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14

Community and Regional Planning

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Planning for the physical development of communities and regions generally requires an interdisciplinary team approach. Although planning generalists may prepare general development plans for smaller communities, more complex and specialized studies require consultation with and guidance from experts and specialists in a diverse array of disciplines. Since civil engineering works are fundamental components in the physical development of cities and regions, the civil engineer plays a prominent role in community and regional planning efforts.

This section is only a brief overview of the most significant issues and approaches used in planning studies. The references at the end of this section contain additional information as well as more extensive bibliographies.

Basic Approach and Organization of Planning

14.1 Need and Justification for Planning

Planning is practiced routinely by individuals, corporations, and governments. Time and activities are scheduled. Efforts are directed toward achieving goals and objectives. Scarce material and time resources are allocated to various competing demands.

Planning is good management, allowing anticipation and preparation for future events, and is concerned with both avoiding future problems and correcting existing problems. Planning helps meet basic human needs, such as housing, transportation, and goods, and conserves and protects resources and maintains environmental quality. The planning approach, by rationally examining the range of available solutions to existing problems, can result in the selection of a solution that does not itself become a future problem.

Governmental actions and programs often require major expenditures for public works and public services. It is therefore understandable that a principal goal of planning is to achieve the most efficient allocation of scarce resources to competing demands.

Governmental decisions have long-term effects yet are made by officials elected to short terms of office. This can result in emphasizing short-term actions and programs at the expense of long-term programs and long-range objectives. Planning is a framework in which to undertake immediate action in the context of long-range goals and objectives.

Other important objectives of planning, particularly regionally, are to enhance intergovernmental coordination and cooperation and to manage intergovernmental conflicts. Many management decisions must be made regarding environmental quality and regional services, and they must transcend the boundaries of individual communities.

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Regional planning can be a structure that addresses important intergovernmental and regional issues and finds solutions through cooperation between individual units of government and coordination of their efforts.

In searching for solutions to problems, attention may be too narrowly focused on a specific functional area or problem, and potential effects on other aspects of physical development may not be fully evaluated. The overall comprehensive approach of community and regional planning encourages examination of side effects and relationships between functional planning areas. In a world of increasing fragmentation and complexity, where emphasis may be on short-term results, planning satisfies the need for a rational decision-making framework based on long-term, comprehensive, and regional viewpoints.

Since many governmental decisions and actions provide guidance for private decision making, the influence of governmental planning extends beyond the sphere of public actions and decision.

14.2 Scale of Planning—Neighborhood, Community, Region

The scale of a particular planning program depends on the nature of the problem being addressed and the potential solutions to that problem. An air-quality problem cannot be addressed or corrected at the neighborhood level. On the other hand, it is not usually necessary to address the specific location and design of neighborhood facilities regionally. Generally, planning at the neighborhood scale is directed toward basic services and common issues, whereas planning at the regional level is directed toward more highly specialized services and facilities, or at those problems that require regional solutions.

Planning at each scale—neighborhood, community, region—should be in the context of the next larger scale: The neighborhood should be planned in relation to the community, and the community within the context of the region.

Neighborhood ▪ A neighborhood has from 2000 to 10,000 residents and is oriented around significant neighborhood facilities, such as an elementary school, neighborhood parkland, and neighborhood shopping area. A well-defined neighborhood has a distinct identity and is clearly separated from surrounding neighborhoods. It also has a cohesiveness and commonality of interests of residents. In many communities, neighborhoods have established citizen organizations that are active in politics and planning. It is useful for planners and elected officials to work with these organizations, if they are representative of the neighborhood.

Neighborhood planning, involving primarily housing and neighborhood facilities, is concerned with specific sites, and there is considerable emphasis on esthetic concerns, such as site design and character of public spaces, and issues like historic preservation. Neighborhood planning can also effectively address the level and quality of basic public services, such as public safety, solid-waste collection, and street maintenance.

In addition to addressing internal conditions and facilities serving the individual neighborhood, planners need to consider the interaction of the neighborhood with other neighborhoods and access of neighborhood residents to community and regional facilities and services, such as public transportation. Neighborhood planning is also important in addressing the neighborhood impacts of major community or regional projects, such as routing of a major highway through a neighborhood or the location of a major public facility within a neighborhood.

Community ▪ Although there is no precise definition, a community ordinarily consists of a number of neighborhoods and generally reflects a greater diversity of interests and concerns as well as a greater degree of economic self-sufficiency than an individual neighborhood. Community planning, often referred to as city planning, is concerned with providing the basic services and facilities of concern in neighborhood planning, but community planning is also directed toward more centralized and specialized facilities and services, such as the location and design of major industrial and shopping areas (including central business districts), middle and high schools, and cultural facilities like libraries, community centers, and other similar community-wide facilities. Community planning ordinarily deals with a single unit of government that has the capability of exercising the control and taking the actions recommended

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in the plan without the need for substantial coordination or cooperative efforts with other units of government.

Region ▪ Regional planning is concerned primarily with issues, problems, or services that overlap or transcend community boundaries. Typical examples include air quality, water quality, transportation systems, specialized cultural and higher educational facilities, regional shopping centers, and specialized industry. The regional approach is sometimes dictated by sheer size, as in the need to achieve economies of scale in wastewater treatment plants. The need for a regional approach may also be necessitated by the proximity of communities to each other.

14.3 Structure and Organization of Planning Agencies

The structure and organization of planning agencies varies from community to community, and there are differences between community planning and regional agencies.

Community Planning ▪ Most communities are engaged in both functional and comprehensive planning activities. Even small units of government have planning commissions engaged in land-use planning and zoning activities, and most operating agencies with significant budgets are engaged in functional planning (for example, a local sewerage or public-works department engaged in functional planning for providing wastewater collection and disposal). There are a number of advantages to functional planning, including the involvement of governmental staff directly responsible for providing the service and having the most intimate knowledge of service provision. The comprehensive viewpoint, on the other hand, permits an assessment of the impacts of a particular single-function plan on other areas of governmental concern, allows relative priorities to be established among separate governmental functions, and permits coordination of separate departmental efforts to achieve common goals and objectives. It is usually beneficial to combine the advantages of the two approaches by establishing a comprehensive planning framework within which detailed functional planning can proceed. This way, functional planning can satisfy the needs of that particular governmental function while contributing to overall community goals and objectives.

Most communities have established comprehensive planning agencies that prepare and administer comprehensive plans for community development and provision of services and coordinate functional planning by individual agencies or departments. These comprehensive planning agencies range from small volunteer committees to large municipal agencies with sizable staffs and significant operating or regulatory responsibilities.

Community comprehensive planning organizations generally take the form of an independent planning commission, planning department, or community development agency. These various forms differ in their administration and relationship to the legislative and executive branches of local government. The independent planning commission is usually governed by a body of representatives appointed by the executive or legislative branch of government. Traditionally, a significant responsibility of independent planning commissions has been to administer and advise on zoning matters. Since zoning decisions are ordinarily a matter of legislative concern, independent planning commissions normally have closer ties with the legislative branch of government than do planning departments or community development agencies and somewhat less direct ties to the executive branch. Independent planning commissions have usually been more oriented toward long-term planning rather than direct involvement in short-term development proposals and projects, although the commissions may administer zoning and subdivision regulations.

A community planning department or development agency is a common fixture in larger units of government with significant executive and administrative programs. These agencies are more closely related to the executive branch and are usually under the authority and administration of the chief executive. A planning department is primarily concerned with planning, land-use decision making, and coordination of functional planning. A community development agency is usually more involved in initiating development proposals, managing specific development projects, and administering governmental operating and regulatory functions, including code enforcement

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and housing functions. Both planning departments and community development agencies tend to place greater emphasis on short-term or current planning and development activities than on long-term goal setting and decision making.

A dual approach, incorporating both an independent planning commission and a community development agency or planning department within the executive branch, can offer the advantages of both types of agencies if the relative roles of the two agencies are clearly defined to avoid unnecessary duplication, overlap, or conflict.

Regional Planning ▪ Regional planning agencies, as differentiated from community planning agencies, are not associated with a single governmental unit but perform planning functions for a region that contains many governmental units. Regional planning agencies are usually independent commissions or councils of governments, with only limited authority, and are primarily advisory in nature.

Regional planning agencies are ordinarily governed by a body of representatives known as a commission or council and commonly named from constituent units of government in the region. Because regional agencies are not associated with a single unit of government, their activities are heavily oriented to intergovernmental coordination and cooperation and to dealing with issues or problems that transcend the boundaries of individual local communities.

14.4 Basic Approach and Methodology in Planning

Figure 14.1 shows a work program for a typical land-use plan. Nearly all planning problems are approached with the same basic methodology, which includes the following key elements:

Identify Current Conditions and Problems ▪ One of the earliest and most time-consuming aspects of any planning process is collecting and analyzing data on current conditions. This analysis should include an evaluation of resources and constraints (physical or economic) that might affect or limit future opportunities, identification of existing problems and deficiencies, and identification of present assets and resources that need to be protected and maintained. It is important to avoid concentrating solely on deficiencies and problems since it is equally important to protect available resources and strengthen or reinforce a community's assets and strong points.

Forecast Trends and Needs ▪ Since the purpose of a plan is to direct and control future events, it is important to understand the changes

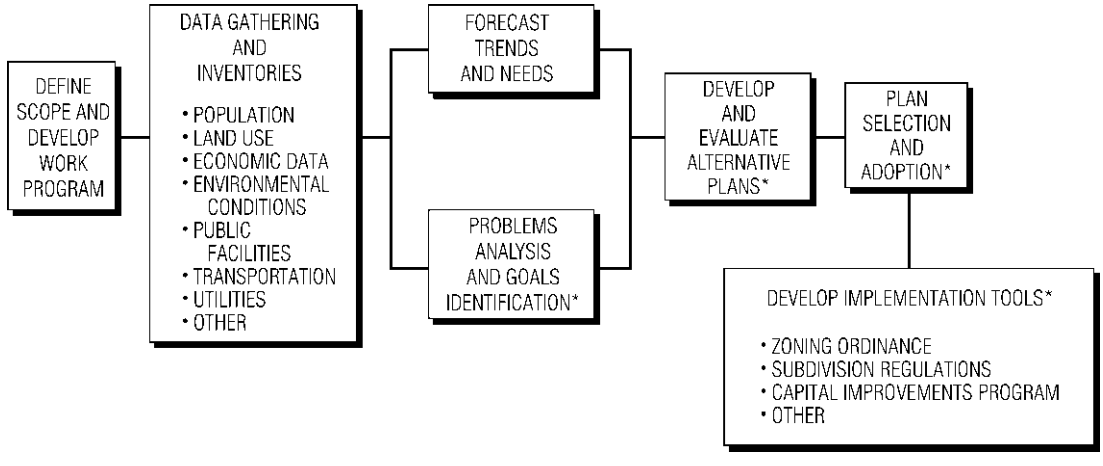

Fig. 14.1 Steps in preparation of a land-use plan. Asterisks indicate steps requiring significant review and participation by the community, elected officials, and concerned organizations.

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that may result from continuation of current trends and programs. This process entails the identification of historical changes and trends and an analysis of whether the basic causes of historical trends and changes retain current validity. Trends are then projected into the future, and future needs and demands are forecast based on these trends. Finally, an evaluation is made of the trends to determine whether or not:

1. They represent future conflicts or problems
2. Projected needs and demands will exceed available resources
3. Projections and forecasts are realistic in light of current information and future changes that can be reasonably anticipated

Establish Goals and Objectives ▪ It is wise to state explicitly the plan's goals and objectives, to help ensure that the goals and objectives are those desired by the community or region and that any conflicts between goals are addressed in the planning process.

Goals and objectives are the ends the plan is designed to achieve. The terms are used interchangeably, but a goal usually represents a long-term target to aim at, without the implication that this target will actually be achieved. An objective is generally considered an end that can be achieved within the planning period. Goals and objectives, as ends, should be distinguished from policies, strategies, programs, and actions, which are means to achieve ends.

In some cases, an objective might be to alter a projected trend or future demand believed undesirable. As an example, a planning study of future water supply may have as an objective the satisfaction of future water needs. Although one approach would be to provide a basic water supply and facilities to satisfy future demand based on projections of existing trends, it may also be possible to alter future demand for water through water-conservation programs. Thus, in planning aimed at satisfying future needs, consideration of ways to alter future demand may be as important as consideration of ways to satisfy that demand.

Outline and Evaluate Alternative Plans ▪ Once goals and objectives have been established, the plan focuses on policies, strategies, programs, and actions designed to achieve the stated goals and objectives. Because there are usually alternative ways of achieving goals and objectives, it is common practice to evaluate a number of alternative plans to provide a range of choices for the general public and elected officials. Each alternative plan should be evaluated for satisfying each individual goal or objective.

Select Recommended Plan ▪ After each alternative plan has been evaluated, the recommended plan is selected from the array of alternatives because it best satisfies all the goals and objectives, although there are often conflicts between various goals and objectives and some goals and objectives are more important than others. A goals-achievement matrix chart, as in Table 14.1, may be used to display the various

Table 14.1 Goals-Achievement Matrix

Alternative plans	Objectives			Cumulative weighted Score	Rank
	Objective 1 (Weight =)	Objective 2 (Weight =)	Objective 3 (Weight =)		
	Score / Weighted Score	Score / Weighted Score	Score / Weighted Score		
A					
B					
C					

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planning objectives, the ability of each alternative plan to satisfy each individual objective, and an evaluation of the overall satisfaction of all objectives by each alternative plan. A goals-achievement matrix can help make the final plan selection more explicit and understandable to citizens and elected officials.

Develop Detailed Implementation and Financing Techniques ▪ After the recommended plan has been selected, it is necessary to outline specific programs and actions necessary for carrying out the plan's policies and strategies. The specific programs and actions should include such important details as financing methods, scheduling, and staffing needs. Practically demonstrating how the plan can be achieved is as important as determining what should be achieved.

14.5 Public Information and Citizen Participation

An essential ingredient in any successful planning program is a public-information and citizen-participation program. Public information is a one-way process designed to inform the general public and elected officials about the planning program and proposals. On the other hand, citizen participation is a two-way mechanism designed to permit the general public to participate directly in formulating objectives and plans and to allow citizens to provide input and opinions to the planning process.

Need ▪ Successful adoption and implementation of any plan requires the support of elected officials and the general public. Hence, they should be extensively consulted during the planning process. In addition, public information and citizen participation improve democratic processes by keeping citizens informed of and involved in governmental decision making. Also, public information and citizen participation often improve the quality of the plan by incorporating additional specific knowledge of local conditions and concerns, as expressed by citizens and elected officials, and ensuring that plans address citizens' real concerns.

Table 14.2 illustrates the roles of citizens, planners, and elected officials at various stages of the planning process.

Timing ▪ Public information and citizen participation are usually continuous activities throughout the planning process, but several key stages of a planning program require significant efforts to inform and involve the public.

It is important to conduct a public-information and citizen-participation effort early in the planning process. At this stage, the purposes are:

1. Inform citizens and elected officials of the objectives and schedule.
2. Enlist elected officials and the public in identifying problems, concerns, assets, and other existing conditions that may affect the planning program.

Table 14.2 Public Participation in the Planning Process

Stage of Process	Role of Participants*		
	Elected Officials	Citizens	Planners
1. Define scope and develop work program	S		P
2. Data gathering and inventories			P
3. Forecast trends and needs			P
4. Problems' analysis and goals identification	P	P	S
5. Develop alternative plans			P
6. Evaluate alternative plans	P	P	S
7. Plan selection and adoption	P	P	S
8. Develop implementation tools	S		P

*P = primary role; S = supporting role.

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3. Let elected officials and the general public participate in formulating goals and objectives.

The second stage of the planning process requiring extensive public information and involvement occurs when alternative plans have been formulated and a preliminary evaluation of those alternatives has been completed. Elected officials and citizens can help identify additional alternatives not considered or overlooked, evaluate the ability of alternatives to satisfy goals and objectives, and identify favored alternatives or features of alternatives.

