Second Edition

LAND DEVELOPMENT CALCULATIONS

Interactive Tools and Techniques for Site Planning, Analysis, and Design

Walter Martin Hosack

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Land Development Calculations

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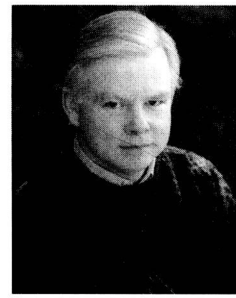

Walter Martin Hosack, AICP, has leadership, management, design, and production experience in city planning, urban design, and architecture, civil engineering, building regulation, code compliance, and zoning administration. Over the past 40 years he has planned, designed, produced, and managed projects ranging in size from residential homes to $100 million commercial and institutional projects. This private practice is accompanied by public experience in the leadership of planning and development efforts at both the state and local levels of government.

Mr. Hosack is retired, holds Bachelors and Masters Degrees in Architecture from Miami University, Oxford, Ohio, and is a charter member of the American Institute of Certified Planners. He was licensed by the State of Ohio, certified by the National Council of Architectural Registration Boards and a past member of the American Institute of Architects.

Preface

The second edition of *Land Development Calculations* has been expanded to improve our ability to build knowledge, evaluate options, and express leadership decisions in the precise language needed to plan and guide the shelter division of our built environment toward the "smart growth" required for a sustainable future.

One of my first planning projects was to assist in the evaluation of a townhouse development proposal. A ravine reduced the buildable area but density regulation was based on the total acres involved. As a result, the number of units permitted was unrealistic given the land available. This left the feasible number open for debate since other variances were required as well. The issue was intensity and context; but the argument focused on detail and appearance, since context could only be defined by intuition. Intuition was discounted by reference to experience and claims of economic hardship as opinion struggled for advantage. The collision occurred within a prescribed legal process but the substance of debate suffered from the tools and knowledge available. A search for precedent ensued, procedure was respected, another decision was made; and my search for a better way to forecast options, evaluate alternatives, explain implications, and provide leadership began.

The tenements of New York City have shown that shelter without open space threatens our health, safety, and welfare; but inadequate quantities can preserve health without improving the physical, social, and economic conditions called "welfare" or "quality of life." We now face an overreaction called "sprawl" that threatens to consume the land that sustains us if pursued indefinitely. This cannot continue without consequence, but we cannot provide shelter without open space to mitigate intensity and stimulate context.

Land Development Calculations explains how to evaluate options. It is a title that emphasizes the mechanics of an idea—one that involves shelter, space, intensity, and context. We need shelter to survive but have learned that excessive intensity has an impact on public health, safety, and welfare. We have learned that open space within cities contributes to their quality of life, but have few facts or parameters to support the opinion. We are also aware that space beyond cities ensures our survival, in addition to the shelter within; but our projects continue to sprawl over the land with suffocating efficiency.

Living in limited areas preserves the open space beyond, but excessive intensity will not produce the balance and context required; nor will excessive sprawl. Context is a function of intensity and turns the space available into places for people. Intensity determines the population and scope of activities that can be sheltered within the area involved. The attached software collection entitled Development Capacity Evaluation has been written to help assess these relationships based on its mathematical ability to predict the options available and benchmark the results achieved. It is based on values assigned to design specification topics within each model. These values are used by embedded equations to forecast intensity and influence the context created. (This second version has been enhanced with two new cost-forecasting modules and a complete revision of its single-family and townhouse forecast models.) Specific predictions are based on the model chosen and the design specification values entered. The conversion of space to context, however, will remain a function of intuition, comparison, talent, and experience that will improve as we learn more about intensity and express the knowledge acquired with a leadership vocabulary.

Design OF mass and space is architecture, but open space is often a by-product that expands or contracts based on the building requirements involved, the land available, and the return on investment expected. Parking is considered open space to justify the intensity constructed, but we all know the difference. Mass becomes sculpture and form becomes appearance to shelter the function within, but context suffers from the intensity introduced and precedent extends the pattern.

Design WITH mass and space is city design. It crosses boundaries to define the intensity expected from the future construction of mass. Design with nature is a fundamental goal. Design with space is a technique to produce the plans required. Design with intensity relates mass to space and defines the population that can be sheltered by the urban form that emerges. The context created uses urban space to improve a city's quality of life and natural space to initiate a symbiotic future. This is the description of an opportunity, however.

