Water and Sewage

Chapter 5

CHAPTER FIVE
WATER AND SEWAGE

1. Both the nature and extent of the strategic development proposals need to be considered in terms of their ability to potentially affect water quality through increases in pollution loadings and any modifications to existing coastlines. Physical impediments to flow, for example, by bridge or tunnel crossings of water bodies (where the crest is above the seabed level in the case of tunnels) can also affect both near and far field water quality depending upon the scale of the structure and local conditions. The complex relationships of the physical forces of tides, bulk water flows, pollution loading and assimilative capacities are beyond the scope of the present study, but will need to be studied in a rational and comprehensive manner as an integral component of the detailed assessments of the Refined Preferred Options.

2. In the 1980's, it was recognised that marine and beach water quality was in decline, and that the assimilative capacities of certain water bodies were under great stress due to the dependence upon the marine environment for the treatment and disposal of industrial and domestic effluent. As a result, the Government commissioned the Sewage Strategy Study (SSS) which was essentially to formulate a plan of action for the territory as a whole. Sewerage Master Plan Studies (SMPs) were undertaken for individual sub-districts. The SMPs were developed to provide the way forward in terms of first aid measures to remedy relatively simple problems quickly, to be followed by the staged development or upgrading of collection, treatment and disposal mechanisms for effluent in individual areas.

3. The three key aims of the SSS were to enhance the planning process, to improve legislative control of effluent discharges and to recommend methods for improving the collection and treatment facilities. The first of these is fundamental to the TDS Review process, while the second goal has been achieved and the strengthening of the Water Pollution Control Ordinance (WPCO) through the Technical Memorandum on Standards for Effluents Discharged into Drainage and Sewerage Systems, Inland and Coastal Waters. The third aim is espoused in the SMPs for each of the delineated catchments.

4. The Strategic Sewage Disposal Scheme (SSDS) was borne from the SSS, and is a complex development scheme which is currently being implemented in phases. The first phase comprises the collection of effluent from Kowloon and east Hong Kong Island via a collection system, in deep tunnel, which will convey the waste to Stonecutters Island where Chemically Enhanced Primary Treatment (CEPT) will be provided. Effluent will initially be discharged via a 1.6km interim outfall, whence ultimately the discharge of effluent will be via an oceanic outfall to the south of Lamma Island.

5. Marine water quality is monitored routinely by EPD through their comprehensive marine monitoring programme. Both water and bottom sediment samples are taken and an extensive suite of biochemical tests are carried out. Annual reports of marine, river and beach water quality are published and the long term trends are discussed therein. In order to define the impacts of the proposed developments on future water quality, it is essential to first estimate the volume of effluent and the pollution loadings associated with such developments. The parameters which were adopted for use in the TDS Review are Rapid Assessment Methods based on the SSS, and refined by the Drainage Services Department.

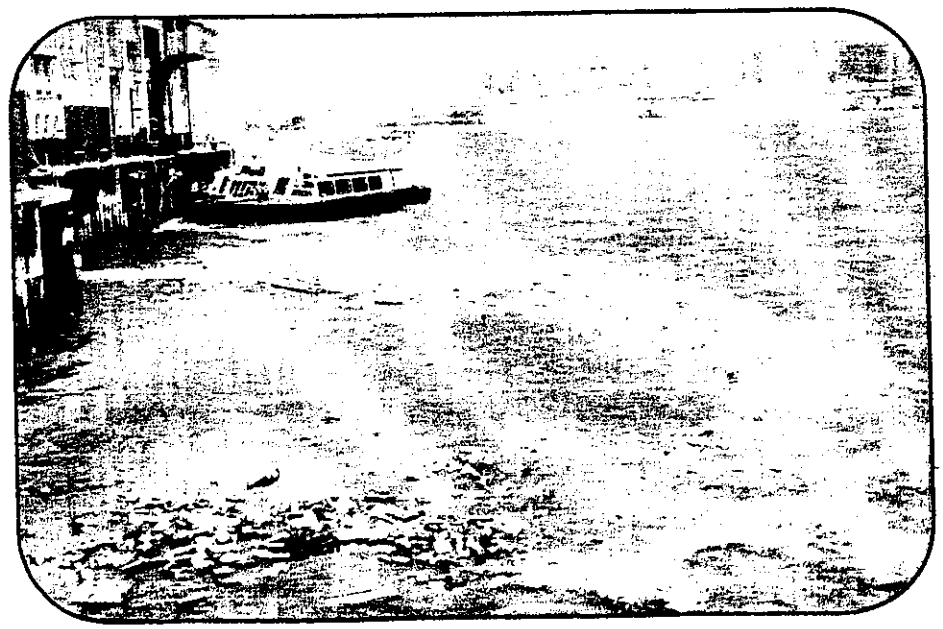
6. A degree of caution must be applied to avoid the wholesale use of individual pollution parameters as their application depends upon the situation being assessed. This is particularly true when assigning even a rough estimate of the environmental costs to a development proposal. The latter will be discussed in more detail later in the text.