Public information and citizen participation are also required after a recommended plan has been tentatively selected by the planning staff and sponsoring agency. This allows elected officials and citizens to comment on the final selected plan, identify potential modifications of the selected plan that would improve or increase support for the plan, and document support for or opposition to the recommended plan.

Mechanisms ▪ A variety of tools and techniques are available for providing public information and citizen participation. Since nearly all these tools and techniques have limitations, a good public-information and citizen-participation program includes many techniques.

The goal of a public-information program is to communicate efficiently key features of the plan to a wide audience. The tools and techniques most commonly used for disseminating information to the public and elected officials include advisory committees, direct mail efforts (including newsletters and project summaries), use of the print media (including news releases, articles and newspaper tabloids or supplements), use of broadcast media (including radio and TV shows), and public meetings. Internet computer access to planning information and for interactive feedback is becoming an important mechanism for public information and citizen participation.

The most common tools and techniques used for citizen participation include advisory committees or task forces, public meetings and public hearings, and public-opinion surveys. Although creation of citizen advisory committees limits participation to a small group of citizens, those citizens are well-informed on the issues and alternatives. Care must be taken to ensure that committees are representative of the community or targeted audience.

Public meetings and hearings, often legally required, are included in most planning programs. Meetings and hearings offer opportunities to present information and to obtain input and opinions from citizens and elected officials. Ordinarily, the format for such meetings includes an initial presentation designed to provide information to citizens and elected officials attending the meeting, followed by an opportunity for those citizens and elected officials to state opinions and participate in analysis or evaluation. Care should be taken to schedule public meetings and hearings at times and locations convenient for citizens and elected officials. In addition, the atmosphere and format should be as comfortable as possible, to encourage participation. Long and technical presentations by the planning staff or consultants should be avoided. An excessively legal or formal atmosphere at public meetings and hearings can be intimidating and discourage participation.

Public-opinion surveys and questionnaires are commonly used in citizen-participation programs. These may take the form of written questionnaires distributed by mail or at public meetings or of direct personal or phone interviews, where the interviewer records responses to standard questions.

Direct personal interviews and telephone surveys are very effective means of obtaining citizen participation. Since these techniques require an interviewer, they usually involve more effort and cost than mail questionnaires. It may be possible in some communities to have volunteers conduct the interviews. The use of an interviewer provides the opportunity to explain the questions and provide clarification if the citizen is confused.

Problems and Pitfalls ▪ The principal pitfalls to avoid in a public-information program are confusion, tedium, and limited distribution. Since the goal is to communicate key features of the plan as efficiently as possible and to as many people as possible, brevity and clarity are of the utmost importance. Language should be nontechnical. Interesting graphics (drawings, graphs, and photographs) should be used liberally to sustain interest and make it easier to understand important information. Lengthy technical documents are too bulky and cumbersome to distribute widely and usually provide more information than the average citizen desires or needs. Project summaries and

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brief articles and presentations can be widely distributed and more effectively communicate with large numbers of persons.

The principal problems and pitfalls in citizen participation include lack of interest and participation and failure to ensure representativeness and randomness in sampling procedures and participation. It can be assumed that voluntary participants in advisory committees and public meetings and hearings are not truly representative of the population as a whole. On the other hand, the involvement of citizens with high interest or who are likely to be directly affected by the plan is crucial to the success of any planning project, even though their opinions may not represent the entire population.

It is difficult to structure survey techniques and written questionnaires to get representative answers. The best results can be obtained by consulting experts on opinion research and survey design, to ensure that questionnaires and survey techniques are formulated to obtain unbiased results. Also, elected officials can usually be expected to represent their entire constituency. The involvement of elected officials in the planning process can be a good tool for ensuring that narrow or unrepresentative interest groups are not exerting undue influence over the outcome and results.

Each public-information and citizen-participation technique has limitations and drawbacks. An effective public-information and citizen-participation program therefore includes a variety of these techniques, used in combination to supplement and complement each other. Nearly every public-information and citizen-participation program should include advisory committees, public meetings and hearings, information dissemination through print and broadcast media, surveys of public opinion, and wide distribution of project or program summaries.

14.6 Projections and Forecasts

Projections and forecasts are made to determine future needs for land and resources and demand for public services. In most cases, projections and forecasts are based on historical data and trends, modified by future expectations and anticipated changes. Historical data are available from various Federal agencies, including the Bureau of the Census, U.S. Departments of Commerce, Health and Human Resources, and Housing and Urban Development. These data are also available from state, regional, and community planning agencies.

Because projections and forecasts deal with the future and the unknown, their validity should be viewed with suspicion. It is usually impossible to predict with any accuracy future effects of technological and societal changes.

Projections for larger and more heterogeneous regions are generally more accurate than those for small geographic areas or for specialized or homogeneous areas. Short-term projections are usually more accurate than projections into the distant future.

Projections based on extrapolation of only a few years of recent historical data risk being influenced by unusual short-term events or trends. Utilizing a longer historical base of record ensures that the future trend projected is not based on a short-term deviation from historical patterns. Since basic changes in growth rates and development patterns can occur rapidly, however, recent trends and events must be taken into account and evaluated to determine whether they will exert any lasting influence in future years.

One of the most common mistakes in making future projections and forecasts is to assume that historical patterns and relationships will remain constant. There have, in fact, been substantial changes within relatively short times in the relationships between population or employment and measures of demand for land or public services. In some localities, for example, in recent years there has been a rapid decline in the number of persons per dwelling unit. This has the effect of requiring substantial additional housing units, even in the absence of population growth, and results in a declining population density even though the density of dwelling units per acre remains the same. Other relationships and factors that have exhibited substantial change include the relative density of industrial employment, expressed as employees per acre; the ratio of total employment to population; the number of automobiles per household; and other similar and basic factors used in planning projections and forecasts. In all cases, it is wise to use local data wherever available, to compare these data with other similar communities, and to carefully evaluate potential future changes in trends and relationships.

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Population ▪ Population projections and forecasts are fundamental to most planning studies since population is one of the most important measures of demand for land, goods, and public services. Historical population data are available from Census publications and can be obtained from state, regional, and community planning agencies. In addition, future population forecasts and projections are commonly made for communities and regions by state, regional, and community planning agencies.

The most common methodology used for making population projections is the cohort-survival technique, which estimates the natural increase in a resident population by subdividing the population into classifications of age and sex and applying specific birthrates and death rates to these classifications. Migration is then factored into the analysis by examining historical migration rates and estimating future migration.

Migration of population into or out of a region or community is the most difficult component of population change to accurately forecast. Migration is heavily influenced by employment and availability of job opportunities. It is therefore important to coordinate population forecasts with forecasts of future economic conditions and employment. Historical migration rates should not be automatically assumed to continue, and future migration forecasts should be based on anticipated rates of job creation and employment opportunities.

Simpler population projection techniques are often used where population projections are not available from planning agencies and where the time and effort involved in making a cohort-survival population forecast are not justified. These include simple graphical projection techniques or arithmetic or geometric projections based on historical growth rates. Projecting future population growth based on historical trends is often inaccurate, and these methods should preferably be used only as a check against other population forecasting techniques. If future employment projections are available for an area, it may be possible to project future population as a ratio between population and employment, taking into account potential changes in that ratio.

Because of uncertainties in population projections and forecasts, particularly for smaller communities, it is often desirable to use several different techniques and establish a potential range of reasonably expected future population forecasts. Once a range has been established, the effects and impacts of using the higher or lower end of the range and the consequences of possible overdesign or underdesign can be evaluated. In some cases, inaccuracies in the forecast may simply alter the useful design life of a facility by a few years; in other cases, the consequences of inaccurate forecasts can be quite serious.

Economic Factors ▪ In most planning studies, there is a need to identify the local economy's present strengths and weaknesses and future potential and needs for growth. The primary factors to be considered include employment, characteristics of the labor force, income, and retail market opportunities. The local economy is the driving force behind population growth because it is growth in the local economy that creates jobs and affects migration rates.

Economic studies are ordinarily restricted to large areas or regions. In most urban areas, the basic unit of study for economic projections is the Metropolitan Statistical Area (MSA), as defined by the Federal government. An MSA is more suitable for economic studies and projections than a smaller area because the MSA is relatively self-contained from an economic standpoint (as one measure, most people who live within an MSA also work within the MSA).

The most common methods of making economic projections and forecasts include economic base studies and input-output studies. Input-output studies are less commonly used for metropolitan areas and are somewhat more complicated than economic base studies. Economic base studies examine that portion of the local economy (the economic base) that exports goods and services from the region and generates income from outside the region. This outside income then generates other local economic activities through a multiplier effect. The economic base technique utilizes ratios to develop relationships between base export market activity, local market activity, and overall local economic activity.

Projections of employment and other economic factors are often broken down into classifications according to the Standard Industrial Classification Codes. This makes the economic projection data more useful for converting into related projections of land needs, waste-generation rates, and other data required in the planning process.

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Land Requirements ▪ Forecasts of future land-conversion needs are usually based on population and employment forecasts. Population is commonly used as a basis for projecting needs for all land-use classifications for areas that are relatively self-contained from an economic standpoint. Where employment projections are available, they may be used to forecast land needs for commercial and industrial land. In cases where both population forecasts and employment forecasts are available, both methods should be used and compared with each other. Land-use data and projections are usually broken down into classifications. These classifications are often based on the Standard Land-Use Coding Manual, but they vary from community to community. Common classifications of land use include residential; manufacturing; transportation, communications, and utilities; wholesale and retail trade; cultural, entertainment, and recreational services; resource production and extraction; and undeveloped land and water areas. It is useful to use a land-use classification system that is compatible with other state, regional, and community planning agencies working in the area.

When making forecasts of future land-conversion needs, it is advisable to base density figures on existing land-use patterns and local conditions. For new development, it is preferable to develop figures reflecting recent typical development densities. Use of total figures that include older development may not reflect future development densities or types. Development densities should be examined and compared with figures from other typical communities to get representative values. Once representative values for the present densities of various land uses have been determined, it is possible to develop density standards for future development, based on historical data and trends as modified by anticipated future changes or plan policies. It is possible for a community to encourage higher or lower densities of development than have been historically experienced by adopting planning policies and taking actions to encourage changes in density.

Resources and Environmental Quality

14.7 Soils, Geology, and Land Characteristics

An analysis of the soils, geology, and land characteristics of the planning area allows the planner to obtain an understanding of surface and subsurface characteristics so that land uses can be located in compatible areas.

Concerns and Potential Problems ▪ Potential problems arising from surface and subsurface conditions can be subdivided into human problems and environmental problems. Human problems include hazards to health, potential injury and loss of life, and economic losses. Health hazards and potential injury or loss of life can result from earthquake damage, landslides, or pollution of surface or groundwater. Economic losses caused by inattention to surface and subsurface conditions can be staggering in magnitude. Examples include high construction costs due to high water tables, shallow bedrock or unstable or compressible soils; high maintenance costs due to expansive soils, compressible or unstable soils, or excessive erosion and deposition; and property damage due to earthquake damage, landslides, expansive soils, and compressible or unstable soils.

Environmental problems may include damage to resources, such as surface and groundwater pollution caused by erosion or poor location and design of waste-disposal sites. An important but neglected resource problem can be declining soil fertility and productivity from excessive erosion. Another factor, which may be important in some areas, is the subsequent inability to extract or utilize subsurface mineral resources after urban development has been allowed to occur on the land surface.

Besides damage to resources, potential environmental problems can include disturbance of natural ecosystems, alteration of wildlife habitat, and removal of vegetative cover. Esthetic problems, such as poor visual or scenic quality as a result of development or visual incompatibility with the landscape, can also occur.

Data and Pertinent Factors to Consider ▪ In most parts of the continental United States, there is a considerable amount of available data regarding surface and subsurface characteristics. Proper use and interpretation of these data require considerable skill and experience. As is the case with most other specialized areas of community and regional planning, it is recommended that qualified experts in soils and geology be consulted

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in the process of interpreting and evaluating data and arriving at conclusions.

Data most commonly used in evaluating surface and subsurface conditions include aerial photographs, topographic maps, geologic reports and mapping, soil surveys, and well data and drillers' logs. The U.S. Geological Survey and state geological surveys are sources of topographic maps and geologic reports and mapping. State geological surveys and water-supply or environmental agencies may be a source of well data and drillers' logs. Aerial photographs are generally available from a variety of Federal, state, and local agencies.

In most areas, modern soil surveys are available from the Soil Conservation Service of the U.S. Department of Agriculture. These detailed soil surveys are a primary tool used by community and regional planners to evaluate surface and subsurface conditions. USDA soil surveys, however, are limited to rather shallow surface deposits. These soil surveys are suitable for general locational planning; for specific site studies, this information needs to be supplemented by more detailed on-site information.

The specific factors of concern will depend on the particular issue or land use in question. Factors important in most planning studies include:

1. Topography (land slopes) and landforms
2. Existing vegetative cover
3. Surface-water features and areas subject to flooding
4. Depth to and type of bedrock
5. Depth to and quality and availability of groundwater
6. Groundwater-flow patterns
7. Soil types and characteristics (fertility and productivity, erodibility, strength and stability, compressibility, swelling characteristics, permeability)
8. Location of mineral resources, including sand and gravel

Mapping and Geographic Information Systems ▪ Community and regional planning practice relies heavily on the visual display of information in the form of maps, airphotos, charts and graphs, sectional and perspective views, and three-dimensional views. Most information displays are now computer-based, and the use of geographic information systems (GIS) for storage, analysis and display of spatial information is commonplace.

GIS systems are computer-based systems that provide a rapid and convenient approach to storing, processing and displaying all kinds of spatial or geographic information—virtually any information that can be mapped. GIS systems make possible the storage and retrieval of vast amounts of spatial data, allow categories of data to be separated into discrete layers of information, and greatly facilitate the processing, analysis and display of individual or combined information layers, or the relationship between information layers. In addition, GIS systems are very useful for communicating and transmitting spatial information, and allow widespread access to geographic information. GIS systems have proven to be such a valuable tool that they are being utilized at every level of government.

Land-Suitability Analysis ▪ One of the most important tools in making locational and siting decisions as a part of planning studies is the analysis of suitability of land for different purposes or land uses.

A common approach to land-suitability analysis is to use a multiple overlay mapping process, which involves four basic steps:

First, the factors of importance to the particular land-use or siting question are selected. For example, if the problem is to site a sanitary landfill, the important factors might include such characteristics as slope, soil type, depth to bedrock, depth to groundwater, and some measure of flooding hazard or distance to surface-water bodies.

In the second step, criteria are established by dividing each factor into relative degrees of suitability. Using the example of siting a sanitary landfill, the slope factor may be subdivided into slight limitations (flat slopes), moderate limitations (moderate slopes), and severe limitations (steep slopes).

In the third step, a suitability map for each factor is prepared for the entire area under consideration. The map indicates areas that have severe limitations, moderate limitations, or slight limitations.

The fourth and final step is to combine the information from the individual factor maps to produce a composite land-suitability map based on

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all factors. Two methods are commonly used to produce composite maps. In the first method, the individual factor maps are simply superimposed on top of each other, and the resulting visual composite image is used. If on each factor map the areas with most severe limitations are mapped as darker shades while areas with less severe limitations are mapped in lighter shades, superimposing these overlays on top of each other yields a composite map in which the darkest areas are the least suitable and the lightest areas the most suitable, taking into account all the factors included in the analysis.

Another approach to deriving the composite map is to divide the planning area into sufficiently small units, for example, by using a two-dimensional grid and then assigning numerical scores to each cell in the grid for each factor. A mathematical composite score is then derived for each cell based on the scores for each factor. The composite scores for each cell are then mapped to derive an overall composite map reflecting all the factors used in the analysis.

A number of examples of practical application of the land-suitability-analysis technique to regional planning problems is included in Ian McHarg, "Design with Nature," Natural History Press, Garden City, New York, and more recent updated information regarding the technique is included in Kaiser, Godschalk and Chapin, "Urban Land Use Planning," University of Illinois Press.