Some land use plans currently include environmental and ecologic components. These components have had difficulty spanning nations with their global purpose; and rarely extend beyond isolated areas. They have not been combined with city design to produce symbiotic form and function, and the result is a context for people that has difficulty meeting its obligation; but our atmosphere, and a single image from space, is showing us the scope required.

City planning and city design attempt to organize urban shelter, movement, open space, and life support systems to serve and protect human activity. The result is often referred to as a built environment distinct from the natural environment it consumes. The conscious effort to design cities has been preoccupied with public spaces, street systems, and their relationship to monumental buildings throughout most of a history that reaches back to at least the gridiron street plan of Hippodamus in the latter half of the fifth century BCE. In the nineteenth and twentieth centuries, planners attempted to separate incompatible land use activities and improve building code requirements to protect the public health, safety, and welfare. This period also recognized that excessive tenement intensity and inadequate sanitation not only threatens those within, but those beyond; while suburban sprawl is a threat to the planet that can only be seen from satellite.

Ian McHarg proposed that we design with nature in the title of his landmark book, which implies that we design with an understanding of intensity to preserve the agricultural and natural systems that make life possible. Intensity involves the relationship of mass and pavement to open space within and across project boundaries. When not left to chance, it often requires government involvement since owners tend to emphasize mass over space in return for profit. The compromise in place accepts parking as open space, since it allows light and air to reach the ground. This formula for survival ignores nature and may provide the bare essentials to man, but still omits places for people in proportion to the intensity constructed, and rarely considers the ecologic consequences involved.

Design with space requires an ability to forecast the choices available, since our culture challenges intuition and expects to be persuaded by a comparison and evaluation of consequences when knowledge is not available. This is particularly true when hardship is a claim that attempts to trump all other provisions. The language and mathematical foundation of Development Capacity Evaluation provides a platform of logic to support city design. It displays intensity options that can be evaluated by all parties involved; and can forecast realistic development capacity given any set of design specification values.

For some reason, the obvious is often obscured by detail in a forest of precedent. Open space must be preserved beyond our cities and provided within to secure our future, but this requires a thorough understanding of intensity. In the end, design with space means learning to live within limits, but we are not even close to defining these parameters with the intensity levels required. Development Capacity Evaluation forecasts the options available. These forecasts represent a leadership language that can precisely define the opportunities present and the decisions taken. This means that intuition can be supported with logic until research replaces it with knowledge. The result will be relationships between mass and space that combine livable cities and lifestyle options with environmental and ecologic preservation.

The goal is a leadership language capable of evaluating and leading the shape and form of cities toward sustainable relationships with the planet; toward agricultural preservation and a better quality of urban life; and toward an understanding of the population this implies. When successful, form will express a symbiotic achievement that transcends industrial progress. Development Capacity Evaluation is a candidate for this universal language; since it can improve the collaborative ability of all who now consider the diversity of life on Earth and the human issues of shelter, movement, life support, and open space in isolation.

The Issue

The issue begins with a single image from space that reveals a gift of unique beauty wrapped in a universe beyond imagination. The visible image in Fig. 1 also accommodates an invisible built environment that is spreading across the face of the planet. The road to a symbiotic future begins with this awareness and the realization that we are now capable of disrupting the balance required.

Many currently believe that we have a right to own a piece of this planet and freedom to use it to pollute the land, sea, and air while disrupting the ecology present. This is a threat that has nothing to do with land ownership and everything to do with permitted use of the land and sea. A successful resolution of this fundamental issue will be reflected in the land allocation of nations, the design of cities, the fabric of urban space, the architecture of shelter, and the scope of populations; but it must overcome a challenge from powers unwilling to adapt to the ecological gift we have been given. This means that we must improve our forecasting ability, strengthen our power to persuade, and improve our ability to learn with a language that has leadership potential.

FIGURE 1 Earth over the Moon. (Source: www.nasaimages.org)

Land Use Allocation

Several images tell the story. San Francisco is shown in Fig. 2 and remains a location that blends the natural world with the artificial world of our presence, even though our activities, movement systems, and populations continue to encroach with predatory consumption, congestion, and pollution.

Los Angeles is shown in Fig. 3 and displays the threat of low-density sprawl unhindered by natural features. It epitomizes parasitic encroachment and produces its own form of predatory consumption.

