NOTES ON:

STANDARDS/CHECKLISTS/FRAMEWORKS/RANGES/REFERENCES/GUIDELINES

FOR:

EVALUATION/PLANNING/DEVELOPMENT

URBAN DWELLING ENVIRONMENTS
LOW INCOME PEOPLE
DEVELOPING COUNTRIES

S E C O N D D R A F T

Education/Research Program: URBAN SETTLEMENT DESIGN IN DEVELOPING COUNTRIES
Department of Architecture, M.I.T. Spring 1973

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URBAN SETTLEMENT DESIGN PROGRAM

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This is a preliminary draft prepared solely as a WORKING PAPER for comments.

The material utilized in this draft is from the files/ case studies of the Education/Research Program: URBAN SETTLEMENT DESIGN IN DEVELOPING COUNTRIES.

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*Only an outline is included.

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*Only limited subtopics are included.

URBAN AREA CONTEXT
General information and description

Existing Conditions

1. GEOGRAPHY (Location, topography, circulation, land use pattern, and values pattern, climate)
2. HISTORY
3. ECONOMY
4. GOVERNMENT
5. DEMOGRAPHY (Population growth, distribution: age-sex)
6. SOCIAL STRUCTURE (Annual income distribution)
7. SOCIAL ECOLOGY (Income pattern-density pattern)
8. LOW INCOME HOUSING SITUATION (Utilities and services, construction types, resources)

SITE CONTEXT
SELECTION, EVALUATION, PLANNING

ENVIRONMENTAL PHYSICAL CONDITIONS

10.(AB) LOCATION, APPROACHES, ACCESSES, TRANSPORTATION
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24.(B) POLICE, FIRE PROTECTION
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34.(B) BUILDING CODES
35.(B) TAX STRUCTURE
36.(B) OTHER

INTRODUCTION

This section is concerned with the SITE CONTEXT. It includes the factors listed above. It provides references for the evaluation/selection/planning of sites in urban areas, particularly in relation to dwelling environments.

The common cases of site investigation are:
-Given an intended use, find suitable sites.
-Given a site, determine options for use/development.

Factors affecting a site have been qualified as follows:
-FACTORS MARKED (A) are primarily site attributes that define the economic and practical feasibility of developing the site. Secondly, they are physical planning determinants.
-FACTORS MARKED (B) are primarily site determinants that define the physical planning. Secondly, they may define the feasibility of the site's development.
-FACTORS MARKED (AB) are both.

The presentation of each of these factors includes: Definitions and Evaluation/Planning Considerations. They are to serve as a framework for preliminary site investigation as well as site planning. It is important that they be viewed as guidelines within a range of alternatives for each specific site factor. They are a checklist in the development of a site.

10. LOCATION, APPROACHES, ACCESSES, TRANSPORTATION

LOCATION, APPROACHES, ACCESSES, TRANSPORTATION are interdependent factors. The accompanying diagram (fig #) of a site in an urban context illustrates the factors:

-LOCATION (POSITION-DISTANCES) in relation to: Residential, Commercial, Industrial areas, City Center, Airport.

-APPROACHES: main routes that reach the site (1, 3).

-ACCESS: linkages to main routes (a, b).

-TRANSPORTATION: means of conveyance along main routes.

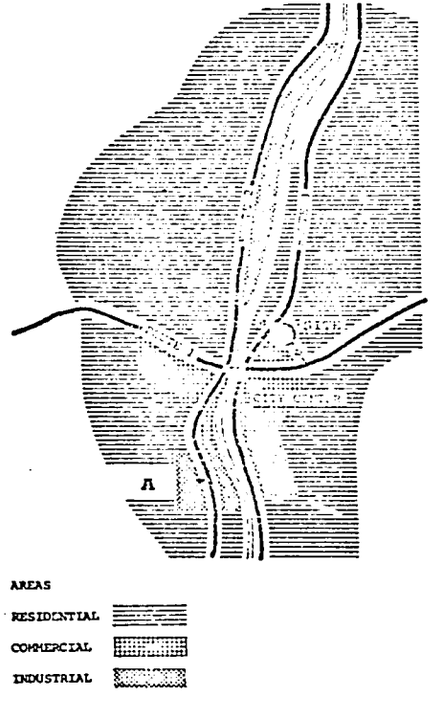


FIGURE # LOCATION, APPROACHES, ACCESSES, TRANSPORTATION

DEFINITIONS

LOCATION(*) - situation: the way in which something (the site) is placed in relation to its surroundings (the urban context).

Location can be in terms of the POSITION(*) of the site in the urban context regarding primarily:

-SITE LAND USE as determined by urban land use patterns, zoning ordinances, and other government regulations.

-SITE VALUE/COSTS as determined by urban land value/cost patterns.

Location can be in terms of the DISTANCE(*) between the site and other elements of the urban context, measured in:

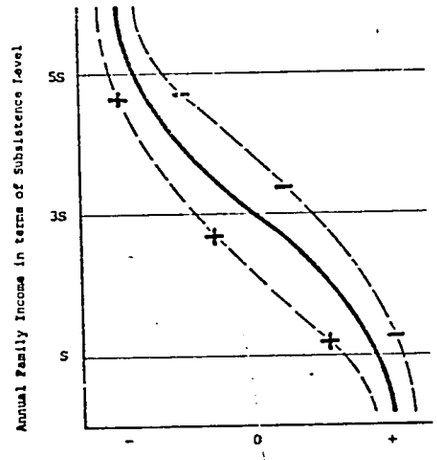
-LENGTHS: meters, kilometers, yards, miles

-TRAVELING TIME: walking, private vehicle, public transportation

-TRAVELING COSTS: % of weekly, monthly, annual income

-TRAVELING FREQUENCY: weekly, monthly, occasionally.

LOCATION PRIORITIES for proximity (DISTANCE) to employment centers by family income are illustrated in the following chart (fig #) (NOTES FOR HOUSING POLICY, John Turner an others, Cambridge, 1971).



5S = 5xS = High/Moderate Income
3S = 3xS = Moderate/Low Income
S = Subsistence Income = Low/Very Low (minimum wage for average family)

+ = Important
0 = Neutral
- = Unimportant

+ = Priorities for Upwarly Mobile Households

- = Priorities for Static or Downwardly Mobile Households

FIGURE # LOCATION PRIORITIES

EVALUATION/PLANNING CONSIDERATIONS

Location in relation to the URBAN CONTEXT should be analyzed/evaluated to determine degrees of availability/adequacy/consistency in terms of the following existing and/or projected conditions:

-LAND USE PATTERN - (Urban area plans, charts) - Uses to be identified: Residential, Business, Commercial, Small Industries, Professional, Industrial, Schools, Playgrounds, Parks, Other.

-POPULATION DENSITY PATTERN: - (Urban area plans, charts) - Ranges to be identified: 100, 200, 300, 400, 500, 600, 700, 800, 900, 1000 inhabitants/Hectare.

-INCOME GROUP PATTERN - (Urban area plans, charts) - Ranges should be identified in terms of income/family/year or in terms of subsistence levels (See: Income Groups).

-LAND VALUE/COST PATTERN - (Urban area plans, charts) - Ranges should be identified in terms of costs/unit area: square meters, Hectares, Acres.

-UTILITIES, SERVICES, COMMUNITY FACILITIES (adjacent/available to the site) - Conditions to be determined: existing, proposed, available at later or unpredictable time, not available, adequacy of the following: Water Supply, Sewerage, Storm Drainage, Paved Roads, Electricity, Street Lighting,

Telephone, Gas, Schools, Recreation, Police, Fire, Health, Refuse Collection, Public Transportation, Social Welfare.

-CENTERS OF EMPLOYMENT - (residential, industrial, commercial, government) when proximity becomes a priority for those low income groups that cannot afford transportation costs (See: Transportation).

DEFINITIONS

APPROACHES(*) - the main routes external to the site (pedestrian/vehicular) by which the site can be reached from other parts of the urban context.

Approaches are qualified by the character of existing and future growth along these routes (congestion; directness or the route; depreciating commercial, industrial, or residential areas). Trends in urban growth may affect a site's approaches.

Approaches are the manner in which POSITION and DISTANCE relate the site with the urban context.

EVALUATION/PLANNING CONSIDERATIONS

Approaches to a site should be analyzed/evaluated to determine availability/adequacy/quality in terms of existing and/or projected routes:

-APPROACHES - (Urban Area/Site Plan, charts) Characteristics to be identified for each approach: Name of Route, Transportation Modes (1), From/To (2), Adequacy (See: Circulation), Character (3).

NOTES:
(1) pedestrian/vehicular, walking, bicycling, private car, bus, subway, railway, etc.
(2) areas linked by the route.
(3) the nature of existing and future growth along these routes in terms of: congestion, directness of the route, physical condition of the route, etc.

DEFINITIONS

ACCESS(*) - the pedestrian/vehicular linkage from/to the site to/from existing or planned approaches (urban streets, limited access highways, public transportation systems, and other systems such as: waterways, airlines, etc.).

Access is a way that allows entrance to and exit from the site proper.

Access can be defined/determined by:
-LINEAR LINKS: highways, streets, or paths from which the site can be entered.
-POINT LINKS: subway stations, bus stops, etc. from which the site can be entered.

EVALUATION/PLANNING CONSIDERATIONS

Access to a site from its approaches should be analyzed/evaluated to determine its availability/adequacy/quality in terms of existing and/or projected conditions:

-ACCESSES - (Site plan, charts) Conditions to be determined: existing, proposed, availability, adequacy of: linear links (highways, streets, paths, etc.), point links (subway stations, bus stops, etc.)

DEFINITIONS

TRANSPORTATION(*) - means of conveyance or travel from one place (the site) to another (other parts of the urban context).

Transportation means can be:

-PRIVATE: bicycle, automobile, etc.

-PUBLIC: bus, subway, taxi, "collectivo", etc.

Transportation can be measured in terms of:

-DISTANCE

-TIME

-COSTS

IDEAL MAXIMUM DISTANCES are illustrated in the following table (fig #) in terms of MODES OF TRAVEL(*), frequency of use and time. From the table it can be inferred that:

In proper environment, certain facilities may be contained within a walking distance; on the other hand, there are other facilities that may be reached via transportation: High schools, Playgrounds; Recreation, Regional; Shopping, Regional-Major Goods; Centers of Employment.

EVALUATION/PLANNING CONSIDERATIONS

Transportation to a site should be analyzed evaluated to determine its availability/ adequacy/quality in terms of existing and/o projected conditions:

-TRANSPORTATION - (Charts) Conditions to be determined: Preferred Modes of Travel, Distance, Traveling Time, Traveling Costs, Adequacy in relation to the following areas High Schools, Playgrounds; Recreation, Regional; Shopping, Regional-Major Goods; Centers of Employment (1)

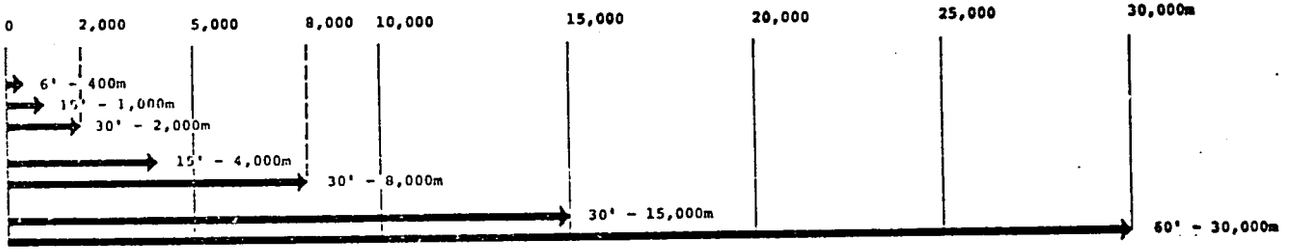
NOTE:
(1) Transportation to/from the site from/to CENTERS OF EMPLOYMENT may be a critical issue for the low income groups. When centers of employment are not located within walking distance, a site could be un acceptable to the income group who cannot afford public transportation fares or a bicycle.

MAXIMUM IDEAL DISTANCES (within Urban Context)

MODES OF TRAVEL (1)

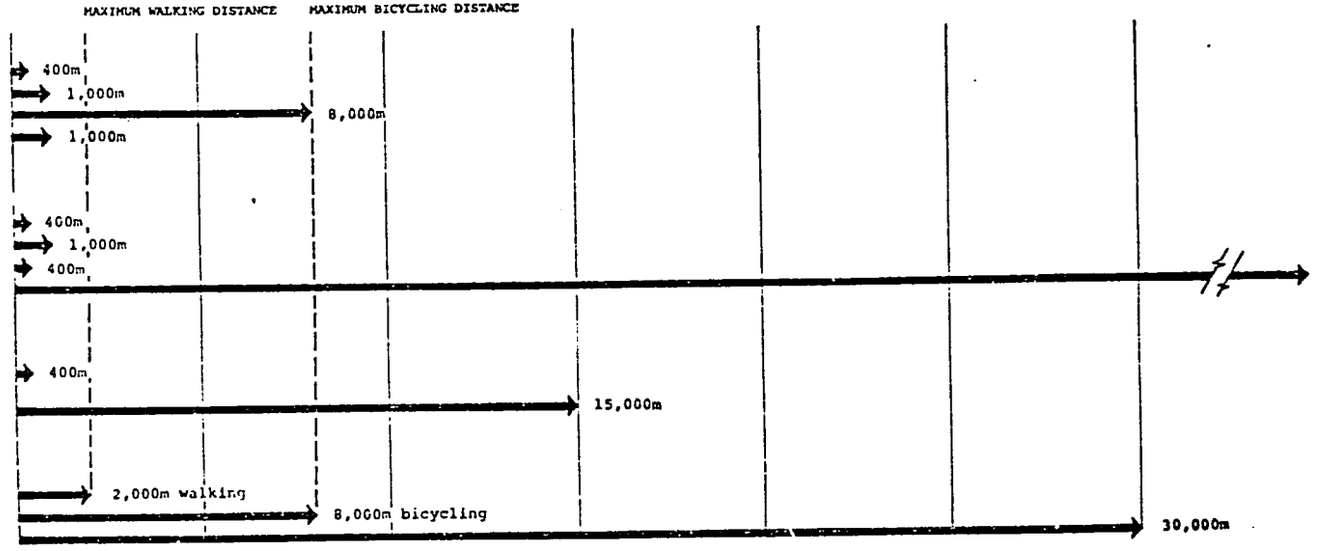
(1) In most U.S.A. urban areas people travel by private automobile even when the destination is within walking distance.

RANGES (Time: minutes Distances: meters)



ACTIVITIES/FACILITIES	FREQUENCY OF TRAVEL
EDUCATION	
-Kinder-playground	Daily
-Primary school-plgd	Daily
-High school-pldg	Daily
-Community service	Daily, weekly
SOCIAL RECREATION	
-Local: Children	Daily, weekly
Adolescents	Daily, weekly
Adults	Daily, weekly
-Regional: Children, Adolescents, Adults	Occasionally
SHOPPING	
-Local: Food, convenience goods/services	Daily, weekly
-Regional: Major goods/services	Weekly, occasionally
EMPLOYMENT	
-Low income groups	Daily
-Other income groups	Daily

DISTANCES



11. SIZE, SHAPE

DEFINITIONS

SIZE(*) - physical magnitude or extent (of the site); relative or proportionate dimensions (of the site).

Size is the amount of space which the site occupies or the amount of land available for development.

Size is defined in terms of SQUARE UNITS: square meters, hectares, square feet, acres.

Size determines the capacity of the site to accommodate future growth/expansions.

Size may determine the facilities required as part of the development:
-SMALL DEVELOPMENTS: generally are part of an adjacent urbanization and can use its supporting utilities, services, and community facilities.
-LARGE DEVELOPMENTS: may be independent communities requiring their own utilities, services, and community facilities.

SIZE, POPULATION, LAND USES

The following charts (figs #) are rough dimensional indicators relating size of site, population, and land uses (percentages and areas).

RANGES OF THE CHARTS:

A. SITE AREAS: from 1 Ha to 100 Ha

B. POPULATION DENSITIES:

Units/Ha	Unit Types	Persons/Ha			
		2P/U	4P/U	6P/U	8P/U
50	Rooms, Row/Group Housing(*), 3-5 story Walk-ups(*).	100	200	300	400
100	Rooms, 3-5 story Walk-ups, 7-20 story High-rise(*).	200	400	600	800
150	(Same as above)	300	600	900	1200
200	Rooms, 7-20 story High-rise	400	800	1200	1600

Units can be DWELLINGS or ROOMS.
DWELLING(*) - a building or other shelter in which people live: HOUSE.
ROOM(*) - a partitioned space of a dwelling specifically used for living. In practice, when counting rooms of a dwelling, only the living areas are included: bedroom, living room, dining room. Others such as: bath, toilet, kitchen, laundry, storage are not counted as rooms.

Units can be defined as follows:

DWELLING(*) - the general, global designation of a building/shelter in which people live. A dwelling contains one or more 'dwelling units'.

DWELLING UNIT(*) - a self contained unit in a dwelling for an individual, a family, or a group.

DWELLING UNIT TYPE - four types of dwelling units are considered:
-Room: A SINGLE SPACE usually bounded by partitions and specifically used for living; for example, a living room, a dining room, a bedroom, but not a bath/toilet, kitchen, laundry, or storage room. SEVERAL ROOM UNITS are contained in a building/shelter and share the use of the parcel of land on which they are built (open spaces) as well as common facilities (circulation, toilets, kitchens).
-Apartment: A MULTIPLE SPACE (room/set of rooms with bath, kitchen, etc.). SEVERAL APARTMENT UNITS are contained in a building and share the use of the parcel of land on which they are built (open spaces) as well as some common facilities (circulation).
-House: A MULTIPLE SPACE (room/set of rooms with or without bath, kitchen, etc.). ONE HOUSE UNIT is contained in a building/shelter and has the private use of the parcel of land on which it is built (open spaces) as well as the facilities available.
-Shanty: A SINGLE OR MULTIPLE SPACE (small, crudely built). ONE SHANTY UNIT is contained in a shelter and share with other shanties the use of the parcel of land on which they are built (open spaces).

C. LAND USES (Percentages and Areas)

Public land: CIRCULATION (streets, walkways, parking areas)

The percentage of land required for circulation depends on the density of the circulation network: primarily, frequency of the network; secondarily, width of the network. A circulation network serving large blocks takes a lesser percentage of land than a network serving small blocks.

Frequency ranges of urban circulation networks are discussed in the PLANNING CONTEXT: CIRCULATION. Ranges are from: 80m x 80m = 6400 square meters (0.64 Ha) to 200m x 200m = 40,000 square meters (4 Ha).

ASSUMPTION: The tables use a frequency of 100m x 100m = 10,000 square meters (1 Ha) and an average width of 16m which results in 30% of the land for circulation (a constant). The ranges have been derived from case studies: URBAN DWELLING ENVIRONMENTS; LAND USES IN AMERICAN CITIES, Bartholomew.

Public land: PUBLIC FACILITIES (schools, playgrounds, parks, other facilities)

The percentage of land required for public facilities depends on the population served. A small population requires less facilities and consequently less percentage of land. A large population requires more facilities and consequently more percentage of land. In other words: new facilities are required with increasing levels of population. Example: a community of 5000 people will require a primary school; and, a community of 20,000 people will require 4 primary schools and, in addition, a secondary school.

ASSUMPTION:

Supporting population	6,000	30,000	60,000
Land for listed public facilities	3 Ha	19 Ha	47 Ha

Ranges have been derived from: "NORMAS MINIMAS URBANIZACION" - CENTRO INTERAMERICANO VIVIENDA Y PLANEAMIENTO - BOGOTA, COLUMBIA, 1968 and case studies: U.D.E.; LAND USES IN AMERICAN CITIES, Bartholomew.

Private land: RESIDENTIAL (dwellings, commercial, professional, small industires)

ASSUMPTION: The private land will be primarily residential but will include commercial, professional, and small industrial uses. The percentage of private land depends on the size of the urban sector considered. If the percentage of land for circulation is a constant (30%) and the percentage of public land increases with population, the percentage of private land, which is the remaining area, diminishes with population.

DIAGRAMS

The following diagrams (figs #) correspond to the 10 areas illustrated in the charts. They show:
-Circulation grid of 100m x 100m.
-Percentage of land use corresponding in all cases to a population density of 600 persons/Ha, which is an average of the densities considered on the charts.

In practice the apportioning of land should be based on a reasonable assumption of its potential saturation. Settlement is a process and densities will increase over time; therefore, low densities will eventually increase.

KEY: The drawings are diagramatic and do not represent a design/layout of the areas indicated.

Land for Public Facilities use

Land for Residential use

EVALUATION/PLANNING CONSIDERATIONS

Size (area) of a site must be computed/evaluated to determine its adequacy/suitability for development.

-SIZE - (site plan, charts) - Areas to be determined: Total size of area within site boundaries, areas unusable due to: topography, soil conditions, easements, rights-of-way, desirable/undesirable environmental influences, desirable/undesirable existing structures.

DEFINITION:

SHAPE(*) - form/configuration of the site surface as defined by its perimeter/boundaries.

Shape determines the feasibility/suitability of a site in terms of land utilization, lot and street layouts:

-COMPACT SHAPES are generally more apt for efficient development.

-IRREGULAR, DISPERSED SHAPES may result in unusable areas and/or uneconomical/inefficient layouts.

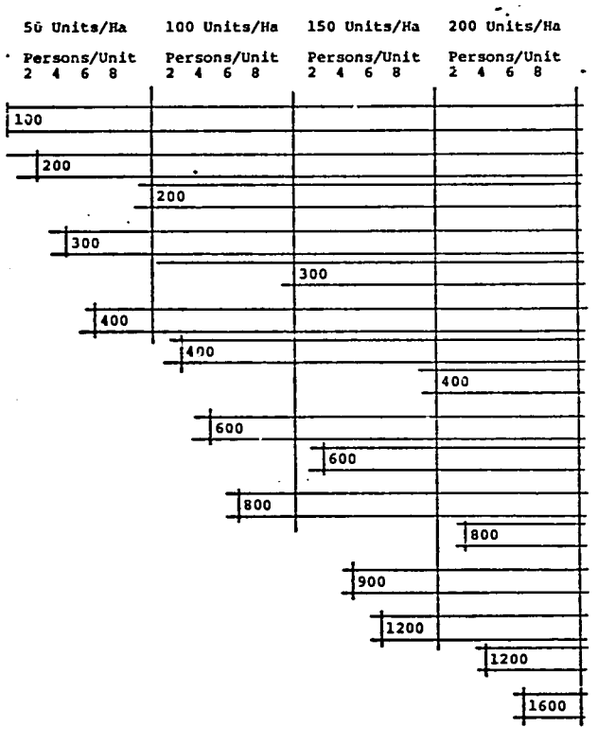
EVALUATION/PLANNING CONSIDERATIONS

Shape of the site must be analyzed/evaluated to determine its usability/suitability for development.

-SHAPE - (site plan) - Conditions to be determined: Shape of usable area(s) (1), feasibility of development (2).

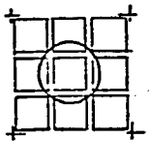
NOTES:
(1) shape(s) of land resulting from analysis of developable land area (size).
(2) capable of economical/efficient development.

SIZE, SHAPE should be considered simultaneously with other land features, topography, adequacy of intended use.

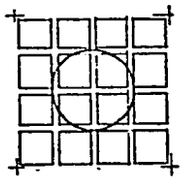


POPULATION		UNITS	PUBLIC LAND				PRIVATE LAND	
Per/ Ha	Total	Total	Circulation %	Circulation Ha	Pub. Facil. %	Pub. Facil. Ha	Residential %	Residential Ha
100	67	33	30	0.30	3	0.03	67	0.67
200	127	32 64	30	0.30	6	0.06	64	0.64
300	183	30 91	30	0.30	9	0.09	61	0.61
400	233	29 58 117	30	0.30	12	0.12	58	0.58
600	323	54 81	30	0.30	16	0.16	54	0.54
800	400	50 100	30	0.30	20	0.20	50	0.50
900	434	72	30	0.30	22	0.22	48	0.48
1200	525	65 88	30	0.30	26	0.26	44	0.44
1600	622	78	30	0.30	31	0.31	39	0.39

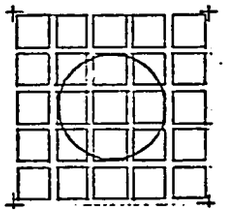
POPULATION		UNITS	PUBLIC LAND				PRIVATE LAND	
Per/ Ha	Total	Total	Circulation %	Circulation Ha	Pub. Facil. %	Pub. Facil. Ha	Residential %	Residential Ha
100	267	133	30	1.20	3	0.13	67	2.67
200	509	127 255	30	1.20	6	0.25	64	2.55
300	730	122 365	30	1.20	9	0.37	61	2.43
400	933	117 233 467	30	1.20	12	0.47	58	2.33
600	1292	215 323	30	1.20	16	0.65	54	2.15
800	1600	200 400	30	1.20	20	0.80	50	2.00
900	1738	290	30	1.20	22	0.87	48	1.93
1200	2100	263 350	30	1.20	26	1.05	44	1.75
1600	2489	311	30	1.20	31	1.24	39	1.56



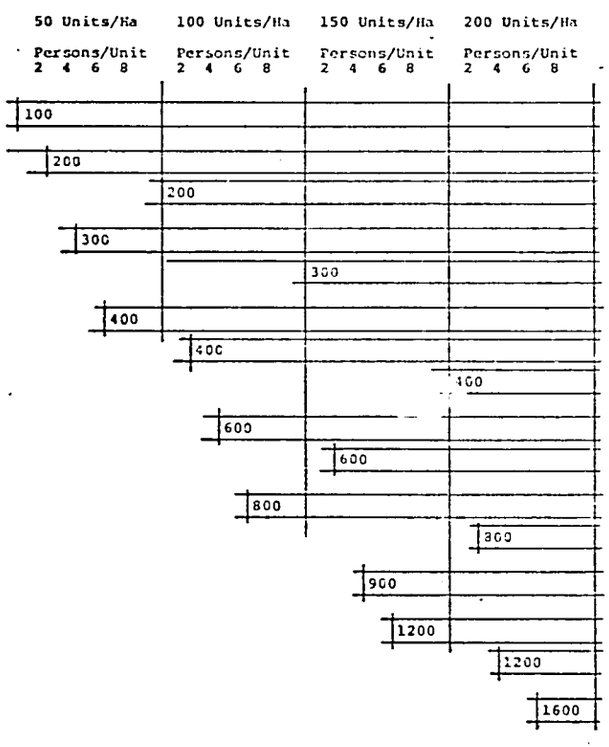
POPULATION		UNITS	PUBLIC LAND				PRIVATE LAND	
Per/ Ha	Total	Total	Circulation %	Ha	Pub. Facil. %	Ha	Residential %	Ha
100	600	300	30	2.70	3	0.30	67	6.00
200	1145	286 573	30	2.70	6	0.57	64	5.73
300	1643	274 822	30	2.70	9	0.82	61	5.48
400	2100	262 525 1050	30	2.70	12	1.05	58	5.25
600	2908	485 727	30	2.70	16	1.45	54	4.85
800	3600	450 900	30	2.70	20	1.80	50	4.50
900	3910	652	30	2.70	22	1.96	48	4.34
1200	4725	591 788	30	2.70	26	2.36	44	3.94
1600	5600	700	30	2.70	31	2.80	39	3.50

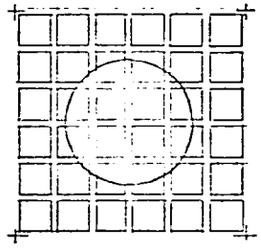


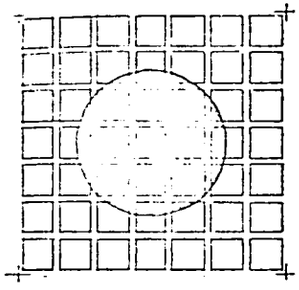
POPULATION		UNITS	PUBLIC LAND				PRIVATE LAND	
Per/ Ha	Total	Total	Circulation %	Ha	Pub. Facil. %	Ha	Residential %	Ha
100	1067	533	30	4.80	3	0.53	67	10.67
200	2036	509 1018	30	4.80	6	1.02	64	10.18
300	2922	487 1461	30	4.80	9	1.46	61	9.74
400	3733	467 933 1867	30	4.80	12	1.87	58	9.33
600	5169	862 1292	30	4.80	16	2.58	54	8.62
800	6400	800 1600	30	4.80	20	3.20	50	8.00
900	6952	1159	30	4.80	22	3.48	48	7.72
1200	8170	1021 1362	30	4.80	27	4.33	43	6.81
1600	9494	1187	30	4.80	33	5.27	37	5.93



POPULATION		UNITS	PUBLIC LAND				PRIVATE LAND	
Per/ Ha	Total	Total	Circulation %	Ha	Pub. Facil. %	Ha	Residential %	Ha
100	1667	833	30	7.50	3	0.83	67	16.67
200	3182	795 1591	30	7.50	6	1.59	64	15.91
300	4565	761 2283	30	7.50	9	2.28	61	15.22
400	5833	729 1458 2917	30	7.50	12	2.92	58	14.58
600	7951	1325 1988	30	7.50	17	4.25	53	13.25
800	9686	1211 2421	30	7.50	22	5.39	48	12.11
900	10445	1741	30	7.50	24	5.89	46	11.61
1200	12388	1549 2065	30	7.50	29	7.18	41	10.32
1600	14397	1800	30	7.50	34	8.50	36	9.00

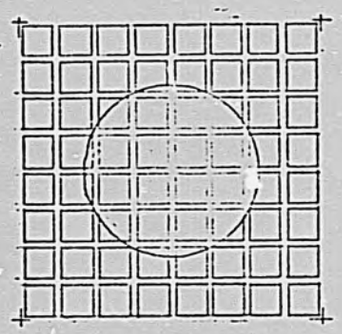




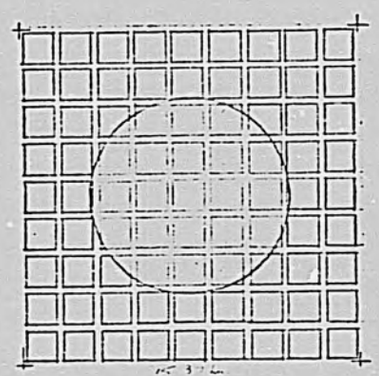


POPULATION		UNITS	PUBLIC LAND				PRIVATE LAND	
Per/Ha	Total	Total	Circulation %	Circulation Ha	Pub. Facil. %	Pub. Facil. Ha	Residential %	Residential Ha
100	2400	1200	30	10.80	3	1.20	67	24.00
200	4582	1145 2291	30	10.80	6	2.29	64	22.91
300	6561	1093 3280	30	10.80	9	3.33	61	21.87
400	8291	1036 2073 4146	30	10.80	12	4.47	58	20.73
600	11261	1877 2815	30	10.80	18	6.43	52	18.77
800	13717	1715 3429	30	10.80	22	8.05	48	17.15
900	14793	2465	30	10.80	24	8.76	46	16.44
1200	17545	2193 2924	30	10.80	29	10.58	41	14.62
1600	20389	2549	30	10.80	35	12.46	35	12.74

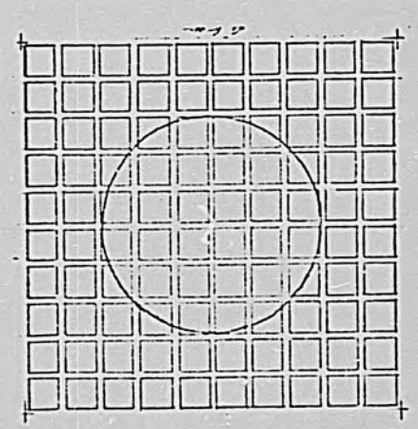
POPULATION		UNITS	PUBLIC LAND				PRIVATE LAND	
Per/Ha	Total	Total	Circulation %	Circulation Ha	Pub. Facil. %	Pub. Facil. Ha	Residential %	Residential Ha
100	3267	1633	30	14.70	3	1.63	67	32.67
200	6236	1559 3118	30	14.70	6	3.12	64	31.18
300	8840	1473 4420	30	14.70	10	4.83	60	29.47
400	11171	1396 2793 5585	30	14.70	13	6.37	57	27.93
600	15172	2529 3793	30	14.70	18	9.01	52	25.29
800	18482	2310 4620	30	14.70	23	11.20	47	23.10
900	19931	3322	30	14.70	25	12.15	45	22.15
1200	23638	2955 3940	30	14.70	30	14.60	40	19.70
1600	27471	3434	30	14.70	35	17.13	35	17.17



POPULATION		UNITS	PUBLIC LAND				PRIVATE LAND	
Per/ Ha	Total	Total	Circulation %	Ha	Pub. Facil. %	Ha	Residential %	Ha
100	4267	2133	30	19.20	3	2.13	67	42.67
200	8092	2023 4046	30	19.20	7	4.34	63	40.46
300	11469	1912 5735	30	19.20	10	6.57	60	38.23
400	14494	1812 3623 7247	30	19.20	13	9.57	57	36.23
600	19685	3281 4921	30	19.20	19	11.99	51	32.81
800	23979	2997 5995	30	19.20	23	14.83	47	29.97
900	25859	4310	30	19.20	25	16.07	45	28.73
1200	30670	3834 5112	30	19.20	30	19.24	40	25.56
1600	34598	4325	30	19.20	36	23.18	34	21.62



POPULATION		UNITS	PUBLIC LAND				PRIVATE LAND	
Per/ Ha	Total	Total	Circulation %	Ha	Pub. Facil. %	Ha	Residential %	Ha
100	5400	2700	30	24.30	3	2.70	67	54.00
200	10194	2549 5097	30	24.30	7	5.73	63	50.97
300	14449	2408 7225	30	24.30	11	8.54	59	48.16
400	18259	2282 4565 9130	30	24.30	14	11.05	56	45.65
600	24799	4133 6200	30	24.30	19	15.37	51	41.33
800	30209	3776 7552	30	24.30	23	18.94	47	37.76
900	32578	5430	30	24.30	25	20.50	45	36.20
1200	37259	4657 6210	30	24.30	32	25.65	38	31.05
1600	42251	5281	30	24.30	37	30.29	33	26.41



POPULATION		UNITS	PUBLIC LAND				PRIVATE LAND	
Per/ Ha	Total	Total	Circulation %	Ha	Pub. Facil. %	Ha	Residential %	Ha
100	6660	3330	30	30.00	3	3.40	67	66.60
200	12544	3136 6272	30	30.00	7	7.28	63	62.72
300	17780	2963 8890	30	30.00	11	10.73	59	59.27
400	22468	2809 5617 11234	30	30.00	14	13.83	56	56.17
600	30516	5086 7629	30	30.00	19	19.14	51	50.86
800	36239	4530 9060	30	30.00	25	24.70	45	45.30
900	38704	6451	30	30.00	27	27.00	43	43.00
1200	44801	5600 7467	30	30.00	33	32.67	37	37.33
1600	50804	6350	30	30.00	38	38.25	32	31.75

12. LAND COSTS

DEFINITIONS

LAND COST(*) - price: the amount of money given or set as the amount to be given as a consideration for the sale of a specific thing (the site).

REAL LAND COST is the sum of:
-ACTUAL LAND COST: "which is set solely by the level of demand. The price of land is not a function of any cost conditions; it is set by the users themselves in competition" - John Turner [7:p.IV-7].
-LAND DEVELOPMENT COSTS: the costs of making raw land ready for development through the provision of utilities, services, accesses, etc.

Actual Land Costs vary with the LOCATION of the land relative to the city center: [7: p.IV-6]
-HIGHEST land costs will generally be found near the center of the city, the point of highest access to markets (highest location demand).
-LOWEST land costs will generally be found in outlying areas, where transportation costs (in time and money) to the city center are incurred (lowest location demand).

Land Development Costs vary with topography and natural features: [8:p.39]
-HIGHEST development costs will generally be incurred on steep/rough or low/damp terrain.
-LOWEST development costs will generally be incurred on level or nearly level land.

REAL LAND COST plus Building Costs determines the TOTAL INVESTMENT. Therefore, land cost will have an impact on the type of housing built. Higher cost sites will require greater unit densities to reduce the land cost per dwelling unit [7:p.IV-1].

Urban land costs can be affected by elements of public policy such as: [30:p.7]
-Zoning Regulations: stabilize land values by restricting the type and degree of development permitted on a particular site.
-Location of Public Works: proximity to utilities and/or community facilities will increase the actual land cost but reduce the land development costs.
-Property Taxation: high taxes can lower the demand for a site and thus lower its costs; low taxes can raise demand for and cost of a site.

Changes in land use through zoning variances will affect the land costs in the proximity of the changes [29:pp.1-25].

In developing particularly large sites, it is important to ascertain the local controls against LAND SPECULATION (See insert).

LAND SPECULATION [33:p.1-23]

Land Speculation is possible because:
-there is a fixed quantity of land in a given location, a supply that cannot be increased as demand increases.
-under the pressures of urbanization, demand for land outruns the supply and is constantly ahead of it.
-there is uncertainty as to where (and when) urban land development will take place.

The prime consideration in speculation is that profits from increases in land value accrue to the speculator. This occurs even though the increases in value are due to community growth, which makes urban land "scarce", and therefore, more valuable.

The speculator may obstruct development, frequently by withholding his land until the price is right, increasing the cost of development.

An attack on speculation must strike at its most attractive feature: PROFITS. Profits come from combinations of:
-low acquisition cost
-small holding cost
-high selling price

METHODS FOR CONTROLLING LAND SPECULATION

A. SITE-VALUE TAXATION: puts tax only on the assessed unimproved value of the land, with no taxes on improvements. It forces the improvement of vacant land to make the land productive enough to pay the tax. The principle is that the value of the land derives from the people as a whole; and, therefore, that increases in value created by their efforts should be appropriated for public benefit.

Site-value taxation is not common in U.S.A., where taxes are distributed: 1/3 in land; 2/3 in buildings and other structures. This system taxes improvements and in effect subsidizes: blight, decay, and slums. It also subsidizes underdeveloped land, since the owners do not pay their share of the cost of the highways, schools, and community facilities that increase the value of their land.

Site-value taxation is common in Australia and New Zealand, where the land carries all or the highest proportion of the real estate tax.

Some types of site-value taxation:
-Land values taxed 100% of assessed value
-Improvements taxed at a reduced percentage of the assessed value
-Reduction in the tax rate on improvements and an increase in the land tax rate

Advantages:
-Puts highest taxes on the central business districts where land values are highest, while residential and industrial areas pay lower taxes.
-Property owners in central business districts can invest in developing their properties since improvements are not taxed.
-It is a measure of protection against blight and decay.
-It is considered a direct means of eliminating privately owned slums, in contrast with the present U.S. tax system that makes their rehabilitation unprofitable.

Disadvantages:
-It could drive land values down regardless of zoning efforts to counteract such a trend.
-It may encourage development of undesirable land.
-It may give rise to tax delinquency and confiscation in depressed areas.
-It works only if improvements are justified by zoning.
-It would aggravate urban sprawl because of pressure to develop land.
-It may aggravate administration problems because of the increased need for zoning to preserve open space.
-It favors the wealthy against low and middle incomes.
-Most objections relate to the need to use zoning restrictions in conjunction with site-value taxation.

B. SPECIAL CAPITAL GAINS TAX: puts tax on land sales.

Profits from land speculation are often taxed as REGULAR capital gains at a rate of 25%. Much of the tax can be regained by increasing the selling price; further inflating land costs.

A SPECIAL capital gains tax on land would reduce speculation by reducing profits and returning those profits to the communities responsible for them.

Advantages/Disadvantages:
-The system has remained mostly theoretical and so commentaries are lacking.
-The primary problem seems political: taxes are unpopular with the electorate.

C. METROPOLITAN LAND CORPORATION: controls urban land supply and lowers land costs by means of land acquisition through a public or public/private agency.

Closely related to land speculation is the disorderly manner in which cities develop. Cities have not been able to grow outward in an organized manner using contiguous land first. Instead, they have been forced to "leap frog" over nearby land, which is controlled by speculators, and move farther from the city. This occurs because speculators buy land ahead of urban development, hold it until development reaches or surrounds them, and then sell it at their own high price.

Many plans for development of metropolitan areas have been unsuccessful, because growth was more explosive than anticipated or because there was no control over land supply. The Metropolitan Land Corporation provides a mechanism by which land can be brought into the market when and where it is needed.

The Metropolitan Land Corporation should:
-acquire urban fringe in much the same manner as acquisitions for urban redevelopment projects are now made.
-install all necessary services.
-set aside land for: schools, parks, community use.
-sell or lease land not for public use to private developers with appropriate controls on its development.

Advantages:
-It provides effective public control over development.
-It eliminates the present dependence on policy regulations: zoning and planning restrictions.
-It prevents speculation, thus lowering land cost.
-It eliminates land shortage.
-It provides a constant flow of building sites.
-It makes contiguous urban growth possible.

Disadvantages:
-There exists the political conflict between private enterprise control and public control.
-It might not be effective against speculation unless all land where speculation could occur is in public control.
-Public acquisition of land removes speculation from the early stages of development only. SPECULATION CAN OCCUR AT ANY STAGE IN THE DEVELOPMENT PROCESS. To avoid speculation altogether, the public must not only own all land, but also develop it and act as its landlord.
-Problems of misallocation of land resources by a public agency may be as serious as speculation.

It should be emphasized that the Metropolitan Land Corporation method eliminates speculation at the early stages of development where large quantities of land are required. It is at this point that the gains from speculation seem to be highest and the consequences most disastrous.

D. OTHER METHODS:
-Zoning/planning restrictions remove uncertainty about "where" development will take place, but does not remove uncertainty about "when".
-Rent Control to control LAND PRICE controls speculation, but promotes neglect of land since returns for capital investment are limited.
-Reduction of the uncertainty surrounding development by, for example, providing information about land use trends, construction trends, economic/population growth to all possible investors.

EVALUATION/PLANNING CONSIDERATIONS

Land Costs of a site must be analyzed/evaluated to determine their suitability/consistency with the total investment the developer is prepared to make.

-ACTUAL LAND COSTS - (maps, charts) - Ranges to be identified in terms of costs/unit area: square meters, hectares, acres (1).

-LAND DEVELOPMENT COSTS - Costs to be determined: Land Clearance, Demolition, Excavation, Land Fill, Overloaded Fill, Other Improvements, Installation of: water system, sewerage, storm drainage, paved roads, electricity and street lighting, telephone, gas, etc. (1).

-BUILDING COSTS - Costs to be determined: Construction, Landscaping (1).

NOTES:
(1) Includes: Professional and Developers fees and profits; financing.

13. LAND OWNERSHIP

DEFINITIONS

LAND OWNERSHIP(*) - lawful claim or title (to land).

Land Ownership can be (See LAND TENURE in the PLANNING CONTEXT):
-PRIVATE: the absolute tenure of land to a person and his heirs.
-MUTUAL: absolute tenure of land to each of two or more associates.
-ILLEGAL: the unauthorized, unlawful, illegitimate, illicit, unlicensed holding or possession of land.
-PUBLIC: the proprietorship of land by the state.

"Today, with the rise of individual tenancy and ownership, mortgages, squatting, multiple sales, subdivision, and inheritance laws, it is indispensable to establish property titles" - Charles Abrams [31:p.58].

It is imperative that the legal owner or owners of a site be clearly determined before making any attempt to purchase. The establishment of legal TITLE(*) to a site is accomplished through a TITLE SEARCH. Once legal ownership of a site has been determined, the developer can evaluate the prudence/practicality of negotiating its purchase. There is a high degree of risk if one acts on uncertain/unverified claims.

The purchase of land on which conflicting CONVEYANCES(*) or titles are held by separate claimants should be avoided.

If land is held by too many individuals, it may be impractical/impossible to find them all and secure the consent of each for a sale.

Frequently, a site large enough for urbanization is composed of several parcels each owned by different parties. The process of putting these individual parcels together for development is LAND ASSEMBLY. A developer should evaluate the prudence/practicality of assembling land, particularly when the site is owned by many individuals with whom negotiations must be conducted separately [32:pp.36-87].

EVALUATION/PLANNING CONSIDERATIONS

The ownership of a site should be determined before any attempts are made to develop it.

-LAND OWNERSHIP - (title search, assessors maps) - Conditions to be determined for each land parcel within the site: Number, Names, and Addresses of Owners; Type of Ownership: Private, Mutual, Illegal, Public; Practicality of Land Assembly.

14. BOUNDARIES

DEFINITIONS

BOUNDARY(*) - something (a line or area) that fixes or indicates a limit or extent (of a site).

Boundaries are defined by:
-LEGAL LIMITS of a site: property lines
-ADJACENT AREAS to the site

Boundary can be in terms of a BARRIER(*), which is characterized by sharp changes in land use or topography, expressed as:
-LINES: limited access highways, etc.
-AREAS: mountains, lakes, etc.

Boundary can be in terms of a MESHING(*) boundary, characterized by continuous, homogeneous land uses or topography, expressed as:
-LINES: property lines, political or municipal divisions, main streets, etc.
-AREAS: similar residential uses, compatible uses (as parks with residential), etc.

NATURAL BARRIERS such as mountains, rivers, lakes or other abrupt changes in land form generally prohibit or limit the development of an area in terms of physical links with the surroundings. Natural barriers can have a positive or negative influence on the site:
-MICRO-CLIMATE: hills or mountains may affect the micro-climate in terms of prevailing winds, sun exposure, precipitation, and temperature.
-VIEWS: lakes or rivers can have a positive influence by providing visual relief and long views to contrast with man-made environments and their limited views.

MAN-MADE BARRIERS can also have a positive or negative influence. Perhaps the greatest man-made barrier is the limited access highway. It cuts physical and social communications between adjacent communities. Because of the path and width of the highway, useless pockets and corners of land are often created.

MESHING BOUNDARIES such as political, administrative etc. do not inhibit the social and functional continuity between contiguous communities. Parks, schools, community facilities, or minor streets do not really limit the physical continuity between communities but rather act as a linkage. The activities at each of these areas can be shared and therefore facilitate social bonds between different developments.

EVALUATION/PLANNING CONSIDERATIONS

The analysis of the MUTUAL INFLUENCE between the site and the different boundaries is essential in planning. It will permit the planning to take full advantage of positive conditions as well as to minimize the negative ones. It will help to define land use and interior circulation.

The ANALYSIS of boundaries will determine the existence of strong negative elements that may jeopardize the development of the site.

-BOUNDARIES - (site plan, charts) - characteristics to be identified for each boundary: specific name and location; type: natural barrier, man-made barrier, meshing boundary, line, area; positive and negative conditions; influence in land use and interior circulation.

15. VIEWS, FLOODING, DUST/DIRT, SMOKE, FUMES, ODORS, NOISE, VIBRATIONS, FIRE/EXPLOSION HAZARDS, AIRPORT DISTURBANCE/ RESTRICTIONS

DEFINITIONS

VIEWS(*) - (that which) is revealed to the vision or can be seen (from the site).

Views are affected by distance and position. Any evaluation of views should be done on the site.

With long distance, views become less real, more abstract, more neutral. Long distances reduce or eliminate noises, odors, numbers, speeds, abruptness of movements, and the "life" of the observed objects; such is the view of the land (the earth) from an airplane. With long distances, the viewer is a spectator and has the choice of ignoring the view.

With short distance, views are real, dominant and are accompanied by noises, odors, movements, and "life". The viewer is no longer a spectator, but becomes an actor with no other choice than to participate in the action. While the view of a busy highway from a hillside (hundreds of meters above) can be interesting, the proximity of a highway is a catastrophe.

Views from the site may have different environmental effects:

-POSITIVE: desirable views: harbors, rivers, mountains, forests, large public parks, commanding views from high sites, etc.