7. Within this Chapter the potential impacts at different planning horizons are defined and the

Chemical Waste
Treatment Centre

Water pollution by
industrial effluent

Floating refuse
in harbour



implications of the Refined Preferred Options at the district and sub-regional level and in the territorial context in terms of future infrastructure needs are outlined. Appendix B contains the calculation sheets based on the population, industrial and employment matrices adopted for use in all of the sectoral studies to provide a consistent approach for all aspects of the assessment of the Preferred Options.

8. One of the water quality sub-objectives required the minimisation of coastal pollution to achieve the WQOs defined by the WPCO. While this is fully supported, it has been noted in previous rounds of assessments that there is no mechanism for such an assessment within the constraints of this Study. Discussions were held with EPD during the course of the Study to ascertain whether or not there was any mechanism which could realistically relate the increases in liquid waste arisings to future pollution loadings in individual water bodies, and further to relate these to the statutory Water Quality Objectives. Water bodies which are particularly sensitive to development pressures include Deep Bay, Mirs Bay and Tolo Harbour. The North-Western Water Control Zone is also affected by the massive influences of pollution discharged from the catchment of the Pearl River Delta.

9. It was however concluded that it is not possible to predict exceedance in the WQO's within the confines of the TDS Review as this would require detailed modelling studies to be carried out not just for Hong Kong waters but also in the wider context. It must be stressed that detailed assessments of future pollution loadings (regardless of the level of treatment applied) should be subject to, inter alia, mathematical modelling studies as a prerequisite of the Environmental Impact Assessments (EIAs) which will be required for all new developments. Water quality modelling will also be required for any projects involving the modification of existing coastlines.

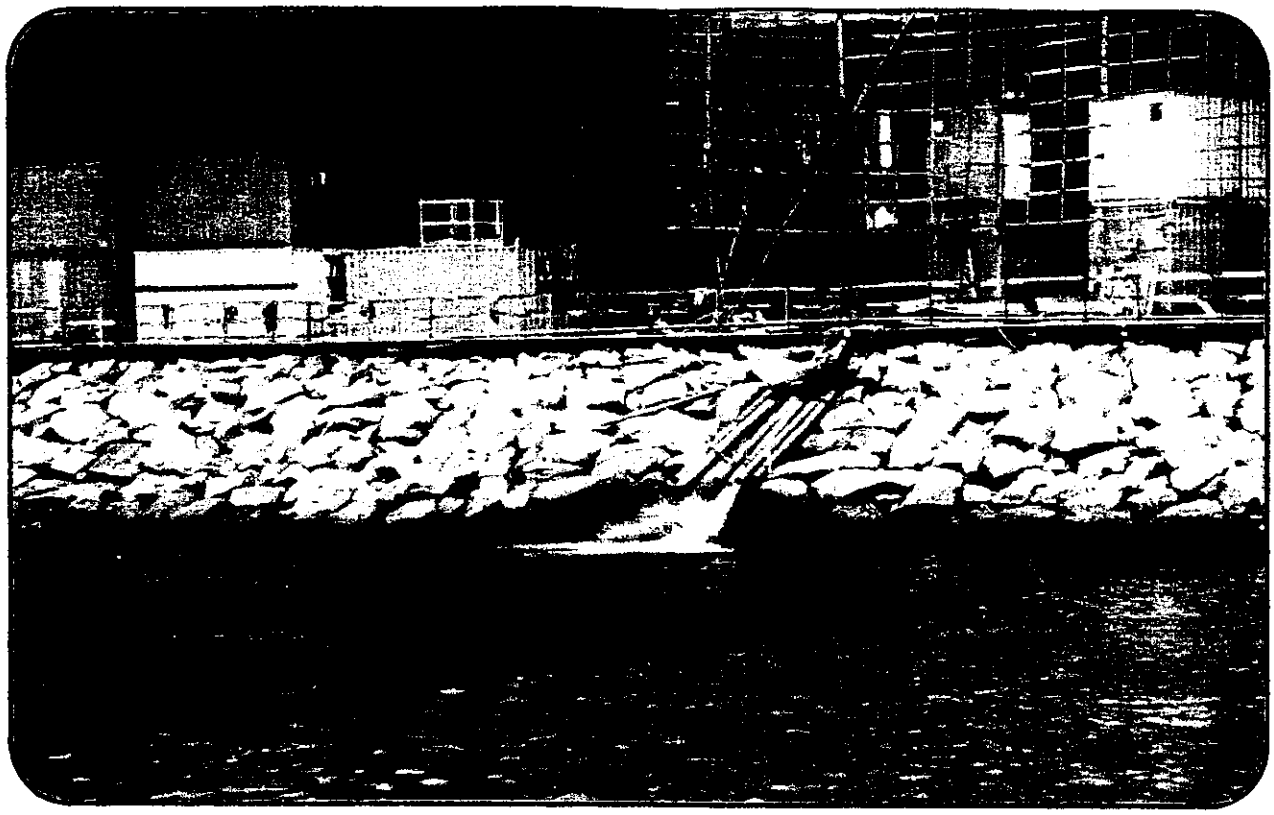
10. The primary objective of the present assessments for liquid wastes was to identify areas where constraints may be placed on existing and planned infrastructure due to development proposals at the different time horizons being considered. This is particularly pertinent as it could have a direct impact on the findings of the Sewerage Master Plans in respect of their implementation and phasing. This is also a significant issue as it relates to direct environmental costs associated with the development strategies, and thus contributes to the overall assessment of their economic feasibility.

