth's atmosphere defies the laws of chemical equilibria. Gaia's work is to make the planet safe for life. It demonstrates an uncanny "intelligence" and homeostatic regulation of the essential chemistry. Atmospheric oxygen is twenty-one percent. If it were to rise a few percentage points, spontaneous combustion would occur and all life would be ingulfed in flames. If oxygen dropped to say

fifteen percent, it would be impossible to ignite fires. This constancy of oxygen is extraordinary considering the changes in the sun's output and the composition of the biota. Other gases critical to life and surface temperature are similarly under a refined control on a planetary scale. We cannot explain how all of this came about, but the significance is clear. There is a wonderful continuity from the tiniest cell to the earth itself. The microcosm and the macrocosm are images or reflections of each other.

9. Instructions in nature are scarcely understood, yet all life shares the same basic information. Humans, frogs, and mushrooms are all built of the same matter laid down in slightly different combinations. Modern biology is revealing the language of the genes, and this language provides the instructional framework for the unfolding creature.

There are other kinds of instructions in nature that are little studied and elusive still. These instructions link life on a transorganismic basis. The genes, for their part, are like a painter, complete with pigments, brushes and canvas. Together and in concert they make landscapes or portraits. But beyond this is something else, it is the "mind" of painting. All paintings by artists, dead and alive, reflect the state of the artist at work responding to instructions which are simultaneously in self and beyond self. Immanental and transcendental qualities merge. This higher order cannot be expressed if the painter is not skilled, highly trained and receptive, but at the same time these instructions remain prerequisites.

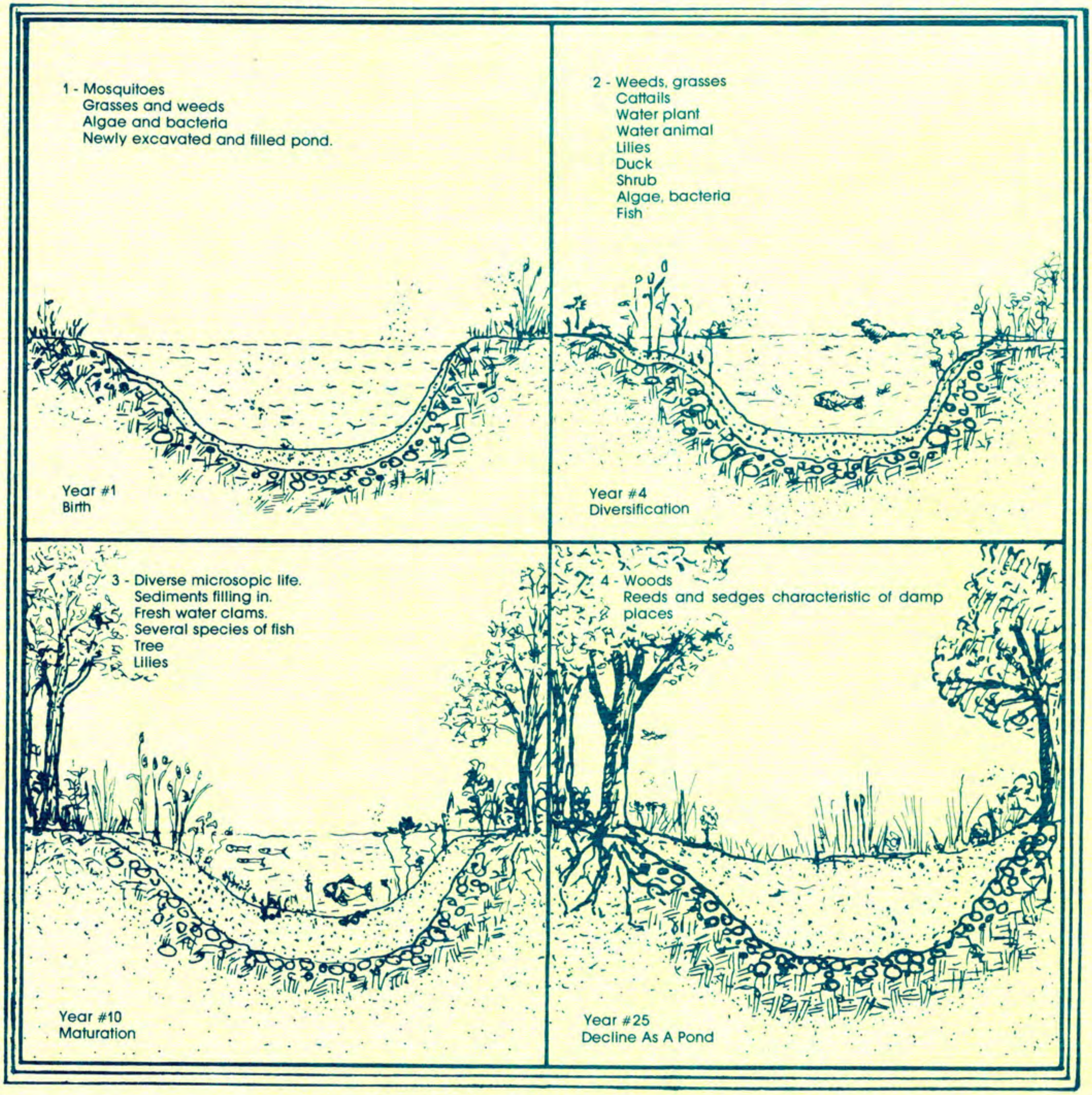
I mention this informational attribute of nature to emphasize that life is not a machine. Working with living material is completely different than working with lifeless subjects. Preparing a window box, designing a cluster of buildings, or reshaping space in a vacant lot can create unpredictable results. If a window box is innoculated with a few handfuls of forest soil, and has flowers and herbs as well as vegetables, and if it is occasionally watered from a wild pond, it will unfold according to its own instructions. It will function as a magnet for unexpected forms of life and be delightful and informative as well as useful. There will be wildness in it. Something comparable happens when buildings, parks, and perhaps even towns are designed from ecological models and instructions. There is a qualitative difference which we can feel. Some might call it a homecoming.

Succession: Change as a Creative Force

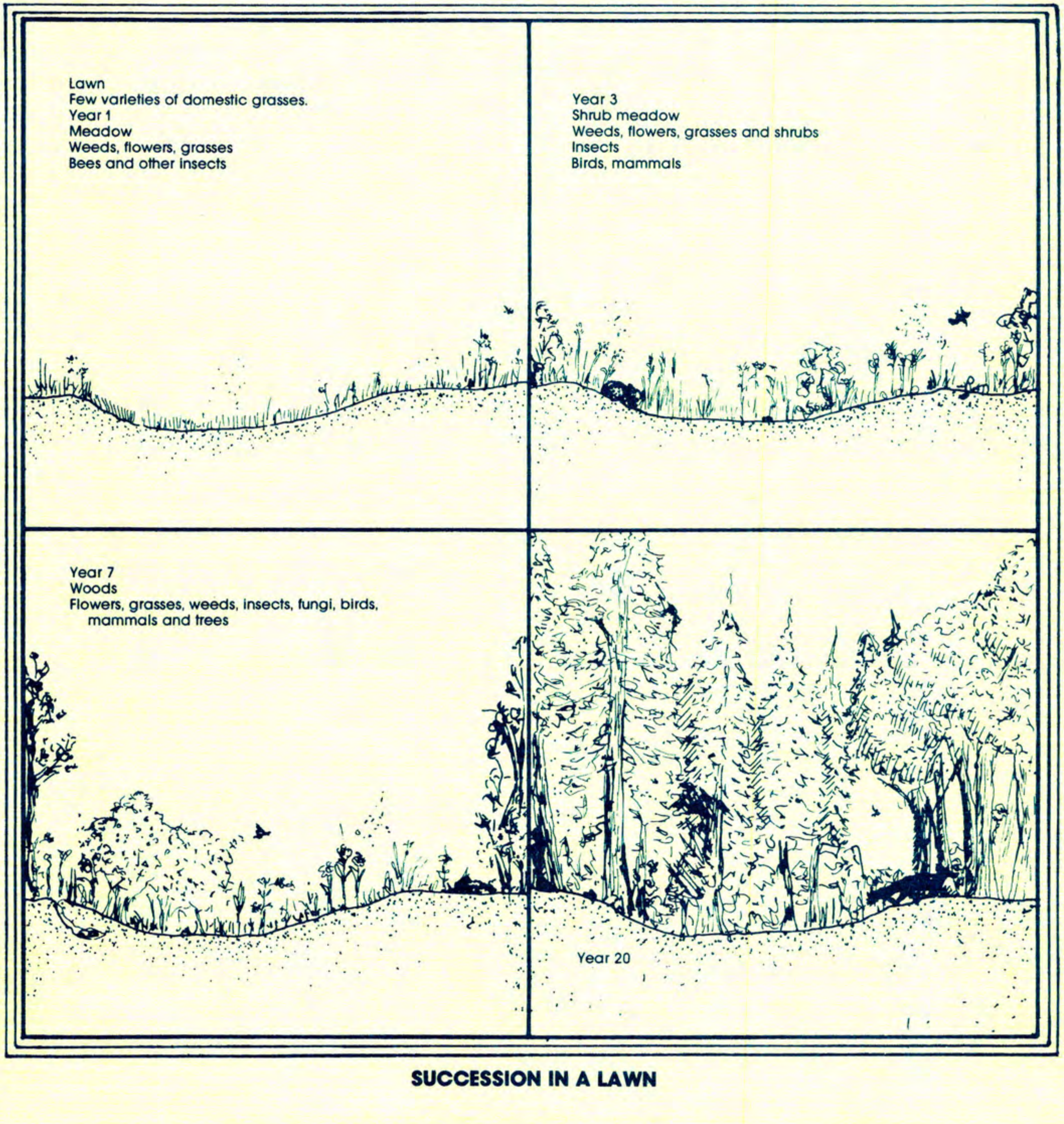
The notion of an ecosystem is derived from the Greek word "oikos," meaning house or home. The term ecosystem refers to an interacting system of living organisms and their non-living environment. In a sense, the environment is the "home" within which organisms live. A pond is the simplest type of ecosystem to visualize because it is contained in a bowl of land with boundaries that are easily seen.

The sketch shows a pond with the major feeding relationships that make up an ecosystem. There are other, equally critical, relationships. Essential gases are controlled by organisms. For example, when exposed to sunlight, the algae give off the oxygen essential to the survival of the animals in the pond. The bacteria and animals produce carbon dioxide which the algae and other plants need in order to live.

Populations of smaller fish are kept in check by predators, and predators, in turn, are regulated by their own reproductive biology, as they produce fewer offspring and, as well, by other creatures like herons, kingfishers, bears, and people.



SUCCESSION IN A POND



SUCCESSION IN A LAWN

To consider such an arrangement "dog eat dog" is to miss the deeper meaning in nature. We all eat to live, and as sentient beings, all need each other. In the end, all life is eaten or decays, so that new life can be born. Biology is about the nature of those cycles.

Time in nature is more complex than time as we experience it. It has seasons linked to the time of year. Life spans can range from minutes for some microorganisms to centuries for certain trees. There is also ecological time, called succession, which is usually measured in decades although the range here is enormous too. Further, there is in nature evolutionary time, usually measured in time frames ranging from centuries to millions of years, which describes the appearance, changes, and often the extinction of life forms. Finally, there is geological time which overlaps with evolutionary time. It measures major physical events such as the formation of mountains and the drifting of continents as well as the major climatic epochs. It's slow motion stuff.

Here we are principally interested in succession, which is an important concept relevant to the redesign of towns, cities, and human services. Successional time is ecosystem specific although some microbial communities may experience it in hours whereas forests may measure successional time in centuries. Succession is the unfolding of ecosystems and leads to change, maturation, increases in diversity, and complexity. It has stages encompassing "birth," "rapid growth," a structural richness phase, maturation and, finally, decay. Even forests grow old. The orderly progression toward full expression of place is dependent on climatic, geological, and edaphic or soil factors, and on external forces like fire and prior human presence.

The series of drawings of a pond show succession in a pond from a simple pool to a damp hollow in the woods.

The drawings of succession in a newly mowed field depicts the same process on land. In these illustrations both examples were triggered by a human act. In the first place it was digging a hole and in the second it was neglecting a lawn.

Succession is a powerful conceptual tool for thinking about, designing, and reshaping communities. It allows us to cope creatively with change, even to steer it. Change in nature is a creative force and its principles should be employed.

In both the succession series, there is an increase in diversity from a few simple organisms to highly evolved creatures in complex associations. There are reasons for this; diversity increases the number and, most importantly, the kinds of relationship which decreases rigid dependencies by spreading them through a more complex community. Diversity leads to an increase in stability, protection from external change, variety, and overall system efficiency. This in turn results in increased order and information flow, and, further, to two qualities that scientists rarely discuss in their analyses, greater harmony and beauty. These are not ephemeral qualities. They have meaning which speaks to us directly.

Take, for example, human settlements. Look at a typical city block (while keeping the diversity of the maturing pond in mind) and there is a good chance that you will see all identical buildings with no topographical variation or range of architectural or cityscape expressions. As a monolithic neighborhood made up of a single architecture in a sterile environment, it is the equivalent of a mowed lawn. There is no diversity of expression. It was probably built during a rapid growth or "early successional" period when housing rather than a neighborhood was the focus of the builders. This kind of city block has the potential to estrange people from each other and the world, whereas a neighborhood with trees, fountains, parks, shops, businesses, and residences intimately woven together can be a pleasure. They are an expression of diversity shaped for human ends.

PART II

KNOWING A PLACE IS THE FIRST STEP IN THE EVOLUTION OF BIOREGIONALLY BASED DESIGN PRACTICES

BIOGEOGRAPHY AND HISTORY

COMMUNITY STRUCTURE

Bioregionally Based Design Practices

Biogeography and History

Very few of us are used to thinking about community in the context of topography and biogeography. Yet, although we are not trained to think that way, New York and New Orleans are different from each other and from Kansas City or Denver, which in turn are different from each other. They are all grounded in very different ways, and their fate was, and is, in their biogeography. The fact that all are viable cities, albeit different, suggests that viability and fate are tied to history and region. Ghost towns and abandoned villages, on the other hand, teach us about communal failures, fragile relationships, and deep changes in fashion. The deserted skeleton of a ghost town makes it possible to imagine what can and does work in a community.

Manhattan

At the opposite pole is New York City. Its topography and biogeography fated it to be one of the world's great centers. Its die was cast with its purchase by the Dutch. Historically, Montreal and New Orleans have been rivals, but never equals for influence. The reasons can be gleaned by making a simple list of the city's major physical and biological attributes.

Initial Attributes:

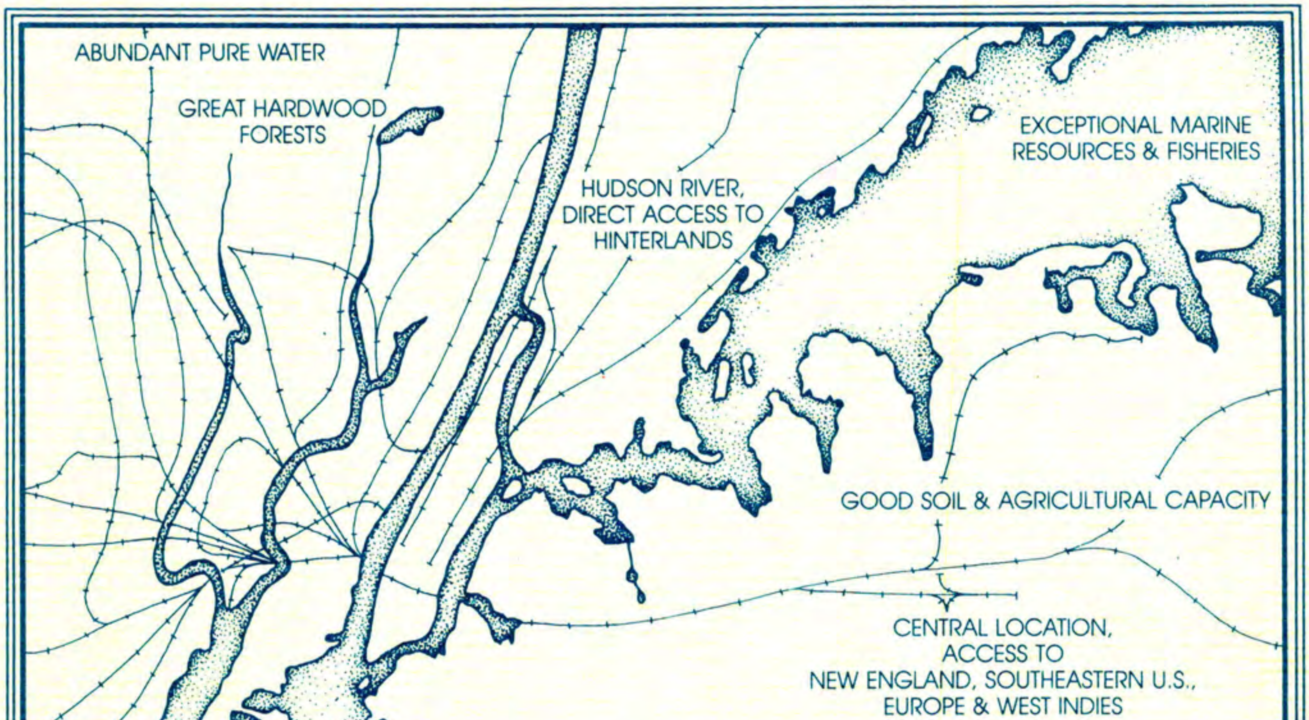
- i. Abundant pure water
- ii. Benign climate
- iii. Good soil and agricultural capacity
- iv. Hudson River and direct access to the Hinterlands
- v. Great hardwood forests
- vi. Exceptional marine resources including fisheries
- vii. Superb harbors which are ice free year-around
- viii. Center of access hub to New England, Europe, the West Indies and Southeastern U.S.

New York City was America's gateway. Coal, a key resource, was close at hand. Shipbuilding and shipping developed to solidify and enhance its biogeographic inheritance.

It was the combination of the above attributes that counted. Boston had most of them, but lacked three which cast it in a secondary role. It did not have a great river to the interior and the Great Lakes connections. The soils were thinner and the climate slightly harsher. Baltimore lacked the deep inland access and Chesapeake Bay isolated it somewhat from the central shipping routes. Montreal was a frozen port in winter and New Orleans was too distant from Europe and New England.

It is possible to make a comparable list for any city, town, or neighborhood. The results are almost always enlightening. In modern times it is necessary to add airports, rail connections (why did the railway go where it did?), and expressways; all of which create structure and help determine fate. The old rules still apply, however, and probably always have and will continue to in the future.

Much of the original basis of wealth by now has eroded. Stock markets and financial communities will not function forever in a vacuum. Distant sources of food, energy, and materials have replaced local production. If this continues much longer, the critical diversity of the region will be lost.



BIOGEOGRAPHY OF MANHATTAN

Examples of exhausted biological resources:

1. Commercial Fisheries. The once-productive Long Island and Jersey shore commercial fisheries are almost gone, eliminated by pollution, habitat destruction, and over-exploitation.

2. Maritime Activity. The indigenous ship building industry is almost gone. The merchant marine has shifted principally to foreign flags and fleets.

3. Agriculture. Development has pushed agriculture off the best soils. It has retreated in scale and proximity to poorer lands "overlooked" by other activities, although there is a trend toward regional food production even in urban environments.

4. Forestry. The great primaeval forests are gone forever, but new "forests" ringing the population centers are growing up again and their biomasses are increasing. The sheer density of the adjoining human population makes them extremely vulnerable.

A key element to the stabilization of New York lies in a renewed caring for its basic biological resources. Although former richness can never be regained, it can provide a plurality of activity that gives society flexibility and a dynamic quality.

It is possible to identify a combination of activities that would help to return much of the resource base to the region. Here, I list eleven.

1. Architectural elements should be modified to reduce sprawl in order to free up as much land as is possible. This clustering should become a continuing process and would require refining.

2. Industry should recycle water and airborne wastes at source which would improve environmental quality making the regions more liveable. People would be less likely to leave their communities.

3. Industry should be modernized around the themes of low energy requirements, internal waste purification, and highly adaptive and flexible working environments. If these qualities were combined with a shift towards high quality, industrial pre-eminence might again be achievable.