-NEGATIVE: undesirable views: blank walls or large industrial areas, the forests of 20th century paraphernalia, elevated highways, gas tanks, bill boards, parking lots, etc.

It is obvious that positive views should be taken advantage of/enhanced and that negative ones should be neutralized.

EVALUATION/PLANNING CONSIDERATIONS

An analysis of the views from a site will determine the existence of strong negative elements which may jeopardize the development of the site.

-VIEWS - (on-site evaluation) - Characteristics to be identified for each view: description and location, type: long or short distance, positive and negative effects.

DEFINITIONS

FLOODING(*) - a rising and overflowing of a body of water that covers land not usually under water.

All sites, particularly the low lying, should be studied to determine their development feasibility in terms of:

-High Water Table

-Likelihood of Present and Future Flooding (from surface run-off, tides, wind-driven sea water, etc.).

In general land subject to flooding should not be developed. However, exceptions are made in urban areas when there are strong reasons for the urbanization of this land. In such cases, the development should be preceeded by an identification of the areas lying within: [22:pp.85-91]

-NATURAL FLOODWAY: the main channel and adjacent overbanks which convey floodflows with destructive velocity (fig #). This area must remain unobstructed so that floods can be discharged adequately and efficiently.

-RESTRICTIVE ZONE/FLOODWAY FRINGE: the flood plain area landward of the natural floodway which would be inundated by low velocity flood waters (fig #). This area may be preferably developed by functions which are relatively unharmed by flooding (such as: agriculture, forestry, recreation, open space, etc.) [23:p.58].

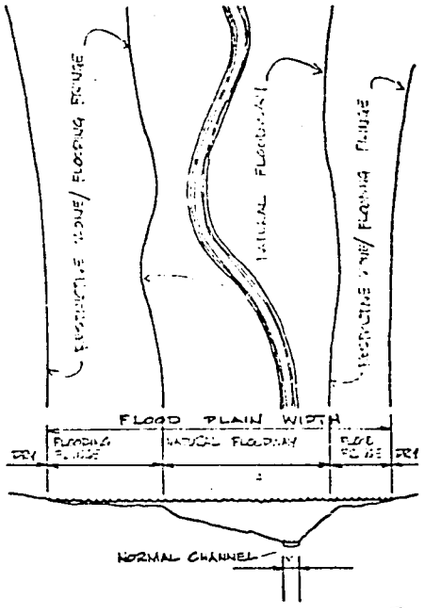


FIGURE #__ FLOOD ZONES [22:pp.85-91]

If buildings or other structures are contemplated in the above areas, special precautions should be taken such as: [24:pp.3-10]

-Avoidance of construction (buildings, bridges, and approaches, earth fills, etc.) within the natural floodway which will constrict the flow of floods.
-Construction of flood storage RESERVOIRS, confining FLOOD WALLS, CHANNEL IMPROVEMENTS (by staightening/widening), or BY-PASSES (to divert floods away from or around the site) will decrease flood hazards.
-Elevation of building floors above known flood crest levels.
-Establishment of operational evacuation plans and procedures.
-Incorporation of: waterproof walls and foundations, ejector pumps, floodgates, cut-off valves on sewers, etc.

Sites subject to flooding are not priced commercially and for this reason are commonly taken by low income and squatter settlements. Examples are found in low land on BAYS or LAGOONS (Cartagena, Columbia), on RIVERS (Guayaquil, Equador; Buenos Aires, Argentina), in GULLIES (Caracas, Venezuela). Some of these sites have been intelligently developed as in Cartagena and Guayaquil. Others are periodically washed away as in Caracas.

EVALUATION/PLANNING CONSIDERATIONS

The flooding of a site should be investigated to determine the site's development feasibility:

-FLOODING - (topographical survey, local flood crest records) - Conditions to be identified for the 50 year flood crest: area within the NATURAL FLOODWAY, area within the RESTRICTIVE ZONE, special precautions which could make the restrictive zone usable by buildings or other structures.

DEFINITIONS

DUST/DIRT, SMOKE, FUMES, ODORS, NOISE, VIBRATIONS

DUST/DIRT(*) - fine dry pulverized particles of earth, grit, refuse, waste, litter, etc.

SMOKE(*) - the gaseous products of burning carbonaceous materials made visible by the presence of carbon particles.

FUMES(*) - a gaseous emission that is usually odorous and sometimes noxious.

ODOR(*) - a quality of something that affects the sense of smell.

NOISE(*) - any sound (affecting the site) that is undesired (such as that produced by: traffic, airports, industry, etc.).

VIBRATION(*) - a quivering or trembling motion (such as that caused by: heavy traffic, industry, aircraft, etc.).

All the above may affect the site because of proximity to industrial plants, factories, quarries, garbage dumps, railroads, expressways, etc.

EVALUATION/PLANNING CONSIDERATIONS

Sites with proximity to sources of dust/dirt, smoke, fumes, odors, noise, and/or vibrations should be studied to determine their desirability/suitability for development.

-DUST/DIRT, SMOKE, FUMES, ODORS, NOISE, VIBRATIONS - (on-site evaluations) - Characteristics to be identified for each source: name and location; type: dust/dirt, smoke, fumes, odors, noises, vibrations; intensity.

DEFINITIONS

FIRE/EXPLOSION HAZARDS(*) - danger: the state of being exposed to harm; liable to injury, pain, or loss from fire/explosion (at or near the site).

Sites with proximity to HIGH HAZARD OCCUPANCIES (areas, buildings, structures involving highly combustible, highly flammable or explosive material) should be avoided. The following are examples of high hazard occupancies: [25:pp.21-22]

-Aluminum powder factories
-Cellulose nitrate plastic factories, warehouses and sales rooms
-Cereal mills
-Distilleries
-Explosives manufacture, storage
-Flour and feed mills
-Petroleum bulk manufacture, storage
-Grain elevators
-Lacquer/paint factories
-Liquified petroleum gas charging or bulk storage plants
-Waste paper plants

Many municipalities have established FIRE LIMITS by law, within which all construction must be fire-resistant or fire-proof. These limits should be identified, because they will determine the construction types allowed by law as well as the areas allowed per structure and the dimensional relationships between buildings. [25:p.38]

EVALUATION/PLANNING CONSIDERATIONS

Sites with proximity to high hazard occupancies should be analyzed/evaluated critically to determine the safety/feasibility of their development.

-FIRE/EXPLOSION HAZARD - (site evaluation, local fire code) - Characteristics to be identified for each hazard: name, location, degree of separation from site.

DEFINITIONS

AIRPORT DISTURBANCE/ZONING RESTRICTIONS

AIRPORT DISTURBANCE(*) - the act or process of destroying the rest, tranquility, or settled state of (a site by the annoyance of airport noise, vibration, hazards, etc.).

AIRPORT ZONING RESTRICTIONS(*) - the regulation of the height or type of structures in the path of moving aircraft.

Site location in relation to existing or proposed airports should be carefully checked, including the possibilities for construction of new airport facilities and runway extensions.

All sites should be studied in terms of their relationship to existing and proposed airport performance standards/zoning restrictions. These will vary between airports and heliports [26: pp. 160-168]. It is important to recognize that these standards/restrictions are continuously changing as a result of changing aircraft size and speed.

Proximity to airports may be undesirable because of noise, vibration, and hazards resulting in personal annoyance. These conditions may be especially critical when the site lies under a flight pattern or within zones of aircraft approaches and take-offs [8:pp.56-62].

EVALUATION/PLANNING CONSIDERATIONS

Site location in relation to airports should be analyzed to determine the desirability/feasibility/adequacy of the site for development.

-AIRPORT DISTURBANCE/ZONING RESTRICTIONS - (local planning commissions, city engineer, aviation agencies) - Conditions to be determined for existing or proposed airports: flight patterns, approach/landing zones, take-off zones, noise levels at site, vibration levels at site, allowable maximum obstruction heights.

16. TOPOGRAPHY, NATURAL FEATURES

DEFINITIONS

TOPOGRAPHY(*) - the configuration of a (land) surface including its relief and the positions of its natural and man-made features.

"The extent and character of such features--simple or complex undulations, watercourses, near and distant views from different points of observation and individual or massed effect of trees--have varied relations to one another and to all developments that can be foreseen. Every element in topography should be considered as an opportunity to be used."

The topography of a site is a composite of its NATURAL FEATURES(*):

-Land Surface Undulations: hills, valleys, slopes, flat land, etc.

-Water Features: streams, rivers, ponds, lakes, marshes, floodplains, etc.

-Vegetation: trees, grasses, ground cover, etc.

-Geological Formations: rock out-croppings.

The main indicator of topography is SLOPE(*) which can be measured in terms of:

-Ratio of vertical: horizontal distance: 1:20, 1:10, 1:6, 1:5, 1:4, 1:3

-Percentage of vertical: horizontal distance: 5%, 10%, 15%, 20%, 25%, 30%

-Degrees from the horizontal plane: 2°, 4.5°, 7°, 9°, 11°, 13.5°

Topography (SLOPE) is a major planning determinant useful in defining: land use, land subdivision, circulation, drainage, and land development and maintenance costs.

The following chart (fig #) gives a rough indication of the limitations imposed on: land use, subdivision, circulation, drainage, land development costs, buildings, vehicular speeds, and surface protection by slopes varying from 0% to greater than 30%.

EVALUATION/PLANNING CONSIDERATIONS

Every element in topography should be considered as an opportunity to be used. Therefore, topography should be analyzed/evaluated to permit the planning of the site to take full advantage of the positive features and to minimize the negative ones.

-SLOPE - (site plan, topographical survey) Ranges to be identified in terms of percentage: 0 to 5%, 6 to 15%, 16 to 30%, 31% and greater.

-TOPOGRAPHY - (site plan) - Characteristics to be identified for each natural feature: Specific Name and Location; Type: land surface undulation, water feature, vegetation, geological formation; Positive and Negative Conditions; Influence in: land use, subdivision, circulation, drainage, land development costs, buildings, vehicular speeds, and surface protection.

SLOPES, LAND USE, LAND SUBDIVISION, CIRCULATION, DRAINAGE, LAND DEVELOPMENT, BUILDINGS, SPEED, SURFACE PROTECTION

ASPECTS	5% (3°) 0 to 5%	15% (9°) 6% to 15%	30% (17°) 16% to 30%	31% 31% UP
LAND USE	No restrictions	10% and up not adequate for playing fields or other large outdoor flat areas because demands heavy grading	Parks or other areas that require little or no grading	
LAND SUBDIVISION	No restrictions in lot dimensions	No restrictions in lot dimensions	30% and up not adequate for small lots; will present foundation and retaining wall problems; Multi-story structures will reduce costs per unit for foundations and land development	
CIRCULATION (VEHICULAR)	Safe, sustained grade for all vehicles U.S.A.	9% to 12% steepest grades for highways U.S.A.	30% to 32% steepest grades for paved streets in U.S.A. Layouts will require roads parallel or diagonal to contours to reduce slope	
DRAINAGE SEWAGE	Flat land may present numerous problems in sewage and storm drainage that will raise improvement costs	5% to 10% will facilitate sewage and storm drainage	20% and up will present problems in sewage and storm drainage that will raise improvement costs	Unusual conditions for land development will require careful study in all aspects
LAND DEVELOPMENT MAINTENANCE	Flat land may not be economical to develop	5% to 10% is more economical to develop than flat or steeper slopes; 10% and up may demand heavy grading, causing greater settlements, erosion	20% and up will increase sharply costs of land development and maintenance	
BUILDINGS	No restrictions	10% and up will require study of soil, building type, construction system, grading, foundations, number of floors		
SPEED -BUS/CAR -PEDESTRIAN	100-120 km/hour 4 km/hour	10% and up no good for sustained distances 9% - 2 km/hour; 10% and up no good for sustained distances		
SURFACE PROTECTION	Surface protection against erosion (rain, wind, intensive use) should be considered with SOIL characteristics			

17. SOIL

DEFINITIONS

SOIL(*) - soil structure: the arrangement of soil particles in various aggregates differing in shape, size, stability, and degree of adhesion to one another.

Knowledge of the specific SOIL CONDITIONS of a site is particularly important for the determination of:
-FOUNDATION SYSTEMS of roads, infrastructure buildings.
-DRAINAGE (surface or subsurface) and erosion characteristics.
-VEGETATION (nature and types) which can be sustained.

There are two commonly recognized broad groups of soils:
-DISTURBED: Soils that have been disturbed by artificial process, such as Excavation, Transportation, and Compaction in Fill.
-NATURAL, UNDISTURBED: Soils that have not been disturbed by artifical process. Although natural, they depend greatly on local conditions, environment, and past geological history of the formations.

Soils are composed from varying amounts of:
-GRAVEL: loose/unconsolidated rock fragments (ranging from 2mm and greater in diameter) [1].
-SAND: loose/distinguishable grains of quartz, feldspar, mica (ranging from 2mm to 0.02mm in diameter) [1].
-SILT: loose/unconsolidated sedementary rock particles (ranging from 0.02mm to 0.002mm in diameter) [1].
-CLAY: lusterless colloidal substance plastic when moist (crystalline grains less than 0.002mm in diameter) [1].
-ORGANIC SOILS: soils composed mostly of plant material [1].

UTILIZATION OF SOIL INFORMATION IN LAND-USE PLANNING: [27:p.10]
-GENERAL SOIL MAP is used for broad land use planning. It allows the study of available soil resources early in the planning process. Such a preview involves consideration of limitations, restrictions, hazards for use relative to the various general soil areas involved.
-DETAILED SOIL MAP is needed for a careful study of individual kinds of soil as classified and mapped in accordance with the given area of interest. Detailed soil maps are essential in considering limitations, restrictions, or hazards for use at later stages of planning. Also, they are used for on-site studies of the soil after planning has progressed to the point of determining specific uses for specific areas.

DRAINAGE CHARACTERISTICS of soils are particularly important in areas not served by public sewerage and where on-site sewage disposal systems will be used.

SOIL INVESTIGATION is conducted in increasing depth/detail/cost as the planning of the site progresses:
-INITIAL SOIL SURVEY: on-site examination of surface soil conditions and reference to a GENERAL SOIL MAP reveal obvious limitations/restrictions/hazards for early planning consideration.
-EXPLORATORY BORING: initial subsurface investigations (borings) are done on a grid superimposed on the areas of interest and on areas indicated as limited/restricted/hazard in the initial survey.
-CONSTRUCTION BORING: subsurface boring done at the planned location of all infrastructure and building footings and roadway sub-bases for design of the foundation systems.

When the site is located on an aquifer (water bearing soil) or in an aquifer recharge area, all prospective land uses should be examined carefully to insure that they will not pollute this water resource [23:p.58].

Soils contain three elements essential to vegetation growth: water, air, and nutrients (minerals and humus). Soil, climate and topography are inseparable vegetation growth factors. Climate is the most important of these [21:pp.246-249].

TABLE OF SOIL CHARACTERISTICS
The following table (fig #) [from 28:p.35] gives the designer an indication of the BEHAVIOR OF THE SOIL for an INITIAL SOIL SURVEY. It serves as a broad outline to act as a guide in deciding whether investigations and evaluations by a competent engineer are required/warranted. When soils are explored as foundations for structures, their natural structure, compactness, and moisture content are of primary importance. In addition, the position of the ground water table plays an important role.

The table does not indicate the variation in a soil formation. The characteristics of any group are given in relative values only. Although given a low rating, certain properties of poorly suited soils may be improved by proper construction methods.

EVALUATION/PLANNING CONSIDERATIONS

Soil conditions should be analyzed/evaluated for the determination of foundation systems, drainage and erosion characteristics, and the nature and types of vegetation which can be sustained.

-SOIL - (soil maps, charts) - Soil Characteristics to be determined: Natural Structure, Moisture Content, Compaction, Workability, Shearing Strength, Compressability and Expansion, Drainage, Potential Frost Action, Corrosion Potential.

Column 4:
WORKABILITY AS A CONSTRUCTION MATERIAL
A measure of the case with which a soil is handled and traversed by ordinary construction equipment.

Column 5:
COMPACTION CHARACTERISTICS
Differentiation of the soil groups with reference to the case with which proper compaction can be obtained, with the assumption of reasonably suitable compaction equipment being used and with proper control of moisture content.

Column 6:
SHEARING STRENGTH WHEN COMPACTED AND SATURATED
It is not an intrinsic property of a given soil, shearing strength varies over a considerable range with varying conditions, such as density, moisture content, and degree of consolidation.

Column 7:
COMPRESSIBILITY AND EXPANSION
Volume changes because of loading or moisture variation.

Column 8:
DRAINAGE
Drainage characteristics have been rated from excellent (very porous) to very poor (impervious).

Column 9:
POTENTIAL FROST ACTION
Frost action is the heave caused by ice lenses forming in a soil and the subsequent loss of strength as a result of excess moisture during thawing periods.

Column 10:
CORROSION POTENTIAL

MAJOR DIVISION 1		GROUPS SYMBOLS 2	TYPICAL NAMES OF SOIL GROUPS 3	GENERAL CHARACTERISTICS: WORKABILITY AS A CONSTRUCTION MATERIAL 4	COMPACTION CHARACTERISTICS 5	SHEARING STRENGTH WHEN COMPACTED & SATURATED 6	COMPRESSIBILITY & EXPANSION 7	DRAINAGE CHARACTERISTICS 8	POTENTIAL FROST ACTION 9	CORROSION POTENTIAL 10	UNIT DRY WEIGHT LB./CU. FT 11	RELATIVE DESIRABILITY FOR VARIOUS USES: Roadways: SUB-BASE WHEN NOT SUBJECT TO FROST ACTION 12	BASE WHEN NOT SUBJECT TO FROST ACTION 13	SUB-BASE WHEN SUBJECT TO FROST ACTION 14	WEARING SURFACE (UNTREATED) 15	SURFACE STABILIZATION WITH ADDITIVES 16	Foundation: LOW BUILDINGS OF COMPACTED FILL 17	Sewage: DOMESTIC SEWAGE DISPOSAL AREA 18
COARSE-GRAINED SOILS	GRAVEL & GRAVELLY SOILS	GW	Well-graded gravels, gravel-sand mixtures, little or no fines.	1	1	1	1	1	1	1	125-140	1	1	1	3	1	1	1
		GP	Poorly graded gravels or gravel-sand mixtures little or no fines.	2	2	2	1	1	1	1	120-130	2	2	2	3	2	2	1
		GM	Silty gravels, gravel-sand-silt mixtures.	2	3	3	2	3-4	2-3	1	130-145	2	2-4	3	4	1	2	2
		GC	Clayey gravels, gravel-sand-clay mixtures.	2	3	4	3	5	2-3	2	120-140	2	3-4	3	1	2	3	2
	SANDS & SANDY SOILS	SW	Well-graded sands, gravelly sands, little or no fines.	1	1	2	1	1	1	1	110-130	1	2	2	4	1	2	1
		SP	Poorly graded sands or gravelly sands, little or no fines.	3	2	3	1	1	1	1	105-120	3	2-4	2	4	1	3	1
		SM	Silty sand, sand-silt mixtures.	3	3	4	2	3-4	4	1	120-135	3	3-5	4	4	2	3	2
		SC	Clayey sands, sand-clay mixtures.	2	3	5	2-3	5	4	2	105-130	3	5	3	2	2	3	NS
FINE-GRAINED SOILS	SOILS & CLAYS LL < 50	ML	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands or clayey silts with slight plasticity	3-4	3-4	5	2-3	3-4	3-5	2	100-125	4	NS	5	NS	3	4	NS
		CL	Inorganic clays of low to medium plasticity gravelly clays, sandy clays, silty clays, lean clays.	3	3	5	3	5	3-4	3	100-125	4	NS	4	5	4	4	NS
		OL	Organic silts and organic silty clays of low plasticity.	4	5	5	3-4	4	3-4	4	90-105	4	NS	5	NS	5	5	NS
	SOILS & CLAYS LL > 50	MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts.	4	4-5	5	4	3-4	3-5	2	80-100	5	NS	5	NS	5	5	NS
		CH	Inorganic clays of high plasticity, fat clays.	5	4-5	5	4	5	3	3	90-110	5	NS	4	NS	5	5	NS
		OH	Organic clays of medium to high plasticity, organic silts.	5	5	5	4	5	3	4	80-100	5	NS	5	NS	5	5	NS
Highly organic soils		PT	Peat and other highly organic soils.	NS	NS		5	3-4	2	5		NS	NS	NS	NS	NS	NS	NS

NOTE: Above soil groups are rated according to relative desirability for being used.

1 - Most desirable (excellent)
2 - Desirable (good)
3 - Medium (fair)
4 - Undesirable (poor)
5 - Most undesirable (very poor)
NS - Not suitable

LL Liquid limit: The water content (0 to 100%) corresponding to the arbitrary limit between the liquid and plastic states of consistency of a soil.

Some soils tend to cause corrosion in underground conduits or pipes placed in them. The corrosion potential depends on chemicals in the soil, usually dissolved in the soil moisture and on the materials from which the conduits are made.

Column 11:
UNIT DRY WEIGHT
Weight of one cubic foot of soil in pounds.

Column 12, 13, 14:
SUBBASE OR BASE MATERIALS
The soil groups are rated as to relative desirability as subbase and base materials, provided they are not subject to frost action in columns 12 and 13. In areas where frost heaving is a problem, the value of materials as subbases will be reduced, depending on the potential frost action of the material, and the relative desirability changes to those shown in column 14.

Column 15:
WEARING SURFACE (UNTREATED)
This considers the wearing surfaces on unsurfaced roads. Generally, sand, clay, gravel mixtures are best.

Column 16:
SURFACE STABILIZATION WITH ADDITIVES
The addition of additives to promote stabilization of soils adds materially to the strength. As in low-cost road construction underneath a foundation slab, stabilization makes the effect of mechanical stabilization through compaction more lasting.

Column 17:
FOUNDATIONS FOR LOW BUILDINGS
up to and including three stories are considered as low building. These ratings do not take into account the effects of subsoils and slope stability factors.

18. CLIMATE

DEFINITIONS

CLIMATE(*) - the average condition of the weather at a particular place over a period of years as exhibited by temperature, wind, precipitation, (sun energy, humidity, etc.).

The intelligent use of climate is important in dwelling and environment design, particularly in developing countries and low income communities where mechanical climate control or special building materials cannot be considered for reasons of technology or cost. This section illustrates climate and human comfort; the climatic factors; climatic zones; factors, elements, controls; design issues and goals. These aspects give only a broad view of the problem; but, they can be used as general guidelines.

The following chart CLIMATE AND HUMAN COMFORT (fig #) illustrates schematically the relationship between human comfort requirements, climate, and environmental control.

SUN CHARTS (fig #) give the position of sun exposure on the sky for a selected locality (latitude) per day, per hour during the year. Sun charts permit the calculation of the sun exposure in terms of sun position, length of time, seasons, and oreintation. The following chart is a simple one. It shows in plan and section, for a given latitude, the trajectory of the sun on the sky during four days of the year: March 21-September 21 (spring-fall); June 21 (winter or summer); and December 21 (summer or winter).

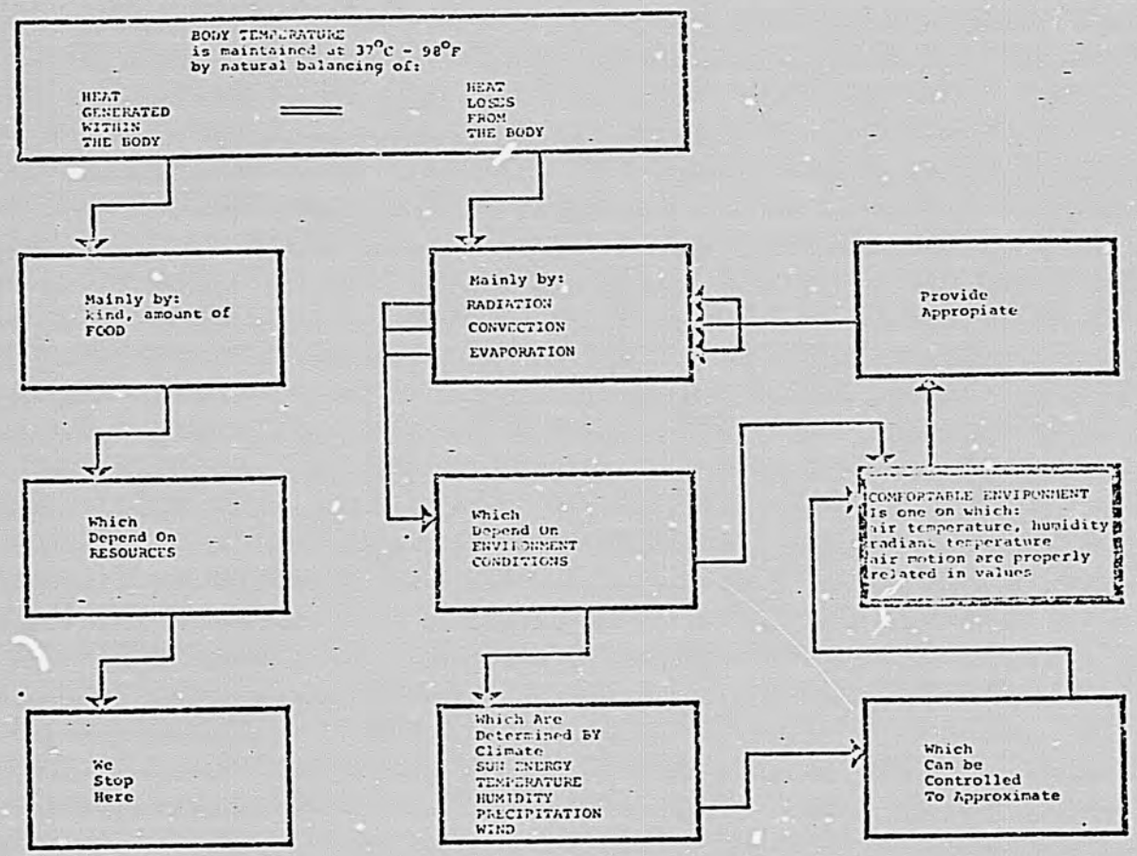
WIND CHART (fig #) shows wind directions and their frequency over time for a given locality.

AIR TEMPERATURE CHARTS (fig #) show median air temperature over time for a given locality.

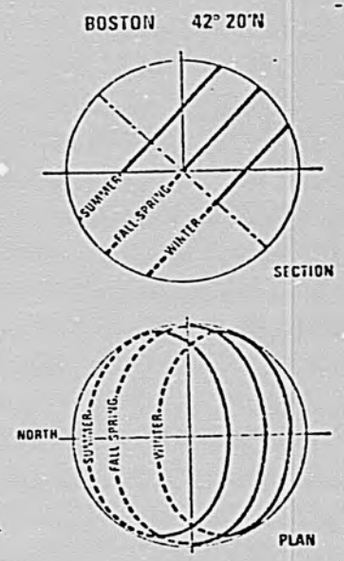
AIR RELATIVE HUMIDITY CHART (fig #) show median air relative humidity over time for a given locality.

RAIN, SNOW CHARTS (fig #) show precipitation amount over time for a given locality.

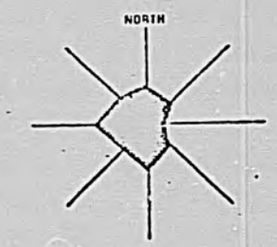
CLIMATE AND HUMAN COMFORT



SUN



WIND



CLIMATIC ZONES (fig #) illustrates climatic zones determined by Relative Air Humidity (dry, moderate, humid) and Air Temperature (cold, temperate, hot). Nine zones are identified. Ranges of human body comfort are those within the shaded area:

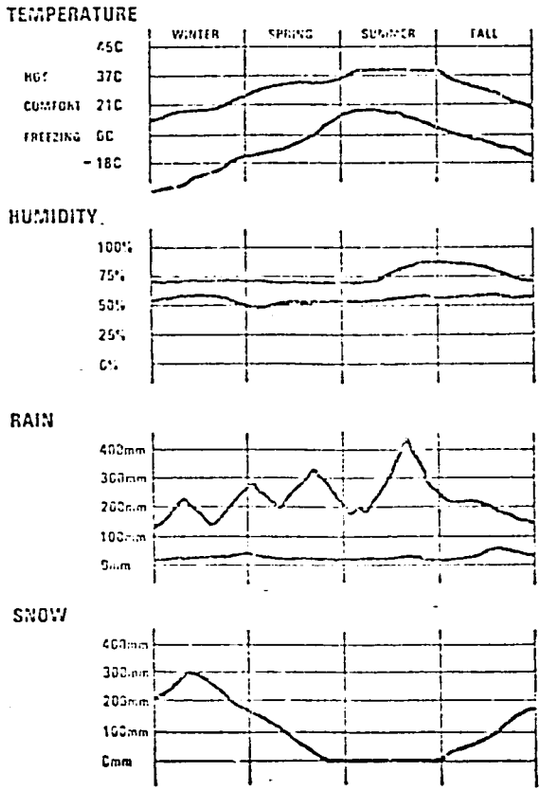
-Air Temperature Comfort: working 15-18 C
resting: 18-20 C

-Air Relative Humidity Comfort:
working: 50%-60%
resting: 40%-70%

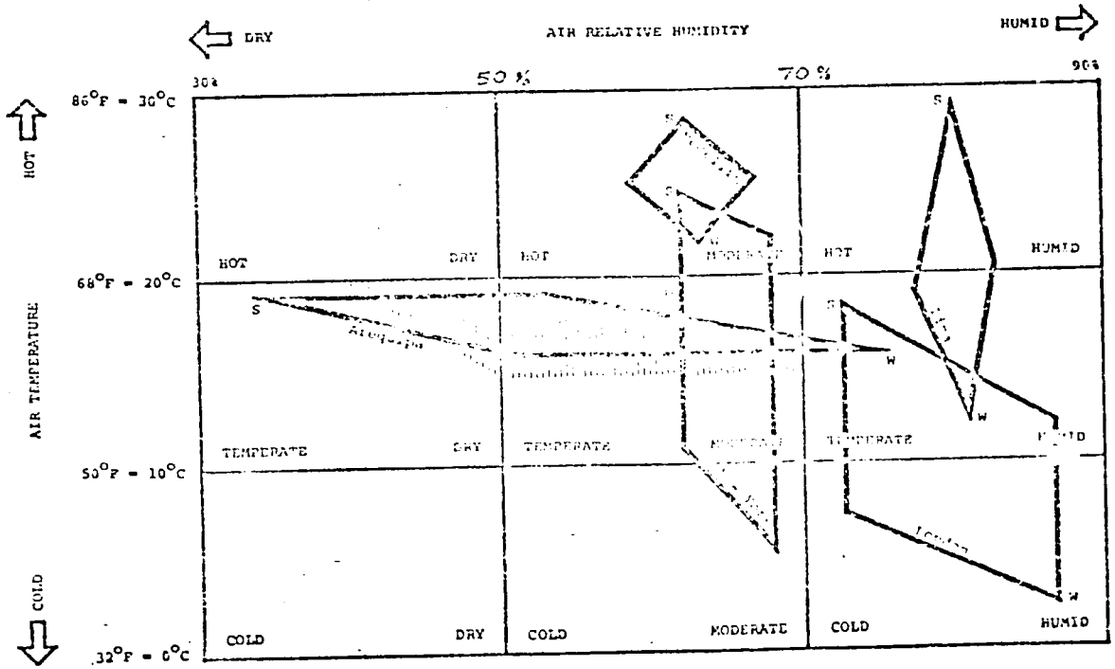
The matrix is for general reference and does not include other factors such as: rates of air movement and the effect of radiant heat that will affect comfort conditions.

Average monthly humidity and temperature of a locality can be plotted to represent an annual curve which become useful as reference points. The following annual climatic curves are shown in fig # :

-LONDON	summer:	Temperate/Humid
	winter:	Cold/Humid
-NEW YORK	summer:	Hot/Moderate
	winter:	Cold/Moderate
-LIMA	summer:	Hot/Humid
	winter:	Temperate/Humid
-MEDELLIN	summer:	Hot/Moderate
	winter:	Hot/Moderate
-AREQUIPA	summer:	Temperate/Dry
	winter:	Temperate/Humid



CLIMATIC ZONES



The following matrix CLIMATIC FACTORS, DWELLING ENVIRONMENT ELEMENTS, BASIC CONTROLS (fig #) shows different dwelling environment elements, climatic factors affecting them and the basic controls of these factors: Orientation (O), Design (D), Materials (M). The matrix emphasizes the importance of orientation and design in climate control. Materials are basic controls only in the cases of walls and roofs.

WINDS, STORMS, FOG, DAMPNESS, TEMPERATURE INVERSIONS may be critical and should be studied, particularly in relation to other conditions such as: views, flooding, dust/dirt, smoke, fumes, odors, noise, and vibrations.

In many areas it is important to check:

-Direction, Speed, Frequency of prevailing WINDS, STORMS.

-Frequency, Duration, Intensity of FOG, DAMPNESS, TEMPERATURE INVERSIONS.

WIND velocity can be measured by the BEAUFORT SCALE: [1]

-Calm	up to 1 mph	smoke undisturbed
-Light Air	1-3	smoke disturbed
-Light Breeze	4-7	wind felt on face
-Gentle Breeze	8-12	wind extends flag
-Moderate Breeze	13-18	raises dust, paper
-Fresh Breeze	19-24	crested water
-Strong Breeze	25-31	power lines whistle
-Moderate Gale	32-38	nation: whole tree
-Fresh Gale	39-46	breaks twigs
-Strong Gale	47-54	some was roofing
-Whole Gale	55-63	trees uprooted
-Storm	64-72	much damage
-Hurricane	73-up	devastation occurs

STORMS manifest themselves by winds of unusual force or direction, which are often accompanied by rain, snow, hail, thunder and lightening, or flying dust/dirt.

DAMPNESS is characterized by moisture, humidity, and FOG by atmospheric saturation with moisture, humidity.

Areas subject to TEMPERATURE INVERSIONS, which result in hazardous air pollution, should be studied carefully. Identification of the major WIND directions, particularly those associated with inversion conditions, can indicate the best ventilated sites. A site located to the windward of the urban air pollution sources will minimize the pollution hazard to the development. [2]: p.64]

CLIMATIC FACTORS, DWELLING ENVIRONMENTS, BASIC CONTROLS

ELEMENTS	CLIMATIC FACTORS AFFECTING ELEMENTS											
	SUN			TEMPERATURE			HUMIDITY			WIND			RAIN		
WALLS	O		M	O		M				O	D		O		M
OPENINGS	O	D		O	D		O	D		O	D		O	D	
ROOF		D	M		D	M								D	M
OVERHANG	O	D											O	D	
SUNBREAKERS	O	D													
SCREENS	O	D								O	D		O	D	
SHRUBS, TREES, ETC.	O			O						O					
LOT	O			O			O			O					
STREET	O	D		O	D		O	D		O	D				

DESIGN ISSUES/GOALS

CLIMATIC ZONES See 'Climatic Zones' chart	CLIMATIC FACTORS AFFECTING CLIMATIC ZONES				
	SUN	TEMPERATURE	HUMIDITY	WIND	RAIN
HOT - DRY	Minimize exposure	Retard inward flow of heat	—	Occasional protection: against hot wind and erosion	—
HOT - HUMID	IDEM	IDEM	Reduce effects by promoting air movements	IDEM	Occasional protection: Against combined effects: rain-wind; To permit maximum openings to cool the air; Against erosion
COLD - DRY	Maximize exposure	Retard outward flow of heat	—	Occasional protection: against cold wind and erosion	—
COLD - HUMID	IDEM	IDEM	—	IDEM	Occasional protection: Against combined effects: rain-wind; Protection against erosion

19. EXISTING STRUCTURES, EASEMENTS, RIGHTS-OF-WAY

DEFINITIONS

STRUCTURES (EXISTING), EASEMENTS, RIGHTS-OF-WAY

STRUCTURE (EXISTING) (*) - something constructed or built (on the site).

EASEMENT(*) - servitude: a right in respect of an object (as land owned by one person) in virtue of which the object (land) is subject to a specified use or enjoyment by another person or for the benefit of another thing (1).

RIGHT-OF-WAY(*) - a legal right of passage over another person's ground (land); the area or way over which a right-of-way exists (such as): a path or thoroughfare which one may lawfully use, the strip of land devoted to or over which is built a public road, the land occupied by a railroad, the land used by a public utility.

NOTES:
(1) An EASEMENT may be: (3)
-An acquired right of use, interest, or privilege (short of ownership) in land owned by another, such as an easement of light, of building support, or of right-of-way. They may be permanent or limited in time dependent upon the easement agreement.
-Conservation Easement: an easement acquired by the public and designed to open privately owned lands for recreational purposes or to restrict the use of private land in order to preserve open space and protect certain natural resources. Some easements are negative, preventing the owner from using his land for specified purposes such as erecting a billboard or cutting trees; and, some are positive, such as water access or hiking easements.
-Scenic Easement: the grant by a landowner to a road agency of the right to use his land for scenic enhancement. This easement bars the owner from changing the use or appearance of his land without the easement holder's consent.

Examples:
-STRUCTURES (EXISTING): buildings, walls, fences, culverts, bridges, roads, railways, utilities, etc.
-EASEMENTS: (elevated and underground) electric power lines, telephone; (underground) sewerage, storm drainage, gas, water supply; conservation; scenic, open space; etc.
-RIGHTS-OF-WAY: land area controlled by future or present transportation pathways.

EVALUATION/PLANNING CONSIDERATIONS

Structures, easements/servitudes, rights-of-way may exist on the site and their effects/implications should be considered.

-STRUCTURES (EXISTING), EASEMENTS, RIGHTS-OF-WAY - (site plan) - Characteristics to be identified for each: Existing Structure, Easement, Right-of-way: description and location, positive and negative conditions, influence in layout.

20. WATER SUPPLY, WASTEWATER SYSTEMS: SANITARY SEWERAGE, STORM DRAINAGE

WATER SUPPLY

DEFINITIONS (See: PLANNING CONTEXT: WATER SUPPLY)

EVALUATION/PLANNING CONSIDERATIONS

Alternatives for supplying water to a site are the same whether the site is within a major distribution grid (as in an urban area) or outside a major grid (as in a newly developed fringe area). The alternatives are: [19: p. 20]

-Connection to an existing distribution network.
-Development of a new central distribution network.
-Development of individual water supply systems.

Since the systems for water collection, transportation, treatment, and distribution are planned/provided/regulated by national/regional agencies, the developer is primarily concerned with the available supply of water for distribution at a site. Connection to an existing distribution system is most desirable. If the site cannot be connected to an existing system, the possibility of a central system should be explored with the appropriate authorities. Individual water supply systems are generally not appropriate in urban situations.

The availability of water supply at a site should be analyzed/evaluated to determine its suitability/consistency in terms of the following existing and/or projected conditions:

-CONNECTION - (urban area/site maps, charts) Conditions to be determined: Possibility of connection; Distance from site to main; Costs of connection, piping to site.

-CAPACITY - (charts, tables) - Amounts to be determined: Quantity, Pressure in relation to demands.

-QUALITY - (public health authorities) - Conditions to be verified: Water source, system protection; Bacteriological quality; Physical characteristics; Chemical characteristics.

-OWNERSHIP/CONTROL/ADMINISTRATION - Conditions to be determined: Names, Addresses of local agencies; Type of control: Private, Public; Efficiency of operation, maintenance.

SANITARY SEWERAGE

DEFINITIONS (See: PLANNING CONTEXT: SANITARY SEWERAGE)

EVALUATION/PLANNING CONSIDERATIONS

Alternatives for sanitary sewerage collection and disposal from a site are generally: [19: p. 106]

-Connection to an existing sewer system.
-Development of a new communal sewer system.
-Development of individual sewage disposal systems.

Since the systems for sewage collection, treatment, and disposal are planned/provided/regulated by metropolitan/municipal agencies, the developer is primarily concerned with the means of sewage disposal available at a site. The connection to an existing sewer system is most desirable. If the site cannot be connected to an existing system, the possibility of a communal system should be explored with the appropriate authorities. Individual sewage disposal systems are generally not appropriate in urban situations.

The availability of sanitary sewerage at a site should be analyzed/evaluated to determine its suitability/adequacy in terms of the following existing and/or projected conditions:

-CONNECTION - (urban area/site maps, charts) Conditions to be determined: Possibility of connection; Distance from site to main; Costs of connection; piping from site.

-CAPACITY - (charts, tables) - Amounts to be determined: Flow, Velocity in relation to the loads.

-OWNERSHIP/CONTROL/ADMINISTRATION - Conditions to be determined: Names, Addresses of local agencies; Type of control: Private, Public; Efficiency of operation, maintenance.

STORM DRAINAGE

DEFINITIONS (See: PLANNING CONTEXT: STORM DRAINAGE)

EVALUATION/PLANNING CONSIDERATIONS

Alternatives for stormwater collection and disposal from a site are generally: [8: p. 48]

-Connection to an existing storm drainage system.

-Use of existing natural streams/valleys.

Since the systems for stormwater collection and disposal are planned/provided/regulated by regional/metropolitan/municipal agencies, the developer is primarily concerned with the means of stormwater disposal available at a site. The connection to an existing storm drainage system is most desirable. If the site cannot be connected to an existing system, the use of existing natural streams/valleys should be explored with the appropriate authorities.

The availability of storm drainage at a site should be analyzed/evaluated to determine its suitability/adequacy in terms of the following existing and/or projected conditions:

-CONNECTION - (urban area/site maps, charts) Conditions to be determined: Possibility of connection; Distance from site to main; Costs of connection, piping from site.

-CAPACITY - (charts, tables) - Amounts to be determined: Flow, Velocity in relation to runoff.

-OWNERSHIP/CONTROL/ADMINISTRATION - Conditions to be determined: Names, Addresses of local agencies; Efficiency of operation, maintenance.

21. ELECTRICITY, STREET LIGHTING, TELEPHONE, GAS

ELECTRICITY

DEFINITIONS (See: PLANNING CONTEXT: ELECTRICITY)

EVALUATION/PLANNING CONSIDERATIONS

Since the systems for electricity generation, transmission, and distribution are planned/regulated by national/regional/metropolitan agencies and provided by public/private suppliers, the developer is primarily concerned with the available supply of electricity for distribution at a site.

The availability of electric service at a site should be analyzed/evaluated to determine its suitability/adequacy in terms of the following existing and/or projected conditions:

-CONNECTION - (urban area/site maps, charts) Conditions to be determined: Distance from site to power lines; Costs of hookup, transmission to site.

-CAPACITY - (charts, tables) - Conditions to be determined: Demand peak: Frequencies, Duration, Power consumption volumes; Average power usage.

-OWNERSHIP/CONTROL - Conditions to be determined: Names, Addresses of local agencies; Type of control: Private, Public, Cooperative, Industrial; Standard of Service: Reliability of service, Quality of service.

STREET LIGHTING

DEFINITIONS (See: PLANNING CONTEXT: STREET LIGHTING)

EVALUATION/PLANNING CONSIDERATIONS

Since street lighting is planned/regulated by metropolitan/municipal agencies and, in virtually all cases, provided by the local supplier of electricity, the developer is primarily concerned with the availability of electricity for street lighting at a site.

The availability of street lighting at a site should be analyzed/evaluated to determine its suitability/consistency in terms of the following existing and/or projected conditions:

-CONNECTION - (utility maps, charts) - Conditions to be determined: Distance from site to power lines; Costs of hookup, transmission to site.

-LIGHTING - Conditions to be determined along approach routes: Level of lighting, Spacing of luminaires, Height of mountings.

-OWNERSHIP/INSTALLATION/OPERATION - Conditions to be determined: Names, Addresses of local agencies; Type of control: Electric utility, Municipal; Reliability of service.

TELEPHONE

DEFINITIONS (See: PLANNING CONTEXT: TELEPHONE)

EVALUATION/PLANNING CONSIDERATIONS

Since the systems for telephone switching and transmission are planned/regulated by national/regional/metropolitan agencies and provided by public-private companies, the developer is primarily concerned with the availability of telephone service at a site.

The availability of telephone service at a site should be analyzed/evaluated to determine its adequacy/quality in terms of the following existing and/or projected conditions:

-CONNECTION - (utility maps, charts) - Conditions to be determined: Distance from site to transmission lines; Arrangement of cables: Overhead, Underground; Costs of hookup, transmission to site.

-OWNERSHIP/CONTROL/ADMINISTRATION - Conditions to be determined: Names, Addresses of local agencies; Operational efficiency in terms of: Switching, Transmission.

GAS

DEFINITIONS (See: PLANNING CONTEXT: GAS)

EVALUATION/PLANNING CONSIDERATIONS

Since the systems for gas collection, transportation, storage, and distribution are planned/regulated by national/regional/metropolitan agencies and provided by public/private suppliers, the developer is primarily concerned with the available supply of gas for distribution at a site.

The availability of gas service at a site should be analyzed/evaluated to determine its suitability/adequacy in terms of the following existing and/or projected conditions:

-CONNECTION - (utility maps, charts) - Conditions to be determined: Distance from site to mains; Costs of connection, piping to site.

-CAPACITY - (charts, tables) - Amounts to be determined: Volume, Pressure in relation to demands.

-SYSTEM QUALITY - Characteristics to be checked: Safety of the network in relation to: Age, Maintenance.

-OWNERSHIP/ORGANIZATION - Conditions to be determined: Names, Addresses of local agencies; Type of control: Private, Public; Efficiency of operation, maintenance; Competitiveness with electricity.

22. PAVED ROADS, WALKWAYS, PARKIN

23. PUBLIC TRANSPORTATION

24. POLICE, FIRE PROTECTION

25. REFUSE COLLECTION

REFUSE COLLECTION

DEFINITIONS (See: PLANNING CONTEXT: REFUSE COLLECTION)

EVALUATION/PLANNING CONSIDERATIONS

Since refuse collection and disposal service is planned/regulated by metropolitan/municipal agencies and provided by public/private collectors, the developer is primarily concerned with the methods of refuse disposal available at a site.

The availability of refuse collection service at a site should be analyzed/evaluated to determine its suitability/adequacy in terms of the following existing and/or projected conditions:

-CAPACITY - (charts, tables) - Quantities collected to be determined in relation to those produced.

-QUALITY OF SERVICE - Conditions to be determined for each material collected: Cost; Frequency of collection; Preparation: Separation, Sepcial treatment, Storage, Location of receptacles, Quantity limitations.

-RESPONSIBILITY/CONTROL - Conditions to be determined: Names, Addresses of local agencies; Type of collection responsibility: Government agency, Contractor under contract with government, Contractor under contract with refuse producers, Producer of refuse.

26. HEALTH

27. SCHOOLS, PLAYGROUNDS

28. RECREATION, PARKS, OPEN SPACE

29. OTHER COMMUNITY FACILITIES

30. BUSINESS, COMMERCIAL, SMALL INDUSTRIES, PROFESSIONAL

GOVERNMENTAL/MUNICIPAL REGULATIONS

31. MASTER PLAN

32. ZONING ORDINANCE

33. SUBDIVISION REGULATIONS

34. BUILDING CODES

35. TAX STRUCTURE

36. OTHER

PLANNING CONTEXT
Guidelines for Development

Land Development	33. LAND USE: RESIDENTIAL
	34. LAND USE: BUSINESS, COMMERCIAL, INDUSTRIAL
	35. LAND USE: SCHOOLS, PLAYGROUNDS, PARKS
	36. LAND USE: MISCELLANEOUS
	37. INCOME SECTOR
	38. INTENSITY OF USE
	39. LAND TENURE
	40. LAND SUBDIVISION (Basic residential layouts)
Circulation	41. EXTERIOR ACCESS
	42. INTERIOR CIRCULATION (Modes, parking)
Utility Infrastructure	43. WATER
	44. SEWAGE
	45. ELECTRICITY
	46. TELEPHONE
	47. REFUSE
Time	48. DEVELOPMENT MODE
	49. IMPLEMENTATION
Socio-Economic Political	50. FINANCIAL PLAN
	51. SOCIAL

33. LAND USE: RESIDENTIAL

In any urban settlement the greater part of the land is used for residential purposes (around 50%), which means occupied by the dwellings and their grounds. The amount of residential area for a given population varies considerably. This wide variation is a function of the type of dwellings and number of stories (detached, semi-detached, row, walk-up apartments, high rise apartments) and also the number of people per dwelling (or number of people per family).

