Urban Areas

City Regions

Urban Areas

- Quantitative, numeric definition

  ex. The US Bureau of the Census defines urban areas as those in which the human population reaches or exceeds densities of 186 people/km2

- Qualitative definition, based on flows and influences

  Urban ecosystems comprise suburban and hinterland areas linked by corridors (transportation, utilities) or affected by the urban core

  Gradients show a range of urban effect and existence of thresholds

Slightly less than half of the world's population now resides in cities, but this is projected to rise to nearly 60% in the next 30 years (United Nations 1993).
The developed nations have more urbanized populations; for example, close to 80% of the US population is urban.

The resulting new forms of urban development, including housing interspersed in forest, shrubland, and desert habits, bring people expressing urban habits, and drawing upon urban experiences, into daily contact with habitats formerly controlled by agriculturalists, foresters, and conservationists (Bradley, 1995).

In the broadest sense, urban ecosystems comprise suburban areas, exurbs, sparsely settled villages connected by commuting corridors or by utilities, and hinterlands directly managed or affected by the energy and material from the urban core and suburban lands.

Urban ecology

- Scientific definition

  Studies of the distribution and abundance of organisms in and around the city and on the biogeochemical budgets of urban areas

- Urban planning definition

  In planning urban ecology focuses on ecological justification for specific planning approaches and on reducing environmental impacts

Ecology IN the cities
Ecology OF the cities

- Ecology IN

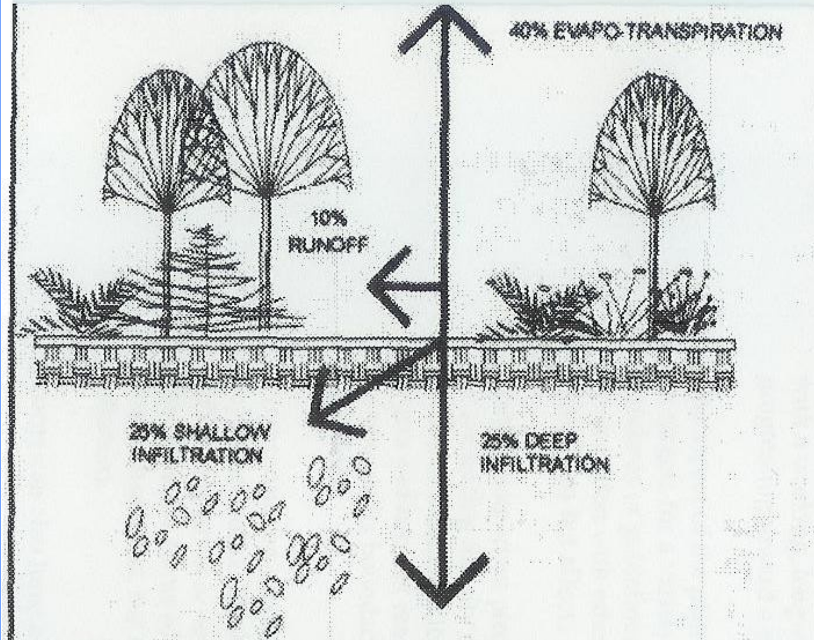
The pioneering and most common approach, examines ecological structure and function of habitats or organisms within cities.

The urban heat island, climate modification directly related to urban land cover and human energy use

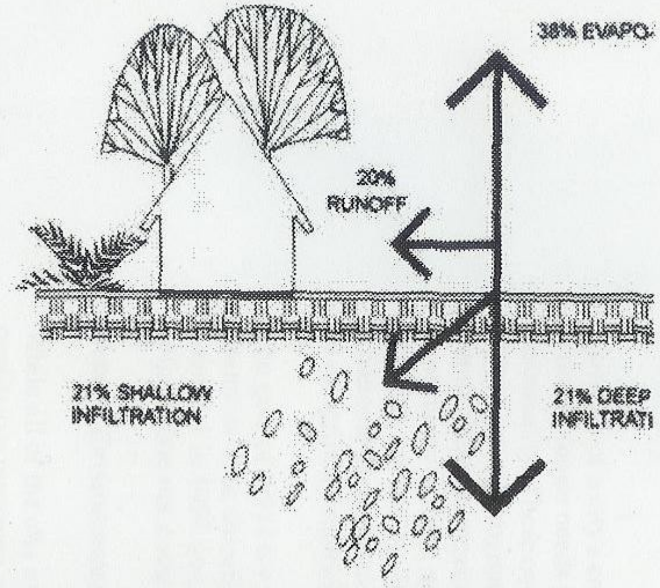
Increased temperatures enhance ozone formation and pollution, with ozone pollution crop production decreases 5-10%

Particulate condensation enhances precipitation 5-10%, greater cloudiness and fog

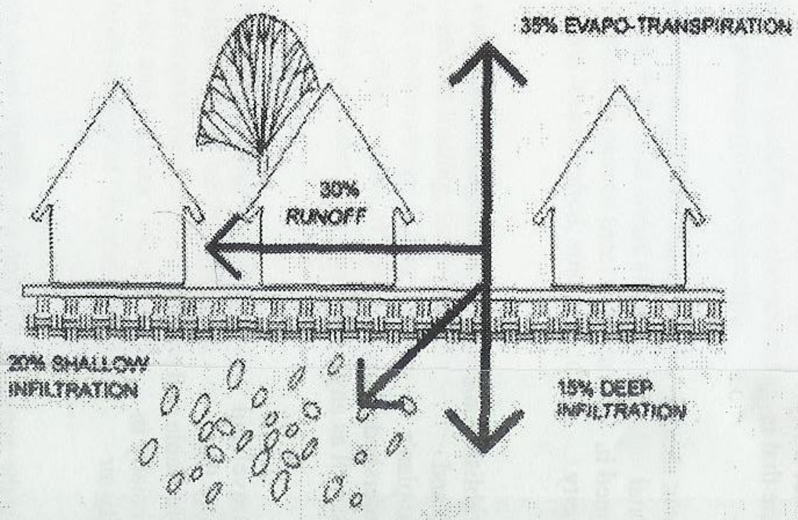
Surface runoff increase, evapotranspiration and water infiltration decrease



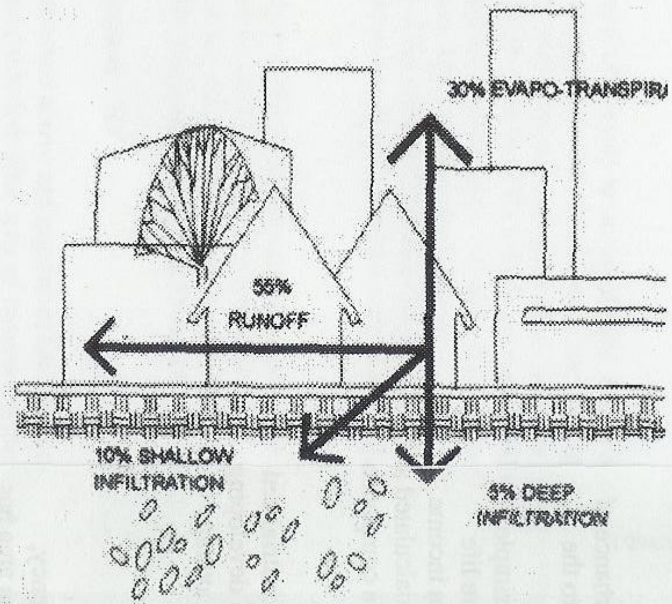
NATURAL GROUND COVER



10-20 % IMPERVIOUS SURFACE



35-50 % IMPERVIOUS SURFACE



75-100 % IMPERVIOUS SURFACE

- Ecology IN

Vegetation

simplified structural composition (less layers)

diminished percentage of native species

In an urban park in Boston, of the plant species present in 1894, 155 were absent by 1993, amounting to a decrease from 84% to 74% native flora. Sixty-four species were new.