4. The city should recycle and re-use sewage and make useable by-products from it.

5. Water should be recycled into city maintenance functions.

6. Urban landscaping based on food and ecological "islands" should be undertaken to develop more liveable environments.

7. Waterfronts should be rehabilitated in order to bring the ocean and the river back into the life of the city.

8. Salt marshes and ocean fish inshore nurseries should be restored.

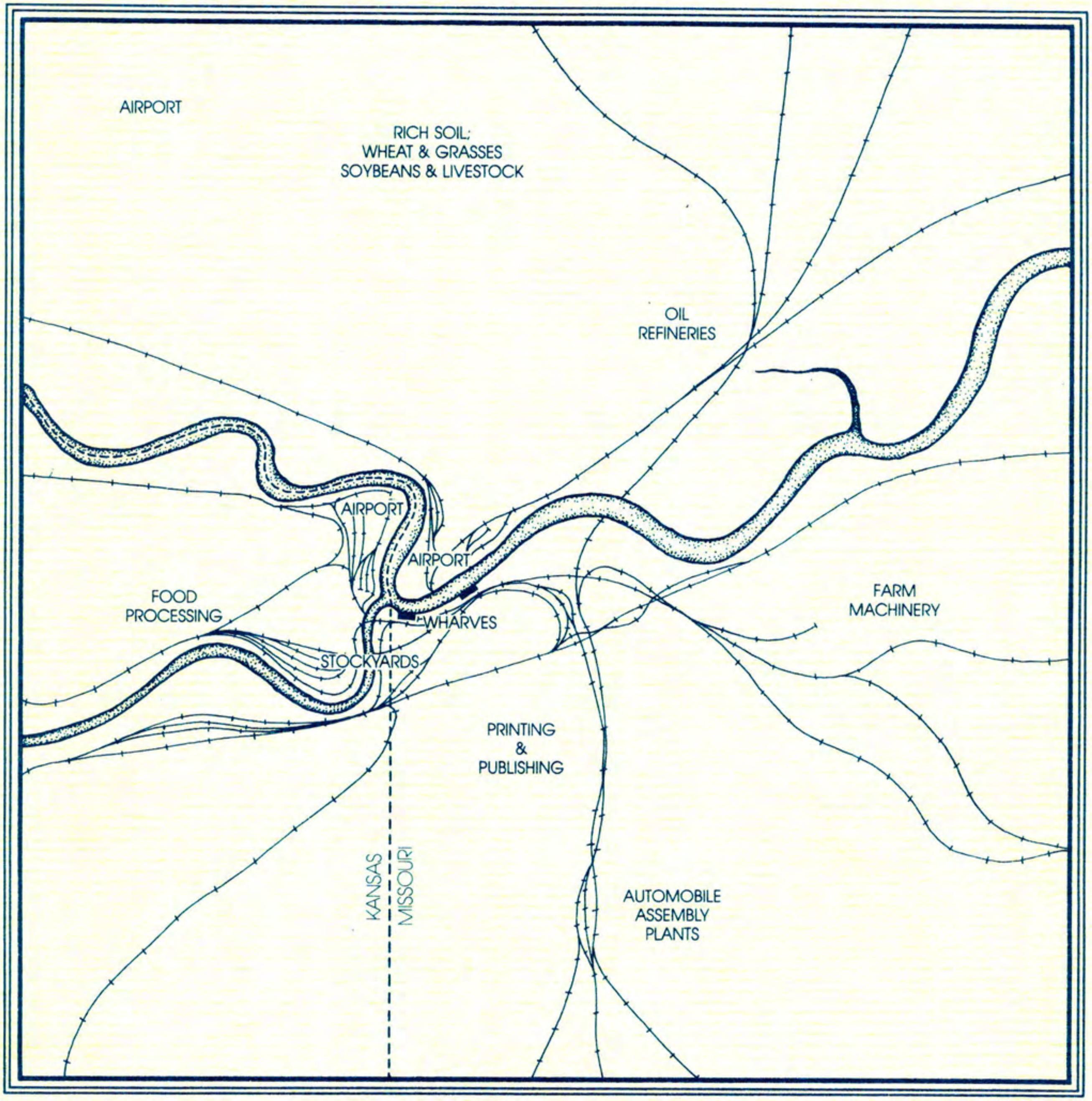
9. Coastal mariculture on the scale of the Japanese should be developed.

10. Some of the original farm lands should be reclaimed.

11. The energy base should be shifted to renewable energy sources, particularly solar, for it is non-polluting and relatively predictable. The supply is continuous and not vulnerable to regional and international disruptions, shortages, or blackmail.

The Cities of the Great Plains

The great plains have their own beauty, destiny, and culture. Flying over the cities of the plains one is immediately struck by the fact that they are located on rivers—Wichita on the Arkansas River,.Topeka on the Kansas River, Kansas City on the Missouri River, and Omaha on the Iowa River. These river veins



BIOGEOGRAPHY OF A PLAINS CITY

or arteries are still essential to these agricultural cities, although perhaps not in the same way as they used to be.

Their biogeography and history have much in common. Some of their qualities that make them viable and regulate their overall size are the following:

1. Water is available in modest but reliable quantities. In recent years there has been a trend to mine deep aquifers for fossil water and use it to support agriculture production.

2. Good to exceptional soils, which are the real wealth of the region. The continuing fertility of the land is essential to the survival of such cities.

3. The climate and soils are superbly adapted to grains and grasses, which are the basis for a viable livestock agriculture.

4. Air, truck, and rail transport are all well developed and together provide a range of alternative shipping modes.

5. Wind is abundant seasonally with potential for generating electricity and hydrogen fuels.

6. Sun is abundant seasonally making the potential high for developing rather than transporting energy and fuels.

7. The plains cities are somewhat isolated geographically. They had to wait for the railroads in the 19th century in order to develop as important commercial centers. It is agriculture that underlies the commerce. These cities are breadbaskets to the world. This, at once, is their great strength and weakness. The weakness lies in the necessity of importing petroleum fuels for agriculture and irrigation systems. Low energy agriculture should be a top priority for the great plains.

The major difference between New York and a plains city is not in energy addiction for both are hooked in comparable ways. It lies rather in the diversity of biogeographic options available to the former as compared to the latter. New York lies at the "belly" of the western industrial world at the entrance to a vast continent and has half a dozen biological resources. The plains city does, however, have two options for strengthening its future. I have already mentioned the soil as the principal basis of wealth. Due to modern agricultural methods, however, soil is eroding rapidly at a rate of tons per acre per year. This erosion has to be stopped or in twenty years the breadbasket capability will be gone forever. As vital as soil is, water, the handmaiden of agriculture, gives the gift of life to the soils and crops. It must be protected, the mining of the aquifers reduced and ultimately discontinued before they are pumped dry.

There are social questions that need addressing as well. Culturally, the plains cities must have artistic and social diversity or they will lose their citizens. There should be a conscious effort to develop indigenous modes of expression that are not parochial or second class. Relative isolation demands striving for high culture that is not a pale imitation of New York.

In terms of manufacturing, the plains cities have been attracted to farm machinery and aircraft industries. The same vigor and entrepreneurial attention could go to promoting solar and wind industries. Solar heating, cooling, drying, and food processing equipment could claim immediate local markets. Aircraft industries should fabricate wind engines as electrical power stations. It has been predicted that wind power will surpass nuclear power by the end of the century. The infrastructure exists in the plains cities to dominate this market. The aircraft industry also has the ultralight and strong technologies to build fast light rail transportation systems that could be elegant and energy efficient. The first of these could use existing railbeds between plains cities. The market for light rail markets will eventually become large and international.

The comparison of the New York and the cities of the great plains, from a biogeographic and historical perspective, is intended to illustrate a new way of thinking about options for the future. What are constraints on one hand can become sources of new directions. Each place has its peculiar attributes. Knowing what they are and how they fit within the overall pattern of an area provides tangible clues, from the wide view, upon which to proceed.

Community Structure: Possibility as Inherited Limitation

The possibilities for change within communities depends upon the biogeography of the larger area, its prior development and use, and, in addition, our perceptions of the place. Prior development is inherited, but like the skeleton in the body it is the basis for structure, movement, and action. From a biological perspective, what is inherited is the backround against which ecological ideas are superimposed. If a neighborhood is mostly vacant buildings or abandoned factories there are reasons for it, yet those same reasons can be turned around to illuminate new opportunities. Renewed social and economic possibilities now often lie fallow in old land, infrastructures, and buildings.

A perception of a community as an evolving organism is essential whether it is one that grew up overnight as a suburb, over decades as most towns and cities, or over centuries as is the case with this country's oldest cities. One way to develop a time perspective is to locate old drawings and photos and another is to gather stories from the old residents. These will begin to create a slow motion time frame of the past in the viewer's mind. The local historical society is often a resource in assembling the bits and pieces of the past. A sense of the structure of your community, how it worked and is working, will evolve, which in turn, can inform planning and action. Another perspective can be gleaned by asking people what they liked and disliked about the community in the past, and how they feel about it now. The resulting lists will etch the strengths of the area and help reveal what should be done to strengthen the community.

Having molded a historical view, it can be used as a backdrop to see the evolution of the community through various aspects of development. Changes over time in the form of roads will begin with early trails and end with the grid that supports current traffic. Transportation will have grown from turn-of-the-century carriage roads to trolleys then to bus and subway routes. Public transportation can be a bell weather in the changing economic and social relationships of an area.

And the location, type and power output of electrical power stations over the years is also informative. If the community is an old one, there has probably been a shift away from local electrical generation to larger stations with greater capacity. Because nuclear power stations are potentially extremely dangerous, they have been moved away from population centers, albeit never far enough.

Hopefully, there may be signs of the beginnings of a return to local power generation as in industrial cogeneration or residential scale wind mills. This would imply communication between producers and users and fairly sophisticated linkages between the local consumers and the larger regional electrical exchange grid.

The story of energy can be rerun with the history of waste treatment. The diagram traces the early settlers' lack of concern for any waste purification, to raw sewage discharge away from housing, to modern complex sewage treatment which are effective but expensive.

	Sewage Time Frame	*Dates*
i	gutter and outhouses	1700's
ii	open drain to river	
iii	closed drain to river	
iv	primary sewage treatment to river	
v	secondary and tertiary treatment and to the river	1980's
vi	recycled solar sewage purification	2000

Any analysis of the impact of industrial development on the structure of communities will involve the relationships between residential, commercial, and manufacturing activities and areas. Examining contemporary aerial photographs within the context of the previously mentioned historical perspective can provide a visual representation of this. Historically, for example, polluting industries and their workers were separated from the middle- and upper-class residential areas. Often commerce grew up between them, close enough to interact with both industry and with the wealthier neighborhood while serving as a barrier between them. Understanding this aspect of cultural history reveals much about the logic of development and the flexibility that exists to alter the configuration.

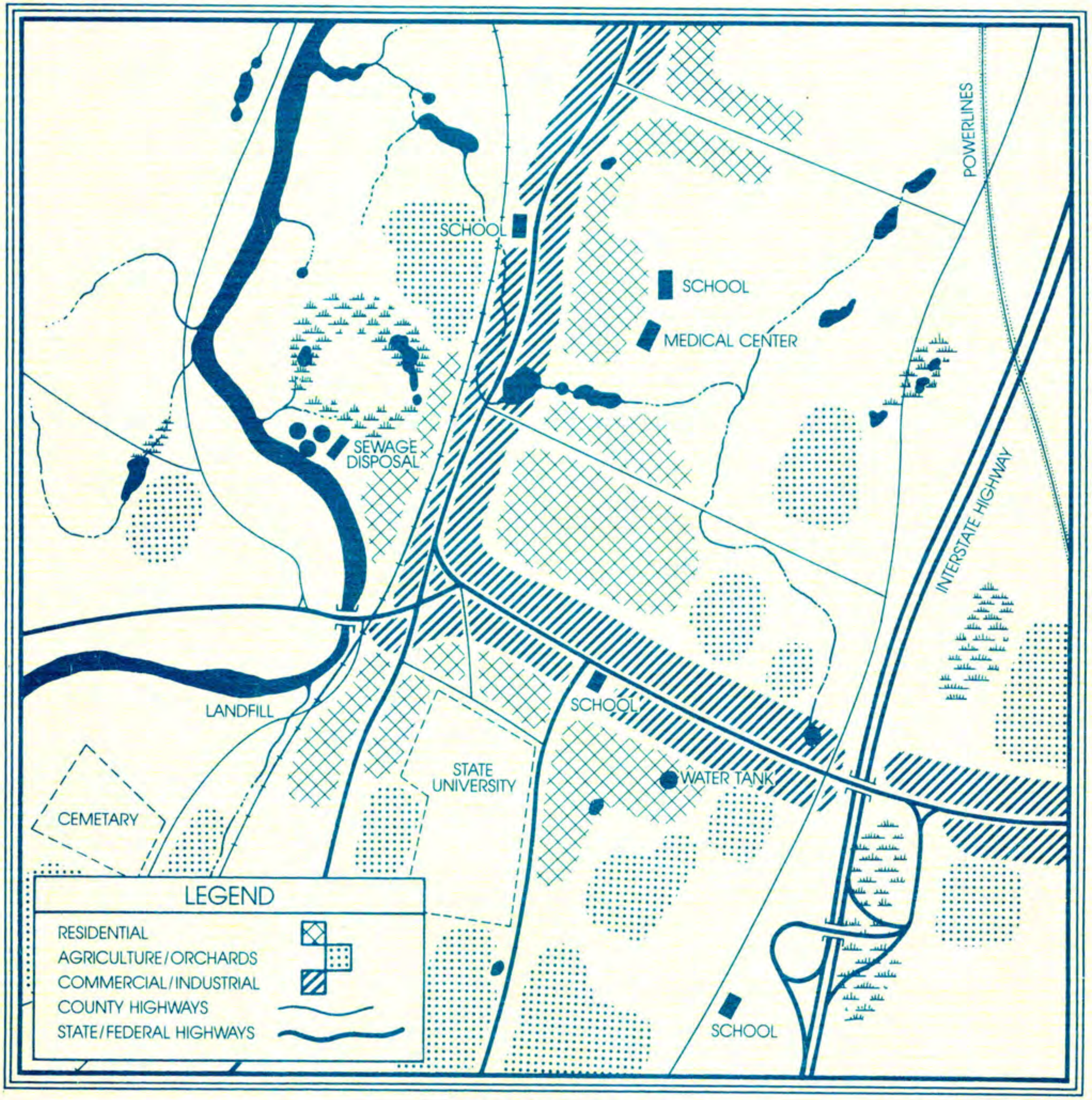
Place Patterning: An Exercise in Town or Neighborhood Planning

There are a number of accessible and inexpensive ways of seeing a place as a whole. One way is to overlay the artificial terrain onto the natural one using maps to see where tensions or compatability exist. For a city, a good street or road map will do. For a small town, a topographic map would be more effective.

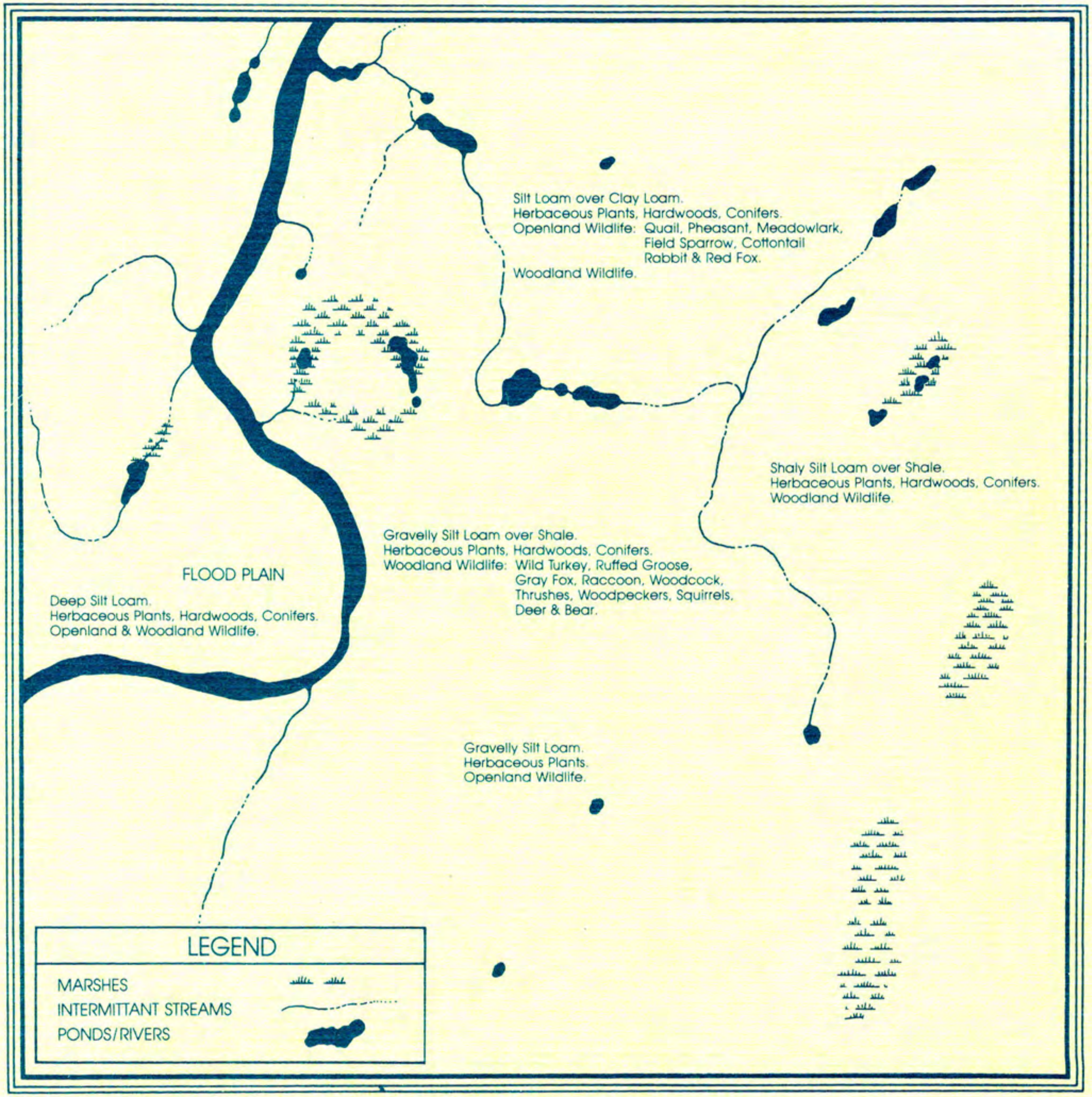
The following should be delineated:

i. All of the natural water flows, including streams and lakes.
ii. Water-related functions, like harbors, docks, and marine terminals.
iii. Railroad lines should be sketched onto the map that contains the water courses.
iv. Major road traffic arteries.
v. Airports.
vi. Electrical power stations or major transmission and distribution sub-stations.
vii. Waste treatment facilities.
viii. Areas which are zoned for residential, commercial, industrial, and governmental purposes.
ix. Agricultural activities.

The next step would be to prepare a biological map which would include waterflows, landforms, soil characteristics, wildlife habitats, and, as much as possible, native vegetation. Specifically, all the green zones should be plotted including parks, open spaces, treed avenues, wooded ravines, and so forth. These biotic arteries will probably be spotty and discontinuous.



A MAP OF DEVELOPMENT



A MAP OF NATURAL CONTOURS

Now you are ready to superimpose the map of industrial patterns created first with the green zone maps, using the waterways as a common reference. Most likely you will discover how transportation arteries cut up topographic and natural connections. This has something to say about how succession is being impeded as well as giving information on possible alternatives; light-rail for example.

The greening of an area is a basic reinhabiting and eco-development strategy. Critical to this is connecting the biological components which should be almost continuous. This can be done with a combination of tactics like sidewalks and vacant lot plantings. But it must be understood at the outset that to undertake a major greening program takes soil, and lots of it. Terrestrial life, humanity included, is utterly dependent upon soil. Soil building, whether in the form of composting or erosion prevention, must be considered with regard to existing and local soil characteristics and landforms. Native vegetation is essential to a soil base, which brings us back to greening as an important strategy.

There are new opportunities in combining manufacturing, waste purification, and agriculture, with housing, marketing, government, and education within the neighborhood. Science and technology now have developed to the point where manufacturing, waste purification, and food production can be miniaturized and decentralized to an unprecedented degree. Each sub element can be designed to assist the other, making possible cities and towns made up of diverse and productive villages. Such villages within the city would function not as isolated entities but as whole systems highly interactive with other villages. Such possibilities could be included in proposals of local planning boards which tend to zone areas according to singular function with a small degree of give and take between them.

These are but a few examples of what one can take away from this exercise or, for that matter, any representation of place that is non-industrial. It points beyond itself to possibility and renewal.

PART III

COMMUNITY SUSTAINABILITY: THE INTERSECTION OF HUMAN NEED, THE LOGIC OF SUCCESSION AND TECHNOLOGY

WATER

HOUSING

FOOD PRODUCTION

TRANSPORTATION

COMMUNITY ENERGY SYSTEMS . . . .
GEORGE TUKEL

Community Sustainability

WATER

Under every city there is a dark and hidden Venice. Water is no longer celebrated out in the open. We take it for granted and hide it from sight at every opportunity. Water is, in its myriad cycles, the source of all life, but industrial societies keep it underground in pipes from source to disposal. Water is used, abused, and polluted, then put back into pipes to be discharged in varying degrees of foulness in some remote river, lake, or ocean. Huge sums of public money are spent on treating waste to keep it out of sight and out of mind.