It is important to easily relate these factors; with this purpose, the tables shown on the following pages have been prepared.
The tables will allow:
to have a comparative idea of the areas required;
to compare different choices;
to combine different types of dwellings (examples?)

FACILITIES/SERVICES REQUIRED
(See other Land Uses)

POPULATION DENSITIES PER Ha., PERSONS PER FAMILY, NUMBER OF FLOORS, TOTAL UNITS, UNITS PER FLOOR, LOT AREAS

The tables contain the following information:
POPULATION DENSITIES PER HECTARE (100 meters x 100 meters)
for: 100-200-300-400-500-600-700-800-900-1000 persons/Ha.

Each density table includes:
- The NUMBER OF PERSONS PER family, household, or dwelling UNIT for 2 to 10 persons per unit (listed horizontally)
- The NUMBER OF FLOORS form 1 to 20 (listed vertically)

The values represent:
a) The NUMBER OF UNITS PER FLOOR
b) The TOTAL NUMBER OF UNITS
c) The AVERAGE LOT AREA

DENSITY : 100

Number of Floors		Persons Per Unit 2	3	4	5	6	7	8	9	10
1	a)	50	33	25	20	16	14	12	11	10
	b)	50	33	25	20	16	14	12	11	10
	c)	200	300	400	500	600	700	800	900	1000
2	a)	25	16	12	10	8	7	6	5	5
	b)	50	33	25	20	16	14	12	11	10
	c)	400	600	800	1000	1200	1400	1600	1800	2000
3	a)	16	11	8	6	5	4	*	*	*
	b)	50	33	25	20	16	14	12	*	*
	c)	600	900	1200	1500	1800	2100	2400	*	*
4	a)	12	8	6	5	*	*	*	*	*
	b)	50	33	25	20	16	*	*	*	*
	c)	800	1200	1600	2000	2400	*	*	*	*
5	a)	10	6	5	*	*	*	*	*	*
	b)	50	33	25	20	*	*	*	*	*
	c)	1000	1500	2000	2500	*	*	*	*	*
6	a)	8	5	*	*	*	*	*	*	*
	b)	50	33	25	*	*	*	*	*	*
	c)	1200	1800	2400	*	*	*	*	*	*
7	a)	7	*	*	*	*	*	*	*	*
	b)	50	33	*	*	*	*	*	*	*
	c)	1400	2100	*	*	*	*	*	*	*
8	a)	6	*	*	*	*	*	*	*	*
	b)	50	33	*	*	*	*	*	*	*
	c)	1600	2400	*	*	*	*	*	*	*
9	a)	5	*	*	*	*	*	*	*	*
	b)	50	*	*	*	*	*	*	*	*
	c)	1800	*	*	*	*	*	*	*	*
10	a)	5	*	*	*	*	*	*	*	*
	b)	50	*	*	*	*	*	*	*	*
	c)	2000	*	*	*	*	*	*	*	*
11	a)	4	*	*	*	*	*	*	*	*
	b)	50	*	*	*	*	*	*	*	*
	c)	2200	*	*	*	*	*	*	*	*
12	a)	4	*	*	*	*	*	*	*	*
	b)	50	*	*	*	*	*	*	*	*
	c)	2400	*	*	*	*	*	*	*	*
13	a)	*	*	*	*	*	*	*	*	*
	b)	*	*	*	*	*	*	*	*	*
	c)	*	*	*	*	*	*	*	*	*
14	a)	*	*	*	*	*	*	*	*	*
	b)	*	*	*	*	*	*	*	*	*
	c)	*	*	*	*	*	*	*	*	*
15	a)	*	*	*	*	*	*	*	*	*
	b)	*	*	*	*	*	*	*	*	*
	c)	*	*	*	*	*	*	*	*	*
16	a)	*	*	*	*	*	*	*	*	*
	b)	*	*	*	*	*	*	*	*	*
	c)	*	*	*	*	*	*	*	*	*
17	a)	*	*	*	*	*	*	*	*	*
	b)	*	*	*	*	*	*	*	*	*
	c)	*	*	*	*	*	*	*	*	*
18	a)	*	*	*	*	*	*	*	*	*
	b)	*	*	*	*	*	*	*	*	*
	c)	*	*	*	*	*	*	*	*	*
19	a)	*	*	*	*	*	*	*	*	*
	b)	*	*	*	*	*	*	*	*	*
	c)	*	*	*	*	*	*	*	*	*
20	a)	*	*	*	*	*	*	*	*	*
	b)	*	*	*	*	*	*	*	*	*
	c)	*	*	*	*	*	*	*	*	*

DENSITY : 200

Number of Floors		Persons Per Unit 2	3	4	5	6	7	8	9	10
1	a)	100	66	50	40	33	29	25	22	20
	b)	100	66	50	40	33	29	25	22	20
	c)	100	150	200	250	300	350	400	450	500
2	a)	50	33	25	20	16	14	12	11	10
	b)	100	66	50	40	33	29	25	22	20
	c)	200	300	400	500	600	700	800	900	1000
3	a)	33	22	16	13	11	9	8	7	6
	b)	100	66	50	40	33	29	25	22	20
	c)	300	450	600	750	900	1050	1200	1350	1500
4	a)	25	16	12	10	8	7	6	5	5
	b)	100	66	50	40	33	29	25	22	20
	c)	400	600	800	1000	1200	1400	1600	1800	2000
5	a)	20	13	10	8	6	5	5	4	4
	b)	100	66	50	40	33	29	25	22	20
	c)	500	750	1000	1250	1500	1750	2000	2250	2500
6	a)	16	11	8	6	5	4	*	*	*
	b)	100	66	50	40	33	29	25	*	*
	c)	600	900	1200	1500	1800	2100	2400	*	*
7	a)	14	9	7	5	4	*	*	*	*
	b)	100	66	50	40	33	29	*	*	*
	c)	700	1050	1400	1750	2100	2450	*	*	*
8	a)	12	8	6	5	*	*	*	*	*
	b)	100	66	50	40	*	*	*	*	*
	c)	800	1200	1600	2000	2400	*	*	*	*
9	a)	11	7	5	*	*	*	*	*	*
	b)	100	66	50	*	*	*	*	*	*
	c)	900	1350	1800	2250	*	*	*	*	*
10	a)	10	6	5	*	*	*	*	*	*
	b)	100	66	50	*	*	*	*	*	*
	c)	1000	1500	2000	2500	*	*	*	*	*
11	a)	9	6	*	*	*	*	*	*	*
	b)	100	66	*	*	*	*	*	*	*
	c)	1100	1650	2200	*	*	*	*	*	*
12	a)	8	5	*	*	*	*	*	*	*
	b)	100	66	*	*	*	*	*	*	*
	c)	1200	1800	2400	*	*	*	*	*	*
13	a)	7	*	*	*	*	*	*	*	*
	b)	100	66	*	*	*	*	*	*	*
	c)	1300	1950	*	*	*	*	*	*	*
14	a)	7	*	*	*	*	*	*	*	*
	b)	100	66	*	*	*	*	*	*	*
	c)	1400	2100	*	*	*	*	*	*	*
15	a)	6	*	*	*	*	*	*	*	*
	b)	100	66	*	*	*	*	*	*	*
	c)	1500	2250	*	*	*	*	*	*	*
16	a)	6	*	*	*	*	*	*	*	*
	b)	100	66	*	*	*	*	*	*	*
	c)	1600	2400	*	*	*	*	*	*	*
17	a)	5	*	*	*	*	*	*	*	*
	b)	100	*	*	*	*	*	*	*	*
	c)	1700	*	*	*	*	*	*	*	*
18	a)	5	*	*	*	*	*	*	*	*
	b)	100	*	*	*	*	*	*	*	*
	c)	1800	*	*	*	*	*	*	*	*
19	a)	5	*	*	*	*	*	*	*	*
	b)	100	*	*	*	*	*	*	*	*
	c)	1900	*	*	*	*	*	*	*	*
20	a)	5	*	*	*	*	*	*	*	*
	b)	100	*	*	*	*	*	*	*	*
	c)	2000	*	*	*	*	*	*	*	*

DENSITY : 300

Number of Floors		Persons Per Unit 2	3	4	5	6	7	8	9	10
1	a)	*	100	75	60	50	42	37	33	30
	b)	*	100	75	60	50	42	37	33	30
	c)	*	100	133	166	200	233	266	300	333
2	a)	75	50	37	30	25	21	19	16	15
	b)	150	100	75	60	50	42	37	33	30
	c)	133	200	266	333	400	466	533	600	666
3	a)	50	33	25	20	16	14	12	11	10
	b)	150	100	75	60	50	42	37	33	30
	c)	200	300	400	500	600	700	800	900	1000
4	a)	37	25	19	15	12	10	9	8	7
	b)	150	100	75	60	50	42	37	33	30
	c)	266	400	533	666	800	933	1066	1200	1333
5	a)	30	20	15	12	10	8	7	6	6
	b)	150	100	75	60	50	42	37	33	30
	c)	333	500	666	833	1000	1166	1333	1500	1666
6	a)	25	16	12	10	8	7	6	5	5
	b)	150	100	75	60	50	42	37	33	30
	c)	400	600	800	1000	1200	1400	1600	1800	2000
7	a)	21	14	10	8	7	6	5	4	4
	b)	150	100	75	60	50	42	37	33	30
	c)	466	700	933	1166	1400	1633	1866	2100	2333
8	a)	18	12	9	7	6	5	4	*	*
	b)	150	100	75	60	50	42	37	*	*
	c)	533	800	1066	1333	1600	1866	2133	2400	*
9	a)	16	11	8	6	5	4	*	*	*
	b)	150	100	75	60	50	42	*	*	*
	c)	600	900	1200	1500	1800	2100	2400	*	*
10	a)	15	10	7	6	5	*	*	*	*
	b)	150	100	75	60	50	*	*	*	*
	c)	666	1000	1333	1666	2000	2333	*	*	*
11	a)	13	9	6	5	*	*	*	*	*
	b)	150	100	75	60	*	*	*	*	*
	c)	733	1100	1466	1833	2200	*	*	*	*
12	a)	12	8	6	5	*	*	*	*	*
	b)	150	100	75	60	*	*	*	*	*
	c)	800	1200	1600	2000	2400	*	*	*	*
13	a)	11	7	5	*	*	*	*	*	*
	b)	150	100	75	*	*	*	*	*	*
	c)	866	1300	1733	2166	*	*	*	*	*
14	a)	10	7	5	*	*	*	*	*	*
	b)	150	100	75	*	*	*	*	*	*
	c)	933	1400	1866	2333	*	*	*	*	*
15	a)	10	6	5	*	*	*	*	*	*
	b)	150	100	75	*	*	*	*	*	*
	c)	1000	1500	2000	2500	*	*	*	*	*
16	a)	9	6	*	*	*	*	*	*	*
	b)	150	100	*	*	*	*	*	*	*
	c)	1066	1600	2133	*	*	*	*	*	*
17	a)	8	5	*	*	*	*	*	*	*
	b)	150	100	*	*	*	*	*	*	*
	c)	1133	1700	2266	*	*	*	*	*	*
18	a)	8	5	*	*	*	*	*	*	*
	b)	150	100	*	*	*	*	*	*	*
	c)	1200	1800	2400	*	*	*	*	*	*
19	a)	7	5	*	*	*	*	*	*	*
	b)	150	100	*	*	*	*	*	*	*
	c)	1266	1900	*	*	*	*	*	*	*
20	a)	7	5	*	*	*	*	*	*	*
	b)	150	100	*	*	*	*	*	*	*
	c)	1333	2000	*	*	*	*	*	*	*

DENSITY : 400

Number of Floors		Persons Per Unit 2	3	4	5	6	7	8	9	10
1	a)	*	100	80	66	57	50	44	40	
	b)	*	100	80	66	57	50	44	40	
	c)	*	100	125	150	175	200	225	250	
2	a)	100	66	50	40	33	29	25	22	20
	b)	200	133	100	80	66	57	50	44	40
	c)	100	150	200	250	300	350	400	450	500
3	a)	66	44	33	26	22	19	16	14	13
	b)	200	133	100	80	66	57	50	44	40
	c)	150	225	300	375	450	525	600	675	750
4	a)	50	33	25	20	16	14	12	11	10
	b)	200	133	100	80	66	57	50	44	40
	c)	200	300	400	500	600	700	800	900	1000
5	a)	40	26	20	16	13	11	10	8	8
	b)	200	133	100	80	66	57	50	44	40
	c)	250	375	500	625	750	875	1000	1125	1250
6	a)	33	22	16	13	11	9	8	7	6
	b)	200	133	100	80	66	57	50	44	40
	c)	300	450	600	750	900	1050	1200	1350	1500
7	a)	28	19	14	11	9	8	7	6	5
	b)	200	133	100	80	66	57	50	44	40
	c)	350	525	700	875	1050	1225	1400	1575	1750
8	a)	25	16	12	10	8	7	6	5	5
	b)	200	133	100	80	66	57	50	44	40
	c)	400	600	800	1000	1200	1400	1600	1800	2000
9	a)	22	14	11	8	7	6	5	4	4
	b)	200	133	100	80	66	57	50	44	40
	c)	450	675	900	1125	1350	1575	1800	2025	2250
10	a)	20	13	10	8	6	5	5	4	4
	b)	200	133	100	80	66	57	50	44	40
	c)	500	750	1000	1250	1500	1750	2000	2250	2500
11	a)	18	12	9	7	6	5	4	*	*
	b)	200	133	100	80	66	57	50	*	*
	c)	550	825	1100	1375	1650	1925	2200	2475	*
12	a)	16	11	8	6	5	4	*	*	*
	b)	200	133	100	80	66	57	50	*	*
	c)	600	900	1200	1500	1800	2100	2400	*	*
13	a)	15	10	7	6	5	4	*	*	*
	b)	200	133	100	80	66	57	*	*	*
	c)	650	975	1300	1625	1950	2275	*	*	*
14	a)	14	9	7	5	4	4	*	*	*
	b)	200	133	100	80	66	57	*	*	*
	c)	700	1050	1400	1750	2100	2450	*	*	*
15	a)	13	8	6	5	*	*	*	*	*
	b)	200	133	100	80	66	*	*	*	*
	c)	750	1125	1500	1875	2250	*	*	*	*
16	a)	12	8	6	5	*	*	*	*	*
	b)	200	133	100	80	66	*	*	*	*
	c)	800	1200	1600	2000	2400	*	*	*	*
17	a)	11	7	5	*	*	*	*	*	*
	b)	200	133	100	80	*	*	*	*	*
	c)	850	1275	1700	2125	*	*	*	*	*
18	a)	11	7	5	*	*	*	*	*	*
	b)	200	133	100	80	*	*	*	*	*
	c)	900	1350	1800	2250	*	*	*	*	*
19	a)	10	7	5	*	*	*	*	*	*
	b)	200	133	100	80	*	*	*	*	*
	c)	950	1425	1900	2375	*	*	*	*	*
20	a)	10	6	5	*	*	*	*	*	*
	b)	200	133	100	80	*	*	*	*	*
	c)	1000	1500	2000	2500	*	*	*	*	*

DENSITY : 500

Number of Floors		Persons Per Unit 2	3	4	5	6	7	8	9	10
1	a)	*	*	*	100	83	71	62	55	50
	b)	*	*	*	100	83	71	62	55	50
	c)	*	*	*	100	120	140	160	180	200
2	a)	*	83	62	50	41	35	31	27	25
	b)	*	166	125	100	83	71	62	55	50
	c)	*	120	160	200	240	280	320	360	400
3	a)	83	55	41	33	27	23	20	18	16
	b)	250	166	125	100	83	71	62	55	50
	c)	120	180	240	300	360	420	480	540	600
4	a)	62	41	31	25	20	17	15	13	12
	b)	250	166	125	100	83	71	62	55	50
	c)	160	240	320	400	480	560	640	720	800
5	a)	50	33	25	20	16	14	12	11	10
	b)	250	166	125	100	83	71	62	55	50
	c)	200	300	400	500	600	700	800	900	1000
6	a)	41	27	20	16	13	11	10	9	8
	b)	250	166	125	100	83	71	62	55	50
	c)	240	360	480	600	720	840	960	1080	1200
7	a)	35	23	17	14	11	10	8	7	7
	b)	250	166	125	100	83	71	62	55	50
	c)	280	420	560	700	840	980	1120	1260	1400
8	a)	31	20	15	12	10	8	7	6	6
	b)	250	166	125	100	83	71	62	55	50
	c)	320	480	640	800	960	1120	1280	1440	1600
9	a)	27	18	13	11	9	7	6	6	5
	b)	250	166	125	100	83	71	62	55	50
	c)	360	540	720	900	1080	1260	1440	1620	1800
10	a)	25	16	12	10	8	7	6	5	5
	b)	250	166	125	100	83	71	62	55	50
	c)	400	600	800	1000	1200	1400	1600	1800	2000
11	a)	22	15	11	9	7	6	5	5	4
	b)	250	166	125	100	83	71	62	55	50
	c)	440	660	880	1100	1320	1540	1760	1980	2200
12	a)	20	13	10	8	6	5	5	4	4
	b)	250	166	125	100	83	71	62	55	50
	c)	480	720	960	1200	1440	1680	1920	2160	2400
13	a)	19	12	9	7	6	5	4	*	*
	b)	250	166	125	100	83	71	62	*	*
	c)	520	780	1040	1300	1560	1820	2080	2340	*
14	a)	17	11	8	7	5	5	*	*	*
	b)	250	166	125	100	83	71	62	*	*
	c)	560	840	1120	1400	1680	1960	2240	*	*
15	a)	16	11	8	6	5	4	*	*	*
	b)	250	166	125	100	83	71	62	*	*
	c)	600	900	1200	1500	1800	2100	2400	*	*
16	a)	15	10	7	6	5	*	*	*	*
	b)	250	166	125	100	83	71	*	*	*
	c)	640	960	1280	1600	1920	2240	*	*	*
17	a)	14	9	7	5	4	*	*	*	*
	b)	250	166	125	100	83	71	*	*	*
	c)	680	1020	1360	1700	2040	2380	*	*	*
18	a)	13	9	6	5	*	*	*	*	*
	b)	250	166	125	100	83	*	*	*	*
	c)	720	1080	1440	1800	2160	*	*	*	*
19	a)	13	8	6	5	*	*	*	*	*
	b)	250	166	125	100	83	*	*	*	*
	c)	760	1140	1520	1900	2280	*	*	*	*
20	a)	12	8	6	5	*	*	*	*	*
	b)	250	166	125	100	83	*	*	*	*
	c)	800	1200	1600	2000	2400	*	*	*	*

Number of Floors		DENSITY : 600									DENSITY : 700									DENSITY : 800									DENSITY : 900									DENSITY : 1000								
		Persons Per Unit									Persons Per Unit									Persons Per Unit									Persons Per Unit									Persons Per Unit								
		2	3	4	5	6	7	8	9	10	2	3	4	5	6	7	8	9	10	2	3	4	5	6	7	8	9	10	2	3	4	5	6	7	8	9	10	2	3	4	5	6	7	8	9	10
1	a)	**********	**********	**********	**********	100	85	75	66	60	**********	**********	**********	**********	**********	100	87	77	70	**********	**********	**********	**********	**********	**********	100	88	80	**********	**********	**********	**********	**********	**********	**********	100	90	**********	**********	**********	**********	**********	**********	**********	**********	100
	b)	**********	**********	**********	**********	100	85	75	66	60	**********	**********	**********	**********	**********	100	87	77	70	**********	**********	**********	**********	**********	**********	100	88	80	**********	**********	**********	**********	**********	**********	**********	100	90	**********	**********	**********	**********	**********	**********	**********	**********	100
	c)	**********	**********	**********	**********	100	116	133	150	166	**********	**********	**********	**********	**********	100	114	126	142	**********	**********	**********	**********	**********	**********	100	112	125	**********	**********	**********	**********	**********	**********	**********	100	111	**********	**********	**********	**********	**********	**********	**********	**********	100
2	a)	****	100	75	60	50	42	37	33	30	**********	87	70	58	50	43	38	35	30	**********	100	80	66	57	50	44	40		**********	90	75	64	56	50	45		**********	100	83	71	62	55	50		**********	**********	**********	**********
	b)	****	200	150	120	100	85	75	66	60	**********	175	140	116	100	87	77	70		**********	233	160	133	114	100	88	80		**********	180	150	129	112	100	90		**********	200	166	142	125	111	100		**********	**********	**********	**********
	c)	****	100	133	166	200	233	266	300	333	**********	114	142	171	200	229	257	285		**********	100	125	150	175	200	225	250		**********	111	133	155	177	200	222		**********	100	120	140	160	180	200		**********	**********	**********	**********
3	a)	100	66	50	40	33	28	25	22	20	****	77	58	46	38	33	29	25	23	****	86	66	53	44	38	33	29	26	****	100	75	60	50	43	37	33	30	**********	83	66	55	47	41	37	33	
	b)	300	200	150	120	100	85	75	66	60	****	233	175	140	116	100	87	77	70	****	266	200	160	133	114	100	88	80	****	300	225	180	150	129	112	100	90	**********	250	200	166	142	125	111	100	
	c)	100	150	200	250	300	350	400	450	500	****	128	171	214	257	300	342	385	428	****	112	150	187	225	262	300	337	375	****	100	133	166	200	233	266	300	333	**********	120	150	180	210	240	270	300	
4	a)	75	50	37	30	25	21	19	16	15	67	56	43	35	29	25	21	19	17	100	66	50	40	33	29	25	22	20	****	75	56	45	37	32	28	25	22	****	83	62	53	41	35	31	27	25
	b)	300	200	150	120	100	85	75	66	60	350	233	175	140	116	100	87	77	70	400	266	200	160	133	114	100	88	80	****	300	225	180	150	128	112	100	90	****	333	250	200	166	142	125	111	100
	c)	133	200	266	333	400	466	533	600	666	116	171	228	285	342	400	457	514	571	100	150	200	250	300	350	400	450	500	****	133	177	222	266	311	355	400	444	****	120	160	200	240	280	320	360	400
5	a)	60	43	30	24	20	17	15	13	12	70	46	35	28	23	20	17	15	14	80	53	40	32	26	22	20	17	16	90	60	45	36	30	25	22	20	18	100	66	50	40	33	28	25	22	20
	b)	300	200	150	120	100	85	75	66	60	350	233	175	140	116	100	87	77	70	400	266	200	160	133	114	100	88	80	450	300	225	180	150	128	112	100	90	500	333	250	200	166	142	125	111	100
	c)	166	250	333	416	500	583	666	750	833	142	214	285	357	428	500	571	642	714	125	187	250	312	375	437	500	562	625	111	166	222	277	333	388	444	500	555	100	150	200	250	300	350	400	450	500
6	a)	50	33	25	20	16	14	12	11	10	58	38	29	23	19	16	14	12	11	66	44	33	26	22	19	16	14	13	75	50	37	30	25	21	18	16	15	83	55	41	33	27	23	20	18	16
	b)	300	200	150	120	100	85	75	66	60	350	233	175	140	116	100	87	77	70	400	266	200	160	133	114	100	88	80	450	300	225	180	150	128	112	100	90	500	333	250	200	166	142	125	111	100
	c)	200	300	400	500	600	700	800	900	1000	171	257	342	428	514	600	685	771	857	150	225	300	375	450	525	600	675	750	133	200	266	333	400	466	533	600	666	120	180	240	300	360	420	480	540	600
7	a)	42	28	21	17	14	12	10	9	8	50	33	25	20	16	14	12	11	10	57	38	28	22	19	16	14	12	11	64	42	31	25	21	18	16	14	12	71	47	35	28	23	20	17	15	14
	b)	300	200	150	120	100	85	75	66	60	350	233	175	140	116	100	87	77	70	400	266	200	160	133	114	100	88	80	450	300	225	180	150	128	112	100	90	500	333	250	200	166	142	125	111	100
	c)	233	350	466	583	700	816	933	1050	1166	200	300	400	500	600	700	800	900	1000	175	262	350	437	525	612	700	787	875	155	233	311	388	466	544	622	700	777	140	210	280	350	420	490	560	630	700
8	a)	37	25	19	15	12	10	9	8	7	43	29	21	17	14	12	10	9	8	50	33	25	20	16	14	12	11	10	56	37	28	22	19	16	14	12	11	62	41	31	25	20	17	15	13	12
	b)	300	200	150	120	100	85	75	66	60	350	233	175	140	116	100	87	77	70	400	266	200	160	133	114	100	88	80	450	300	225	180	150	128	112	100	90	500	333	250	200	166	142	125	111	100
	c)	266	400	533	666	800	933	1066	1200	1333	228	342	457	571	685	800	914	1028	1142	200	300	400	500	600	700	800	900	1000	177	266	355	444	533	622	711	800	888	160	240	320	400	480	560	640	720	800
9	a)	33	22	16	13	11	9	8	7	6	38	25	19	15	12	11	9	8	7	44	29	22	17	14	12	11	9	8	50	33	25	20	16	14	12	11	10	55	37	27	22	18	15	13	12	11
	b)	300	200	150	120	100	85	75	66	60	350	233	175	140	116	100	87	77	70	400	266	200	160	133	114	100	88	80	450	300	225	180	150	128	112	100	90	500	333	250	200	166	142	125	111	100
	c)	300	450	600	750	900	1050	1200	1350	1500	257	385	514	642	771	900	1028	1157	1285	225	337	450	562	675	787	900	1012	1125	200	300	400	500	600	700	800	900	1000	180	270	360	450	540	630	720	810	900
10	a)	30	20	15	12	10	8	7	6	6	35	23	17	14	11	10	8	7	7	40	26	20	15	13	11	10	8	8	45	30	22	18	15	12	11	10	9	50	33	25	20	16	14	12	11	10
	b)	300	200	150	120	100	85	75	66	60	350	233	175	140	116	100	87	77	70	400	266	200	160	133	114	100	88	80	450	300	225	180	150	128	112	100	90	500	333	250	200	166	142	125	111	100
	c)	333	500	666	833	1000	1166	1333	1500	1666	285	428	571	714	857	1000	1142	1285	1428	250	375	500	625	750	875	1000	1125	1250	222	333	444	555	666	777	888	1000	1111	200	300	400	500	600	700	800	900	1000
11	a)	27	18	13	10	9	7	6	6	5	31	21	15	12	10	8	7	7	6	36	24	18	14	12	10	9	8	7	40	27	20	16	13	11	10	9	8	45	30	22	18	15	12	11	10	9
	b)	300	200	150	120	100	85	75	66	60	350	233	175	140	116	100	87	77	70	400	266	200	160	133	114	100	88	80	450	300	225	180	150	128	112	100	90	500	333	250	200	166	142	125	111	100
	c)	366	550	733	916	1100	1283	1466	1650	1833	314	471	628	785	942	1100	1257	1414	1571	275	412	550	687	825	962	1100	1237	1375	244	366	488	611	733	855	977	1100	1222	220	330	440	550	660	770	880	990	1100
12	a)	25	16	12	10	8	7	6	5	5	29	19	14	11	9	8	7	6	5	33	22	16	13	11	9	8	7	6	37	25	18	15	12	10	9	8	7	41	27	20	16	13	11	10	9	8
	b)	300	200	150	120	100	85	75	66	60	350	233	175	140	116	100	87	77	70	400	266	200	160	133	114	100	88	80	450	300	225	180	150	128	112	100	90	500	333	250	200	166	142	125	111	100
	c)	400	600	800	1000	1200	1400	1600	1800	2000	342	514	685	857	1028	1200	1371	1542	1714	300	450	600	750	900	1050	1200	1350	1500	266	400	533	666	800	933	1066	1200	1333	240	360	480	600	720	840	960	1080	1200
13	a)	23	15	11	9	7	6	5	5	4	26	17	13	10	8	7	6	5	5	30	20	15	12	10	8	7	6	6	34	23	17	13	11	9	8	7	6	38	25	19	15	12	10	9	8	7
	b)	300	200	150	120	100	85	75	66	60	350	233	175	140	116	100	87	77	70	400	266	200	160	133	114	100	88	80	450	300	225	180	150	128	112	100	90	500	333	250	200	166	142	125	111	100
	c)	433	650	866	1083	1300	1516	1733	1950	2166	371	557	742	928	1114	1300	1485	1671	1857	325	487	650	812	975	1137	1300	1462	1625	288	433	577	722	866	1011	1155	1300	1444	260	390	520	650	780	910	1040	1170	1300
14	a)	21	14	10	8	7	5	5	4	4	25	16	12	10	8	7	5	5	4	28	19	14	11	9	8	7	6	5	32	21	15	12	10	8	7	6	5	35	23	17	14	11	10	8	7	6
	b)	300	200	150	120	100	85	75	66	60	350	233	175	140	116	100	87	77	70	400	266	200	160	133	114	100	88	80	450	300	225	180	150	128	112	100	90	500	333	250	200	166	142	125	111	100
	c)	466	700	933	1166	1400	1633	1866	2100	2333	400	600	800	1000	1200	1400	1600	1800	2000	350	525	700	875	1050	1225	1400	1575	1750	311	466	622	777	933	1088	1244	1400	1555	280	420	560	700	840	980	1120	1260	1400
15	a)	20	13	10	8	6	5	5	4	4	23	15	11	9	7	6	5	5	4	26	17	13	10	8	7	6	5	5	30	20	15	12	10	9	7	7	6	33	22	16	13	11	9	8	7	6
	b)	300	200	150	120	100	85	75	66	60	350	233	175	140	116	100	87	77	70	400	266	200	160	133	114	100	88	80	450	300	225	180	150	128	112	100	90	500	333	250	200	166	142	125	111	100
	c)	500	750	1000	1250	1500	1750	2000	2250	2500	428	642	857	1071	1285	1500	1714	1928	2142	375	562	750	937	1125	1312	1500	1687	1875	333	500	666	833	1000	1166	1333	1500	1666	300	450	600	750	900	1050	1200	1350	1500
16	a)	18	12	9	7	6	5	4	******	******	21	14	10	8	7	6	5	4	4	25	16	12	10	8	7	6	5	4	28	18	14	11	9	8	7	6	5	31	20	15	12	10	8	7	6	5
	b)	300	200	150	120	100	85	75	**********	**********	350	233	175	140	116	100	87	77	70	400	266	200	160	133	114	100	88	80	450	300	225	180	150	128	112	100	90	500	333	250	200	166	142	125	111	100
	c)	533	800	1066	1333	1600	1866	2133	2400	**********	457	685	914	1142	1371	1600	1828	2057	2285	400	600	800	1000	1200	1400	1600	1800	2000	355	533	711	888	1066	1244	1422	1600	1777	320	480	640	800	960	1120	1280	1440	1600
17	a)	17	11	8	7	5	5	**********	**********	**********	20	13	10	8	6	5	5	4	4	23	15	11	9	7	6	5	5	4	26	17	13	10	8	7	6	5	5	29	19	14	11	9	8	7	6	5
	b)	300	200	150	120	100	85	**********	**********	**********	350	233	175	140	116	100	87	77	70	400	266	200	160	133	114	100	88	80	450	300	225	180	150	128	112	100	90	500	333	250	200	166	142	125	111	100
	c)	566	850	1133	1416	1700	1983	2266	**********	**********	485	728	971	1214	1457	1700	1942	2185	2428	425	637	850	1062	1275	1487	1700	1912	2125	377	566	755	944	1133	1322	1511	1700	1888	340	510	680	850	1020	1190	1360	1530	1700
18	a)	16	11	8	6	5	4	**********	**********	**********	19	12	9	7	6	5	4	******	******	22	14	11	8	7	6	5	4	4	25	16	12	10	8	7	6	5	4	27	18	13	11	9	7	6	6	5
	b)	300	200	150	120	100	85	75	**********	**********	350	233	175	140	116	100	87	77	******	400	266	200	160	133	114	100	88	80	450	300	225	180	150	128	112	100	90	500	333	250	200	166	142	125	111	100
	c)	800	900	1200	1500	1800	2100	2400	**********	**********	514	771	1028	1285	1542	1800	2057	2314	******	450	675	900	1125	1350	1575	1800	2025	2250	400	600	800	1000	1200	1400	1600	1800	2000	360	540	720	900	1080	1260	1440	1620	1800
19	a)	15	10	7	6	5	**********	**********	**********	**********	18	12	9	7	6	5	4	******	******	21	14	10	8	7	6	5	4	4	23	15	11	9	7	6	5	5	4	26	17	13	10	8	7	6	5	5
	b)	300	200	150	120	100	85	**********	**********	**********	350	233	175	140	116	100	87	******	******	400	266	200	160	133	114	100	88	80	450	300	225	180	150	128	112	100	90	500	333	250	200	166	142	125	111	100
	c)	633	950	1266	1583	1900	2216	**********	**********	**********	542	814	1085	1357	1628	1900	2171	2442	******	475	712	950	1187	1425	1662	1900	2137	2375	422	633	844	1055	1266	1477	1688	1900	2111	380	570	760	950	1140	1330	1520	1710	1900
20	a)	15	10	7	6	5	**********	**********	**********	**********	17	11	8	7	5	5	**********	**********	**********	20	13	10	8	6	5	5	4	4	22	15	11	9	7	6	5	5	4	25	16	12	10	8	7	6	5	5
	b)	300	200	150	120	100	85	**********	**********	**********	350	233	175	140	116	100	87	**********	**********	400	266	200	160	133	114	100	88	80	450	300	225	180	150	128	112	100	90	500	333	250	200	166	142	125	111	100
	c)	666	1000	1333	1666	2000	2333	**********	**********	**********	571	857	1142	1428	1714	2000	2285	**********	**********	500	750	1000	1250	1500	1750	2000	2250	2500	444	666	888	1111	1333	1555	1777	2000	2222	400	600	800	1000	1200	1400	1600	1800	2000

34. LAND USE: BUSINESS/COMMERCIAL/INDUSTRIAL

DESIGN CONSIDERATIONS:

In an urban settlement the business, commercial and industrial uses ordinarily take a small part of the land (around 10%). It is PRIVATE LAND and may grow at the expense of residential land. It is very common that at small scales, a part of the dwelling is for business-commercial, small industry or business, commercial, smal industry buildings, contains a dwelling: at large scales, business, commercial, occupy the ground floor an apartments occupy the floors above also the complete lot In short: land for business, commercial, small industrie are a small percentage of the whole settlement and, in addition, can be integrated in a building with dwellings As a consequence, THE DETERMINATION OF THESE AREAS IS LESS CRITICAL THAN OTHER AREAS--ONLY THE LOCATION IS CRITICAL.

NOTE:

(Charts N° of inhabitants
Area of B. C. I.
Area of B. C. I. Ha/1000 inhabitants

Include: Planning design interim figures - pg. 189-231-232.
Also Super Manzana - Germany - San Juan
Make comments - should be incremental values
German

35. LAND USE: SCHOOLS, PLAYGROUNDS, PARKS

Land for educational facilities and playgrounds are generally of PUBLIC OWNERSHIP although private ownership is also frequent. However, standards are the same in both cases.

In any residential development, the location and size of the land devoted to educational facilities and playgrounds is very important.
LOCATION because: a) Most of this space should be within walking distance of the residential area served; b) they may also serve as a social center.
SIZE because: a) Future expansions should be contemplated; b) rise in the cost of land will make difficult the purchase of additional land if needed in the future.

Educational facilities can be listed by the age of users as follows:

1) Pre-schools (nursery, kindergarten) Age 2-7
2) Primary and elementary schools " 6-16
3) Secondary schools (junior, senior high) " 12-20
4) Higher education (colleges) " 18 and up
5) Other types: Schools for abnormal children, special training, adult education.

At the RESIDENTIAL SCALE the main concern are PRE-PRIMARY and SECONDARY schools.

AREAS served by schools are generally in relation to the age of users. In the U.S.A., the following distances are generally recommended which define the areas served.[1]

[1]Engelhardt, N. L., Jr. "The School Neighborhood Nucleus," The Architectural Forum.

1) PRE-SCHOOLS should be within a short walking distance. Children in nursery schools are usually brought by their parents and under ordinary conditions the distance should not exceed 1/4 of a mile (400 m or 5 minute walk).

   It has been found that when children are required to walk more than a 1/4 of a mile to a playground, they will probably never get there. There are simply too many distractions "en route". Playgrounds should, therefore, be well dispersed through the neighborhood and should provide no less than 100 sq. feet for each child in attendance.

2) PRIMARY SCHOOLS would be within a medium walking distance of approximately 1/2 of a mile (800 m. or 10 minute walk). School buses and private cars are used also as a means of transportation to primary schools.

3) SECONDARY SCHOOLS, if within a walking distance, should be approximately: 1 mile (1600 m. or 20 minutes walk) for Junior High and 1 1/2 miles (2400 m. or 30 minutes walk) for Senior High Schools; buses and private cars are used in these cases more frequently.

   In LATIN AMERICA, secondary schools, in general, do not serve a determined district but rather they draw students from the whole urban area; therefore, the zone of influence is not limited by walking distances. Finally, mode of travel is not by school buses or private cars but by public transportation.

The following diagram illustrates WALKING DISTANCES in the U.S.A.:

NURSERY SCHOOL
1/4 mile, 400 m 5 minutes R = 300 m

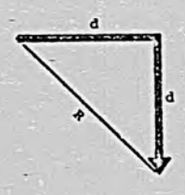
PLAYGROUND
1/4 mile, 400 m 5 minutes R = 300 m

PRIMARY SCHOOL
1/2 mile, 800 m 10 minutes R = 600 m

JUNIOR HIGH SCHOOL
1 mile 1600 m 20 minutes R = 1200 m

SENIOR HIGH SCHOOL
1 1/2 miles, 2400 m 30 minutes R = 1800 m

Distances should be measured along route walked:
$D = d + d$



or Radius:
$R = \sqrt{2}\ d$

SUMMARY OF SCHOOL SITE STANDARDS

Standards, vary with the culture, social and economic conditions, educational systems, environment, climate, etc. The following set of conditions for the selection of a site are given as a point of reference.

a) SIZE Sizes of sites can be inferred from physical standards/areas charts. At the end of this section a few area charts are included as well as sketches of sites to illustrate areas and relationships of buildings and playgrounds.

b) LOCATION Location is a compromise between different factors such as:
Relative centrality of the facility to the areas served; character of the land and surroundings: view, topography, boundaries, land use, drainage, noises, pollution; proximity to other public community facilities; topographic conditions to facilitate flat areas for playing fields; accessibility in terms of distance, time, mode of travel, age of students.

The following notes on educational facilities in Latin America illustrate briefly: Rapid growth of urban areas and educational needs; population distribution; estimate of actual and near future needs; goals and characteristics of secondary education.

Source: EDIFICIOS PARA LA EDUCACION MEDIA EN AMERICA LATINA CONESCAL, MEXICO 1968.

Main trends in secondary education: From the secondary schools for elites to the secondary schools for the masses.

The enrollment in Secondary Education in Latin America has doubled in the last decade: From 3,000,000 pupils in 1956 to 6,200,000 in 1965.

The Constitutions of most of the countries have not made secondary education free and obligatory as it is with the elementary education. However, the governments have been forced to create more and more secondary schools. Latin America is changing from the secondary schools. Latin America is changing from the secondary schools for elites (minorities) to the secondary schools for the masses (majorities). This presents enormous problems concerning demands for teachers as well as demands for physical facilities (sites and buildings).

Rate of population growth in Latin America is the greatest in the world:

Europe	0.73%	annually
Asia	1.93%	"
Africa	2.30%	"
Latin America	2.85%	"

World population will double in 25 years. In the urban areas of Latin America, population will double in 10 years. In 1980, the school population 5 to 24 years old (from kindergarten to college) will increase in 60 million.

Great economic and cultural changes are taking place as a result of the two-fold process: Dissemination of the rural population and growth of the urban population. The need for educational buildings in urban areas will increase still in larger proportions because in urban areas the number of 10 to 15 years old population that work is smaller than in rural areas and, consequently, greater is the number that demand education. In addition, one of the reasons of rural emigration to the cities is the hope of parents to provide a better education to their children; consequently, they will expect to get in the cities what they cannot expect in the country.

In the developed countries, the rate of population growth is relatively small. The population in school age is small and the active and productive population is large. Therefore, a great number of people support with their work the education of the small school age population.

In the developing countries the opposite occurs; a small group of productive population needs to support the education of a large school age population.

In Latin America:
86% of the population, up to 15 years old, needs to be supported by 40% of the population above this age.

In U.S.A.:
60% of the population, up to 15 years old, needs to be supported by 40% of the population above this age.

From 5 to 14 years old is the age group for kindergarten-elementary schools. From 15 to 19 years old is the age group for secondary schools, although in many instances there are pupils of 20 and more years of age.

PROJECTED CLASSROOM NEEDS IN LATIN AMERICA
(assuming one classroom for every 40 pupils.)

PRIMARY SCHOOLS (5 to 14 years old)
1970 53,062,000 pupils require 1,326,-50 classrooms
1980 91,715,000 pupils require 2,292,875 classrooms
which is an addition of approximately 1,000,000 classrooms

SECONDARY SCHOOLS (15 to 19 years old)
1965 29,234,000 pupils require 730,850 classrooms
1980 45,104,000 pupils require 1,123,600 classrooms
which is an addition of approximately 400,000 classrooms.

Each classroom represents 50% of the total school building area. Therefore, the quivalent of 800,000 classrooms will be needed by 1980 for secondary schools.

GOALS OF SECONDARY EDUCATION in Latin America:

a) Continue basic education initiated at elementary levels.
b) Foster the individual to discover his own aptitude and find the appropriate field of study and work for their own benefit and the benefit of the community.
c) Offer other possibilities of technical formation to those not apt to continue advanced studies.
d) Offer the adequate preparation to those apt to continue advanced studies.

CHARACTERISTICS of the new educational structures:

1) Universalization of medium education to make it accessible to all elementary school population.
2) Two principal cycles:
   a) Common or basic, oriented to increment the general culture acquired at lower level, develop the personality and orient his activity.
   b) Specialization or orientation toward more specific fields.
3) Manual activities integrated with the educational programs.
4) Foster activity programs leading to discovery of vocation.
5) Vinculate students with laboral and professional activities of their own communities.

The accompanying charts show different sets of SITE STANDARDS for Latin America, U. S. A., England and information on: Supporting population: type of facility pupils: grades, age, number; areas: building site, playground, building site and playground: location, source.

The building site includes areas for buildings, adjacent spaces, buffers, parking, service yards, and landscaping. Playgrounds include areas for sportsfields Building site and playgrounds include combinations of both areas but are not necessarily an addition.

When possible, it is convenient to COMBINE BUILDING SITE AND PLAYGROUNDS because:

1) Facilitates the use of playgrounds, which although it is a community facility, it is mostly used by the school children;
2) Toilets, showers, and locker facilities can be shared;
3) Permits a reduction on the total area which is not possible when the two facilities are separated.

SCHOOLS SITE STANDARDS

SUPPORTING POPULATION (PEOPLE)	TYPE OF FACILITY	PUPILS				AREA						LOCATION	NOTES
						SITE		PLAYGROUND		SITE & PLAYGROUND			
		GRADES	AGES	% OF POPULATION	NUMBER	Ha	m^2/p	Ha	m^2/p	Ha	m^2/p		
750	Kindergarten Primary School		5-14	25%	188					0.30 0.60	16 32	Latin America	SOURCE: Proposed minimum standards agency for international development-Washington, D. C., 1966
2,500	Primary School		5-14	25%	625					1.00 2.00	16 32		
7,500	Idem		5-14	25%	(1) 1,875					3.00 6.00	16 32		(1) More than one school
15,000	Idem		5-14	25%	(1) 3,750					6.00 12.00	16 32		
7,500 15,000	Sports Fields												
600 (1)	Infant Park		5-6	5%	30			0.05	17	0.05	17	Central America	SOURCE: Normas Minimas Urbanizacion centro Interamericano Vivienda y planea miento-Bogota, Colombia, 1968.
6,000 (2)	Idem		5-6	5%	300			0.50	17	0.50	17		
6,000 (2)	Primary School Sports Ground		7-14	20%	1,200	1.00	8	1.00	8	2.00	16		(1) Estimated 100 families
6,000 (2)	Parks							0.50		0.50			(2) Estimated 1000 families
30,000 (3)	Secondary School		15-19	10%	3,000	1.50	5			1.50	5		(3) Estimated 5000 families
30,000 (3)	Parks Sports Grounds							2.50		2.50			
2,000	Secondary Schools		15-19		200	0.34	17	0.04	2	0.38	19	Latin America	SOURCE: Edificios para Educacion media en America Latina CONESCAL-Mexico, 1968
20,000	Idem		15-19		2,000	3.40	17	0.40	2	3.80	19		
800 (1)	Kindergarten		5-6		60	0.023	4			0.023	4	Colombia	SOURCE: Proyecto Sogamoso-Paz de Rio-CINVA-Bogota Colombia 1956
4,000 (2)	Primary School		7-14		525	1.01	19			1.01	19		(1) 120 families (2) 600 families
12,000 (2)	Secondary School		15-19		450	1.25	28			1.25	28		
5,000	Primary School				1,000	0.4	4	0.80	8	1.2	12	Venezuela	SOURCE: Estudios, Esquemas, Ejemplos Escuelas Primarias Ministerio Educacion-Venezuela 1963

SUPPORTING POPULATION (PEOPLE)	TYPE OF FACILITY	PUPILS				AREA						LOCATION	NOTES
						SITE		PLAYGROUND		SITE & PLAYGROUND			
		GRADES	AGES	% OF POPULATION	NUMBER	Ha	m^2/p	Ha	m^2/p	Ha	m^2/p		
1,600 (1)	Nursery School		3-4		40							U.S.A.	SOURCE: The School-N.L. Engel Hardt, Jr. Architectoral Forum
	Kindergarten		5										(1) Estimated 400 families
4,000 5,400	Elementary School	1-6	6-11	15%	600 800	1.20 2.00	15 25	1.20 2.80	15 35	2.00 (1) 4.00	25 50		SOURCE: Proposed Standards Public Educational Facilities Detroit City Planning Commission - Detroit 1960 (1) Combined Use
16,000 20,000	Junior High School	7-9	12-14	6%	1000 1200	4.00 8.00	33 66	12.00 16.00	100 133	16.00 (1) 20.00	133 166		(1) Combined Use
34,000 40,000	Senior High School	10-12	15-17	5%	1700 2000	6.00 12.00	30 60	12.00 16.00	60 80	18.00 (1) 22.00	90 110		
	Elementary School			Urban Suburban							50 80	U.S.A.	SOURCE: Professor Howard, Department of City Planning, M.I.T. 1969
	Junior High School			Urban Suburban							53 100		
	Senior High School			Urban Suburban							80 133		
2,500	Nursery				40	0.10	25					LONDON (ENGLAND)	SOURCES: Greater London Plan, 1944
5,000	Primary School (infant)				175	0.80	45	0.40	22	1.20	68		Abercrombie, London, 1945
5,000	Primary School (junior)				290	0.80	28	1.20	42	2.00	71		
20,000	Secondary School (boys modern)				450	1.20	26	5.2	115	6.40	142		
[illegible]	Secondary School (girls modern)				450	1.20	26	5.2	115	6.40	142		
30,000	Secondary School (technical)				270	0.80	29	3.2	118	4.00	148		
60,000	Secondary School (boys grammar)				360	0.80	22	4.4	122	5.20	144		
60,000	Secondary school (girls grammar)				360	0.80	22	4.4	122	5.20	144		
60,000	Young People's College				270	3.6	133	6.4	237	10	370		
60,000	Technical College				-								

The accompanying chart summarizes the preceeding charts and permits a comparison of different sets of site standards for Latin America, U.S.A., and England for supporting population of 60,000 people.