Wildlife

interaction and gene flow altered by fragmentation

generalist species increase, woodland species decrease, exotic generalists such as pigeons, starlings, and sparrows can constitute 80% of the bird community in the summer, and 95% in winter (Wetterer 1997).

Soil

physical disturbances by fill material, coverage by impervious surfaces,

addition of fertilization and irrigation, concentration of heavy metals,

salt and acidity

Urban Soils

Human effects on urban soils

- Removal of plant/animal nutrients
- Drainage, mining, excavating
- Altering water tables
- Addition of pathogenic organisms, toxic materials
- Burying soil under solid fill or water

Example: National Mall in DC

- Marshland filled to 6 m above original elevation with rubble
- Railroad station late 1800's
- Temporary housing during WWI
- Demolition and new streets, sidewalks and buildings
- Current management: aeration and application of composted sewage sludge

Example: Great Mall in Central Park

- 1842: 25 acre reservoir
- 1930: thin soil layer capping a debris landfill; significant heavy metal levels
- Subsequently: heavy use, compaction, erosion, runoff into adjacent lake

Characteristics of Urban Soil

- Vertical and spatial variability
- Modified structure (compaction)
- Surface crust on bare soil (hydrophobic)
- Presence of anthropogenic materials, contaminants
- Modified temperature regimes

- Elevated pH
- Restricted aeration and drainage
- Interrupted nutrient cycling
- Modified biological community

Vertical and Spatial Variability

- Changes abruptly at one or more levels in the profile (lithologic discontinuity) due to stripping, filling, mixing, etc.
- Cumulative effects of historical uses: agriculture, roadways, buildings, utility lines, digging, filling, leveling, organic additions
- Backfilled topsoil often from another site

Structure and Compaction

- Natural processes tend toward aggregation and lower bulk density
- Soil manipulation breaks aggregates apart and increases bulk density
- Disrupted organic matter cycle → poor structure and low biological activity
- Disrupted freeze-thaw cycles
- High salt content encourages dispersion
- Little vegetative cover → bare soil → erosion
- Anthropogenic compaction

Surface crusting

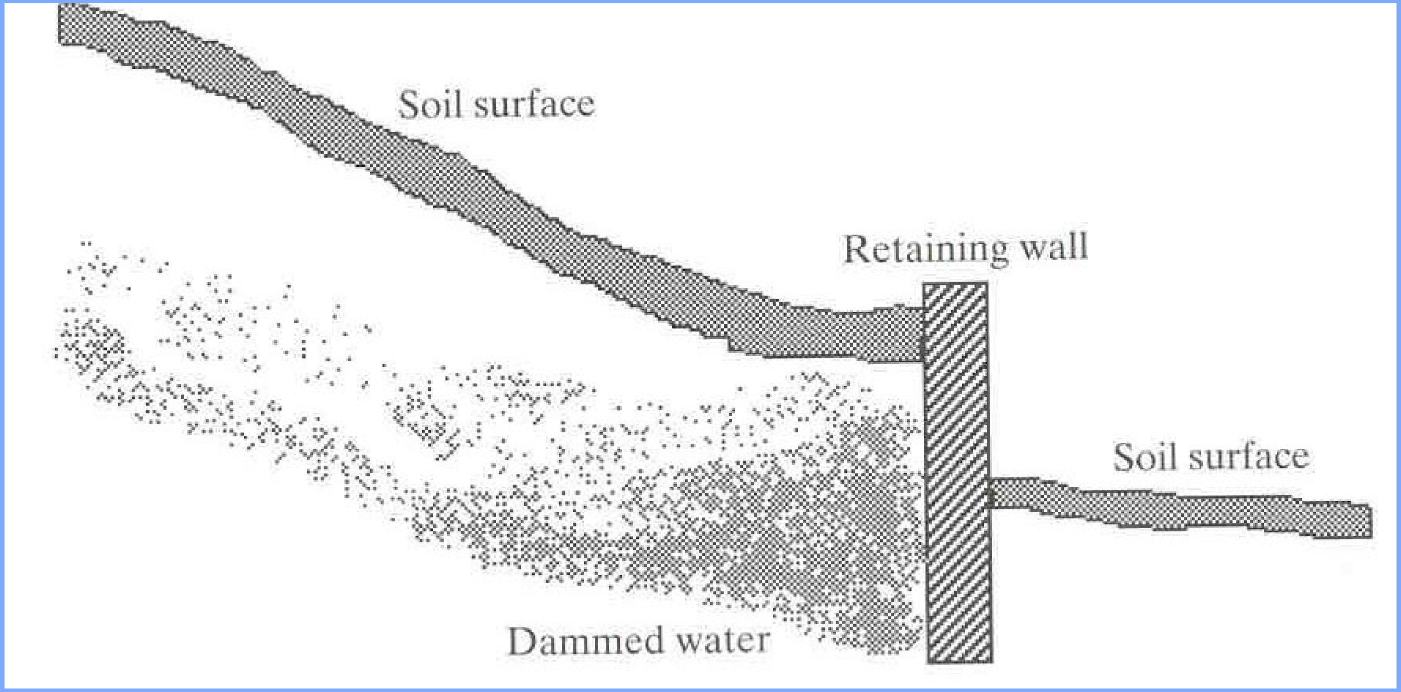
- Deposition of petroleum-based aerosols and particulates → water-repellant compounds
- Bare soil → exposure to raindrops → disintegration of surface aggregates
- Reduced infiltration and gas exchange

pH elevation

- De-icing with $CaCl_2$ or $NaCl_2$
- High Ca atmospheric pollution
- Release of Ca from construction rubble (bricks, plaster, cement)
- Acid rain washing Ca from building faces

↓ Aeration and Drainage

- Disrupted continuity (walls, sidewalks, curbs, pipeshafts, streets, foundations, grade changes) → damming, ponding
- Impermeable covers (asphalt, concrete) slow wetting and drying



Soil temperature

- Heat loading: incoming radiation absorbed and re-radiated by buildings and streets; low vegetative cover so most reaches soil
- ↑ heat

  -↑ day and night air temperature (0.5-1.5°C)

  -10-20% ↓ wind speed

  -2-10% ↓ relative humidity

  -5-10% ↑ clouds and total rainfall

Organic matter

- Low inputs (leaves and litter cleared away)
- Low biological activity
- Few or no earthworms

