PART I　緒論

河川與城市

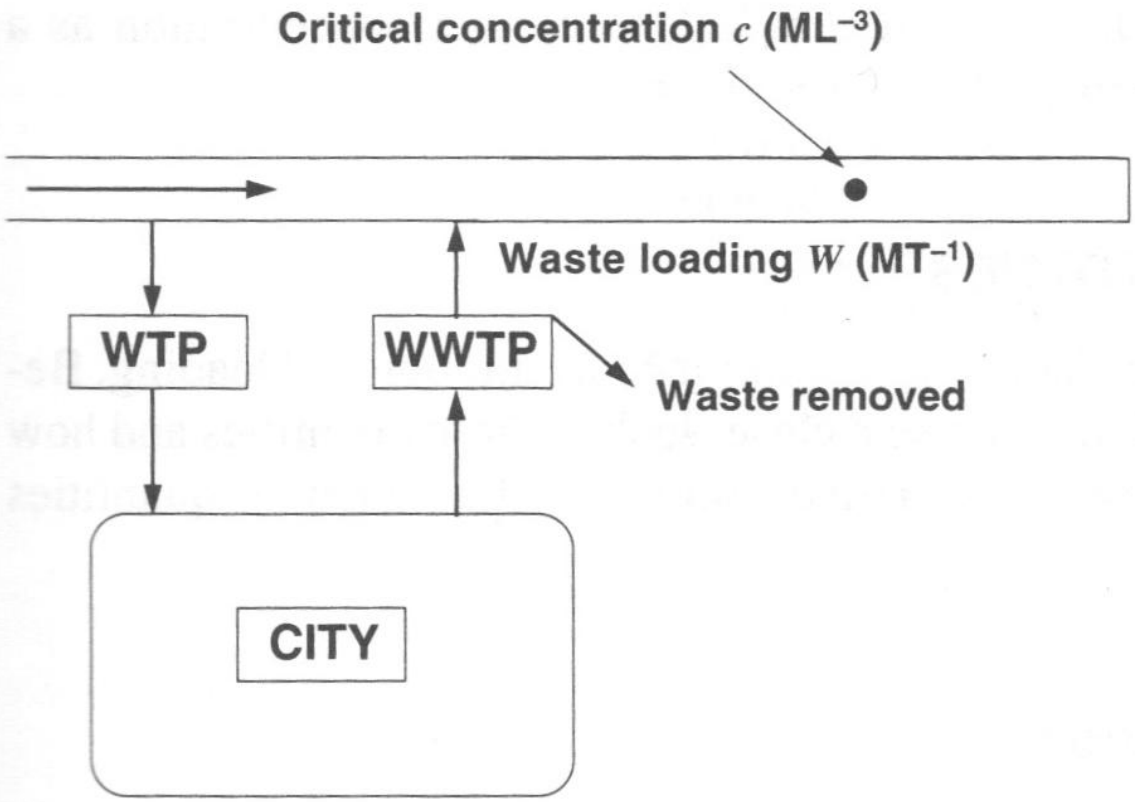