As the chart shows the difference in physical standards (site areas) between Latin America and U.S.A./England is quite remarkable.

IN PRIMARY SCHOOLS: Latin America $16m^2$/pupil; U.S.A. $25/50m^2$/pupil; England (London) $71m^2$/pupil.

IN SECONDARY SCHOOLS: The area per pupil in Latin America is more than 12 times smaller than in U.S.A./England: Latin America = $19m^2$/pupil; U.S.A. = Junior High School $133/166m^2$/pupil plus Senior High School $90/116m^2$/pupil; England (London) = Modern School $142m^2$/pupil, Technical School $148m^2$/pupil. Overall area per pupil for a supporting population of 60,000 people: Latin America $22m^2$/pupil; U.S.A. $70m^2$/pupil; England $94m^2$/pupil.

SCHOOLS SITE STANDARDS, (SUMMARY)

1 LOCATION	2 TYPE OF SCHOOL or FACILITY	3 PUPILS IN EACH SCHOOL	4 NUMBER OF SCHOOLS	5 TOTAL NUMBER OF PUPILS	6 TOTAL AREA Has	7 AREA/PUPIL m^2/PUPIL	8 NOTES
LATIN AMERICA (Central America)	Infant Park (1)	60	50	3000	5	17	SOURCES: (1) Normas Minimas Urbanizacion-Centro Interamericano Vivienda y Planeamiento-Bogota-Colombia-1969-Paises Centro Americanos. (2) Edificios Para Educacion Media en America Latina-CONESCAL-Mexico-1968.
	Primary (1)	1200	10	12,000	20	16	
	Parks (1)				5		
	Secondary (2)	2000	3	6000	1140	19	
	Parks (1)				5		
	TOTAL		63	21,000	46.40	22	
U.S.A. (Detroit)	Nursery (3)	40	40	1600			SOURCES: (3) The School, N.L. Engelhardt, Jr. Architectural Forum (4) Proposed Standards, Public Educational Facilities, Detroit City Planning Commission, Detroit 1969.
	Elementary (4)	600	15	9000	30	25	
	Junior High (4)	1200	3	3600	60	166	
	Senior High (4)	1500	2	3000	30	100	
	TOTAL		60	17,200	120	70	
ENGLAND (London)	Nursery (5)	40	24	960	2.40	25	SOURCES: (5) Greater London Plan, 1944 Abercrombie, London, 1945 The same source also included a young people's college and a technical college with a total of 10 Has.
	Primary (infant) (5)	175	12	2100	14.40	68	
	Primary (junior) (5)	280	12	3360	24.00	71	
	Secondary (5) (boys, modern)	450	3	1350	19.20	142	
	Secondary (5) (girls, modern)	450	3	1350	19.20	142	
	Secondary (5) (technical)	270	2	540	8.00	148	
	Secondary (5) (boys, grammar)	360	1	360	5.20	144	
	Secondary (5) (girls, grammar)	360	1	360	5.20	144	
	TOTAL		58	10,380	97.60	94	

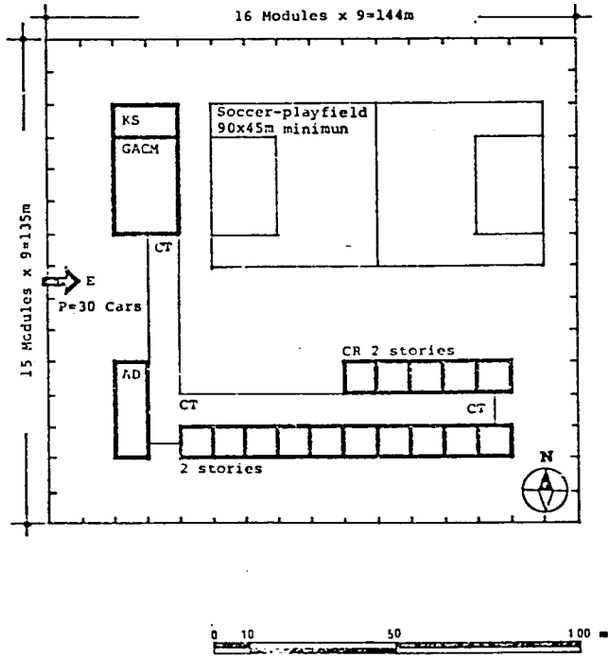
SCHOOLS SITE SKETCHES

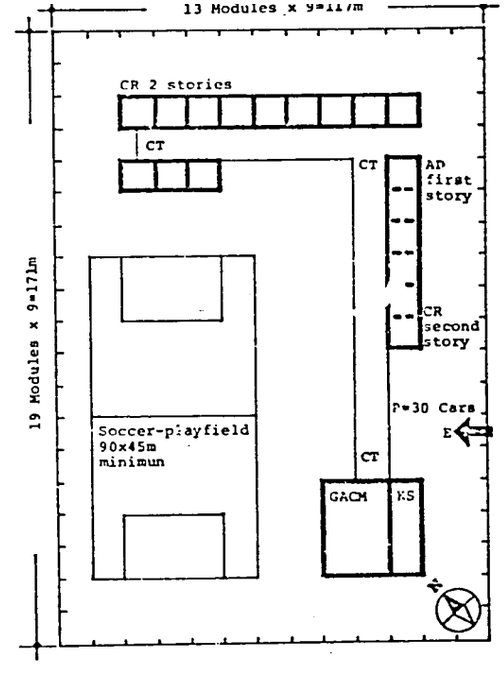
ELEMENTARY SCHOOL (Latin America)
30 classrooms x 40 pupils = 1200 pupils
Module = 9.00 meters
Typical classroom = 9 x 9 m.
Site area = approximately 2 hectares
16 m^2/pupil

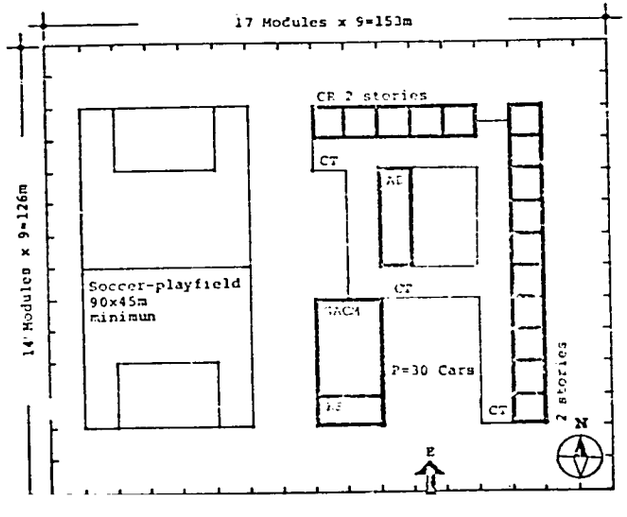
The orientation shown is for the following climates:
HOT/TEMPERATE temperatures
DRY/MODERATE humidities
The orientation provides maximum protection from the sun to the classroom openings.

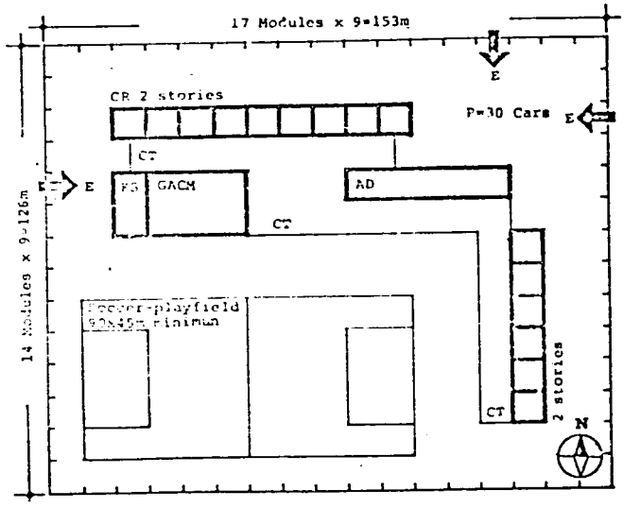
KEY

E = Entrance
AD = Administration
CR = Classroom
CT = Circulation, toilets
GACM = Gymnasium, auditorium, cafeteria, multi-purpose room
KS = Kitchen, services
P = Parking









37. INCOME GROUPS

DEFINITIONS

INCOME:
The amount (measured in money) of gains from capital or labor.
The amount of such gain received by a family unit per year may be used as a basis for the interpretation of income groups.

METHODS OF COMPUTATION OF INCOME GROUPS:

A) INCOME GROUPS BY QUINTILES: A distribution based on the income for each fifth of all families for each year.

PROCEDURE in the computation of income groups by quintiles:

1) Determine the TOTAL NUMBER OF FAMILIES within the area of study and the income per year of each family unit.
2) Each 1/5 of the total number of families represents a quintille group (20% of the population).
3) Each 1/5 or quintille include a range of income range.
4) When the range of incomes is very wide within a quintille and a more detailed, accurate index is desired; the quintille can be further subdivided in smaller fractions.

B) INCOME GROUPS BY SUBSISTANCE LEVEL DISTRIBUTION (from John F. C. Turner: Method of Income Distribution for Mexico City)
Five general divisions of annual income distribution are designated based upon the established SUBSISTANCE LEVELS for the area of study. SUBSISTANCE LEVEL is the minimum amount of money (as of food and shelter) necessary to support life. In this level, 80%-90% of the household income is used for diet; there is little or no margin of income for rent, housing sciences or savings. In many cases, the subsistance income is considered to be equivalent to the official minimum wage for the area.

Based on the subsistance (minimum wage) income, five divisions of income groups may be determined:

1) VERY HIGH (10 x subsistance level)
   -The income group that represents the most economically mobile sector of the population.
2) HIGH (5 x subsistance level)
   -The income group that can afford to purchase housing and unsubsidized rents and mort age payments.
3) MODERATE (3 x subsistance level)
   -The income group that can afford limited housing and rent with government assistance.
4) LOW (1 x subsistance level)
5) VERY LOW (below subsistance level)
   -The income group with no household income available for housing, services or transportation.

DESIGN CONSIDERATIONS

The composition of the resident income groups within a proposed project determines:

1) The PROGRAM TYPE
2) The DISTRIBUTION of income groups within the project
3) The LOCATION of project in physical context

38. INTENSITY OF USE

DEFINITIONS:

The INTENSITY OF USE (or DENSITY) indicates the number of lots/persons/families per unit in a subdivision. The density of a residential subdivision must be within a certain range of accepted standards that will ensure an efficient, economic, and functional development.

DESIGN CONSIDERATIONS:

A TOO LOW DENSITY does not allow intensive development of commercial areas to justify their inclusion; a higher density will allow better land utilization.

POPULATION, DENSITIES, AREA REQUIRED

AREA REQUIRED IN HECTARES FOR VARYING DENSITIES

Persons	10 persons/ha	20 persons/ha	40 persons/ha	60 persons/ha	80 persons/ha	100 persons/ha	200 persons/ha	300 persons/ha	400 persons/ha
1	0.010	0.005	0.003	0.002	0.002	0.002	0.001	0.001	0.001
2	0.020	0.010	0.007	0.005	0.004	0.003	0.002	0.002	0.002
3	0.030	0.015	0.010	0.007	0.006	0.005	0.004	0.003	0.003
4	0.040	0.020	0.013	0.010	0.008	0.007	0.005	0.004	0.004
5	0.050	0.025	0.017	0.012	0.010	0.008	0.006	0.005	0.005
6	0.060	0.030	0.020	0.015	0.012	0.010	0.007	0.006	0.006
7	0.070	0.035	0.023	0.017	0.014	0.012	0.008	0.007	0.006
8	0.080	0.040	0.027	0.020	0.016	0.013	0.009	0.007	0.006
9	0.090	0.045	0.030	0.022	0.018	0.015	0.010	0.008	0.007
10	0.100	0.050	0.033	0.025	0.020	0.017	0.011	0.008	0.007
20	0.200	0.100	0.067	0.050	0.040	0.033	0.022	0.017	0.014
30	0.300	0.150	0.100	0.075	0.060	0.050	0.033	0.025	0.022
40	0.400	0.200	0.133	0.100	0.080	0.067	0.044	0.033	0.029
50	0.500	0.250	0.167	0.125	0.100	0.083	0.056	0.042	0.036
60	0.600	0.300	0.200	0.150	0.120	0.100	0.067	0.050	0.043
70	0.700	0.350	0.233	0.175	0.140	0.117	0.078	0.058	0.050
80	0.800	0.400	0.267	0.200	0.160	0.133	0.089	0.067	0.057
90	0.900	0.450	0.300	0.225	0.180	0.150	0.100	0.075	0.064
100	1.000	0.500	0.333	0.250	0.200	0.167	0.111	0.083	0.071
200	2.000	1.000	0.667	0.500	0.400	0.333	0.222	0.167	0.143
300	3.000	1.500	1.000	0.750	0.600	0.500	0.333	0.250	0.214
400	4.000	2.000	1.333	1.000	0.800	0.667	0.444	0.333	0.286
500	5.000	2.500	1.667	1.250	1.000	0.833	0.556	0.417	0.357
600	6.000	3.000	2.000	1.500	1.200	1.000	0.667	0.500	0.429
700	7.000	3.500	2.333	1.750	1.400	1.167	0.778	0.583	0.500
800	8.000	4.000	2.667	2.000	1.600	1.333	0.889	0.667	0.571
900	9.000	4.500	3.000	2.250	1.800	1.500	1.000	0.750	0.643
1000	10.000	5.000	3.333	2.500	2.000	1.667	1.111	0.833	0.714
2000	20.000	10.000	6.667	5.000	4.000	3.333	2.222	1.667	1.429
3000	30.000	15.000	10.000	7.500	6.000	5.000	3.333	2.500	2.143
4000	40.000	20.000	13.333	10.000	8.000	6.667	4.444	3.333	2.857
5000	50.000	25.000	16.667	12.500	10.000	8.333	5.556	4.167	3.571
6000	60.000	30.000	20.000	15.000	12.000	10.000	6.667	5.000	4.286
7000	70.000	35.000	23.333	17.500	14.000	11.667	7.778	5.833	5.000
8000	80.000	40.000	26.667	20.000	16.000	13.333	8.889	6.667	5.714
9000	90.000	45.000	30.000	22.500	18.000	15.000	10.000	7.500	6.429
10000	100.000	50.000	33.333	25.000	20.000	16.667	11.111	8.333	7.143
20000	200.000	100.000	66.667	50.000	40.000	33.333	22.222	16.667	14.286
30000	300.000	150.000	100.000	75.000	60.000	50.000	33.333	25.000	21.429
40000	400.000	200.000	133.333	100.000	80.000	66.667	44.444	33.333	28.571
50000	500.000	250.000	166.667	125.000	100.000	83.333	55.556	41.667	35.714
60000	600.000	300.000	200.000	150.000	120.000	100.000	66.667	50.000	42.857
70000	700.000	350.000	233.333	175.000	140.000	116.667	77.778	58.333	50.000
80000	800.000	400.000	266.667	200.000	160.000	133.333	88.889	66.667	57.143
90000	900.000	450.000	300.000	225.000	180.000	150.000	100.000	75.000	64.286
100000	1000.000	500.000	333.333	250.000	200.000	166.667	111.111	83.333	71.429
200000	2000.000	1000.000	666.667	500.000	400.000	333.333	222.222	166.667	142.857
300000	3000.000	1500.000	1000.000	750.000	600.000	500.000	333.333	250.000	214.286
400000	4000.000	2000.000	1333.333	1000.000	800.000	666.667	444.444	333.333	285.714
500000	5000.000	2500.000	1666.667	1250.000	1000.000	833.333	555.556	416.667	357.143
600000	6000.000	3000.000	2000.000	1500.000	1200.000	1000.000	666.667	500.000	428.571
700000	7000.000	3500.000	2333.333	1750.000	1400.000	1166.667	777.778	583.333	500.000
800000	8000.000	4000.000	2666.667	2000.000	1600.000	1333.333	888.889	666.667	571.429
900000	9000.000	4500.000	3000.000	2250.000	1800.000	1500.000	1000.000	750.000	642.857

39. LAND TENURE

DEFINITIONS:

LAND TENURE is the act, right, manner or term of holding land property. There are several types of land is held and for what period of time. These legal definitions are established to determine the division of property among various owners, or the relationship between owner and occupier, or between creditor and owner; and between private owners and the public, and includes the asscessment of taxes on private land rights and the regulation of land use through government control.

There are TWO BASIC FORMS of land tenure:

1. LAND OWNERSHIP, where the exclusive right of control and possession of a parcel of land is held.
2. LAND TENANCY, which is the temporary holding or mode of holding a parcel of land of another.

The EIGHT BASIC TYPES of urban land tenure are described in the following table:

LAND TENURE TYPES

	TENURE TYPE	DESCRIPTION/DEFINITION	COMMON NAME	LEGAL TERM	QUALIFICATION AND DEGREE OF TENURE	CONSTRAINTS	CAPACITY TO CHANGE WITH TIME
OWNERSHIP TYPES	1 PRIVATE LAND OWNERSHIP	The absolute tenure of land to a person and his heirs without restriction of time. Land held in ownership with all private rights except the payment of taxes and the rights of State to condemn and to police.	FREEHOLD OWNERSHIP	FREE SIMPLE ESTATE	Highest form of personal ownership: the owner holds the largest possible quantity of rights for the longest period of time. The rights are effective immediately.	All rights of ownership except the right of State to tax, condemn, and police. Additional cost of land due to credit (interest) charge.	Will remain until sold or changed in form by owner. Maximum flexibility.
			MORTGAGE	EQUITY OWNERSHIP	Subject to mortgage: requires a division of title between the mortgagee (the superior interest) and the owner's claim (equity interest)		
			INSTALLMENT PURCHASE	CONTRACT LAND OWNERSHIP	A lesser form of mortgage. Land is purchased by installment payments over an extended period of time.		
		The right to use or profit from a parcel of land without becoming the owner or formal leasee. Legal possession by decree without charge.		USUFRUCT			
	2 MUTUAL OWNERSHIP	Mutual agreement under which two or more parties join to build or buy as one.	CONDOMINIUM COOPERATIVE	CONDOMINIUM	Portion of an estate is privately owned with the agreement to contribute to the upkeep of common grounds or property. Condominiums may be either vertical (building) or horizontal (clusters).	Transfer of portion of private property subject to approval of condominium.	Flexibility in conversion of small parcels (horizontal) into larger area for joint development.
	3 ILLEGAL TENURE	Illegal possession or invasion of land in which a government or private owner tolerates possession.	SQUATTING	SQUATTER TENURE		Minimal rights to property. Tenant may be legally evicted.	
	4 PUBLIC LAND OWNERSHIP	Privilege of use of public land granted by a government.		INCORPOREAL RIGHTS	Easements, rights of way, licensed franchises for private use, etc. are forms of incorporeal rights.	Maximum government control.	
TENANCY TYPES	RENTAL WITH OPTION TO PURCHASE	Leasehold with option to purchase land at a later date.		HIRE PURCHASE	System gives tenant hope of ownership and encourages the improvement of his house.		
	6 LAND RENT/LEASE	Land for building is leased rather than purchased. Generally a long term lease.	BUILDING OWNERSHIP	LAND LEASE			
	7 TENANCY (RENT)	The transfer of the limited rights of possession from landlord to tenant in exchange for payment or service.	LEASE	ESTATES FOR YEARS	A lease having a definite term of duration.		
				TENANCY BY SUFFERANCE	Tenant remains in possession after term of lease expires.		
				TENANCY AT WILL	No definite term of duration. A less secure type of rental.		
	8 MOBILE OWNERSHIP	Building (structure) which is not permanently affixed to the land may be moved by building owner to other site. NOT A FORM OF LAND TENURE.		MOBILE OWNERSHIP	Building owner may relocate shelter when landlord demands possession or a rent that the tenant cannot afford.		

40. LAND SUBDIVISION

UTILITIES AND SERVICES IN URBAN AREAS

Urban areas are expanding rapidly as a result of the population explosion and rural immigration. In urban areas, the provision of utilities and services and their maintenance and operation had become one of the more critical problems, because of:
a) the speed and magnitude of expansion;
b) the large scale implications, involving factors such as: population, natural resources, disposal, pollution, investment, operation, long term planning.

This study deals with one general, yet basic aspect of the problem: the evaluation of systems for the distribution/collection of utilities and services.

UTILITIES INCLUDE: streets, sidewalks, sanitary and storm sewers, water, electricity, telephone.
SERVICES INCLUDE: street cleaning and repair, maintenance of sewer and water systems, street lighting, refuse collection, garbage collection, police and fire protection, mail distribution.

The utility and services systems have two components:
a) lines of distribution/collection (networks);
b) areas served (lots or larger sectors).

Lines of distribution/collection (networks) are usually in the lines of circulation: highways, streets, walkways, which are publicly owned lands. In fact, circulation defines the distribution/collection networks of the utilities and services. The area served is usually privately owned land. The combination of circulation lines and areas served constitute the urban layout.

In broad terms, this study presents a method to measure, compare and evaluate urban layouts as a means to achieve economy in the provision, maintenance and operation of utilities and services.

Furthermore, the method illustrates clearly some obvious and practical facts which are usually ignored in urban layouts; lines of utilities and services are reduced when:
a) lots are larger in area;
b) widths of lots are minimized;
c) access of lots is only on one side and on the shortest side;
d) connectors that run transverse to the lot accesses are less frequent.

But most important, the method permits all these different determinants to be quantified, always resulting in a numerical value. So, in similar circumstances, different layouts will have corresponding numerical values which will be comparable and will give a direct value index of any line of utilities and services, whatever it will be: sewage, water, street lighting, garbage collection, street cleaning, etc.

URBAN AREAS IN DEVELOPING COUNTRIES

In developing countries, the provision of utilities and services in urban areas is particularly important because:
a) population explosion and rural immigration are more acute;
b) one of the primary forms of settlement is squatting;
c) site and services programs for settlements are gaining recognition in government circles.

In squatter settlements, land is occupied, subdivided and very soon covered by all kinds of shelters and dwellings built by the occupants solely by their own efforts and resources.

It should be emphasized that the construction of a shelter can be done within the limits of individual/family resources and initiatives, because used, rejected or cheap materials can be provided; no special skills or techniques are required; few and simple tools can be utilized and the shelter can be always started from a minimum.

If the provision of shelter is a relatively simple matter, the provision of utilities and services for a community is not; it demands more than individual effort. It demands, in fact, a collective effort both from the community and from the government in planning and mobilizing political, economical, and technical resources.

In squatter settlements, utilities and services are not provided nor anticipated initially and very soon this became a critical matter. Invariably, the development and improvement of the squatter settlements depend entirely on the community's ability to procure water, sewage, electricity and other services from the city. More often than not, unplanned sprawl and inefficient or inadequate use of the land makes the provision of utilities and services difficult and uneconomical. When the latter is the situation, the alternatives are: either to pay a high price for the development and improvement or not to pay and let the community stagnate.

In squatter settlements, the need for a simple method of measurement, comparison and evaluation of utility layouts is apparent. The sooner it is applied, the greater are the chances of adequate planning of layout improvements.

The top priority in lower income groups is not housing, but maximum opportunities for employment; site and services programs must recognize this. Therefore, only security of tenure and minimum urban services (water, electricity, sanitation, education, health facilities) are provided. In addition, in urban areas, some new basic policies are now being widely recognized:
a) the whole living environment of the community is the critical determinant, rather than the individual dwelling unit;
b) existing housing stock including slums and squatter settlements should be preserved if possible;
c) private participation (initiative, responsibility, capital) should be fully utilized;
d) the lowest income sectors should be reached.

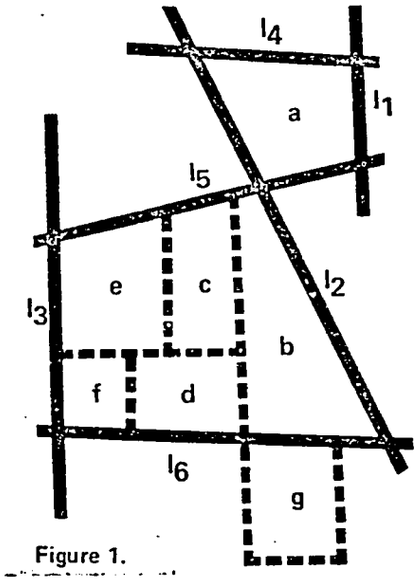
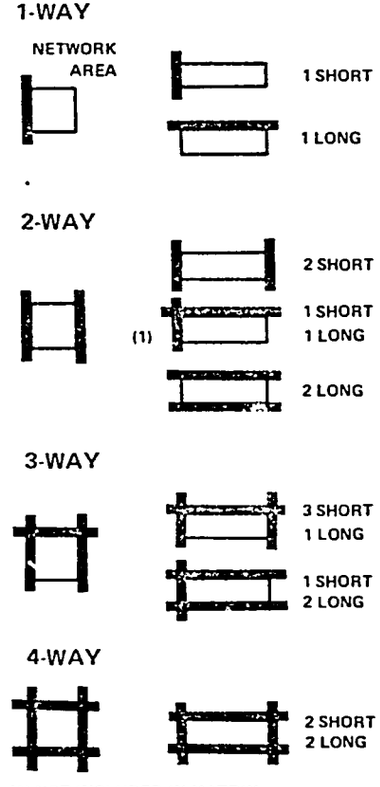


Figure 1.



(1) NOT INCLUDED IN MATRIX

Figure 2.

In site and services programs as well as in new urban policies, efficient planning of utilities and services is important and, therefore, a simple method of evaluation becomes an indispensable design tool.

EFFICIENCY/EFFECTIVENESS OF NETWORKS

Network is defined as a system of lines within a plane surface, crossing at any intervals.

In Figure 1: l_1, l_2, l_3 etc. constitute the network.

Areas are defined as surfaces included within the network with at least one side tangent to the network.

In Figure 1: a, b, c, etc. are areas.

The efficiency/effectiveness of a network can be defined as the ratio of the length of the network to the area(s) contained within, or tangent to it. In the form of an equation:

Efficiency of network = R-value

$$= \frac{\text{network length}}{\text{areas(s) contained or tangent}}$$

The R-value varies inversely to network efficiency, a smaller R indicates a greater efficiency and vice versa.

It can be observed that two categories of efficiency ratios can be obtained:
a) those that correspond to each area a, b, ...n, and
b) the segments of the network to which each area is tangent:

$$R_a = \frac{l_{1a} + l_{4a} + l_{2a} + l_{5a}}{a};$$

$$R_b = \frac{l_{5b} + l_{2b} + l_{6b}}{b};$$

$$R_c = \frac{l_{5c}}{c};$$

The first value (R) may be defined as the efficiency of a whole system. The second set of values (R_a, R_b, etc.) may be defined as the efficiency of each area a,b, etc., considered separately.

The efficiency values (R-value) are a function of certain variables: area, proportion of the area, mode of network access (tangency).

The matrix, which is shown in Figure 3, is a guide to illustrate different ranges of R-values as well as to understand the relationships among the set of variables. It contains only selected magnitudes of the variables and assumes an orthogonal system; nevertheless, it can be applied to any other system as well. Units are expressed in the metric system: meters (m^2), hectares (Ha). The matrix variables are:

AREA:

$1m^2$ equivalent to $\frac{1}{10,000}$ Ha;

$100m^2$ equivalent to $\frac{1}{100}$ Ha;

$10,000m^2$ equivalent to 1 Ha;

AREA RATIO:

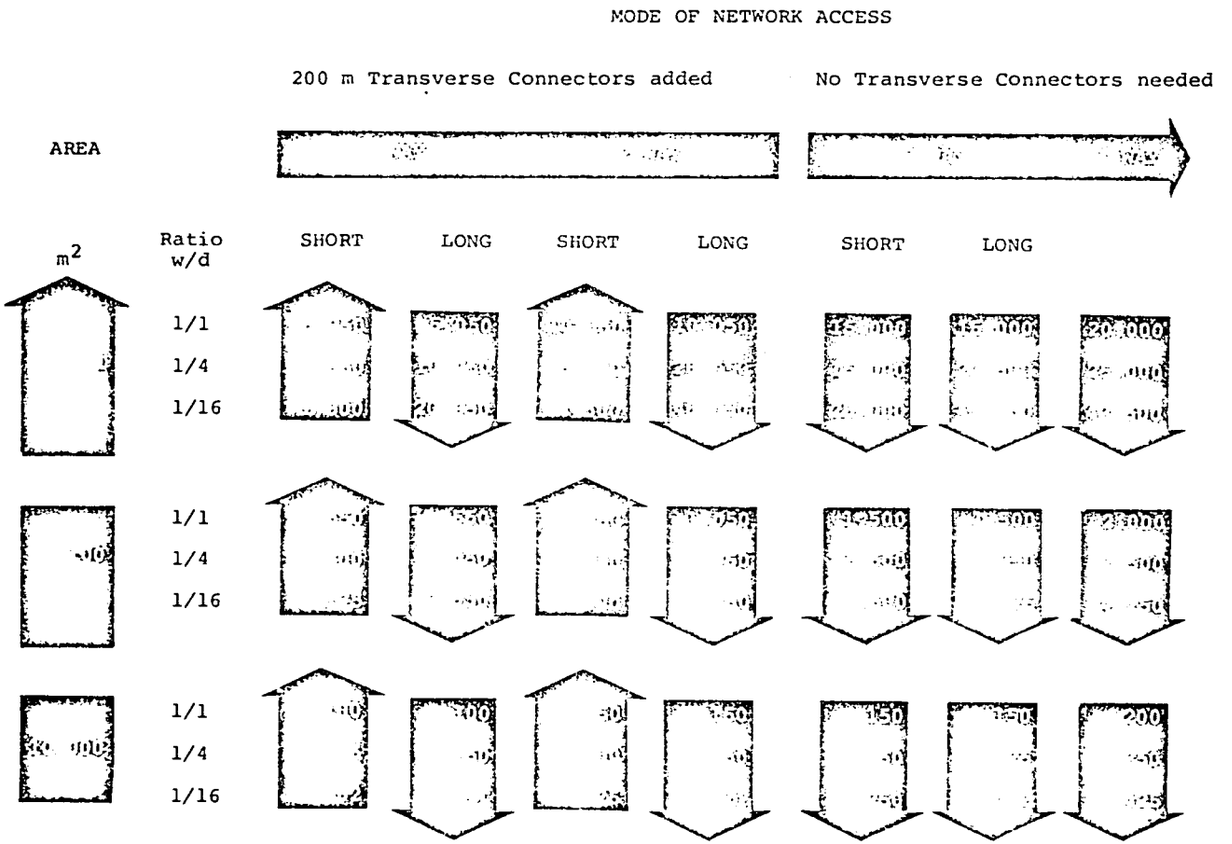
$\frac{\text{WIDTH (w)}}{\text{DEPTH (d)}}$: 1/1; 1/4; 1/16.

NETWORK ACCESS MODE:

Accesses are the sides of the areas tangent to the network. The basic configurations are shown in Figure 2.

A network implies at least a two directional system. The 1 and 2 way configurations imply only a one directional system, therefore, transverse connectors are added to create the network. To simplify the matrix, only transverse connectors spaced 200 meters are considered.

BASIC MATRIX OF R-VALUES



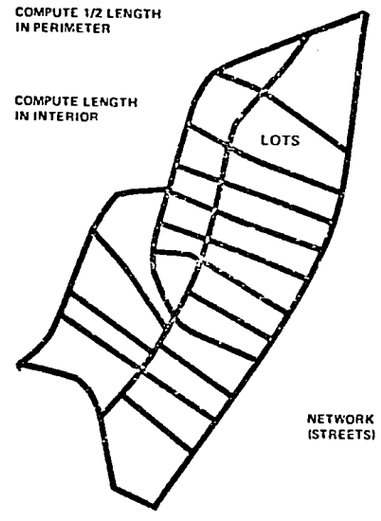
(1) Not applicable:
the 400 m. length of the area does not permit transverse connectors every 200 meters.

Ratios 1/1 are square areas, therefore short = long.

Arrows indicate direction of increasing R-value

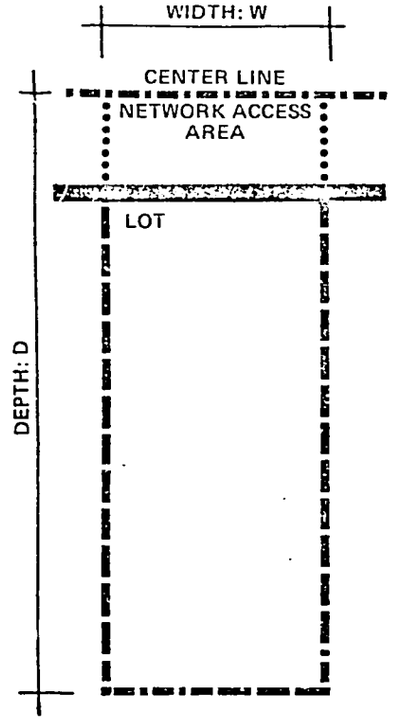
$$\text{R-Values} = \frac{\text{NETWORK LENGTH IN METERS (m)}}{\text{AREA IN HECTARES (Ha)}}$$

Figure 3. Basic Matrix of R-Values.



$R = \frac{\text{NETWORK LENGTH (m)}}{\text{RESIDENTIAL SECTOR AREA (Ha)}}$

Figure 5. Residential Sector.



$R = \frac{W\ (m)}{WD\ (Ha)}$

Figure 4. Lot.

From the matrix the following observations can be made:

a) the larger the area, the smaller is R;

b) the smaller the number of network accesses, the smaller the R;

c) the smaller is the $\frac{W}{d}$ ratio, the smaller is R in 1 way short and 2 way short cases (which are the most typical cases);

d) the larger the $\frac{W}{d}$ ratio, the smaller is R in 1 way long, 2 way long, 3 way short and long, 4 way cases (which are not typical);

e) comparable R values are those within approximately the same area;

f) within the same area the range of R-values is still quite wide, as the following figures show:

AREA	MINIMUM	MAXIMUM
$1m^2$	1300.	42,500
$100m^2$	175.	4,250
$10,000m^2$	62.5	425

THE WIDE RANGE OF R-VALUES WITHIN THE SAME AREA CLEARLY SHOWS THE PRIME IMPORTANCE OF LAYOUT IN QUESTIONS AFFECTING EFFICIENCY AND HENCE ECONOMY.

EVALUTION OR URBAN LAYOUTS.

The method of evaluation presented here is a particular application of the concept proposed about and can be used for lots as well as for residential sectors. (figures 4 and 5). In both cases, the method consists of two stages:

a) the determination of the R-value (unit length of network per unit area):

$R = \frac{\text{network length in meters (m)}}{\text{lot-network access areas in Ha.}}$

b) the relationship [illegible] R-value with the following set of variables: lot area, lot dimension, lot accesses frequency of transverse connectors.

THE VARIABLES.

Lot Width: Width of the lot in meters (m), (figure 4).

Lot-Network Depth: Depth of the lot plus the distance of the lot to the center of the street (center line) in meters (m).

Lot-Network Area: Includes the area of the lot plus 1/2 of the area of access (street/sidewalks) in square meters (m^2).

The accompanying charts include a range of areas varying from a minimum of $100m^2$ to maximum of $800m^2$ which covers a wide variety of areas and still permits small incremental variations ($25m^2$).

For practical reasons, the network is defined by its main dimension: length. The area of the network is included with the lot area. The percentages of areas of lots and areas of circulation should be evaluated separately.

Width-Depth Ratio:

$\frac{w(m)}{d(m)} = \frac{\text{Width of lot}}{\text{Depth of lot}}$

In the charts, it varies from 1/1 (squares) to 1/5 (elongated rectangles). The range is empirical.

Network Access Mode: the charts include only the configurations most common in practice: 1 way short and 2 way short.

Transverse Connectors: The 1 way and 2 way configurations imply [illegible] rectangular system [illegible] area connectors provide the other direction, creating a network. In the charts, for practical reasons, transverse connectors are spaced at intervals of 5, 100, 125, 150, 175 and 200 meters.

PROCEDURE FOR EVALUATION

a) To Compute from a Plan the R-Value in a Given Lot:

1. Divide:

$$\frac{\text{network length (1/2 width of lot) (m)}}{\text{lot \& network access area (Ha)}} = R_1$$

2. Divide:

$$\frac{\text{lot \& network access depth}}{\text{no. of lots between transverse connectors}} = \text{length of connectors per lot}$$

3. Divide:

$$\frac{\text{length of connector per lot}}{\text{lot \& network access area}} = R_2$$

4. Add:

$$R_1 + R_2 = R$$

b) To Compute from a Plan the R-Value in a Given Residential Sector:

1. Select a homogeneous sector where lots are simil in area;
2. Measure the network length (streets, walkways) counting 1 length when they serve lots on both sides and 1/2 when they serve lots in boundaries;
3. Divide:

$$\frac{\text{network length (m)}}{\text{residential sector area (Ha.)}} = R$$

c) To Find the Corresponding R-Value in the Charts f a Lot:

1. Find from plans:
   the lot-network access area, the approximate wid depth dimension and ratio if the lot is served b or 2 way short, the approximate distance between transverse connectors;
2. Find in chart:
   the corresponding lot network access area and determine within this area the R-value that corresponds to the other variables.

d) To Find the Corresponding R-Value in the Charts for a Residential Sector:

1. Compute the average lot-network access area by dividing the total area by the number of lots;
2. Proceed as indicated in c) 1 and 2.

CHARTS FOR EVALUATION

The charts permit the evaluation comparison of the ratio of services to lots or residential sections in terms of:
LOT AREAS, LOT RATIOS, CIRCULATION LAYOUT, MODE OF NETWORK ACCESS, TRANSVERSE CONNECTORS AND DIFFERENT COMBINATIONS OF THESE VARIABLES.

The charts can be used to evaluate and compare existing cases, but more importantly, can be used as a design tool to evaluate different options. Eight charts are available, providing information for lots of average areas 25 square meters to 800 square meters. They are included at the end of this chapter.

LAYOUT MODELS.

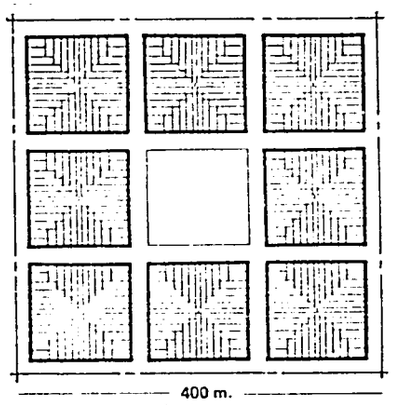
Three layout models are included to illustrate the evaluation of different layouts in which the lot plus network area is approximately the same.

The models represent the following typical urban layouts: Roman-Hispanic, Grid-iron, Cluster.

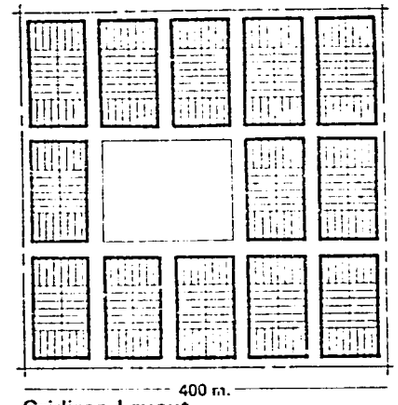
COMMENTS.

Area of public ownership for circulation: Gridiron (32.6%) and Roman-Hispanic (31.8%) are the layouts that require more public land. Cluster (23.4%) layouts require considerably less public land.

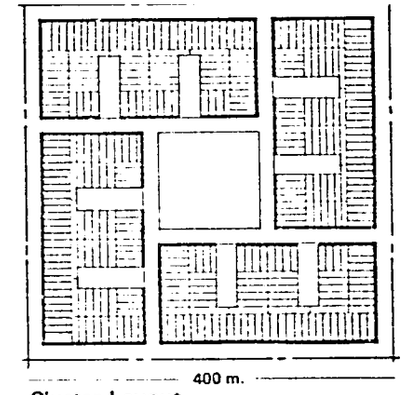
R-values: Gridiron (R=200) has the highest value and, consequently, is the most inefficient. Roman-Hispanic (R=150) have compatible, smaller values and are consequently more efficient. Cluster layouts have the added advantage of permitting the segregation of the semi-private access areas reducing the public area for circulation to R = 114.



Roman-Hispanic Layout.



Gridiron Layout.



Cluster Layout.

ROMAN-HISPANIC LAYOUT.

AREAS OF A BLOCK	Ha	%
Private ownership (lots):	1.21	68.20
Public ownership (circulation):	0.56	31.80
TOTAL	1.77	100.00

NUMBER OF LOTS: 44

AVERAGE LOT AREA = $\frac{1.77}{44}$ = 402m^2

FROM PLANS: R = $\frac{\text{network}}{\text{block area}}$ = $\frac{2.66}{1.77}$ = 150

FROM CHARTS:

CORRESPONDING APPROXIMATE AREA: 400m^2

$\frac{\text{WIDTH}}{\text{DEPTH}}$ Ratio = 1/10

MODE OF NETWORK ACCESS: 1 way short

TRANSVERSE CONNECTOR SPACING: 125 150

CORRESPONDING R = 145 158 = 151

GRIDIRON LAYOUT.

AREAS OF A BLOCK	Ha	%
Private ownership (lots):	0.72	67.40
Public ownership (circulation):	0.35	32.60
TOTAL	1.07	100.00

NUMBER OF LOTS: 28

AVERAGE LOT AREA = $\frac{1.07}{28}$ = 383m^2

FROM PLANS:

R = $\frac{\text{network}}{\text{block area}}$ $\frac{2.13}{1.07}$ = 200

FROM CHARTS:

CORRESPONDING APPROXIMATE AREA: 375m^2

$\frac{\text{WIDTH}}{\text{DEPTH}}$ Ratio = 1/4

MODE OF NETWORK ACCESS: 1 way short

TRANSVERSE CONNECTOR SPACING: 125 150

CORRESPONDING R = 209 195 = 202

CLUSTER LAYOUT

AREAS OF BLOCK	Ha	%
Private ownership (lots):	2.69	76.60
Public ownership (circulation):	0.82	23.40
TOTAL	3.51	100.00

NUMBER OF LOTS: 89

AVERAGE LOT AREA = 394m^2

FROM PLANS:

R - values for Circulation

(1) Public (2) Private

R = $\frac{\text{network}}{\text{block area}}$ = $\frac{400}{3.51}$ = 114 (1)

$\frac{160}{3.51}$ = 45 (2)

TOTAL 159

FROM CHARTS:

CORRESPONDING APPROXIMATE AREA: 400m^2

$\frac{\text{WIDTH}}{\text{DEPTH}}$ Ratio = 1/5

MODE OF NETWORK ACCESS: 1 way short

TRANSVERSE CONNECTOR SPACING: 200

CORRESPONDING R = 161 .

CASE STUDIES

The following two case studies are included to illustrate two diverse situations in the use of the R-value. The first case, South End in Boston, Massachusetts is a planned regular layout on a relatively flat site. The second case, El Agostino, is a random, formally unplanned layout located on a steep slope. For both cases, the R-value may be derived and used as a design tool. The R-values in these two examples are not similar; $278m^2$ in the South End and $136m^2$ in El Agostino.

SOUTH END, BOSTON, U.S.A.

ORIGINS: Private instant development. Established 1850-60.

POPULATION 1960: 3,262 persons

INCOMES 1960: U.S. $2,284 average per household per year, which is 30% of the average for the Boston Metropolitan Area.

LAYOUT: Typical row housing, designed layout. Long, narrow lots with access in front and back. Rectangular blocks on flat, filled site. Originally: single family 4-5 story row-houses. Now: multi-family two bedroom walk-up apartments.

LAND USE: Residential

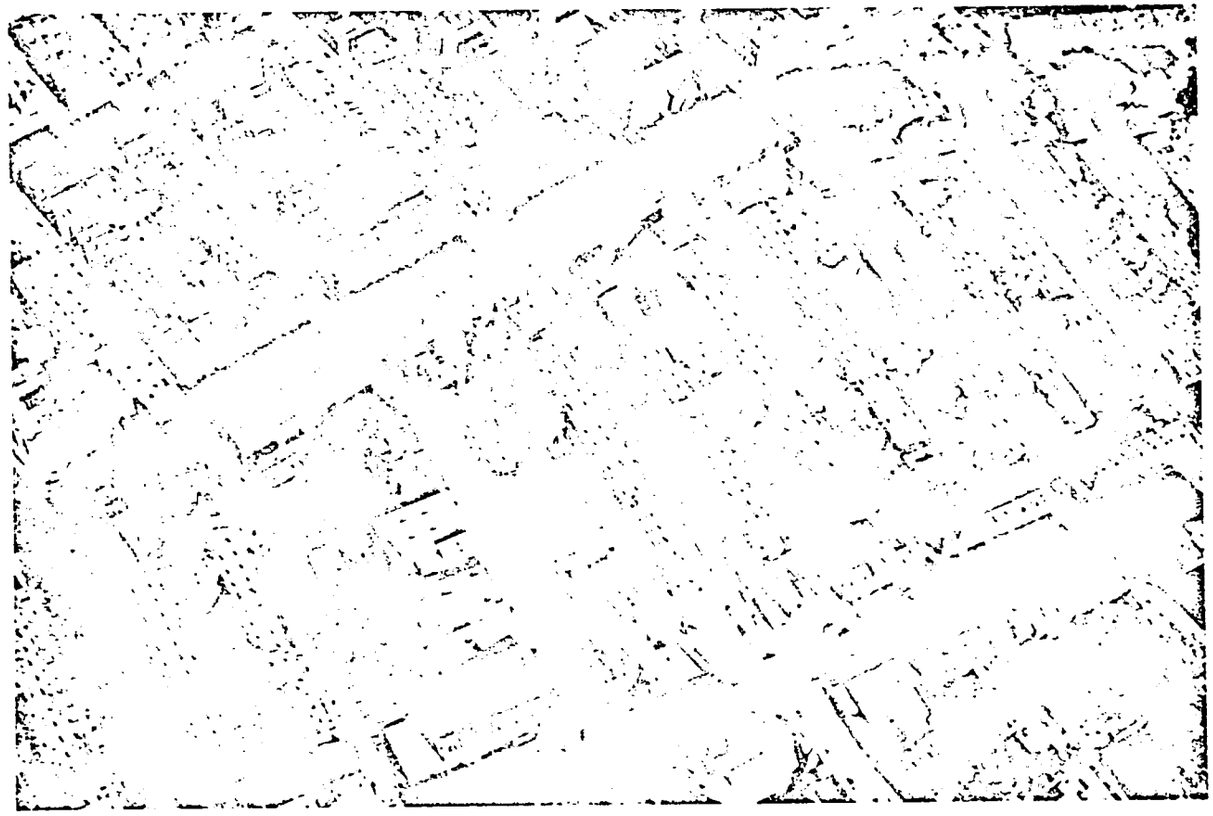
CIRCULATION: Local street in front for automobiles and pedestrians. Service alleys at rear, for occasional automobile circulation, parking.

SELECTED SECTOR OF THE LOCALITY.

AREA	Ha	%
Private ownership (lots):	1.15	59.90
Public ownership (circulation):	0.77	40.10
TOTAL	1.92	100.00

NUMBER OF LOTS: 69

AVERAGE LOT AREA = $\frac{1.92}{69} = 278m^2$



SOUTH END, Boston. Air view of street and block pattern of row housing.

Source: *Urban Dwelling Environments*; Caminos, Turner, Steffian; Cambridge, M.I.T. Press; 1969.