Land-suitability analyses have a number of advantages when making locational and siting decisions as a part of planning studies: The technique has the capability of analyzing the suitability of all land within the area to be considered, rather than being limited to a few selected alternative sites. The technique can generally be adapted to use data readily available in most areas. The technique, while suited to manual analysis and the capabilities of small planning agencies and consulting firms, is also adaptable to the use of computers and modern data-processing techniques and GIS systems. Furthermore, one of the most important advantages of land-suitability analysis is that it provides the capability of communicating and explaining a complex multifactor environmental analysis in a format easy for public officials and the public to understand. Thus, land-suitability analysis can often be instrumental in explaining and obtaining support for controversial locational and siting decisions.

14.8 Water Resources and Supply

One of the most fundamental aspects of planning for future urban development and land uses is the provision of adequate supplies of water necessary for domestic and commercial potable water needs, manufacturing needs, irrigation, cooling water needs, and power generation. The basic water-supply system includes sources of supply, treatment (if required), and distribution to the locations of use. Storage of untreated or treated water is an important element in all water-supply systems.

Water Use and Water Consumption ▪ Water for domestic uses, most manufacturing and industrial cooling uses, power generation, and other purposes is usually available for nearby reuse. Water that is converted into water vapor through evaporation or transpiration from plants is considered consumed because it is not available for nearby reuse. Irrigation is usually the most significant aspect of water consumption. (See Sec. 21 for more information on water supply, use, and demand.)

There are variations over time in both supply of and demand for water. Variations in the quantity of water available are caused by long-term drought conditions or seasonal variations in precipitation, stream flow, and groundwater recharge. Variations in the demand for or use of water are caused by long-term trends (population increases, industrial growth, increasing or decreasing per capita use), seasonal variations (lawn watering), and daily and hourly fluctuations caused by living patterns or firefighting.

Impoundments or storage facilities are commonly used to accommodate fluctuations in either supply of or demand for water. Basic supply storage of untreated water in surface impoundments is commonly used to accommodate long-term droughts and seasonal variations. Storage of treated water close to the distribution system, on the other hand, is a common technique for accommodating short-term daily and hourly fluctuations in water demand. In all cases, sufficient storage must be provided to last through those periods when demand is greater than basic supply or distribution capabilities. Withdrawals from storage during periods when demand is higher than basic capacity are then compensated by replenishing

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storage during periods when demand is less than basic supply capacity. Where groundwater is used for water supplies, the aquifers themselves may act as storage facilities. On a long-term basis, withdrawal must be balanced by recharge to avoid depletion of groundwater supplies.

Overall demand for water and patterns of water use can be significantly affected by metering and pricing policies and by information and regulatory programs directed at water conservation.

Development and Protection of Water Supplies ▪ The basic water supply for a community or region is obtained from either surface-water or groundwater supplies. Surface water may be obtained by direct draft from rivers or by withdrawal from lakes and impoundments. Direct withdrawal from rivers, without storage, is normally feasible only where low flows during periods of prolonged drought are greater than peak water demand. Rivers are also subject to rapid variations in water quality and vulnerable to discharges or spills of toxic and hazardous substances.

Withdrawal from lakes and impoundments is a more common source of water for most metropolitan areas. Lakes and impoundments offer storage capacity to offset supply shortages during long-term droughts and accommodate short-term seasonal fluctuations. Lakes and impoundments have advantages and disadvantages from a water-quality standpoint. Because a substantial volume of water offers dilution, lakes and impoundments are less subject to significant water-quality changes from temporary or accidental pollution. On the other hand, because of the longer retention time of water in lakes and impoundments, pollution is retained longer rather than being transported downstream. Many lakes and impoundments are also subject to a natural aging process called eutrophication. Land-use changes and development activities in the watershed of a lake or impoundment can accelerate the discharge of sediment and nutrients to lakes and impoundments, speeding up the eutrophication process and creating nuisance conditions because of excessive aquatic weed and algae growth.

In many areas, part or all of a community's or region's basic water needs may be satisfied by groundwater supplies. Protection of groundwater recharge and discharge areas is important in managing the groundwater resource. Groundwater discharge areas, such as springs or wetlands, are important in providing base flow in surface streams. Protection of groundwater recharge areas is critical for protecting groundwater supplies. Discharge of pollution in the recharge area can result in transport of contaminants throughout the groundwater aquifer and elimination of the aquifer as a source of supply. In addition, land-use changes and surface activities in recharge areas can affect the rate of recharge and limit the aquifer's long-term supply capacity.

The quality of groundwaters may be adversely affected by waste-disposal practices or land application of chemicals. Waste-disposal practices of concern include septic tanks, livestock waste, sanitary landfills, and waste-storage or -treatment lagoons. Proper location and design of these installations can prevent groundwater pollution. Wide-scale land applications of fertilizers, pesticides, and herbicides and use of road deicing salts and other chemicals are more difficult to control and can have a widespread effect on groundwater quality. Waste-injection wells and leaking underground fuel tanks can also create problems.

14.9 Drainage and Flooding

Flooding problems and surface drainage, as concerns of community and regional planning studies, differ primarily in degree of severity. The principal concern with flooding is the desire to avoid injury and loss of life and reduce property damages caused by major floods (those having a recurrence interval of 25 to 100 years). Surface-drainage systems, on the other hand, are primarily concerned with convenience and providing access to property during relatively minor storms (those having a recurrence interval of 2 to 10 years).

Flood-Damage Prevention ▪ The most important means of reducing loss of life and damages from flooding include flood warning and evacuation systems, flood insurance, flood-proofing, watershed management, floodplain management, and flood-control structures, such as reservoirs, levees, floodwalls, and channel improvements.

Flood warning and evacuation systems are economical and effective means of avoiding injury

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and loss of life during major flooding events. They are most effective near large streams when there is adequate time to provide warning and allow evacuation. Flood insurance programs seek only to minimize the economic hardship associated with property damages and losses caused by flooding by compensating for those losses.

Floodplain management is a land-use management technique designed to avoid increases in flood damages by restricting new development and construction in areas subject to flooding. This is normally accomplished through zoning restrictions on the area subject to flooding, usually the 100-year floodplain. These restrictions commonly require that new construction be constructed on fill or elevated by other means above the level of the design flood. Land-use activities in the floodprone area may be restricted to uses that would not suffer extensive damage from flooding. In some cases, a two-zone system is adopted. A floodway (the area necessary to convey flood waters without substantial increases in upstream flood stages) is defined, and no filling or obstruction is allowed within the floodway. In the remainder of the floodprone area (called the flood fringe area), development and structures may be permitted if they are protected from flooding and adequate access is provided.

Floodproofing is a technique for designing buildings and structures to resist flood damages when it is necessary to locate these structures in the floodplain (as may be the case with wastewater-treatment plants). Floodproofing can be accomplished through provisions in zoning and building regulations. Floodproofing can be costly and yet does not ensure adequate access to structures. For these reasons, the primary use of floodproofing should be those instances where it is necessary to locate new buildings in the floodplain or where existing high-value structures need protection.

Watershed management can affect flooding by encouraging detention and infiltration of rainfall in upland areas, thereby decreasing runoff and resultant flooding. Watershed management is most effective in reducing flood damages from minor storms. It is very effective in reducing increases in flooding that result from land-use changes and urbanization.

Major flood-control works are the most frequently used method of reducing flooding and flood damages. Flood-control reservoirs, levees, floodwalls, and channel improvements are the most common elements of a structural flood-control program. These works usually involve large capital expenditures. They have significant direct effects on flooding conditions. They are most effective in protecting existing development and should be used in combination with nonstructural techniques, such as floodplain management, to be fully effective. They are, however, ineffective in avoiding greater future flood damage caused by increased downstream occupancy of the floodplain. In some instances, levees, floodwalls, and channel improvements can increase flood stages and damage downstream from the area protected by these improvements.

Urban Drainage Systems ▪ Urban drainage systems are designed to remove surface water from land surfaces expeditiously, to avoid inconvenience and provide access to property during minor storms. Urban drainage systems are costly and involve a significant investment by both individual property owners and governments.

As urban areas are developed, the amount of impervious land surface increases as the land is covered with parking lots, streets, and rooftops. Increasing imperviousness results in dramatic increases in storm runoff, frequency and intensity of peak flows, and flooding resulting from storms. As a result, the flow capacity and erosion resistance of natural channels are overtaxed. Subsequent improvements to natural channels and enclosure of flow in conduits speeds runoff processes even more. Full development of a watershed, therefore, may cause peak rates of runoff several times greater than those experienced prior to development.

In lower density areas, it may be advantageous to retain the natural drainage system rather than invest in substantial improvements to open channels or conduits. Where development densities and land-use patterns permit, protection and preservation of natural drainage systems can provide the following:

1. Lower costs than conventional storm-sewer systems
2. Open space and recreation opportunities
3. Scenic beauty associated with streams and greenways incorporated into drainage corridors
4. Reduction of nonpoint-source pollution by providing vegetated areas that filter surface runoff entering the surface-drainage network

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5. Decrease in streambank and streambed erosion by vegetative stabilization and streambank protection
6. Opportunities to offset increased stormwater runoff by providing for increased infiltration of storm runoff
7. Reduction in the effect of increased peak runoff and increased flooding by providing opportunities for incorporating temporary storage and detention of runoff and flood waters

Environmental corridors—linear systems of open-space lands developed around drainage and stream networks—offer the opportunity for protection and multipurpose use of natural drainage corridors in urban areas. Environmental corridors are discussed in more detail in Art. 14.12.

Use of natural channels and maintenance of natural drainage systems may not be possible or economical in high-density areas. In addition, upland watershed management techniques, including detention and infiltration of storm runoff, are necessary to offset any potential increases in flow volumes and peak rates of runoff over natural conditions. If these increases are not mitigated, the change from natural conditions can destabilize the natural channel and subsequently cause erosion and deposition.

In urbanized areas, streets and roadways are fundamental and integral parts of the urban drainage system. Local streets and associated channels may be the main conveyance of runoff from minor storms, and streets and associated drainage systems need to be located, designed, and maintained with their drainage function in mind.

14.10 Water Quality and Waste Disposal

Water-quality and waste-disposal issues often overlap or transcend municipal boundaries; hence they are frequently addressed at a regional level. The intergovernmental nature of water-quality and waste-disposal issues usually requires close cooperation and coordination between the planning agency, state and Federal environmental regulatory agencies, local units of general government, and local special-purpose sewerage and solid-waste agencies.

Water-Quality Objectives ▪ An initial step in the water-quality planning process is establishing water-quality objectives related to proposed or desired uses of surface water and groundwater. Water uses usually considered include use as a potable water supply, industrial use for cooling or process water, livestock watering, irrigation, recreation, power generation, and support and propagation of fish and aquatic life. In most cases there will be multiple uses of water.

After proposed or anticipated uses of a water body have been determined, specific water-quality standards can be established. These represent minimum or maximum limits for specific parameters or constituents that are consistent with proposed uses. Water-quality standards are usually established by state regulatory agencies.

When evaluating surface-water-quality conditions and objectives, it is important to distinguish between base flow and runoff or high-flow conditions. Base-flow water quality, or water quality during low-flow conditions, is of most concern for continuous uses of water and for recreation and support and propagation of fish and aquatic life. Base-flow water-quality conditions exist most of the time and are affected most by continuous municipal and industrial wastewater and cooling-water discharges. The quality of groundwater contributions to base flow can also be important in determining base-flow water quality. The water quality of storm runoff during high-flow conditions may be important in some instances, particularly if runoff water quality is worse than base-flow water quality. Runoff water-quality conditions are temporary and usually of most concern in determining loading of pollutants to downstream water bodies.

Discharge of organic and chemical materials from municipalities and industries causes pollution. Thermal pollution may result from discharges of cooling water from industries and power generation. These discharges often involve extremely large volumes of water with elevated temperatures, and the discharges can affect water uses and have significant effects on fish and aquatic life.

Wastewater Treatment and Discharge ▪ The most common approach in urban areas is to collect municipal and industrial wastewaters at a central wastewater- or sewage-treatment plant,

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treat the wastewaters, and discharge the treated effluent to surface waters. The principal alternatives to treatment and surface discharge include land application of treated or untreated wastewaters, underground injection of wastewaters, and recycling of treated wastewater for direct reuse. Although these alternative approaches are not widely used, they may be appropriate in specific circumstances.

Wastewater-treatment plants may utilize biological or physical-chemical-treatment processes, discussed in Sec. 22. The level or degree of treatment provided varies; however, secondary treatment using biological processes is quite common. This type of treatment removes about 80 to 90% of the solids and organic materials from the wastewater and is economical.

Advanced waste treatment (beyond secondary) is provided where necessary to meet water-quality objectives. It usually involves additional processes directed at reducing or removing specific substances or constituents in the wastewater.

In addition to removing solids, organic materials, and other substances from wastewater, it is necessary to develop environmentally sound means of disposing of the solids, sludge, and other materials removed in the treatment process.

The location of treatment plants and level of treatment are selected to be consistent with the assimilative capacity of the receiving waters. Small streams with low flows may be capable of absorbing and purifying only small quantities of wastewater. When the projected waste load will overtax a stream's assimilative capacity, alternatives include finding another discharge location where the receiving water has a greater assimilative capacity or providing a higher level of treatment. Regionalization of wastewater treatment (replacing several smaller, wastewater treatment plants with a large regional plant) may be cost-effective in some cases because of economies of large-scale construction and operations. Disadvantages of regionalization include concentrating wastewaters at one location, which may overtax the assimilative capacity of streams, and the additional cost of transporting the wastewaters to the regional treatment plant.

In rural or low-density areas, the provision of sanitary sewers and central wastewater treatment plants is ordinarily not economically feasible. Septic tanks are the most common waste-disposal method in these areas. If properly designed and maintained, septic tanks and tile-drainage fields can be an acceptable permanent method of disposal of domestic wastewaters in rural or low-density areas. This requires suitable soils to accommodate tile-drainage disposal systems. Also, sufficient land area is needed to replace the tile-drainage field in the event of failure. Special design and construction techniques can be used in situations involving poor soils, shallow bedrock, and high water tables, but these techniques usually mean high installation costs.

Nonpoint-Source Pollution ▪ A significant element of regional water-quality planning is nonpoint-source pollution. This is usually defined as pollution from widespread and diffuse sources, such as storm runoff from rural and urban land surfaces, as well as pollution from activities such as mining and silviculture. The main concern of nonpoint-source pollution is pollutant loading to downstream water bodies, particularly sediment and plant nutrients.

Sediment affects water clarity and aquatic life, and deposition of sediment can adversely affect habitats such as spawning areas, clog drainage structures, reduce flow capacity, and create navigation problems. In addition, sediment often carries other pollutants, including nutrients, metals, and toxic substances. Plant nutrients (such as phosphorus and nitrogen) can create nuisance algae and aquatic weed conditions in downstream water bodies and accelerate the eutrophication (or aging) of downstream lakes and impoundments.

Phosphorus is the plant nutrient most directly related to peoples' activities, more subject to control, and often the limiting nutrient for plant growth. Thus control of nonpoint-source pollution is often directed at control of phosphorus. Organic materials, metals, and toxic substances may also be of concern in urban runoff, and pesticides and herbicides may be significant concerns in agricultural areas.

The main sources of urban nonpoint-source pollution include erosion from construction sites, runoff from developed urban lands, and runoff from streets and parking lots. Erosion from construction sites is often a major source of sediment and pollutants in runoff from developing urban areas because erosion from unprotected construction sites occurs at rates from 10 to 100 times the normal rate of erosion on agricultural

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cropland. Management practices directed at controlling urban nonpoint-source pollution include vegetative management and erosion control at construction sites; detention and infiltration of urban runoff; and improved housekeeping practices, such as street sweeping and removal of leaves and yard debris.

The main sources of agricultural nonpoint-source pollution are runoff from barnyards and livestock concentrations and cropland erosion and runoff. Irrigation return waters may also create significant water-quality problems in some areas. Management practices directed at controlling agricultural nonpoint-source pollution include soil conservation, barnyard-runoff control programs, management of livestock waste, and careful application of fertilizers and pesticides.

A number of other potential sources of nonpoint-source pollution include mining, silviculture, and logging practices. Management of vegetation and erosion-control practices are applicable to many of these nonpoint sources. In addition, other specific management practices are utilized to address particular problems.