Manhattan is shown in Fig. 4 and illustrates the threat of high-density development extruded between rivers and sprawling across plains to produce another form of excessive intensity, encroachment, and pollution.

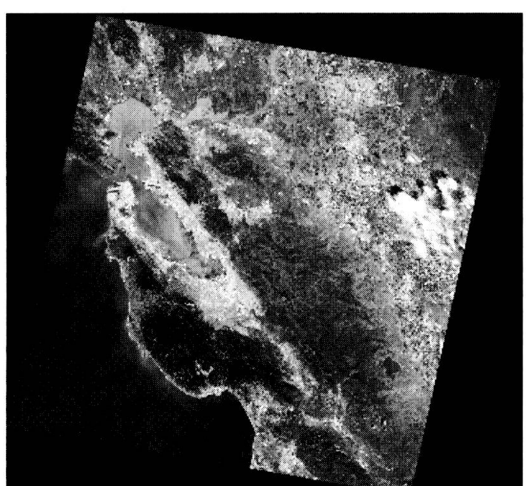

FIGURE 2 San Francisco Bay. (Source: www.nasaimages.org)

FIGURE 3 Los Angeles Area. (Source: www.nasaimages.org)

All three are examples of the artificial world we call the built environment, and illustrate the evolving relationship between us, them, and the universe beyond.

The Natural Environment

Fortunately, many examples of the natural environment remain. One example can be seen in Fig. 5 which illustrates the intersection of the Amazon River with the Rio Negro. It has expanded from the plant and animal kingdoms of Linnaeus to eight categories of life on Earth, but they have always been there, and our discoveries have not ended.

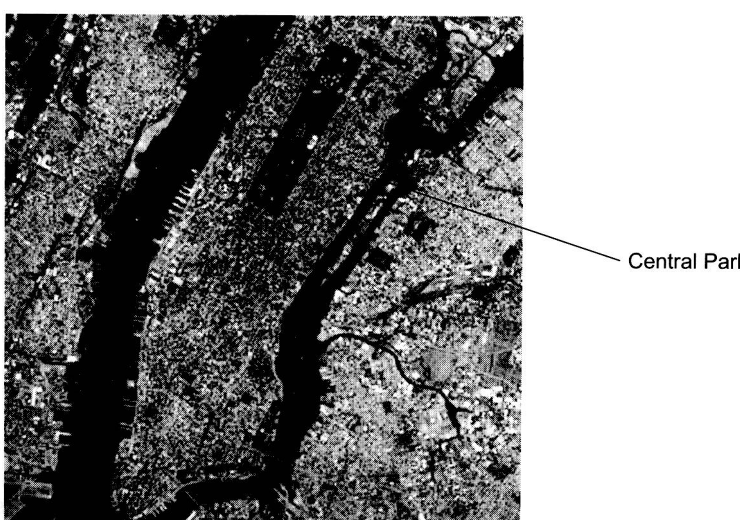

FIGURE 4 Manhattan. (Source: www.nasaimages.org)

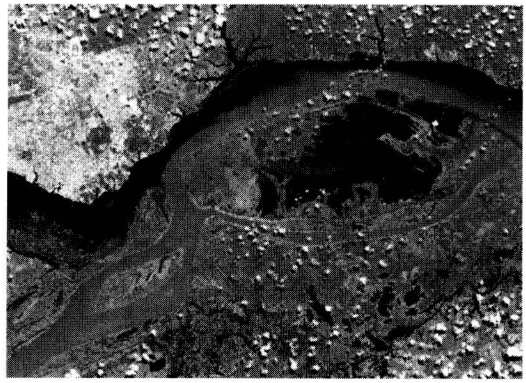

FIGURE 5 Amazon River at the Rio Negro River. (Source: www.nasaimages.org)

The Built Environment

We can be seen in the aerial photograph of Manhattan if we use our imagination while looking at Fig. 4. We have not always been there, but most of us now exist within versions of a built environment that contains four divisions: shelter, movement, open space, and life support.

Shelter

The most obvious feature of the Manhattan photograph is development cover and pavement. Development cover is constructed to provide shelter and contains building cover, parking cover, and other pavement in various quantities. (Other pavement can include private roads, drives, loading areas, and miscellaneous pavement such as sidewalks and plazas.)