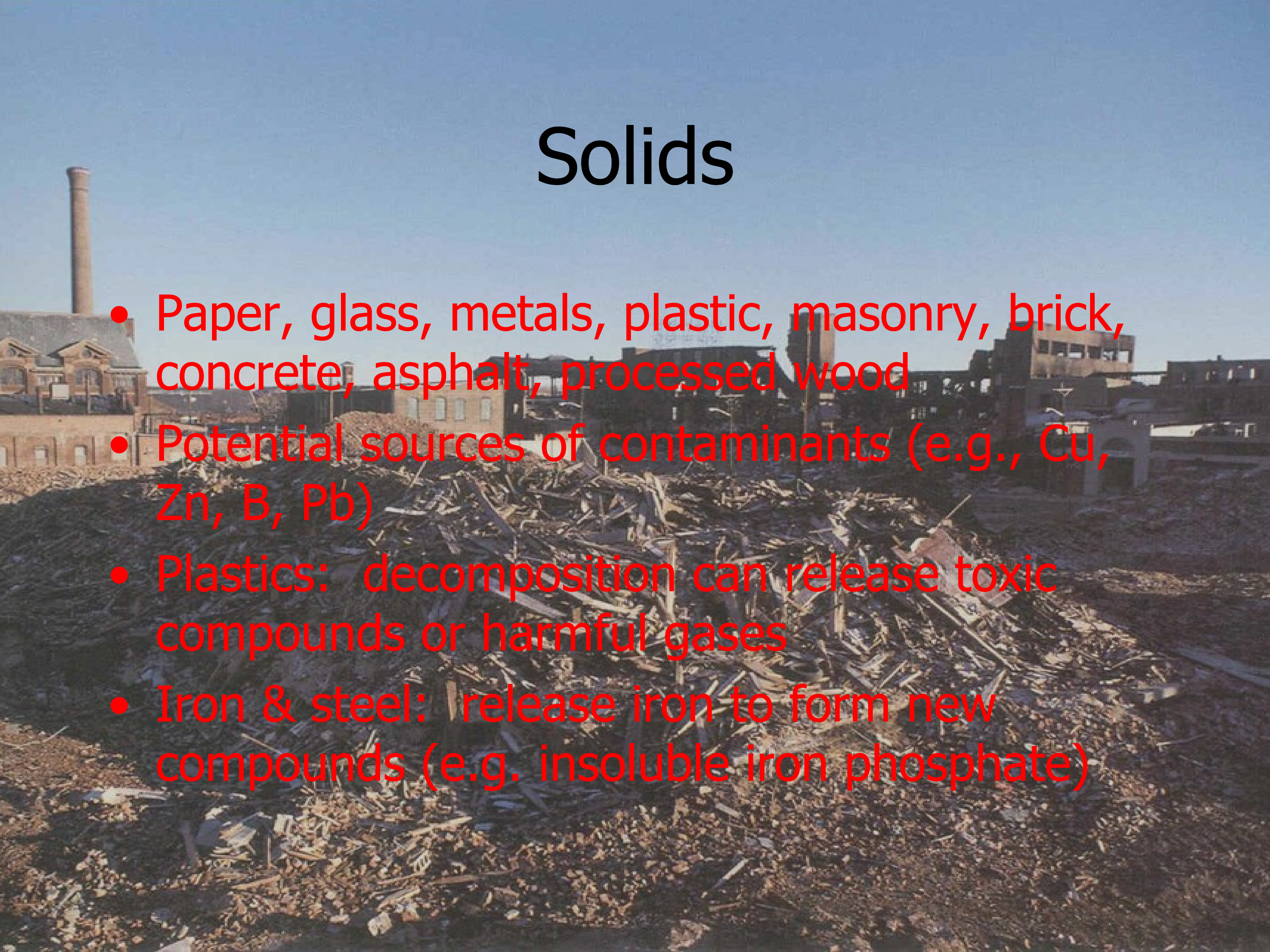
➢ Results in ↓ fertility

Fill materials

- **Structures demolished and rubble used as hard fill**
- **Leveling and reshaping of terrain**
- **High % of solid contaminants**
- **Wet areas commonly “reclaimed” with fill (Made Land)**

Soil Contamination

- Concentration of a substance in soil above background levels; may exceed toxicity threshold
- Deliberate dumping or application, storage, wet or dry deposition, transport from overland flow, remnant materials



Solids

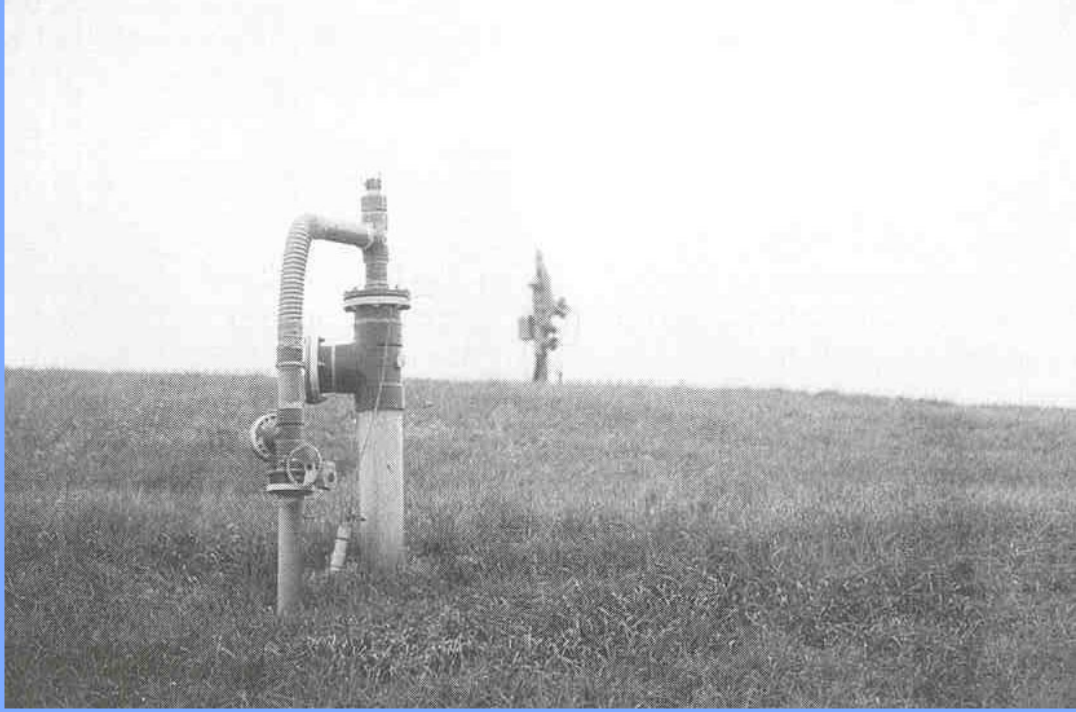
- Paper, glass, metals, plastic, masonry, brick, concrete, asphalt, processed wood
- Potential sources of contaminants (e.g., Cu, Zn, B, Pb)
- Plastics: decomposition can release toxic compounds or harmful gases
- Iron & steel: release iron to form new compounds (e.g. insoluble iron phosphate)

Liquids

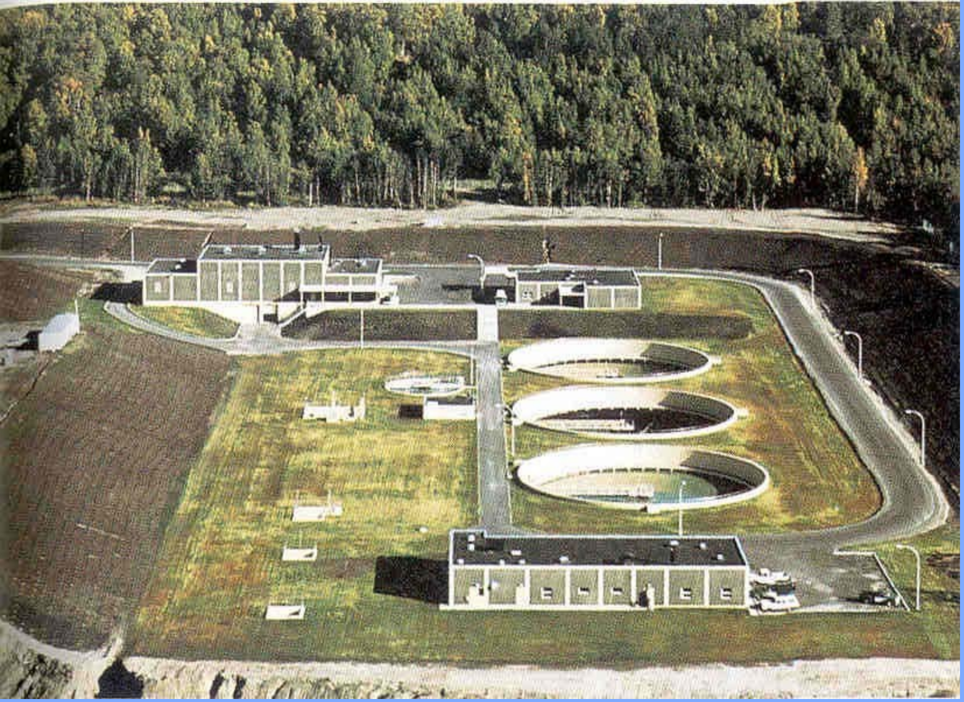
- Industrial wastes
- Sewage effluents
- Sludges
- Industrial washwater
- Runoff