Solid-Waste Disposal ▪ The collection and disposal of solid wastes is one of the more significant and costly public services in urban areas.

Resource recovery (recycling) and volume reduction of solid wastes are often utilized to reduce the quantity of waste for ultimate disposal. Resource recovery may be directed at recovering the energy value, the materials value, or the organic and biological value of solid waste. Energy recovery includes the production of steam or hot water through incineration or direct burning.

In addition to resource recovery, incineration has been commonly used as a volume-reduction technique for solid waste. Conversion of solid-waste materials into fuels for generating energy is also practiced in a number of areas. Facilities that convert solid wastes into fuel for power generation or that produce steam or electricity through direct incineration of wastes involve high initial construction costs and annual operating and maintenance costs. Significant savings can be realized if fuel prepared from solid wastes can be burned in existing boilers and power-generation facilities as a substitute for a portion of the normal fuel.

Organic materials can often be recycled by returning them to the land and processing and using these wastes as soil conditioners and natural fertilizers and for erosion control. This approach may be applicable for crop residues, animal manures, wastewater-treatment sludges, leaves and yard wastes, tree wastes, canning wastes, and other decomposable organic wastes.

Individual materials can be recovered and recycled from solid waste either before or after the waste has been collected. This approach is most applicable to materials of relatively high value or materials easily segregated. Newsprint, ferrous metals, office paper, scrap metal of high value (such as copper), used motor oil, and similar materials can often be economically recovered and recycled from solid wastes. The economics of recovering and recycling individual materials varies, and the success of these endeavors usually depends on the availability of markets for the recovered materials.

The ultimate disposal of solid wastes and residue from volume-reduction and resource-recovery processes is placement of these wastes and residues in open dumps and landfills. Open dumps and uncontrolled landfills are common, but they are not environmentally sound or acceptable means of solid-waste disposal. Sanitary landfills, in contrast, are an engineered method of land disposal, which can be acceptable from an environmental standpoint and which are flexible and economical means of solid-waste disposal. Such landfills should be located in environmentally suitable locations and designed to prevent pollution of groundwater. It is also desirable to locate disposal sites close to major waste generators, to minimize hauling costs. This is an important factor in overall solid-waste costs because hauling costs often exceed disposal costs.

14.11 Air Quality

Air-quality problems are usually not confined to a single local jurisdiction. Therefore, they are usually addressed on a metropolitan or regional basis. Air-quality problems are most serious in metropolitan areas where climate and physiography contribute to serious air-pollution episodes as a result of temporary temperature inversions and stagnation of air-circulation patterns.

Pollutants of most concern in air-quality studies include sulfur dioxide, suspended particulates; hydrocarbons, oxides of nitrogen, carbon monoxide, and ozone—all of which have serious

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potential ill effects on public health, particularly in exacerbating respiratory illnesses. Besides affecting public health, most of these pollutants have significant adverse effects on plants' growth and health. Sulfur dioxide and nitrogen oxides can also contribute to acidic precipitation, which can have important adverse effects on fish and aquatic life in some areas. Finally, air pollution often results in increased haze and reduced visibility.

The principal sources of sulfur dioxide and suspended particulate matter are stationary, such as industrial smokestacks, power generation, and combustion of fossil fuels. The principal means of reducing these emissions include controls on stack emissions and substitution of low-sulfur or cleaner fuels in fuel combustion. Forest fires, burning solid wastes, and fugitive dust from wind erosion and construction sites can also significantly contribute these pollutants in some areas.

The principal sources of hydrocarbons, oxides of nitrogen, and carbon monoxide are vehicle emissions. Ozone results from the action of sunlight on nitrogen oxides and hydrocarbons and is therefore also a result of vehicle emissions. The principal means of reducing vehicle emissions include emission controls and altering transportation systems to encourage reduced travel or to make travel more efficient by encouraging greater use of mass transit, ridesharing and carpooling, bicycling, and other modes of transportation.

14.12 Outdoor Recreation and Open Space

Outdoor recreation and open-space planning is conducted at both community and regional levels. The objective of a community or regional outdoor recreation and open-space plan is to provide opportunities, lands, and facilities to satisfy demand for such activities as walking, swimming, boating, bicycling, fishing, camping, sports and games, and outdoor cultural events.

Function and Classification of Open Space ▪ Open-space lands can be classified into five general categories, according to the primary function of the open space. These include lands devoted to:

1. Resource production, including such uses as agriculture, forestry, and mining
2. Environmental protection, including fish and wildlife refuges, wetlands and marshes, ground water recharge areas, and watershed and stream-corridor protection areas
3. Protection of public health and safety, including floodplains, landslide and earthquake-hazard areas, fire-hazard areas, steep slopes, and areas of high noise exposure (such as airport flight paths)
4. Satisfaction of community outdoor recreation needs, including parks, playgrounds, trails, and other recreation areas
5. Buffer areas and separation between adjacent communities or incompatible land uses, growth-management boundaries and barriers, and utility and transportation corridors—as a determinant of urban form

A thoughtful and well-designed open-space system includes elements of all five open-space functions, within an integrated multipurpose network of community and regional open spaces.

Environmental Corridors ▪ The discussion in Art. 14.9 of urban drainage systems indicated the potential advantages of protecting and utilizing natural drainage systems. The concept of environmental corridors is utilized in community and regional planning programs to address the multiple concerns of drainage, water quality, recreation, and open space. Environmental corridors are linear systems of open space that include environmentally sensitive lands and natural resources requiring protection from disturbance and development and lands needed for open space and recreational use. These linear features are developed around drainageways and stream channels, floodplains, wetlands, and other resource lands and features (Fig. 14.2).

Protection and preservation of environmental corridors directly relate to environmental protection in general, and specifically to water-quality enhancement through reduction of nonpoint-source pollution and protection of natural drainage systems. In addition to protecting natural drainage systems in urban areas, environmental corridors can protect and preserve sensitive environmental areas, such as wetlands, floodplains, woodlands, steep slopes, and other areas that would impair surface or groundwater quality if disturbed or developed.

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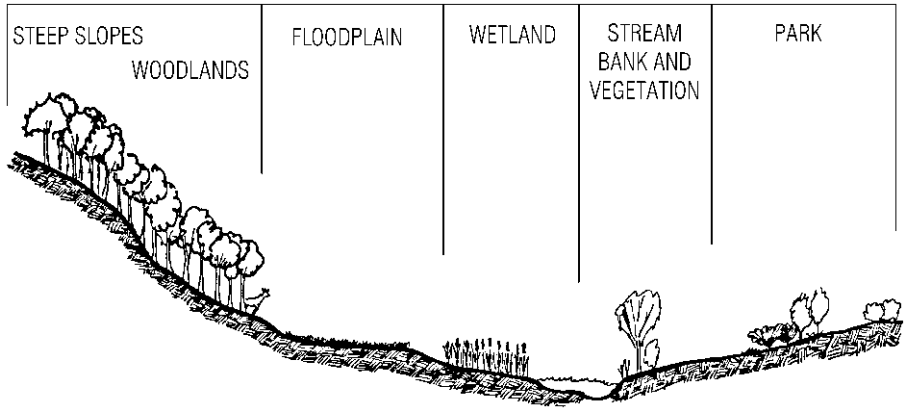

Fig. 14.2 Components of an environmental corridor: woods on steep slopes to minimize erosion and provide habitat for wildlife, floodplains, wetlands, parks, and stream banks and vegetation, with buffer zones along the streams to filter out pollutants, prevent flood damage, and provide recreation areas.

Most open-space and recreational uses are compatible with these lands. Therefore, environmental corridors can be a major part of the needed open space for a community or region. In addition, the linear nature of environmental corridors is suited to increasingly popular recreational activities requiring trail development, such as hiking, biking, cross-country skiing, and nature walks. Finally, the linear aspect of environmental corridors provides continuity, which enhances the value of the corridors as wildlife habitat.

Multipurpose environmental corridors can be delineated and protected in both urban and rural areas through a combination of regulation and acquisition. Regulatory protection through floodplain zoning and zoning restrictions on shorelands, wetlands, and conservancy areas is appropriate where public access is not needed and allows lands to remain in private ownership. It is necessary to acquire lands through dedication or purchase where public access is required for recreation, for provision of structures such as detention basins, or where access is needed for public maintenance of stream channels and structures. In addition, public acquisition through dedication or purchase may be required to protect important resource areas vulnerable to development and not adequately protected through zoning or other regulatory means. Conservation easements may also be used in instances where fee-simple title is not needed.

Parks and Playgrounds ▪ Traditionally, planning at the community level has focused heavily on public park and playground development. More recent trends have placed greater emphasis on the satisfaction of recreation needs through multipurpose use of resource protection areas and environmental corridors. There remains, however, a need for provision of parks and playgrounds in the community or regional outdoor recreation and open-space plan.

There is a difference between intensive and active use areas for outdoor games and sports and passive or extensive uses, such as scenic enjoyment and picnicking. Playgrounds and playfields are examples of recreation areas designed for intensive or active use, whereas parks are usually oriented to satisfy needs for both active and passive uses.

It is extremely important to provide for coordination and joint use of school and community recreation facilities. A neighborhood playground provided in conjunction with a neighborhood school site can satisfy students' recreation needs as well as be a neighborhood playground. Community playfields, located in conjunction with middle or high schools, can provide similar benefits of joint and efficient use of land and facilities. Specific programs for coordination and joint provision of outdoor recreation facilities are necessitated in most areas because separate government agencies are responsible for recreation and schools.

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Convenient location and access are important attributes of parks and playgrounds. Playgrounds and playfields have a high degree of locational flexibility since the principal requirement is for relatively level, well-drained land. They should be located in conjunction with or in proximity to neighborhood and community schools. A location that provides safe and convenient access is important for both the school and the recreational facility.

Resource protection areas and parks have less flexibility in location. The best sites are often dependent on the location of scenic areas, water features, and resources needing protection. Hence, greater effort must be made in providing adequate and convenient access to the sites by transportation systems, including mass transit, bicycles, and pedestrians.

14.13 Urban Design and Esthetics

Urban design and esthetics are concerned with shaping urban form and identity and improving the quality of the visual landscape. The subject is complex, involving the design skills of many disciplines—architects, landscape architects, urban designers and planners, and civil engineers.

Principles and Elements of Urban Design and Form ▪ Perhaps the most important principle in urban and regional design and form is that each element in the physical landscape be designed within the context of the next larger unit. Buildings should be designed to relate to the street or block, blocks designed within the context of the neighborhood, the neighborhood related to the community, and the community planned within the context of the region. Ideally, each element will have a clear and distinct identity but will be compatible with its surroundings and landscape and appropriate in the context of its larger setting. Elements should work together as a cohesive unit if properly planned and designed.

The key elements in urban form and identity that most people use to construct a mental image of a city include pathways (routes of circulation), districts (component areas or neighborhoods), edges (of districts), landmarks (prominent visual features helpful in orientation and identification), and nodes (centers of activity). A visual experience may be relatively static if experienced at one location. Most visual experiences, however, consist of a dynamic sequence of activities and views that occurs during movement from one location to another.

The dynamic and sequential nature of this experience should be taken into account and can be improved by carefully designing and locating urban elements and considering the relationship between elements. Transitions from one district or visual setting to another are extremely important—diversity and contrast add variety to experience—but extreme contrast or rapid transition may disturb or disorient the viewer.

Appropriate scale, also important, depends on the mode and speed of movement. Correct scale of a visual element is substantially different for a pedestrian than for a passenger in a fast-moving automobile.

Tools and Techniques ▪ Tools and techniques available to governmental bodies to foster and enhance urban design and esthetic considerations include education and information programs, regulatory programs, and design and location of public facilities.

Visual surveys of the community or region are an important element in an urban-design education and information program. A visual survey is an inventory of view experiences, scenic vistas, landmarks, approaches, and other visual aspects of the community or region. The purposes of a visual survey are to inform the public and elected officials of visual assets to be protected and to point out visual problems needing correction or improvement.

Regulatory programs are one of government's principal tools in attempting to improve the quality of the visual landscape and to shape urban form and identity. An important approach to reducing visual clutter in urban areas is to require that utilities be placed underground wherever feasible.

Zoning and subdivision regulations usually provide for the regulation of signs, fences, landscaping requirements, buffer areas, and other features that can have an important impact on the visual environment. In addition, building height, bulk, and site placement (setbacks) are regulated through zoning.

In some communities, a substantial degree of architectural control and design review is provided through the establishment of architectural review

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boards or urban design commissions. These groups, which commonly include professional designers as well as citizens, review development proposals and projects for visual quality and architectural compatibility.

Land-use planning and zoning regulations can also be used to protect significant views and landmark visibility and to maximize the benefits of significant views through zoning and building placement. Regulations can preserve lines of sight and prevent adverse development of areas or landmarks that are viewed. Zoning regulations can also be used to encourage higher densities or public uses in prime viewing areas, thus maximizing the opportunities for enjoyment of such views. Thoughtful urban design can maximize views by limiting building height, with higher buildings permitted farther away from prime views and landmarks and lower buildings placed closer to the views. This permits maximum exposure and enjoyment of views and landmarks and avoids interruption of lines of sight by nearby buildings and obstructions.

Design and location of public spaces and facilities are important opportunities for government to exert a positive influence on urban design and visual quality. Perhaps the most important role for communities is utilizing open-space acquisition and protection policies to achieve the goals of urban design and esthetics: shaping urban form and identity and improving the quality of the visual landscape. Open-space acquisition and protection policies can be used to protect scenic resources, to define district or community edges and provide buffer areas between districts, and to define and protect pathways or corridors for future uses.

Streets and roadways are public spaces and facilities with pervasive and substantial impacts on the quality of the visual experience for most residents of a community or region. By properly fitting streets and roadways to the landscape, paying careful attention to street furnishings and hardware (such as paving materials, street lighting, traffic signs and control devices, bus shelters, and other structures), and providing for sensitive landscaping of street and roadway corridors, a community can have a significant beneficial impact on the everyday visual experience of most residents. It is important to pay particular attention to main corridors and entrances to a community with high volumes of travel because these routes have high visual impact and often shape the image of a community for visitors.

In addition to streets and roadways, government can influence visual quality through design and location of other public buildings, spaces, and facilities. In all cases, key elements include good design in the context of the immediate surroundings and the larger unit, sensitive landscaping of public spaces, and provision of art in public spaces.

Historic Preservation ▪ Preservation and reuse of existing historic buildings and landmarks is an important planning issue in many communities. Historic preservation is significant to urban design and esthetics, in addition to the historic heritage being preserved.

The usual approach is to designate historic sites, landmarks, or districts. Once designated (under a variety of local, state, and Federal laws), changes in the exterior appearances of buildings are restricted, and tax incentives are often provided to encourage preservation of the building exteriors. In most cases, the building interiors may be adapted to modern use, although interiors may also be preserved in outstanding cases. Designation of individual buildings, sites, or landmarks may be limited to outstanding examples of architecture or historic interest. Designation of entire historic districts permits the inclusion of many buildings of lesser importance from a historic or architectural standpoint, to retain the historic flavor of the district and compatible architectural surroundings.

Land-Use Planning

14.14 Housing and Residential Land Use

Housing is a basic need in society and occupies most of the developed or urban land in a community or region. Hence, housing and residential land use is a central element in most community and regional land-use plans.

Housing is provided primarily by the private sector. However, government is directly involved in controlling location and type of housing and residential development as well as providing public services and facilities in residential areas. Federal, state, and local governments also provide financial assistance for low-income and elderly housing.

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Housing Types ▪ The principal distinction in housing types is between single-family detached homes, which represent the largest proportion of housing provided in most areas, and multifamily units, including apartments and townhouses. Duplexes, or attached two-family homes, may be treated similarly to either single-family detached homes or multifamily units, depending on the specific area and circumstances.

Group quarters, such as dormitories and residential hotels, may be important in some circumstances involving military installations or institutions like universities.

Mobile homes and factory-built housing units are an important segment of the housing market. These prefabricated dwelling units are often treated separately from housing constructed on-site, primarily because of differences in construction, architecture, and permanence of siting.