11. The methodology adopted for previous rounds of evaluations has been maintained herein to provide a consistent approach to estimating pollution loads and effluent flow rates. Data matrices provided by PlanD were modified, in accordance with the agreement reached with EPD, in that only 3% of the E1 category of industries consume large volumes of water (or produce large quantities of liquid waste). The remaining 97% of the E1 industry was assumed to be non-water generating and the future effluent flows and pollution loads (of this portion) were calculated on the basis of the factors used for the E3/E4 industries.

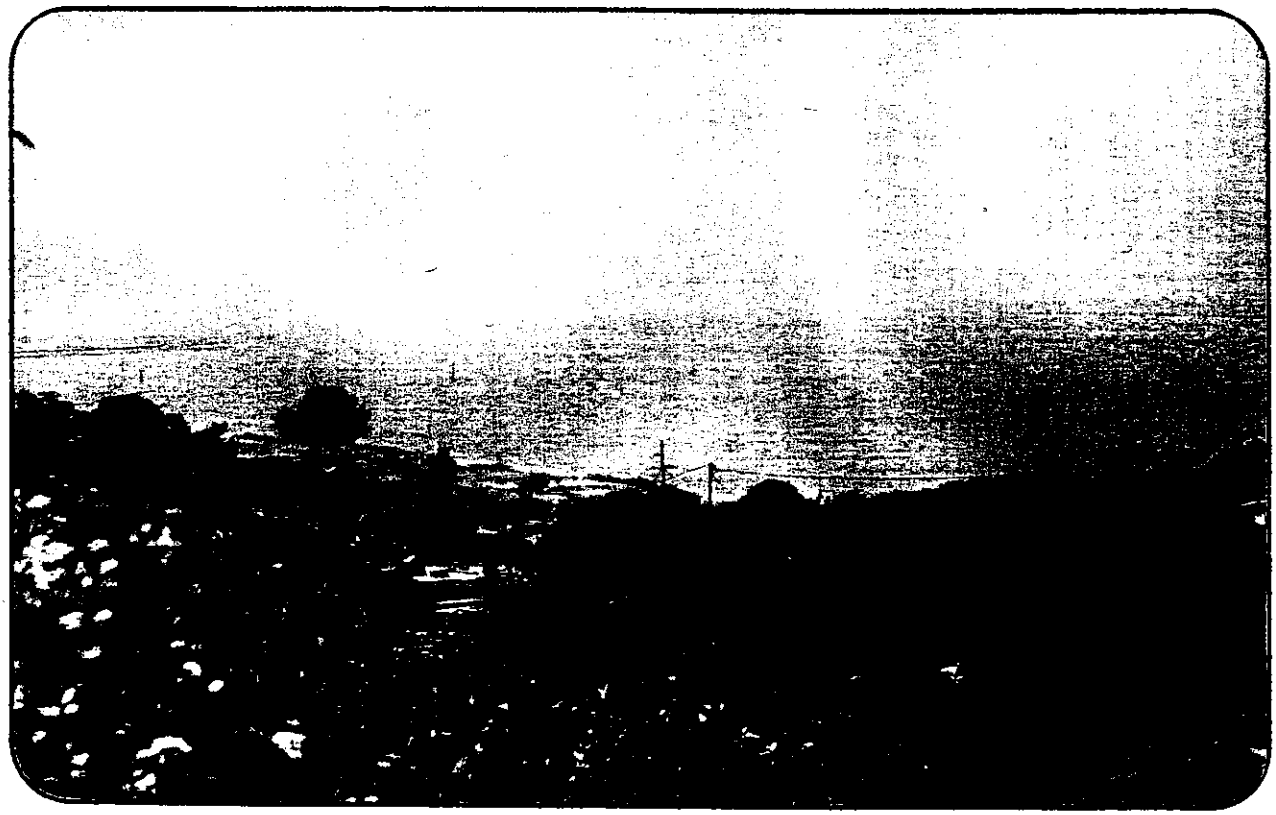
Projected Daily Effluent Flow Rates

12. Data were sourced from, inter alia, the relevant TDS Technical Reports, the Sewage Strategy Study (1989), the Strategic Sewage Disposal Scheme and from discussions with the EPD. The data matrix which was adopted for use throughout this study identified existing and future treatment works, ultimate design capacities and proposals for future effluent treatment and disposal arrangements. Daily effluent flow rates were estimated using the method proposed by the Sewage Strategy Study 1989 and developed for the strategic development areas and at a district level in the Drainage Design Manual.