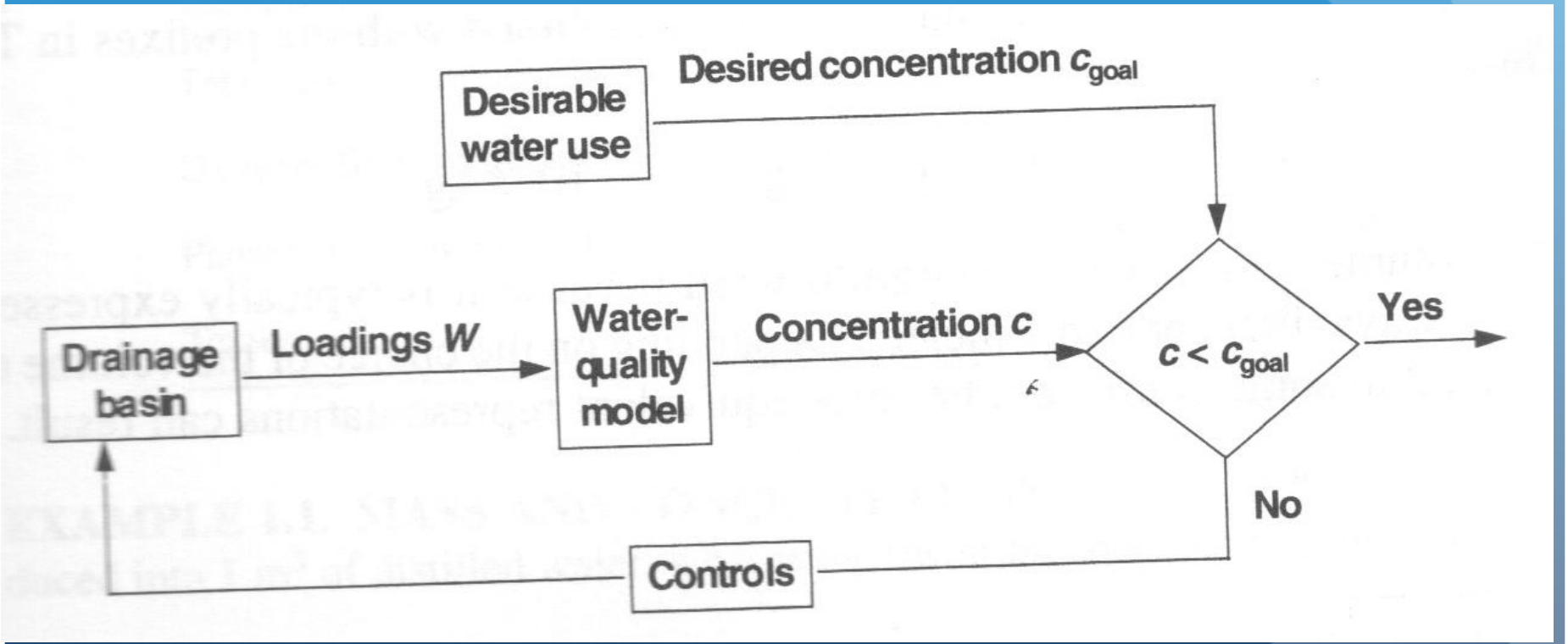
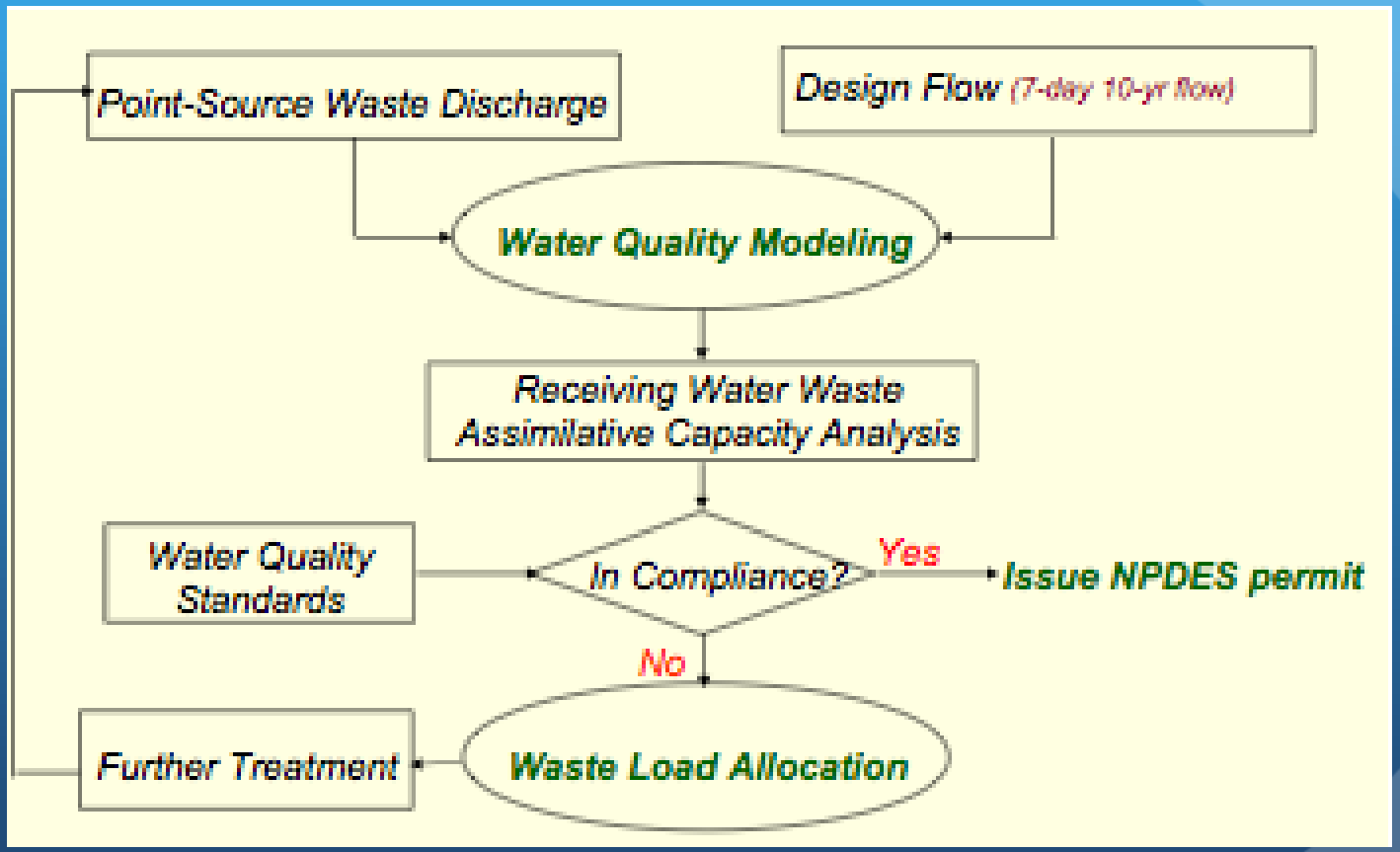