Goals and Objectives ▪ A fundamental goal of planning is to provide for a sufficient supply of housing units to accommodate the needs of the population. These housing units should be provided and maintained in safe, healthy, and sound condition. They should be located for convenient access to neighborhood and community activities and facilities. There should be a broad choice of housing types to suit the differing needs and desires of various segments of the population. In addition, an important objective is to ensure that housing is available at costs compatible with residents' income levels.

Establishing Needs ▪ A critical initial step in establishing housing and residential land needs in a community or region is to conduct a survey of the existing housing stock. This survey should be concerned not only with the numbers of available housing units but with their condition. Existing housing can be described as being in sound condition (requiring only conservation of existing condition), deteriorating condition (requiring repairs and rehabilitation), or dilapidated condition (requiring clearance or reconstruction). The survey of existing housing stock should also note other problems and deficiencies and describe trends and indicators of potential problems. Vacancy rates can be an important indicator of surpluses or deficiencies in the housing market or for specific housing types. Conversion of single-family homes to multifamily use is also an indicator of change in housing demand and may lead to neighborhood destabilization.

Future dwelling-unit needs can be predicted on the basis of population forecasts divided by the average number of persons per dwelling unit. Because the average number of persons per dwelling unit may change substantially over time, it is important to examine historical trends and future potential changes in this ratio.

The difference between total future needs and that portion of the existing housing stock that can supply safe and sound housing units at a future date represents the additional housing units to be constructed. Table 14.3 illustrates the assumptions and steps needed to complete a housing-needs analysis.

The total additional acreage required for new residential construction is based on the number of additional dwelling units needed and assumed future types and densities of housing units. In rural or undeveloped areas lacking public water or sewerage facilities, residential densities are usually less than 2 units per acre. These low densities result from reliance on on-site waste disposal (septic tanks) and water supply and the need to avoid overtaxing public services and facilities. In urban areas with public water and sewer service, densities generally range from 2 to 8 dwelling units per acre for detached single-family housing (with most new construction in the 2- to 5-dwelling unit per acre range); 5 to 20 units per acre for duplexes, townhouses, and garden apartments; and 30 or more dwelling units per acre for high-rise multifamily residential development.

Location and Design ▪ Planning and design of residential land uses are normally formulated on the neighborhood concept. The neighborhood is a relatively self-contained area containing from about 2000 to 10,000 residents, oriented around significant neighborhood facilities, such as an elementary school, neighborhood park or playground, and neighborhood shopping area. Proper neighborhood layout and design include adequate access to community and regional transportation systems, utilities, and public facilities. A neighborhood should not be divided by major transportation corridors or incompatible land uses. It is desirable to have a gradual transition from high- to low-density areas and to provide buffers between different types and densities of land uses. In addition, higher densities may be most appropriately

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Table 14.3 Illustrative Housing-Needs Analysis

Component	2000 (Census)	2020 (Forecast)
Population and households		
Total population	300,000	400,000
Group quarters population	15,000	20,000
Household population	285,000	380,000
Average household size, persons/unit	3.1	2.9
Total households	91,900	131,000
Housing units		
Total households	91,900	131,000
Vacancy rate, %	3.9	5.0*
Total housing units	95,600	137,900
Housing needs, 2000–2020		
Increased number of units needed	42,300	
Replacement of existing units†	5,000	
Total additional units needed	47,300	
Annual housing unit construction needs	2,365	

* Desired vacancy rate.

† Includes units lost through disaster, demolition, and conversion.

located near major transportation corridors and activity nodes or major facilities.

In many areas, instead of typical rectilinear or gridiron layout of streets and lots, cluster developments and planned-unit developments are used. These alternative layouts provide the opportunity for curvilinear arrangements and street layouts, which permits siting streets and homes in a manner more compatible with topography. The curvilinear layouts made possible through clustering and planned-unit development also provide greater opportunities for preserving existing trees and natural vegetation and can reduce overall land-grading requirements. By providing for smaller clustered lots and common open space, these approaches reduce the need for improvements and utilities. The result is more effective use of land and less wasteful provision of open space. Figure 14.3 illustrates some of the open-space and cost advantages of cluster developments over conventional subdivisions.

Although there are a number of advantages to planned-unit development and cluster development, there have been some abuses and disadvantages. The use of dead-end streets and cul-de-sacs presents disadvantages to public services. Dead-end water mains do not provide as much available fire flow as do looped mains, and dead-end streets require service and delivery vehicles to turn around and double back, which can raise the cost of public services. Generally, it is advisable to avoid excessively long dead-end streets or cul-de-sacs.

The design and location of streets is commonly provided for and specified in subdivision regulations. Moderate street grades are important for ensuring access (particularly for public-safety vehicles during adverse weather conditions) and can also be important in avoiding drainage problems. The width of residential streets is also usually specified in subdivision regulations and depends on the need for on-street parking in a particular area. Also, because of the importance of pedestrian movement and bicycle transportation in neighborhood planning and layout, sidewalks and bicycle routes should be provided to ensure safe access of children and adult residents to neighborhood schools and facilities.

Mixed-Use Neighborhood Planning ▪ Land use planning from the 1950s through the 1980s followed the post-war trend toward low-density auto-dependent suburban development patterns, characterized by a high degree of segregation or separation of land uses, as well as income stratification in new residential neighborhoods.

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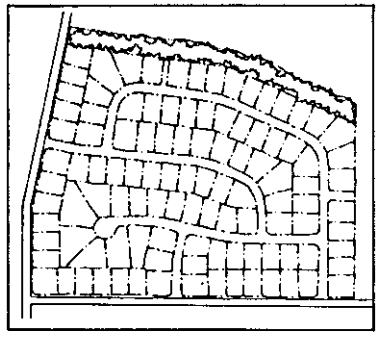
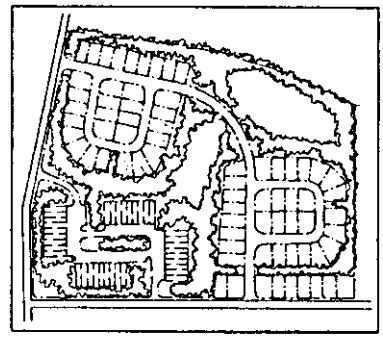


NUMBER OF LOTS: 108
OPEN SPACE: 10%
LINEAR FEET OF STREETS: 5,400
LINEAR FEET OF SEWER LINES: 5,400

(a) CONVENTIONAL SUBDIVISION



NUMBER OF LOTS: 108
OPEN SPACE: 50%
LINEAR FEET OF STREETS: 4,900
LINEAR FEET OF SEWER LINES: 3,900

(b) OPEN-SPACE SUBDIVISION

Fig. 14.3 Comparison of conventional and open-space subdivisions. (*Reprinted from "How will America Grow?" Citizens Advisory Committee on Environmental Quality, 1976.*)

As these suburban developments have aged, their problems and shortcomings have become both more evident and serious. In the 1990s, planners began to increasingly explore development patterns that would retain the desirable features and social functionality of the better urban neighborhoods built in the early 1900s, adapted to contemporary settings and circumstances.

This return to traditional neighborhood planning concepts is central to most current trends in planning thought, characterized by terms such as "traditional neighborhood development", "new urbanism" and "smart growth". Many of the concepts, and examples of this trend in neighborhood planning and development are presented in Peter Katz' 1994 book "The New Urbanism" (McGraw-Hill), included in the list of references at the end of this section.

The most basic principles and objectives of this approach to neighborhood planning and development (or redevelopment) are presented in Table 14.4.

14.15 Commercial Land and Shopping Areas

Planning of commercial land and shopping areas is basically concerned with provision of goods and services to consumers. In addition, commercial and service-related employment has a significant impact on the economy.

Classification and Types ▪ Standard land-use classifications for commercial land and shopping areas include wholesale and retail trade; finance, insurance, and real estate; services (personal, business, repair, and professional); and offices.

Commercial and shopping areas can be classified as regional centers, community areas, local or neighborhood areas, and limited-function or specialized areas. Regional centers include such major concentrations as the central business district of a metropolitan area and regional shopping centers. Community areas include the central business district of a community and community shopping centers. Local or neighborhood areas include neighborhood concentrations or shopping streets, neighborhood shopping centers, and rural concentrations.

Limited-function or specialized areas include highway service concentrations along major streets and highways and at highway intersections and freeway interchanges. Office space for professional, finance, insurance, real estate, and other similar services and entertainment areas, nightclubs, and specialized functions such as new and used car sales may be provided either as part of regional

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Table 14.4 Desirable Neighborhood Characteristics

Principle or Characteristic	Purpose or Rationale
• Compact, higher density	• Provide population base for neighborhood facilities, services, shopping, transit, employment within a reasonable walking distance (¼–½ mile). Enhances social interaction, reduces auto dependence.
• Mix of land uses	• Provide opportunities for shopping, professional services, employment within neighborhood. Reduces auto dependence and travel.
• Clustered development with smaller lots, more common or public open space	• Allows easy access to expanded and more diverse recreational opportunities. More efficient use of land, improves community appearance, enhances social interaction.
• Diverse mix of housing types and costs	• Provide housing for full range of family sizes, ages and income levels. Reduces segregation and income stratification, enhances social diversity.
• Garages and parking lots behind structures, with alleys and service drives	• Improves community appearance.
• Neighborhood public facilities and spaces (schools, parks, libraries, neighborhood centers, etc.) and shopping areas coordinated as focal points at visible and accessible locations	• Improves visibility, access and use of neighborhood facilities and shopping areas.
• Interconnected or grid-style neighborhood street systems with narrower streets	• Fosters distribution rather than concentration of neighborhood auto traffic, reduces congestion, slows neighborhood auto traffic, better and safer pedestrian and bicycle travel, easier and more flexible navigation and movement within neighborhood.
• Transit-oriented development with transit stops within walking distance of all parts of the neighborhood and at activity centers	• Enhances mobility and access to the larger community and region, particularly important for those not able to drive. Increases ridership and support for the transit system, reduces auto dependence.
• Pedestrian-friendly design	• Improves access to neighborhood facilities, services, shopping, jobs; reduces neighborhood auto trips and auto dependence.

centers, community neighborhood areas, or as separate limited-function or specialized areas.

Goals and Objectives ▪ The basic goal of commercial land and shopping areas is to provide an adequate supply of goods and services. Also, different types of shopping areas and centers should be provided, to satisfy a variety of routine and specialized shopping needs. In addition, commercial land and shopping areas should be located and designed to maximize convenience to and safety of the individual consumer.

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Establishing Needs ▪ Future needs for commercial land and shopping areas are usually based on population forecasts. If economic studies and forecasts are available, future needs based on population forecasts should be consistent with forecasts of employment, retail sales, or other economic factors. Economic studies and market surveys are often the basis for determining specific deficiencies and needs in the commercial sector. Market surveys can be used in conjunction with an inventory of existing commercial land and the present commercial economy and with forecasts of future needs to determine needed additions to commercial land and shopping areas.

Location and Design ▪ Since convenience and access are the fundamental objectives of planning for commercial land and shopping areas, location is the key attribute of a well-planned commercial land network. Regional or community centers should have direct access to major highways as well as mass transit (for employees as well as consumers). A highly visible location is important for regional and community centers.

Commercial lands and shopping areas usually attract and generate high volumes of traffic, so control of traffic and ingress and egress to the shopping area is extremely important. It is also essential, when designing the site, to provide for separation of pedestrian and vehicular traffic and to ensure that pedestrian movement is safe and convenient.

Since most consumers use automobiles for shopping trips, provision of adequate parking is a key element in design of a shopping area. New shopping centers ordinarily have adequate parking within a reasonable walking distance of a number of stores. The provision of adequate off-street parking is particularly important for existing downtown and community shopping areas if they are to compete with community and regional shopping centers.

The appearance of commercial areas and shopping centers can help attract consumers. Landscaping is an important element since many major shopping centers feature large barren parking areas. Control of signs is also important, particularly in commercial strips located along streets and highways. In addition, landscaped buffer areas are often important for protecting adjacent land uses.

Level, well-drained sites are desirable for shopping centers and commercial areas. Without good drainage, the volume and peak rates of storm runoff can be a problem in new shopping centers and commercial areas because of the relatively large areas of impervious paving and rooftops. Innovative approaches to incorporating treatment and infiltration of parking lot runoff have been developed to offset adverse impacts.

Shopping and commercial areas have some special service needs. These include truck deliveries, for which appropriately located loading and unloading areas of sufficient size for the purpose should be provided, and collection and removal of large quantities of refuse and paper wastes, for which solid-waste storage areas and efficient, economical collection practices are essential.

Pedestrian malls, which are open or enclosed pedestrian shopping ways or streets, are provided in many large shopping centers. This concept also has been adapted to central business districts and downtown community shopping areas, where pedestrian malls are created by eliminating vehicular traffic from former shopping streets. In some cases, however, limited vehicular access is retained for transit, delivery vehicles, and bicycles.

Undesirable Conditions for Commercial Development ▪ These often arise from strip commercial development, highway interchanges in rural or undeveloped areas, and commercial overzoning.

Inasmuch as commercial activities and shopping areas thrive on exposure and access, much commercial development has traditionally located along major highways and thoroughfares. This strip form of commercial development has created a number of undesirable conditions; as a result, most community and regional plans attempt to ensure that new shopping areas are not located and designed in this fashion.

Strip commercial development is inconvenient for the consumer who needs to make more than one shopping stop or who wants to comparison shop. Provision of ingress and egress directly from major traffic arteries to individual stores creates traffic-safety hazards and disrupts the flow of traffic, creating unnecessary congestion. Furthermore, there is evidence that it is more difficult to provide adequate levels of security, so strip

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commercial development may be somewhat more vulnerable to crime. For these reasons, most plans recommend the clustering of stores in commercial and shopping areas to permit consumers to satisfy their shopping needs at one location. Where it is necessary to develop commercial areas in a strip fashion, access can be provided from frontage roads paralleling the major traffic artery, rather than directly from the highway. Frontage roads can also be used in some circumstances to reduce the undesirable conditions associated with existing strip commercial development.

Highway interchanges in rural or undeveloped areas can make difficult the provision of adequate support services for commercial areas. In many instances, substantial high-value commercial facilities (often highway-service facilities oriented to motorists' needs) develop around rural intersections and interchanges, and services that are most important are often lacking, including sewage disposal, water supply, police and fire protection, and solid-waste collection and disposal. Generally, joint or cooperative provision of these services is better and more economical than individual on-site solutions. It may be necessary to devise or develop a joint management structure to provide these services cooperatively or to use special or existing governmental units to provide necessary services.

Another undesirable condition encountered in the planning of commercial land and shopping areas is overzoning. In many cases, communities attempt to attract and encourage commercial growth by zoning a great deal of land for commercial purposes in desirable locations. Overzoning commercial land or zoning all suitable areas should be avoided, to ensure that commercial development that does occur is in the proper location and that local governmental units retain control over the type and location of commercial areas. Zoning of commercial land should ordinarily be done only in response to specific proposals at the time of development, and the plan should specify only general locations for new shopping centers and commercial developments.

14.16 Industry

Planning for industry is primarily concerned with making suitable land and support services available for manufacturing and production of goods and materials. Agriculture, mining, and forestry are also industries but usually receive separate and special treatment in most planning studies.

Objectives and Needs ▪ The goals and objectives of planning for industry include:

1. Strengthening the economic base of the community. (Industry, by producing goods and materials for export from the community or region, brings in outside income that has a multiplier effect on the local economy.)
2. Encouraging development of various types of industrial and manufacturing concerns, to provide a diversified employment base. (A diversified employment base is usually more stable and less subject to sudden market fluctuations or economic downturns.)
3. Providing a sufficient number of industrial and manufacturing jobs tailored to the capabilities of the available workforce.
4. Providing adequate and suitable land for manufacturing and production purposes.
5. Locating industry to provide for economical and efficient transport of raw materials and finished goods and to be conveniently accessible to employees.