In the recent past our clinical use of water has created immense health benefits. Such practices as pathogen-killing poisons like chlorine, separate waste treatment, and distant disposal have eliminated or, at least, reduced water-borne diseases in many areas. Great public health improvements have been made. It is high time that our use of water be improved again. Water should be brought up, out of underground pipes, and be exposed to solar energy, kept exceedingly pure and celebrated within every community. Water can and should become a very visible part of the fabric of architecture, settlements, and the city or landscape. A range of possibility can be found in the use of fountains and the need for waste purification.

The Fountain

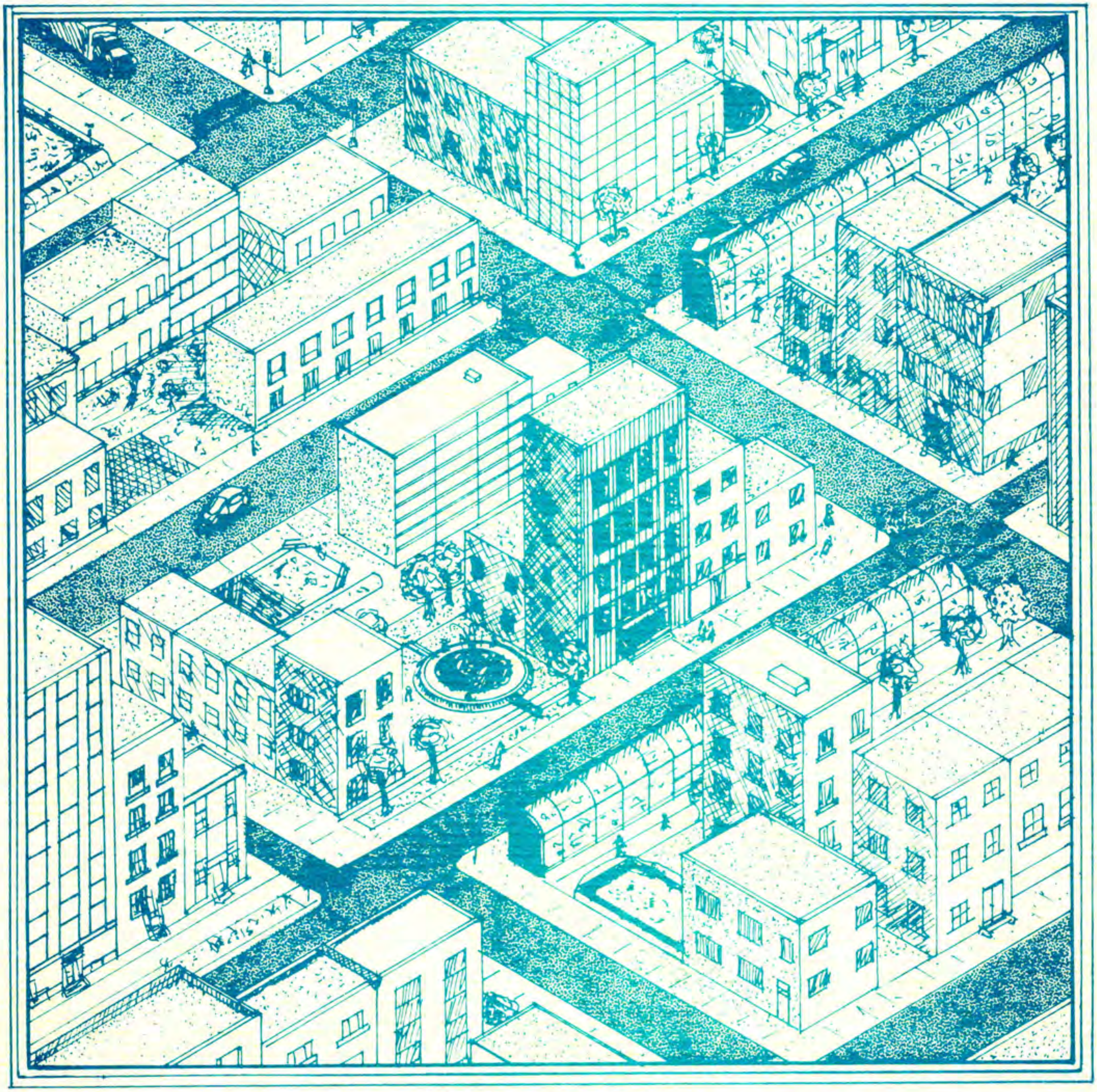
The most ancient honoring of water, after the well, is the fountain; water sprayed into the air then cascading downward in splashes of light, smells, and sound.

Every urban block should have a fountain. A fountain breaks the heat of a midsummer's day. The splashing casts a spell and is soothing. The sketch shows my amphitheatre fountain design, large enough for parents as well as children to sit in. The lowest level is deep enough for a good splash, while the upper tiers on the upwind side are relatively free of spray. There is a central pool for purifying the fountain water which uses aquatic plants floating in containers, as well as snails and goldfish. The fountain is powered by solar cells which directly drive the pump that lifts the water into the air. The brighter and hotter the sun, the higher and faster the plume. It would be still at night. The fountain water can be heated in a Big Fin(TM)-type solar collector mounted and covered next to the south-facing side of the fountain. This would extend the fountain season into early fall and allow it to begin again in late spring.

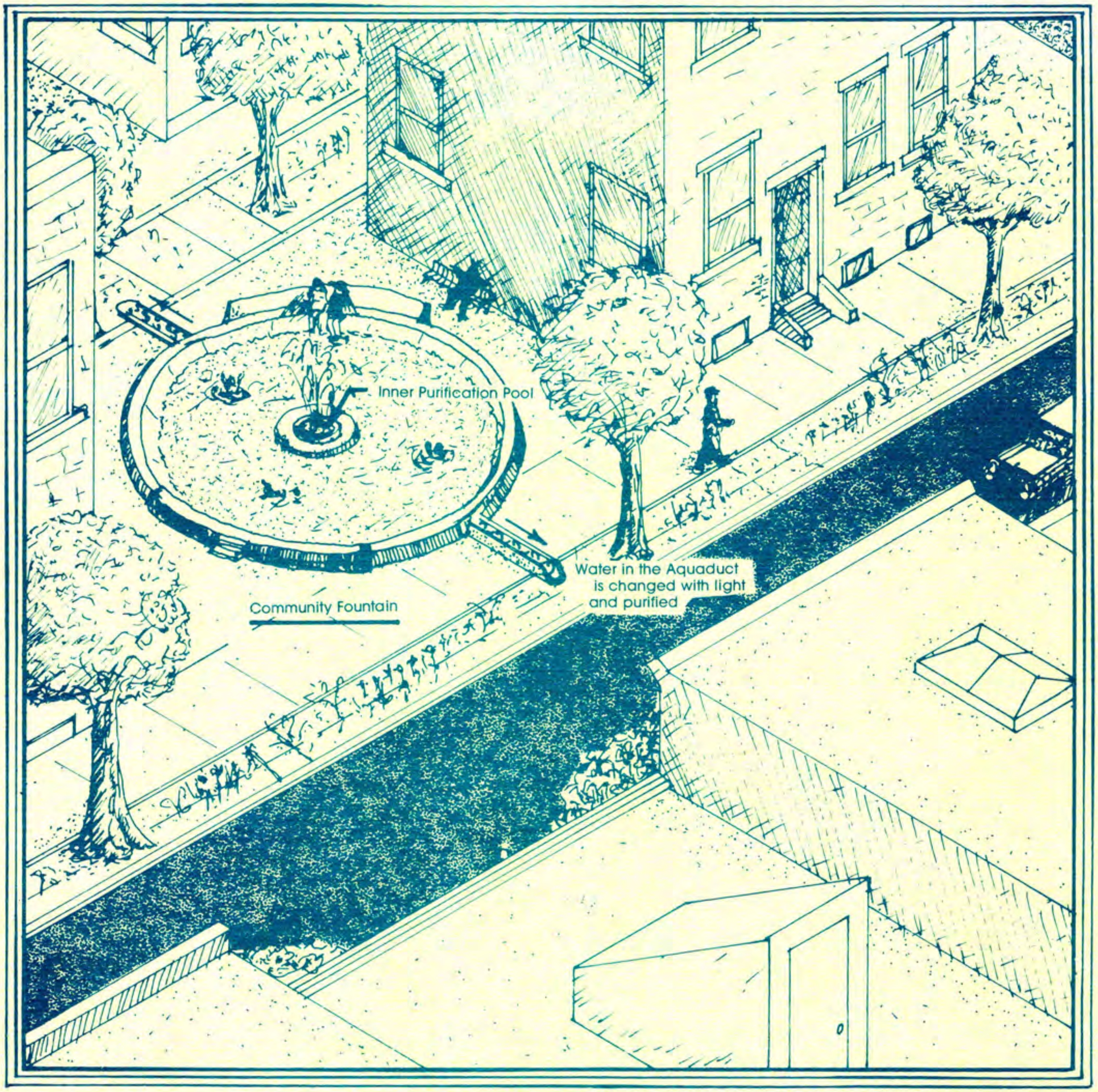
The water would need changing, the frequency depending upon the number of people using it. The old water shouldn't be thrown away but used to irrigate nearby trees and grounds.

The sketch also illustrates a new kind of aqueduct through which water flows exposed directly to light and air. The water course or aqueduct is shaped to produce vortex patterns. For some reason, yet to be explained, European scientists have found that water flowing through such a system is purified. The shallow stream is cleaned upon exposure to copious amounts of light and oxygen.

I envisage sculptural concrete aqueducts or streams as water transporters to irrigate sidewalk gardens especially. Fountain water could be transported this way to its end use. Children and adults could race



VISIONS OF WATER



THE FOUNTAIN CAN BECOME A CENTER WITHIN THE CITYSCAPE

model boats in the aqueducts, and sidewalk regattas might become the rage. In a more practical vein, such aqueducts could redirect storm and run-off water to storage lagoons, and serve other useful and non-destructive purposes.

The Solar Sewage Wall

New solar and biotechnologies are transforming waste treatment, which now can become local, decentralized, and of direct economic and ecological benefit to the community.

The following is a new sewage treatment idea which creates structural elements along streets and celebrates nature's most efficient ways of purifying human wastes in ecological cycles assisting, in turn, the whole community environment.

I call it the "Solar Sewage Wall." It creates a barrier that separates pedestrians from traffic and is a long, thin, greenhouse-like structure with its south wall and ceiling translucent to sunlight. The north wall is a dark painted brick, block, or concrete mass capable of storing some of the radiant heat trapped in the structure.

The Solar Sewage Wall is continuous, running parallel to the sidewalk. Inside the structure, at the intake end, is a sewage grinder and an ozone sterilization unit for killing pathogens or disease organisms. The main part of the interior is comprised of three tiers of shallow fiberglass channels or streams sloped in steps so that the sewage water flows back and forth and downward through the facility. The water enters at one end of the upper channel, flows the full length of the Solar Sewage Wall, splashes down a step, and flows back along the middle channel to the intake end, then splashes down to the lower channel where it flows back again to the outlet end. Finally, it is discharged, pure, into low solar water silos for subsequent reuse.

Aquatic plants like water hyacinth and other efficient removers of nutrients and toxic substance clean up the pulverized and sterilized sewage effluent. The aquatic plants are cropped and fed to poultry or composted (my own ducks prefer water hyacinth to most other green feeds). By the time the water leaves the Solar Sewage Wall it is ready for any kind of reuse.

Such a facility would get quite hot when the sun is shining brightly, especially in summer. The staff would need to adjust, perhaps by working from 4:00 A.M. to 10:00 A.M. for part of the year if the heat is intolerable. The plants and many of the microorganisms, however, thrive on heat. Biological purification is optimized in water temperatures that approach 100°F. Over-heating can be prevented by venting and by growing such plants as grape vines up the outside of the south wall.

The Solar Sewage Wall is not completely worked out. All the components have been studied and work, so risks of failure are not high if an aquatic biologist is operating the facility. A civil engineer, a biologist, and a public health officer could easily solve any problems. Many valuable by-products would accrue from such a purification process.

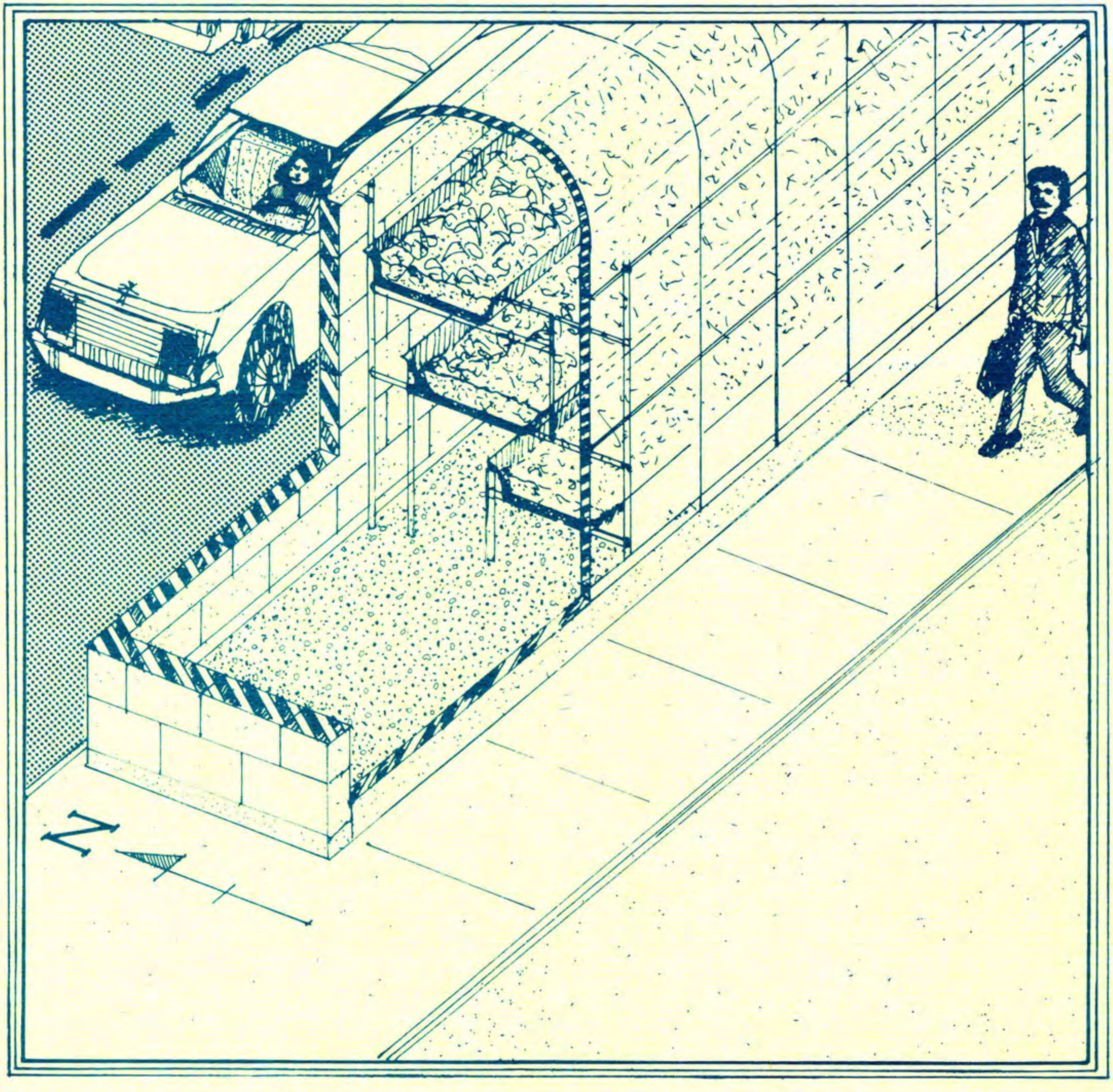
These include:

1. Compost: Aquatic plants and organic sediments.

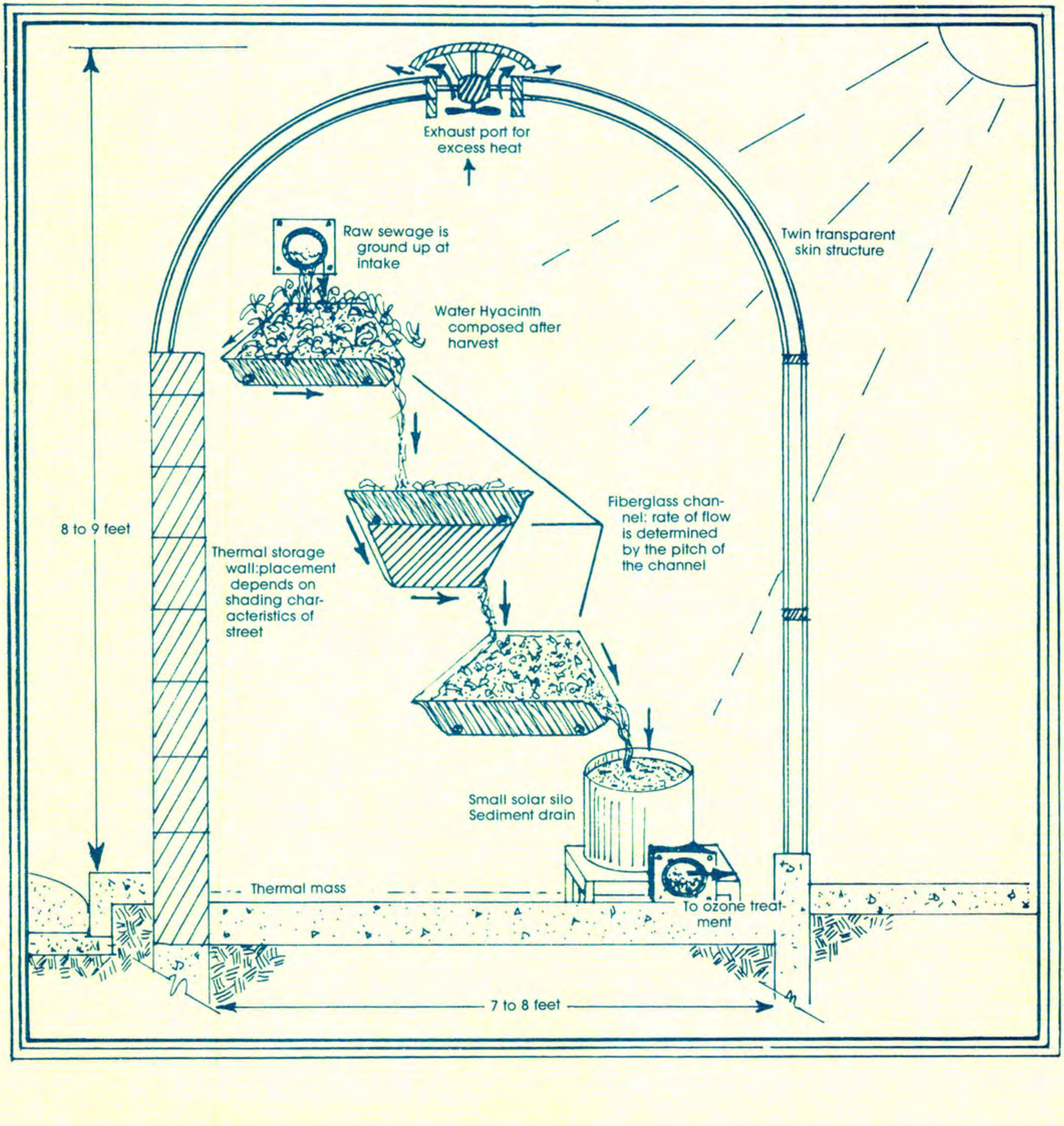
2. Pure Water: For irrigation, in pools, gardens, etc.

3. Local Employment: Staff to operate facility and process by-products.

4. Tropical Fish: The lower and possible middle channels and solar silos would make excellent fish propagating facilities.



BLOCK SCALE WASTE AND SEWAGE PURIFICATION FOR URBAN NEIGHBORHOODS


Exhaust port for excess heat
Raw sewage is ground up at intake
Water Hyacinth composed after harvest
Twin transparent skin structure
Fiberglass channel: rate of flow is determined by the pitch of the channel
8 to 9 feet
Thermal storage wall:placement depends on shading characteristics of street
Small solar silo
Sediment drain
Thermal mass
To ozone treatment
7 to 8 feet

5. Hatchery Fish for Aquaculture: The same two components could produce over a hundred-thousand baby tilapia or African perch annually for city fish farmers.

6. Snails: Ornamentals and cleaners for hobby aquarists.

7. Live Fish Feeds: Small aquatic animals like daphnia could be harvested and sold. There are daphnia species that do well in waste treatment facilities.

8. Greenhouse Plants: Tropical plants suspended below the flowing channels would thrive in the hot and humid environment. Orchids and other valuable plants like papaya or figs could be propagated in large numbers.