FIGURE 1.1
An urban water-wastewater system. A water treatment plant (WTP) purifi es river water for human consumption. A wastewater treatment plant (WWTP) removes pollutants from sewage to protect the receiving water.

河川水質管理要項

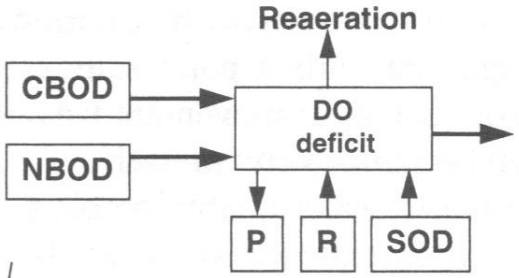

Desirable water use
Desired concentration c_{goal}
Drainage basin
Loadings W
Water-quality model
Concentration c
$c < c_{goal}$
Yes
No
Controls

1972 Clean Water Act: Point-Source Water Pollution Control



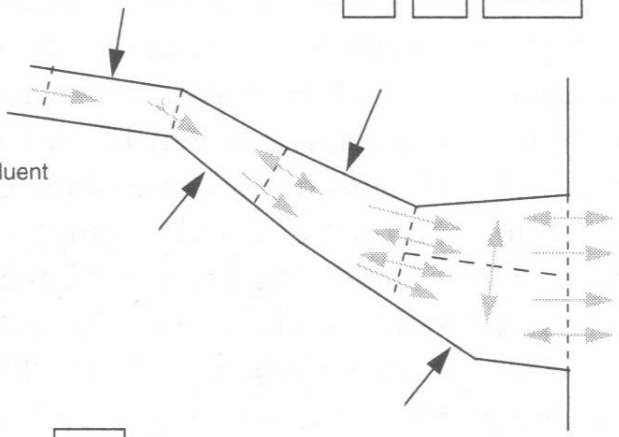
1925–1960 (Streeter-Phelps)

Problems: untreated and primary effluent
Pollutants: BOD/DO
Systems: streams/estuaries (1D)
Kinetics: linear, feed-forward
Solutions: analytical



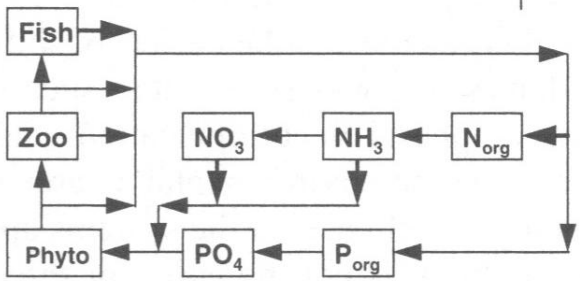
1960–1970 (computerization)

Problems: primary and secondary effluent
Pollutants: BOD/DO
Systems: estuaries/streams(1D/2D)
Kinetics: linear, feed-forward
Solutions: analytical and numerical



1970–1977 (biology)

Problems: eutrophication
Pollutants: nutrients
Systems: lakes/estuaries/streams (1D/2D/3D)
Kinetics: nonlinear, feedback
Solutions: numerical



1977– present (toxics)