FROM PLANS

$R = \frac{\text{network}}{\text{sector area}} = \frac{650}{1.92} = 338\text{m/Ha}$

FROM CHARTS

CORRESPONDING APPROXIMATE AREA: 275m^2

$\frac{\text{WIDTH}}{\text{DEPTH}}$ Ratio $= \frac{1}{8}$

MODE OF NETWORK ACCESS: 2 way short

TRANSVERSE CONNECTOR SPACING: 75m

CORRESPONDING $= 346\text{m/Ha}$

COMMENTS

Lots are medium size and consequently R-values are in medium ranges.

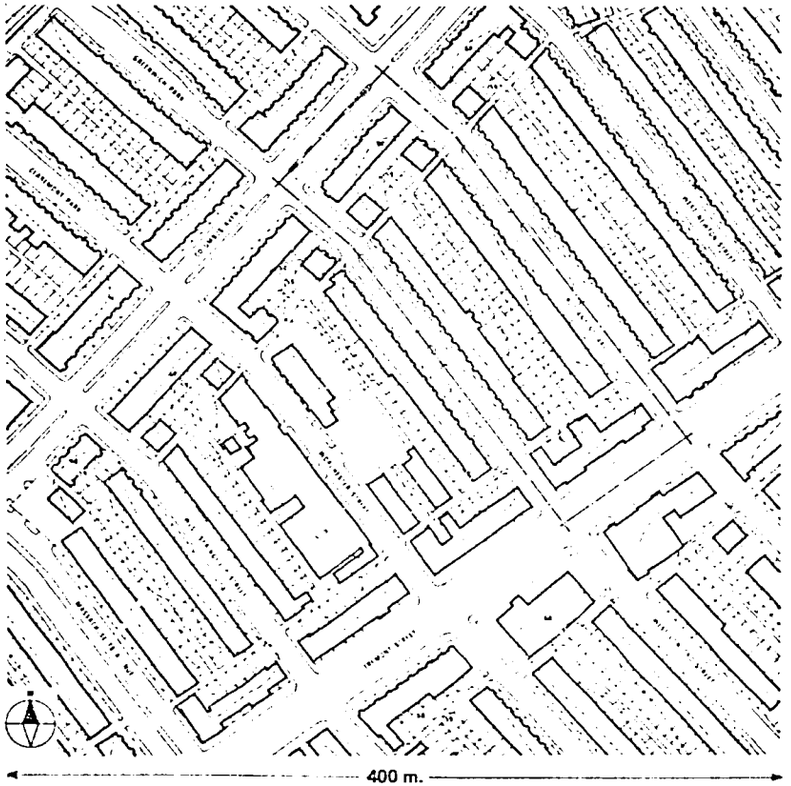
Within the same lot area: lots are narrow and deep, ratio $\frac{w}{d} = \frac{1}{8}$ which reduces R. On the other hand, lots have access on 2 sides and transverse connectors are close which increases R considerably.

R-value will be substantially reduced with one way access and increased spacing of transverse connectors, from R = 346 to R = 173.

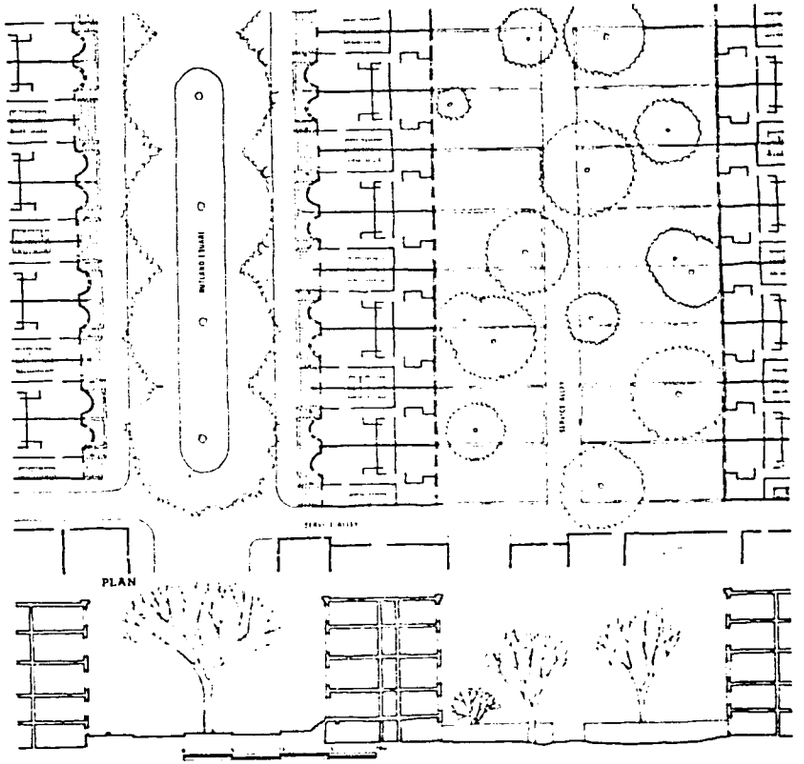
Lot proportions are very efficient and very well used with the 4-5 story row housing. Land is not wasted, open spaces are generous, set backs are well used. Percentage of public land devoted to circulation is very high: 40%, because two sides have access.

The availability of utilties and services is adequate.

It is significant that the most neglected areas are the back alleys.



SOUTH END, Boston. Plan. Selected sector is the area enclosed by the broken line.



SOUTH END, Boston. Dwelling Group.

EL AGOSTINO (HILL), LIMA, PERU.

ORIGINS: Squatter settlement, progressive, spontaneous development. Established 1948.

POPULATION 1964-65: 2500 persons in 460 households.

INCOMES: Not available. In an adjacent squatter settlement, (El Agostino flat) incomes are relatively high, despite physical poverty. In 1965, US $1,380 average per household per year.

LAYOUT: Growth by the accretion of the individual or small group decisions. Very steep site: 30-40% slope. Passage ways parallel to the contours; passages, many with stairways, perpendicular to them. Single family, 1-2 story row houses.

LAND USE: Residential.

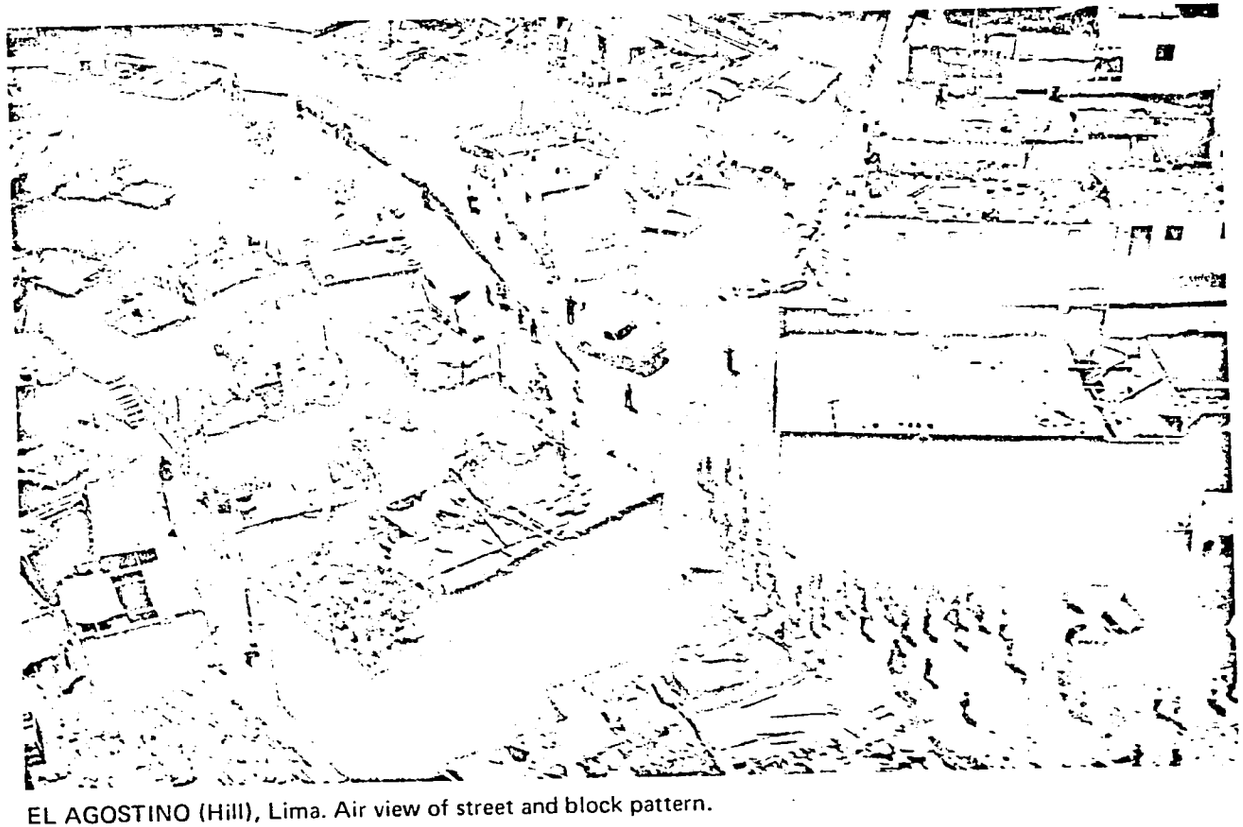
CIRCULATION: Only one vehicular road along the lowest contour. The other passage ways for pedestrian use only. Principal paths parallel to contours and main access to lots. Also, cul-de-sacs and interval court yards give access to several plots.

SELECTED SECTOR OF THE LOCALITY.

AREAS	Ha	
Private ownership (lots):	1.78	72.95
Public ownership (circulation):	0.66	27.05
TOTAL	2.44	100.00

NUMBER OF LOTS: 179

AVERAGE LOT AREA: $\frac{2.44}{169} = 136m^2$



EL AGOSTINO (Hill), Lima. Air view of street and block pattern.

FROM PLANS

$R = \frac{\text{network}}{\text{sector area}} = \frac{1670}{2.44} = 644\text{m/Ha}$

FROM CHARTS

CORRESPONDING APPROXIMATE AREA: $125m^2$

$\frac{\text{WIDTH}}{\text{DEPTH}}$ Ratio = 1/3

MODE OF NETWORK ACCESS: 2 way short

TRANSVERSE CONNECTOR SPACING: 75m

CORRESPONDING R = 649m/Ha

COMMENTS

Lots are small and consequently R=values are in the upper ranges. Still, within the same lot area, R is very high because: lots are relatively wide and not deep, ratio $\frac{W}{D}$ = 1/3; but mainly, lots have access on two sides and transverse connectors are close.

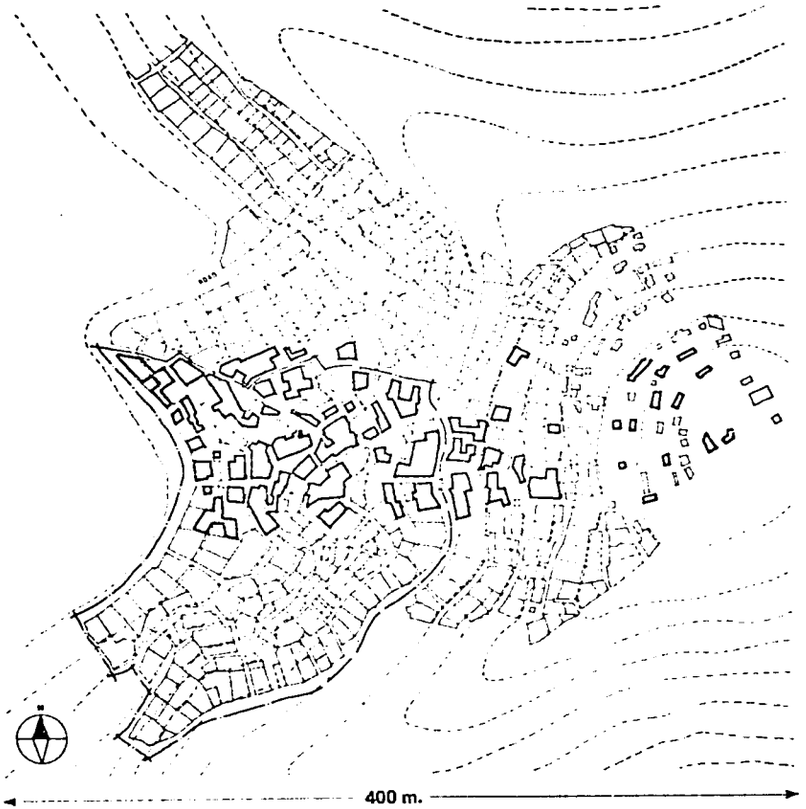
R-value will be substantially reduced with one way access, from R = 649 to R = 391.

The steep slope and other determinants may account for the layout and lot proportions which do not seem very efficient.

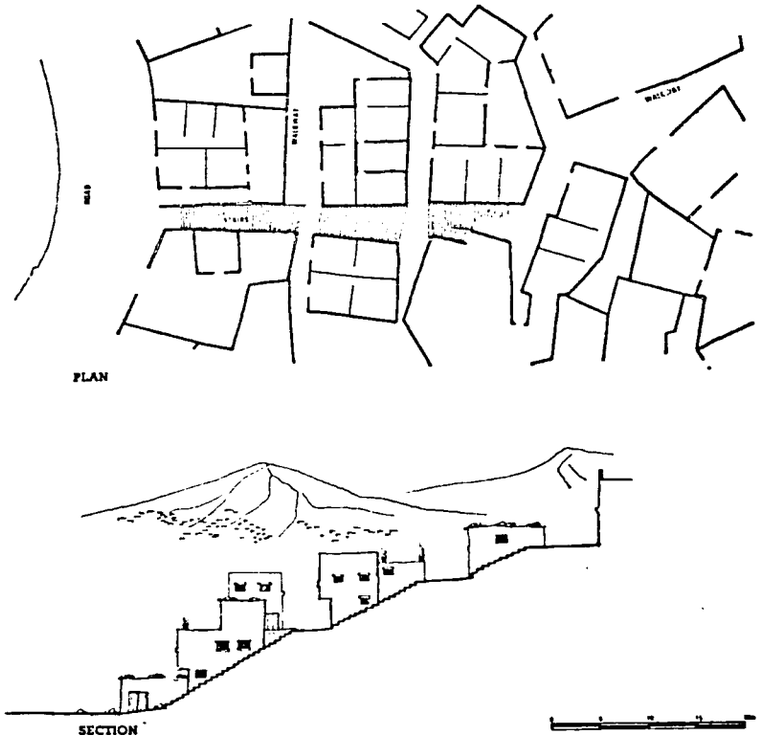
Despite the 2 side accesses, percentage of public land devoted to circulation is small: 27.05%, because narrow circulation.

The availability of utilities and services is very limited. Only schools and public transportation are adequate.

Completion of utilities and services may prove to be very costly because of the layout.



EL AGOSTINO (Hill), Lima. Plan. Selected sector is the area enclosed by the broken line.



EL AGOSTINO (Hill), Lima. Dwelling Group.

AREA	RATIO	WIDTH	DEPTH	1 WAY SHORT 75	100	125	150	175	200	2 WAY SHORT 75	100	125	150	175	200
25	1/ 1	5.00	5.00	1133	1099	1079	1066	1057	1049	2133	2099	2079	2066	2057	2049
25	1/ 2	3.54	7.07	840	807	787	773	764	757	1547	1514	1494	1480	1471	1464
25	1/ 3	2.89	8.66	710	677	657	644	634	627	1288	1254	1234	1221	1211	1204
25	1/ 4	2.50	10.00	633	599	579	566	557	549	1133	1099	1079	1066	1057	1049
25	1/ 5	2.24	11.18	580	547	527	513	504	497	1027	994	974	961	951	944
25	1/ 6	2.04	12.25	541	508	488	474	465	458	949	916	896	883	873	866
25	1/ 7	1.89	13.23	511	477	457	444	435	427	889	855	835	822	813	805
25	1/ 8	1.77	14.14	486	453	433	420	410	403	840	807	787	773	764	757
25	1/ 9	1.67	15.00	466	433	413	400	390	383	800	766	746	733	723	716
50	1/ 1	7.07	7.07	840	807	787	773	764	757	1547	1514	1494	1480	1471	1464
50	1/ 2	5.00	10.00	633	599	579	566	557	549	1133	1099	1079	1066	1057	1049
50	1/ 3	4.08	12.25	541	508	488	474	465	458	949	916	896	883	873	866
50	1/ 4	3.54	14.14	486	453	433	420	410	403	840	807	787	773	764	757
50	1/ 5	3.16	15.81	449	416	396	382	373	366	765	732	712	699	689	682
50	1/ 6	2.89	17.32	422	388	368	355	345	338	710	677	657	644	634	627
50	1/ 7	2.67	18.71	400	367	347	333	324	317	667	634	614	601	591	584
50	1/ 8	2.50	20.00	383	349	329	316	307	299	633	599	579	566	557	549
50	1/ 9	2.36	21.21	369	335	315	302	292	285	604	571	551	538	528	521
75	1/ 1	8.66	8.66	710	677	657	644	634	627	1288	1254	1234	1221	1211	1204
75	1/ 2	6.12	12.25	541	508	488	474	465	458	949	916	896	883	873	866
75	1/ 3	5.00	15.00	466	433	413	399	390	383	799	766	746	733	723	716
75	1/ 4	4.33	17.32	422	388	368	355	345	338	710	677	657	644	634	627
75	1/ 5	3.87	19.36	391	358	338	324	315	308	649	616	596	583	573	566
75	1/ 6	3.54	21.21	369	335	315	302	292	285	604	571	551	538	528	521
75	1/ 7	3.27	22.91	351	318	298	284	275	268	569	536	516	503	493	486
75	1/ 8	3.06	24.49	337	304	284	270	261	254	541	508	488	474	465	458
75	1/ 9	2.89	25.98	325	292	272	259	249	242	519	484	464	451	442	434
100	1/ 1	10.00	10.00	633	599	579	566	557	549	1133	1099	1079	1066	1057	1049
100	1/ 2	7.07	14.14	486	453	433	420	410	403	840	807	787	773	764	757
100	1/ 3	5.77	17.32	422	388	368	355	345	338	710	677	657	644	634	627
100	1/ 4	5.00	20.00	383	349	329	316	307	299	633	599	579	566	557	549
100	1/ 5	4.47	22.36	356	323	303	290	280	273	580	547	527	513	504	497
100	1/ 6	4.08	24.49	337	304	284	270	261	254	541	508	488	474	465	458
100	1/ 7	3.78	26.46	322	288	268	255	246	238	511	477	457	444	435	427
100	1/ 8	3.54	28.28	310	276	256	243	233	226	486	453	433	420	410	403
100	1/ 9	3.33	30.00	300	266	246	233	223	216	466	433	413	400	390	383

AREA	RATIO	WIDTH	DEPTH	1 WAY SHORT 75	100	125	150	175	200	2 WAY SHORT 75	100	125	150	175	200
125	1/ 1	11.18	11.18	580	547	527	513	504	497	1027	994	974	961	951	944
125	1/ 2	7.91	15.81	449	416	396	382	373	366	765	732	712	699	689	682
125	1/ 3	6.45	19.36	391	358	338	324	315	308	649	616	596	583	573	566
125	1/ 4	5.59	22.36	356	323	303	290	280	273	580	547	527	513	504	497
125	1/ 5	5.00	25.00	333	299	279	266	257	249	533	499	479	466	457	449
125	1/ 6	4.56	27.39	315	282	262	249	239	232	498	465	445	431	422	415
125	1/ 7	4.23	29.58	302	269	249	235	226	219	471	438	418	404	395	388
125	1/ 8	3.95	31.62	291	258	238	224	215	208	449	416	396	382	373	366
125	1/ 9	3.73	33.54	282	249	229	215	206	199	431	398	378	364	355	348
150	1/ 1	12.25	12.25	541	508	488	474	465	458	949	916	896	883	873	866
150	1/ 2	8.66	17.32	422	388	368	355	345	338	710	677	657	644	634	627
150	1/ 3	7.07	21.21	369	335	315	302	292	285	604	571	551	538	528	521
150	1/ 4	6.12	24.49	337	304	284	270	261	254	541	508	488	474	465	458
150	1/ 5	5.48	27.39	315	282	262	249	239	232	498	465	445	431	422	415
150	1/ 6	5.00	30.00	299	266	246	233	223	216	466	433	413	399	390	383
150	1/ 7	4.63	32.40	287	254	234	220	211	204	441	408	388	375	365	358
150	1/ 8	4.33	34.64	277	244	224	211	201	194	422	388	368	355	345	338
150	1/ 9	4.08	36.74	269	236	216	202	193	186	405	372	352	339	329	322
175	1/ 1	13.23	13.23	511	477	457	444	435	427	889	855	835	822	813	805
175	1/ 2	9.35	18.71	400	367	347	333	324	317	667	634	614	601	591	584
175	1/ 3	7.64	22.91	351	318	298	284	275	268	569	536	516	503	493	486
175	1/ 4	6.61	26.46	322	288	268	255	246	238	511	477	457	444	435	427
175	1/ 5	5.92	29.58	302	269	249	235	226	219	471	438	418	404	395	388
175	1/ 6	5.40	32.40	287	254	234	220	211	204	441	408	388	375	365	358
175	1/ 7	5.00	35.00	276	242	222	209	199	192	419	385	365	352	342	335
175	1/ 8	4.68	37.42	266	233	213	200	190	183	400	367	347	333	324	317
175	1/ 9	4.41	39.69	259	225	205	192	183	175	385	351	331	318	309	301
200	1/ 1	14.14	14.14	486	453	433	420	410	403	840	807	787	773	764	757
200	1/ 2	10.00	20.00	383	349	329	316	307	299	633	599	579	566	557	549
200	1/ 3	8.16	24.49	337	304	284	270	261	254	541	508	488	474	465	458
200	1/ 4	7.07	28.28	310	276	256	243	233	226	486	453	433	420	410	403
200	1/ 5	6.32	31.62	291	258	238	224	215	208	449	416	396	382	373	366
200	1/ 6	5.77	34.64	277	244	224	211	201	194	422	388	368	355	345	338
200	1/ 7	5.35	37.42	266	233	213	200	190	183	400	367	347	333	324	317
200	1/ 8	5.00	40.00	258	224	204	191	182	174	383	349	329	316	307	299
200	1/ 9	4.71	42.43	251	217	197	184	174	167	369	335	315	302	292	285

AREA	RATIO	WIDTH	DEPTH	1 WAY SHORT 75	100	125	150	175	200	2 WAY SHORT 75	100	125	150	175	200
225	1/ 1	15.00	15.00	466	433	413	399	390	383	799	766	746	733	723	716
225	1/ 2	10.61	21.21	369	335	315	302	292	285	604	571	551	538	528	521
225	1/ 3	8.66	25.98	325	292	272	259	249	242	518	484	464	451	442	434
225	1/ 4	7.50	30.00	299	266	246	233	223	216	466	433	413	399	390	383
225	1/ 5	6.71	33.54	282	249	229	215	206	199	431	398	378	364	355	348
225	1/ 6	6.12	36.74	269	236	216	202	193	186	405	372	352	338	329	322
225	1/ 7	5.67	39.69	259	225	205	192	183	175	385	351	331	318	309	301
225	1/ 8	5.30	42.43	251	217	197	184	174	167	369	335	315	302	292	285
225	1/ 9	5.00	45.00	244	211	191	177	168	161	355	322	302	288	279	272
250	1/ 1	15.81	15.81	449	416	396	382	373	366	765	732	712	699	689	682
250	1/ 2	11.18	22.36	356	323	303	290	280	273	580	547	527	513	504	497
250	1/ 3	9.13	27.39	315	282	262	249	239	232	498	465	445	431	422	415
250	1/ 4	7.91	31.62	291	258	238	224	215	208	449	416	396	382	373	366
250	1/ 5	7.07	35.36	274	241	221	208	198	191	416	382	362	349	339	332
250	1/ 6	6.45	38.73	262	229	209	195	186	179	391	358	338	324	315	308
250	1/ 7	5.98	41.83	252	219	199	186	176	169	372	339	319	305	296	289
250	1/ 8	5.59	44.72	245	211	191	178	168	161	356	323	303	290	280	273
250	1/ 9	5.27	47.43	238	205	185	172	162	155	344	310	290	277	267	260
275	1/ 1	16.58	16.58	434	401	381	368	358	351	736	703	683	669	660	653
275	1/ 2	11.73	23.45	346	313	293	279	270	263	559	526	506	493	483	476
275	1/ 3	9.57	28.72	307	274	254	240	231	224	481	448	428	414	405	398
275	1/ 4	8.29	33.17	284	250	230	217	207	200	434	401	381	368	358	351
275	1/ 5	7.42	37.08	268	234	214	201	191	184	403	369	349	336	326	319
275	1/ 6	6.77	40.62	256	223	203	189	180	173	379	346	326	312	303	296
275	1/ 7	6.27	43.87	247	213	193	180	171	163	361	327	307	294	285	277
275	1/ 8	5.86	46.90	239	206	186	173	163	156	346	313	293	279	270	263
275	1/ 9	5.53	49.75	233	200	180	167	157	150	334	301	281	267	258	251
300	1/ 1	17.32	17.32	422	388	368	355	345	338	710	677	657	644	634	627
300	1/ 2	12.25	24.49	337	304	284	270	261	254	541	508	488	474	465	458
300	1/ 3	10.00	30.00	299	266	246	233	223	216	466	433	413	399	390	383
300	1/ 4	8.66	34.64	277	244	224	211	201	194	422	388	368	355	345	338
300	1/ 5	7.75	38.73	262	229	209	195	186	179	391	358	338	324	315	308
300	1/ 6	7.07	42.43	251	217	197	184	174	167	369	335	315	302	292	285
300	1/ 7	6.55	45.83	242	209	189	175	166	159	351	318	298	284	275	268
300	1/ 8	6.12	48.99	235	202	182	168	159	152	337	304	284	270	261	254
300	1/ 9	5.77	51.96	229	196	176	162	153	146	325	292	272	259	249	242

AREA	RATIO	WIDTH	DEPTH	1 WAY SHORT 75	100	125	150	175	200	2 WAY SHORT 75	100	125	150	175	200
325	1/ 1	18.03	18.03	410	377	357	344	334	327	688	654	634	621	611	604
325	1/ 2	12.75	25.50	329	296	276	262	253	246	525	492	472	458	449	442
325	1/ 3	10.41	31.22	293	260	240	226	217	210	453	420	400	386	377	370
325	1/ 4	9.01	36.06	272	238	218	205	195	188	410	377	357	344	334	327
325	1/ 5	8.06	40.31	257	224	204	190	181	174	381	348	328	314	305	298
325	1/ 6	7.36	44.16	246	213	193	179	170	163	359	326	306	293	283	276
325	1/ 7	6.81	47.70	238	204	184	171	161	154	342	309	289	276	266	259
325	1/ 8	6.37	50.99	231	198	178	164	155	148	329	296	276	262	253	246
325	1/ 9	6.01	54.08	225	192	172	159	149	142	318	284	264	251	242	234
350	1/ 1	18.71	18.71	400	367	347	333	324	317	667	634	614	601	591	584
350	1/ 2	13.23	26.46	322	288	268	255	246	238	511	477	457	444	435	427
350	1/ 3	10.80	32.40	287	254	234	220	211	204	441	408	388	375	365	358
350	1/ 4	9.35	37.42	266	233	213	200	190	183	400	367	347	333	324	317
350	1/ 5	8.37	41.83	252	219	199	186	176	169	372	339	319	305	296	289
350	1/ 6	7.64	45.83	242	209	189	175	166	159	351	318	298	284	275	268
350	1/ 7	7.07	49.50	234	201	181	167	158	151	335	302	282	268	259	252
350	1/ 8	6.61	52.92	227	194	174	161	151	144	322	288	268	255	246	238
350	1/ 9	6.24	56.12	222	189	169	155	146	139	311	278	258	244	235	228
375	1/ 1	19.36	19.36	391	358	338	324	315	308	649	616	596	583	573	566
375	1/ 2	13.69	27.39	315	282	262	249	239	232	498	465	445	431	422	415
375	1/ 3	11.18	33.54	282	249	229	215	206	199	431	398	378	364	355	348
375	1/ 4	9.68	38.73	262	229	209	195	186	179	391	358	338	324	315	308
375	1/ 5	8.66	43.30	248	215	195	182	172	165	364	330	310	297	288	280
375	1/ 6	7.91	47.43	238	205	185	172	162	155	344	310	290	277	267	260
375	1/ 7	7.32	51.23	230	197	177	164	154	147	328	295	275	261	252	245
375	1/ 8	6.85	54.77	224	191	171	157	148	141	315	282	262	249	239	232
375	1/ 9	6.45	58.09	219	186	166	152	143	136	305	272	252	238	229	222
400	1/ 1	20.00	20.00	383	349	329	316	307	299	633	599	579	566	557	549
400	1/ 2	14.14	28.28	310	276	256	243	233	226	486	453	433	420	410	403
400	1/ 3	11.55	34.64	277	244	224	211	201	194	422	388	368	355	345	338
400	1/ 4	10.00	40.00	258	224	204	191	182	174	383	349	329	316	307	299
400	1/ 5	8.94	44.72	245	211	191	178	168	161	356	323	303	290	280	273
400	1/ 6	8.16	48.99	235	202	182	168	159	152	337	304	284	270	261	254
400	1/ 7	7.56	52.92	227	194	174	161	151	144	322	288	268	255	246	238
400	1/ 8	7.07	56.57	221	188	168	155	145	138	310	276	256	243	233	226
400	1/ 9	6.67	60.00	216	183	163	150	140	133	300	266	246	233	223	216

AREA	RATIO	WIDTH	DEPTH	1 WAY SHORT 75	100	125	150	175	200	2 WAY SHORT 75	100	125	150	175	200
425	1/ 1	20.62	20.62	375	342	322	309	299	292	618	585	565	551	542	535
425	1/ 2	14.58	29.15	304	271	251	238	228	221	476	442	422	409	400	392
425	1/ 3	11.90	35.71	273	240	220	206	197	190	413	380	360	346	337	330
425	1/ 4	10.31	41.23	254	221	201	187	178	171	375	342	322	309	299	292
425	1/ 5	9.22	46.10	241	208	188	175	165	158	350	316	296	283	274	266
425	1/ 6	8.42	50.50	232	199	179	165	156	149	331	298	278	264	255	248
425	1/ 7	7.79	54.54	225	191	171	158	148	141	316	283	263	250	240	233
425	1/ 8	7.29	58.31	219	185	165	152	142	135	304	271	251	238	228	221
425	1/ 9	6.87	61.85	214	180	160	147	137	130	295	261	241	228	218	211
450	1/ 1	21.21	21.21	369	335	315	302	292	285	604	571	551	538	528	521
450	1/ 2	15.00	30.00	299	266	246	233	223	216	466	433	413	399	390	383
450	1/ 3	12.25	36.74	269	236	216	202	193	186	405	372	352	338	329	322
450	1/ 4	10.61	42.43	251	217	197	184	174	167	369	335	315	302	292	285
450	1/ 5	9.49	47.43	238	205	185	172	162	155	344	310	290	277	267	260
450	1/ 6	8.66	51.96	229	196	176	162	153	146	325	292	272	259	249	242
450	1/ 7	8.02	56.12	222	189	169	155	146	139	311	278	258	244	235	228
450	1/ 8	7.50	60.00	216	183	163	149	140	133	299	266	246	233	223	216
450	1/ 9	7.07	63.64	211	178	158	145	135	128	290	257	237	223	214	207
475	1/ 1	21.79	21.79	362	329	309	296	286	279	592	558	538	525	515	508
475	1/ 2	15.41	30.82	295	262	242	228	219	212	457	424	404	391	381	374
475	1/ 3	12.58	37.75	265	232	212	199	189	182	398	364	344	331	322	314
475	1/ 4	10.90	43.59	248	214	194	181	171	164	362	329	309	296	286	279
475	1/ 5	9.75	48.73	235	202	182	169	159	152	338	305	285	271	262	255
475	1/ 6	8.90	53.39	226	193	173	160	150	143	320	287	267	253	244	237
475	1/ 7	8.24	57.66	220	186	166	153	143	136	306	273	253	240	230	223
475	1/ 8	7.71	61.64	214	181	161	147	138	131	295	262	242	228	219	212
475	1/ 9	7.26	65.38	209	176	156	143	133	126	286	252	232	219	210	202
500	1/ 1	22.36	22.36	356	323	303	290	280	273	580	547	527	513	504	497
500	1/ 2	15.81	31.62	291	258	238	224	215	208	449	416	396	382	373	366
500	1/ 3	12.91	38.73	262	229	209	195	186	179	391	358	338	324	315	308
500	1/ 4	11.18	44.72	245	211	191	178	168	161	356	323	303	290	280	273
500	1/ 5	10.00	50.00	233	199	179	166	157	149	333	299	279	266	257	249
500	1/ 6	9.13	54.77	224	191	171	157	148	141	315	282	262	249	239	232
500	1/ 7	8.45	59.16	217	184	164	151	141	134	302	269	249	235	226	219
500	1/ 8	7.91	63.25	212	179	159	145	136	129	291	258	238	224	215	208
500	1/ 9	7.45	67.08	207	174	154	141	131	124	282	249	229	215	206	199

AREA	RATIO	WIDTH	DEPTH	1 WAY SHORT 75	100	125	150	175	200	2 WAY SHORT 75	100	125	150	175	200
525	1/ 1	22.91	22.91	351	318	298	284	275	268	569	536	516	503	493	486
525	1/ 2	16.20	32.40	287	254	234	220	211	204	441	408	388	375	365	358
525	1/ 3	13.23	39.69	259	225	205	192	183	175	385	351	331	318	309	301
525	1/ 4	11.46	45.83	242	209	189	175	166	159	351	318	298	284	275	268
525	1/ 5	10.25	51.23	230	197	177	164	154	147	328	295	275	261	252	245
525	1/ 6	9.35	56.12	222	189	169	155	146	139	311	278	258	244	235	228
525	1/ 7	8.66	60.62	215	182	162	149	139	132	298	264	244	231	222	214
525	1/ 8	8.10	64.81	210	177	157	143	134	127	287	254	234	220	211	204
525	1/ 9	7.64	68.74	206	172	152	139	129	122	278	245	225	212	202	195
550	1/ 1	23.45	23.45	346	313	293	279	270	263	559	526	506	493	483	476
550	1/ 2	16.58	33.17	284	250	230	217	207	200	434	401	381	368	358	351
550	1/ 3	13.54	40.62	256	223	203	189	180	173	379	346	326	312	303	296
550	1/ 4	11.73	46.90	239	206	186	173	163	156	346	313	293	279	270	263
550	1/ 5	10.49	52.44	228	195	175	162	152	145	324	290	270	257	247	240
550	1/ 6	9.57	57.45	220	187	167	153	144	137	307	274	254	240	231	224
550	1/ 7	8.86	62.05	213	180	160	147	137	130	294	261	241	227	218	211
550	1/ 8	8.29	66.33	208	175	155	142	132	125	284	250	230	217	207	200
550	1/ 9	7.82	70.36	204	171	151	137	128	121	275	242	222	208	199	192
575	1/ 1	23.98	23.98	341	308	288	275	265	258	550	517	497	483	474	467
575	1/ 2	16.96	33.91	280	247	227	214	204	197	428	394	374	361	352	344
575	1/ 3	13.84	41.53	253	220	200	187	177	170	374	340	320	307	297	290
575	1/ 4	11.99	47.96	237	204	184	170	161	154	341	308	288	275	265	259
575	1/ 5	10.72	53.62	226	193	173	159	150	143	319	286	266	253	243	236
575	1/ 6	9.79	58.74	218	185	165	151	142	135	303	270	250	236	227	220
575	1/ 7	9.06	63.44	212	178	158	145	135	128	290	257	237	224	214	207
575	1/ 8	8.48	67.82	207	173	153	140	130	123	280	247	227	214	204	197
575	1/ 9	7.99	71.94	202	169	149	136	126	119	272	239	219	205	196	189
600	1/ 1	24.49	24.49	337	304	284	270	261	254	541	508	488	474	465	458
600	1/ 2	17.32	34.64	277	244	224	211	201	194	422	388	368	355	345	338
600	1/ 3	14.14	42.43	251	217	197	184	174	167	369	335	315	302	292	285
600	1/ 4	12.25	48.99	235	202	182	168	159	152	337	304	284	270	261	254
600	1/ 5	10.95	54.77	224	191	171	157	148	141	315	282	262	249	239	232
600	1/ 6	10.00	60.00	216	183	163	149	140	133	299	266	246	233	223	216
600	1/ 7	9.26	64.81	210	177	157	143	134	127	287	254	234	220	211	204
600	1/ 8	8.66	69.28	205	172	152	138	129	122	277	244	224	211	201	194
600	1/ 9	8.16	73.48	201	168	148	134	125	118	269	236	216	202	193	186

AREA	RATIO	WIDTH	DEPTH	1 WAY SHORT 75	100	125	150	175	200	2 WAY SHORT 75	100	125	150	175	200
625	1/ 1	25.00	25.00	333	299	279	266	257	249	533	499	479	466	457	449
625	1/ 2	17.68	35.36	274	241	221	208	198	191	416	382	362	349	339	332
625	1/ 3	14.43	43.30	248	215	195	182	172	165	364	330	310	297	288	280
625	1/ 4	12.50	50.00	233	199	179	166	157	149	333	299	279	266	257	249
625	1/ 5	11.18	55.90	222	189	169	156	146	139	312	278	258	245	236	228
625	1/ 6	10.21	61.24	214	181	161	148	138	131	296	263	243	229	220	213
625	1/ 7	9.45	66.14	208	175	155	142	132	125	284	251	231	217	208	201
625	1/ 8	8.84	70.71	204	170	150	137	127	120	274	241	221	208	198	191
625	1/ 9	8.33	75.00	199	166	146	133	123	116	266	233	213	199	190	183
650	1/ 1	25.50	25.50	329	296	276	262	253	246	525	492	472	458	449	442
650	1/ 2	18.03	36.06	272	238	218	205	195	188	410	377	357	344	334	327
650	1/ 3	14.72	44.16	246	213	193	179	170	163	359	326	306	293	283	276
650	1/ 4	12.75	50.99	231	198	178	164	155	148	329	296	276	262	253	246
650	1/ 5	11.40	57.01	221	187	167	154	144	137	308	275	255	242	232	225
650	1/ 6	10.41	62.45	213	180	160	146	137	130	293	260	240	226	217	210
650	1/ 7	9.64	67.45	207	174	154	140	131	124	281	248	228	214	205	198
650	1/ 8	9.01	72.11	202	169	149	136	126	119	272	238	218	205	195	188
650	1/ 9	8.50	76.49	198	165	145	132	122	115	264	230	210	197	187	180
675	1/ 1	25.98	25.98	325	292	272	259	249	242	518	484	464	451	442	434
675	1/ 2	18.37	36.74	269	236	216	202	193	186	405	372	352	338	329	322
675	1/ 3	15.00	45.00	244	211	191	177	168	161	355	322	302	288	279	272
675	1/ 4	12.99	51.96	229	196	176	162	153	146	325	292	272	259	249	242
675	1/ 5	11.62	58.09	219	186	166	152	143	136	305	272	252	238	229	222
675	1/ 6	10.61	63.64	211	178	158	145	135	128	290	257	237	223	214	207
675	1/ 7	9.82	68.74	206	172	152	139	129	122	278	245	225	212	202	195
675	1/ 8	9.19	73.48	201	168	148	134	125	118	269	236	216	202	193	186
675	1/ 9	8.66	77.94	197	164	144	130	121	114	261	228	208	194	185	178
700	1/ 1	26.46	26.46	322	288	268	255	246	238	511	477	457	444	435	427
700	1/ 2	18.71	37.42	266	233	213	200	190	183	400	367	347	333	324	317
700	1/ 3	15.28	45.83	242	209	189	175	166	159	351	318	298	284	275	268
700	1/ 4	13.23	52.92	227	194	174	161	151	144	322	298	268	255	246	238
700	1/ 5	11.83	59.16	217	184	164	151	141	134	302	269	249	235	226	219
700	1/ 6	10.80	64.81	210	177	157	143	134	127	287	254	234	220	211	204
700	1/ 7	10.00	70.00	204	171	151	138	128	121	276	242	222	209	199	192
700	1/ 8	9.35	74.83	200	166	146	133	123	116	266	233	213	200	190	183
700	1/ 9	8.82	79.37	196	162	142	129	120	112	259	225	205	192	183	175

AREA	RATIO	WIDTH	DEPTH	1 WAY SHORT 75	100	125	150	175	200	2 WAY SHORT 75	100	125	150	175	200
725	1/ 1	26.93	26.93	319	285	265	252	242	235	504	471	451	438	428	421
725	1/ 2	19.04	38.08	264	231	211	197	188	181	395	362	342	329	319	312
725	1/ 3	15.55	46.64	240	207	187	173	164	157	347	314	294	281	271	264
725	1/ 4	13.46	53.85	226	192	172	159	149	142	319	285	265	252	242	235
725	1/ 5	12.04	60.21	216	183	163	149	140	133	299	266	246	232	223	216
725	1/ 6	10.99	65.95	209	175	155	142	132	125	284	251	231	218	208	201
725	1/ 7	10.18	71.24	203	170	150	136	127	120	273	240	220	207	197	190
725	1/ 8	9.52	76.16	198	165	145	132	122	115	264	231	211	197	188	181
725	1/ 9	8.98	80.78	195	161	141	128	119	111	257	223	203	190	180	173
750	1/ 1	27.39	27.39	315	282	262	249	239	232	498	465	445	431	422	415
750	1/ 2	19.36	38.73	262	229	209	195	186	179	391	358	338	324	315	308
750	1/ 3	15.81	47.43	238	205	185	172	162	155	344	310	290	277	267	260
750	1/ 4	13.69	54.77	224	191	171	157	148	141	315	282	262	249	239	232
750	1/ 5	12.25	61.24	214	181	161	148	138	131	296	263	243	229	220	213
750	1/ 6	11.18	67.08	207	174	154	141	131	124	282	249	229	215	206	199
750	1/ 7	10.35	72.46	202	169	149	135	126	119	271	238	218	204	195	188
750	1/ 8	9.68	77.46	197	164	144	131	121	114	262	229	209	195	186	179
750	1/ 9	9.13	82.16	194	160	140	127	118	110	255	221	201	188	178	171
775	1/ 1	27.84	27.84	312	279	259	246	236	229	492	459	439	425	416	409
775	1/ 2	19.69	39.37	260	227	207	193	184	177	387	354	334	320	311	304
775	1/ 3	16.07	48.22	237	203	183	170	160	153	340	307	287	274	264	257
775	1/ 4	13.92	55.68	223	189	169	156	146	139	312	279	259	246	236	229
775	1/ 5	12.45	62.25	213	180	160	146	137	130	293	260	240	227	217	210.
775	1/ 6	11.37	68.19	206	173	153	139	130	123	279	246	226	213	203	196
775	1/ 7	10.52	73.65	201	167	147	134	125	117	269	235	215	202	192	185
775	1/ 8	9.84	78.74	196	163	143	130	120	113	260	227	207	193	184	177
775	1/ 9	9.28	83.52	193	159	139	126	117	109	253	219	199	186	176	169
800	1/ 1	28.28	28.28	310	276	256	243	233	226	486	453	433	420	410	403
800	1/ 2	20.00	40.00	258	224	204	191	182	174	383	349	329	316	307	299
800	1/ 3	16.33	48.99	235	202	182	168	159	152	337	304	284	270	261	254
800	1/ 4	14.14	56.57	221	188	168	155	145	138	310	276	256	243	233	226
800	1/ 5	12.65	63.25	212	179	159	145	136	129	291	258	238	224	215	208
800	1/ 6	11.55	69.28	205	172	152	138	129	122	277	244	224	211	201	194
800	1/ 7	10.69	74.83	200	166	146	133	123	116	266	233	213	200	190	183
800	1/ 8	10.00	80.00	195	162	142	129	119	112	258	224	204	191	182	174
800	1/ 9	9.43	84.85	192	158	138	125	116	108	251	217	197	184	174	167

41. 42. CIRCULATION

BASIC DEFINITIONS

CIRCULATION: Provide interaccessibility among land uses, by means of:

1. Transport methods (mode):
   foot, horse, cycle, auto, truck, transit, train, boat, aircraft.
2. Routes or ways:
   path, road or street, rail, waterway, airway.
3. Terminals:
   parking space, dock, port, etc.

For purposes of this study circulation will be analized in relation to:

- Urban Residential Areas
- Site and Services Programs
- Pedestrian and Vehicular Routes (Road System)
- Parking Areas (Terminals)

1. ROAD SYSTEM

CLASSIFICATION

In relation to a Site:

1. EXTERIOR
2. INTERIOR

According to Control and Maintenance:

1. PRIVATE (Nor included in study)
2. SEMI-PRIVATE
3. PUBLIC

According to Mode of Use:

1. PEDESTRIANS
2. PEDESTRIANS (dominant) AND VEHICLES
3. VEHICLES AND PEDESTRIANS
4. VEHICLES (dominant) AND PEDESTRIANS
5. VEHICLES

According to Area Served:

1. PATHS
2. LOCAL STREET
3. SECONDARY STREET
4. MINOR ARTERIAL

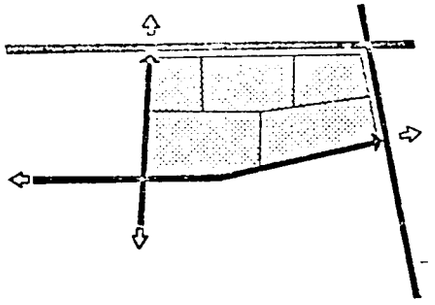
5a. MAJOR ARTERIAL

5b. INTRA COMMUNITY HIGHWAY

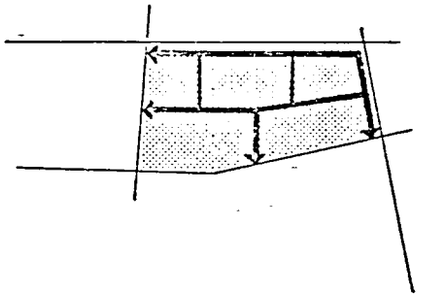
5c. INTERSTATE

CIRCULATION IN RELATION TO A SITE

EXTERIOR CIRCULATION/ACCESSES: the existing and proposed circulation system/accesses outside of the site but affecting the site. These include limited access highways as well as meshing access to the surrounding areas. Exterior circulation/accesses are generally given conditions.



INTERIOR CIRCULATION NETWORK: the pedestrian/automobile circulation system inside the site. This is a design component to be determined by the exterior accesses (existing conditions) and land development requirements.



CIRCULATION ACCORDING TO CONTROL AND MAINTENANCE.

SEMI-PRIVATE AND PUBLIC CIRCULATION: The land which is utilized by the circulation grid is usually considered to be under public ownership.

Circulation areas under semi-private ownership are those which have restricted private use as a consequence of the layout. This allows maximization of private responsibilities over control and maintenance of the roads. Furthermore, development costs are greatly reduced.

CIRCULATION ACCORDING TO MODE OF USE AND AREA SERVED

In the following chart, these parameters are considered:

SPEED (3) (5)	Usual speed, expressed in Kilometers Per Hour. (Kph) (1 Kilometer = 0.625 mile) (1.6 Kilometer = 1 mile)
CAPACITY (6)	Expressed in Vehicles Per Lane Per Hour V/L/H).
CHARACTER (4) (7)	Use characteristics, basically expressed in terms of Pedestrian and Vehicles.
CONTROL (8)	Manner of achieving the desired use.
WIDTH (9)	Right of Way (R.O.W.), expressed in terms of meters (m); Includes sidewalks, parking and traffic lanes, median and/or green strips. (1 meter = 3.33 ft.) (0.3 meter = 1.00 ft.)
LANES (10)	Expressed in number of lanes (N°); includes parking, median and traffic lanes.
GRADE (11)	Acceptable inclination of the roads, expressed in percentage (%).
FUNCTION (12)	Service given for various modes
SPACING (13)	Distance between roads within the road network (grid), expressed in meters (m).