13. Effluent volumes and pollution loads were calculated for residential, employment generated and industrial developments proposed for both Refined Preferred Options at the three time



An outfall from a waterfront construction site,
a potential pollution source



The Deep Bay Zero Discharge Policy prohibits any new and
permanent point source discharge to the waters

horizons. Estimates of residential, industrial and employment generated contributions to the effluent budget were made at the district level, permitting comparison between the options. Furthermore, this permitted an assessment to be made as to whether liquid effluent generated by developments proposed under the entire scenario, or individual components thereof, could be accommodated within the appropriate existing or planned waste-water treatment facilities.

14. Effluent flow rates associated with strategic growth areas were also calculated, in addition to flow contributions from the three basic sectors of developments, for each planning horizon. The summaries of the individual contributions by district and at the sub-regional level, are provided in Appendix C. From the illustrations provided in Figure 5.1, it is apparent that for the assessment of the Preferred Options, the volume of industrial and domestic effluent generated on a daily basis generally similar in each of the sub-regions. In the Metro area, the forecast volume of industrial waste-water is much higher than the domestic contribution in all the three time horizons.

15. These results are scrutinised as the pattern is not in keeping with observed trends. The conclusion was drawn that the E1 industries (i.e. the manufacturing category) of the data matrices prepared by PlanD had combined many industrial groups which were not actually major water users. The data matrices were reformulated taking account of the industrial development trends, as described previously, with 3% of the E1 category being ascribed to heavy polluting industries. Once this issue was resolved, the daily flow rates were then re-calculated and the results are presented in Appendix C1 and summarised in Figure 5.2.

16. The revised forecasts indicate that the contribution of residential flows to the effluent budget are consistent with those originally calculated using the initial data matrix. The forecasts relating to the employment-generated and industrial developments reflect both the redistribution of jobs and industries in the second set of matrices as well as the improved method for estimating flows for the E1 category industries.

17. In respect of the Metro area, the revised data indicates an increase of about 30% in the flow rates from the employment-generated developments, with a reduction of at least 50% in the industrial contributions. In overall terms, a reduction of about 40 - 50% in the overall volume of effluent generated was forecast for these revised estimates. The ratios of domestic to industrial effluent, which can be inferred from existing treatment facilities, are also now more realistic. It should be noted that these forecasts will need to be considered in future studies to determine whether the planned sewerage can accommodate the effluent forecast at different locations within the system. This will require detailed study which is beyond the scope of this study. In both the NENT and NWNT the forecast volumes of industrial and employment liquid wastes were reduced by between 40 - 50% compared to those forecast for the Preferred Options for the same reasons as given in para.16 above. In the SWNT, a reduction by 25% of the original industrial effluents forecast was predicted with a commensurate 50% reduction in the employment contribution. In the SENT, with the redistribution of jobs to take account of areas with spare capacity it was observed that in 2001 the employment contribution would rise by 2006 but then tails off by 2011.

18. While it was observed that by redistributing jobs and industrial floor space in concert with a more realistic industrial pollution scenario was beneficial in terms of infrastructural requirements, the development proposals will need to be critically examined in future studies to determine the effects on existing and planned infrastructure (both in terms of the extent and implications). This will require, inter alia, assessments of the system hydraulics (for example, if a significant increase is proposed at the head of the system this could have a much greater impact on system hydraulics than further downstream) which is too detailed to be considered in the strategic context.

19. In terms of the strategic residential developments, obviously Scenario B will exert a greater effect on existing facilities. Areas considered to be long term development options include the Border Zone and the Yuen Long and Tuen Mun Corridor will require detailed environmental assessments to be carried out, to determine the extent of the collection, treatment and disposal requirements. It should be stressed that the Deep Bay Water Control Zone has a zero discharge policy attached to it, and therefore disposal of effluent form these development areas will need to be diverted to the North-Western Waters. The level of treatment and the point of discharge will also need to be carefully considered, preferably in the forthcoming consultancy study relating to the provision and upgrading of sewage collection, treatment and disposal facilities for the NWNT.

20. It is pertinent to note that in the baseline studies it was assumed that a population threshold of 600,000 persons should be the upper limit for development in the NWNT. On the basis of the present estimates, this will be exceeded even by the residential base growth.

21. Liquid wastes for the residential components are, not surprisingly, very similar at a sub-regional level at the year 2001, with the major contribution being that of the base growth. By 2006, differences between the two Scenarios are evident particularly in the SENT (although it should be noted that Tseung Kwan O connects to the Metro area under the SSDS rather than SENT which is the defined sub-region for planning purposes) and by 2011 in SWNT, NENT and NWNT due to increases in population forecast in those areas.

22. Similar sub-regional trends are shown for the forecasts of liquid wastes generated by the employment-related developments, in which the differences between the Scenarios are most apparent in the long term. In rural NWNT, rural SWNT and particularly rural NENT, the development proposals for Scenario B are reflected by the significant increases in disposal requirements. At the district level, the main differences between the two strategies are identified in Fanling/Sheung Shui, North Lantau and the rural NWNT, all by 2011, with the forecasts for Scenario B placing a greater constraint on the sewage collection, treatment and disposal systems. This is particularly pertinent in connection with the disposal options and the long term management of receiving water quality.