Moving waste treatment onto the block and in modern solar facilities would change attitudes toward waste. People will be able to watch it; see how it is working; offer suggestions to make it better; and come to trust it. Sewage will be seen for the valuable renewable resource it is and the recycling process will become capable of supporting diverse economic activities contrasting sharply with the remotely sited sewage plants of contemporary communities.

HOUSING

Climate is the Arbitrator of Design

Climate, as the principal source of energy, sculpts societies. Climate is not just weather. It is rather a blend of wind, sun, rain, heat and cold compounded and cast into the larger imprint of time. Climate helps define a place and our role in it. It is the differences between climate and our preferred body environment that originally inspired clothing, architectures, furnaces, and air conditioning.

Natural systems are extraordinarily sensitive to climate. A particular combination of sun, rain, moisture, and heat and cold produced the familiar hardwood forests of the northeast. They are unlike any other. They bear the stamp of the unique climate of the region. Nature, in a wooded area, abhors a mowed field. The land "wants" to be a forest. Every neglected pasture quickly returns first to shrubs and in a couple of decades to forest.

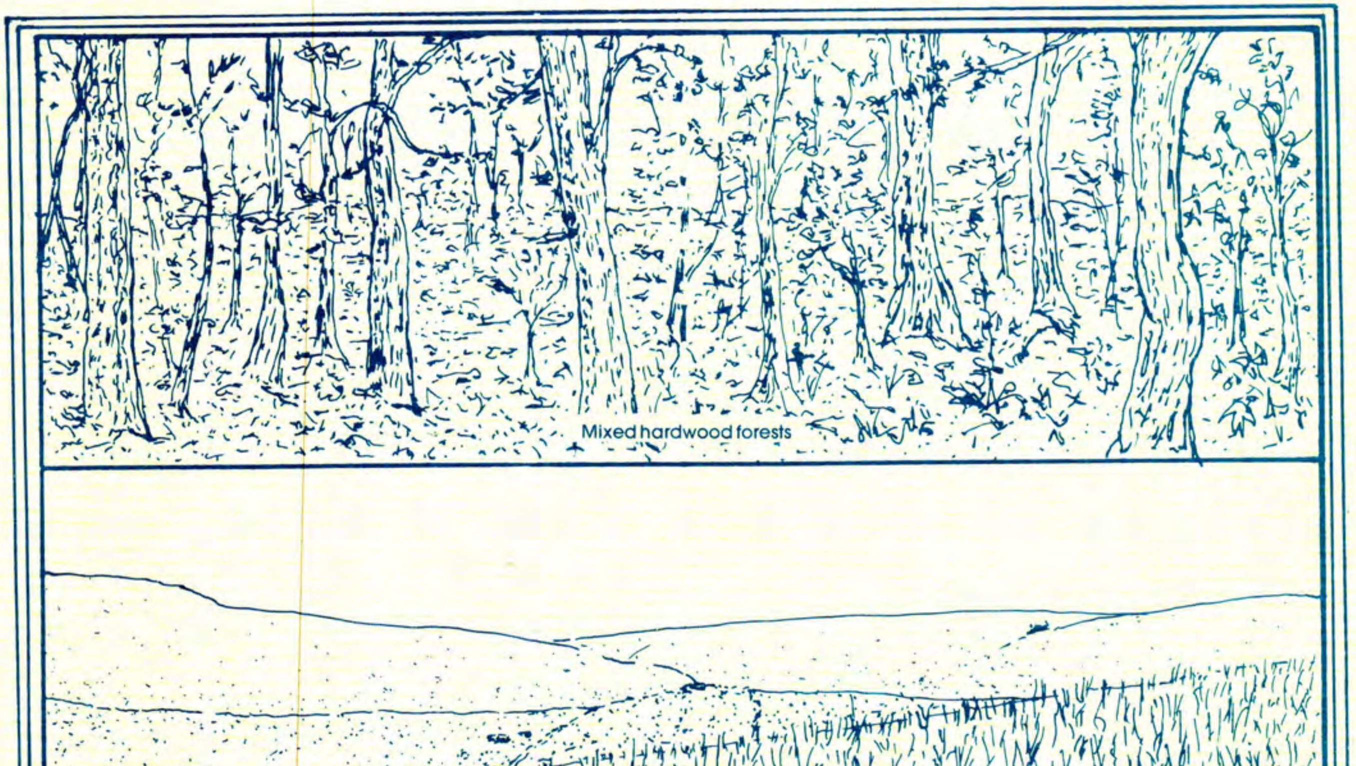
Prairies are very different. They are created by particular combinations of wind, seasonal rains, abundant sun, and periodic fire. Prairie grasses and prairie flowers are a blanket for the land's and the climate's "memory."

As may seem more obvious, deserts, too, reflect climate. Here, intense sunshine, wind, extreme daily temperature oscillations, and dryness mesh to create the sparse aesthetic beauty of mesquite, cactus, and desert flowers.

Each of these bioregions portray the meaning of climate in the broadest terms. In many ways, they shape the psychology of settlers and settlements and have a symbolic nature as well. The forests of New England indicate the predominance of moisture. The diffuse light from the sky is buffered by the North Atlantic Ocean and is filtered and muted.

The prairies symbolize movement and light, like a terrestrial sea. Distances with winds, sun, and dark intermittent rain clouds building far off. Winter cold.

Deserts convey intensity—searing heat, glaring sun, deep night cold, and raw archtypical forms—beauty beyond the human hand.



CLIMATE IS REAL: THE SURROUND SPEAKS OF IT

Traditional Communities' Embodied Climate

Northeastern Woodlands

Before the coming of Europeans, native Americans in the northeast, lived in quonset-like long houses made of saplings and layers of bark. "Quonset" may be an Indian name for a house in a forest. The architecture "fit." It was highly suited to the climate. A recent computer study of the optimal shape for a low energy, advanced solar bioshelter was uncannily reminiscent of the quonset long house. It was sited in an east-west direction, insulated and reflective on the north side and north side interior, respectively, and transparent to light on the south side. Except for the transparent glazing, our ideal building could have existed centuries ago.

Early European settlers in New England had other ideas for houses that favored high-pitched roofs, salt box shapes, and many fireplaces. They were fairly energy-conserving structures, but the open fireplaces burned up copious amounts of the then plentiful wood. Surrounded by forest, the settlers were wasteful.

By the 19th century New England had changed. Houses were not in the main climatically sited but faced the street or road reflecting wealth and status. Some of them were elegant and almost timeless in their purity of line, but they required a lot of heating fuel, and increasingly, the principal fuel was coal, which at relatively low temperatures of firing in household furnaces or stoves, was a polluting material.

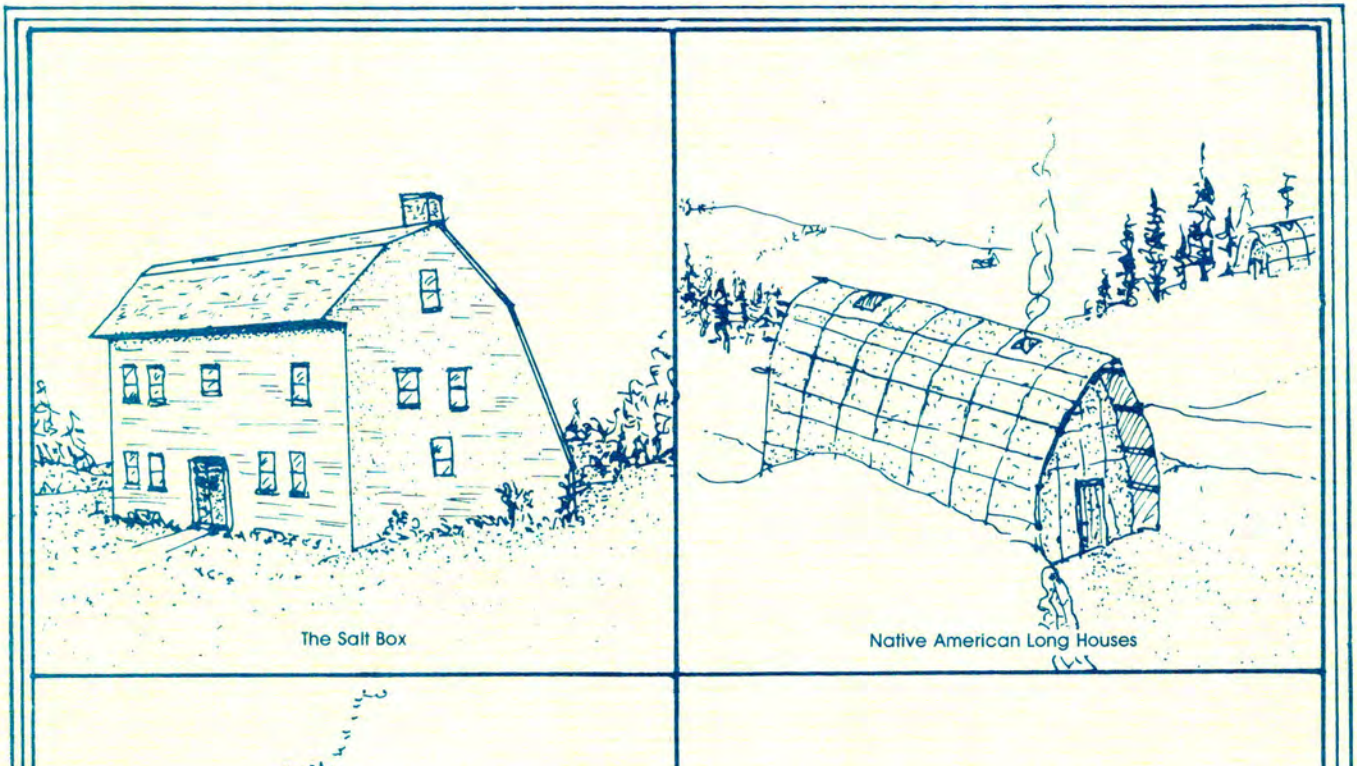
By the middle of the 20th century climatic sensibility had been utterly abandoned. The sprawling, inefficient, badly sited fuel-consuming California ranch house moved east and into suburbia. Excessive heating and cooling were required by the poor use of glass, spread out configurations and single story architecture. As often as not, picture windows faced north, further exposing the house to heat loss and chilling winds. This architecture may well have been a low point. At its worst, such architecture ignored climatic design and was little more than display. In the last few years, however, household architecture has changed considerably. More expensive fuel has spawned a solar architecture that takes into account siting, wind and exposure, insulation, and favorable surface-to-volume ratios. Some of them are reminiscent of the early salt box architecture, with glass on the south face to let the warming sun in. In this case, the oil embargo did architecture a favor.

The Prairies and Plains

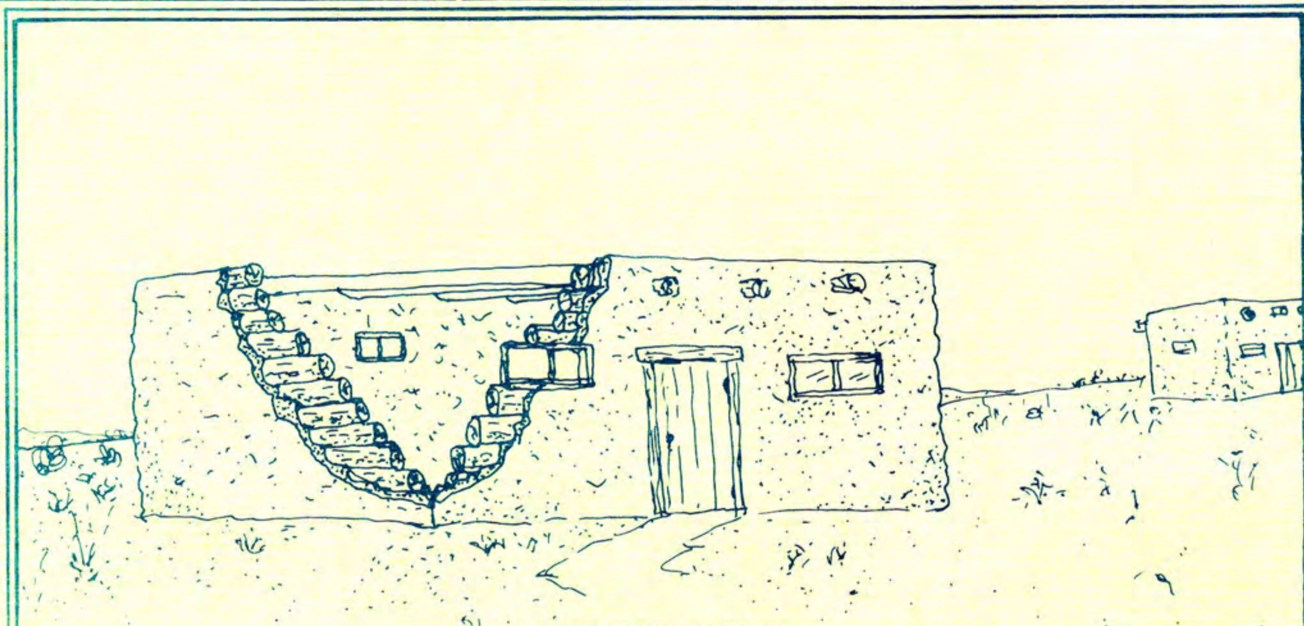
The teepee is the epitome of traditional architecture on the plains. In a region where hunting grounds shifted and fuel was hard to come by, the teepee was light, portable, energy efficient, and seasonally adjustable. In a sense they were like soft, architectural extensions of clothing.

Being farmers, the early white settlers were more stationary. Livestock and grains necessitated storage and buildings. Sod houses and barns were the result. Some were well bermed with sod and dirt and faced south for light and supplemental heating. They had to be low-energy houses, as wood was scarce. The main drawback, apart from the social stigma of living in what appeared to be a hole in the ground, was that they were seasonally damp and musty as there were no waterproofing materials suitable for keeping the moisture out.

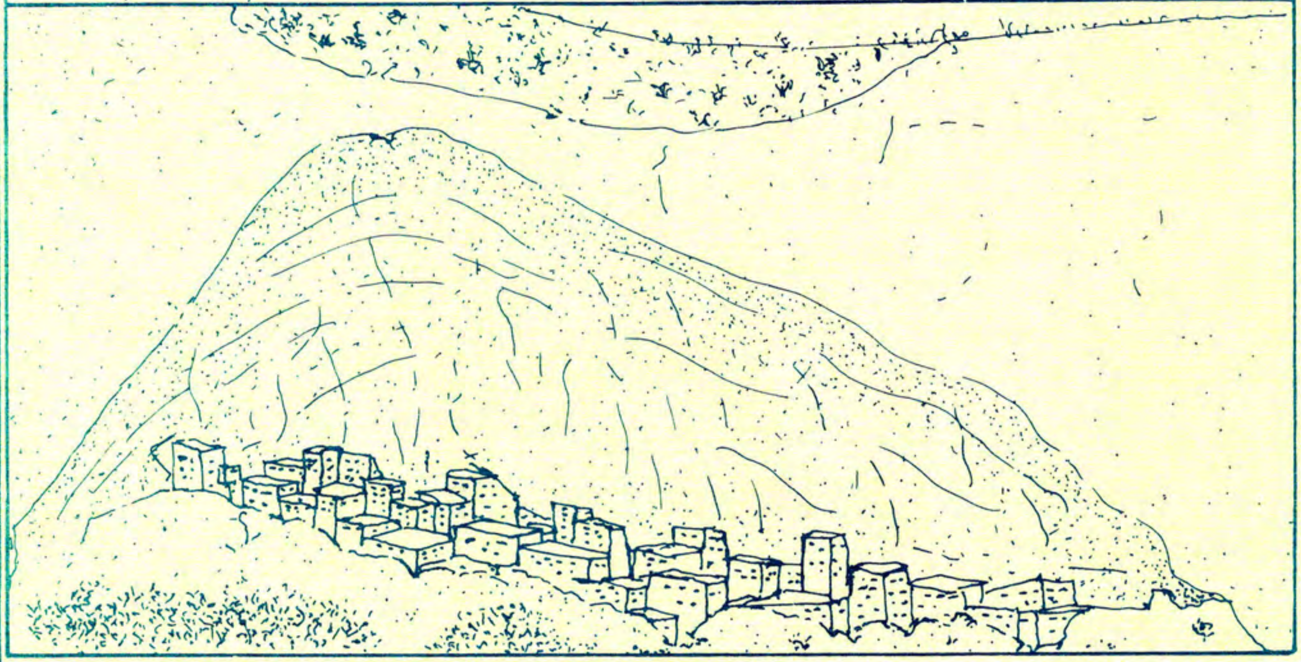
By the middle of the 20th century, prairie architecture had caught up with the rest of the country. Here, too, the California ranch-



TRADITIONAL COMMUNITIES' EMBODIED CLIMATE



Arizona Adobe Log House



"Solar Face" of Rock Formation

type house came into vogue. Oil and natural gas kept the prairie "ranchers" warm in winter and cool in summer. Prairie dwellers could feel as much in the cultural mainstream and as effective consumers as Californians.

Prairie architecture could have taken another course, and may yet. An indigenous housing which is part of and grows out of the land forms could be developed if traditional notions on the plains were grafted to some modern ideas. A marriage of bermed and sod-covered structures, looking like hillocks, connected to light—solar forms rising out of the earth in teepee shapes could evolve. These, combined with partially sunken, south-
side courtyards that trap and direct low-angle winter sun into south-facing glazed walks would produce a powerful and practical architectural statement.

The Desert

The extreme climate of the deserts have produced some of the most beautiful and powerful town architecture in North America. For over a thousand years native American builders developed and refined their design with nature.

Hopi builders were perhaps the great masters at minimizing the effects of climatic extremes. The ruins of the ancient settlements of Keet Seel and Betatakin in Arizona are dramatic examples of their genius. Betatakin was occupied in the 13th century during a disastrous period known as the Long Drought.

Climate was softened by a variety of siting and building techniques. The towns were built into massive, south-facing, rock faces that trapped radiant energy when the winter sun was low in the sky. They used heatabsorbing thick adobe as a building material to buffer the extremes of heat and cold. Inside the village, or family unit, courtyards were built to create microclimates favorable for drying grains, possibly even for growing vegetables and herbs. Hopi villages were the products of a synthesis of form and function that embodied a high desert culture.

Pueblos and villages, since the arrival of the Spanish, have not been so well sited. Military considerations were predominent in some cases. Both natives and the settlers continued to use adobe clay as a building material, recognizing its function as a thermal buffer preventing overheating in summer and extreme chilling in the winter.

Thick walls, proper solar orientation, adobe, and suitable lighting persisted in regional architecture. Some of this tradition has been kept, but there has not been an overall social structure to build a village as a single, complete, highly evolved entity. Architecture was piecemeal and not part of a defined village entity.

And again, by the middle of the 20th century, the urban architecture, particularly in Tucson and Phoenix, had become California ranch with a twist. Rough logs covered patios and cactus sprouted out of lawns. These houses were costly to heat and cool.

But in the desert, too, the future of settlements may yet take a turn for the better. Surely the spirit of the ancient peoples lingers in rocky canyons and on mesa heights.

Glass bioshelters, adobe structures, desert gardening, and carefully-wrought water cycles that include seasonal entrapment of water directed via wadis to be stored in solar ponds need integrating and thinking through. Culture, agriculture, architecture, and form can be played out in a desert harmony.

Working with what exists

To transform and rebuild existing buildings and communities is challenging, even noble, work. Run-down buildings, shabby blocks, abandoned warehouses, and the like are the real new territory for urban reinhabitation.

There is a "science" to working with that which exists comprised of a peculiar mixture of theory, research and practicality. It is a science of "found objects." It does not try to build from scratch, but takes what is and works with it to transform the object or place. There is no English name for this, but the French call it bricolage. Practitioners are bricoleurs, which translates as "enlightened tinkers with what is at hand."

Such a person is, in an age of increasing scarcity, potentially a new kind of hero who can look at a neighborhood with different eyes, and see everything there not as a problem or a burden, but as an opportunity. A bricoleur would see what was, is, and can be, as a splendid continuum which must come full circle.