Future land needs for industry are usually based on employment forecasts. For industries utilizing multishift operations, peak shift employment should be utilized for determining land needs rather than total employment. For new industries in planned industrial parks, density may be as low as 5 to 10 employees per acre. Much higher densities are common for multistory plants and for industries and manufacturing plants in high-density areas. Additional land may be needed to accommodate the relocation of existing manufacturing enterprises to low-density or suburban areas.

In many communities, land well-suited for industry may be in short supply. Such land should be reserved and protected from development for other land uses (such as residential) that have less stringent locational and site requirements. Zoning land for industry and reserving land in planned industrial parks are common approaches to reserving future industrial land.

Location and Design ▪ Most new sites for industry and manufacturing plants are located in

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outlying or suburban areas, often in planned industrial parks. These suburban locations and industrial parks are characterized by low density and one-story buildings, to meet industrial needs for space for expansion, material storage, loading and unloading areas, and employee parking.

Manufacturing plants and industrial sites require access to major transportation facilities, both for importing raw materials and exporting finished products. Access to major highway and rail facilities is important in almost all cases. Roadways should be capable of accommodating large trucks. Airport industrial parks are sometimes provided for industries relying heavily on air transport. Access to water-transportation facilities, including docking and loading or unloading facilities, can be important and beneficial for industries receiving or shipping bulk materials.

Industrial sites should be level and well-drained and have suitable soils for foundation requirements for equipment, machinery, and structural loads. Land area should be sufficient to accommodate expansion needs, requirements for material storage and loading and unloading areas, and employee parking. For multishift operations, employee parking needs may have to take into account some overlap of shifts. Access to transit facilities for employees is desirable and can reduce employee parking needs. If public transit is not available, carpools or vanpools can be organized to reduce parking demands.

In most new industrial areas, substantial buffer areas are provided to protect adjacent land uses. Attractiveness and landscaping are considered important attributes, and substantial building setbacks are often required. Zoning and site regulations for industrial areas usually contain specific performance standards to limit emissions, pollution, noise, and other potential nuisances to acceptable levels.

14.17 Community Facilities and Institutions

Community facilities and institutions include private and public educational facilities, libraries and cultural facilities, hospitals and health-care facilities, public-safety facilities, governmental administrative facilities, water and wastewater-treatment plants, and solid-waste facilities.

Educational Facilities ▪ Educational facilities include public elementary, middle (junior high) and high schools, private and parochial schools, universities, junior colleges, vocational and technical schools, and other specialized schools.

Public elementary schools are for students from kindergarten through sixth grade. Elementary schools are ordinarily designed to serve a neighborhood within a ½-mi service radius. They have an ideal enrollment of 400 to 600 students. As the discussion in Art. 14.12 indicated, the optimum land use results when elementary schools are provided in conjunction with a neighborhood park or playground. The ideal site size for a combined school-park incorporating an elementary school and a neighborhood playground is 10 to 15 acres. An elementary school-park should be located on a collector street and sited so that children do not have to cross major highways or traffic arterials to travel to and from school.

Middle or junior high schools are for grades 7 to 9. These schools are ordinarily designed to serve a community, with a desired service radius of 1 to 1¼ mi. The ideal enrollment of a middle school is from 500 to 1500 students. A middle school should be located in conjunction with a district park or community playfield. A middle-school site that includes sufficient open space and recreation area ranges from 25 to 35 acres. A middle school should be located near arterial streets, preferably with access to mass transit.

Senior high schools are for grades 10 to 12. The schools are usually designed to serve a community, preferably with a service radius of 1½ to 2 mi. The ideal enrollment for a high school is 1000 to 2000 students. A senior high school should be located in conjunction with a district park or community playfield. A site of 40 to 50 acres includes adequate lands for open space and recreation areas. A senior high school should be located near arterial streets, preferably with access to mass transit.

In many areas, parochial and private schools educate a significant proportion of the population. When projecting space and facility needs for public schools, it is necessary to account for anticipated enrollment in private and parochial schools. When planning for higher educational facilities, including junior colleges, universities, and vocational and technical schools, it is useful to distinguish between those facilities and campuses where most of the student body reside on campus and

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commuter campuses where most students travel daily to and from the campus. Location and access, including access to mass transit, is a particularly important consideration for commuter campuses.

Libraries and Cultural Facilities ▪ In larger communities, a headquarters or main library may be provided in addition to community branch libraries. An important attribute of a main library is accessibility, particularly access to mass transit and pedestrians. Community branch libraries serve a population of from 20,000 to 30,000 residents located within a 1- to 1½-mi service radius. Generally, community branch libraries serve about the same area as a middle or senior high school, and the ideal location for a community branch library is adjacent to or near a senior high school. This provides for joint use of the library facilities by students and residents and can allow the library joint use of the school's off-street parking facilities outside school hours. If a location near a middle or senior high school is not possible, a location in a community shopping center or community business district should be considered. Generally, branch libraries have a minimum site requirement of about 1 acre for a one-story building.

Community cultural facilities include museums, concert halls, civic centers, performing arts centers, and municipal stadiums. Many of these facilities are significant traffic generators and should be located close to major highways and accessible to mass transit.

Health Facilities and Hospitals ▪ Health facilities include general and special hospitals, nursing homes, and mental health institutions. The minimum desirable size for a full-service general hospital is about 200 beds, which requires a support population of 50,000 to 75,000. Major facilities, particularly general hospitals and emergency and trauma centers, should be easy for patients to find and accessible to major highways. Accessibility to mass transit is also important for serving the needs of the hospital staff.

Public-Safety Facilities ▪ Public-safety facilities include police stations, fire stations, and emergency medical and ambulance services.

Police stations are often centralized, but in large cities, district or precinct police stations may be provided. Because most responses to crimes in progress are from mobile patrol units, the location of police stations is not as critical as that for fire stations. The location of jails and detention facilities and convenient access to courthouses, however, can be important determinants in the location of police stations. The need for central communications may also be an important factor in location.

In selection of locations for fire stations, response time to fires and other emergencies is extremely important. A basic pumper company should be provided for a maximum service radius of 1½ mi, and a basic ladder company should be installed for a maximum radius of about 2 mi. High-value areas require backup response from other nearby stations. Fire stations should have direct access to the major street and highway network. Additional stations may be needed in areas that can be isolated, such as areas where at-grade railroad crossings or temporary flooding can prevent access.

Emergency medical service or ambulance service is increasingly a governmental responsibility. Response time is also important for emergency medical service, and it is often recommended that this service be operated out of local fire stations.

Other Governmental Facilities ▪ Governmental administrative facilities include city halls, courthouses, post offices, multipurpose community and neighborhood centers, and municipal garages and maintenance facilities. Because many governmental administrative facilities are used by local citizens, these facilities should be easy to find and have convenient access.

The location of water and wastewater-treatment plants is ordinarily constrained by the location of water sources or by location of the most suitable receiving water for treated wastewater. For wastewater-treatment plants, it is usually wise to provide buffer areas to protect surrounding areas from potential odor problems.

Solid-waste facilities include transfer stations, recycling centers, processing plants and incinerators, and disposal sites. For facilities used by residents, convenient access is an important factor. Other solid-waste facilities should be located to minimize transportation costs and impacts, by providing access to major streets and highways and avoiding truck traffic on local or neighborhood streets. Location of solid-waste facilities near

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compatible land uses is desirable but buffer areas must be provided where adjacent land uses are sensitive to truck traffic and other impacts.

Utility and Transportation Systems

14.18 Service-Area Planning

Delineating the most desirable forms and patterns of urban development partly depends on those patterns that allow public services and utilities to be provided in the most cost-effective and efficient manner. Conversely, governmental control over the extension and timing of extension of public services and utilities can influence growth patterns and be an important technique in guiding both the location and timing of urban development.

Urban Services ▪ In most governmental jurisdictions, basic or general governmental services are available to all residents regardless of location. These include courts, basic police and fire protection, hospitals and health-care facilities, public-health programs, and construction and maintenance of public streets and highways and solid-waste disposal facilities.

In cities, villages, and other incorporated municipalities where development takes place at urban densities, a higher level of governmental services is generally provided. These additional urban services include public water-supply and distribution systems, public sanitary sewerage systems, higher levels of police and fire protection, solid-waste collection services, urban mass transit, urban drainage facilities and streets with curbs and gutters, and neighborhood facilities such as parks and schools. Since a chief function of urban governments is to provide urban services, a primary focus of community and regional planning studies is the determination of those areas that are anticipated will develop to urban densities and require urban services.

Urban Service Areas as a Planning Tool ▪ Most regions have more than enough vacant developable land to accommodate anticipated urban development. In some communities, boundary restrictions may limit the amount of vacant developable land available, with the result that all vacant land will be developed within the planning period. In most cases, however, only part of the available land area will be developed for urban uses within the planning period. The purpose of urban service areas is delineation of those areas that are proposed for development at urban densities within the planning period and where the governmental unit intends to provide urban services by the end of the planning period. Urban densities include most residential land uses with densities higher than 2 units per acre and nearly all commercial and industrial land uses.

Urban-service-area delineation allows the governmental unit to plan the orderly extension of utilities and public services. This permits efficient utilization of capacity of facilities and utilities and avoids premature extension of utilities and services to pockets of development scattered over wide areas. Orderly extension of public services and utilities is an additional tool for controlling location and timing of development, to complement zoning and other growth-management techniques. Urban-service-area delineation also provides guidance to the private sector as to which areas are to receive public services within the planning period.

Delineation of Urban Service Areas ▪ The procedure for delineation of an urban-service area is summarized in Table 14.5.

The initial step is to identify those lands that are environmentally sensitive or unsuitable for development at urban densities. Lands that might be excluded from consideration for urban development include floodplains, wetlands, areas of steep slopes, environmental corridors, and areas of unsuitable soils or geology, valuable or unique vegetation, mineral resources, or wildlife habitat.

The second step is to locate potential boundaries for the urban service area. These may include either natural or constructed barriers to development, such as limited-access highways, rail corridors, stream or environmental corridors, and floodplains or wetlands. Drainage area or watershed divides are important boundaries for potential urban service areas because of the efficiency and desirability of providing sanitary sewerage and drainage facilities on a drainage-area basis.

The third step is to determine the amount of vacant developable land required to accommodate anticipated urban development during the planning period. The total amount of additional land needed for urban development can be determined

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Table 14.5 Steps in Delineation of an Urban Service Area

1.	Identification of environmentally sensitive or otherwise unsuitable land
2.	Location of potential boundaries for the urban service area
3.	Determination of vacant land needed for development
4.	Delineation of alternative service areas
5.	Recommendation of a specific urban service area

from the land-use needs and forecasts (based on density standards and population and economic forecasts, discussed in Art. 14.6).

In the fourth step, alternative service areas having sufficient developable land to accommodate needed development are delineated. Ordinarily, it is advisable to delineate alternative urban service areas somewhat larger than needed to accommodate development. This is necessary for recognition of typical patterns of development. (Urban services are normally provided to areas prior to complete development.) A slightly larger area also provides some flexibility in the location of urban development.

Finally, a recommended urban service area is delineated. Although it is desirable to use natural or constructed barriers to development as boundaries, arbitrary boundaries may sometimes be necessary to provide the proper size. Bear in mind that urban-service-area boundaries will change with time and with changing conditions and forecasts.

Ultimate or Design Service Areas ▪ Most community and regional plans are prepared for medium-term planning periods ranging up to 20 to 25 years in the future. This period is the longest term for which reasonably detailed forecasts can be made. The physical life of many facilities (such as underground water and sewer lines) is often much longer than 20 years, and some of these facilities may be designed for periods ranging up to 50 years or more. The designer is concerned therefore with growth and capacity needs substantially beyond normal planning periods. A common approach is to assume full or complete development of the potential or ultimate service area of the facility (which may be a drainage area for sanitary sewerage and drainage facilities, for example), if that assumption appears reasonable and consistent with medium-range (20-year) growth trends. It is also usual to assume distribution and types of land use consistent with the medium-term plan and growth trends. It is advisable for designers to review these long-term design assumptions with the planning agency responsible for making medium-term growth forecasts, to ensure that the long-term assumptions are reasonable and realistic.

Long-term forecasts are extremely questionable. For some types of facilities (particularly underground pipes), it is usually economical to provide extra capacity to allow for future uncertainty. For other facilities, it may be best to assume the risk that capacity may be reached earlier or later than the specific design period. If capacity can be added easily, short design periods may be most appropriate and cost-effective.

Short-Term Staging Boundaries ▪ In addition to the medium-term (20 year) and long-term service areas used to forecast growth and plan and design for facility needs, it is useful to delineate areas where urban services and utilities will be extended within the short-term future (5 to 10 years). This approach guides private landowners and developers regarding the specific intentions of the governmental unit to provide services, directs short-term growth and development activities into specific areas, and avoids the inefficiency of serving, in the short term, individual areas or developments widely scattered throughout the 20-year urban service area. Short-term staging of public services and utilities can be extremely effective as a growth-management technique.

14.19 Utility Systems Planning

After areas proposed for urban development (urban service areas) have been delineated (Art. 14.18), plans can be prepared for providing these areas with urban services and utilities. Public water distribution and sanitary sewerage systems are significant governmental responsibilities and

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capital investments in newly developing areas. Natural gas, electricity, and telephone service are provided by the private sector in most areas but may be provided by government in some jurisdictions. In most communities, solid-waste collection is a governmental responsibility but may be provided by contracting with private collection firms.

Water-Distribution Systems ▪ Water-distribution systems provide an adequate supply of potable water for residential, commercial, and industrial use and adequate water for firefighting throughout the urban service area. The specific criteria for layout and design of water-supply and distribution facilities are covered in more detail in Sec. 21. Following is a brief overview of those aspects of water-supply and -distribution systems of concern in general planning studies.

Water-distribution systems provide potable water under pressure, either by gravity from high-level reservoirs or under pressure from pumping stations. Required flow rates for firefighting purposes are usually the determining factor in sizing water mains in distribution systems and establishing distribution-system storage requirements. Ordinarily, distribution mains are laid out in a grid or looped fashion to avoid dead-end mains. Distribution mains should be buried at sufficient depths to avoid freezing in winter.

Distribution storage may be provided in either ground or elevated storage tanks. The primary purposes for distribution storage include operating storage, fire-reserve storage, and emergency-reserve storage. Operating and fire-reserve storage capacity is provided to satisfy peak hourly demand rates or peak fire flow rates, which are greater than the basic supply and transmission capacity. Emergency-reserve storage provides water during an interruption in supply or a breakdown in basic supply or transmission facilities. Elevated storage also stabilizes pressures in the system and allows gravity distribution during power outages when pumping stations are out of service.

Sanitary Sewerage Systems ▪ Development patterns that conform to topography and result in the layout of sanitary sewerage systems that drain by gravity result in greater reliability and significant savings in operating costs. Lift or pump stations are required in many cases, however, and generally result in a system more costly to operate and more vulnerable to power outages or equipment breakdown.

Most areas developed in recent years have been provided with separate sanitary and storm-water sewers. There are in many cities, however, older areas that are served by combined sewers, which carry wastewater during periods of dry weather to a wastewater-treatment plant and carry storm runoff mixed with wastewater during periods of rainfall and discharge to surface-water bodies. Combined sewer systems can aggravate poor-water-quality conditions in receiving waters, and corrective solutions are difficult and expensive.

Sanitary sewers are sized to accommodate peak flows. Peak flows are based on average flow rates, determined from local flow data where available. Where local data are not available, a flow of 100 gal per capita per day is commonly assumed. This flow includes provision for usual residential and commercial wastewater flows plus an allowance for normal infiltration and inflow. Significant industrial contributions must be added to this figure. Peaking factors applied to the average daily flow rate commonly range from 1.5 to 2.0 (for sewers serving very large areas) to 4.0 (for small sewers serving relatively limited areas). The minimum diameter for sanitary sewers is 8 in, which, at minimum recommended slope, can serve a population of 1000 to 1500, or several hundred homes.

Where pumping or lift stations must be provided, it is desirable to have backup or standby facilities in the event of power outages or equipment breakdowns. More specific criteria and details regarding the design of elements of the sanitary sewerage system are in Sec. 22.