Height combines with building cover to produce architectural mass, and the combination of mass with all other development cover produces intensity.

Intensity is offset by the project open space provided, but is not relieved by remote parks. Central Park is an oasis from intensity but does not relieve the desert involved. It would have to weave through this desert to alter the environment in a manner more familiar to London and Paris.

The elements of a site plan rarely change. It is their quantities that determine the environment involved. These elements are identified in the generic site plan of Fig. 6. Site plans are more fully discussed in Chap. 1 which illustrates many of the elements that combine to produce intensity, form, context, appearance, and development capacity.

Development Cover

The potential development cover area on a piece of property is determined by first subtracting an estimated percentage for all public and private rights-of-way and easements that will be provided within the gross land area available. The remainder defines the net land area available. An unbuildable area percentage is subtracted from the net lot area to determine the buildable land area available. (Unbuildable areas can include, but are not limited to, ravines, marshes, ponds, and unstable soil.) A planned

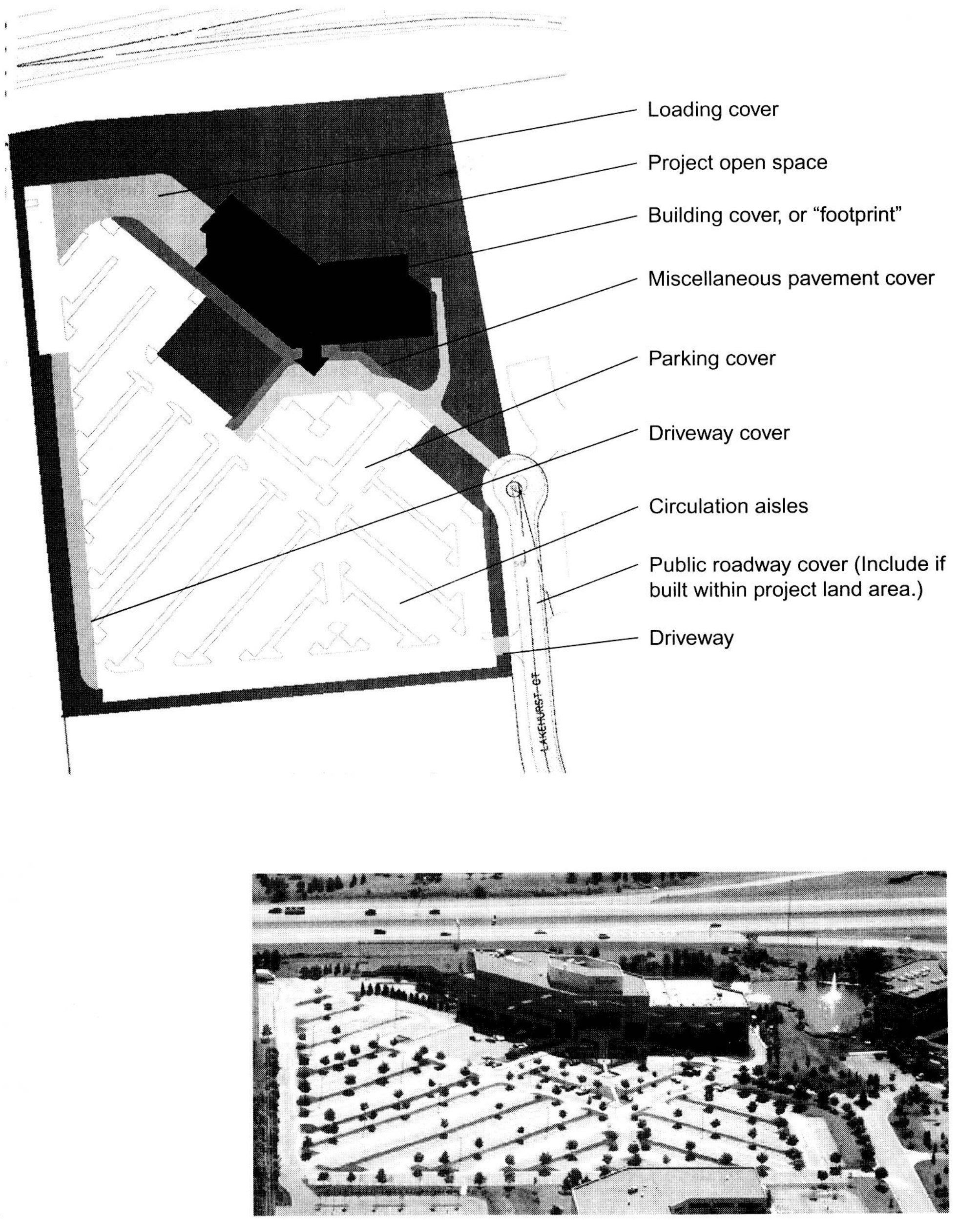

Figure 6 Generic elements of a site plan.