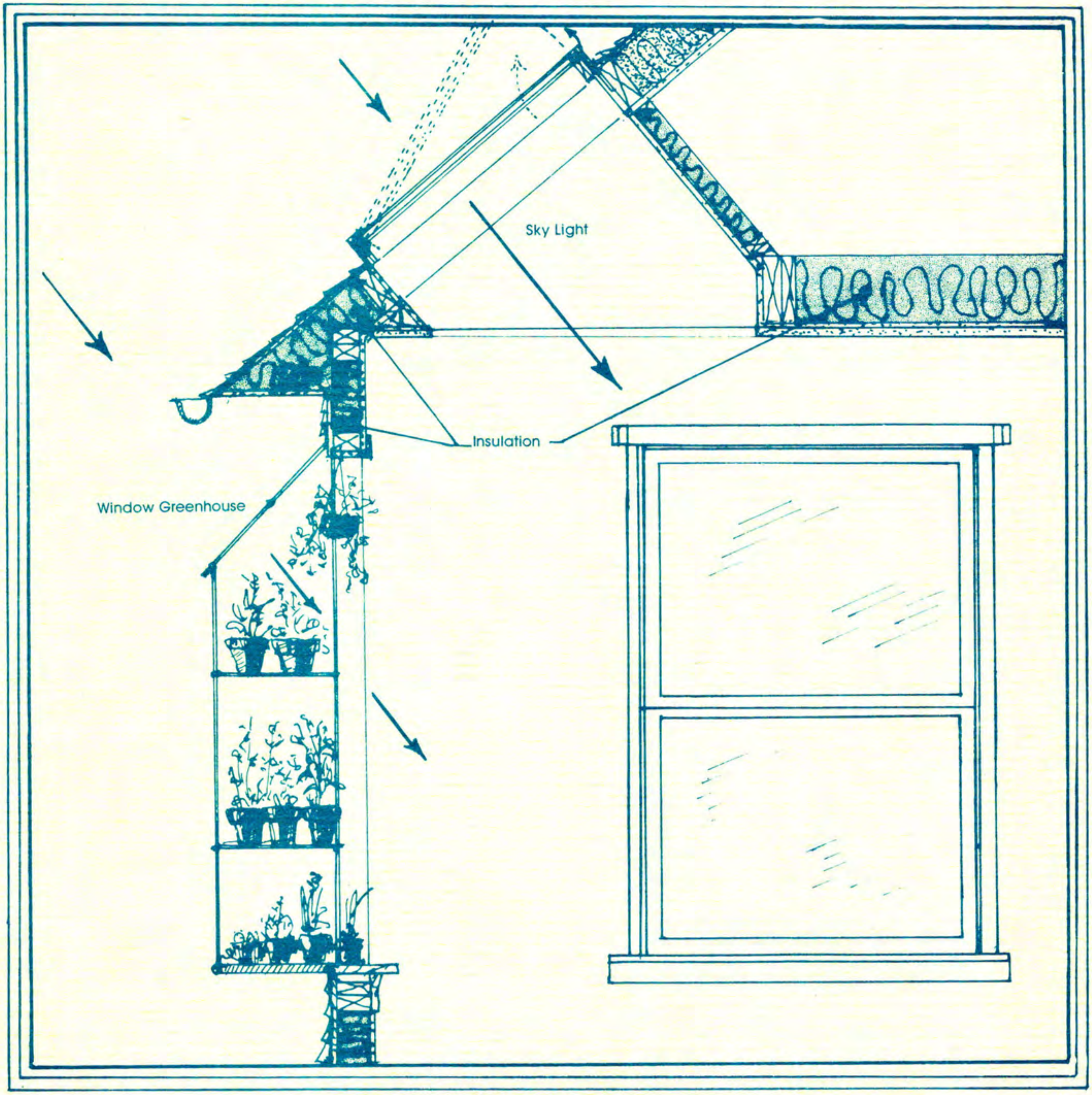
Most developers destroy before rebuilding. Restorationists rebuild to recapture former glories. Designers like clean slates. The bricoleur is different. There is an assumption that the true potential of a house, a block, or a whole town has scarcely been tapped. The most humble objects, like a hundred feet of sidewalk, can be transformed. There is a human dimension to bricolage. The bricoleur tries to listen to the voice of a place as expressed through the history and inhabitants. There is a responsibility to maintain continuity. To transform is not to innoculate with misplaced status. If restoration leads to displacement, it is failure. The benefits of restoration must accrue first to residents and subsequently to others who are attracted by the change.

Inviting Change

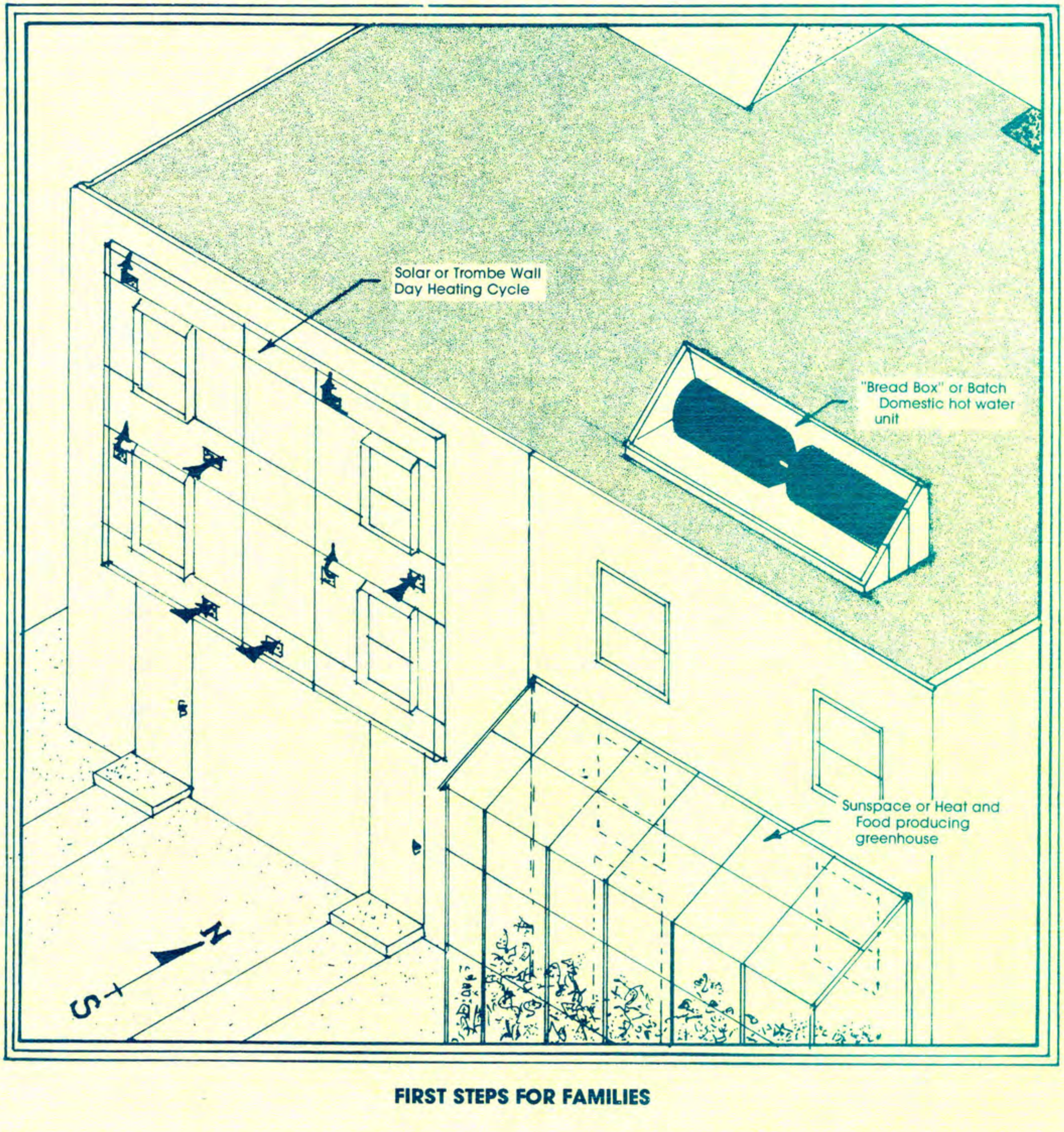
With all housing, the only way to start is by insulating the buildings well. This reduces reliance on heavy fuel consumption for heating and cooling. Sealing cracks is essential. Draftiness is uncomfortable and people get sick more readily.

In almost any house, factory, or office building for that matter, sky lighting should be considered so that light from the sky can penetrate cold, dark buildings to create soft, beautiful, always changing light. Light shafts can be elaborate or just simple boxes lined with aluminum foil. Underground architects, like Malcolm Wells, are masters at designing to allow natural light to move around inside a building.

Once a structure has been tightened up, and possibly a sky light has been introduced, the next logical step in the progression is to add passive solar elements. This need not be complex either. The sketch shows the addition on the south side of a sky light and a window greenhouse. Both provide a modest amount of solar heating, but what is most important is the psychological effect created. The structure comes alive, responding to clouds, rain, sun, and the changing light of day. The night sky enters too and residents can become acquainted with the stars and changing moon. Not too many generations ago our ancestors believed in the night sky, and the vault of the heavens was the great drama mirrored, in a small way, on the human stage. Shakespeare's writings are full of the impact of the sky on human mind and destiny.



INVITING CHANGE



FIRST STEPS FOR FAMILIES

First Steps for Families

Solar conversion can take a number of forms. The building and the site can dictate what these will be.

The sketch illustrates the trombe or solar wall alternative. The existing brick, stone, or masonry south wall has an additional transparent layer built onto its exterior. The original wall acts as a heat absorber and storage. Sun-warmed air between the wall and exterior glazing rises and enters the building at the top through vents. Cool air is sucked into the trombe wall via lower vents. This cycle heats the house during the day. In winter, the vents are closed at night and the interior is warmed by the mass wall which had been storing heat during the day and which now radiates it to the interior. In summer, the cycle is reversed. The trombe wall vents are closed during the day and hot air is exhausted straight out the top. At night, exterior and interior venting is opened to cool the building. There are lots of variations on the trombe wall theme. Most of them work and are cost effective.

Another alternative is the addition of a passive solar heated sunspace with heat storage. A heat and food producing greenhouse when plants and fish are raised in it, this solar addition heats the adjacent house during the middle of the day in much the same way a solar wall does but it cools very rapidly at night. Depending on the uses of the sunspace, as additional living space or greenhouse, heat storage is added to its interior and sized to "carry" the sunspace at a desired temperature range through the night.

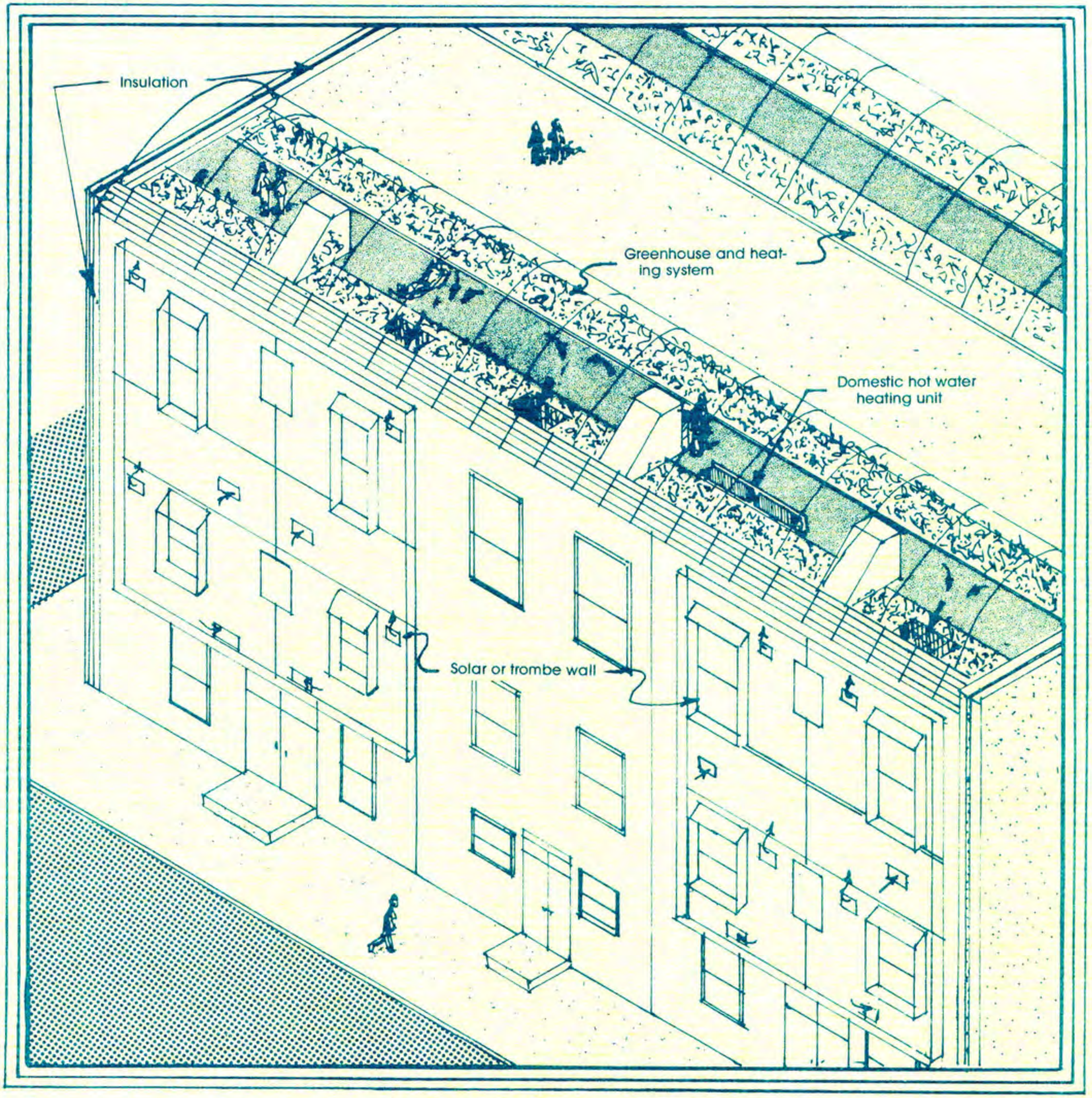
Sometimes enough heat storage—usually water in containers to absorb heat during the day to release it at night—cannot be designed into the sunspace. In this case, night insulation or curtains can be used to reduce heat loss to the night sky and achieve the desired results. In any case, close attention must be paid to these insulating schemes because they can too easily become elaborate and expensive.

The solution I like the best is the one I use in my house, namely, a silo fish farm in the flower and vegetable growing attached greenhouse, with the fish tanks supplying enough carry through heat to keep all alive, leaving a night curtain as being unnecessary.

Having greenhouses or "greening" that interact with the living space can also serve as air purifiers. People justifiably worry that tight well-insulated buildings with fewer air changes will produce indoor air pollution. One solution is to utilize an air-to-air heat exchanger but nature's processes can be duplicated inside the house. Placing clusters of plants near a window is an effective and simple ecological solution. The plants breathe air and purify it. Again, as in the natural world, the interchange in close proximity, of people and plants can be beautiful and benign.

First Stops for Neighborhoods

There are places where it is impractical to think of rebuilding housing unit by unit. In neighborhoods with row or tenement housing, it makes good sense to work with the entire block. On a block scale, available options go up and per unit costs go down. This argues for a neighborhood-owned, development corporation that rebuilds and operates the overall structures and support elements. One of the advantages of a block scale is that there is a great thermal and spacial mass to work with. Engineers describe this as a favorable surface-to-volume ratio meaning that it takes less energy and fewer materials or space to accomplish a given task.



FIRST STEPS FOR NEIGHBORHOODS

The sketch shows a block of row housing that has been redesigned and rebuilt to be almost exclusively solar-heated and to provide a garden environment all year. The block is insulated at both ends and the side away from the street. The entire roof is a combination greenhouse and hot water collector. Hot water for all the houses is stored in a long, stainless steel tank that runs along the north wall for the full length of the interior of the greenhouse. It is painted black and is heated by direct solar radiation and by the collector in front of the greenhouse. The storage tank both helps to heat the greenhouse and provides metered hot water to the residents.

Normally, the greenhouse would overheat during the day, but in this design the greenhouse is connected via ducts to a common basement. During the day hot air is stored in the basement. At night it percolates upward to warm residents. My own solar-restored house works very effectively this way.

The greenhouse would also act as roof insulation, retarding heat loss from the upper story ceilings, and would provide a safe and beautiful combination roof park and garden.

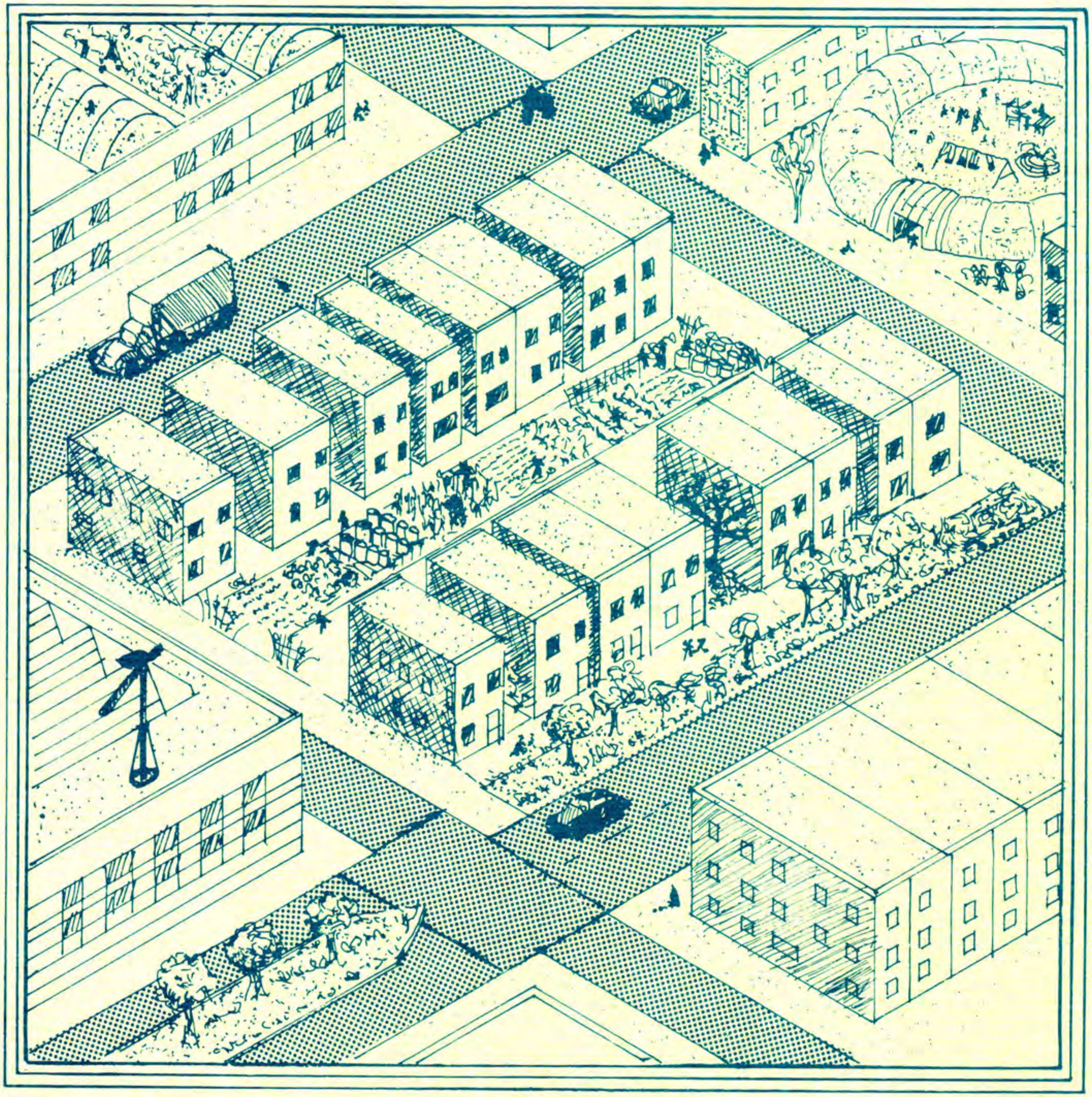
During the worst winter weather neighbors go up to their private greenhouse entrance to meet and chat and gossip from their overlook. Privacy is not violated, but the greenhouse is a commons. Flowers, vegetables, earthy smells, bird song—but not cats or dogs—would hold the promise of spring and the strength of shared experience. The roof-top bioshelter would become a social healing place.

FOOD PRODUCTION

In "ECONOMY OF CITIES," Jane Jacobs chronicles the genesis of the major agricultural revolutions over the past ten-thousand years. Whether it was the selection of grains, the domestication of animals, the mechanization of culture methods or the recent hybrids of the Green Revolution, all dramatic changes in farming originated in the cities and spread outward to the countryside.

The current agricultural revolution is no exception. It is characterized by its urban emphasis and its ecological underpinnings. New biotechnologies, information, and biological components are being assembled into systems capable of producing a diversity of foods in relatively small spaces. The goal of the new agriculture is to replace current dependency on fuel consuming, agricultural hardware with structural and living analogs of natural systems, powered by renewable energy sources.

In the future, urban agriculture will have many forms. Shade trees will be partially replaced by an urban orchardry of fruits and nuts. Sunlit walls will become architectural backdrops for espaliered fruits and vine crops. Shrubs, which purify air by removing auto exhaust, lead, and zinc will be planted in raised beds between the streets and sidewalks. Community gardens and gardening will increase as participation grows. Agricultural bioshelters will fill vacant lots and ring parks. Floating bioshelters will line harbors and produce their fish, vegetables, flowers, and herbs for sale. Old warehouses and unused factories will be converted into ecologically inspired agricultural enterprises. Fish, poultry, mushrooms, greens, vegetables, and flowers will be grown in linked and



FOOD PRODUCTION IN THE CITY

integrated cycles. Roof tops will utilize bioshelter concepts for market gardens all year. One day towns and cities will add farming to their repertoire of functions.