Solid-Waste Collection ▪ In urban residential areas, solid-waste collection is usually provided door to door by collection trucks and crews. It is one of the most costly public services provided to property and residents in urban areas. Collection is commonly provided as a governmental responsibility, utilizing either governmental employees and government-owned equipment or private contractors. Collection is usually provided once or twice weekly. Wastes are normally placed at the street curb for collection in residential areas. Some communities, however, collect at the rear of

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properties or provide a set-out and set-back service for residents.

Solid-waste collection is a very labor-intensive service. Efficiency and cost-effectiveness require good labor management and efficient layout of collection routes.

Waste containers and storage practices are extremely important for efficient and effective solid-waste collection. In residential areas, proper containers and storage practices improve the appearance of the neighborhood and reduce the potential for litter and health hazards. In addition, use of proper containers and locations for collection can improve the convenience and efficiency of the collection effort and yield substantial cost savings. In multifamily residential, commercial, and industrial areas, solid-waste storage needs and requirements are often neglected in site planning and layout, yet it is usually advisable to provide for containerized waste storage and collection in these high-density areas. In addition, on-site compaction of wastes often helps reduce storage-space requirements and enhances collection efforts.

The discussion of solid waste disposal in section 14.10 included resource recovery and recycling. Many communities have instituted or expanded curbside collection of recyclable materials. This often requires modifications or redesign of the solid waste collection system.

Private Utilities ▪ Other significant utilities provided to individual homes and properties include natural gas, electricity, telephone, and cable television. In a few limited locations, steam or hot water may also be supplied and distributed for district heating purposes. These services are usually provided by private utilities, but in some cases they may be provided by government-owned utilities.

Underground installation of utilities is a significant issue in most communities. Underground installation of all utilities can substantially improve community appearance, as discussed in Art. 14.13, and it can reduce maintenance needs and increase reliability of utility service. Another major issue regarding utility service is the desirability of reserving or providing multipurpose utility corridors for joint use or installation of utilities. This can result in more efficient use of land and avoid problems such as disruption during construction and confusion as to location of utilities. The issue of joint use of multipurpose utility corridors has been thoroughly investigated by a number of organizations, including the American Society of Civil Engineers.

14.20 Transportation System Planning

Comprehensive multimodal transportation system planning is an extremely complex subject. This type of planning is a significant portion of the total planning effort of most regional and metropolitan planning agencies, working in concert with state highway departments. Following is only a general overview of the main principles and issues of transportation system planning.

Elements of Transportation System Planning ▪ The principal modes of transportation include: pedestrian facilities and bicycles; street and highway vehicles (automobiles, buses, and trucks); rail transportation (intercity rail, commuter trains, subways); air transportation; and water transportation.

The principal elements for each mode of transportation include the vehicle (automobile, train, barge); the travel way (highway, rail line, waterway); and terminal or transfer facilities (parking lot, rail terminal, port). Because many trips involve the use of more than one mode of transportation, it is important for the plan to fully accommodate and facilitate transfer between modes. Terminal or transfer facilities should be provided for transfer from one mode to another and may also provide storage space for vehicles. Parking lots and garages are primary examples.

The most important goals and objectives of transportation planning include:

1. Enhancing the mobility of residents and accessibility to employment, shopping areas, education, health-care, and other public facilities
2. Increasing the convenience and safety of necessary travel, including consideration of different modes and transfer between modes
3. Avoiding detrimental impacts of transportation facilities on neighborhoods and communities
4. Reducing the monetary and time costs associated with travel and transportation facilities

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Pedestrian Facilities and Bikeways ▪ Walking and bicycles are important transportation modes in neighborhood travel, for short trips and for circulation in high-density areas, such as central business districts and university campuses. Bicycles also may be used extensively in some areas seasonally, for recreation and work trips.

Outdoor pedestrian facilities commonly include such elements as sidewalks, pedestrian malls, and pedestrian bridges or overpasses. Bike lanes may be provided as separately marked lanes on existing streets or as entirely separate paths. Separate bike paths may be reserved exclusively for bicycles or jointly used by cyclists and pedestrians. In areas of light travel, sidewalks may be used jointly as bikeways and pedestrian facilities if curbs are ramped. Adequate bicycle parking and storage facilities are critical elements at the terminus of trips or at transfer points. It is important to design pedestrian and bikeway facilities as integrated networks that tie into other modes of transportation and to design these networks to avoid conflicts between modes of transportation.

Street and Highway Planning ▪ Street and highway planning is the most significant aspect of multimodal transportation system planning since most trips are made by automobile. For planning and designing the street and highway network, streets and highways are classified according to function; these classifications include freeways, expressways, arterial streets and highways, collector streets, and local streets. Section 16 contains detailed guidelines and design criteria for various classes of streets and highways.

Traffic-carrying capacity of streets and highways is based on the concept of level of service (see Sec. 16). The highest level of service is A, which represents free flow of traffic at design speeds. The lowest level is F, which represents unstable congested flow conditions at low speeds. The maximum carrying capacity of a street or highway generally corresponds most closely to level of service E, which is characterized by unstable traffic flow and average speeds of about 30 mi/h.

The primary function of **freeways and expressways** is to carry traffic. Ordinarily, no direct access is provided to adjacent land, although frontage roads paralleling the expressway or freeway may be utilized to provide access to abutting land. Expressways may have at-grade intersections with cross streets, and freeways usually have grade separations and interchanges to provide uninterrupted traffic flow. Freeways and expressways are commonly designed as 4- to 8-lane, divided highways capable of carrying average traffic volumes of 25,000 to over 40,000 vehicles per day. The primary use of freeways is for medium to long intraurban trips and for intercity travel.

The primary function of **arterial streets and highways** is to carry traffic for most major intraurban trips over 1 mi, particularly during peak hours. Arterial streets and highways ordinarily provide only limited direct access to adjacent land. This direct access is usually focused on major facilities, shopping centers, or other significant traffic generators. Arterial streets and highways are usually designed with 4 to 6 travel lanes, may have parking lanes, and may be either divided or undivided highways. These facilities are capable of carrying average traffic volumes up to about 25,000 vehicles per day.

Collector streets carry traffic and provide access to adjacent land. Collector streets are most appropriate for short to medium (½ to 1-mi) intraurban trips. Collector streets receive traffic from local streets and transmit it to arterial streets and highways, expressways, or freeways. Collector streets, spaced to relieve excessive traffic volumes on local streets, are commonly designed with 2 travel lanes and 2 parking lanes, with the capability of carrying up to 8000 to 10,000 vehicles per day.

Local streets provide access to adjacent land. They are normally used only for very short (½-mi or less) intraurban trips. Local streets commonly have 2 travel lanes and 1 parking lane. Traffic volumes are normally kept to minimum levels.

Right-of-way requirements for streets and highways vary considerably to accommodate space needs for utilities, sidewalks, and landscaping. Total public right-of-way for local streets is usually about 60 ft; for collector streets, 66 to 80 ft; and for arterial streets and highways, 80 to 120 ft. Special lanes for buses or bicycles are added in some cases, which results in additional right-of-way requirements. Specific cross-sectional details and geometry are discussed in more detail in Sec. 16.

Parking Requirements ▪ Since most trips are by auto, parking needs are usually important considerations in land use, transportation, and site planning. An adequate supply of parking is necessary to ensure convenient access and smooth

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functioning of the transportation system, but parking often requires a large proportion of the land or site facilities at major activity centers or destinations. Table 14.6 indicates the parking requirements for major land uses, appropriate where most of the travel to and from the uses is by auto rather than transit or pedestrians.

Urban Mass Transit ▪ Urban mass transit includes bus systems (providing both local and express service) and rail systems, such as subways, elevated trains and tramways, and commuter railroads. Paratransit (taxicabs, airport limousines, and special services, such as elderly or handicapped vans) is important for serving special needs and areas.

Urban mass-transit systems are heavily oriented to serving trips to work or school and regular trips to large activity centers, such as central business districts. These systems can substantially reduce parking needs and congestion in central business districts.

Bus systems are the most commonly used form of urban mass transit. They have the advantage of flexibility, in that routes can be changed and new areas added quite easily, and the system can be adapted relatively easily and economically to changing conditions. Bus systems utilize existing streets and highways and do not require major investments in the travel way or terminal or transfer facilities. Bus systems are capable of providing transportation service to within convenient walking distance of residential areas.

Table 14.6 Parking Requirements

Office	3 spaces per 1000 ft^2 of gross leasable floor area (GLA)
Retail	Range from 3 spaces per 1000 ft^2 of GLA for convenience stores to 5 spaces per 1000 ft^2 for regional shopping centers
Restaurants	20 spaces per 1000 ft^2 of GLA
Hotels	1.25 spaces per room
Industrial	0.6 space per employee
Residential	Range from 1 to 1.5 spaces per multi-family unit to 2 spaces per single-family residence

Source: Institute of Transportation Engineers and Urban Land Institute.

Important factors in improving bus ridership and service include convenience, comfort, and speed. Local bus service can be convenient if stops are located relatively close together, routes are spaced to keep walking distances relatively short ($\frac{1}{4}$-mi maximum), and time intervals between buses are relatively short, particularly during peak hours. Comfort can be enhanced by providing modern equipment and bus shelters.

Local bus service can be quite slow compared to automobile or rail travel and is most suited for short to medium intraurban trips. Express bus service along major arterials or freeways, with limited stops, is more suitable for longer trips. Exclusive travel lanes and preferential treatment for buses have been utilized in some locations to significantly reduce travel times. Local buses can be feeders to express bus or rail transit for long intraurban trips. Besides serving local feeder buses, express buses can utilize park-and-ride facilities, where provision is made for all-day parking for commuters.

Rail facilities used in urban transit systems include subways and commuter railroads. Subways or sometimes elevated trains or tramways are used for circulation in very high density areas with significant travel volumes, such as central business districts of large cities. Commuter rail facilities are used for commuter travel along high-density corridors in major metropolitan areas.

Rail transit efficiently serves high volumes of travel with minimum use of land and facilities and effectively reduces congestion during peak hours. Rail transit requires a large population base generating high traffic volumes to be feasible. The disadvantages of rail transit include a fixed location and a high cost for the travel way and stations or terminals. Rail systems are inflexible in location and ordinarily not capable of providing convenient service within reasonable walking distance in residential areas. To overcome these disadvantages, the following guidelines are suggested:

1. Rail transit should be used where most appropriate: for medium to long intraurban trips along very high-density corridors, for travel to and between major activity centers in large urban areas, and for circulation within very high density areas, such as central business districts.
2. Rail transit facilities should be located in high-density corridors generating substantial travel demands.

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3. Local feeder-bus service and park-and-ride facilities should be provided to maximize convenience.
4. Attempts should be made to reduce costs where possible by utilizing existing rail facilities and by locating rail routes in or adjacent to other transportation facilities, such as freeway rights-of-way.

Urban Transportation Modeling ▪ The urban transportation planning process in most metropolitan areas considers more than one major mode of travel. The process is sufficiently complex to require computer models. The models simulate travel patterns and volumes and allow evaluation of alternative land-use patterns and transportation-system network changes or adjustments needed to satisfy travel needs. Figure 14.4 illustrates the basic steps in the urban transportation modeling process. It includes feedback and reiteration designed to seek a match between travel demand and transportation facilities capable of satisfying that demand.

Intercity Rail, Air, and Water Transportation ▪ Rail, air, and water transportation facilities, like highways, are important for providing intercity movement of people and goods. Intercity rail travel usually focuses on freight movement, with less emphasis on passenger travel. Because rail transportation is an important mode for movement of freight and bulk materials, availability of rail facilities can be a major factor in location of industries. Section 19 presents engineering and design aspects of rail facilities.

Air transportation is a significant mode for intercity passenger travel as well as high-value, low-bulk freight. The two major categories of air travel include commercial air carriers and general aviation, which uses small private and business planes. The needs of commercial air carriers and general aviation often conflict. In many areas, consideration is given to separating the two types of air travel and providing separate facilities for each.

Airports are the major terminal and transfer facilities for air travel of concern to the community and regional planner. (Specific engineering and design aspects of airports are discussed in Sec. 18.) Land needs for airports can range from as little as 50 to 100 acres, for a small airport serving light planes, up to 15,000 to 40,000 acres or more, for a major international airport. An important consideration is provision of sufficient spacing from other airports to avoid air-traffic conflicts.

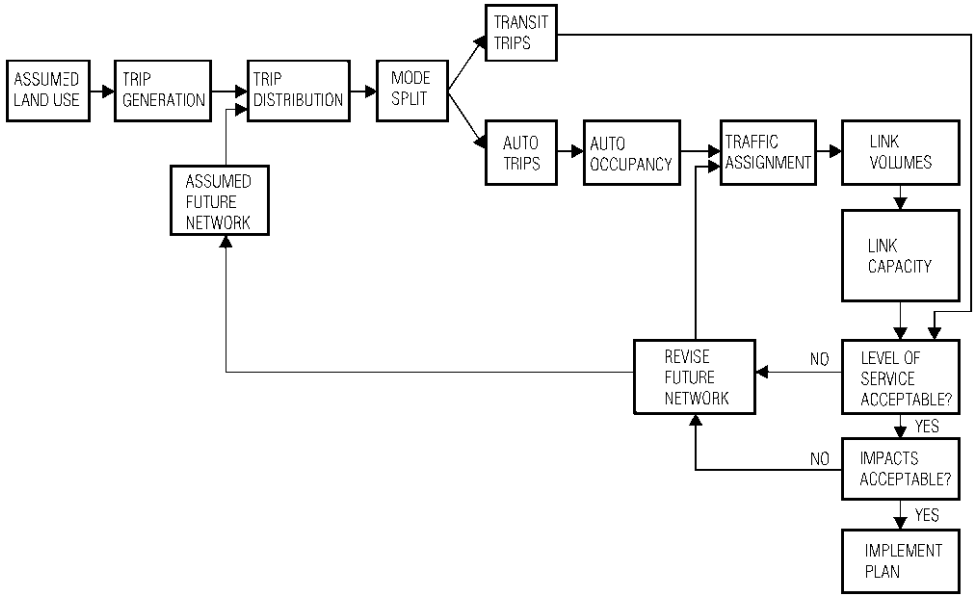

Fig. 14.4 Steps in urban transportation modeling.

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Flat terrain in an elevated location, as well as absence of physical barriers or hazards, is important in airport siting. Good soils and drainage are key features, as is availability of utilities. Since trips rarely end at the airport, airports serve primarily as transfer facilities, so accessibility and interconnection with major regional transportation facilities are other critical elements in airport location. Compatibility with adjacent land uses also is a significant issue with most airports because of safety requirements and noise problems. Strict control of use of adjacent land, particularly land near approach and takeoff paths, is essential to avoid future problems.

Water transportation is an important mode of transportation for bulk materials. The main concern of community and regional planners is provision of terminal and transfer facilities (ports and harbors). Specific design and layout of ports and harbors is discussed in Sec. 23.

Implementation Tools and Techniques

14.21 Comprehensive and Functional Plans

The comprehensive plan for a community or region, sometimes called the master plan or city plan, is the most important and central document for management and control of an area's physical development and growth. The comprehensive plan addresses all aspects of the physical development of a community or region. The main subjects of most comprehensive plans include: resources and environmental quality, private and public uses of land, community facilities and utilities, and circulation.

The comprehensive plan serves a number of very important purposes:

1. As a statement of community goals and policies. (Thus, citizens and elected officials should be intimately involved in the preparation of a comprehensive plan.)
2. As a guide to governmental and private decision making. (To be effective and useful, the comprehensive plan should be designed to be used constantly by both the executive and legislative branches of government. The plan should be updated and revised frequently.)
3. As an overall framework to guide the preparation of more specific and detailed plans for individual services or facilities or plans for community subareas or neighborhoods and to coordinate those functional and subarea plans.
4. As a legal basis and foundation for land-use and growth-management tools, such as zoning, official mapping, subdivision regulation, annexation, public-utility and service extension policies, land acquisition, and capital-improvements programming.