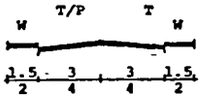
CIRCULATION MODES, USERS, ROAD CHARACTERISTICS

MODES	TYPES	USERS						ROAD CHARACTERISTICS				
		PEDESTRIAN		AUTOMOBILES				WIDTH	LANES	GRADE	FUNCTION	Accepted SPACING
		SPEED KPH	CHARACTER	SPEED KPH	CAP. V/L,H	CHARACTER	CONTROL					
1	2	3	4	5	6		8	m. 9	No. 10	% 11	12	m. 13
PEDESTRIANS	Paths	4	Pedestrian circulation and other social functions: Children games, people gathering, strolling, leisure etc.	NOT APPLICABLE		NOT APPLICABLE Only emergency vehicles access	Is established by the design, the street layout and use.	3-4	NOT APPL.	30	Serve primarily for pedestrian access to interior lots and communal parking facilities. Secondarily for limited and controlled access of service and emergency vehicles such as fire trucks, ambulances, police patrols, etc.	60-200
PEDESTRIANS (dominate) AND VEHICLES	Residential Street Neighborhood Street Minor Street Local Street	4	Pedestrian circulation, strolling	16 24		Pedestrian dominate over vehicles. Usually local traffic limited to pedestrians and private, emergency, service vehicles.	Control of traffic frequency, character and speed are mainly established by the street layout and use.	9-12 12-16	2 3	32	Give access to residential property	80-200
VEHICLES AND PEDESTRIANS	Collector Street Secondary Street Connector Street	4	Pedestrian circulation, strolling	30 40	300	Vehicles dominate but do not control circulation. Usually local and through traffic for all kinds of vehicles and pedestrians.	Controls are established for the protection of pedestrians: crosswalks, traffic lights rails, overpasses and underpasses.	12-16 18-22 23-29	3 4	5 to 15	They provide for through traffic, may delineate a neighborhood, give access to communal parking lots, pedestrian paths, service streets and are used for secondary transport routes.	400-800
VEHICLES (dominate) AND PEDESTRIANS	Inter Community Access Minor Arterial Distributor Primary Street Main Spine R.	4	Pedestrian circulation	60	600 900	Vehicles dominate strongly over pedestrians. Usually through traffic for all kinds of vehicles and pedestrians.	Stricter controls are established for the protection of pedestrians: rails, traffic lights, overpasses and underpasses.	23-28 29-34	4 6	5 to 15	They provide access to the locality from intracommunity highways and also usually determine major transportation routes within locality; form the principal focus or spine of the development.	1200-1600
VEHICLES	Major Arterials	NOT APPLICABLE		56-72	1000	Exclusive use by vehicles: relatively high speed with large volume of traffic flow. Through traffic for all kinds of vehicles.	Controls for driving safety are established.	[illegible]	6 or more	[illegible]	[illegible]	2400-320
	Expressways Intra Community Highway			60-80	1800			60-7[illegible]			Usually form boundaries for neighborhoods. Provide metropolitan and city continuity and unity.	1600-4800 1000-5000
	Freeway Thruway Tollroad Interstate			96 100				60-90			Provide regional and metropolitan continuity and unity.	Variable

STREET/ROAD SECTIONS

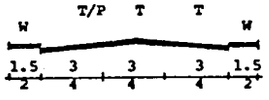
W = Walk lane
T = Through traffic lane
P = Parking lane
M = Median lane

- PEDESTRIANS

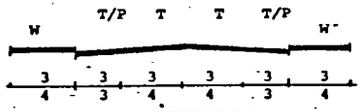


R.O W.
9 meters
12 meters

- PEDESTRIANS (dominate) AND VEHICLES

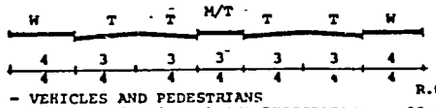


R.O.W.
12 meters
16 meters



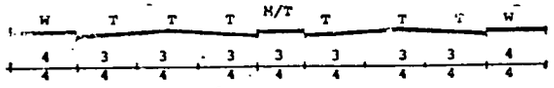
R.O.W.
18 meters
22 meters

- VEHICLES AND PEDESTRIANS



- VEHICLES AND PEDESTRIANS
- VEHICLES (dominate) AND PEDESTRIANS

R.O.W.
23 meters
28 meters



- VEHICLES (dominate) AND PEDESTRIANS

R.O.W.
29 meters
36 meters

DESIGN IMPLICATIONS

A. Staging of Circulation

In low cost residential urbanization developments, the initial construction of the entire circulation system is usually prohibitively expensive.

Priorities for circulation development must be established which relate to initial and projected population densities. Only minimum amounts of circulation and infrastructure which will allow the community to function at a particular stage of development should be provided. The staging of the circulation development must be coordination with the staging of infrastructure. Water, sewerage, storm drainage, electricity and telephone has been expanding with expanding densities and new development. Since most utility easements are within circulation R.O.W.'s, the development of both should be concurrent.

In the planning and initial occupation of the development, land needs to be set aside for all of the proposed R.O.W.'s and infrastructure easements. Initially, only those circulation modes which provide for public transit routes and access to individual lots need be developed. As densities increase, they can be developed and surfaced in relation to the nature of the traffic they carry.

B. Other Considerations

Circulation is a fixed or permanent entity within the physical environment. Its development and utilization are long term investments not easily altered to meet changing demands.

The network layout within the Site is determined by the size and proportion of lots forming a typical block, maximum desirable travel distances and the interplay of movement between pedestrians and vehicles.

The primary ordering framework around which the Site is developed is provided by the Circulation network; it is compulsory in defining Infrastructure networks and a helpful factor in defining Land Use.

Circulation can be considered a critical factor specially in those cases (Site and Services programs), in which successful solutions demand maximum utilization of the resources available (land, money, time, etc.).

With an efficient Circulation network, Land utilization (See Land Use) is better and utilities provision is cheaper.

C. Circulation Requirements

THE OVERALL PHYSICAL PLAN, INCLUDING CIRCULATION LAYOUT AND LAND USE (See Land Use) IS THE BASIC ELEMENT OF ANY PROJECT.

ERRORS OR MISCONCEPTIONS AT THE LEVEL OF THE PHYSICAL PLAN WILL AFFECT ALL OTHER ASPECTS AND DETAILS INVOLVED.

Basic circulation requirements are specially related with:

1) CIRCULATION LENGTH contain almost all the Utility and Services lines (water, sewage, electricity, garbage collection, street cleaning, etc.), and for these reasons it determines the efficiency of the layout or, in other terms, the economic viability of the project (Development costs, maintenance cost, etc.).

   Consequently, MINIMIZATION OF CIRCULATION LENGTHS BETWEEN CERTAIN LIMITS SHOULD BE AN IMPORTANT GOAL.

2) AREA USED FOR CIRCULATION PURPOSES. The provision of an excess circulation area at the expense of private areas has direct consequences in the economic feasibility of the project.

   It means more or less little private lots and also less area available for commercial, educational and other facilities, which is a crit cal issue in Site and Services projects (See Land Use).

   An evaluation of many cases indicated that the average area % dedicated to circulation use is 20-25%.

PARKING AREAS

In urbanizations without direct vehicular access to all lots and without private parking, it is necessary to provide parking facilities for present or future demands.

Standards for parking are generally specified by zoning regulations which define parking ratios for different land-use categories. In residential areas, the ratio is stated as the number of parking spaces per dwelling unit or family.

Requirements for parking will vary according to the structure of travel habits including walking distances and existing and projected availability of private automobiles.

Communal parking primarity for residential purposes is a function of: climate, site topography, walking times, market factors and distances related to the transporting of goods by hand.

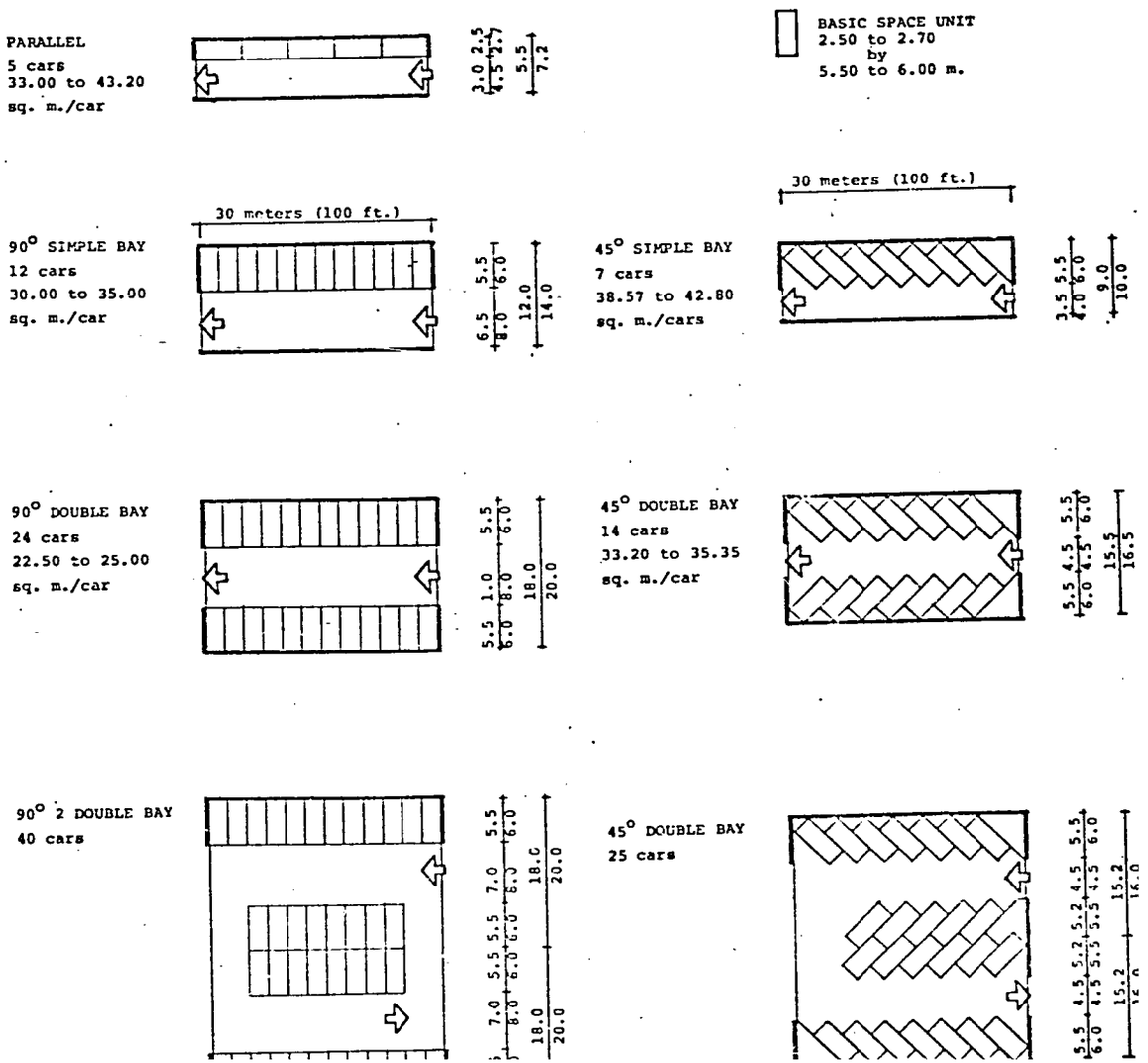
Recommended distances from the parking facility to the most remote dwelling unit vary between 60 meters and 150 meters.

Since these facilities do not produce income from the land set aside for parking, it is recommended that land with potentially low economic value be reserved for this purpose; maintaining convenience of access.

parking classification

1. PRIVATE (within individual lots) (Not included in study)
2. PUBLIC
   A. ON street
   B. OFF street

PARKING BAYS



43. WATER SUPPLY, WASTEWATER SYSTEMS: SANITARY SEWERAGE, STORM DRAINAGE

Water supply and wastewater systems (sanitary sewerage and storm drainage) are interdependent in metropolitan areas. The World Health Organization strongly recommends that water supply, sanitary sewerage, and storm drainage be considered as a unit and their co-ordinated planning be an integral part of the metropolitan plan [41: p. 32, 37].

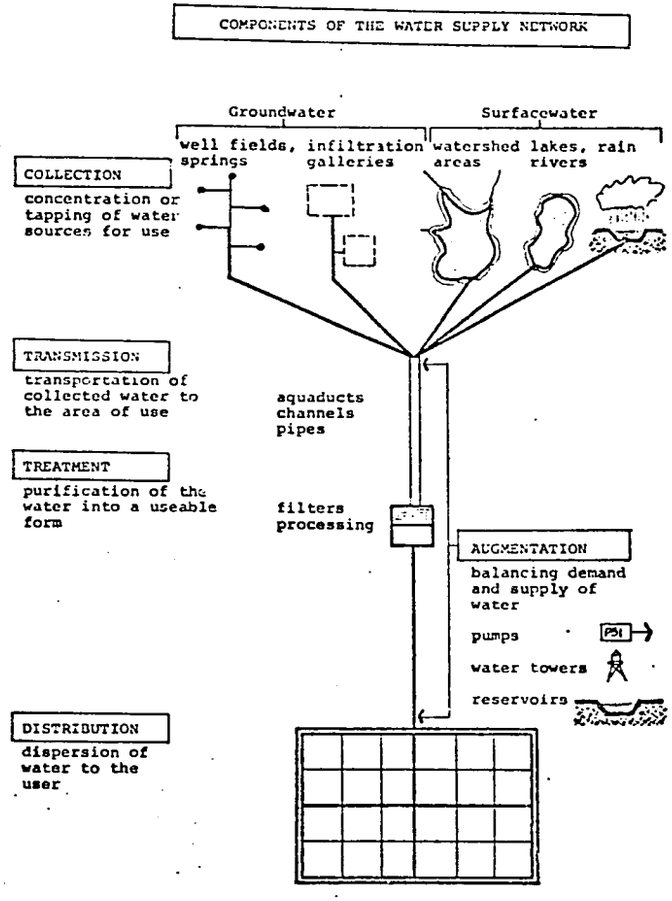
The information included here is rather summarized and should be used only for reference, ranges, or to clarify criteria.

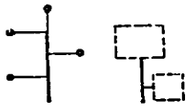
DEFINITIONS

WATER SUPPLY(*) - means (system) for supplying water (as for a community) usually involving reservoirs, pipelines, and often the watershed from which the water is ultimately drawn.

The COMPONENTS of the water supply system are illustrated in the following figures: [19: pp. 12-24]

-Water Supply Network Diagram (fig #).
-Collection Components Chart (fig #).
-Transmission Lines (fig #).
-Treatment Systems (fig #).
-Augmentation Components Chart (fig #).
-Distribution Systems Chart (fig #).
-Distribution Components Chart (fig #).





COMPONENT:	WELLS, SPRINGS, INFILTRATION GALLERIES	WATERSHED AREAS	LAKES, RIVERS	RAINFALL
FUNCTION:	receives water from underground seepage	receives water from surface runoff	receives water from natural collection source	receives water from rainfall
RESPONSIBILITY:	dependent on scale; large scale developer furnishes; small scale individual	developer installs, finances and maintains as needed	developer finances as needed	usually individual responsibility
CONTROL:	collection systems deeded to	city in all cases regional board controls	regional board controls	individual controls
CHARACTERISTICS:	system dependent on soil and geological conditions; generally used for individual use best for large lots over 1,000 m^2	size is dependent on rainfall, evaporation rate, and runoff hilly terrain is best for use of the catchment area a 25-50 year design period	most common system for very large urban areas	rarely used in urban areas only used if no other alternative
SCALE OF DEVELOPMENT:	densities less than 10/p/ha. if individual; suburbs 25,000 to 50,000 population if city system	supply determines scale cities over 500,000	purification cost determines scale; cities over 500,000	usually individual dwellings
EXAMPLE OF USE:	Memphis, Tennessee	New York, Boston	Chicago	Bermuda
ADVANTAGES:	low cost	large scale econmical supply	unlimited supply	
DISADVANTAGES:	pollution danger; forced to connect to city system if individual well; wells drop water table level	dry seasons may affect supply; may require long distance transmission lines	may be highly polluted	dependent on weather; dry seasons may limit supply

TRANSMISSION LINES

COLLECTION - TRANSMISSION - TREATMENT - DISTRIBUTION

COMPONENT: Transmission lines

FUNCTION: conveys water from collection source to area of use; generally from watershed areas or distant lakes not used in connection with wells, adjacent lakes.

RESPONSIBILITY: developer finances and installs

CONTROL: deeded to city

CHARACTERISTICS: generally composed of pipe sizes over 24" or large covered channels; 48" not an uncommon size of pipe. For this use, New York City uses 180" & 204" pipe.

gravity flow systems mostly used and are the most economical. Sometimes the water is pumped if necessary. 20-25 yr. design period.

transmission lines should be kept to a minimum in length because of the high cost for installation.

SCALE OF DEVELOPMENT: determined by supply available, distance determined by the size of pipe and resultant pressure loss of transmission lines.

TREATMENT SYSTEMS

COLLECTION - TRANSMISSION - TREATMENT - DISTRIBUTION

COMPONENT: Filtration plant

FUNCTION: renders water in a more desirable form for consumption. generally water from lakes, rivers and watershed areas require treatment.

RESPONSIBILITY: developer finances and installs

CONTROL: deeded to city; American Public Health Service controls quality in the U.S.

CHARACTERISTICS: treatment process consists of removing solids and purifying. Objectionable taste, odor, temperature and color are altered to desired quality of water.

a service storage system is generally used to store the water supply after purifying.

prime but remote areas may be developed by staging the filtration system. Only initial needs are met; they may then be economically annexed by the city as expansion occurs.

initial costs are high.

20-25 year design period

STEPS IN PROCESS OF TREATMENT:

aeration: oxidation of iron, removal of CO_2 and other dissolved gases, and addition of oxygen to water

sedimentation: settling out of heavy suspended matter; process speeded by addition of $ALSO_4$ to coagulate colloidal matter

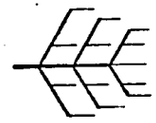
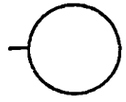
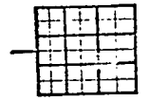
filtration: removal of solid particles

disinfection: addition of chemical which kills bacteria causing disease; usually chlorine is used.

Treatment plants generally have a capacity of 1/2 to 1/3 of the required capacity for the system.

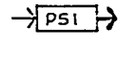
SCALE OF DEVELOPMENT: Limited by supply and cost which developer is willing to assume.

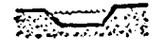
DISTRIBUTION SYSTEMS

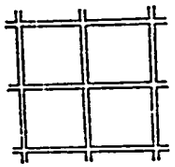
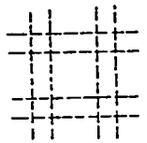
	Tree system	Radial system	Grid system
COMPONENT:	Tree system	Radial system	Grid system
RESPONSIBILITY:	developer	finances and installs	
CONTROL:	deeded to city	in all cases	
CHARACTERISTICS:	usually in low density, outlying regions. dead ends need constant flushing to prevent bacterial growth min. main: 8" with 2", 4" or 6" feeders (USA) usually a single main trunk, reducing in diameter as the pipes are located farther from the source.	surrounds several city blocks usually includes backup feeder pipes to augment flow	most common system in urban areas a hiearchial system, nested sizes increase as system grows in scale. system is composed of tree and radial networks.
SCALE OF DEVELOPMENT:	Best for a linear city growth pattern	relatively small scale	relatively large scale
ADVANTAGES:	avoids duplication of large feeder lines	provides flow backup if break occurs, allows easy maintenance, fits pattern of streets easily.	
DISADVANTAGES:	water liable to quick stagnation No cross connections in reserve for repairs usually difficult to size for fire flows		Many duplicate lines No clear idea as to how water flows in system

AUGMENTATION





	BOOSTER PUMP	WATER TOWER	WATER TANK	RESERVOIRS
COMPONENT:	BOOSTER PUMP	WATER TOWER	WATER TANK	RESERVOIRS
FUNCTION:	increase of line pressure for better service	communal scale backup supply; provides pressure also;	individual scale backup supply: also provides house pressure backup	stores water till use, controls fluctuations in supply and pressure
RESPONSIBILITY:	developer finances and installs		individual	developer installs
CONTROL:	deeded to city	deeded to city	individual	deeded to city
CHARACTERISTICS:	generally raises pressure to increase distance and height of flow used to maintain required pressure	pumps are used to fill towers regulate flow if service is irregular or pressure varies capacity: one to three day supply also used for fire storage standard tanks are 50' diameter at 1 million gallons and 90' diameter at 2 million gallons welded tanks available at 50,000 to 500,000 gallons	pressure when available fills tanks regulates flow when service is highly irregular or pressure drops during peak conditions capacity: one days supply	usually covered to keep out impurities one to three day storage required supply also used for maintenance of the fire supply generally position on high elevations filled by pumping or transmission line pressures

			ACCESS POINTS		
			INDIVIDUAL	COMMUNAL	
COMPONENT:	DISTRIBUTION MAINS	DISTRIBUTION LINES	SERVICE LINES	STANDPIPES	FLOW METERS
FUNCTION:	Supplies water to distribution lines	supplies water to house lines	supplies water to individual dwellings	supplies public faucet	controls flow of water
RESPONSIBILITY:	developer finances and installs, if oversized (for expansion) city usually contributes to costs		house lines are individual	installed by city or developer	individual
CONTROL:	deeded to city in both cases		house lines are individual	deeded to city	
CHARACTERISTICS:	pipe sizes 12" and over are considered mains (U.S.) max. pressure of 130 psi, 40 average, 20 psi min. sized with 250 gpcd capacity usually cast or spun iron; asbestos-cement, pvc or reinforced concrete also used designed for peak daily flows 20-25 year design capacity average miles of mains per 1000 population: 2.6: range: 0.7 to 5.3 in small communities	generally pipe sizes of 6"; also 2", 4" and 8" pressure ranges from 20 to 60 psi, 40 average designed for peak hourly flows 2": not suitable for extension; 4": not suitable if growth of demand; 6": for bulk flows, extensions 8": for reinforcement lines	3/4" min. house pipe USA Code; to 1 1/2"; sometimes 1/2" min. pressure 8 psi for fauc flow capacity varies from 20 to 150 gpcd (US) copper most common pipe; steel, lead and pvc also used in pipes designed for probability of use per minute designed for full use	pipe size determined by expansion potential capacity of 1.5 to 5 gpcd, dependent on distance from standpipe. 5 gpcd standard designed for temporary use of full development	use of meters cuts use of water by approximately one-half requires extra pressure for operation, high friction loss first cost is high, $35-70 (US) recommended when cost of operation high, quantity of water limited, and treatment of water required
SCALE OF DEVELOPMENT:	400/600 meter distribution grid	each block of development	individual dwelling	100 to 300 meter	

DISTRIBUTION COMPONENTS

FREE FLOW CONNECTIONS	FIRE HYDRANTS	VALVES
allows use of any amount; controls by cost of water	accessible water sources to smother fires	provides maintenance and failure cutoffs
	installed by developer	
flat rate of water per time unit	deeded to city	
usually higher water use than if with metered by a factor of 2	may only be placed on 6" pipe for adequate flow capacity	usually placed at intersections
does not require extra pressures for operation	pressures of 20 to 60 psi allowed if fire department have pumper trucks; pressures above 60 psi necessary if no truck augumentation available	spacing is 100 m to 200 m.
no installation costs	fire flows of approximately 175-250 gpm required, dependent on size of community and value of area	
recommended if there is an inefficient collection and reading service and if water is relatively cheap and available	spacing of hydrants from 60 m. to 125 m., dependent on property value; usually placed at street intersections	

CONSTRUCTION COSTS for water supply systems vary from $300 per capita in the USA (1965) [36: p. 2-26] to $25 per capita in developing countries (1962) [38: p. 54]. The total construction cost of a water supply system is distributed approximately as follows: [36: p. 2-26]

-Collection-Transmission: 25%

-Purification-Treatment: 10%

-Distribution: 50%

-Service Lines, Meters: 15%

The AVAILABILITY of existing/proposed water distribution systems in relation to a prospective site is an important factor in site selection [8: p. 45] (See: LOCATION).

ALTERNATIVES for supplying water to a site are the same whether the site is within a major distribution grid (as in an urban area) or outside a major grid (as in a newly developed fringe area). The alternatives are: [19: p. 20]

-Connection to an existing distribution network.

-Development of a new central distribution network.

-Development of individual water supply systems.

The following chart (fig #) illustrates the water supply components necessary for each of these alternatives. [19: p. 21]

REQUIRED COMPONENTS

WATER SUPPLY SOURCE

	EXISTING WATER SYSTEM	NEW SYSTEM	INDIVIDUAL SYSTEM
COLLECTION	not applicable	best source from rivers, lakes. well fields are more expensive	wells, cisterns
TRANSMISSION	(required if outside distribution area)	transmission lines should be minimized because of cost	not applicable
TREATMENT	not applicable	must meet U.S. public health standards	(sometimes chlorine treatment necessary)
DISTRIBUTION	connection of new system of mains and services to existing grid; might require pressure boost pumps	new distribution grid of mains and services must be laid	pumped flow to dwelling required
SCALE OF DEVELOPMENT	limited by city supply available; min. economical density: 10/ha.	limited by water supply and amount invested; min. economical density 10 p/ha.	individual lots; less than 10 p/ha.
ADVANTAGES:	lower costs, a proven reliable system	no dependence on city system if the supply is inadequate or faulty	an economical supply
DISADVANTAGES	if city supply is faulty, reliance on bad system	high first cost; duplication of city system	seasonal variation possible, danger of pollution, must tie-in with city

The CAPACITY of existing/proposed water distribution systems adjacent/available to a site should be adequate to carry the load of the proposed settlement as well as future developments in the areas served by the system. If connection to a public system is possible, the developer should ascertain its capacity from the appropriate local authority [8: p. 45]. The development of a site may be precluded when its prospective water supply is either unavailable or of inadequate capacity.

The capacity of a water distribution system to serve a site is a function of: [36: p. 13-4]

-QUANTITY (rate of draft) of the water it provides to the site.

-PRESSURE of the water in the system at the site.

Most water supply and wastewater disposal systems include relatively massive structures (dams, reservoirs, treatment works, and extensive piping) which take a long time to construct and are not easy to expand. Selecting the CAPACITY of these systems is not simple. Among the needed estimates are the following: [36: p. 5-2]

-Period: the number of years for which the proposed system and its components are to be adequate; see (fig #) for periods often employed in practice.

Table 5-1 Design Periods for Water and Wastewater Structures

Type of Structure	Special Characteristics	Design Period, Year
Water supply		
–Large dams and conduits	Hard and costly to enlarge	25–50
–Wells, distribution systems, and filter plants	Easy to extend	
	When growth and interest rates are low*	20–25
	When growth and interest rates are high*	10–15
–Pipes more than 12 in. in diameter	Replacement of smaller pipes is more costly in long run	20–25
–Laterals and secondary mains less than 12 in. in diameter	Requirements may change fast in limited areas	Full development
Sewerage		
–Laterals and submains less than 15 in. in diameter	Requirements may change fast in limited areas	Full development
–Main sewers, outfalls, and interceptors	Hard and costly to enlarge	40–50
–Treatment works	When growth and interest rates are low*	20–25
	When growth and interest rates are high*	10–15

* The dividing line is in the vicinity of 3% per annum.

-Population: the number of people to be served.

-Flows: the rates of water use and wastewater release in terms of per capita consumption and sewage discharge.

-Area: the area to be served and the allowances to make for population density and areal water consumption and wastewater release from residential, commercial, and industrial districts.

-Hydrology: the rates of rainfall and runoff for storm and combined sewerage.

The QUANTITY of water demanded in an area is a function of such existing/estimated factors as: [19: p. 25, 30, 31]

-Population: as population increases, demand for water supply increases.

-Land Use and Intensity of its Use: industrial, commercial, and residential areas will have varying demands; there may be variations between high, medium, and low income residential areas; as the density of an area increases, the demand for water in that area increases.

-Local Climatic Conditions: extremes of heat and cold increase consumption; arid areas require a larger water supply than areas with high rainfall.

-Habits of People: culture, living patterns should not be neglected as factors.

-Mechanical Systems: seasonal demand for air conditioning can increase water use by as much as 5 to 7 times normal usage; installation of sewers increases water use by 50% to 100%; installation of meters can decrease water use by 50%.

-Fire Flows: and not demands for per capita consumption determine the size and supply of US water supply systems (especially those in small towns); this is true even though the quantity of water used yearly for fire fighting is small; oversizing the system for fire flow standards can represent up to 40% of today's piping costs.

-Pressure: with high pressure, more water is used and more is wasted through pipe leakage and faucet overflow.

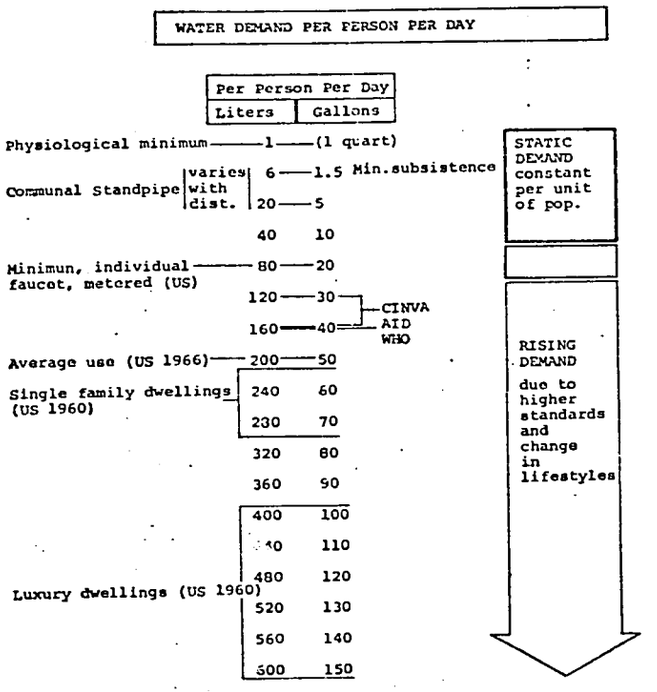
-Water Quality: better quality water instills confidence in its users and is used in greater quantities than poorer water.

-Cost of Water: slight variations of water use are noted with water costs.

The quantity of water used for domestic purposes in the USA is distributed approximately as follows: [19: p. 29]

-Flushing toilets:	41%
-Washing and bathing:	37%
-Kitchen use:	6%
-Drinking:	5%
-Washing clothes:	4%
-General household use:	3%
-Gardening:	3%
-Car washing:	1%

Ranges of the quantities of water demanded per person per day are illustrated in the following chart (fig #) [19: p. 27].



Range of use in the United States: 35 to 546 gallons/person/day
Range of use in England: 20 to 40 gallons/person/day

Variations in quantity of water demanded occur: [36: p. 5-16]

-Seasonally: major peaks occur during summer heat, drought; minor peaks occur during extreme winter cold.

-Daily: peaks on weekdays; troughs on week ends.

-Hourly: peaks at noon; troughs in the early hours of the morning.

-In addition there must be suitable allowances for sudden, heavy, unpredictable drafts to fight fires.

The quantity of water demand is measured in: [19: p. 26]

-Gallons per capita per day (gpcd); liters per capita per day (lpcd): usual means of measurement.

-Acre feet of water: used to measure storage areas, reservoirs.

-Gallons per minute (gpm); liters per minute (lpm): rate of water draft.

The PRESSURE applied to water in a system determines the rate of flow (velocity) of the water in that system. Pressure is lost through friction from the pipe walls, fittings, and bends. Indirectly, pressure determines the distance water will flow through a given pipe. For example: a 6" pipe will serve dwellings for a distance of X meters at Y pressure; if the pressure is doubled, 2Y will serve dwellings for a distance of 2X meters. Two ways to develop pressure are: [19: p. 34]

-Elevation: gravity provides the potential energy.

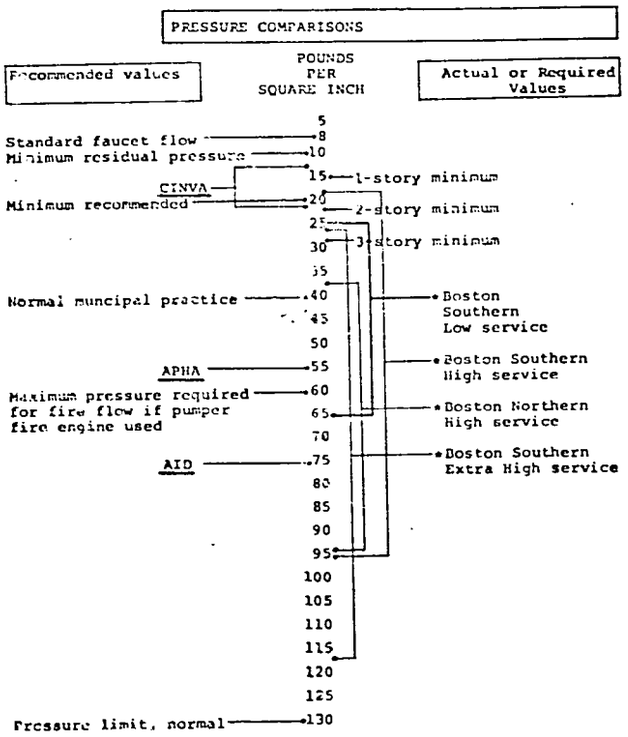
-Pumping: energy is induced artificially through mechanical means.

A comparison of pressures recommended by existing standards is illustrated in the following diagram (fig #): [19: p. 36]

-CINVA standards do not include fire flow conditions, but are reasonable for use in developing countries from the technical installation and consumption demand aspects.

-APHA standards (USA) include fire flow conditions, but pumpers would be required.

-AID standards are impractical for low income developing areas. Although the fire pressure would be adequate without expensive pumping equipment, the necessary installation skills, additional piping expense, and the increased water consumption (and waste) make these standards unrealistic for developing countries.



*High services are areas where elevation changes force higher than normal pressures in order to reach the peak elevations; elevation changes of more than 200' normally require separate service areas.

Criteria for PRESSURE REQUIREMENTS includes: [19: p. 35]

-Minimum pressure of 8 psi (the amount needed for faucet flow) should be available at the farthest reaches of the network for satisfactory service.

-Minimum standard pressure in USA is 20 psi at the street line to overcome frictional resistance in the house distribution system.

-Pipes should be sized to achieve minimum pressure loss. Larger pipes allow greater lengths, because they offer less frictional resistance and, thus, less pressure loss.

-Pressures over 60 psi: are not needed for fire flow; induce high leakage losses in a system; and necessitate stronger, more costly pipe. The higher the pressure, the more water will be consumed.

-130 psi is considered to be the upper pressure limit.

Water pressure can be measured in terms of: [19: p. 34]

-Feet of head: historical measure from gravity source.

-Pounds per square inch (psi): pressure per unit area.

-Kilograms per square centimeter: metric pressure per unit area.

The QUALITY of the public water supply is a major function of the quality of the public health. "Water to be used for a public supply must be potable/drinkable. However, water should not be chemically pure; water devoid of dissolved and suspended matter is neither palatable nor hygenic. Water that is ideal as a beverage may not be suitable for all other purposes such as: washing, bathing, ice making, paper manufacturing, etc. [37: p. 385].

The quality of water may deteriorate after treatment for various reasons. In a distribution system, the quality may be affected by: [37: p. 375]

-Corrosion of pipes.

-Flushing, which dislodges foreign matter.

-Ingress of dirt and living organisms through leaks.

-Cross-connections, which permit the flow of nonpotable water into a conduit containing potable water.

-Aftergrowth of organisms: bacteria, algae, etc.

-Solution of metals with which the water comes in contact.

WATER QUALITY STANDARDS promulgated in USA by the U.S. Public Health Service, 1962 cover: [36: p. 19-17, 19-18]

-WATER SOURCES and their PROTECTION: general rules.

-BACTERIOLOGICAL QUALITY: specific rules.

-PHYSICAL CHARACTERISTICS: acceptable limits.

-CHEMICAL CHARACTERISTICS: acceptable limits.

U.S. PUBLIC HEALTH SERVICES DRINKING WATER STANDARDS, 1946 [34: pp. 622-625]

A. Standards for WATER SOURCES and their PROTECTION: outline general rules for water sources and define required anti-pollution controls. "Approval of water systems is subject to close enforcement of sanitary precautions, proper operation by qualified personnel, adequate capacity to meet peak demands without danger, reliable recording of analytical results, and compliance with quality standards" [36: p. 19-19].

Water supply shall be obtained from a source which is:
-Free from pollution, or
-Adequately purified by natural (physical, biological) processes, or
-Adequately protected by artificial treatment.

The water supply system should be free from:
-Sanitary Defects: faulty location, design, or construction of water works which may prevent water purification.
-Health Hazards: faulty operating conditions which endanger water purification.

B. Standards for BACTERIOLOGICAL QUALITY: define the quality of water supply in terms of the most probably number of coliform bacteria present. Official evaluations of bacteriological quality are to be based on quantitative tests for the presence of coliform bacteria performed by state health agencies, local government laboratories, water works authorities, or approved commercial laboratories [36: p. 19-18].

The frequency of SAMPLING and the location of sampling points on the distribution system should be such that the bacteriological quality of the water supply can be accurately determined. The minimum number of water samples to be collected and examined each month shall be in accordance with the population served as shown below [36: p. 19-18].

POPULATION	SAMPLES PER MONTH
to 2,000	2
10,000	12
50,000	50
100,000	95
900,000	300
2,000,000	400
4,500,000	500

C. Standards for PHYSICAL CHARACTERISTICS: establish limits for the turbidity, color, taste, and odor which are acceptable in drinking water.

The physical characteristics of a public water supply should be examined at least once a week to determine its acceptability in terms of the following limits:
-Turbidity: caused by suspended solids; shall not exceed 10 parts per million (ppm) on the silica scale.
-Color: caused by organic matter/minerals in solution; shall not exceed 20 parts per million (ppm) on the platinum-cobalt scales.
-Taste/Odor: caused by algae, decomposing organic matter, dissolved gases, industrial wastes; shall not be objectional.

D. Standards for CHEMICAL CHARACTERISTICS: establish limits for the amounts of soluable mineral substances and residual treatment chemicals which are safe/acceptable in drinking water.

The presence of the following (poisonous) substances in excessive concentrations constitutes grounds for rejection of the supply: lead, fluoride, arsenic, selenium, and hexavalent chromium. Salts of barium, hexavalent chromium, heavy metal glucosides, or other substances having deleterious physiological effects shall not be used in water treatment.

The following chemical substances (present in natural or treated waters) should not occur in excessive concentrations, especially where other more suitable supplies are available: copper, iron, manganese, magnesium, zinc, chloride, sulfate, and phenolic compounds. Total solids in water of good chemical quality should not exceed 500 ppm, but 1000 ppm may be permitted if such water is not available.

For chemically treated waters (lime softened, zeolite/ion exchange treated waters, etc.) specific requirements concerning alkalinity should be met.

The OWNERSHIP/CONTROL/ADMINISTRATION of water supply can be: [37: pp. 582-583]

-Private: organized as a corporation, partnership, or single owner.

-Public: organized as an autonomous department of a city government or as a department which is subordinate to another such as public works; either being responsible directly to the mayor, a board of commissioners, or the people.

According to the World Health Organization (WHO), the most efficient maintenance and operation of water supply or wastewater disposal systems occurs under an agency having central control over the entire area served. "In a metropolitan area consisting of more than one municipality, water and sewerage authorities, with central purchasing and repair services, can operate more economically than separate smaller municipal agencies. Centralized operation has the added advantage of making it economically possible to include highly skilled engineers and technicians on the staff.

"All the public utilities in the metropolitan area can be combined into one central organization; experience in one metropolitan area with the consolidation of operation and maintenance functions for a number of public utilities, including water, sewerage, electricity and telephone services, has proved encouraging, and this type of organization may be worth considering in other areas of the world" [41: p. 35].

FINANCING a water supply or wastewater disposal system can be accomplished by: [37: p. 601-611]

-Direct Taxation: seldom used for self-supporting services such as water works.

-Special Assessments: levied against property to pay for improvements that are of direct benefit to the property assessed.

-Revenue Bonds: may be issued by privately or publicly owned systems; use revenues from water supply and physical value of works as security.

-Issuance of Stock: usually by privately owned waterworks, raises capital for the development of a water supply, which can be leased/sold to the city.

-Mortgage Bonds: may be sold to the public, usually by privately owned waterworks, as shares of the mortgage which resulted from the hypothecation of the physical assets or anticipated income of the works.

-Government Grants and Loans: may be awarded to contributing and self-supporting waterworks, especially during periods of economic emergency or to encourage water conservation.

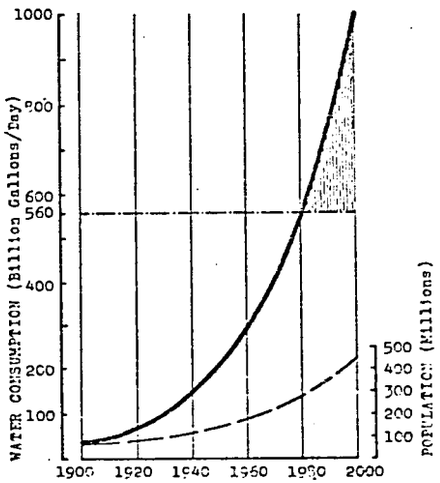
The principal source of REVENUE for water supply and wastewater disposal systems comes from the sale of water [37: p. 605]. This self-liquidating attribute of water supply (and sewerage) is extremely important in justifying the considerable outlay of capital usually required. Water rates and sewerage charges must be determined properly but fairly for operation, maintenance, and amortization. A practical method for collecting sewerage charges has been to make them a percentage of the water charges [41: pp. 33-34].

APPENDIX

THE WATER CRISIS

The world's fresh water supply is limited; and, there is an increasing demand for that water. The following graph illustrates the balance between total available water and the demand for water in the US from 1900 to 2000 (fig #).

(FIG #) U.S. WATER BALANCE [35:p.424]



KEY:

Water Consumption Growth

Population Growth

Total quantity of water available from all natural sources.

Water consumption which can only be met through water re-use.

The rapid growth of both population and water consumption has sharply increased the need for the re-use of water by all non-consumptive uses (industries) and increased the need for control over the consumptive uses (artificial irrigation) [35: p. 424].

Existing water usages should be evaluated and improved to make more efficient uses of water. Wasteful uses which should be improved include:

-Artificial Irrigation: accounted for approximately 50% of US water consumption (1960); consumed nearly all water in many developing countries [35: pp. 423, 424].

-Industrial Uses: accounted for approximately 40% of US water consumption (1960); and, are taking an increasing share of the world's water, while at the same time, multiplying the pressure of pollution on natural sources [35: pp. 424, 425].

-Domestic Use: "since water works were introduced in European and American cities, the quantities of water each citizen takes and consequently thinks he needs have been constantly mounting" [40: p. 158].

-Water Closet Sewage Systems: consume over 40% of US domestic water supply.

"It is sheer good fortune that, as far as we know, water is not lost to the globe, but recirculates in the hydrological cycle of nature, but unfortunately not as fast as we manage to use it. This explains why today on all continents an annual net loss of water can be registered. Furthermore, the quantity of this net loss is mounting with each passing year" [40: p. 175].

"In the broad sense, water is a renewable resource. It circulates on the Earth in a complex series of pathways known collectively as the hydrological cycle (fig 4). The oceans serve as the principal reservoir, from which an estimated 875 cubic kilometers (ck) evaporate per day. About 775 ck return to the ocean through condensation and precipitation, there being a net windborne transfer of some 100 ck from the seas to the land. About 260 ck daily fall upon the land, 100 ck of which are blown in from the sea and 160 ck have been previously evaporated from the land. The cycle is balanced by about 100 ck of daily runoff from the land to the sea via the streams, rivers, and flow of ground water. But even though it circulates, the finite supply of fresh water still places limits on the number of people that can be supported, both in specific locations and on the Earth as a whole" [40: p. 133] [49: pp. 63-64].

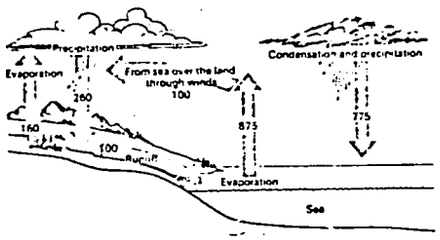


FIGURE 4-3
Hydrological cycle (in cubic kilometers per day). (Data from Borgstrom, *Too Many*, Macmillan, New York, 1967).

WATER POLLUTION [49: p. 126-128]

"In many communities direct threats to human health arrive through the faucet. The drinking water that flows from the tap in some localities has already passed through seven or eight people." Through chlorination and filtration this water should be safe to drink. "Unfortunately, the water in many US cities is often unsafe to drink. Although proper chlorination may help, there is growing evidence that high contents of organic matter in water can somehow protect viruses from the effects of chlorine. Infectious hepatitus is spreading alarmingly in the United States, and a major suspect for the route of transmission is the 'toilet-to-mouth pipeline' of many water systems not made safe by chlorination.

"As the populations of many municipalities grow, their sewage treatment facilities, though once adequate, are quickly outgrown. Funds for new facilities can be obtained only at the expense of those needed for better schools, police departments, water systems, roads, and other public services. Inevitably, it seems, the available funds are insufficient to meet all these needs, which are created in part by increases in population. Lax inspections and public health standards permit construction of septic tanks too close together or in unsuitable soils in many of the rural and suburban areas where there are no general sewage facilities.

"As population grows so does industry, which pours into our water supplies a vast array of contaminants: lead, detergents, sulfuric acid, hydrofluoric acid, phenols, ethers, benzenes, ammonia, and so on. As population and industry grow, so does the need for increased agricultural production, which results in a heavier water-borne load of pesticides, herbicides, and nitrates. A result is the spread of pollution not just in streams, rivers, lakes, and along seashores, but also (and most seriously) in groundwater, where purification is almost impossible. With the spread of pollution goes the threat of epidemics of hepatitus and dysentery, and of poisoning by exotic chemicals.

"Water pollution with sewage provides one of the classic examples of diseconomies of scale accompanying population growth. If a few people per mile live along a large river, their sewage may be dumped directly into the river and natural purification will occur. But if the population increases, the waste-degrading ability of the river becomes overstrained, and either the sewage or the intake water must be treated if the river water is to be safe for drinking. Should the population along the river increase further, more and more elaborate and expensive treatments will be required to keep the water safe for human use and to maintain desirable fishes and shellfishes in the river. In general, the more people there are living in a watershed, the higher the per capita costs of avoiding water pollution will be."

WATER SUPPLY IN DEVELOPING COUNTRIES [38: pp. 10-16]

Water supply is a critical factor in public health and economic development in most parts of the world, particularly in developing countries. In 1963, the World Health Organization studied the urban water supply conditions and needs of developing countries in Africa, Asia, and Latin America. Very considerable shortages in urban water supply were reported for nearly every country as illustrated in the included charts (fig #). The factors exerting the greatest effect on urban water deficiencies in most developing countries were identified as follows:

-Although the improvement of water supplies depends largely on governmental support, many governments have not made water requirements a matter of government policy.

-Schemes for community water supply are often not included in national development plans.

-Urban water needs are often insufficiently represented in the general development of water resources because no priority policies have been established and no general master plans are in effect.

-The most significant factor is the lack of adequate financial support.