Street Orchards and Farms

Orchards, yielding fruit, berries and nuts, can find their place on the streets and the houses. Fresh produce and a re-connect with the local soil base via its strong preserver—trees—can appear in heavily built-up towns and neighborhoods.

The sketch shows the transition from decoration to street orchardry and the use of buildings as backdrops for vine and espaliered tree crop production. Both methods could be applied on side streets.

City air is polluted. The closer to the ground and the busier the streets the worse is the condition of the air. In recent years European ecologists, particularly in Vienna, have been searching for shrubs, trees, and herbs which purify foul air and have found many plants that did so, particularly when planted as "hedgerows." Up to 90% of the lead was removed, or prevented from crossing the plant barrier. As an added bonus, the street noise dropped dramatically. Most thoroughfares and cross streets should have a "hedgerow" and a sidewalk with clean air. The health of the citizenry would be the beneficiary.

Street farms will be a cornerstone of the dispersed food production practices in the city. A mixture of solar aquaculture and vegetable and fruit production, it will redefine the architecture of our street landscapes and provide the image of the city as a source of food supply and nourishment.

The sketch illustrates how an alternate street or neighborhood core can be redesigned to house an ecologically integrated mixture of household food growing and street farming. Raised bed vegetable and berry production, fruit and nut orchardry, and nurseries are combined. The street zone could be used by the community or leased to urban farmers who tend and market the crops locally.

Whether in street farms or bioshelters, aquaculture, or fish farming, makes sense in cities and towns. Solar aquaculture has been invented and developed to a fine science over the last ten years. It is now both possible and cost effective to grow fish and shellfish in small spaces, using relatively little water. It is done using the New Alchemy solar tank—a translucent cylinder that provides a superb habitat for algae-based ecosystems that contain cultured fish.

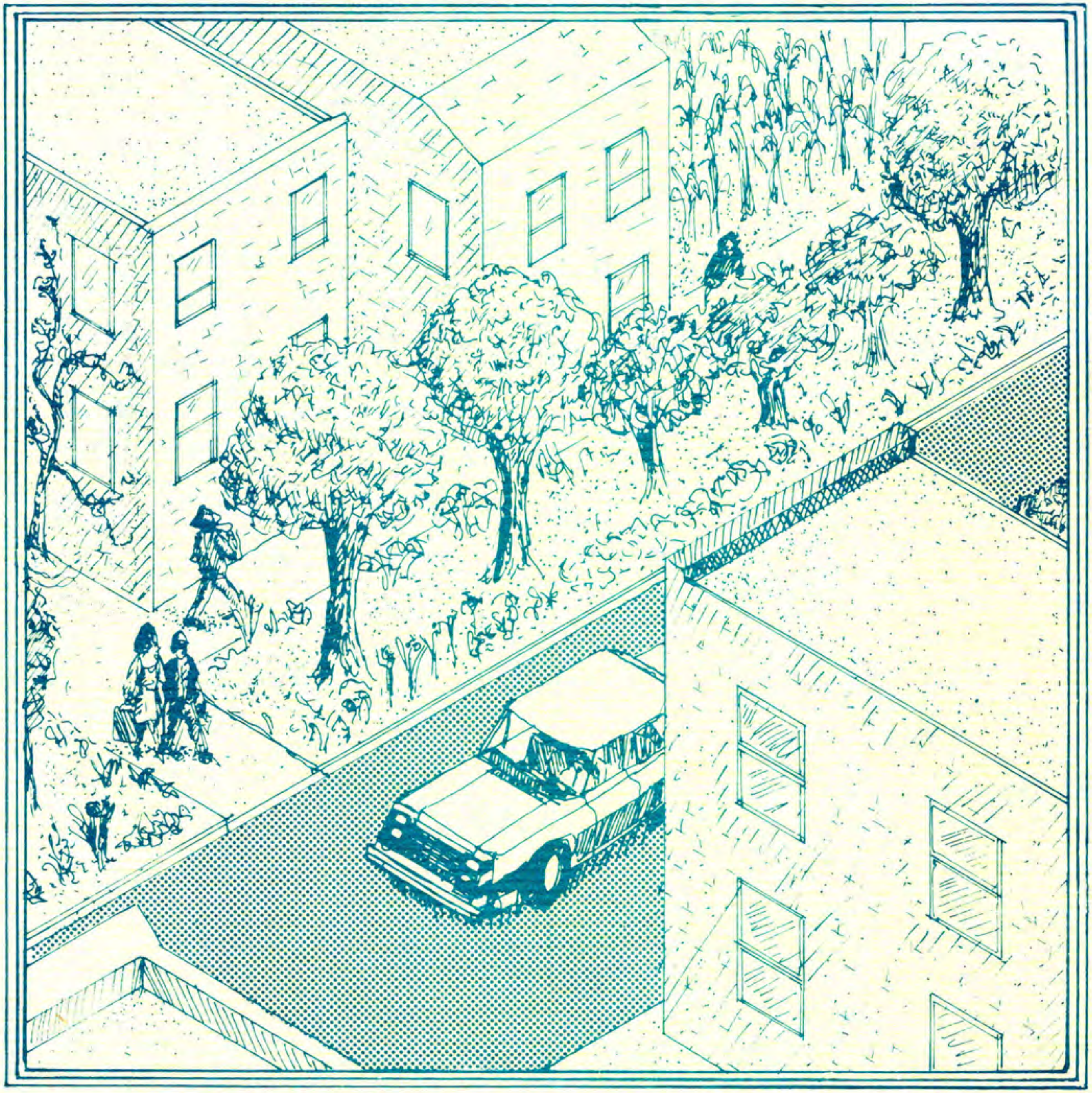
The solar tanks are the most productive standing water aquaculture systems yet devised. Apart from the sun, they use only small amounts of supplemental energy.

In cities and towns, old buildings, corners of lots, parks, and virtually any place lit by the sun for a goodly portion of the day lends itself to fish farming.

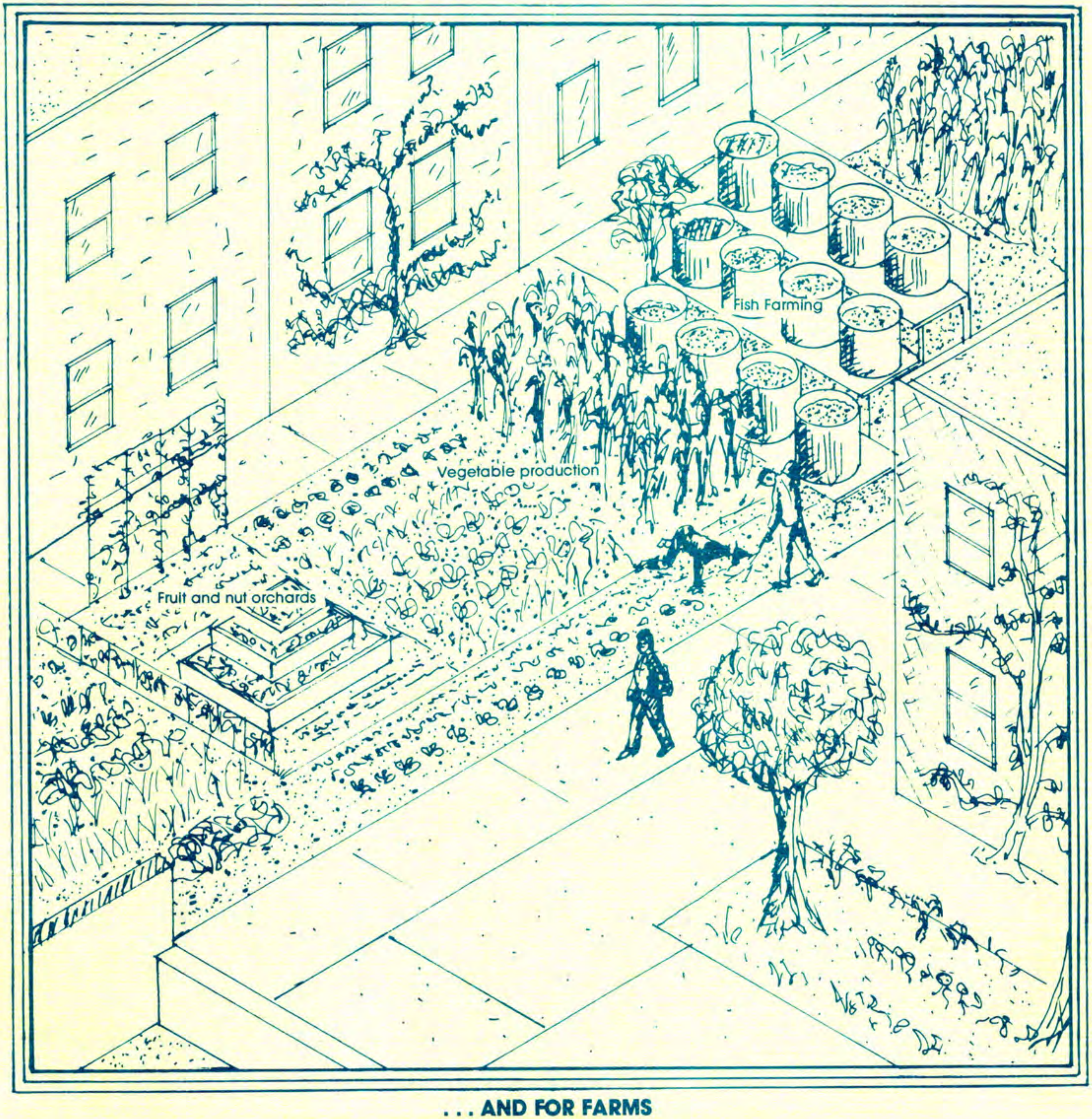
These solar tanks are highly adapted to an aquaculture placed right where the market is. It's now possible to sell fresh, even live fish, on a street corner. The farm and retail outlet have become one.

Container gardening, neighborhood gardens, purifying hedgerows, urban orchards, bioshelters, parks, and tree nurseries are all integral to the eco-development of communities. All are dependent on first-class soils. A soil building program is at the core of much urban restoration and composting is the key to transforming organic materials, including garbage, into soil.

The current methods of managing organic wastes are little short of tragic. Mixed with other garbage, organic materials are shipped off at great expense to rot in some unsightly landfill. The same materials could



STREETS CAN BE A SETTING FOR ORCHARDS



. . . AND FOR FARMS

be separated at source and composted on the block. All that is required to make compost are organic materials, a little moisture, and some bacterial innoculants. Composting in large, slowly rotating drum composters big enough for the wastes from a whole block seems an appropriate scale.

Drum composting is hygienic. It eliminates rats, mice, raccoons, skunks, flies, and most garbage odors from the compost in the making. It looks neat and technologically advanced, yet is easy to operate. The drums are in sections and can be filled daily so composting can be done in batches. It can be designed to absorb solar energy with a heat absorbing winter "blanket" and to self-cool with a reflective cover in summer.

The compost produced is then sieved, bagged and ready to market. The chief market would most likely be local greening, gardening, and urban reforestation programs. Garbage removal costs would be much reduced especially if recyclable dry materials, such as bottles, were handled at the same source.

There may come a time when compost and soil production in cities becomes an important business. Neighborhoods would find it to their advantage to establish composting, soil making, and solar sewage treatment areas and lease these activities to neighborhood-owned corporations or private companies. Either way, all would benefit.

Bioshelters

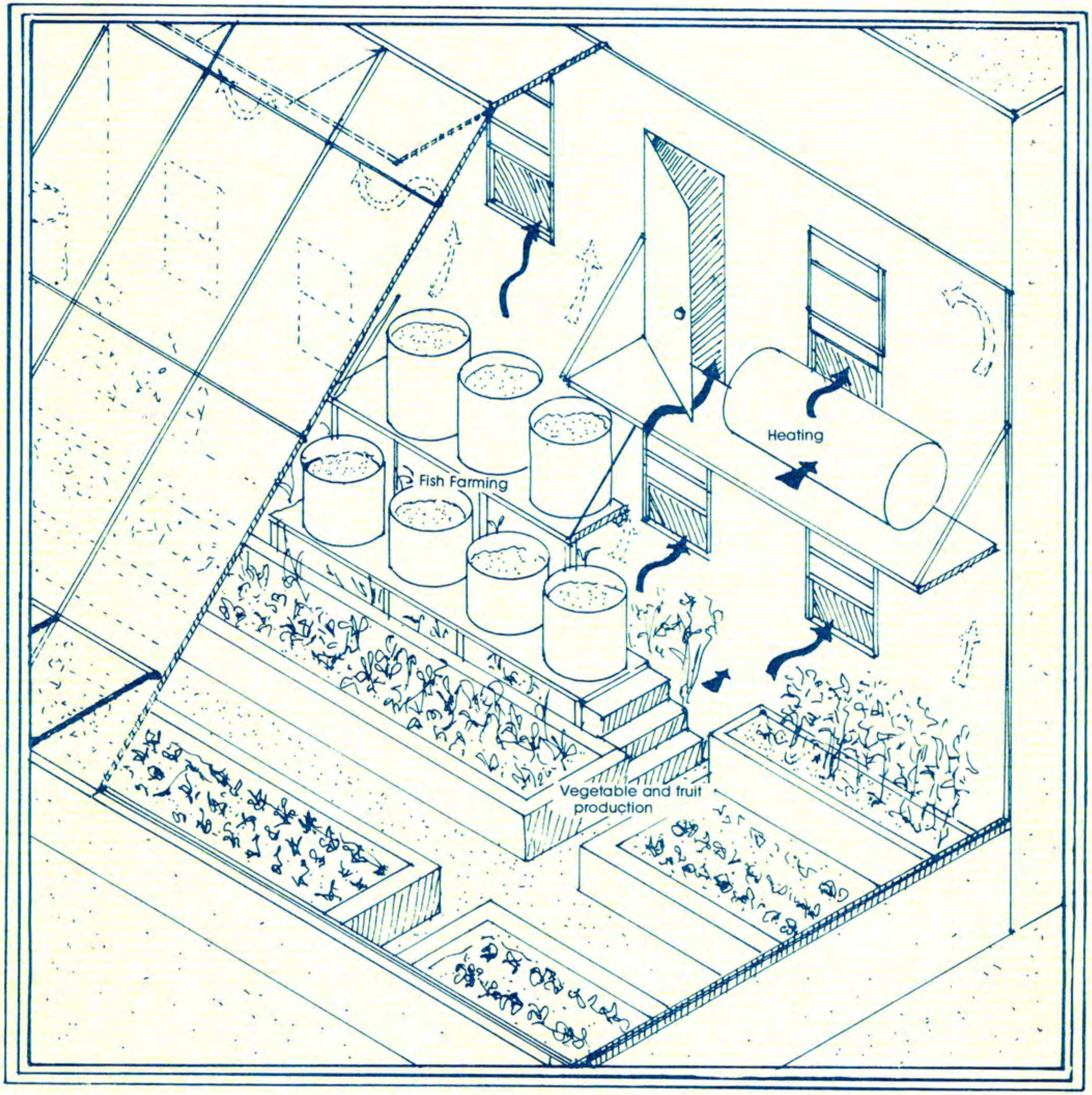
Bioshelters are solar-heated, greenhouse-like environments designed to produce foods on a year-around basis and, if attached to living or working spaces, to provide supplemental heat to the building as well. They combine ingenious solar trapping and energy conserving concepts, with terrestrial and aquatic ecosystems that support the intensive culture of fish, aquatic plants, crops, fruits, vegetables, and flowers. A bioshelter is further characterized by internal self-reinforcing biological cycles.

It need not be a complex structure. The sketch shows a two-story lean-to structure next to the building. Notice how such a structure not only supports agriculture while providing for heating, but it also provides an optimal climate "free" for the adjacent building. In addition, it illustrates the use of water to grow food.

Their adaptiveness is exemplified by their role in my house which has been retrofitted to include a bioshelter. I use the solar silos in the bioshelter as solar heat collectors and storage units for the whole house. The sunspace houses the solar silos and hanging plants. It is glass roofed and glass fronted. Radiant energy is absorbed by the tanks, and they heat up during the day. A fan blows their warmth into the lower rooms and the heat rises through the building and returns cooled to the bioshelter. There is enough of a lag so that daytime heating continues through the night.

During the summer the cycle is a cooling one. The glazing creates a temperature differential between the outside and the interior of the greenhouse. As a consequence, air starts to climb and flows as an interior "breeze" out the air shimney on the north side. Cooler outside air is, as a result, sucked in and moves quickly through the building. I have found that this kind of solar air conditioning can work.

The solar silos play a beneficial role in summer, too. They act as thermal buffers. They absorb the sunlight and prevent overheating of the air in the growing area.



STRUCTURES FOR YEAR ROUND FOOD PRODUCTION

Earthworks

The structure shown on this page is based on bioshelter modelling and research on aquaculture-based vegetable hydroponics at New Alchemy. Fish pond water feeds the crops. Crop wastes are fed to fish. These processes are contained within a "wall" bioshelter that is currently under development.

The bioshelter illustrated here is nested in the ground by a berm with the south side exposed in the manner of the underground houses of Malcolm Wells. It uses advanced tent technologies developed by the designer Bill Moss combined with translucent membranes that are integral to the framing.

An intriguing possibility for such a large structure is that it could encircle a large lot leaving a substantial courtyard in the center. The bioshelter could be an urban farm with a safe playground and kids' pools in the donut center. Neighborhoods might be sufficiently interested in such a ringed park that they would be willing to lease the land for the bioshelter eliminating substantial land costs to the urban farmer.

Food Barns

The renaissance in urban agriculture may well find its fullest flowering in old warehouses and factories of down-at-the-heels sections of older cities and mill towns. It should be possible to take a badly lit multistory warehouse or factory and cover the roof with a full array of solar cells. The cells would be mounted at an angle to the sun giving the roof a sawtooth look. Solar energy would be transformed at about a 10 percent conversion efficiency to produce artificial sunlight inside the building. The solar cells would power indoor grow lamps. The building would be heat conserving and at the same time, be generating its own interior light for a variety of food growing activities.

An alternative, perhaps better approach, would be to replace the solid roof with a translucent one, allowing natural light to permeate the whole building and make about six times as much light available. The drawback to this approach would be heat loss to the night sky which would require night curtains in winter. Also supplemental light would be required even in the glazed roof version, but it could be provided by the utilities or from a co-generating electric windmill.

Inside the converted warehouse or factory one could have a multi-story, integrated farm producing ducks and chickens, fishes and shellfish, compost, mushrooms, vegetables, and tropical fruits like figs, kiwi and passion fruit, and expensive flowers. This would involve using the basement and at least three floors, the upper two being girders and cross frames through which light passes.

Possible Converted Warehouse Design

1. Ceiling Area: Vine crops, especially tropical fruits.

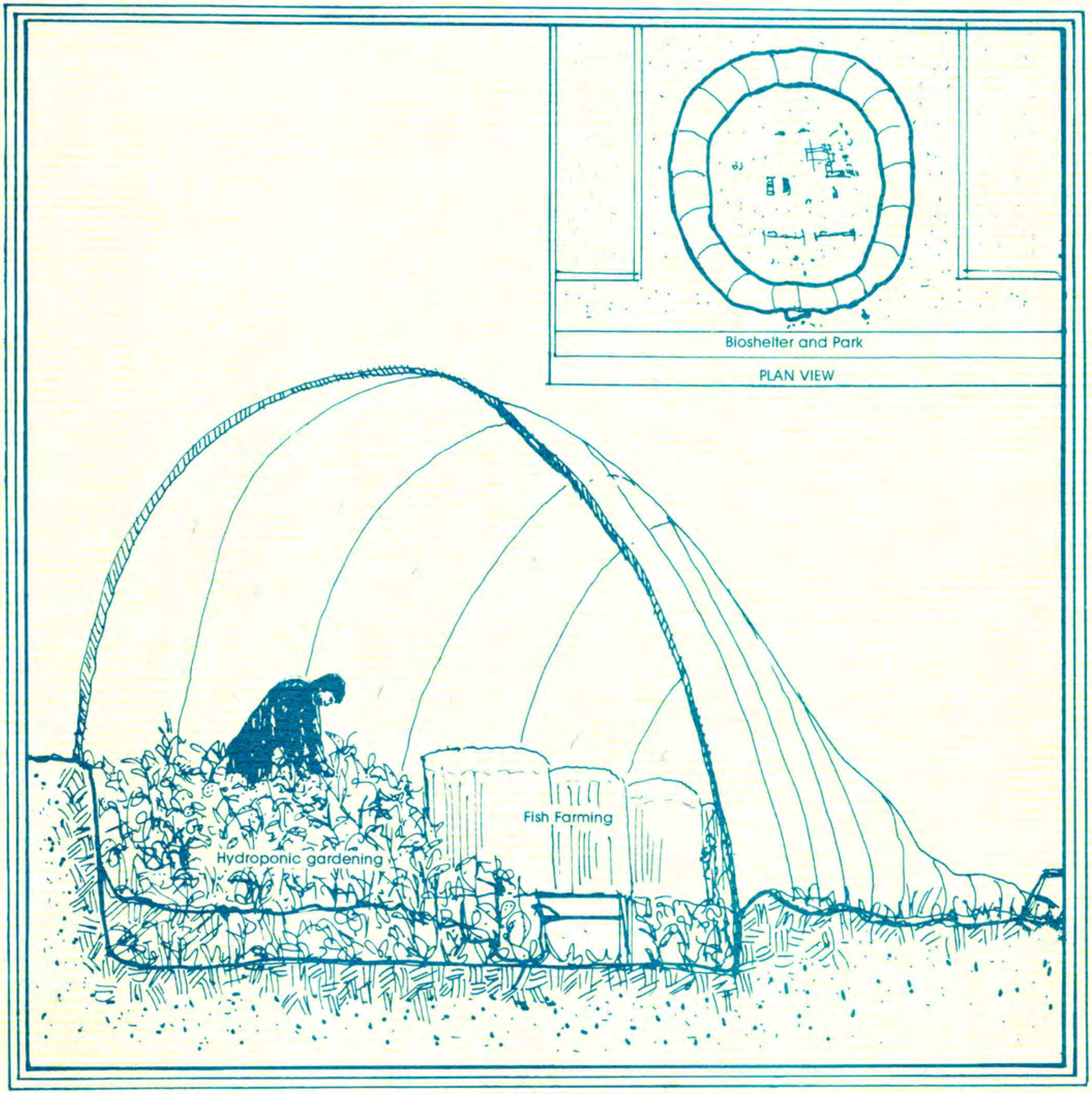
2. Top Floor: Tomatoes and cucumbers grown in an aquaculture-fed medium.