- Heavy metals
- Sulfates, sulfides
- Nitrates, ammonium
- Salts

Gases



- Landfills: methane, CO_2 (plus traces of CO, ethane, HS, NH_3, ethylene, propylene, hydrogen cyanide) displace atmospheric gases (incl. O_2) and alter redox status in the overlying soil
- Radon (from uranium-bearing bedrock) can diffuse through soil and foundations into buildings
- Gasoline leaks
- Buried industrial wastes



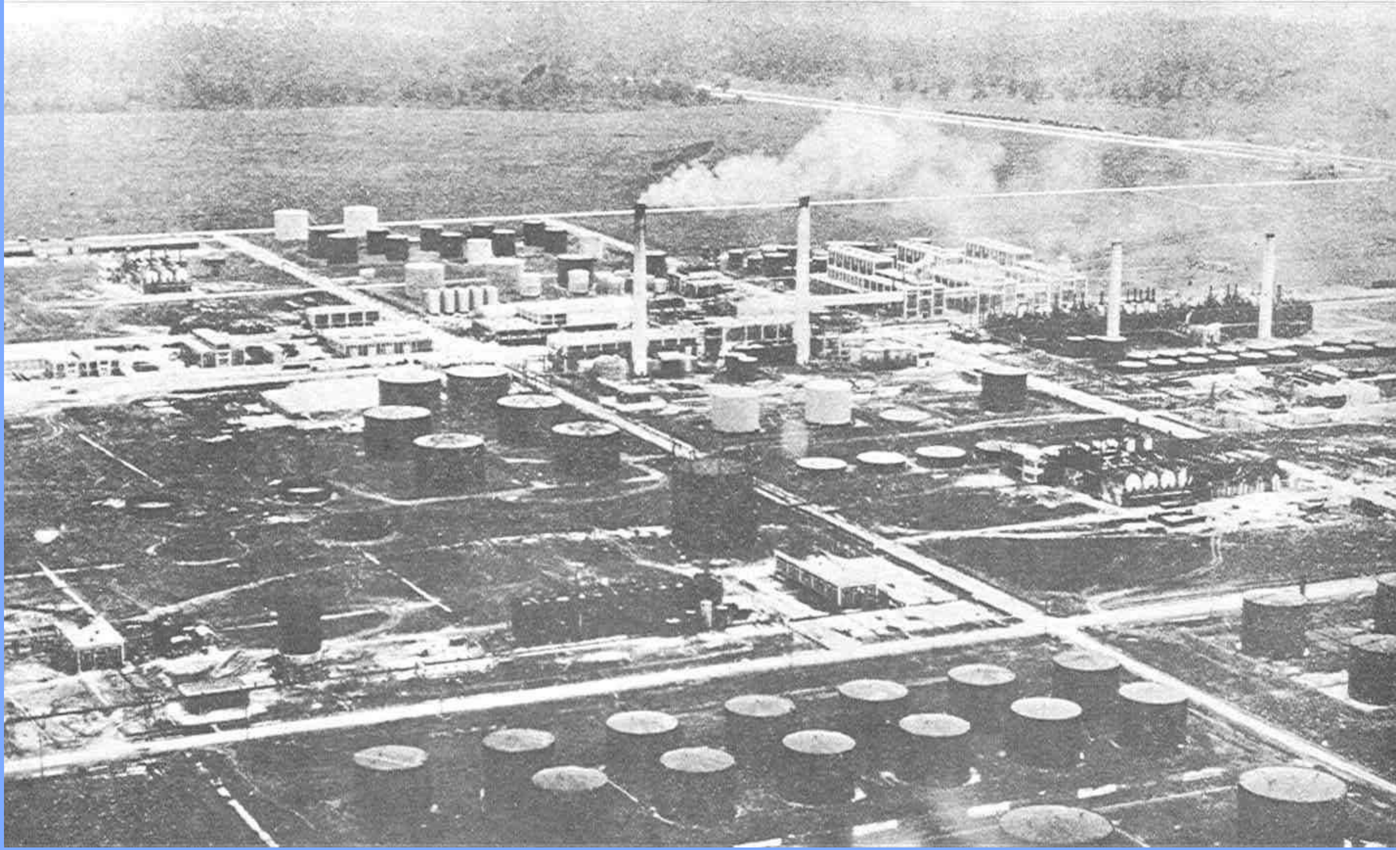
Organic wastes

- Imported: organic wastes (industrial, sludge) applied to non-urban land and imported as fill
- On-site: remnant organic material from early urbanization
- Sludge and composted sludge may contain heavy metals; repeated application may lead to accumulation

Pesticides

- Imported: Pesticides applied to non-urban land and imported as fill
- On-site: Urban pesticide applications
- Urban soils sometimes higher in pesticide residue than agricultural soils in the same region
- Chlorinated hydrocarbons and other banned pesticides persist in the soil; decomposition slowed by low biological activity