or required project open space percentage is then subtracted to define the buildable land area, and must include setback area requirements, if present. Finally, other pavement percentage estimates for driveways, loading areas, and miscellaneous pavements are also subtracted from the buildable area to define the core development cover area remaining. This is the area available for building cover and parking cover.

The relationship between building cover, building height, and parking cover within this core area determines development capacity. The relationship between development capacity and project open space defines the intensity planned or provided.

Development Capacity

Development capacity is a function of the parking system and building height chosen. A parking system determines the number of parking spaces that can be provided within a given area. Building height reduces a building footprint and increases the land remaining for parking within a core area. The maximum development capacity of a core area is a function of the ideal relationship between parking cover and building cover based on the building height, parking system, and design specification values chosen.

For example, when a design decision specifies grade parking around, but not under, a building; the optimum relationship between parking cover PCA and building cover BCA within a core area CORE is a function of the core mass divided by its capacity coefficient. The core mass is simply a function of the core area available CORE multiplied by the number of building floors f contemplated. The capacity coefficient is a function of the building floors f and parking specifications (s and a) involved. This equation is illsutrated below and derived in Chap. 21.

Development Capacity Equation

For nonresidential design solutions using grade parking around, but not under the building, development capacity can be expressed as:

$$\mathrm{GBA} = \frac{f(\mathrm{CORE})}{\left(1 + \frac{fs}{a}\right)}$$

However, there is no need to use equations since they are embedded in the forecast models of the Development Capacity Evaluation collection. These can be chosen by using decision trees.

Decision Trees

A sample decision tree is shown in Fig. 7 and is one of three provided in Chap. 1. It involves the following choices.

1. Land Use Decision:

   Is a residential, nonresidential, or mixed-use project involved?
2. Parking System Decision:

   Is surface parking, structure parking, or no parking involved?
3. Parking Type Decision:

   What is the parking configuration contemplated?
4. Given Decision:

   Is the land area known or the gross building area objective?
5. Forecast Model

   The appropriate model is found at the end of the decision path taken.