3. Second Floor: Greens, particularly lettuce, grown in light-supplemented rotating drums suspended off the floor.

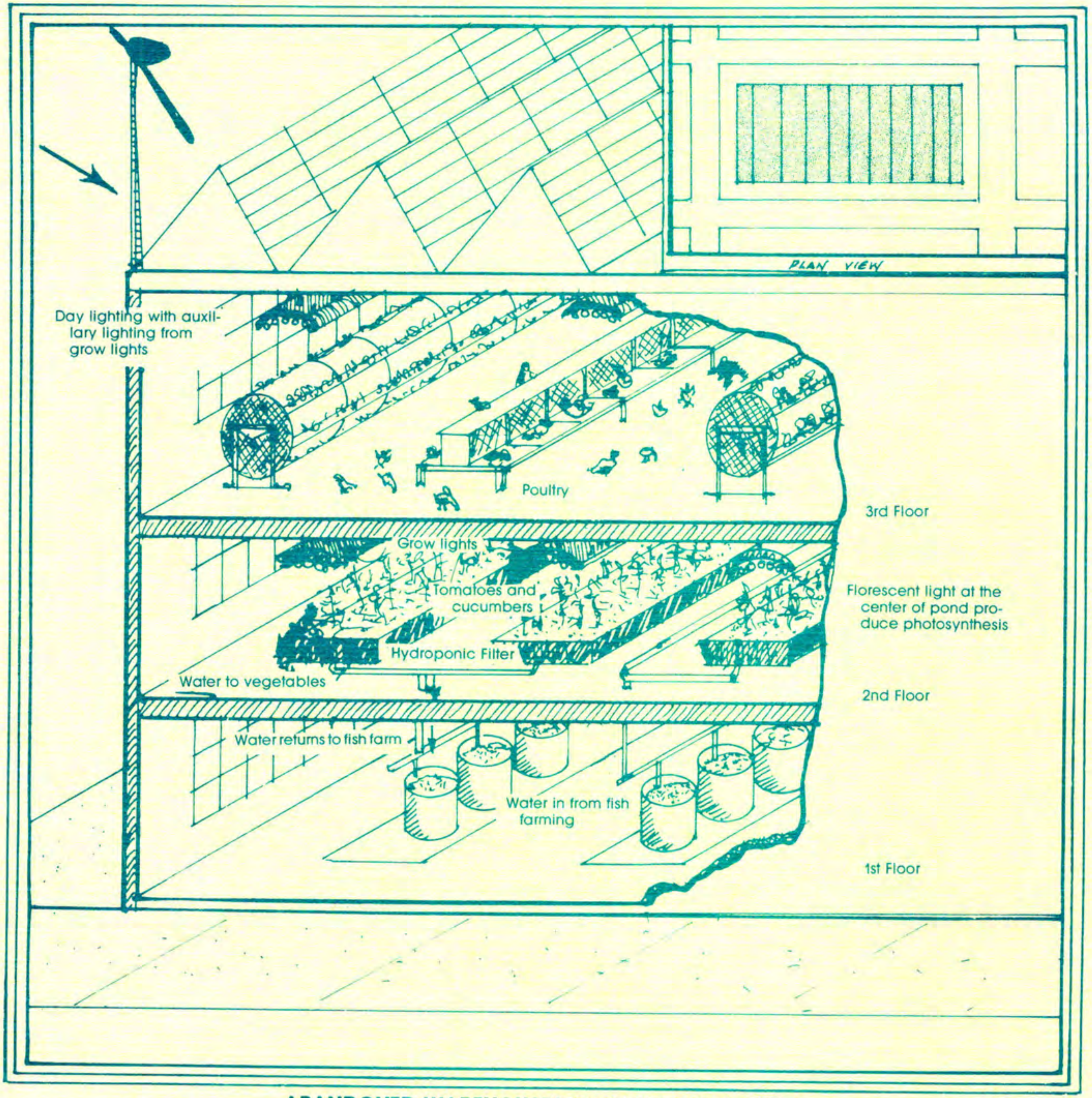
4. Second Floor (Floor Level): Ducks and chickens raised in free-range system deep bedded with dried seaweed. Nesting boxes around the periphery.

5. First Floor (Ceiling Area): Controlled light flowers.

6. Floor Level: Fresh water fish culture and sea water shellfish and shrimp culture in solar silos.


Bioshelter and Park
PLAN VIEW
Fish Farming
Hydroponic gardening

EARTHWORKS



ABANDONED WAREHOUSES CAN BECOME CENTERS FOR FOOD PRODUCTION

Artificial light and ceiling light provide illumination.

Illumination also within the solar silos.

7. Basement: Compost for carbon dioxide production, for heating and treating poultry wastes, and aquatic plants. The compost should be important in growing of flowers and lettuce, as well as other greens, and salable as a soil amendment.

Compost, dried water hyacinth with modest additions of manure, would make an excellent medium for the commercial production of mushrooms.

The lights, compost, poultry, and sunlight would produce enough heat to warm the whole complex with no additional heating required. All wastes would be treated and recycled internally. Any excess could be packaged as soil amendments.

The economics for converting a factory to a solar food barn are still conjectural. However, if every square foot of each floor or growing level produced $10 a year of produce, the $10 times the eight levels would be equivalent to $80 per square foot. If two-thirds of the interior were in production, a 1/4-acre building would produce roughly three-quarters of a million dollars gross in food annually. It may be possible to do better with good luck with the fish and shellfish and an excellent flower and mushroom operation. The limits are as yet uncertain but a local enterprise, utilizing the community for full- and part-time labor, could turn the agricultural equation around.

Roof-Top Farming

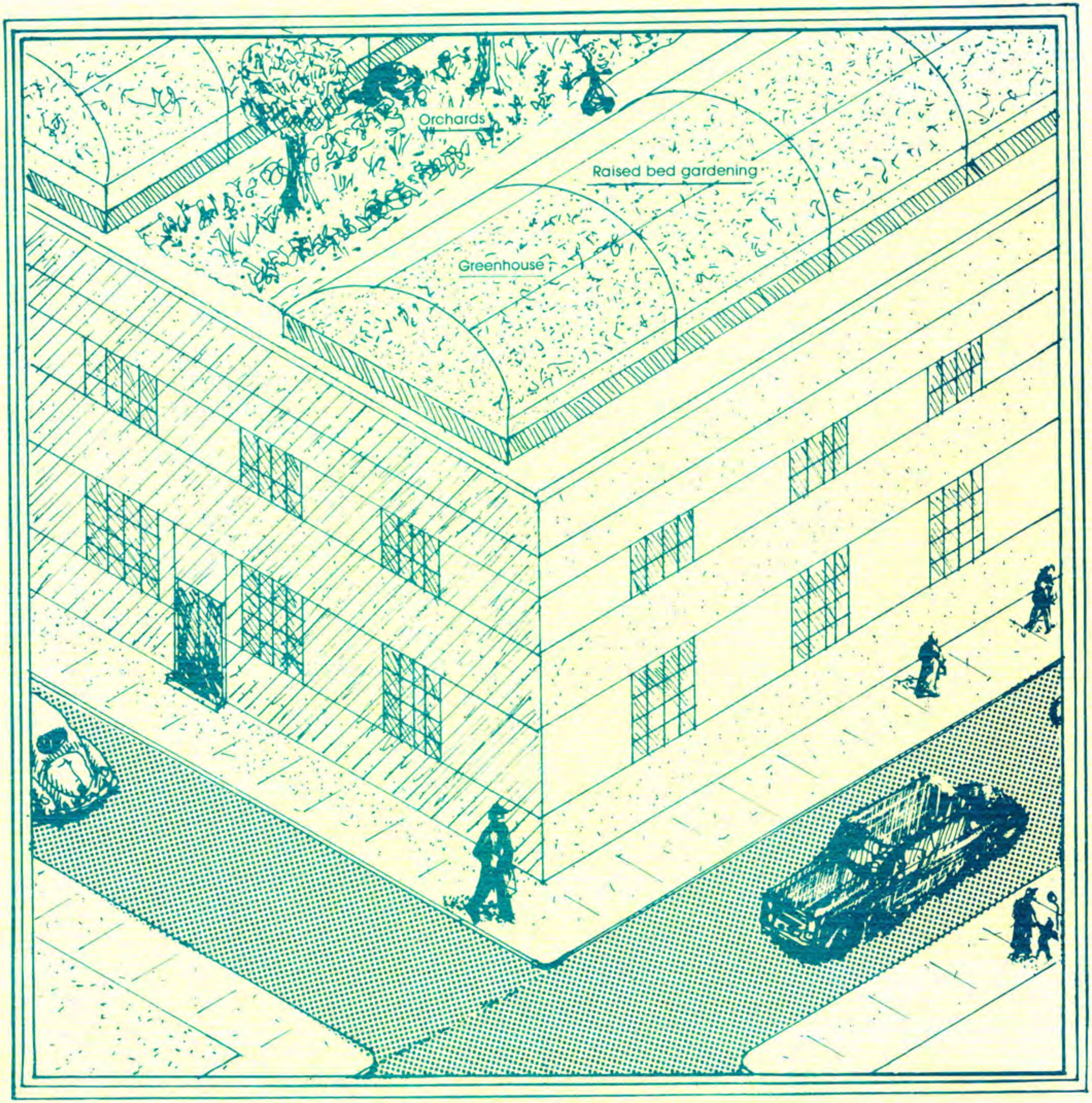
In almost any urban area there are flat roof tops galore, offering real opportunities for gardening and for fabricating "wild" ecological islands in the city. Roof tops can support orchardry, market gardens, greenhouses, and poultry barns, although, in the latter case, all wastes must be composted immediately. The exceptional building can support fish farming on the roof. However, as each gallon of water weighs about ten pounds, a ten-thousand gallon facility would weigh fifty tons. It is essential for a structural engineer to evaluate the strength of any roof top being considered for aquaculture.

The sketch shows a combination bioshelter, fish farm, outdoor garden, and orchard. The facility is designed to help heat the building below. It is one of many variations on a theme.

The urban agricultural revolution would be both ecological and topographical. It would be topographical in that it would find and adapt to unused spaces in the towns or cities. However bizarre the space, agriculture would be designed to fit and operate within its constraints. The new agriculture would be ecological in that the design is directly based in nature. It is powered by many different kinds of aquatic, light, soil, compost, nutrient, wind, and gas cycles which are constantly changing and always interacting.

Food and energy systems, based on material cycles and low steady flows of energy, can be grafted onto our cityscape. Compact and fitting into newly undefined spaces, they will be many different worlds in miniature.

The flexibility, look, and vitality of life in densely populated areas will have much to do with how low energy designs and an environment formed by and dependent on constant pulses of high quality energy work on each other. It will be a unique exchange.



ROOF TOP FARM

TRANSPORTATION

The importance of the mobility that cars and trucks provide to our everyday and commercial lives is illustrated by how little travel patterns have changed given the large price increases in gasoline since 1972. Yet, we must begin to see the question of transportation within a larger time frame. Transportation in our economic context is a primary product and is crucial to manufacturing. Auto businesses employ one in five Americans and consume nearly 40% of the 6.7 billion barrels of oil used in the U. S. every year. For most of us, car mobility is a birthright. We tend to live in one place, travel to work, educate children far from home, play and shop at a distance, and finally vacation a long way from where we live. Our car addiction makes place separation possible.

Dislodging this wedge that has been driven into our communities will mean that transportation alternatives will be designed to support and fit an image of place locatedness and the necessary activities that would allow such a cultural understanding to nurture itself.

Transportation could develop to conserve energy, to dramatically increase the quality and diversity of travel and be matched more directly to function. The emphasis will be less on speed per se and disruption and more on net efficiency and genuine mobility. Personal travel will become more social and will range from health promoting exercise to convivial transportation including dining en route, enjoying scenery, or taking courses, like languages, via new electronic options.

Transportation will begin to change its shape and face in this process. Helping this along are technological options well beyond the drawing board or experimental stages: smaller and more energy efficient cars, light rail trains, new kinds of taxis, commuter buses and bicycles, motorcycles with climate and body protection, airships, extraordinary airplanes like Rutan's Cunard Winged Planes, and ocean voyagers, including sail/auxiliary bioshelters which I have called "Ocean Arks."

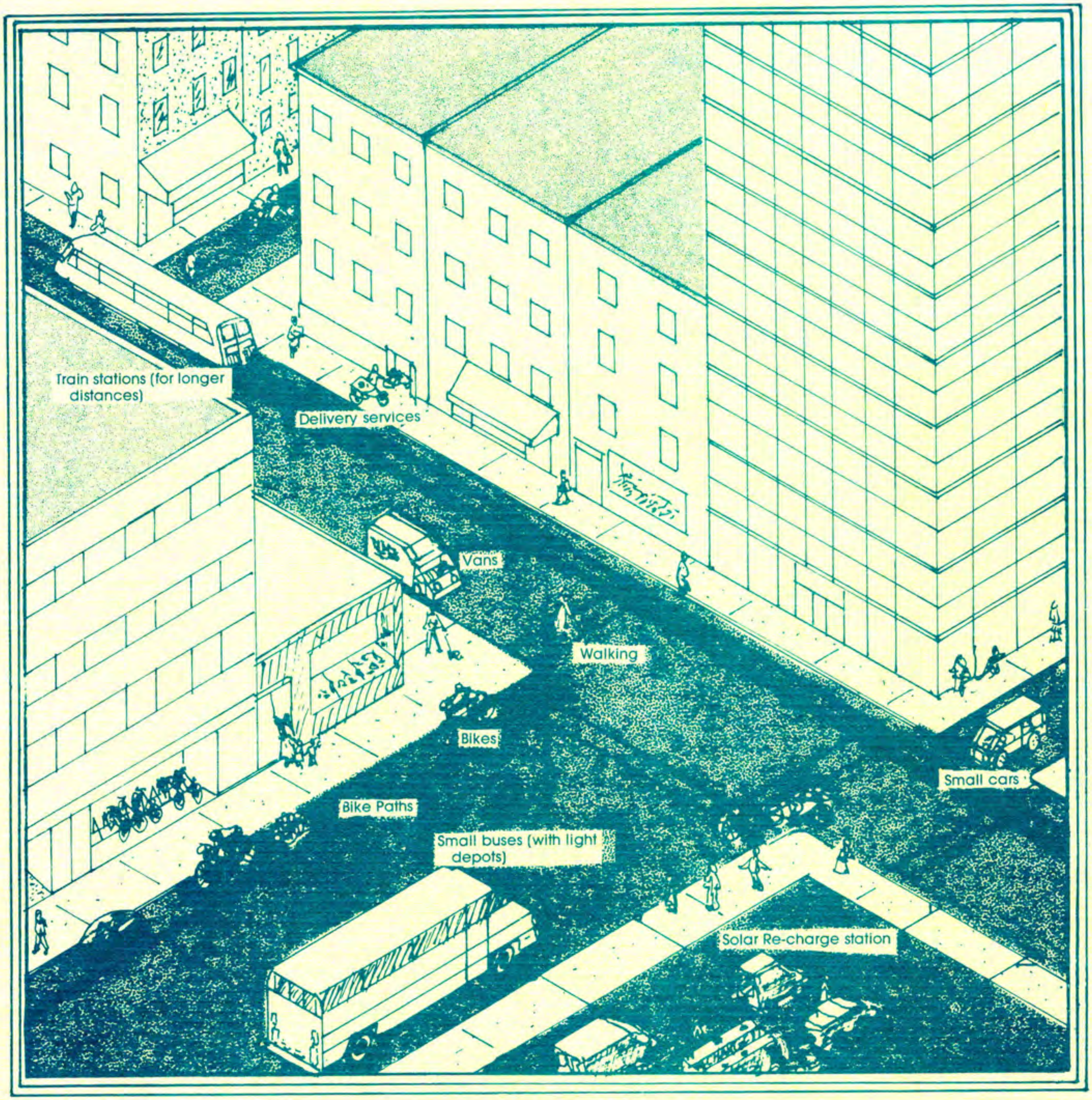
Neighborhoods*

Whatever the specifics of change in transportation, implicit in them are transformations of the structure of cities, neighborhoods, and towns. There will be a focus on integrating different transportation systems creating much greater overall travel efficiency. This could mean that neighborhoods will really come into their own and no longer be by-passed or disconnected. A variety of new or recovered linkages and options for internal neighborhood development will begin to emerge.

Foot power or walking is coming back where it has a chance. Developers of shopping malls like Jim Rouse, who build Harborfront in Baltimore and Feneuil Market in Boston, have discovered that people like to walk when it is safe and made interesting with shops, sidewalk vendors, and plantings. They prefer to park their car and cover the ground on foot enjoying the activity and the scenery.

Most of the previous sections, in the pursuit of architectural, energy, and agricultural solutions, have created pedestrian environments. The child, infirm, or old person, as well as the brisk walking adult, should have a variety of avenues for walking.

The bicycle which began in the late 1800's as a serious transportation device had degenerated into a toy until the 1970's when it began to be seen again as serious transportation machine. Neighborhoods would be



MOVING ABOUT

The particular mix of designs and technologies for transporting people, goods, and services will be decided upon locally. It will be probably characterized, though, by a reassessment of the role of the automobile within the community and a hard discussion on how services and goods will be moved about given the existing transportation base, available technical possibilities and choices of financing.

well advised to design their streets to accommodate bicycles as well as cars. A street bike network would be optimal.

The automobile is going to change and, in fact, the change is already underway. Chris Swan's work shows how more use—specific transportation—is evolving, from tiny electric city cars, to highly efficient taxis, and finally, to van commuter buses which emphasize relaxed, luxurious commuting for six to nine people. This kind of automobile development increases efficiency by offering a preciseness of fit for each mode of transportation.

There may well be opportunities for private neighborhood transportation companies to use taxis and vans to the neighborhood's immediate advantage. Depending on the time of day they could transport commuters, pick up supplies and materials, or provide personal transportation to more major transportation links like subways and light rail trains.