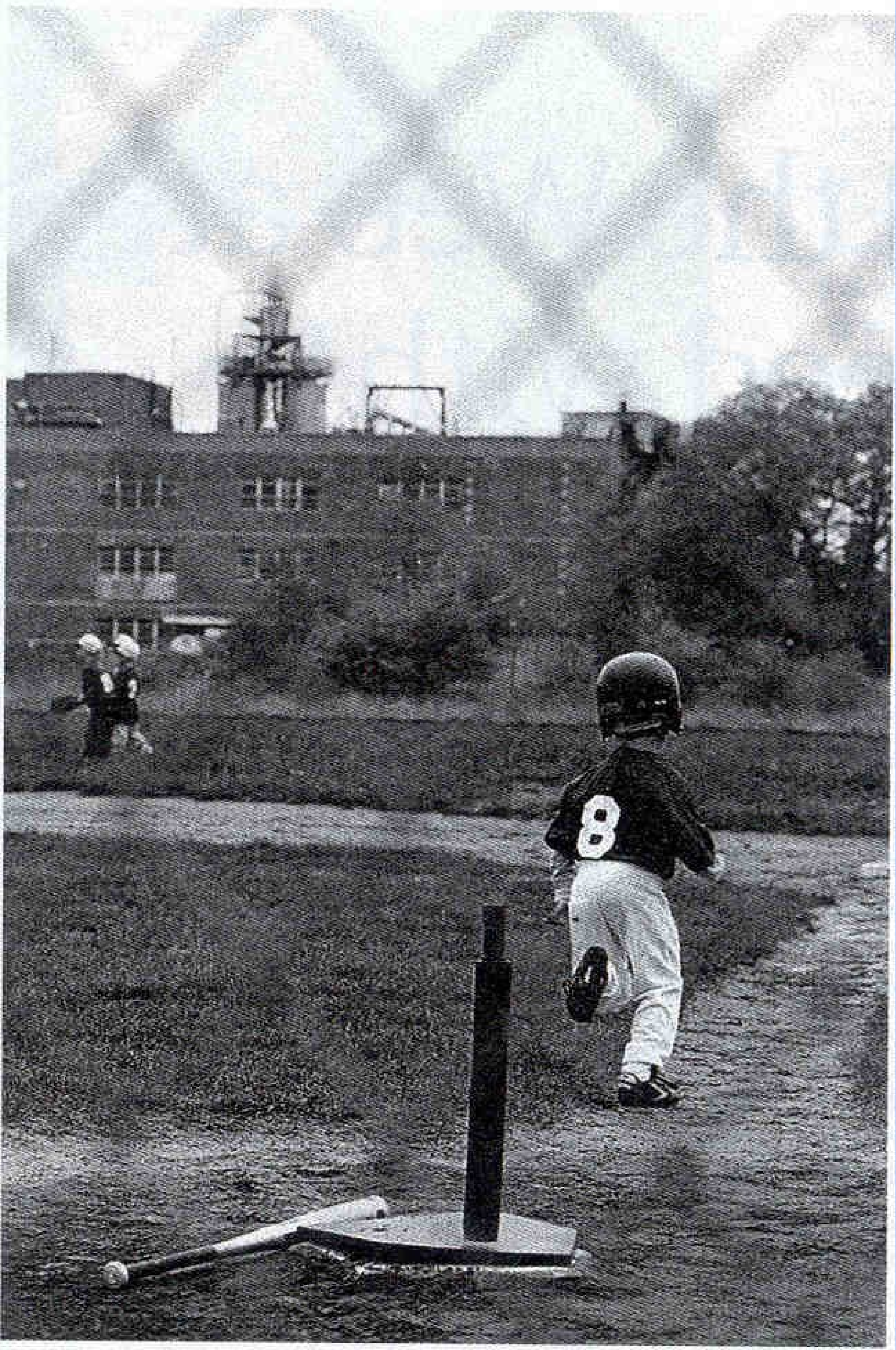
Heavy metals



- Atmospheric deposition of metallic aerosols from fossil fuel combustion, power plants, industrial processes.
- Absorbed by plants and soil organisms
- Persistent; slow leaching from the soil

Sources of heavy metals

Arsenic	Pesticides, coal & petroleum wastes, mine tailings
Cadmium	Electroplating, paint residues, plastics, batteries
Chromium	Stainless steel, chrome-plating, paints, fire brick
Copper	Mine tailings, copper dust, fly ash, fertilizers
Lead	Batteries, wet & dry deposition, steel mill residues
Mercury	Industrial catalyst, pesticides, metals
Nickel	Wet & dry deposition, electroplating, batteries
Zinc	Batteries, galvanized metals, brass & rubber production (Craul, 1992)



Why do we care?

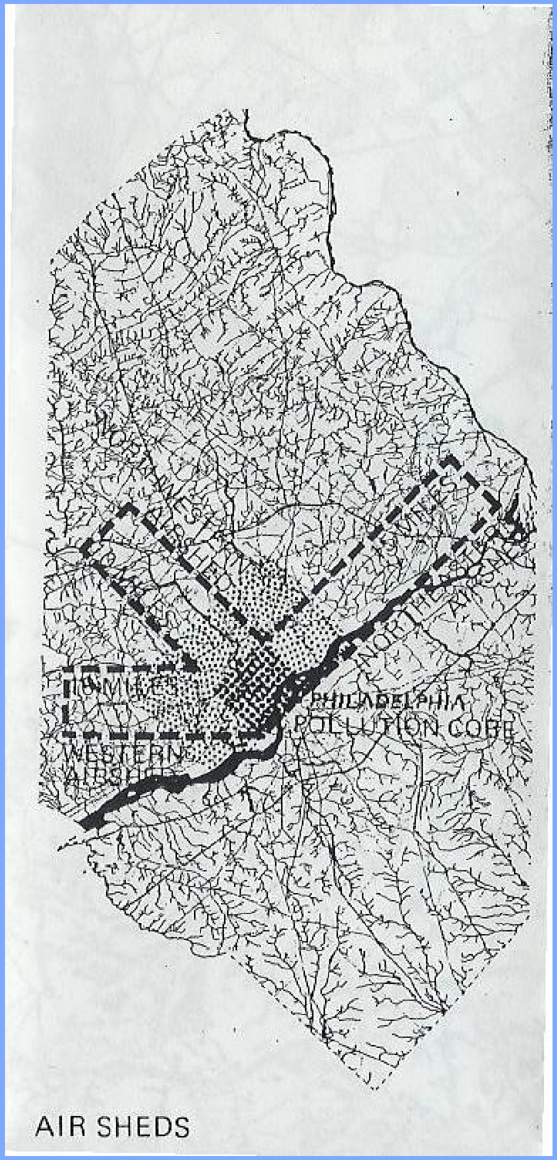
- Contaminants: contact with polluted soil through recreation (children especially vulnerable), urban gardening programs (food chain), volatilization
- Street trees and green spaces: plant health may be severely restricted
- Soil is largely a non-renewable resource; as larger and larger areas become urbanized we need to find ways to maintain good soil condition

Health implications

- Exposure to industrial contaminants is linked to health effects such as asthma, stillbirths, miscarriages, neurological disease, and cancer
- Effects on domestic animals, wildlife and fish

Implications for urban gardens

- Cornell study (1983) of NYC vacant lots found lead concentrations of 93-1,010 ppm
  - Daily consumption limit: 1g/day of soil with 300 ppm lead (~1/4 tsp.)



- Philadephia winds

  west, northwest, northeast

- Air volume

  15 cubic miles

- Airsheds

  at 4 mph, on the long axis 15 miles, on the cross axis 10 miles to provide ventilation

- Ecology OF

Budgetary approach

dynamic, open system interaction within communities

flow between patches

If we think of the industrial city at the simplest possible level in systematic terms, we can visualize it as a system of one-way flows of energy and materials. The flows proceed from sources in the outer landscape, to production and consumption in the city, to waste sinks in the air, water, and land. Sources are continuously depleted and have few means of regeneration because the materials that might otherwise replenish them are going into distant sinks. The sinks are continually overfilled because their natural capacity to assimilate energy and materials is far exceeded by the concentrated quantities being put out from the cities. ….. it will require that we rethink our ways of designing cities (Lyle, 1993)

- The working landscape becomes the unifying, integrating network of urban form, rather than a decorative addition as in the industrial city.

- The urban landscape collects water when it rains and holds it in ponds or tanks for future use or allows it to infiltrate slowly into underground storage. The same working landscape that filters, assimilates, and stores water and nutrients also serves to filter, cool, and direct the flow of air. Masses of trees are located around heavily traveled streets, industrial plants, and other sources of air pollution, where they assimilate some pollutants, such as carbon dioxide, and produce oxygen. They also create micro-climates within the city.

- Making visible the ecological processes that support life is an important part of this emerging landscape. Within this green matrix, communities form identifiable neighborhoods.