Problems: toxics
Pollutants: organics, metals
Systems: sediment-water interactions/ food-chain interactions (lakes/estuaries/streams)
Kinetics: linear, equilibrium
Solutions: numerical and analytical

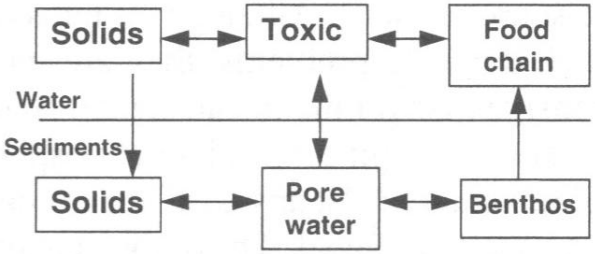
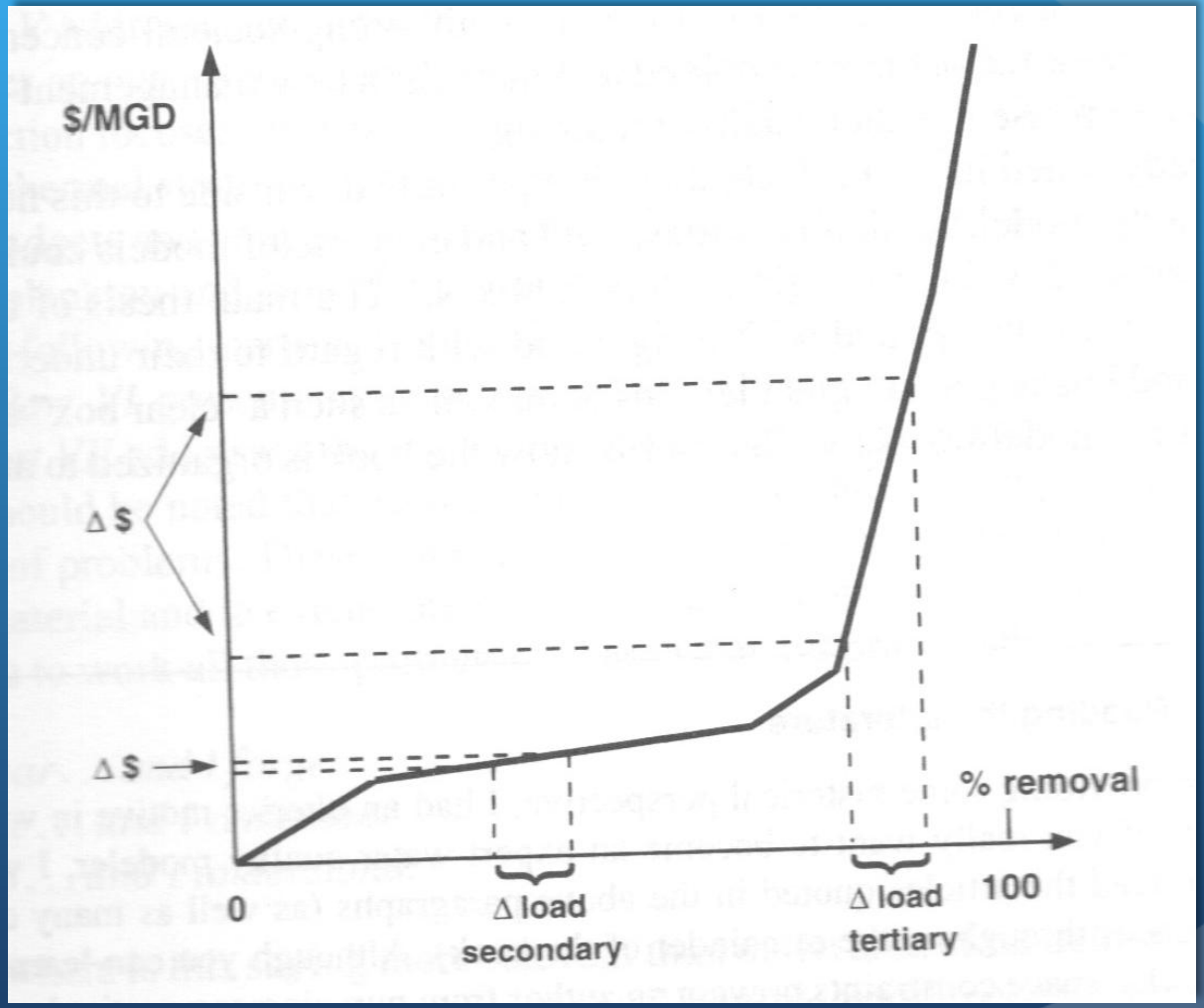


FIGURE 1.6
Four periods in the development of water-quality modeling.