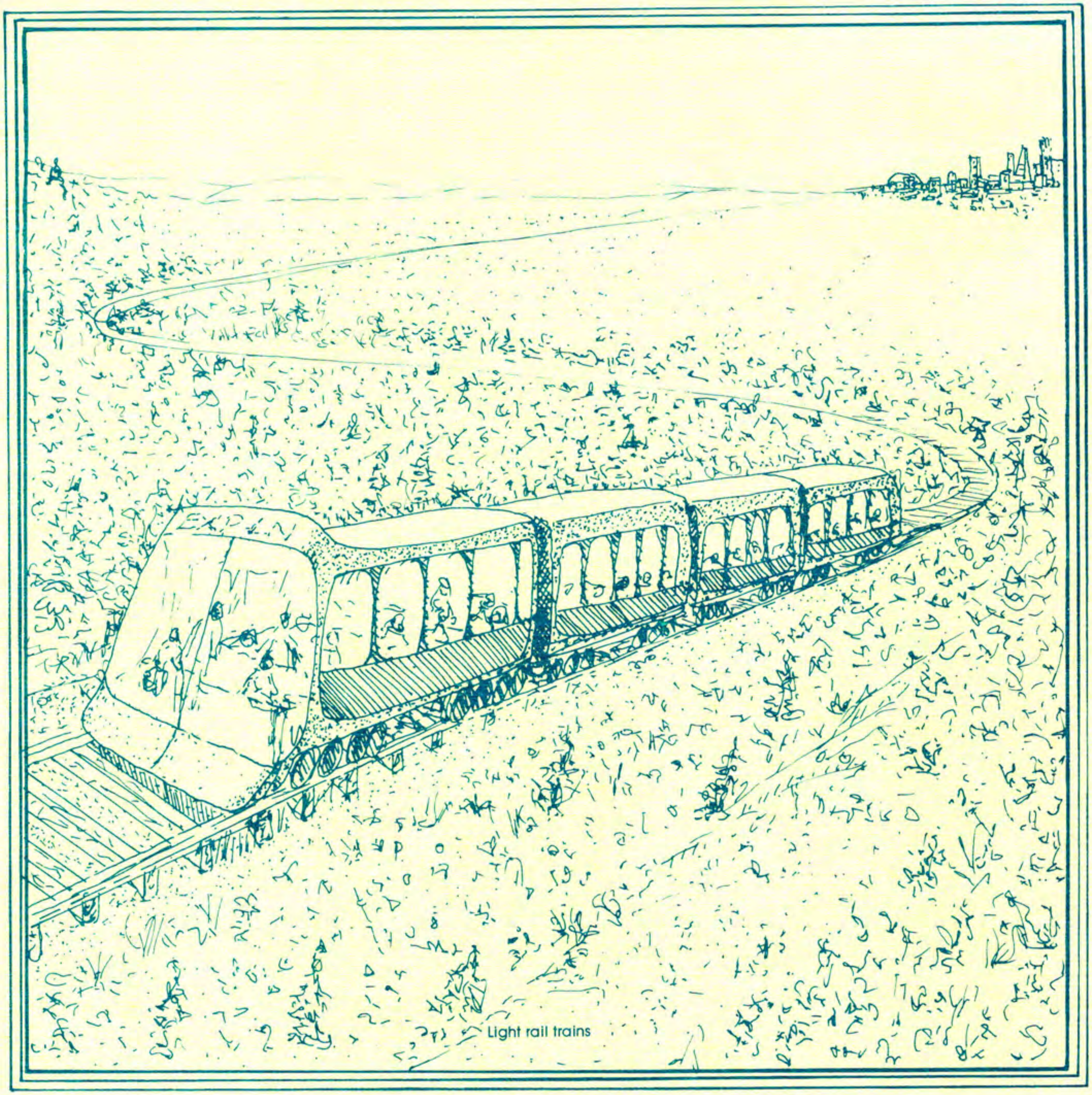
Activities that used to lend a feeling of intimacy to a neighborhood can reappear because of their value as being energy "wise." Good examples are delivery trucks, street vendors, and small local stores and restaurants. Land use definitions and traffic management have and will continue to be reunderstood to accomplish different sets of goals. There will be interesting contrasts of old and new and original searches for cultural forms that give meaning to both as to include the rediscovery of what we mean when we say we live in a given place.

Transport for Longer Distances*

Chris Swan has designed light rail trains that are really more developments out of electric trolley technologies than they are of traditional heavy and ponderous trains. One of his trains is designed to be powered entirely by the sun and will travel between San Francisco and Las Vegas. When it climbs through the mountain passes, we shall have reached the solar age. Such trains represent a new and flexible dimension to mass transportation. The light rail cars can carry commuter bicycles, offer on-board haute cuisine dining, solarium cars, curtains to create small compartment-like spaces, bookstore and newsstand cars, sauna and shower cars, sleepers, even movie cars. These trains are not Amtrak, reluctant tech; they utilize the same kind of thinking and high technology that goes into high performance machinery, off-shore boats, and aircraft.

*C. Swan. 1980. Light Rail: How to Make It Work. *Co-Evolution Quarterly*, No. 25, Spring, 1980: 44-45.

Occasional Paper: C. Swan. 1981. Transformation of Transportation. Office of Appropriate Technology, State of California, 1600 Ninth Street, Sacramento, California 95814.



MOVING AROUND

Community Energy Systems

Pulses on the Cityscape

As bioregions become more vivid as the location for reinhabitation, the questions of the interrelations between these decentralized locations to preserve them as life-places, rises to the surface. Economic and cultural exchanges will still take place but with a transportation infrastructure suited to a different set of "importing" and "exporting" needs.

Common needs within the community—food and shelter, for example—are met through activities as diverse as people selling vegetables they have grown in their gardens to the importing of timber products milled thousands of miles away. These means of provision, complex as they are, should be accountable for their energy and material use patterns, whether the corresponding technical and productive bases be mechanical or biological. This statement of worth can follow from a design process which balances net energy efficiency, succession, and technology. Integrated with emergent reinhabitory practices, this process allows for the creation or rediscovery of activities, unique to locale, to meet common needs.

In a sense, this process closes the loop on community activities so that they are contained and workable as well as self regulating and evolutionary within their distinct boundaries. Living systems, though, are always open systems and are not sealed from energy, matter, and information moving through its borders. The communication and relations between part-systems is just as important as the workings internal to them. The nature of the whole, however, reflects the interaction of individual ways of behaving rather than individual behavior itself. These exchanges, in turn, are characterized by the quality and the quantities of energy flow by means of which work is done and the whole is organized.

For example, large quantities of available high quality energy will accelerate growth and levels of production associated with ecologically immature systems. Imagine a village supplied with or importing large amounts of cheap electricity from a nuclear facility or large-scale windmill farm. It will grow rapidly, feeding back assets to enlarge its energy supply in order to maintain the growth pattern. This village is in a self-imposed state of "runaway" growth. The development of the village is industrial and its dominant characteristics are low net energy efficiency, a simple and unmysterious cultural make-up and a vulnerability to external disturbance. What are the repercussions for this village when the power supply is curtailed or stopped altogether?

The idea that the amount and quality of energy are inseperable from the characteristics of the system through which it flows is important for several reasons. First, it provides a metaphor for understanding how important the course of energy is to the shaping of the community. If separate activities are accountable for their own energy and material usage, it is this movement of energy which allows for diverse pathways of work and information while tying the parts together from an energetic point of view. Consequently, working from the metaphor, power generation and supply have much to do with the evolution of the whole.

Secondly, taking succession as a preferred model of structural change, it provides criteria by which the design of a community based power supply system can be undertaken. A low energy focus, that is, the drawing off of solar income without importing high quality energy, will yield a different set of supply options.

Finally, with the realization that energy density—the delivery of power and natural resources to high-energy locations—is as critical to community make-up as population density, the analytical procedures used to gauge carrying capacity of the bioregion can no longer reflect merely the per capita demand for necessities. In addition, the levels of service that can be supported by renewable sources must also be considered.

Taken together, community development with a low energy focus (ecodevelopment) and reinhabitation provide a basis for the necessary transformation of the present utility structure and patterns of energy use.

A Watershed Utility

Historically, the logic of growth employed by utility companies has resulted in remote, large-scale, capital intensive generation facilities coupled to large service districts. The natural resource base of many communities has been and continues to be taxed if not destroyed by the exporting of "fuels" to distant locations, the importing of toxic by-products that can result from energy conversion processes, and the effects of locating power plants near or within those communities. Nuclear energy, owing to the nature of its uranium mining, waste disposal, and operating procedures, is the clearest example of this pattern but it is not alone.

This industrial mode for supplying power, with its technological and financial capabilities, is reinforced socially due to the public perception of utility companies as the only organizations capable of supplying energy at present levels.

Culturally, the availability of constant surges of high quality energy in the form of power has created a pattern of energy use and waste indicative of a people which consumes heavily without regard to long-term effects and flexibility.

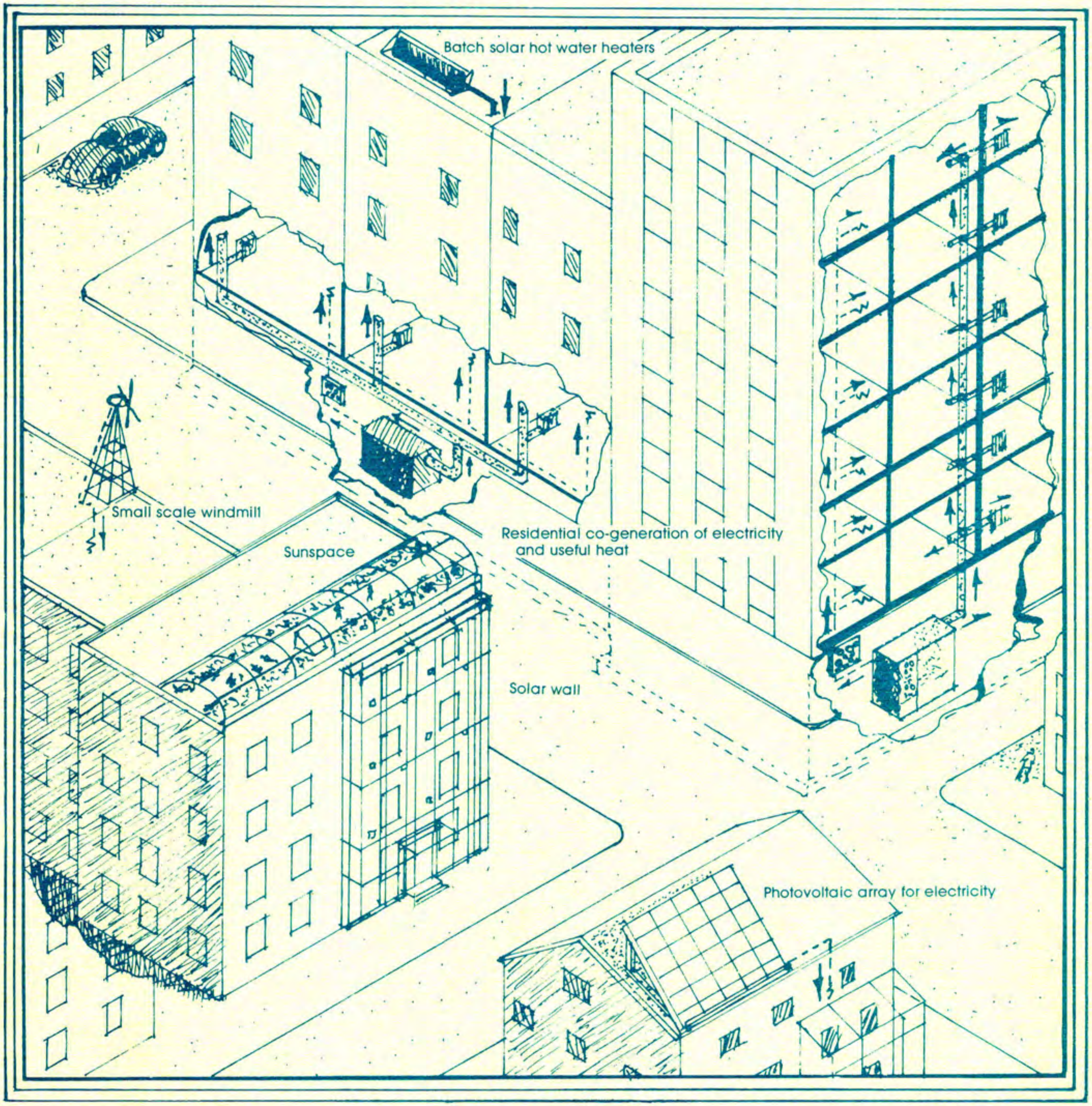
Finally, it has reduced and kept the natural surround at an early monocultural if not an artificial state—a loss of wealth, information, and beauty that will be difficult to recover.

Contrast this with the notion of a watershed utility: an organization responsible for supplying power for necessary services—heat, lighting, and refrigeration, for example—while maintaining the bioregion through a soft supply system embodied in reinhabitory practices. Scaled to local eco-systems and direct observation and reaction by local inhabitants, a watershed utility is the attempt to satisfy certain basic human requirements: power generation, transmission, and distribution; fresh water supply; waste treatment; and safeguarding the health of local watersheds and their populations in the delivery of services to the human community.

A new social contract is therefore necessary between the public and suppliers of energy to the community. Under the current contract, public utilities are assured a rate of profit in return for a guaranteed level of service. Implicit to this understanding and institutional arrangement is the acceptance of the market-place, in specific, and economics, in general, as the mediators between consumer and supplier. Insofar as economic terms are incommensurable with ecological terms, as the current environmental destruction attests to, a shift is essential from the present agreement to one involving a watershed utility on the one hand and the many generators and consumers of power on the other. As the agent of the public, the watershed utility would attempt to balance human service requirements against the well-being of the life place. This shift does not mean that the important questions of economy are ignored or forgotten, but rather that they take place within a different context: ecologics has replaced formal economics.

Examples of the practical effects of this

Soft supply systems, while containing components driven by both fossil fuels and renewable sources of energy, will find its definition in the climatic, topographical and natural resources of the bioregion. The integration of benign technologies into the existing cityscape can be undertaken according to reinhabitory technics and the capital requirements and life-cycle costs of the alternatives.



FROM THE GROUND UP

institutional change could be in tying the scale of the utility structure to the geography of the watershed and in redefining the role of the utility company within the community. No longer a simple generator and distributor, the utility would now assume the social function of responsibility for a viable and dependable distribution network linking a large number of decentralized power producers to a large number of power consumers while providing intermediate sized supply back-up and storage.

The characteristics of succession of watersheds and bioregions would become the common denominator for assessing the status of the various species, including the human species, while answering questions of costs, service standards, and technological base.

What, then, would be some goals of the watershed utility?

- To decrease or minimize extra-regional energy imports,
- To decrease high quality surges of energy through the local eco-system while meeting service levels and standards,
- To maintain reliable levels of service to local inhabitants by providing back-up power and power grid coordination,
- To evolve a technological base within the community which will deliver these services as well as complement succession with the local eco-system,
- To involve local inhabitants in the supply and generation of power to the general community, and
- To locate public decision making about power supply and demand within the wider context of the energetics of the life-place.

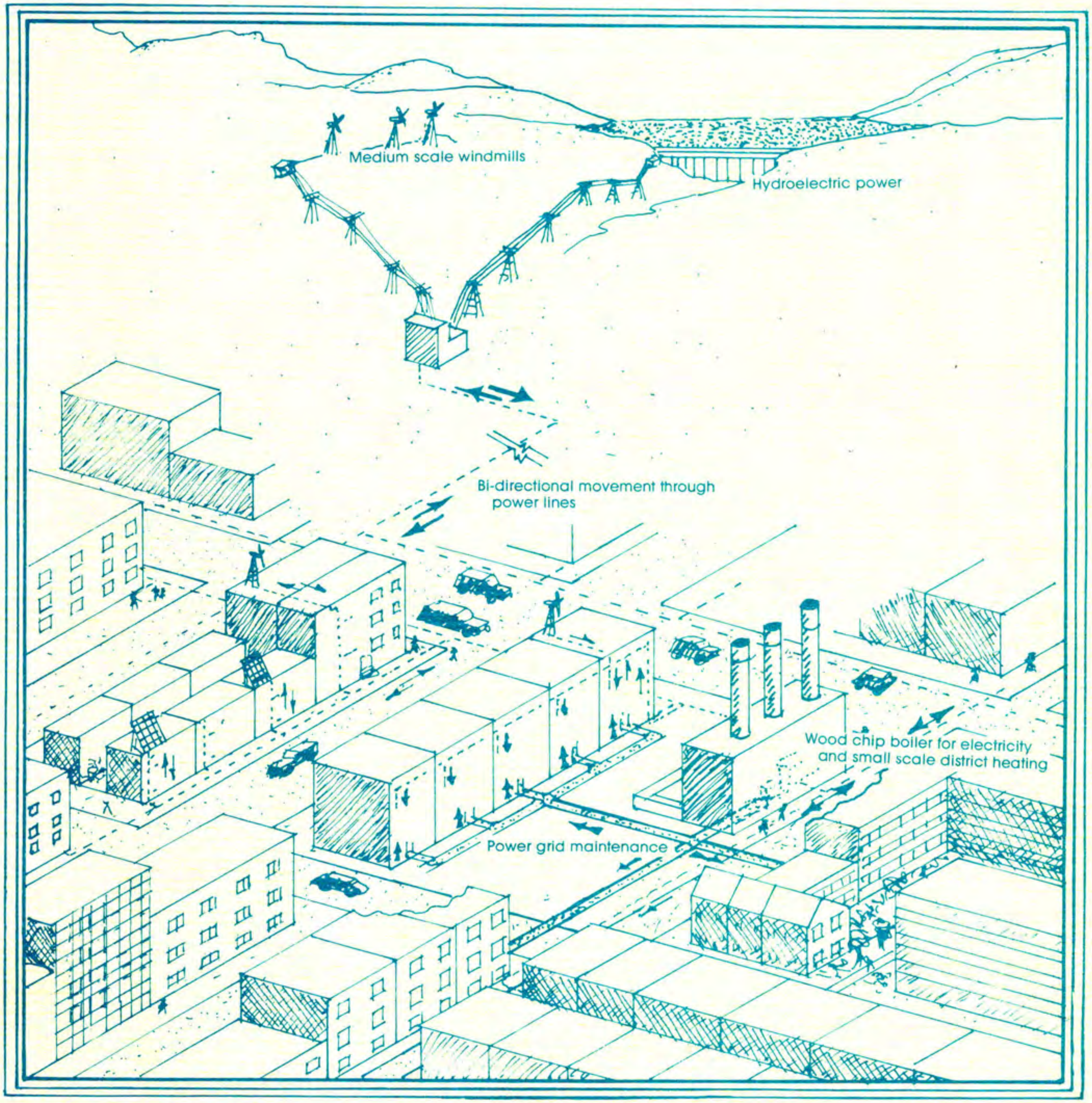
Going for the Soft Spots

Changing the existing situation will mean the elaboration of strategies to reinhabit villages and cities—adaptive tactics—so that the design and delivery of services becomes interwoven with preserving the worth of a place—bioregional worth.

Consider two styles of change that could fall within the orientation of a watershed utility: community based—"from the bottom up" and institutionally based—"from the top down." These movements from two directions converge at a common destination: the watershed utility.

The community-based pathway moves from household activities (energy conserving and renewable energy applications such as home weatherization or passive solar energy retrofits) to neighborhood or village scale efforts (which are reflected in fuel resource cooperatives and commonly owned generation facilities such as medium-scaled wind mills and roof greenhouses sited on the top of row houses or residential co-generation units). In this manner, the "where did it come from/where did it go" blindness is replaced by the inclusion of the generation and consumption of power as concerns for reinhabitation. For example, woodlot management practices have to be riding a learning curve equal to the combined effect of the increased use of wood as a fuel source and the development of conversion technologies that use wood as their feedstock, whether it be a wood stove for house heating or large wood chip boilers used to produce electricity. Financial options for accomplishing "bottom up" activities can range from Sweat Equity programs and labor/material exchange cooperatives to more orthodox means, the mortgage market.

The watershed utility is a good example of a service delivery organization because it provides support for local reinhabitory initiative by arranging financing options, buying back excess power produced by families and community groups and managing the power grid to ensure reliability and service standards. It becomes essential to the long term health of the bioregion when aiding communities to balance human necessity against solar income: a basic ingredient of carrying capacity.



FROM THE TOP DOWN

Working "from the top down" will probably mean first trying to alter the present institutional arrangement so as to allow for other choices. The immediate problem in the realization of a watershed utility is not "how to operate it well" but rather the creation of the conditions for its possibility: namely, a change to smaller scale local ownership and control. Escalating fuel prices and a feeling of impotence has already provided the catalyst for some counties and townships to effect this change. The result has been local ownership of gas and electrical distribution networks with the ownership of generating and transmission facilities remaining with the utility companies.

Despite the evident financial and political complexities in negotiating with utility companies, the next step would be to gain ownership of the necessary transmission facilities and to begin the integration of a soft supply system, built upon the bioregional resource base, into the existing transmission and distribution infrastructure that is now under local jurisdiction.

An example of this is occurring under the aegis of Burlington (Vermont) Municipal Electric. In this case, a municipal power company has purchased a modest-sized generation facility utilizing locally available wood chips as its feedstock. And a reciprocal back-up agreement enables neighboring utility companies to trade excess capacity.

Maneuvering on the institutional level to create the decentralized conditions which allow for alignment of power generation with bioregional worth will necessarily involve large sums of capital. Consequently, communities will, in most cases, have to fall back on their tax base or look to the bond market for the revenues needed to "buy back" their energy futures from utility companies.

With the meeting of these two pathways, we will have shifted axis. Whether a watershed utility exists as an organization or as an ensemble of activities and institutional niches, it will eliminate the present diseconomies of scale which are in the sole self-interest of an invester-owned utility's rate of profit. They will be replaced by the benefits which are in the interests of a watershed utility: preservation of a life-place; support for reinhabitation; and a power delivery system which is anchored in solar income and reliable service, accountable to energy efficiency, and amenable to various pathways of implementation.