-Inept and inadequate operation and management, lack of an effective administrative machinery and a lack of a technical staff to promote and design water supply systems and to improve existing systems are additional handicaps.

-The legislation is inadequate, water rights are poorly defined, and clear definition of responsibilities is lacking.

-The role of ministries of health in community water supply are not always clearly defined.

As a result of the factors listed above, over 70% of the urban population of developing countries has an inadequate piped water service, or is being supplied with unsafe water, or both. Unless these deficiencies are eliminated, present shortcomings will continue to exist and even worsen with rapid population expansion. Where piped water is unavailable, people turn to sources that are likely to be unsafe, exposing themselves to various water-borne diseases.

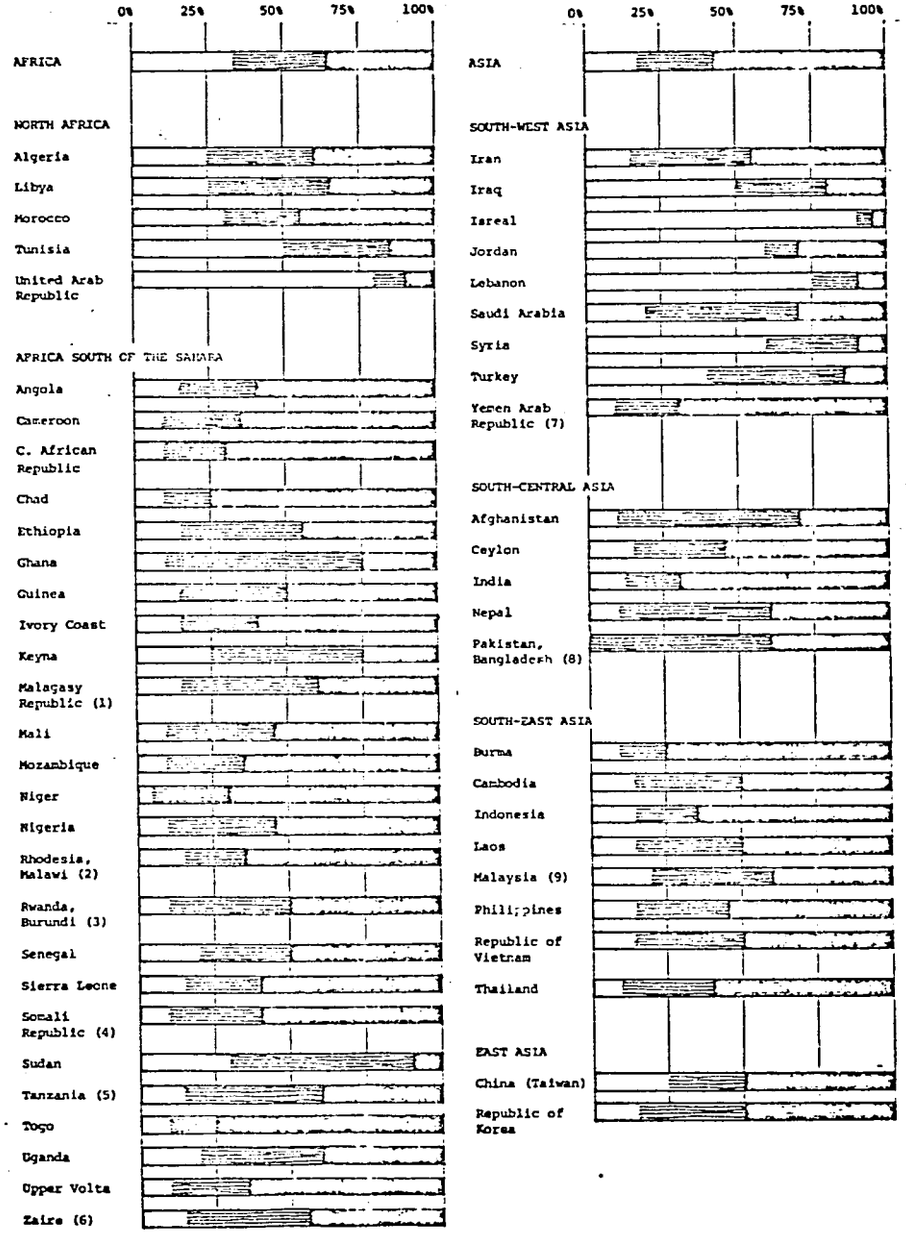
FIGURE # WATER SUPPLY IN DEVELOPING COUNTRIES

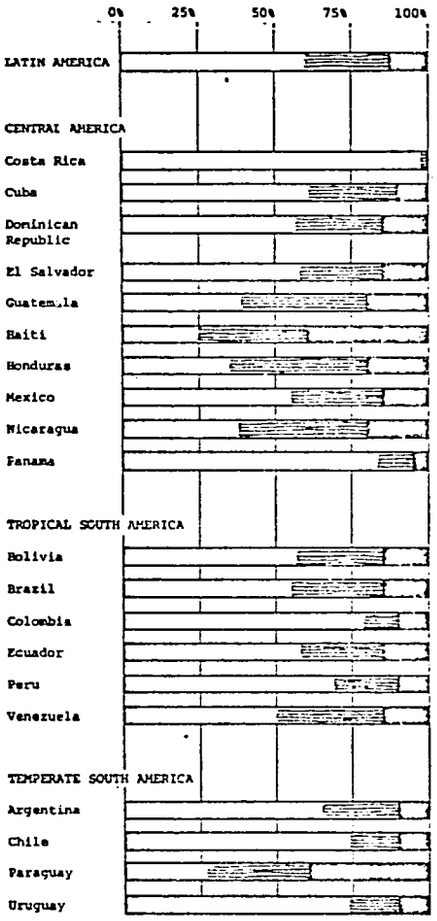
KEY - PERCENTAGE OF HOUSEHOLDS:

-With House Connections

-With Public Outlets

-Not Served





NOTES: The names of several of the developing countries studied by the World Health Organization have changed since the date of the study, 1962. These names in 1962 were:
(1) Madagascar
(2) Federation of Rhodesia and Nyasaland
(3) Ruanda-Urundi
(4) Somalia
(5) Tanganyika
(6) Congo (Leopoldville)
(7) Yemen
(8) Pakistan (East and West)
(9) Federation of Malaya

METHODS FOR REDUCING WATER CONSUMPTION AND THE COSTS OF SUPPLY

A. WATERLESS TOILET SYSTEMS: could reduce US water consumption by up to 40%.

Promising innovations in this area include: [39: p.32]
-The Vacumatic System: employs a vacuum flushing toilet, which uses about 5% of the water required by conventional toilets, reducing sewerage collection and treatment as well as reducing water waste.
-Self-contained Toilet-incinerator: uses no water, but requires fuel for burning the sewage and can contribute to air pollution.
-Closed Recirculating System: requires very infrequent water supply and releases no sewage outside the system, reducing water supply and wastewater disposal requirements.

B. WATERLESS FIRE FIGHTING: using foams or fogs could reduce the costs of water distribution to about 60% of today's piping costs; and, since fire reserves would no longer be necessary, more water would be available for consumption [39: pp. 34, 35].

C. WATER FLOW-LIMITING DEVICES: which are designed not for billing purposes but to eliminate water waste, are needed.

In the present state of water meter development, the metering of all connected customers is far from ideal, especially in developing countries. However, a durable, inexpensive flow-limiting device could be most useful for the minimum connected customers (those having only one faucet/dwelling). By lowering water system construction costs through water waste control and by reducing operating costs relative to a metered system, such a device could increase the number of dwellings connected and reduce the number of public hydrants [38: pp. 29-30].

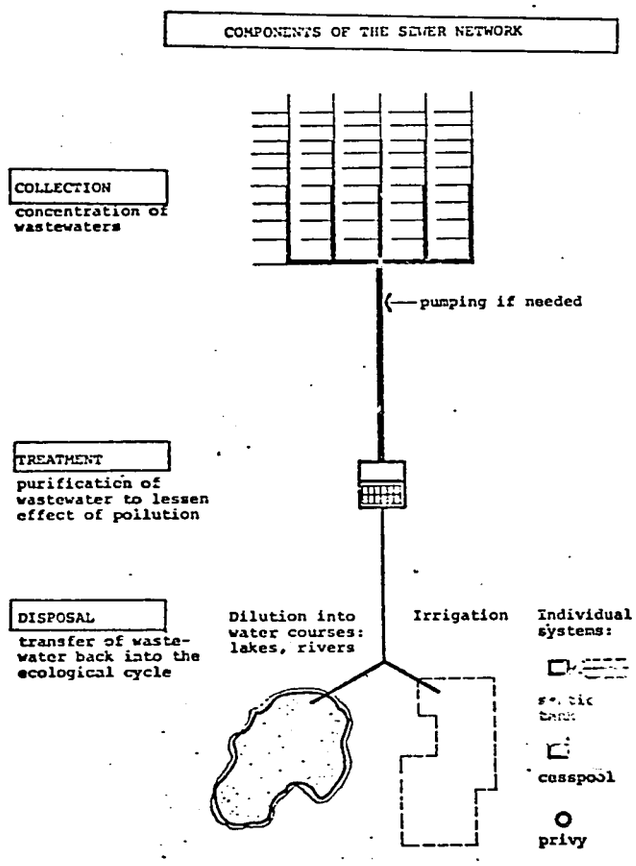
44. SANITARY SEWERAGE

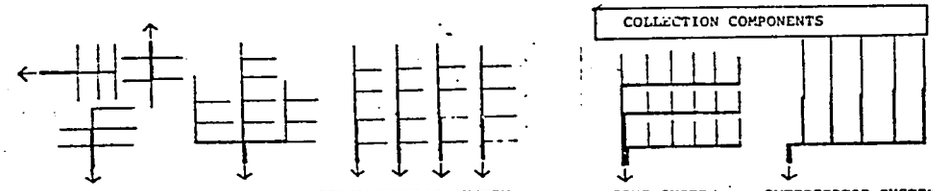
DEFINITIONS

WASTEWATER SYSTEMS (Sewerage or Drainage Systems) are structures for the collection, treatment, and disposal of sanitary sewage (domestic and industrial wastewaters) and/or stormwater runoff. When sanitary sewage and storm waters are collected in the same sewer system, it is called a combined system of sewerage; and, when they are collected separately, in SANITARY SEWERAGE and STORM DRAINAGE, it is a separate system of sewerage. Combined sewerage is common in the older cities of the world (London, Paris, New York, Boston), where they evolved from existing systems for storm drainage [36: p. 3-1].

SANITARY SEWERAGE(*) - the system of artificial usually subterranean conduit to carry off sewage (composed of Excreta: waste matter eliminated from the human body; Domestic Wastes: used water from a home/community containing 0.1% total solids; and some Industrial Wastes [34: p. 167]) but not water from ground, surface or storm.

The PRIMARY PURPOSE of the sanitary sewer network is to transport and dispose of human wastes from each household in a safe, sanitary manner. Since a sewage disposal system is a potential source of contamination, the selection of sewerage modes should preceed the selection of modes of water supply [19: p. 98].





COMPONENT:	RADIAL SYSTEM	FAN SYSTEM	PERPENDICULAR SYSTEM	ZONE SYSTEM	INTERCEPTOR SYSTEM
RESPONSIBILITY:	developer finances and installs in all cases				
CONTROL:	systems deeded to city in all cases				
CHARACTERISTICS:	for both combined and sanitary system used for flat sites	for sanitary systems	storm sewers or combined systems rarely used for combined systems	for combined systems for irregular topographical areas	for combined systems usually sized for only small rain flows requires water course to dump storm flows which system cannot handle
EXAMPLE OF USE:	Berlin	Vienna	Manhatten, New York	Boston	Cleveland, Ohio
ADVANTAGES:	easy to expand	allows single treatment plant; concentrates flow into a single outfall	shortest route to disposal; allows direct dumping of heavy storm flows	eliminates major pumping good for flat areas	allows single treatment plant
DISADVANTAGES:	requires multiple treatment plants	difficult to expand	pollution dangers of water disposal areas requires multiple treatment plants	requires large main sewer difficult to expand	requires large sewer as main difficult to expand pollution danger

The COMPONENTS of the sanitary sewerage system are illustrated in the following figures: [19: pp. 99-105, 110]

-Sanitary Sewerage Network Diagram (fig #).

-Collection Systems Chart (fig #).

-Treatment Systems Chart (fig #).

-Disposal Systems Chart (fig #).

-Collection Components Chart (fig #).

TREATMENT SYSTEMS

COLLECTION - TREATMENT - DISPOSAL

COMPONENT: Treatment plant

RESPONSIBILITY: developer finances and installs if plant needed

CONTROL: deeded to city

CHARACTERISTICS: treatment consists of removing solids and objectionable material from water carrier to prevent pollution of outfall areas. In some cases, temperature of the effluent must be altered to match the outfall streams if streams are small in relative scale.

design period from 20 to 25 years; 10 to 15 years if interest rates are high.

PROCESS

Primary treatment: (large solids)
grit chambers
settling tanks
sludge drying beds

Secondary treatment: (suspended matter)
trickling filter
activated sludge
sand filtration

Disinfection: chlorine usually used

Lagoons are sometimes used with remarkable success; they have no odor and are simple to operate. (See following page).

SCALE OF DEVELOPMENT: Limited by the degree of purity demanded for specific situations; it is directly proportional to cost.
10,000 gpd is classified as the threshold of large systems.

LAGOONS: TREATMENT AND DISPOSAL SYSTEM

COMPONENT: Lagoons (also called oxidation ponds)

FUNCTION: the use of bacterial and algae action to digest wastes; in the cycle the bacteria converts the sewage into food for the algae which releases oxygen which the bacteria feeds on in return; the algae eat the CO_2, nitrates and other products of the bacteria process. Raw or secondary treated sewage may be the input into the lagoon.

RESPONSIBILITY: the developer is responsible for his own system, the city provides system if used for the whole area

CONTROL: city policy controls system; health laws govern

CHARACTERISTICS: minimum depth of 1 meter to prevent weeds from growing; maximum depth of 1.5 meters since the sunlight necessary for the photosynthesis action of algae does not penetrate any deeper than this; the depth should be uniform throughout.

the bottom may be paved or unpaved, sandy or soil; it may need to be paved if the input flow of sewage is less than the seepage rate and evaporation. Avoid irregular shoreline; shape is not critical in any respect.

system is balanced in size so input flow equals seepage and evaporation loss, for smaller system secondary overflow field must be provided.

should not be located near water supplies; 400-800 meters from residential area for safety reasons

supports 17 to 60 pounds/acre of B.O.D. (solids)

climate critical in location; needs sunlight, windy weather aids mixing process; if ice covered may have temporary odor upon thawing in spring

SCALE OF DEVELOPMENT: supports 100 to 500 houses per acre of pond

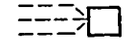
ADVANTAGES: no treatment plant needed, low cost; no maintenance problems; more efficient digester of bacterial waste, no odor, less than conventional plants; accepts raw sewage; allows pipe network with future hook-up to city service without loss; land may be reused. Approx. 1/10 to 1/50 of the cost of septic tanks.

DISADVANTAGES: requires large areas of low cost land; not efficient on cloudy days; no long term experience (25-50 years) with system; odor when system overloaded

DISPOSAL METHODS

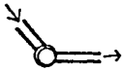
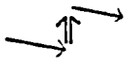
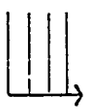
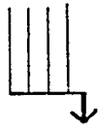
	Dilution in water courses	Irrigation fields
COMPONENT:		
RESPONSIBILITY:	developer	developer
CONTROL:	regional or local board	
CHARACTERISTICS:	may be emptied into water without treatment if diluted to 2.5 cps of water per 1,000 persons in swift streams and 10 cfs of water per 1,000 persons into sluggest streams. (6 cfs average)	May be either subsurface or surface irrigation Subsubsurface requires drain field.
EXAMPLE:	New York	Berlin
SCALE OF DEVELOPMENT:	Dependent on the size of the water course used for dumping	Dependent on soil characteristics; also on the water table and geological conditions.
ADVANTAGES:	Easy access Low cost.	A satisfactory alternative if no water courses are accessible for dumping. May be used for crops if water is scarce.
DISADVANTAGES:	Danger of pollution in the water courses.	Danger of the contamination of groundwater supplies. More expensive for municipal if no cheap land available.

INDIVIDUAL DISPOSAL



	SEPTIC TANK	CESSPOOL	PRIVY
COMPONENT:			
RESPONSIBILITY:	individual	individual	individual
CONTROL:	individual	individual	individual
CHARACTERISTICS:	requires drain field to take care of effluent system dependent on soil and geological conditions sized at 50/75 gpcd; 500 gallons minimum capacity; no storm flows allowed drain field max. length of 100' on flat site; 6' spacing of lines; 4" tile for drain; 100' from water source percolation of waste acts as treatment plant; tank stores solids min. slope of 3/4" 100 feet of drains; if too steep; drains fail	does not require drain field store effluent in large fluid filled tank where liquid slowly spees out highly dependent on soil and geological conditions	consists of hole in ground short term use only 1.5 m. min. depth treat with lime and cover with 18" of soil after use 1 seat per 15 people on communal scale
SCALE OF USE:	individual only; lots over 2 acres	indivicual only in both cases	
ADVANTAGES:		low cost	low cost, or no cost
DISADVANTAGES:	may not be used with wells; more expensive first costs than public system cannot expand easily requires maintenance	may not be used with wells pollution and disease dangers; contaminates water supplies easily; more than septic tank	

COMPONENTS

COMPONENT:	HOUSE SERVICE	COLLECTION LINES	MANHOLES	LIFT PUMPS	LATERALS	MAINS
FUNCTION:	connection for each dwelling to convey sewage to system	supplies sewage to main lines	clean out access points; velocity & pressure drop points; changes in directions	forces sewage to higher elevation to avoid deep pipe network	combines flow from collection lines	combines flow from laterals
RESPONSIBILITY:	individual	developer installs and finances	developer installs and finances			
CONTROL:	individual	deeded to city	deeded to city			
CHARACTERISTICS:	cast iron pipe becomes service line into house 4" min. size (US)	min. size of pipe is 8" (US) pipe sized by min. cleaning velocity and physical cleaning potential 6" pipe sometimes acceptable if no extensions are planned	.6 to 1.0 meter in diameter spacing of 90-120 meters if pipe under 24"; if over, may be spaced at 180 meters and up required at all bends and changes in elevation may become "drop" mannoles to protect against excessive velocity	may be optional usually duplicate pumps located in manholes requires maintenance on regular basis; usually not desirable to install	designed for 400 gcd	designed for 250 gcd the depth of this pipe is critical in the system layout, since all laterals and service lines must be above the main for economical flow
SCALE OF DEVELOPMENT:	each dwelling	each block of development	300-600 meter spacing	as needed		

CONSTRUCTION COSTS for sanitary sewerage in North America (1965) are distributed approximately as follows: [36: p. 3-30]

-Collection: 60% ($30 - $100 per capita)

-Treatment: 40% ($20 - $47 per capita)

In a COMPARISON OF CONSTRUCTION COSTS in 1965, sanitary sewerage and water supply systems related as follows: [36: p. 3-30]

-Sewage Collection Systems: half the cost of water distribution systems.

-Sewage Treatment Systems: twice the cost of water purification systems.

The AVAILABILITY of existing/proposed sanitary sewerage in relation to a prospective site is an important factor in site selection [8: p. 45] (See: LOCATION).

ALTERNATIVES for sanitary sewage collection and disposal from a site are generally: [19: p. 106]

-Connection to an existing system.

-Development of a communal system.

-Provision of/reliance on individual systems for each dwelling.

The following chart (fig #) illustrates the sanitary sewerage components required for each of the above alternatives [19: p. 107].

REQUIRED COMPONENTS

TYPE OF SYSTEM

	EXISTING SEWER SYSTEM	COMMUNAL SYSTEM	INDIVIDUAL SYSTEM
COLLECTION	connection of new system to existing city network	provision of pipe network and connection to private disposal	individual pipe service lines
TREATMENT	not required	complete plant of primary and secondary treatment lagoon may be used	not required
DISPOSAL	not required	dilution in water course, irrigation or lagoon must be provided	septic tank with drain field, or cesspool or privy must be provided
SCALE OF DEVELOPMENT	no limits if city pipe net able to handle additional capacity	usually more than 100 dwellings make communal systems economicly competitive	large lot conditions of low density; generally greater than 1500m^2; dependent on soil
ADVANTAGES	reliable system lower cost per unit; no treatment plant must be provided	no dependence on city system if inadequate	feasible alternative on small scale
DISADVANTAGES	may inherit bad system	high first costs; usually not well maintained; loss of investment if city expands	pollution dangers; loss of investment if city expands

The CAPACITY of existing/proposed sanitary sewerage adjacent/available to a site should be adequate to carry the load of the proposed settlement as well as future developments in the areas served by the system. If connection to a public system is possible, the developer should ascertain its capacity from the appropriate local authority [8: pp. 45, 46]. The development of a site may be precluded when its prospective sanitary sewerage is either unavailable or of inadequate capacity.

The capacity (hydraulic performance) of a sanitary sewage and/or storm water collection system to serve a site is a function of: [36: pp. 14-7,- 14-12]

-FLOW (rate of discharge) of wastewater volumes it can remove from the site.

-VELOCITY of the wastewater flow in the system serving the site.

Most wastewater disposal systems include relatively massive structures that take a long time to construct and are not easy to expand. Selecting their capacity is not simple [36: p. 5-2]. See WATER SUPPLY for the estimates needed for capacity selection.

The probable sewage FLOW from an area is a function of such existing/estimated factors as: [34: p. 198, 200] [36: pp. 5-21, 15-1]

-Population: as population increases, sewage discharge increases.

-Land Use and Intensity of its use: industrial, commercial, and residential areas will have varying sewage discharges; there may be variations between high, medium, and low income residential areas; as the density of an area increases, the sewage discharge from that area increases.

-Water Consumption: sewage quantities are generally from 60% to 90% of the quantity of the water supplied.
-Habits of People: culture, living patterns should not be neglected as factors.
-Type and Number of Plumbing Fixtures: some fixtures (kitchen sink with garbage disposal, flush valve toilet) use more water producing greater sewage discharge than other fixtures (kitchen sink without disposal, flush tank toilet); as the number of fixtures increases, the design flow increases.
-Pressure of Water Supply: with high pressures, more water is lost to the sewerage through faucet overflow.

Sewage flow is never constant. Variations in it occur: [34: p. 198]
-Seasonally: troughs occur during vacation periods, holidays.
-Daily: peaks on weekdays; troughs on weekends.
-Hourly: peaks at noon; troughs in the early hours of the morning.

Minimum flows used in sewerage design in USA are: [34: pp. 262-265]
-100 gallons per capita per day (gpcd): for treatment works.
-250 gpcd: for mains, outfalls.
-400 gpcd: for submains, laterals.

Sewage flows are between 60% to 90% of the quantity of the water supplied. However, 100% is used in design of the sewerage components to provide allowance for infiltrations and illegal connections [19: p. 111].

The flow within proposed sanitary sewerage should be based on an average maximum. Daily water meter readings from a similar existing settlement taken over an extended period of time, including weekends and maximum days, would be of value in determining an average maximum daily flow estimate. "Caution must be used when interpreting quarterly, semi-annual, or annual meter readings, as averages derived from these figures will be low unless corrected for vacation periods, weekends, holidays, and seasons of the year" [34: p. 198].

The flow of sewage discharge is usually measured in: [36: p. 5-1]
-Gallons per capita per day (gpcd); liters per capita per day (lpcd): usual means of measurement of average rate of flow.
-Gallons per day (gpd); liters per day (lpd): average rate of flow.

The VELOCITY of wastewater in a system should be sufficient to transport waterborne wastes or storm scourings with little or no deposition; but, the velocity should not be so great that channel surfaces are eroded [36: p. 14-1]. The following velocities define these limits:
-2 to 2.5 feet per second (fps): minimum self-cleansing velocity; below this there will be deposition of solids making access to sewers necessary for inspection and cleaning [36: p. 3-9].
-8 to 10 fps: maximum in concrete sewers to avoid abrasion damage [36: p. 3-11].

Cleansing potentials (velocity), not just flow requirements, dictate minimum wastewater pipe sizes (8 in. in USA). Hydraulic performance of sewers is improved by increasing their GRADE or slope, which increases the velocity of flow and reduces the sewage depth in the sewer [36: p. 14-7].

The CONCENTRATION, COMPOSITION, and CONDITION of raw wastewaters is analyzed to identify its: [36: p. 20-4]
-Possible effects on the collection system.
-Probable response to treatment.
-Possible influences on receiving bodies of water or land into/onto which these wastes are to be disposed.

Tests measuring the CONCENTRATION of sewage reflect its strength in terms of: [36: p. 20-6]
-Solid matter: which is potentially offensive to the sight whether it is dissolved, suspended, or settleable.
-Organic matter: which is potentially offensive to the smell because of its putresibility.

The concentration of municipal wastewaters depends on water use, nature and tightness of the collection system, and the degree of stormwater collection. While these factors affect the dilution of sewage, the pollutional load remains unchanged [36: p. 20-17].

Tests measuring the COMPOSITION of sewage reveal its content in terms of: various forms of nitrogen, phosphates and other fertilizing substances, dissolved oxygen (DO), chloride, sulfide, acidity, alkalinity, radioactivity, and accutely toxic wastes [36: p. 20-6]. Wastes from within settlements are composited within the collection system producing relatively constant per capita amounts of suspended solids, organic matter (in terms of Chemical Oxygen Demand (COD) and Biochemical Oxygen Demand (BOD)), and other substances of special concern in the disposal of sewage [36: p. 20-15].

Tests measuring the CONDITION of sewage explain the progress of the decomposition of organic substances in wastewaters, effluents and receiving waters in terms of: [36: p. 20-7]
-Physical, Chemical, and Biochemical tests: for odor, temperature; sulfide, Ph; DO, BOD, COD, and nitrogen.
-Biological tests: for growths of indicators of pollution and bacteria (including coliform organisms).

The condition of wastewater at treatment works or at the outfall of the sewerage is a function of the time of travel (dependent on the length and grade of the collecting system) and the temperature of the wastewater. Long lines, low grades (sluggish flow), and high temperatures destroy the freshness of wastewaters and promote decomposition of its putresible materials [36: p. 20-17].

For discussion of OWNERSHIP/CONTROL/ADMINISTRATION and FINANCING of sanitary sewerage, see WATER SUPPLY.

45. STORM DRAINAGE

DEFINITIONS

STORM DRAINAGE(*) - storm sewer: a sewer (system) designed to carry water wastes except sewage (exclusively: storm water, surface runoff, or street wash).

The PRIMARY PURPOSE of a storm drainage system is the removal of storm water runoff to prevent flooding. Flooding results in high material damages, washing away streets, sidewalks; undermining building footings; and threatening water supplies by infiltration and contamination [19: p. 119].

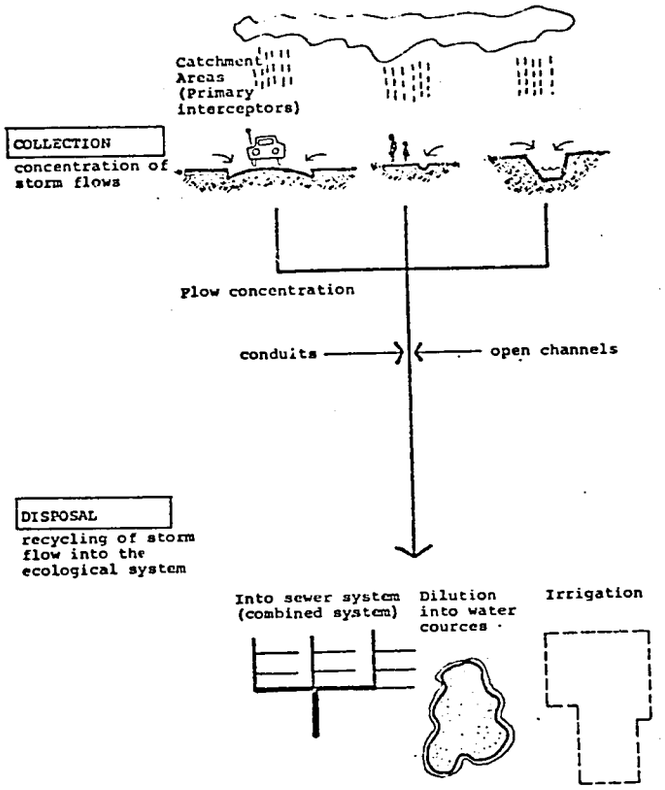
The COMPONENTS of the storm drainage system are illustrated in the following figures: [19: pp. 120-124]

-Storm Drainage Network Diagram: (fig #

-Collection Components Chart: (fig #).

-Disposal Systems Chart: (fig #).

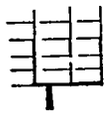
THE STORM DRAINAGE NETWORK



COLLECTION: Primary Interceptors

COMPONENT:	WALKWAYS	ROADWAYS	DITCHES
FUNCTION:	immediate control of water runoff, allowing dispersed runoff til need for pipes required		
RESPONSIBILITY:	developer is responsible for financing and installation		
CONTROL:	city controls and maintains all three components		
CHARACTERISTICS:	curbed sidewalk controls runoff into desired direction walkways are sloped to keep pedestrians dry but still allow water control	15-23 cm. curbs channel water to inlets and concentrate water into desired volume for given pipe diameter roads are crowned to keep water out of normal vehicular travel sections under normal runoff conditions since emergency vehicles normally have a higher body and larger tires, they may easily negotiate the streets when they are flooded	swallow ditches are standard requirements (FHA-US) usually located on sides of streets to drain road bed
SCALE OF DEVELOPMENT	as needed	access to each DU	along roads
ADVANTAGES:	allows water concentration for economical pipe sizing	allows economical sizing for pipes allows multiple use of existing system	inexpensive
DISADVANTAGES:	heavy rains flood sidewalk	25-50 year rains flood roadway	constant maintenance required

COLLECTION
Flow Concentration



	PIPE NETWORK	CHANNEL NETWORK
COMPONENT:	PIPE NETWORK	CHANNEL NETWORK
RESPONSIBILITY:	developer connects to city	developer established
CONTROL:	city maintains systems in each case	
CHARACTERISTICS:	gravity flow system	gravity flow system
	min. vel: 2.5 fps when flow at full section; max. flow of 8 fps. if pipe unlined, 15 fps if concrete lined. 12" min. recommended pipe size (U.S.)	2.5 fps min. flow
		brick lined to prevent scouring
	2 centimeters per 100 meter slope a common recommendation	
	layout related to street drain system	
SCALE OF DEVELOPMENT:	economy dictates scale	large areas; dependent on rainfall intensity and duration
ADVANTAGES:	good for small rainfall control	inexpensive system for large flows
DISADVANTAGES:	difficult to change or alter as area becomes built-up and runoff increases	becomes a physical boundary
	unable to design for large flows economically	becomes trash collection site, health hazard

DISPOSAL SYSTEMS

	SEWER SYSTEM	DILUTION	IRRIGATION
COMPONENTS:	SEWER SYSTEM	DILUTION	IRRIGATION
RESPONSIBILITY:	connected by developer		
CONTROL:	deeded to city	regional board regulates use	
CHARACTERISTICS:	system called "combined" when connected to sewer	most common system in urban areas	used in flat areas
			used where water is at a premium
EXAMPLE OF USE:	Boston		Berlin
SCALE OF DEVELOPMENT:	limited by existing network size	limited by size and flow of water course	limited by soil drainage ability
ADVANTAGE:	only one pipe network needed	inexpensive	may be used as water source in arid areas; agriculture value
DISADVANTAGES:	impossible to adequately design; pipe sizing must resort to overflow which results in contamination of area and health dangers	pollutes water system easily during heavy rains	only useful if land is inexpensive
			danger of pollution of ground water

CONSTRUCTION COSTS for storm drainage and/or combined sewerage in North America (1965) was about 3 times as much as sanitary sewerage (See SANITARY SEWERAGE). It is very costly to plan for all eventualities of flooding. Therefore, a compromise between the cost of flood damage and the cost of drainage is necessary in most cases [19: p. 119].

"For economic reasons, it is current practice to separate storm water drainage from sanitary sewerage because of the otherwise excessive size of pipe for a combined system and the overload placed upon the sewage treatment plant" [8: p. 181].

The AVAILABILITY of existing/proposed storm drainage in relation to a prospective site is an important factor in site selection [8: p. 45] (See: LOCATION).

ALTERNATIVES for stormwater collection and disposal from a site are generally: [8: p. 48]

-Connection to an existing system.

-Use of existing natural streams or valleys.

The CAPACITY of existing/proposed storm drainage adjacent/available to a site should be adequate to carry the load of the proposed settlement as well as future developments in the areas served by the system. The greatly increased runoff from an area as it becomes fully developed should not be overlooked. If connection to a public system is possible, the developer should ascertain its capacity from the appropriate local authority. Natural drainage of adjacent land cannot be cut off; and, excessive stormwater may not be discharged onto adjacent land or into any stream or public drain without definite written permission from the owner or public authority [8: pp. 45, 46, 48]. The development of a site may be precluded when its prospective storm drainage is either unavailable or of inadequate capacity.

The capacity (hydraulic performance) of a storm water collection system to serve a site is a function of FLOW and VELOCITY [36: pp. 14-7 - 14-12]. See SANITARY SEWERAGE.

Most wastewater disposal systems include relatively massive structures that take a long time to construct and are not easy to expand. Selecting their capacity is not simple [36: p. 5-2]. See WATER SUPPLY for the estimates needed for capacity selection.

Storm FLOWS are the product of: [36: p. 15-12]

-Rainfall Intensity: the rate of rainfall; intensity usually decreases with increasing storm duration; the shorter the time of concentration (time required for runoff to reach and flow through sewerage), the larger the flows [36: p. 7-12].

-Runoff-Rainfall Ratio: the percentage of stormwater runoff that is not reduced by evaporation, depression storage, surface wetting, and percolation; with rainfall duration, runoff-rainfall ratios rise increasing runoff flow.

-Size of the Drainage (tributary) Area.

Because the rainfall intensity and the runoff-rainfall ratio are variable over time, storm flows reaching a given point in the drainage system are compounded of waters falling within the time of concentration; and, peak runoff normally occurs when the entire drainage area comes into action [36: p. 15-12].

Overland flow is a function of the absorbtion, roughness of the drainage area surface. Runoff is 100% only when drainage areas are impervious and storms last long enough. Composite runoff-rainfall ratios can be computed from information such as the following: [36: pp. 15-13 - 15-14]

AREAL COMPONENT		RUNOFF %	
Streets:	asphalt:	70 to 95%	
	concrete:	80	95
	brick:	70	85
Drives and Walks:		75	85
Roofs:		75	95
Lawns:	sandy soil, flat (2%):	5	10
	steep (7%):	15	20
	heavy soil, flat (2%):	13	17
	steep (7%):	25	35

The staging of developments becomes critical in terms of storm runoff flows. Initial stages will have lower runoff characterisitics than the final stages, which will require a well developed drainage system [19: p. 127]. Development seals land surface with roads, parking lots, roofs, etc., resulting in increased stormwater runoff.

For VELOCITY of stormwater flow, see SANITARY SEWERAGE.

The CONCENTRATION, COMPOSITION, and CONDITION of stormwater is analyzed in the same manner as sanitary sewerage. See SANITARY SEWERAGE.

The OWNERSHIP/CONTROL/ADMINISTRATION of storm drainage is usually public [19: pp. 121-124]. See WATER SUPPLY for additional information.

FINANCING for storm drainage systems is usually arranged by the developer during the development/construction stages and deeded to the municipality when the development is completed [19: pp. 121-124]. See WATER SUPPLY for additional information.

METHODS FOR INCREASING THE EFFICIENCY OF WASTEWATER SYSTEMS

A. WATERLESS TOILET SYSTEM: could reduce US domestic water consumption by 40% with a corresponding reduction of sewage flow.

Promising innovations in this area include: [39: p.32]
-The Vacumatic System: employs a vacuum toilet that discharges approximately 1.5% of the sewage discharged by conventional toilets.
-Self-contained Toilet-incinerator: uses no water and discharges no sewage.
-Closed Recirculating System: discharges no water; employs a self-contained treatment system to purify and return all water used directly to supply.

B. SEWERAGE ECONOMIES: [19: p. 112, 188]
-Cost of Pipe: is generally lowest when the largest pipe with the required capacity is used; however, with pipes over 48", the pipe cost increases at a faster rate than capacity increases, making the use of multiple smaller mains less costly.
-Use of Larger Pipe than required at Less Grade: allows reduction in the trench depth; the savings in grading costs is generally greater than the additional cost of the larger pipe.
-Reinforced Concrete Pipe: may result in 40% savings over the construction costs of other pipes.

C. STORM WATER RETENTION ON INDIVIDUAL LOTS: can lower the immediate runoff flows and allow the use of smaller pipes; runoff should be kept dispersed on the surface as much as possible before concentrating it into the pipe network [19: p. 112].

46. ELECTRICITY, STREET LIGHTING, TELEPHONE, GAS

DEFINITIONS

ELECTRICITY, STREET LIGHTING, TELEPHONE, GAS

ELECTRICITY(*) - electrification: the process (network) for supplying (a site) with electric power.

Although electricity is not necessary for the sustenance of life, it has become a vital service, supporting a wide range of urban activities. The more urbanized an area becomes, the more dependent it is on electricity for: [19: p. 130-131]

-Power: for convenience services in each household; utility services: walls, pumps, sewer lift pumps, treatment plants; etc.

-Lighting: which provides night security and allows activities to extend for a longer period of time, increasing the functionality of an area.

-Communication: through telephone, telegraph, television, and radio.

-In addition, the standard of living of an area is intimately coupled with the amount of electricity furnished to the individual dwellings.

The electric utility is a monopoly in the sense that only one utility serves a community. However, it does have to meet competition in the sense that, for instance, cooking, water heating, and domestic refrigeration can in many areas be done more economically by gas. [44: p.2].

The COMPONENTS of the electrical network are illustrated in the following figures: [19: pp.132-139]

-Electrical Network Diagram (fig #).

-Generation Components Chart (fig #).

-Transmission Components (fig #).

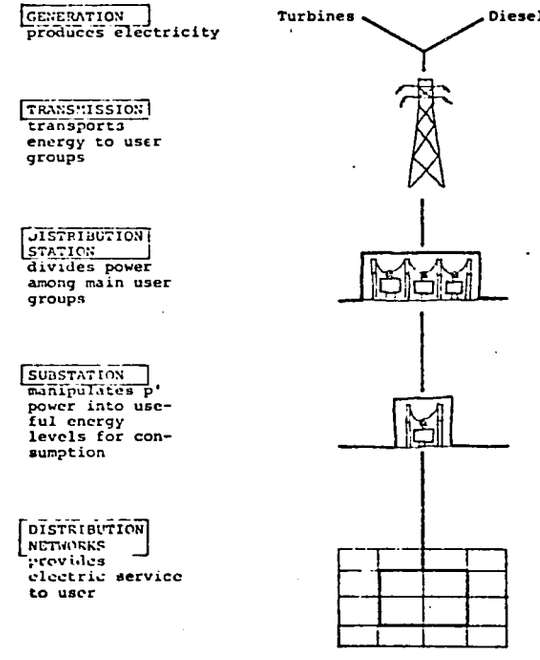
-Transmission, Distribution Substations Chart (fig #).

-Distribution Network Chart (fig #).

-Distribution Components Chart (fig #).

-Distribution Layout Chart (fig #).

ELECTRICAL NETWORK COMPONENTS



GENERATION COMPONENTS

GENERATION	Transmission	Dist. Station	Substation	Dist. Network

COMPONENT:	Turbine Generation	Diesel Generation
RESPONSIBILITY:	provided by company	
CONTROL:	regional public board	company controls
CHARACTERISTICS:	turbines may be energized by water power or steam generation systems; steam is produced by coal, gas, oil, or nuclear heat generators water motivated systems generally require a damed water supply	diesel systems are generally powered by electricity, gas or oil motors
SCALE OF DEVELOPMENT:	usually many cities are served by one plant	usually for small systems only; mainly a backup use in most cases
ADVANTAGES:	inexpensive production of power	portable system; not dependent on fixed power supply for motivation
DISADVANTAGES:	requires transmission lines and a water storage system; high first cost	expensive means of electric supply

TRANSMISSION COMPONENTS

Generation	TRANSMISSION	Dist. Station	Substation	Dist. Network

COMPONENTS:	Tower and Cable Lines for transmission
FUNCTION:	supports cables for long range transmission
RESPONSIBILITY:	company installs and finances
CONTROL:	regional control
CHARACTERISTICS:	towers are approximately 45 meters high, 9 to 18 meter bases; require 30 to 60 meter easements

DISTRIBUTION STATIONS

Generation	Transmission	DIST. STATION	Substation	Dist. Network

COMPONENTS:	Distribution Station (transformer station)
FUNCTION:	maintains power pressure and boosts transmission distances
RESPONSIBILITY:	company installs, finances and maintains
CONTROL:	company control
CHARACTERISTICS:	from hdro power sources, lowers power from 230 kv to 115/69 kv from steam sources, lowers power from 138/115 kv to 34.5/13.2 kv

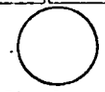
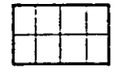
SUBSTATION COMPONENTS

Generation	Transmission	Dist. Station	SUBSTATION	Dist. Network

COMPONENTS:	Substations
FUNCTION:	furnishes power to dwellings and street lights
RESPONSIBILITY:	company finances, installs and maintains
CONTROL:	controlled by company
CHARACTERISTICS:	usually located as close to users as possible lowers power from 13.2/4v kv to 2400/7200 volts usually widely spaced at low densities; spacing decreases as density increases

DISTRIBUTION NETWORK

Generation	Transmission	Dist. Station	Substation	DIST. NETWORK

COMPONENT:	Radial Layout	Ring Layout	Network Layout
RESPONSIBILITY:	all financed, installed and maintained by company		
CONTROL:	controlled by company in all cases		
CHARACTERISTICS:	earliest system for layouts used in low density remote areas	used for large population centers	combination of ring and radial systems; developed as result of growth of ring and radial layouts
ADVANTAGES:	avoids duplication of cables	allows back-up for emergencies	allows backup line for emergencies
DISADVANTAGES:	no emergency backup line		

DISTRIBUTION COMPONENTS

COMPONENT:	Transmission Cable	Poles Or Channels	Transformers
FUNCTION:	carries power to user	supports cable provides protection to lines	converts power to useable voltage
RESPONSIBILITY:	installed, financed and maintained by company		
CONTROL:	public policy and safety requirements dictate control		
CHARACTERISTICS:	5.5 m. above street surface or buried underground in conduits	30 to 55 m. spacing; 15 to 30 cm. from curb 9 to 11 m. high poles; channels come in 9" by 9" sections; they are used when changes are anticipated in underground services; channels are based on 5 to 10 year design period; manholes are needed for channels every 150 to 210 m.; poles are cheaper; channels are used in urban areas where the cables are more subject to change	transformers may be on pads, buried, or suspended from poles transformers may be increased if additional power is demanded

ELECTRICAL NETWORK LAYOUT

METHOD:	Total Underground	Partial Underground	All on Poles
CHARACTERISTICS:	all lines in channels; used in congested areas	primary voltage system of power on poles, secondary voltage system in channels; used in residential areas	primary and secondary voltages on poles, low density areas
ADVANTAGES:	no interference with traffic; favorable visual aesthetics no climatic problems of maintenance low maintenance costs in general	lower cost than if all underground makes use of existing light poles for primary voltage system	lowest cost
DISADVANTAGES:	high cost of installation	climatic problems with cables (sleet failures)	climatic problems (sleet danger causes cable failure) relatively high maintenance

The installation of electricity requires: [19: p. 131]

-Specialists with highly technical skills.
-Equipment which is highly sophisticated.
-Planning on a large scale/regional basis.
-Safe guards to protect against misuse after installation which can be dangerous to life and property.

Many factors enter into the COST of generation and distribution of electricity, the principal ones being the effective utilization of the equipment (capital investment) and the cost of fuel. Because of these factors, the rates charged by utilities vary widely. The customers are usually classified as residential, rural, commercial, industrial, public street and highway lighting, and other public authorities and utilities for rate charging purposes. Residential and rural rates are simple energy charges, but the other rates are usually in two parts: a demand charge plus an energy charge [44: pp. 7,8].

"The cost of electric service is dependent on the amount of system capacity required to serve the load (demand) as well as on the volume (kilowatt-hours) used." The greater the number and variety of customers, the more efficient will be the use of the distribution system, the cost of which is a large factor in the cost of service. Increasing the volume of business reduces the unit cost of the system capacity required. These are some of the economic reasons why it is in the public interest to have only one utility in a given area [44: pp. 1,2].

Of the TOTAL INVESTMENT made in electric utility systems, half is for the distribution of electricity from the generating stations or a power substation to the customer. It is somewhat less than half where the distribution is mostly open-wire overhead and somewhat more than half where a large part is in underground cables [44: p. 212].

The AVAILABILITY of existing/proposed electric service in relation to a prospective site is an important factor in site selection [6: p. 45] (See: LOCATION).

The CAPACITY of existing/proposed electric service adjacent/available to a site should be adequate to carry the DEMAND of the proposed settlement as well as future developments in the areas served by the system [44: p. 2].

Variations in demand occur: [44: p. 10, 11]
-Seasonally: summer evening peak occurs later in the day than the winter peak; "daylight-saving-time" usually creates a valley between 4:00 P.M. and 9:00 P.M.; duration of the evening peak is greatest in the winter.
-Daily: peaks on weekdays; troughs on weekends.
-Hourly: minor peaks at noon and major peaks in the evening; troughs in the early morning hours.

The demand for electric energy is measured in:
-Watt-hours (Wh): measures the power (wattage) delivered/consumed in a specified period of time.
-Kilowatt-hours (kWh): measures 1000 watts of power per time.
-Kilovolt-amperes (kVA): measures power usage averaged over long periods of time such as seasonally.

POWER is the product of:
-Voltage (V): measures the potential difference or electromotive force (emf) which causes the current to flow in a system.
-Amperage (amps): measures the flow of current in a system.

The VOLTAGE for residential service in USA is uniformly 120 V. In 1949 the Edison Electric Institute and the National Electric Manufacturers Association adopted this value as the national standard for appliance design. Abroad, voltages are usually 200 or 230 volts. This voltage difference makes for considerable difference in the method of distribution: [44: pp. 212, 229]
-USA: "voltage is reduced in a distribution substation to a value of 2400 to 13,800 V. and a second reduction is made to utilization voltage (120 V) by means of a large number of small transformers mounted on poles, or located in vaults, known as distribution transformers."
-Abroad: "subtransmission voltage (13,200 to 69,000 V) is brought into a kiosk or vault and reduced to 230 V, and a relatively large area is covered at 230 V."

The induced voltage of distribution transformers, of which there are many used on any system, is proportional to the total flux linkage and the FREQUENCY. The higher the frequency, the smaller the cross-sectional area (flux linkage) of the transformer core, reducing the length of copper in the coils [44: p. 97].

FREQUENCIES commonly used are: [44: p. 97]
-60 cycles per sec (cps): US standard frequency.
-50 cps: standard frequency in most other countries.
-40 cps: used in some areas of Maine, New York, and South Carolina.
-30 cps: used in some areas of Colorado, Michigan, and North Carolina; and some direct current in the older districts of cities such as New York, Chicago, and Boston.
-25 cps: used for electric railway supply.

STANDARD OF SERVICE, from the viewpoint of system operation, is determined chiefly by the following: [44: pp. 2-3]
A. RELIABILITY of service.
B. QUALITY of service.
C. ECONOMY of production.

STANDARD OF SERVICE [44: p. 2-3]

A. "RELIABILITY of service implies ability to supply electric energy to all customers whenever they demand it and in such quantities as may be required. Such reliability is measured by the number of customers affected. It is dependent on sound design and competent operation.