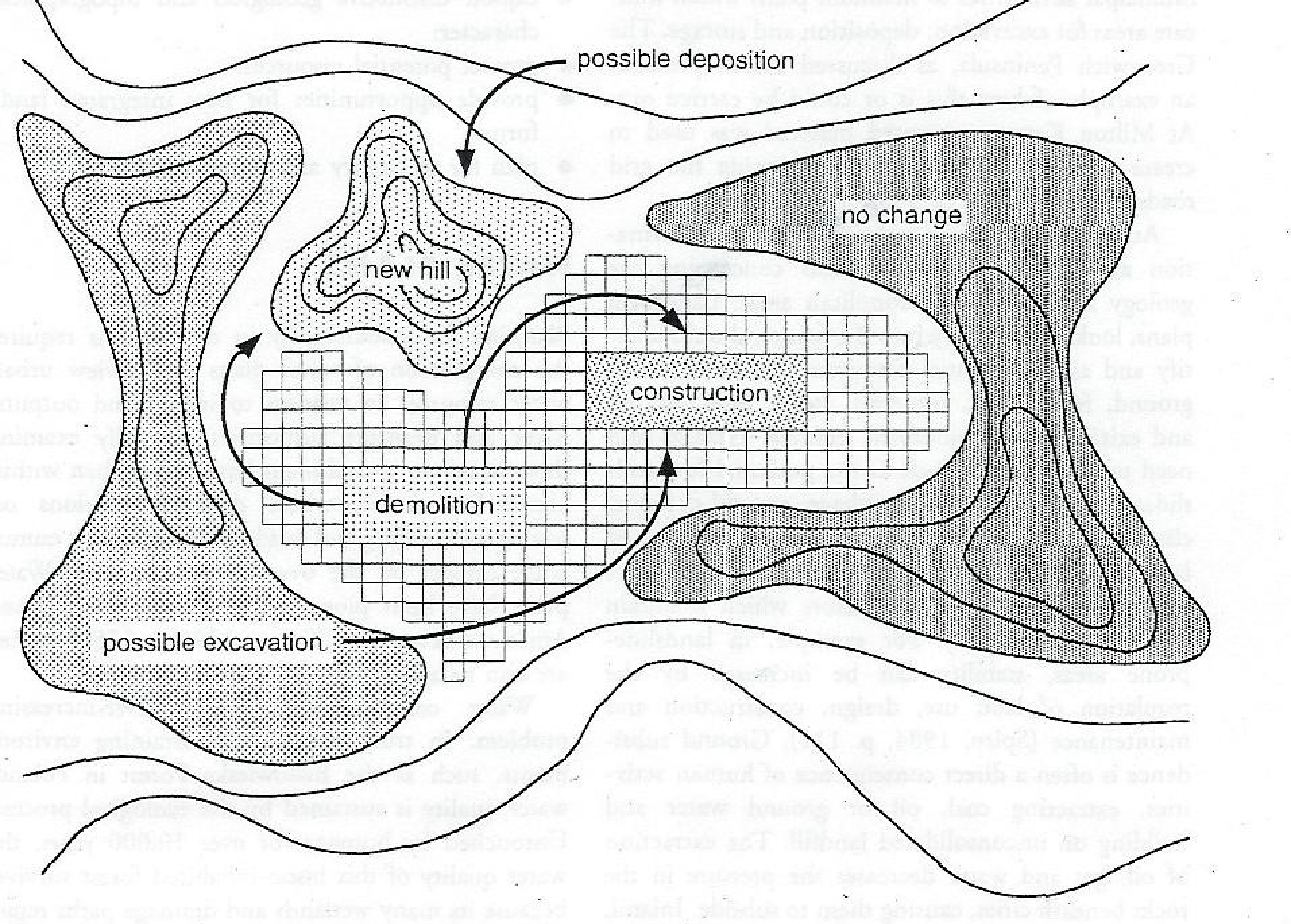


Figure 9.3 Landform plans could show where change is possible, desirable and undesirable.

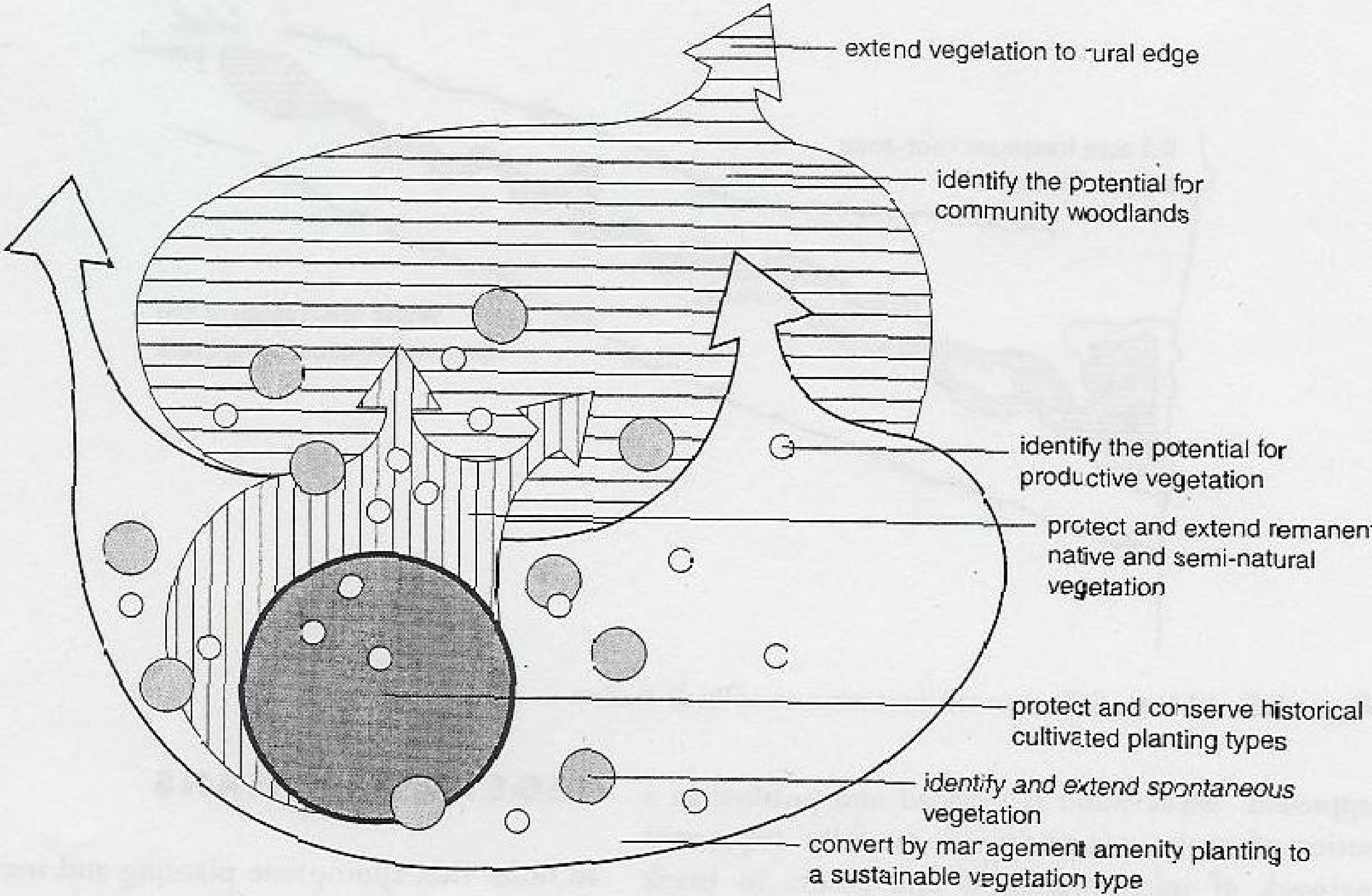
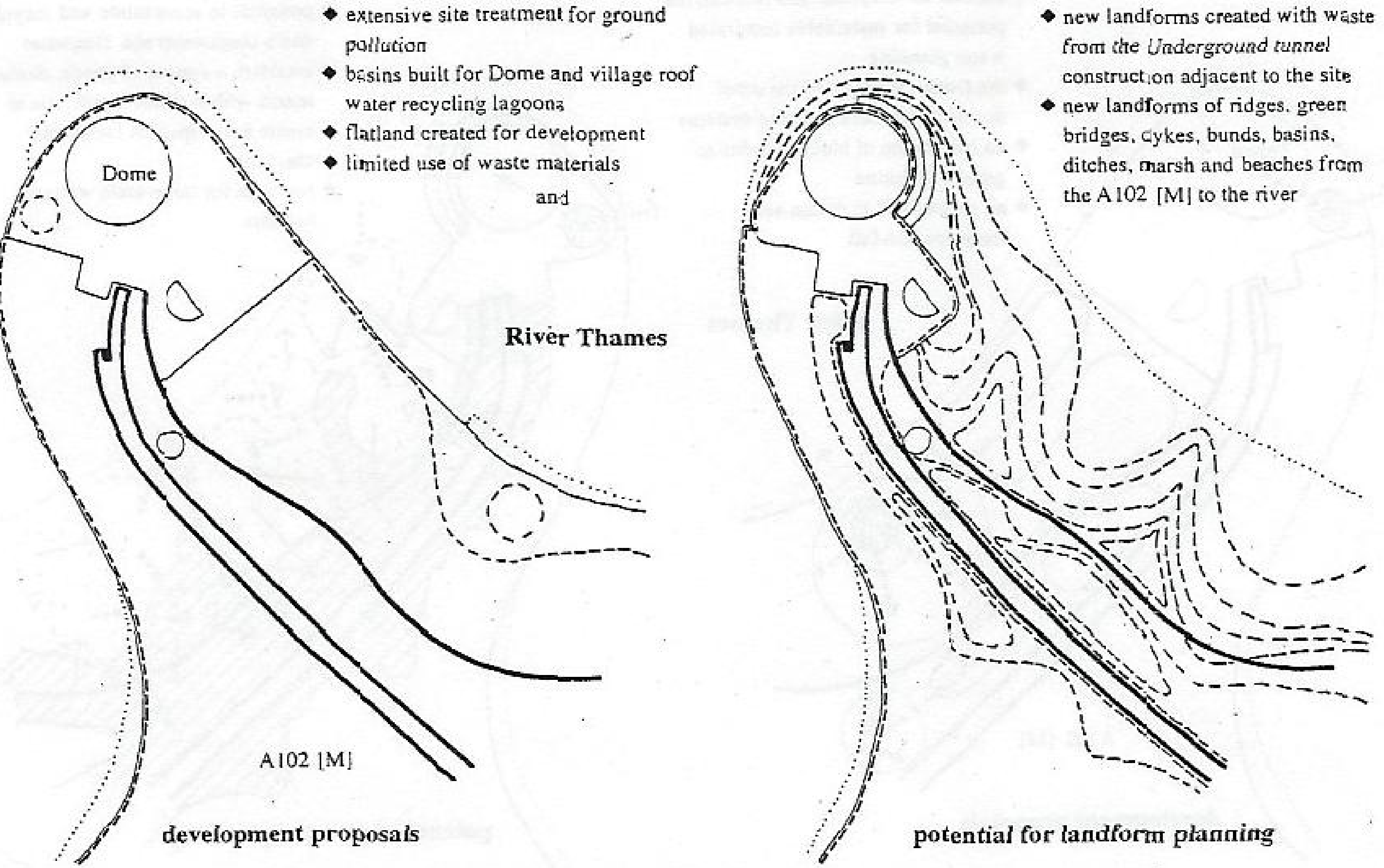