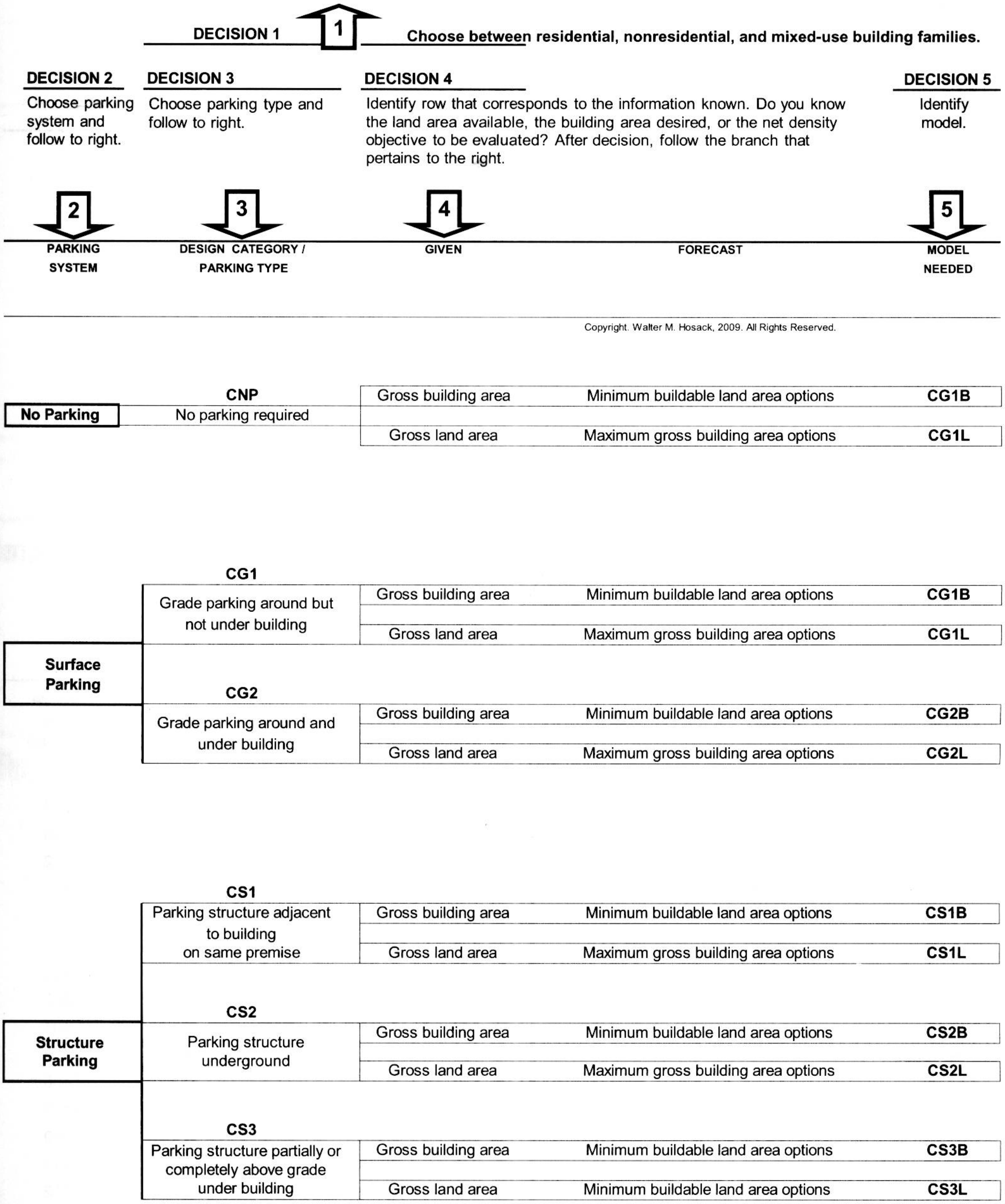

FIGURE 7 Generic decision tree format.

Forecast Model CG1L

Development capacity forecast for ***NONRESIDENTIAL BUILDINGS*** *based on the use of an adjacent* ***GRADE PARKING LOT*** *located on the same premises. When s and a equal zero in the design specification below, the forecast pertains to conditions when* ***NO PARKING*** *is required.*

Given: *Gross land area.* ***To Find:*** *Maximum development capacity of the land area (gross building area potential) based on the design specification values entered below.* ***Premise:*** *All building floors considered equal in area.*

DESIGN SPECIFICATION

Enter values in boxed areas where text is bold and blue. Express all fractions as decimals.

Given:	**Gross land area**	**GLA=**	**5.882**	acres	256,220	SF
Land Variables:	Public/private rights-of-way & paved easements	W=	**0.150**	fraction of GLA	38,433	SF
	Net land area	NLA=	5.000	acres	217,787	SF
	Unbuildable and/or future expansion areas	U=	**0.000**	fraction of GLA	0	SF
	Gross land area reduction	X=	0.150	fraction of GLA	38,433	SF
	Buildable land area remaining	**BLA=**	5.000	acres	217,787	SF
Parking Variables:	Est. gross pkg. lot area per space in SF	s =	**375**	ENTER ZERO IF NO PARKING REQUIRED		
	Building SF permitted per parking space	a =	**250**	ENTER ZERO IF NO PARKING REQUIRED		
	No. of loading spaces	l=	**1**			
	Gross area per loading space	b =	**1,000**	SF	1,000	SF
Site Variables:	**Project open space as fraction of BLA**	**S=**	**0.300**		65,336	SF
	Private driveways as fraction of BLA	R=	**0.030**		6,534	SF
	Misc. pavement as fraction of BLA	M=	**0.020**		4,356	SF
	Loading area as fraction of BLA	L=	0.005		1,000	SF
	Total site support areas as fraction of BLA	Su=	0.355		77,225	SF
Core:	**Core development area as fraction of BLA**	**C=**	0.645	C + Su must = 1	140,562	SF