Comprehensive plans may take the form of either a general or policy plan or a physical master plan that contains detailed locations of specific land uses and facilities. Each format has important advantages and disadvantages. The general or policy plan is generally more compact and easy to prepare, read, and use. The general plan addresses only the more important goals and policies, leaving specific details to individual cases and special studies. A general or policy plan is most useful as a guide to general governmental decision making and is the easiest form to update and keep current.

A plan that contains specific locations of land uses and facilities illustrates the practical results of applying the plan goals and policies, making it easier for citizens and elected officials to understand. A detailed physical plan addresses specific locational decisions and has the advantage of pointing out areas of potential controversy and conflict prior to implementation. Since detailed proposals are more likely to point out implementation and feasibility problems early in the process, detailed physical plans can be instrumental in moving expeditiously from plan policies to implementation. Detailed physical plans are more difficult to prepare and update and are much more cumbersome to use and read. A particular disadvantage of bulky and cumbersome detailed plans is that important or key issues tend to get lost in a maze of detail.

The most advisable approach is to combine the best elements or attributes of the general or policy plan with those of the detailed comprehensive plan. Plan goals and policies should be clearly highlighted as the overall framework. It should be recognized that goals and policies are not sufficient in themselves. Therefore, it is important that the plan include a sufficiently detailed illustration of the proposed physical development of the community or region to show the desired end results.

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The format should allow for convenient and frequent revision and updating and contain text summaries of detailed functional or subarea plans. Detailed plans for specific functions, services, or subareas, such as neighborhoods, should be incorporated as separate documents or appendixes that can be individually prepared, changed, and updated.

Figure 14.5 illustrates a typical comprehensive growth and development plan for a small community; Fig. 14.6 shows one for a metropolitan region.

14.22 Zoning and Subdivision Regulations

Zoning ordinances and subdivision regulations are regulatory means of implementing the comprehensive plan and controlling land conversion and development processes. Both zoning and subdivision regulation are based on the community's exercise of police power to enact laws protecting its citizens' public health, safety, morals, and general welfare.

The zoning ordinance designates, with a map and text, land-use districts and outlines compatible land uses permitted within each district. Also specified are conditional uses or special uses that may be permitted within a land-use district under certain conditions after specific review in individual circumstances. The zoning ordinance normally includes provision for various residential, commercial, industrial, and open-land districts. Within each district, the zoning ordinance specifies (in addition to land use) density or area requirements for individual parcels; height, bulk, and placement of structures; and regulations regarding provision of off-street parking and loading areas, signs, landscaping and buffer areas, noise- and pollution-emission standards, and other requirements.

The zoning ordinance is based on the comprehensive plan, but it is not identical to the land-use plan element of the comprehensive plan. The zoning map is a short- to medium-term assignment of land uses rather than long-term. It often represents a compromise between existing land-use patterns and those in the comprehensive plan. The ordinance usually contains provisions for temporary nonconforming uses and procedures for variances from the ordinance requirements. In some communities, added flexibility is built into the zoning ordinance by providing more general requirements for density (such as Land-Use Intensity Standards) and performance standards rather than specific requirements for lot area and building placement. In many communities, the zoning ordinance contains a provision for planned-unit developments, which allows greater flexibility for large integrated developments but requires detailed review and approval of specific development proposals.

Subdivision regulations govern the process of dividing land and converting it to building sites. Subdivision regulations usually include procedures for submittal, review, and approval and recording of plats for land records.

A two-step planning process is normally specified. In the first step, a preliminary plat is prepared and submitted to obtain approval of the overall layout and design of the area prior to detailed design. In the second step, a final plat is prepared and submitted, to serve as the legal instrument of public record for land-recording purposes.

Subdivision regulations also specify requirements and design standards for layout of streets, blocks, lots and parcels, open spaces, and relationships with adjacent areas and land uses. Specifications for grading, streets, and other required improvements and facilities are often included. In addition to requiring installation of certain public improvements and utilities, many communities require dedication of land for public facilities or open spaces as part of the land-division procedure.

14.23 Capital-Improvements Programming and Financing

A capital-improvements program is a short-range (5- to 6-year) plan and schedule for financing and constructing major public facilities and physical improvements recommended in the comprehensive plan. A capital-improvements program is needed because many projects are too large to finance or complete in one year.

The program should be designed for use as a budgeting tool. It should be prepared for a specific governmental unit, with significant involvement of the legislative and executive branches of government, particularly governmental agency and department staff. Although usually prepared

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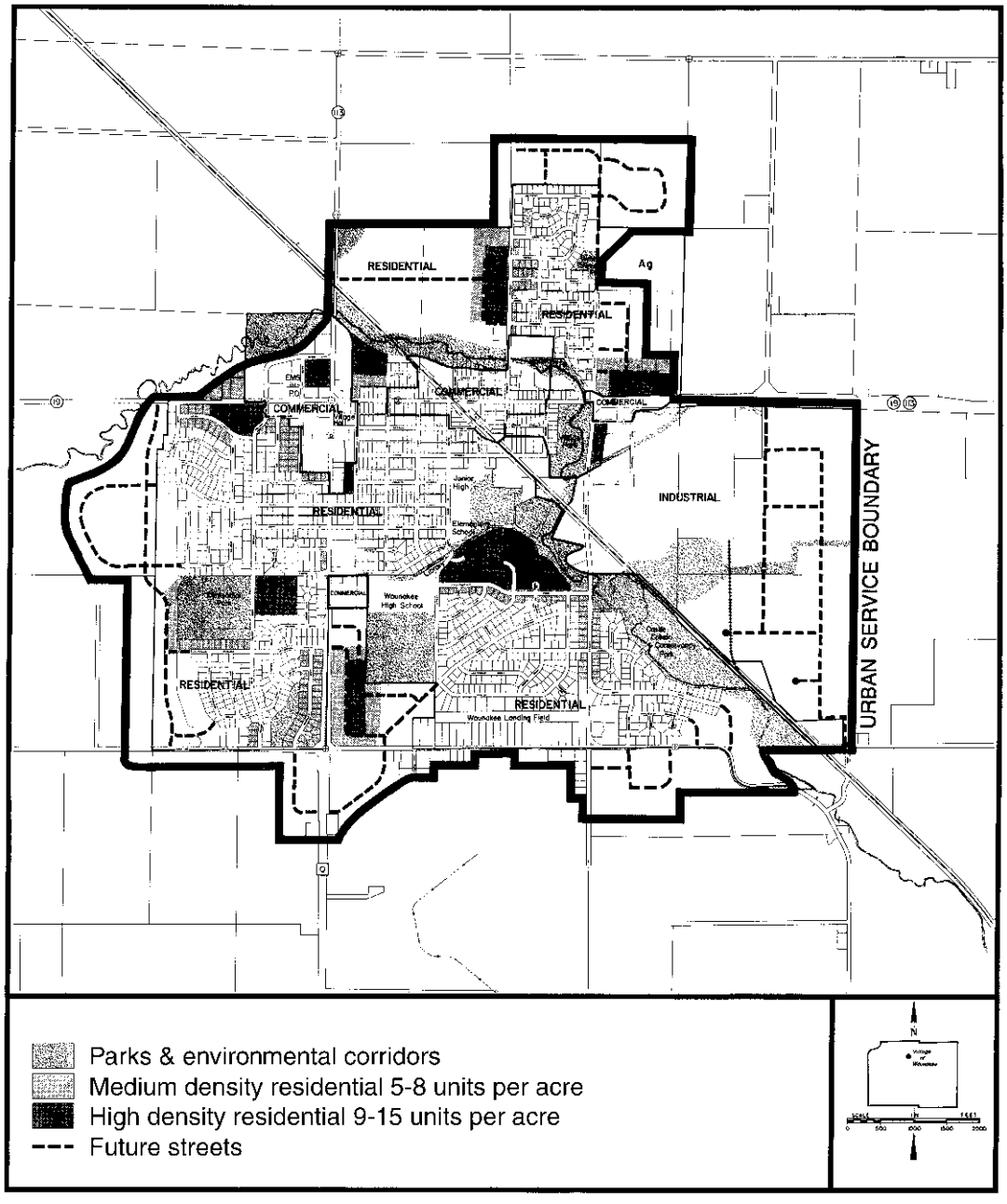

Fig. 14.5 Development plan for a small community, developed by the Dane County Regional Planning Commission, Madison, Wis., 1988, for the village of Waunakee.

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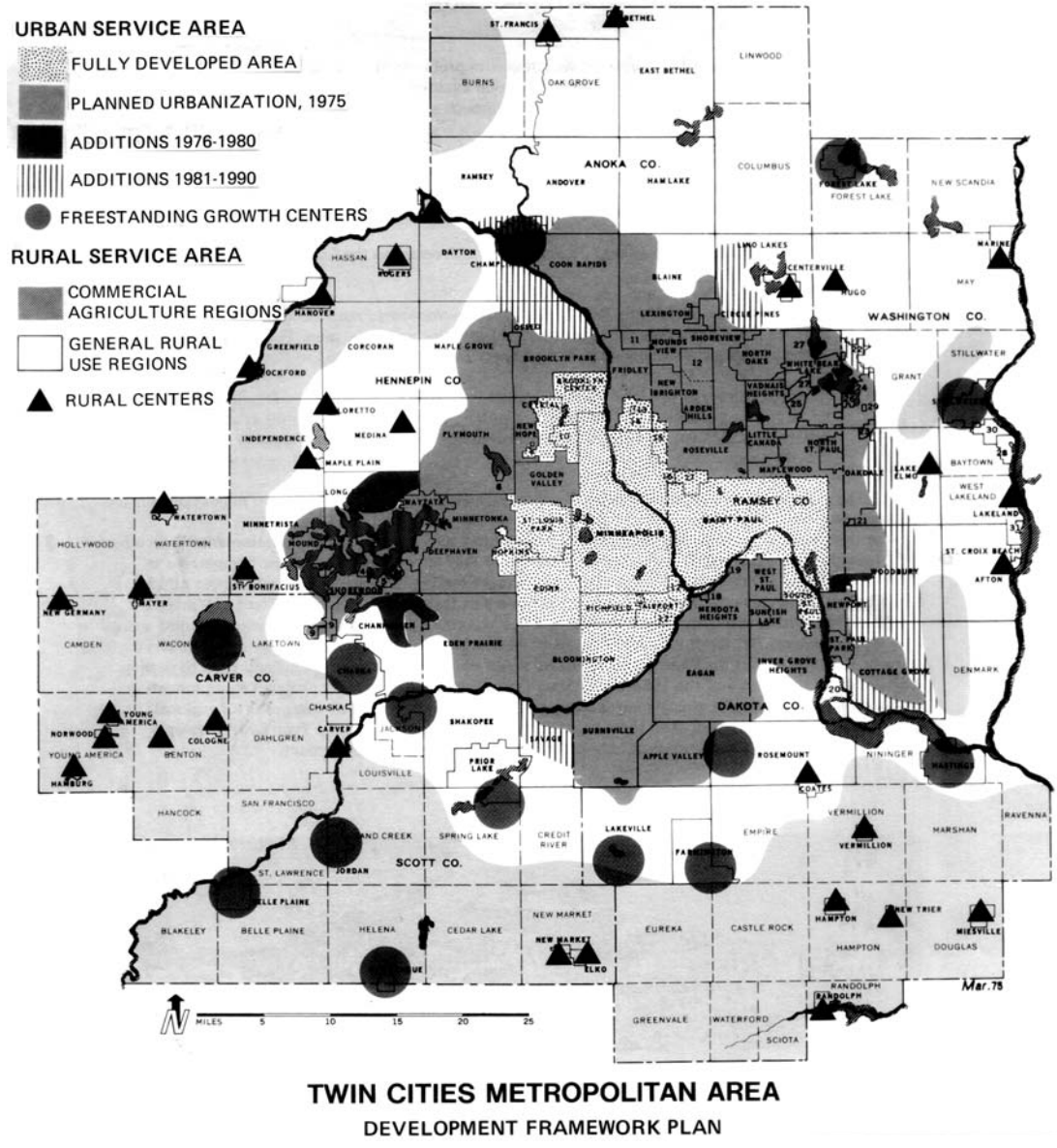

Fig. 14.6 Regional development plan. (*Reprinted with permission from "The Politics and Planning of a Metropolitan Growth Policy for the Twin Cities," The Metropolitan Council of the Twin Cities Area, St. Paul, Minn., 1976.*)

to cover a 5- to 6-year period, the program should be updated and revised annually as part of the budget process. The first year of the capital-improvements program should contain a detailed budget and description of activities; later years of the program should show an annual budget and activities in less detail.

The initial step in preparing a capital-improvements program is a financial analysis of the revenues, expenditures, and indebtedness of the

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governmental unit. Normal operating and maintenance expenditures, which must be paid out of current revenues, are evaluated and projected for future years. Projected future revenues in excess of operating and maintenance expenditures are available for financing capital improvements.

After the financial analysis has been completed, the recommended capital improvements from the comprehensive plan are evaluated and assigned priorities. Those improvements that are to be initiated within the short-range programming period are selected. Evaluation of and assignment of priorities to projects is a sensitive process, which requires extensive involvement from elected officials and governmental department heads.

Finally, based on available revenues and financing mechanisms, recommendations are made, projected budgets are prepared, and long-term financing arrangements are proposed.

Governmental expenditures are financed from a variety of general revenue sources and grants from other levels of government. Basic local governmental revenues include taxes on real and personal property, income taxes, sales taxes, direct user charges and fees, special assessments against benefited property, and grants from state and Federal governments.

Major capital expenditures may be financed over short- or long-term periods. Loans are commonly used for short-term financing periods of less than 10 years; bonds are normally used for long-term financing. Bonds may be revenue bonds (which are repaid from user fees and charges), general obligation bonds (repaid from general tax revenues), or assessment bonds (repaid from special assessments). Revenue bonds are most suitable for improvements that provide income in the form of user charges or fees (such as those from use of water and sewerage systems). Revenue bonds and assessment bonds often require somewhat higher interest payments than general obligation bonds. General obligation bonds, on the other hand, require voter approval in many states.

Equity is a principal concern in determining the appropriate method of financing. Although financing arrangements often try to assess costs against those who directly benefit from a service, many basic taxing and financial proposals also reflect other governmental objectives, such as lighter tax burdens for low-income individuals or heavier taxes on luxury items.

14.24 Other Implementation Tools

Other important tools that can significantly help implement comprehensive plans include phasing and extension of public services and utilities; official mapping; codes, permits, and impact statements; and rehabilitation and clearance.

The approach to and advantages of phasing and extension of public services and utilities is briefly outlined in Art. 14.18. By controlling the location and timing of the extension of public utilities and the provision of public services to newly developing areas, the governmental unit can exert considerable influence over the location and timing of development.

Many states permit communities to prepare and adopt an official map, which pinpoints the location of future streets and other public facilities. The map is an indication of the community's intent to acquire specified property for public purposes, and the adopting ordinance usually prohibits development of specified lands until the community is notified and has an opportunity to acquire them. Projects sufficiently defined to fall within the capital-improvements programming period are suitable for official mapping.

Codes, permits, and impact statements are also a means for allowing governmental examination and control of construction and activities having a significant impact on physical development. Codes, such as building and sanitary codes, contain detailed requirements and specifications to ensure adequate new construction and minimum acceptable conditions in existing facilities. Vigorous code enforcement is especially important for preventing further decline in areas showing signs of deteriorating housing and facilities.

Governmental agencies and departments require permits or impact statements for a variety of projects and activities. Permits, such as conditional-use permits, discharge permits, activity permits, and impact statements allow an examination of the impacts of particular projects or activities and may result in the placing of restrictions on the project or activity to ameliorate adverse impacts.

Where housing, structures, or facilities are deteriorating or dilapidated, rehabilitation or clearance may be the appropriate solution. Rehabilitation programs are oriented to deteriorating

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areas, structures, and facilities that can be restored to acceptable conditions. The principal elements of a successful rehabilitation program usually include vigorous code enforcement, repair or reconstruction of public facilities, and provision of technical and financial assistance in private upgrading efforts. Clearance and redevelopment may be necessary where structures and facilities are dilapidated and restoration to acceptable conditions is not cost-effective. Close cooperation between the public and private sectors in redevelopment projects is important to success.

14.25 References

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