23. The implications of these forecasts on existing, future or planned effluent disposal arrangements are such that, even in the short term, the capacity of the treatment works in certain areas will be grossly exceeded. For example, the design capacity of the Yuen Long Sewage Treatment Works (STW) is about 70,000m^3/d, which will be achieved at 2001 (both Scenarios A and B) and exceeded by 2006.

24. Similarly, at the Shek Wu Hui STW the current design capacity is about 59,800m^3/d, and even the Base Growth exceeds this by almost 30%. Although proposals to expand this STW were examined in the Northern SMP, the major influxes in population now forecast for Scenario B may not have been taken into account. This will require to be reviewed during the implementation stage of the upgrading of the Shek Wu Hui STW as the predicted daily volume of effluent by 2011 under Scenario B will be more than twice the capacity of the existing treatment works. Similarly, at the Tai Po STW the volume of liquid wastes arising on a daily basis due to the Base Growth will be marginally acceptable in terms of existing capacity. By the year 2006, the capacity will be exceeded by about 7% (taking account of Tai Po town only and not any of the rural areas which may subsequently be connected).

25. In the NWNT, the STW at San Wai will have about 10% spare capacity when all the flows generated by the Base Growth are collected. However, by 2006 there could be an exceedance of about 6% under Scenario B and 24% by 2011. Under Scenario A, the exceedance is forecast to be a more modest 10% at 2011. It is apparent that consideration needs to be given to ensuring the infrastructure is in place in time to accommodate even base growth and

that the systems can accommodated the scale of development proposed. Key concerns also centred around the developments proposed in the Border Area, and the uncontrolled spread of developments in the rural NWNT.

26. Notwithstanding the foregoing, it is pertinent to note that the policy objectives laid down in the White Paper on Pollution in Hong Kong - A Time to Act include :

(a) to minimise adverse environmental effects by ensuring the consequences for the environment are properly taken into account at an early stage, of all new developments on site selection, planning and design. Although the development threshold previously proposed is forecast to be exceeded, the opportunity exists in the NWNT to provide a sub-regional collection system with centralised treatment facilities as there are not the same land constraints as in, for example, Metro area (N.B. San Wai is not constrained and could be upgraded as part of such scheme).

(b) to seize opportunities for environmental improvement as they arise in the course of urban redevelopment. This is being espoused by the fundamental aim of the development strategies in which the collection, treatment and disposal of industrial and domestic effluent is being given primary consideration.

(c) to safeguard urban encroachment into rural areas unless adequate services have been provided. This is a basic tenet of development control which has been applied to the SENT in connection with the protection of receiving water quality.

Projected Pollution Loads

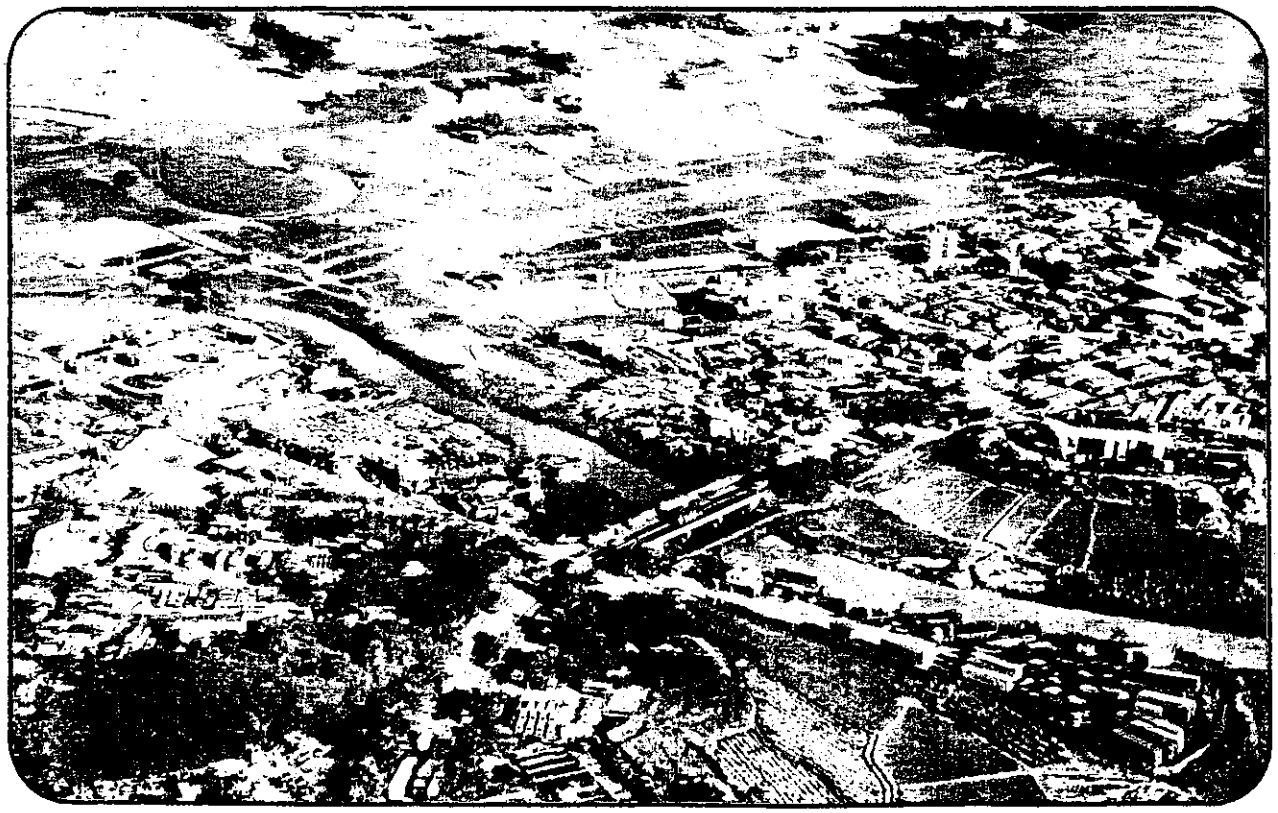
27. Pollution loads were estimated using the method proposed in the Sewage Strategy Study and the Draft Drainage Design Manual which uses rapid assessment methods involving pollution loading factors and population data matrices. Pollution loadings were calculated for Biochemical Oxygen Demand (BOD), Total Kjeldahl Nitrogen (TKN), ammonia (NH_3), and E.coli. Estimated pollution loads are also included in Appendix C for the first round evaluations, and C1 provides the results of the second round evaluations.