PLANNING FORECAST

no. of floors **FLR**	**CORE** minimum land area for BCG & PLA	gross building area **GBA**	parking lot area **PLA**	pkg. spaces **NPS**	footprint **BCA**	bldg. SF/acre **SFAC** function of BLA	flr area ratio **FAR** function of BLA
1.00	140,562	**56,225**	84,337	224.9	**56,225**	11,246	0.258
2.00		**70,281**	105,421	281.1	**35,140**	14,057	0.323
3.00		**76,670**	115,005	306.7	**25,557**	15,335	0.352
4.00		**80,321**	120,481	321.3	**20,080**	16,065	0.369
5.00		**82,683**	124,025	330.7	**16,537**	16,538	0.380
6.00	*NOTE: Be aware when BCA becomes too small to be feasible.*	**84,337**	126,505	337.3	**14,056**	16,868	0.387
7.00		**85,559**	128,339	342.2	**12,223**	17,113	0.393
8.00		**86,499**	129,749	346.0	**10,812**	17,301	0.397
9.00		**87,245**	130,868	349.0	**9,694**	17,450	0.401
10.00		**87,851**	131,776	351.4	**8,785**	17,571	0.403
11.00		**88,353**	132,529	353.4	**8,032**	17,672	0.406
12.00		**88,776**	133,164	355.1	**7,398**	17,756	0.408
13.00		**89,137**	133,705	356.5	**6,857**	17,828	0.409
14.00		**89,448**	134,172	357.8	**6,389**	17,891	0.411
15.00		**89,720**	134,580	358.9	**5,981**	17,945	0.412

WARNING: These are preliminary forecasts that must not be used to make final decisions.
1) These forecasts are not a substitute for the "due diligence" research that must be conducted to support the final definition of "unbuildable areas" above and the final decision to purchase land. This research includes, but is not limited to, verification of adequate subsurface soil, zoning, environmental clearance, access, title, utilities and water pressure, clearance from deed restriction, easement and right-of-way encumbrances, clearance from existing above and below ground facility conflicts, etc.
2) The most promising forecast(s) made on the basis of data entered in the design specification from "due diligence" research must be verified at the drawing board before funds are committed and land purchase decisions are made. Actual land shape ratios, dimensions and irregularities encountered may require adjustments to the general forecasts above.
3) The software licensee shall take responsibility for the design specification values entered and any advice given that is based on the forecast produced.

FIGURE 8 Generic development capacity forecast model.

Forecast Model

Figure 8 illustrates a forecast model found at the end of a decision path. The model produces predictions based on values entered in its design specification template. Depending on the model chosen, it will predict the development capacity of land in terms of its gross building area potential,

OR

The land area required to accommodate a given gross building area objective. Figure 8 is a nonresidential forecast example that predicts the development capacity of land in terms of its gross building area potential.

Gross Building Area

The forecast panel shown in Fig. 8 presents gross building area predictions in rows based on the building height chosen. These gross building areas can be multiplied by unit values to forecast construction cost, return on investment, real estate value, population capacity, government revenue, energy consumption, and a host of other cost/benefit implications.

Implications

When one or more design specification values are modified in Fig. 8, a new forecast is produced. This makes it possible to compare and evaluate many options with a few keystrokes in the time it has previously taken to draw one, with a corresponding improvement in the decisions taken.

Opportunity

Figure 1 illustrates that we are a microscopic species that must learn to learn to live within sustainable ecologic limits. This means that we must understand the shelter options and decisions implied, since unrestrained growth will eventually consume what sustains us; and we cannot survive without the shelter we build. While we learn, cities can begin with land use allocation patterns that produce economic stability, balance intensity, and preserve agricultural capacity as discussed in Chap. 6. The goal of this book is to provide a tool that can help—based on a precise vocabulary that can express the ideas and options required for leadership evaluation and direction.

Acknowledgments

I was tempted to repeat my first edition acknowledgement because it will always be relevant, but decided to include it by reference to spare you the redundancy.

This edition adds those who struggle with ideas. Their contributions are the options of choice and the essence of leadership. Their search is uncertain, inspired by observation, driven by intuition, motivated by anticipation, buffeted by opinion, defended with persuasion, and cloaked in a fog they must sail beyond. These are the navigators who emerged when they first imagined potential. Anyone who sails these turbulent seas is lost without an anchor as they search the horizon. I thank them all from the past, present, and future and my anchor for life:

Elizabeth Fanning Hosack.