Figure 9.6 Potential for vegetation change.



ure 9.12 Greenwich: the development proposals – potential for landform planning.

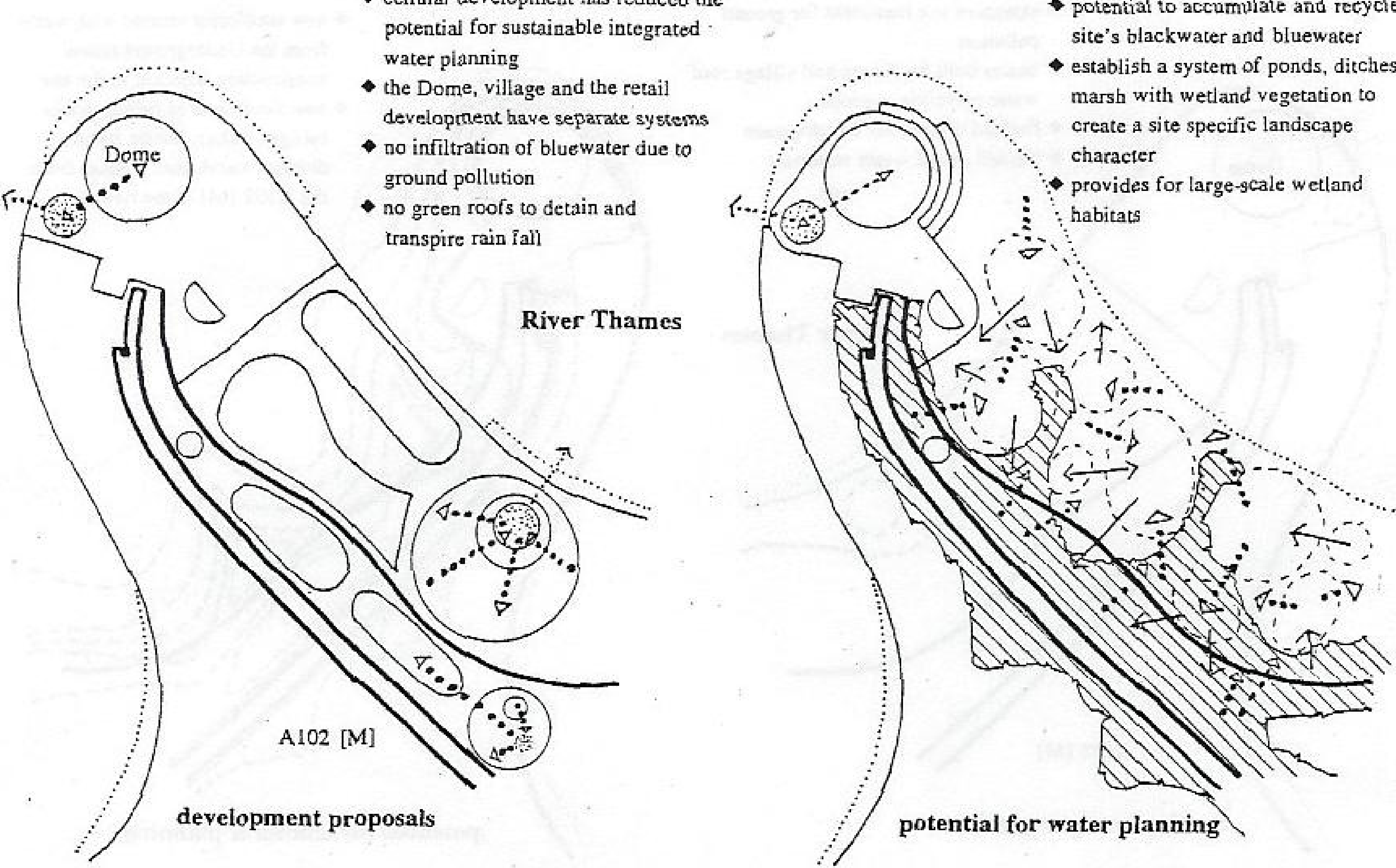
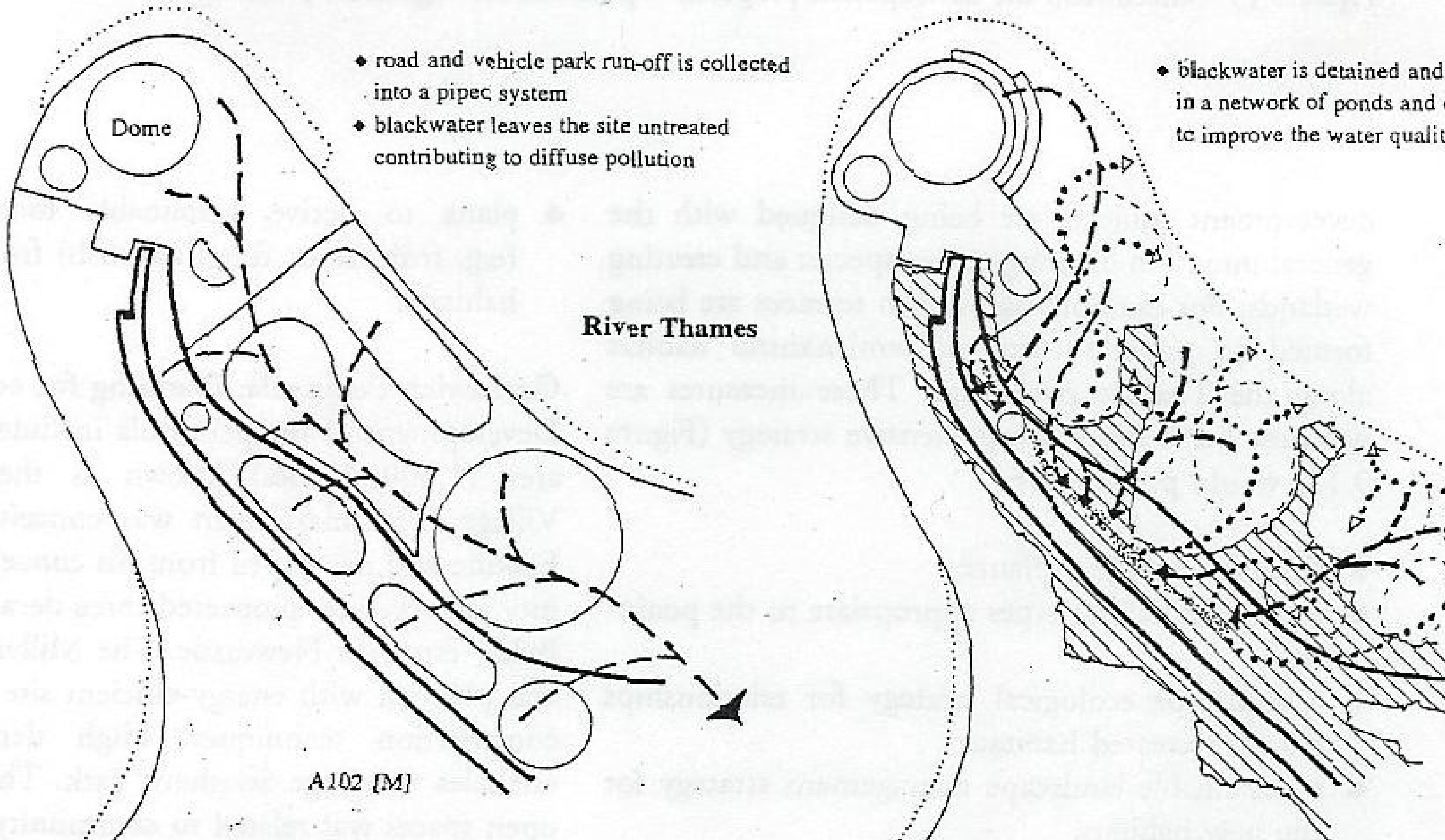