28. Total toxic metal loads were not calculated, as the control strategies developed by EPD to remove these at source are assumed to be in place in the short/medium term. Between the two scenarios, there are comparatively small differences in pollution loads generated (see Figure 5.2). However, it is apparent that the significant increases between the years 2001 and 2011 will require detailed consideration to ensure the necessary level of treatment is applied to maintain marine water quality and the habitat supported therein, particularly in the NENT and NWNT as illustrated in Figure 5.3. All of the disposal options will require to be scrutinised in terms of their cost benefits all the while being required to achieve the stated WQO's.

29. From the estimates made, it is apparent that the forecast pollution loadings for the employment and industrial categories have altered in concert with the estimates of flow (refer to Appendix C). The estimated pollution loadings have been included to illustrate the extent of the problem for treatment in certain areas, and the levels of treatment which may be required. In terms of environmental expenditure it is possible to estimate an order of costs associated with the level of treatment necessary to achieve the standards set for receiving waters. However, such an exercise would involve much detailed consideration being given to policy and future proposals, and is outside the scope of this study.

30. In order to give an indication of the estimated costs associated with treatment, reference has been made to the revenue which could be collected under the Sewage Charges for domestic

Uncontrolled spread of open storage activities
in North West New Territories



Uncontrolled development near the border area

households using the volume of effluent generated for the Base Growth and the two development scenarios. For illustrative purposes, it was roughly estimated that the revenue accrued on a daily basis from the residential population could be of the order of HK$2 million for Base Growth, increasing to about HK$2.3 million in 2011 for Scenario A and HK$2.5 million in 2011 for Scenario B. Estimating the revenue associated with commercial and industrial wastes is more complex as, in addition to the Sewage Charges, trade effluent surcharges are also added, and are derived on the basis of the nature of the businesses and whether or not the premises are located within a Water Control Zone. To give a very broad estimate of the total daily Sewage Charges applied the basic tariff multiplied by the predicted volumes of effluent. For the Base Growth, the estimated revenue would be in excess of HK$3.8 million increasing to about HK$4.8 million by 2011 under Scenario B. It should be noted that the additional Trade Effluent Surcharges would substantially inflate the estimates as these are, with a few exceptions, at least double the basic charge rate.

Population in Unsewered Development Areas

31. Strategic growth areas for which there is presently no sewage collection and/or treatment facilities include Lok Ma Chau/San Tin (18,400 head of population), Fanling North (about 20,000 head of population), Rural NWNT (10,000 head of population), and the Border Zone. All of these areas will require detailed study to ensure there is adequate infrastructure in place prior to their development.

32. Proposed residential development areas which are currently unsewered are primarily included in the Scenario B options in the long term. Although the proposed residential developments in Rural NWNT are relatively small in comparison to the total population proposed in the development strategy, the fact this development component is proposed for the Preferred Options of both Scenarios A and B, at an early stage of development will require detailed study. Further developments in the NT will have far reaching territorial and regional implications in terms of collection, treatment and disposal options and in connection with long term water quality management, all of which will need to be considered in detail.

33. On the basis of the population forecasts, protection of water courses and sensitive water bodies, especially in Deep Bay and Mirs Bay, will be a key issue. It is pertinent to note that the Border Area, which is considered as a potential long term development area, will require detailed environmental assessments to determine the full implications on water quality as well as fragile ecosystems in the receiving water bodies.