水污染物(water pollutant)

- 病原體（pathogens）
- 需氧廢棄物（oxygen-demanding wastes）
- 養分（nutrients）
- 鹽類（salts）
- 熱污染（thermal pollution）
- 重金屬（heavy metals）
- 農藥（pesticides）
- 揮發性有機化合物（volatile organic compounds）

污染物處理成本與效益



Fundamental Quantities

- Mass and Concentration
  - C=m/V
  - m=mass, V=volume
  - mg/L=g/m^3
- g/m^3=(g/(m^3*(1g/cm^3))m^3/$10^6$$m^3$=1g/$10^6$g=1ppm (Parts per million), 1 g substance /10^6 g water=1 ppm
  - Density of water≈1g/cm^3
- ppt=g/L Parts per thousand; Total dissolved solids, salinity
- ppm=mg/L Parts per million; Oxygen, BOD, nitrogen
- ppb=µg/L Parts per billion; phosphorus, chl a, toxics
- pptr=ng/L Parts per trillion; toxics

Example 1

1.1 If $2*10^{-6}$ lb of salt is introduced into 1 m^3 of distilled water, what is the resulting concentration in ppb?

1.2 You have 1 ppb standards of the pesticide alachlor in water and in hexane (density=0.66g/mL). What is concentration of each standard in ug/L?

Fundamental Quantities

- Rates
  - Mass loading rate
  - W=m/t
  - m=mass
  - C=Concentration=m/V

Loading =W=QC

Fundamental Quantities

- Rates
  - Volumetric flow rate
  - U=velocity of water in the conduit(LT^{-1})
  - A_c= cross-section area of the conduit(L^2)

Flow =$Q=UA_c$

Fundamental Quantities

- Rates
  - Mass flux rate
  - U=velocity of water in the conduit(LT^{-1})
  - A_c= cross-section area of the conduit(L^2)
  - m=mass

$$\text{Flux} = J = m/(t\,A_c) = W/A_c = Uc$$

Example 2: Loading and Flux

A pond having constant volume and no outlet has a surface area A_s of $10^4 m^2$ and a mean depth H of 2 m. It initially has a concentration of 0.8 ppm. Two days later a measurement indicates that the concentration has risen to 1.5 ppm. (a) What was the mass loading rate during this time? (b) If you hypothesize that the only possible source of this pollutant was from the atmosphere, estimate the flux that occurred.

Example 3

- You require 4 m^3s^{-1} of water with a salt content of 0.1 gL^{-1} for irrigation purposes. You have two reservoirs from which you can draw water (Figure 1). Reservoir A has a concentration of 500 ppm, whereas reservoir B has 50 ppm. What flow rate must be pumped from each reservoir to meet the objective?

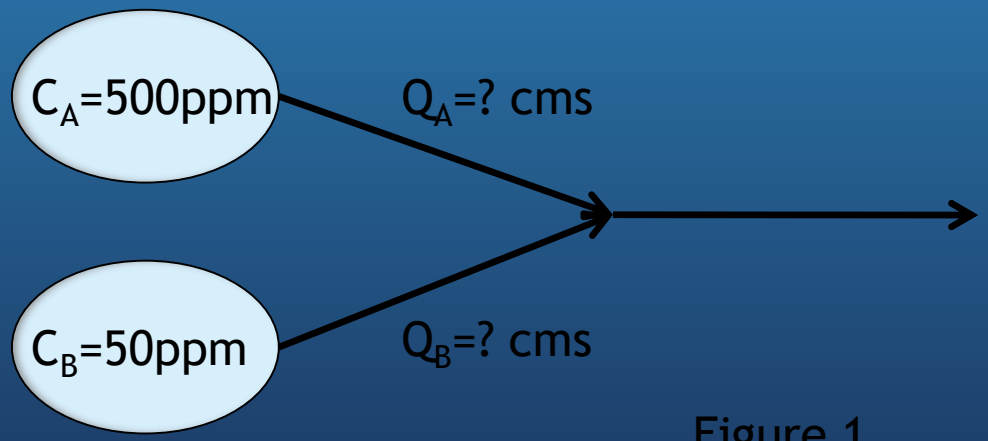


Figure 1