B. "QUALITY of service is indicated by the degree of attainment of standard voltage and frequency in the supply of electric energy. The design of the transmission and distribution systems determines how close to the standard the personnel can maintain voltage and frequency. Even competent personnel cannot maintain the standard if the system is poorly laid out.

C. "ECONOMY of production is affected through proper load division among the various stations on the system and among the equipment in each station."

The OWNERSHIP/CONTROL of electricity generation, transmission, and/or distribution can be: [45: p. 6-9]
-Investor-owned: serving generally prescribed areas under territorial franchises granted by state or local government agencies.
-Public (non-federal): organized mostly as municiple or state "authorities".
-Cooperative: organized as distributors, mostly in rural areas in USA, purchasing their power from federal or investor-owned systems.
-Industrial: producing power for their own use and permitted by state/local authorities to sell excess power to the public (in France, many Asian nations, etc.) [46: p. 20].
-Public (federal): organized to install and operate power generation, transmission, and distribution on a regional basis, i.e.: Tennessee Valley Authority (USA); Bonneville Power Administration (USA); Southeastern Power Administration (USA); Southwestern Power Administration (USA); Power Ministry (United Kingdom); Electricite de France (France).

FINANCING an electricity supply system can be accomplished by: [46: pp. 19-24]
-Direct Taxation: seldom sufficient by itself for the large amounts of capital needed for power facilities.
-Long-term Revenue Bonds: usually issued by municipalities who depend largely on this method for all their capital.
-Free Market Investment: usually practiced by private business enterprises; this is a voluntary investment of private (or public as in Japan) capital.

The source of REVENUE for electric service comes from the sale of kilowatt-hours of energy to consumers at rates based on their demand peaks (covering cost of equipment installed to meet the demand) and on the energy actually consumed (covering operating and fuel costs). The money that these rates bring to the utility is intended to cover all costs plus a fair return on the investment [44: p. 8].

THE ENERGY SITUATION [49: p. 53-58]

"The energy situation is uncertain and complex, but it can be summarized as follows: We are not yet running out of energy, but we are being forced to use the resources that produce it faster than is probably healthy. Our supplies of fossil fuels - coal, petroleum, and natural gas - are finite and will probably be consumed within a few hundred years, possibly much sooner.

"We are living beyond our means, 'spending our capital,' depleting what are essentially nonrenewable resources. Furthermore, some organic chemists consider the burning of fossil fuels for energy production to be one of the least desirable uses for these large molecules. Petroleum and coal have many other uses in areas as diverse as lubrication and the production of plastics.

"The world's potential production of hydroelectric power is roughly equivalent to the amount of power now produced by fossil fuels. There are, however, serious problems in utilizing it to the utmost. Much of the potential lies in underdeveloped countries (UDC), where the power could not be used unless those countries become industrialized, and global ecological factors and shortages of resources will prevent industrialization in most of them. Furthermore, hydroelectric power depends on dams, which under present conditions of technology are temporary structures. In a few hundred years, sometimes much less, their reservoirs fill with silt and becomes useless. Finally, there is an aesthetic question. Do we wish to impound and control all of the wild rivers of the earth?

"For many years men have speculated about the sun as a source of non-depletable power, but large-scale utilization of solar energy presents serious technological problems, especially in a crowded world. Sunlight must be gathered over large areas; the collecting device for an electric generating plant with a capacity of 1,000 megwatts (enough power to supply electricity to a city of perhaps 1.5 million people) would have to cover an area of about 16 square miles.

"Tidal power, also the subject of some speculation, does not have more than a minute fraction of the potential of water power, and will presumably never be of more than local importance."

The power potential of the heat of the earth's core (geothermal energy) may, according to the most optimistic sources, produce as much as one-half of America's electrical power by the end of this century.

"Many people who are aware of the approaching end of our fossil fuel resources assume that uranium-based nuclear power will soon simply replace the fossil fuels." There is a widely held misconception that nuclear power is cheap. "The largest nuclear generating stations now in operation are, even with their massive hidden subsidies, just competitive with or marginally superior to modern coal-fired plants of comparable size (in areas where coal is not scarce). Smaller nuclear plants are less economical than small plants that operate on fossil fuels. In this connection it is important to note that UDCs rarely can use the outputs of large power plants. There are simply not enough industries, lightbulbs, appliances, neon signs, electric trains, buses, streetcars, and so on to utilize that much electricity. Significantly, the cost of the modernization and industrialization required to utilize the electrical power exceeds the cost of the power itself by several magnitudes. All things considered, only those UDCs that are now short of fossil fuels or have problems in transporting them would have reason to choose nuclear power.

"Nuclear energy, then, is a panacea neither for the developed countries nor the underdeveloped countries. It may relieve, but not remove, the pressure on fossil fuel supplies, and may provide reasonably priced power in certain parts of the world where these fuels are not abundant.

"A second common misconception about nuclear power is that it can reduce our dependence upon fossil fuels to zero as soon as that becomes necessary or desirable. In fact, nuclear power plants produce only electrical energy; and electrical energy constituted only 19 percent of the total energy consumed in the United States in 1960. Thus the length of time that nuclear fuels can postpone the exhaustion of our coal and oil depends on how much the use of electrical energy can be increased." This will require a conversion to electric or fuel-cell-power for transportation, electric heating, as well as electrically powered industries. All such conversions will take time and will be extremely expensive.

"It is clear that mankind, if it survives for another century or so, will witness drastic changes in the use of energy sources. It does not appear, however, that availability of energy itself will place a limit on population growth, although difficulties accompanying the transition from one source to another might well do so. The ultimate limits to the use of energy (assuming radioactive pollution and other safety problems associated with nuclear energy can be solved) come not from its shortage, but from the problem of dissipating the heat to which all useful energy is ultimately degraded."

47. STREET LIGHTING

DEFINITIONS

STREET LIGHTING(*) - a service for urban street illumination to improve vision at night.

The local supplier of electricity will, in virtually all cases, directly or indirectly supply the electricity for street lighting [47: p. 186].

The OBJECTIVES of street lighting, listed approximately in the order of chronological development, might be classified as: [47: pp. 1-2]

-Crime Reduction: there are fewer crimes committed under bright street lights than under dim, inadequate lights.

-Extension of Activity: urban activity is extended, especially in commercial areas, through street lighting.

-Traffic Safety: improved lighting reduces night accidents.

The practical objective in street lighting is to enhance the visibility of objects/things to be seen. Visibility can be analyzed according to the following factors: [47: p. 57]

-Size: of the object or its critical detail.

-Contrast: between the object and its background.

-Brightness: light reflected from the object to the eye.

-Time: available for seeing; speed of vision which becomes important when object or observer is in motion.

The COST of providing street lighting is composed of capital costs, operating costs, and electricity costs. The largest of these is the capital cost or that which is invested in physical plant: lamps/luminaires, poles, wires, etc. To keep lighting costs to a minimum, efficient luminaires should be used at wide spacings and high mounting heights [47: pp. 69, 186].

Street lighting LEVEL is measured by footcandles. The minimum levels recommended by the American Standards Association (ASA) for public safety are: [47: pp. 69, 85]

-0.9 to 2.0 footcandles: densely developed commercial/industrial areas.

-0.6 to 1.2 footcandles: moderate/low density commercial/industrial areas.

-0.2 to 0.9 footcandles: residential with/without commercial areas.

-1.4 footcandles: urban expressways.

-1.0 footcandles: rural expressways.

-2.0 footcandles: urban expressway interchanges.

-1.4 footcandles: rural expressway interchanges.

Street light SPACING should not exceed 6 times the MOUNTING HEIGHT: i.e.: for 7 meter mounting height, the spacing should not exceed 42 meters [47: p. 94].

Minimum MOUNTING HEIGHT, according to the ASA, is 6 meters; and, the majority of lamps require a mounting height of 7.5 meters or more. "Higher mounted units will provide greater areal coverage, more uniformity, reduction of glare, but a lower footcandle level. It is necessary to weigh the effects of installing larger lamps against a greater number of smaller units at lower mounting heights, and with maximum glare potential. Generally, units should be mounted as high as possible and lamp size selected to give the required average footcandles" [47: pp. 93-94].

Street lights can be configured in the following ARRANGEMENTS: [47: p. 76]

-One-side of street: results in a nonuniform brightness pattern, which is more pronounced as road width increases; lighted side will be brighter than nonlighted side.

-Staggered/Opposite sides of street: results in a uniform brightness pattern equal on both sides of the road, making this the most preferred arrangement.

-Mounted over Center of street: results in a brightness pattern which is equal on both lanes of travel and can be uniform on narrow streets where closely spaced.

In practice, center mounted lamps are commonly installed with long spacings of 60 to 90 meters in residential areas even though the brightness pattern is spotty [47: p. 77].

Situations requiring special consideration of spacing, mounting, lighting levels, etc. are: [47: pp. 91-92]

-Obstructions, trees: field inspection will determine where each light can be most effectively mounted.

-Hills, curves: steep grades may require that lights be tilted slightly for uniformity of distribution; short radius curves may require that lights be placed on the outside of the curve; shortened spacing may be necessary where lights must be placed on the inside of a curve.

-Grade intersections: where two traffic streets intersect, the lighting level should be double that of either street; at "T" intersections, the lighting should be located opposite the entrance of the intersecting street, intensifying the silhouette of anyone entering the intersection.

-Interchanges: at ramps, overpasses where there is grade separation, lights may have to be specially arranged to prevent glare on adjacent roadways; where roadways themselves are not illuminated, the approaches to interchanges should be lighted at gradually increasing levels to avoid impaired vision due to abrupt brightness change at interchanges.

-Underpasses: short underpasses such as under city streets/railroads, can usually be lighted with normal street lights placed so that resultant lighting level is the same as for the street itself; for long underpasses where normal streetlamps cannot provide adequate lighting levels, tunnel illumination should be used.

-Tunnels: daytime lighting requires 100 footcandles at tunnel entrances tappered within the distance to be traveled in the first 15 seconds at normal speed to 5-10 footcandles, normal tunnel lighting level; nighttime lighting should be tappered to 50% of normal tunnel level for 200 meters at tunnel exists.

The OWNERSHIP, INSTALLATION, OPERATION of street lighting can be by: [47: p. 186]
-Local Supplier of Electricity: which most often furnishes this service, may be paid by a municipality on a filed flat monthly rate or on a special renewable contract. See ELECTRICITY - OWNERSHIP/CONTROL.
-Municipality/Other Public Body: which sometimes owns and maintains its own equipment, and may employ the local electricity supplier/contractor to undertake the operation of the system where it is unable to do so itself.

FINANCING the capital, operating, and electricity costs of street lighting can be accomplished by: [47: p. 186]
-Investment: by the local supplier of electricity which adds street lighting to its utility plant like any other equipment it installs in the regular course of business.
-100% Assessment: levied on the benefited property owners usually by a municipality.
-General Obligation/Special Bonds: issued by a municipality with a special sinking fund to retire the issue in a specific term of years.
-Contributions: made by a business community to a municipality for the purpose of lighting a particular commercial area.

48. TELEPHONE

DEFINITIONS

TELEPHONE(*) - an electrical communication network interconnecting all subscribing individuals and transmitting over wires.

The COMPONENTS of the telephone network are: [19: p. 141]
-Area Switching Centers: toll centers, primary centers, sectional centers, regional centers.
-Trunk Lines: long distance transmission.
-Central Office: switchboards; controls 35,000 customers and 2,000 trunk lines; design period is 15 to 20 years.
-Short Transmission Lines: serving each subscriber.
-Individual Telephones

The OPERATION of the telephone network is dependant on: [19: p. 141]
-Switching: from unit to desired unit; occurs at the central office with local calls; may go from primary to sectional to regional centers with long distance calls.
-Transmission: of sound in a manner which is adequate for hearing.

ALTERNATIVES for transmission in a telephone network include utilization of: [19: p. 141]
-Telephone Company Power: generating its own direct current, transmitting over its own lines, and using backup systems of batteries to provide for breakdowns; this type of telephone system is usually available for emergency use during failures of the regular electrical power services.
-Electric Power System: which can be used for telephone transmission through the development of carrier systems; with this system, telephone company installs less cable with low resultant installation costs.

The ARRANGEMENT of cables are usually: [19: p. 142]
-Underground in Ducts: in dense urban areas.
-Overhead/Aerial on Poles: in low density areas at less cost than in underground ducts.
-Buried Cable Without Ducts: for long distance trunk lines, since they are not subject to frequent change.

The OWNERSHIP/CONTROL of telephone networks is usually by a semi-private company under limited public law control. All components are provided by the company [19: p. 141].

49. GAS

DEFINITIONS

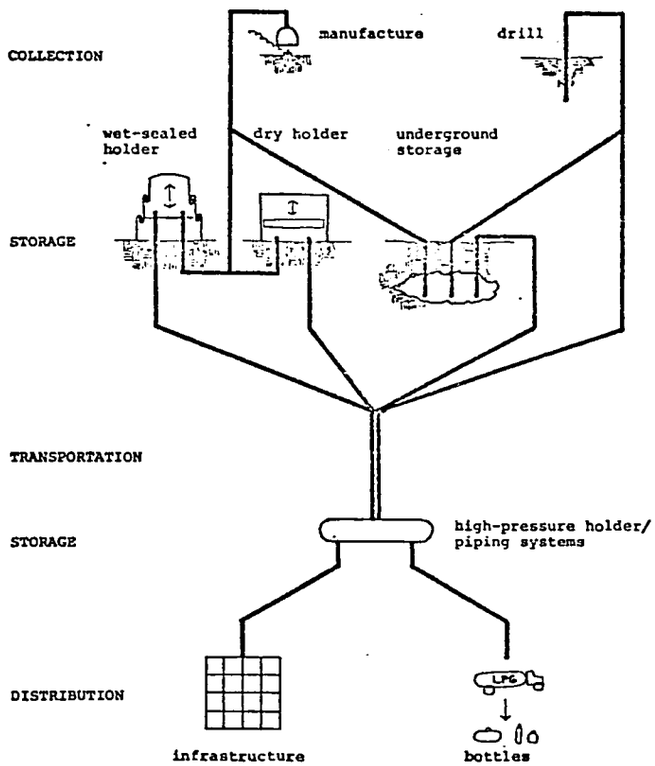
GAS(*) - a system for supplying natural gas, manufactured gas, or liquefied petroleum gas to a site and individual users.

The PURPOSE of the gas network is to provide energy for cooking, water heating, room/central heating, refrigeration, air conditioning, etc. Gas energy is competitive with electricity in performing these functions where gas is available [44: p. 2].

The COMPONENTS of the gas network are illustrated in the following figures: [43: pp. 13-80]

-Gas Network Diagram (fig #).
-Collection Methods Chart (fig #).
-Transportation Methods Chart (fig #).
-Storage Methods Chart (fig #).
-Distribution Methods Chart (fig #).

GAS NETWORK DIAGRAM



GAS COLLECTION METHODS

METHOD:	manufactured [43:pp.15-34]	drilled [43:pp.35-50]
RESPONSIBILITY:	private industry and/or public industry	
CONTROL:	regional, national public boards/commissions	
CHARACTERISTICS:	made as by-product in manufacture of coke (carbonization); or, made through complete gasification of coal/oil	found in earth's crust many times with oil
SCALE OF DEVELOPMENT:	carbonization, gasification once practiced locally now consolidated to serve national/regional markets (Europe)	practiced to serve national markets where resources are plentiful (US, USSR)
ADVANTAGES:	makes use of the gaseous by-product of coke manufacture	cheap gas once drilling is complete
DISADVANTAGES:	gasification is expensive relative to drilling	natural reserves are not available to all areas

LOW-PRESSURE GAS STORAGE METHODS [43:pp.51-55]

METHODS:	water-sealed holder	dry holder
RESPONSIBILITY:	public/private utility	
CONTROL:	public board control	
CHARACTERISTICS:	telescoping tanks sealed by water filled channels; located at gas manufactory	large fixed shells confining gas beneath a giant piston which rises/falls with gas volume; located at gas manufactory
ADVANTAGES:	cannot explode because no air exists within the shell	exterior appearance, while very large, not as unsightly as water-sealed holders
DISADVANTAGES:	moving parts are vulnerable to leaks	
	costly to construct, unsightly, unsuitable for high pressures, vulnerable to frost	can explode if gas leaks into air filled chamber above the piston
	very large dimensions, cannot be concealed	

GAS TRANSPORTATION METHODS

METHODS:	pipeline [43: pp.63-65]	tanker [43: pp.71-80]
RESPONSIBILITY:	private company/public central authority	
CONTROL:	regional/national public boards/commissions	
CHARACTERISTICS:	high pressure lines with welded joints inspected by x-ray; tested, protected by wrapping to prevent leakage	transport liquefied gas over long distances
SCALE OF OPERATION:	gas is piped farther than 2000 miles at pressures of 60 to 100 atmoshpheres, requiring relatively thin wall pipes and low pumping costs; higher pressures require stronger more costly piping, pumping systems	Methane, Propane, Butane can be liquefied by pressure at room temperature; normally, methane is transported at -162°C, requiring equipment made of very special materials.
ADVANTAGES:	best method for short distance transportation over land	flexible, economical method for long distance transportation
DISADVANTAGES:	long distance transportation only practical when points of supply and delivery are firmly/unchangably established large capital expediture required to bury piping which can be used for the established ronte only international transportation endangered with deterioration of political relationships.	methane requires extremely cold temperatures necessitating use of special alloys and hermetically sealed insulation in the tanks on board ship, pipes running along jetties and tanks on land extreme precautions must be taken to prevent explosion dangers.

HIGH-PRESSURE GAS STORAGE METHODS [43:pp.55-61]

METHODS:	underground	high-pressure holder	transportation piping
RESPONSIBILITY:	public/private utility		
CONTROL:	public board control		
CHARACTERISTICS:	storage in exhausted gas fields; limestone aquifers used for storage for distribution on a regional scale	commonly horizontal cylinders with domed ends; gas is compressed into them and removed by simple expansion used for storage at distribution end of network	oversized pipelines can be used to store gas at high pressures with considerable volume
ADVANTAGES:	no moving parts; easy to conceal; relatively cheap to build		
DISADVANTAGES:	great leakage potential		

GAS DISTRIBUTION METHODS

METHOD:	infrastructure [43:pp.65-67]	bottle [43:pp.13,45-46]
RESPONSIBILITY:	private/public utility companies install and maintain all components.	
CONTROL:	public control board/commission	
CHARACTERISTICS:	small diameter, low pressure mains, service pipes; pressure regulating devices located as needed; 1/50 to 1/10 atmosphere pressure range; meters located at each customer (lot)	liquifiable gas-(butane/propane) stored in liquid form at room temperature in light steel cylinders, which are periodically trucked to users.
SCALE OF DEVELOPMENTS:	mains, service pipes installed in urban street rights-of-ways	primarily rural/areas remote from infrastructure
ADVANTAGES:	ready energy source competitive with electricity	portable, flexible source of gas supply
DISADVANTAGES:	expensive to install; not flexible	unsightly bottles

The AVAILABILITY of existing/proposed gas service in relation to a prospective site is a factor to be considered in site selection; but, even if the infrastructure is not available, gas may be supplied in bottles at reasonable cost. See LOCATION.

The CAPACITY of existing/proposed gas service adjacent/available to a site should be adequate to carry the DEMAND of the proposed settlement as well as future developments in the areas served by the system [8: p. 45].

The capacity of a gas distribution system to serve a site is a function of: [43: pp. 61-62]
-VOLUME (rate of flow) of gas it conveys to the site.
-PRESSURE of the gas in the system at the site.

Variations in the VOLUME of gas demanded occur: [43: pp. 51-58]
-Seasonally: peaks in winter; troughs in summer.
-Daily: peaks on weekdays; troughs on weekends.

Volume of gas demanded/consumed is measured in:
-Cubic feet (cu ft); cubic centimeters (cu cm): common measure for billing purposes.
-Cubic feet per minute (cu ft/min); cubic centimeters per minute: measure of rate of gas flow in pipes.

The PRESSURE of gas in a system is proportional to the square of the volume (rate of flow). For example: a pressure change from 4 inches of water to 16 inches is necessary to double the rate of flow in a given pipe [43: p. 62].

Gas pressure is measured in: [43: pp. 56-58]
-Inches of water; centimeters of water: used in measuring the lowest pressures such as those in domestic service pipes.
-Inches of mercury; centimeters of mercury: used in measuring slightly higher pressures such as those in industrial service pipes.
-Pounds per square inch (psi); kilograms per square centimeter (kg/sq cm): used in measuring the highest pressures such as those in transportation piping/high pressure holders.
-Atmoshpheres: used in measuring the highest pressures also; a ratio of the pressure in the system to the atmospheric pressure.

Pressures commonly used are: [43: pp. 55, 57, 59, 63, 66]
-5 to 8 inches of water: for ordinary domestic supply.
-30 to 40 inches of water: for medium-pressure mains which are sometimes used to distribute gas to low-pressure mains, service pipes.
-50 to 100 atmospheres: in long distance pipelines and high-pressure holders; gas has been injected into porous underground sandstone storage areas at 40 atmospheres.

The COSTS of installing and operating a gas piping system are lowest when large diameter pipes are used at relatively low pressures, involving relatively thin walled pipe and low pumping costs. An equal volume of gas can be transported in smaller diameter pipes at a high pressure by using thicker/stronger pipes at higher pumping costs [43: pp. 63-64].

The QUALITY/CONDITION of a gas network should be checked to insure public safety. Old, poorly maintained pipes are subject to major leakage problems which can saturate an area and cause violent catastrophes [19: p. 143]. Mechanically joined cast iron pipe of the spigot-and-socket type is most common in distribution mains, necessitating low pressures. While steel is the traditional service pipe material, they are now often made from rigid polyvinyl chloride (PVC). This material is easy to install and is free from the soil corrosion that rusts cast iron/steel [43: p. 66].

The OWNERSHIP/ORGANIZATION of gas collection, transportation, storage, and/or distribution can be: [43: pp. 91-108]
-Public (regional/national): administrating the operation of interconnected regional networks and networks crossing state boundaries.
-Public (municipal/local): organized primarily as local distributors.
-Private Company: serving areas granted to them by a public utility agency through a franchise; their operation is controlled quite firmly by public agencies.

FINANCING a gas supply system can be accomplished by: [43: pp. 91-108]
-Federal Grants: issued for construction of networks in communities where they might not be an economic proposition in USA; only means of finance in France, Great Britain, USSR, etc.
-Private Investment: usually practiced in the sense that capital is subscribed by individuals who may receive dividends in return, but operations (profits) are firmly controlled by public agency.

50. REFUSE COLLECTION

REFUSE COLLECTION

"The word waste refers to the useless, unwanted, or discarded materials resulting from normal community activities. Wastes include solids, liquids, and gases. Atmospheric wastes consist of particulate matter, such as dust and smoke, fumes, and gases. Liquid wastes consist mainly of sewage and industrial wastewaters, including both dissolved and suspended matter. Solid wastes are classed as REFUSE. The physical state of wastes may change in their conveyance or treatment. Dewatered sludge from wastewater treatment plants may become solid wastes; garbage may be ground and discharged into sewers becoming water-borne wastes; and fly ash may be removed from stack discharges and disposed of as solid or as water-borne wastes."

"REFUSE comprises all of the solid wastes of the community. It also includes semi-liquid or wet wastes with insufficient moisture and other liquid contents to be free-flowing" [42: pp. 13-14].

The information included here is rather summarized and should be used only for reference, ranges, or to clarify criteria.

DEFINITIONS

REFUSE COLLECTION(*) - the service for collection and disposal of all the solid wastes from a community.

The PRIMARY PURPOSE of the refuse collection service is the sanitary removal and disposal of the solid wastes, especially garbage, to assure proper control of diseases such as typhoid, plague, dysentary, cholera, etc. [41: p. 38].

"Consumer refuse will continue to be a major problem of urban areas. With a rising population, an increase of refuse production per capita, and increasingly inadequate means of refuse disposal, new disposal solutions and better utilization of current methods are needed.

"The amount of waste generated is generally too great to insure individual disposal in a desirable manner; consequently, urban areas usually provide the service of removal and final disposal.

"The increased population with its increased refuse production results in greater dangers of ground pollution. Great care must be exercised in the placement of the disposal areas to insure the proper respect for economic as well as environmental costs" [19: p. 145].

"The problem of pollution from solid wastes can take several forms; gross or surface pollution, and pollution of subsoil, water and air. In reviewing these problems, it was found that they were especially important in the fringe areas of many metropolitan areas of Eastern and Western Pacific regions, Africa, and Latin America, because of a shortage of basic sanitary facilities" [41: p. 39].

The component REFUSE MATERIALS can be classified in several different ways. Sometimes they are classified by point of origin (domestic, industrial, institutional, commercial, industrial, agricultural or street sources); and, other times they are classified as organic or inorganic, putrescible or nonputrescible, combustible or noncombustible. One of the most useful classifications is based on the character of the materials: [42: pp. 14-22]

-Garbage: wastes from preparation, cooking, serving food.

-Rubbish: combustible: paper, cardboard, wood, plastics, rags, cloth, leather, grass, leaves, etc.; noncombustible: metals, cans, soil, stones, bricks, glass, etc.

-Ashes: residue from fires used for cooking or heating.

-Bulky Wastes: large auto parts, tires, large appliances, furniture, trees, stumps, branches, etc.; require special collection arrangements, vehicles.

-Street Refuse: street sweepings, leaves, catch basin dirt, contents of litter receptacles.

-Dead Animals: from cats, dogs to horses, cows; require special arrangements.

-Abandoned Vehicles: autos, trucks; require special equipment.

-Construction, Demolition Wastes: lumber, roofing, rubble, conduit, wire, insulation, etc.; require special collections.

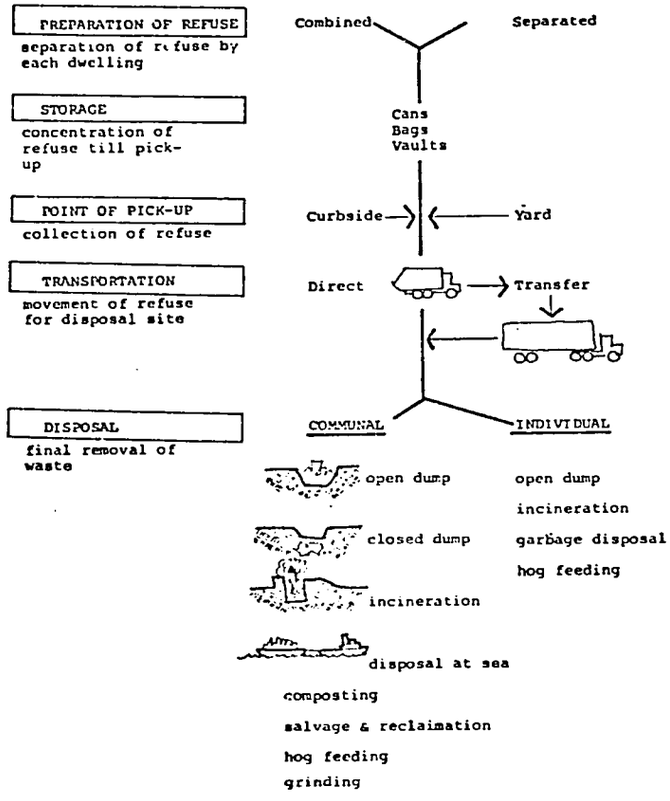
-Industrial Wastes: residues of industrial processes/manufacturing operations; its removal should be the responsibility of the industry.

-Special Wastes: hazardous: pathological wastes, explosives, radioactive materials; security wastes: confidential documents, negotiable papers, etc.; require very special handling and disposal.

-Animal, Agricultural Wastes: manures, crop wastes; collected only when agricultural areas are engulfed by urban growth.

-Sewage Treatment Residues: course screenings, grit, sludge, etc.

REFUSE DISPOSAL NETWORK



PREPARATION OF REFUSE

COMPONENT:	Combined	Separate
RESPONSIBILITY:	individuals of each dwelling prepare refuse	
CONTROL:	public law determines process required	
CHARACTERISTICS:	all types of refuse are in one lot; garbage, rubbish, ashes, street refuse, and industrial wastes becoming more favorable than separate systems. in most urban areas	the garbage is separated from the rubbish and ashes this method is essential if hog feeding is a major form of disposal bottles, cans must be washed to remove food particles
USE EXAMPLE:		BOSTON (U.S.)
ADVANTAGES:	most practical, simple for homeowner most economical for pickup	allows the use of selective disposal methods; salvage, hog feeding. etc. good where individual garbage disposals are used and refuse already separated more effort on part of home owner requires two pickup times and two pickup vehicles; higher cost requires two disposal methods

The COMPONENTS of the refuse collection service are illustrated in the following figures: [19: pp. 146-151]

-Refuse Disposal Diagram (fig #).

-Collection Types Chart (fig #).

-Storage Methods Chart (fig #).

-Pick-up Point Alternatives Chart (fig #).

-Transportation Methods Chart (fig #).

-Disposal Methods Chart (fig #).

METHOD:	METAL CANS	PLASTIC CANS	BAGS	INDIVIDUAL VAULTS	COMMUNAL VAULTS
FUNCTION:	mainly for rubbish, also for garbage	mainly for garbage	mainly for garbage	for rubbish	for rubbish
RESPONSIBILITY:	individual provides in most case; in rare situations the city will provide to promote standardization			individual	developer or disposal firm
CONTROL:	public law controls methods and procedures in all cases				
CHARACTERISTICS:	must have lid to prevent odor and flies from penetration; must be waterproof and lightweight; must be easy to clean; must be within size what one man can carry, usually 75 to 100 pounds; must control rubbish to prevent spread		highly sanitary easy to handle no need to return some cities require plastic bags for garbage	usually constructed of brick or concrete requires shoveling of refuse into truck; a slow and costly operation	metal construction refuse dumped directly into truck or hauled in container to disposal
	usually required by city for its strength and durability must be kept off ground to prevent rusting; life is 2-3 years if underground, invites problems of freezing and water infiltration; but cannot be tipped and it is concealed 55 gallon drums not recommended	ligher than metal; will not rust tends to crack in cold weather rodents may chew through walls susceptable to fire	paper bags are used for rubbish use is very efficient but the cost is high allows reduction in pickup crews not widely used in the US	usually garbage is disposed into them also resulting in objectional odors and difficulty in keep them clean; freezing weather prevents adequate dumping; the danger of fires in vaults is a continual danger usually difficult to keep surrounding area clean located in alleys generally	difficult to keep surrounding area clean located in special areas concealed from buildings holds volumes up to 15 cu.yards
SCALE OF USE:	each dwelling	each dwelling	each dwelling	each dwelling	multifamily housing
EXAMPLE OF USE:	Boston, for rubbish		Boston requires plastic bags for garbage		

POINT OF PICKUP

METHOD:	CURBSIDE	YARD
RESPONSIBILITY:	owner must move to curb or alley	pickup men must move to truck
CONTROL:	public law determines	public law or added payments by owner provide service
CHARACTERISTICS:	refuse contained in cans or other enclosure to prevent scattering	garbage men pick up refuse container from door step and transport to truck; sometimes container returned to yard as part of the service
EXAMPLE OF USE:	Boston (U.S.)	
ADVANTAGES:	lower cost to city	convenient to owner allows neater street; easier and less street maintenance
DISADVANTAGES:	less convenient to owner litters streets with overturned refuse containers	higher cost to city if not borne by added payments of owner

TRANSPORTATION

METHOD:	DIRECT TRUCK PICKUP			TRANSFER PICK-UP METHOD
RESPONSIBILITY:	city or private contractor provides service			
CONTROL:	city policy sets service requirements			
CHARACTERISTICS:	Pick-up vehicle must be odor free, water tight, clean and psychologically obstruse; loading height is the most critical factor for efficient use; size, height and width of vehicle determined by road parameter; vehicles usually also used for snow removal and other services.			In this method the trucks are emptied into a larger transfer van holding 10-20 small truck loads system allows savings in running time to disposal area largest savings is possible if disposal area is 10 miles distant
	Open Top low cost; in most cities; capacity of 10-20 yds; may be used for odd refuse; refuse blows away easily; odor common	Enclosed same as open but no odor or littering by wind; limited in size of refuse capacity	Compactor compresses refuse; saves man-hours; allows large capacity without exceeding street parameters	

The trucks are emptied directly into disposal area.

Frequency of pickup is related to temperature and weather; the hotter the weather, the more frequent the pickup requirements; twice a week in warm climates to once a week in cold are common; once every two weeks in small cities; if garbage is separated from rubbish, it does not require as frequent pickups in hot climates

			DISPOSAL	
METHOD:	OPEN DUMPS	CLOSED DUMPS	INCINERATION	DISPOSAL IN LAKES,OCEAN
FUNCTION:	all refuse into pits or on land sites	all refuse buried into marginal land	combustion of all refuse	dumping of all waste into available water course
RESPONSIBILITY:	city or private contract company provides service			
CONTROL:	city policies and health codes			
CHARACTERISTICS:	located in unwanted areas such as quarries, and marsh lands; on inexpensive land; artificial trenches may be dug if no depressions available must be located in areas not subject to flooding and with proper drainage; geological conditions important to prevent contamination of the water table	requires two foot dirt cover per day	volume reduced .5 to 20%; eliminates moisture and gases; requires 1,250-1,800 F temperature, multiple burners reduce pollution by better combustion individual incinerations illegal in most cities taxes pay for system; 3,000-4,000 dollars per ton initial cost; $4-6 per ton operating cost	barges are used to deposit refuse in water
LOCATION:	downwind,from residential areas; within 10 miles of city; in industrial areas; on marginal land		in industrial areas; wind not a factor	
SCALE OF DEVELOPMENT:	small communities 412 people/ac.foot of dump	medium to high denisty areas 1,430 people/ac.foot of dump	large, high density urban areas 2,080 people/ac.foot of space	
ADVANTAGES:	requires only one collection trip per area low cost, no machines, no supervision,simple allows explosive methane gas to escape	reclaims marginal land; no odor, no health hazard allows 50% reduction in vol.	convenient location, little need for land; not affected by weather, flexible operation bottles and metals may be sold heat may be utilitized if on large scale (Chicago)	no land requied for dumps no eyesore, odor, no health hazard
DISADVANTAGES:	uses large amounts of land difficult to reuse spreads odor holds water, fly danger, eyesore, may pollute water supply ruins future land use fire hazard	may pollute water supply high cost, requires special machines, emits explosive methane gas which must be vented; settles 10-25% within 6 months; 2 yrs before light load support; does not allow basements	high cost, skilled labor, high maintenance costs; ashes must still be removed to dump not justified if land fill available air pollution hazard salvage may be carried on in other methods also	high extra hauling cost by barge water becomes polluted storage needed when lake freezes

MINOR DISPOSAL METHODS

METHOD:	HOG FEEDING	SALVAGE & RECLAMATION	GARBAGE GRINDING	MECHANICAL COMPOSTING
FUNCTION:	maintenance of farm for profit by feeding garbage	use of materials to be sold	shredding of garbage and washing into sewe	biochemical degradati of organic material
RESPONSIBILITY:	private company	city or private company	city, company or individual	
CONTROL:	health codes	market values	city policies	
CHARACTERISTICS:	traditional method of disposal; treated with heat to kill bacterial trickinosis 25% of garbage in US fed to hogs in 1961 (R:31) restaurants and hotels contribute most to program	15% reduction in volume useful for a small portion of refuse only	may be handled by city or by individual older sections of city don"t have disposal units so individual systems must be augmented by city system	resultant fertilizer of very high quality not successful in the US because of the high cost and no market used in European countries extensively
ADVANTAGES:	provides income from refuse minimum effort, inexpensive	potential sale of end products	convenient to owner sanitary method of disposal	end product of fertilizer may be sold
DISADVANTAGES:	most of refuse not eatable; dependent on separated pickup hazard of disease spread usually distant from sources of supply	high labor cost of separation uncertain of product or market unsanitary process	only small portion may be grinded must have two systems high costs difficult to justify might overload sewers; solids increase by 100%; grit by 40%; demands higher pressure and supply	50% of refuse is non-compostible and must still be disposed of in other manner no or little market in the US

The per capita COSTS per year for refuse collection in USA (1960) ranges from $0.24 to $7.40, reflecting wide variations in relative efficiency, amount of service, or the kind of service [42: p. 79]. According to WHO, almost 70% of the total cost of garbage (refuse) disposal is for transport [41: p. 39].

The AVAILABILITY of refuse collection services in relation to a prospective site is a factor to be considered in site selection; but, in general, it can always be provided within reasonable limits of cost and of quality of service. See LOCATION.

The CAPACITY of existing/proposed refuse collection service available to a site should be adequate to carry the QUANTITY of refuse produced by the proposed settlement as well as by future developments in the areas served by the utility. The developer should insure that adequate refuse collection is available to a site in his preliminary site considerations [8: p. 66].

The QUANTITY of refuse collected as related to the quantity produced is a function of such factors as: [4]: pp. 22-27]

-Population: as population increases, refuse production increases.

-Land Use and Intensity of it use: industrial, commercial, and residential areas produce varying quantities of refuse; there may be variations between high, medium, and low income residential areas; as the density of an area increases, the refuse collection required by that area increases.

-Material Consumption: as per capita consumption of disposable material goods increases, per capita refuse production increases.

-Frequency of Collection: with frequent service, more refuse per capita is collected; but, smaller quantities are set out each collection day.

-Refuse Separation: communities requiring refuse separation may make more frequent collections of smaller quantities than those making combined collections.

-Amount of On-site Disposal Permitted: when on-site burning is allowed, refuse quantity decreases; installation of garbage disposals have reduced the quantity collected from 25% to 10% of total refuse; with on-site disposal, collections may only amount to 50-75% of the total refuse produced.

-Cost of Collection: where direct collection charges are made, householders may dispose of more combustibles on-site; costs increase with increased collection frequency.

-General Trends: while garbage and ash quantities are decreasing, amounts of combustible rubbish, particularly paper, plastics, are increasing; there are great increases in volume of refuse and considerably lesser increases in weight of refuse.

The quantity of average municipal refuse by weight in USA has the following composition: [42: p. 39]

-Paper:	42%
-Combustible Rubbish:	22
-Food Wastes:	12
-Noncombustible Rubbish:	24

Variations in quantity of refuse collected occur: [42: pp. 31-32]

-Seasonally: winter climates have winter peaks (ashes), summer peaks (garbage, yard rubbish).

-Daily: peaks after weekends, holidays.

The quantity of individual refuse production in USA (1965) was estimated at 4.5 pounds per capita per day or 1650 pounds per capita per year. Assuming a straight line trend from 1955, growth of refuse production will continue to increase at about 0.07 lb/cap/day or 25 lb/cap/yr [42: p. 25].

US residential refuse quantities collected in 1965 varied from 1.1 lb/cap/day to 3.2 lb/cap/day or from 386 lb/cap/yr to 1152 lb/cap/yr [42: p. 27].

Refuse quantities are measured in: [19: p. 145]

-Pounds per capita; kilograms per capita: measure of refuse produced per person; usually based on per day or per year.

-Acre-foot: measure of dump or fill volume.

The PREPARATION of refuse for collection is an important factor in determining the effectiveness and efficiency of the refuse collection service. If refuse is dumped indiscriminately in a heap in a backyard or alley, the work of collecting and disposing of it is difficult and expensive; and, it is a nuisance and a menace to public health. However, the refuse can be prepared for collection when the householder is made responsible for: [42: pp. 42-44]

A. SEPARATION: into classes/kinds of material.

B. SPECIAL TREATMENT: for each class.

C. STORAGE IN ADEQUATE RECEPTACLES: for public health and ease of collection.

D. LOCATION OF RECEPTACLES: for ease of collection and householder convenience.

E. LIMITING QUANTITY: to make collection service uniform.

PREPARATION OF REFUSE FOR COLLECTION [42: pp. 42-74]

A. The PREPARATION of refuse is influenced by the disposal method used for various classes of refuse. The following disposal methods usually employed by municipalities and the separation required in each instance are discussed below:

-Hog Feeding: garbage must be separated from all other refuse.

-Central Grinding: cans, bottles, broken glassware, crockery, metals, ashes, and similar refuse must be separated from refuse which can be ground and discharged into the sewerage system.

-Incineration: combustibles must be separated from noncombustibles.

-Open Burning: combustible materials except garbage should be separated from other refuse.

-Open Dumping: ashes, masonry building rubble, etc. may be disposed by open dumping.

-Sanitary Fill: no separation required.

-Ashes for Cover Material: ashes, other mineral matter are separated for use as cover for open dumps/sanitary fills.

-Ashes for Street Maintenance: ashes must be completely separated from all other refuse.

-Composting: vegetation, leaves, etc. must be separated from all other non-decaying refuse.

-Recovery and Sale: householders required to separate designated materials which the city can sell.

Separation can be affected by collection practices such as:

-Multiple collection agencies which demand that materials handled by each be kept separate.

-Differences in frequency of collection can necessitate the separation of refuse into several classes.

-Bulky trash items such as tree branches, household appliances, etc. are sometimes collected by special vehicles.

B. SPECIAL TREATMENT of garbage, rubbish, and ashes may be required in order to insure better sanitation, more economical collection, or more effective disposal.

Special preparation of garbage for collection is usually given the most attention by the city officials responsible for collection and disposal of refuse, because of its high putrescibility and greater difficulty of disposal. Usually it must be drained of free moisture, often it has to be wrapped in paper, and in some instances the bundles must be tied.

Special preparation of rubbish for collection is required by many cities to reduce the cost of collecting certain kinds of bulky material such as:

-Cartons, Boxes: may be required to be broken apart, laid flat, and tied in bundles.

-Tree Branches: may be required to be cut into 4 foot lengths and tied into bundles of not more than 75 pounds.

-Tin Cans: may be required to be washed and/or crushed.

-Household Furniture, Appliances: may be collected as whole units by a special service or as bundles of broken pieces by regular service; may be collected by charitable organizations for salvage.

-Dangerous Rubbish: poisons, explosives, acids, caustics, infected materials are usually required to be disposed of directly by individuals.

Speical preparation of ashes for collection includes the presentation of only cold ashes for collection in specified containers.

C. Separation and special treatment of refuse is of little value without STORAGE IN ADEQUATE RECEPTACLES to protect the refuse until it is collected. There are several kinds of refuse containers that insure sanitary storage of garbage, prevent the escape of refuse, and provide for economical collection. Garbage containers must be watertight, have tight-fitting covers, and be easy to clean. Rubbish receptacles should not allow refuse to leak through crevices or be blown from the top. Containers for ashes should be leakproof and fireproof. All receptacles should be easy to empty and be equipped with handles. Receptacles should be sized according to the weight of the refuse to be contained in order to make the handling of them easy and economical for collectors.

D. The LOCATION OF RECEPTACLES must be at the place from which the regular collectors will accept them. In many cases, householders find such locations also the most convenient places to keep the containers between collections. However, when collections are made from the curb, the containers must usually be kept elsewhere. The location of receptacles is largely a matter of municipal regulation, although it may be left to the householder's convenience.

E. Regulations for LIMITING THE QUANTITY of refuse which will be collected from a single residence at one time are established to:

-Maintain the service rendered on a uniform basis.

-Insure a more or less constant collection from week to week.

"However, regardless of who collects and hauls the refuse, the government should police the activity to insure conformity to regulations/standards insofar as they affect the communities health" [42: p. 3].

Two types of standards must be recognized when considering refuse collection: [42: p. 3]

-Public Convenience: collection location (curb vs. backyard), collection frequency, combined vs. separated collections, etc.

-Public Health: refuse storage regulations, minimum collection frequencies, refuse collection vehicle regulations, etc.

The principle methods of FINANCING refuse collection are summarized as follows: [42: pp. 268-295]

-General Property Tax: distributes collection cost on an ability to pay basis, insures collection from all properties, operates with less overhead than billing methods; but, allows large refuse producers to be subsidized by the small producers.

-Separate Property Tax: levies tax on property for the specific purpose of refuse collection; has similar limitations and advantages as general property tax.

-Service Charges: collected on basis of the measured/estimated quantity of waste removed; makes charges/fees proportional to cost of refuse collection; makes administrative costs of billing high.

-Can, Container Rental Charges: made to provide refuse producers with municipally owned, standard receptacles, and to cover costs of emptying, servicing, maintaining, and replacing these containers.

-Special Assessments: made against properties benefiting from the service.

-Miscellaneous Revenues: sale of private collection licenses, fees for salvage privileges, sale of salvaged material, sale of collection privileges, etc.

"It is generally accepted that municipal functions performed for the good of a whole community should be financed from general taxation, while those conducted for the particular benefit of certain individuals or organizations should be supported by charges or fees against the persons or properties benefited" [42: p. 269].

The RESPONSIBILITY/CONTROL for regulating the functions and services of refuse collection should rest with the local government, since the storage, collection, and disposal of refuse affect the health and welfare of community. Refuse collections may be performed by: [42: p. 3]

-Government agency

-Contractor under contract with the government.

-Contractor under direct contract with the resident or refuse producer.

-Refuse producer himself.

THE SOLID WASTE PROBLEM [49: p. 128-129]

"An extremely serious problem facing the United States and other affluent countries is the accumulation of solid wastes in open dumps or inadequate fills. These dumps are not just aesthetic disasters; if they are burned they contribute to air pollution, water percolating through them pollutes groundwater supplies, and they serve as breeding grounds for such annoying and disease-bearing organisms as rats, cockroaches, and flies.

"It is becoming universally recognized that current methods of dealing with the solid waste problem are utterly inadequate. A report by the U.S. Department of Health, Education and Welfare recently labeled 94 percent of the 12,000 disposal sites in the United States as "unacceptable." Many cities are facing disposal crises as population growth simultaneously produces more waste and reduces the available land for dumping. Waste disposal is another classic case where per capita costs tend to go up as population grows.

"Sanitary landfill, where space is available, is a more satisfactory (and expensive) solution than dumping, but it also generates many problems. Water pollution continues, dust pollution is created, and nonbiodegradable materials (those not quickly broken down by microorganisms) which do not compact easily, lessen the utility of the fill. Incineration of wastes is another answer which in France and other European countries has been combined with power production in trash-fired power plants. Unless great care is taken, of course, this answer may merely substitute air pollution for land pollution."

METHODS FOR INCREASING THE EFFICIENCY OF REFUSE DISPOSAL

A. RECYCLING/REUSE OF REFUSE: could reduce the weight of materials for disposal by up to 40% in the US. Paper, paper products, and certain metals are potentially reclaimable not only in terms of the known technology of recovery, but also in terms of the volumes of these materials. Recycle of glass, rubber, and plastics should also be studied [48: p. 27].

"In the face of the obvious need to minimize the wasteful scattering of nonrenewable resources, the design of all of man's manufactured devices, from home appliances to computers, should take into account the possibility of recycling their components" [49: p. 129].

B. LEGISLATION: could place heavy taxes on any product or wrapping that is designed to be discarded rather than recycled, and could prohibit the manufacture of nonbiodegradable products. Heavy deposits could be required to encourage the recycling of reusable materials [49: p. 129].

C. REFUSE SEPARATION SYSTEMS: may have economic advantages that go beyond the value of reusing resources. Lower cost of disposal can result from a decrease in tonnage left after separation. Methods of mechanical processing/separation include: screening, air tables, flotation, magnetic and heavy media separation, vibration, and chemical treatment [48: p. 34].

D. REFUSE COMPACTION: reduces the volume and increases the density of refuse, thereby reducing transportation costs and facilitating final deposit. Compacted refuse could be transported by rail from urban centers to areas in need of fill material for reclaiming submarginal lands resulting from strip mining/erosion [48: pp. 33, 34].

48. DEVELOPMENT MODE

49. IMPLEMENTATION

50. FINANCIAL PLAN

51. SOCIAL

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