34. Planning guidelines on water quality require strict controls on discharges into Tolo Harbour. Although the effluent flows associated with the proposed developments at Whitehead (about 1,700 m^3/day) are comparatively small, they will still require to be treated to remove nitrogen loads in order to comply with the provisions of the Technical Memorandum.

35. The implications of developing other unsewered areas including the Border Area and parts of the Northern New Territories without the early provision of comprehensive sewage treatment facilities is a fundamental concern especially in terms of the protection of water quality in Deep Bay (which has a zero discharge policy ascribed to it). It is pertinent to note that these issues will be addressed in the Yuen Long and Kam Tin Sewage Master Plan Study. In addition, it is also understood the development of the Border Area is a long term development option which will be subject to full scale environmental and engineering assessments.

Pollution Status of Coastal Waters and Land Uses Associated with Strategic Residential Developments

36. Most of the strategic residential developments are in areas adjacent to water bodies which either suffer poor water quality or are grossly polluted (Shenzhen River and Deep Bay). This is a particular concern and mechanisms will need to be identified to minimise the impacts of these developments on receiving water quality and to improve the environs for new residential developments.

Proximity of Outfalls to Sensitive Receivers

37. This performance measure did not assist in the assessment of the Refined Preferred Options, and existing mariculture zones, gazetted beaches, and marine conservation areas which could be adversely impacted by proposed developments were identified. Except for the proposed residential developments at Whitehead (with respect to Tolo Harbour) and in the Border Area (with respect to Deep Bay), there are no other areas which gave cause for concern in this context.

Proximity of Outfalls to Confined Water Bodies

38. Table W14 in Appendix C identifies the receiving waters for existing and proposed outfalls. This information was not used in isolation but rather in conjunction with other performance measures.

Population Adjacent to Sensitive Water Bodies

39. Sensitive water bodies were defined as Deep Bay, Mirs Bay, Tolo Harbour, Tseung Kwan O, Port Shelter and Rambler Channel. For all of the Refined Preferred Options, strategic growth populations are greatest in the NWNT with the long term strategic growth population associated with the B Scenario greater than Scenario A.