Figure 9.13 Greenwich: the cellular development proposals – potential for integrated water planning.



development proposals

potential for blackwater planning

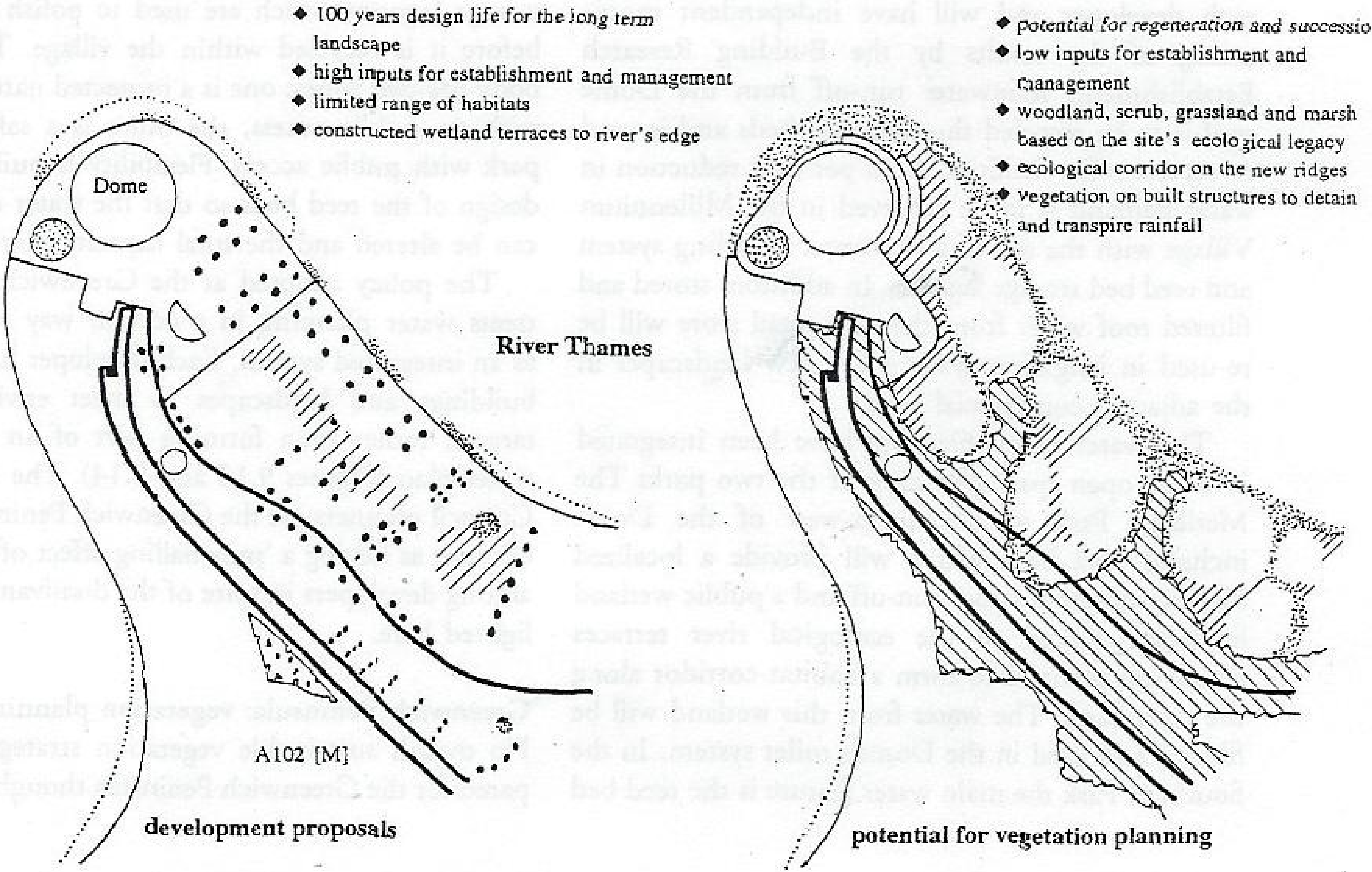


Figure 9.15 Greenwich: the development proposals – potential for vegetation planning.

www.greenwichpeninsula.co#554BC