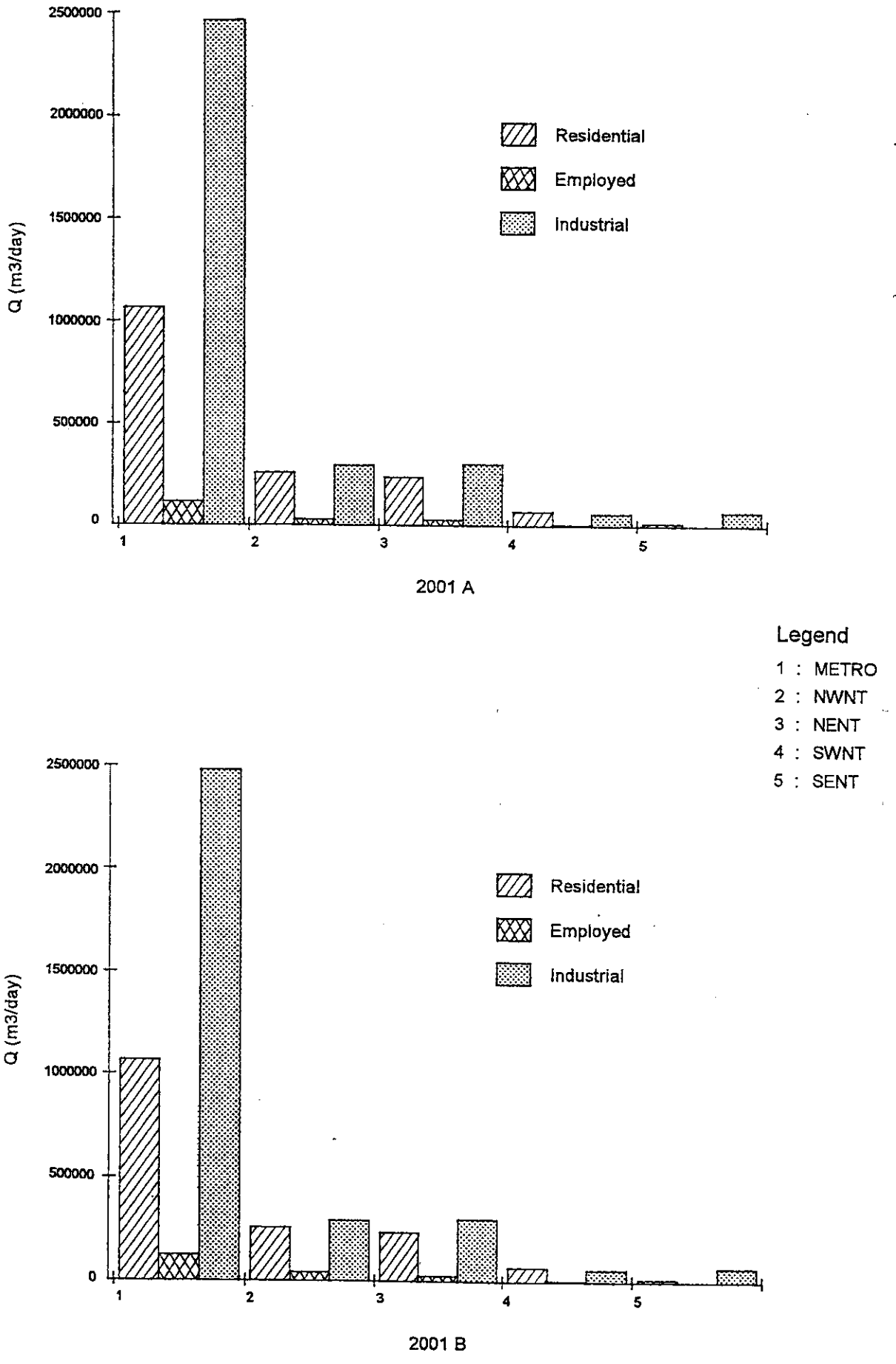


Figure 5.1 Liquid Waste Forecast (Prototype Preferred Options)

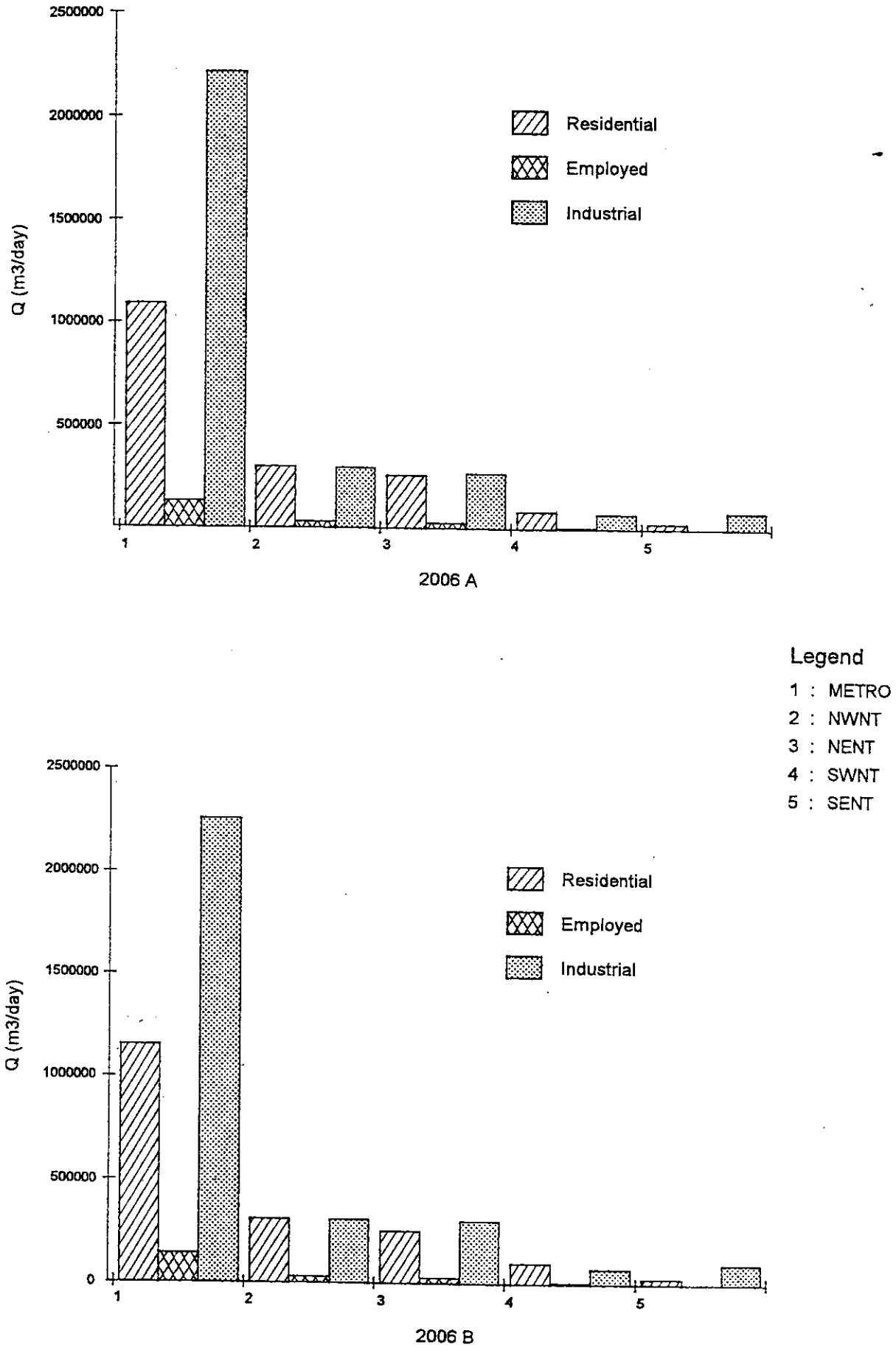


Figure 5.1 cont. Liquid Waste Forecast (Prototype Preferred Options)

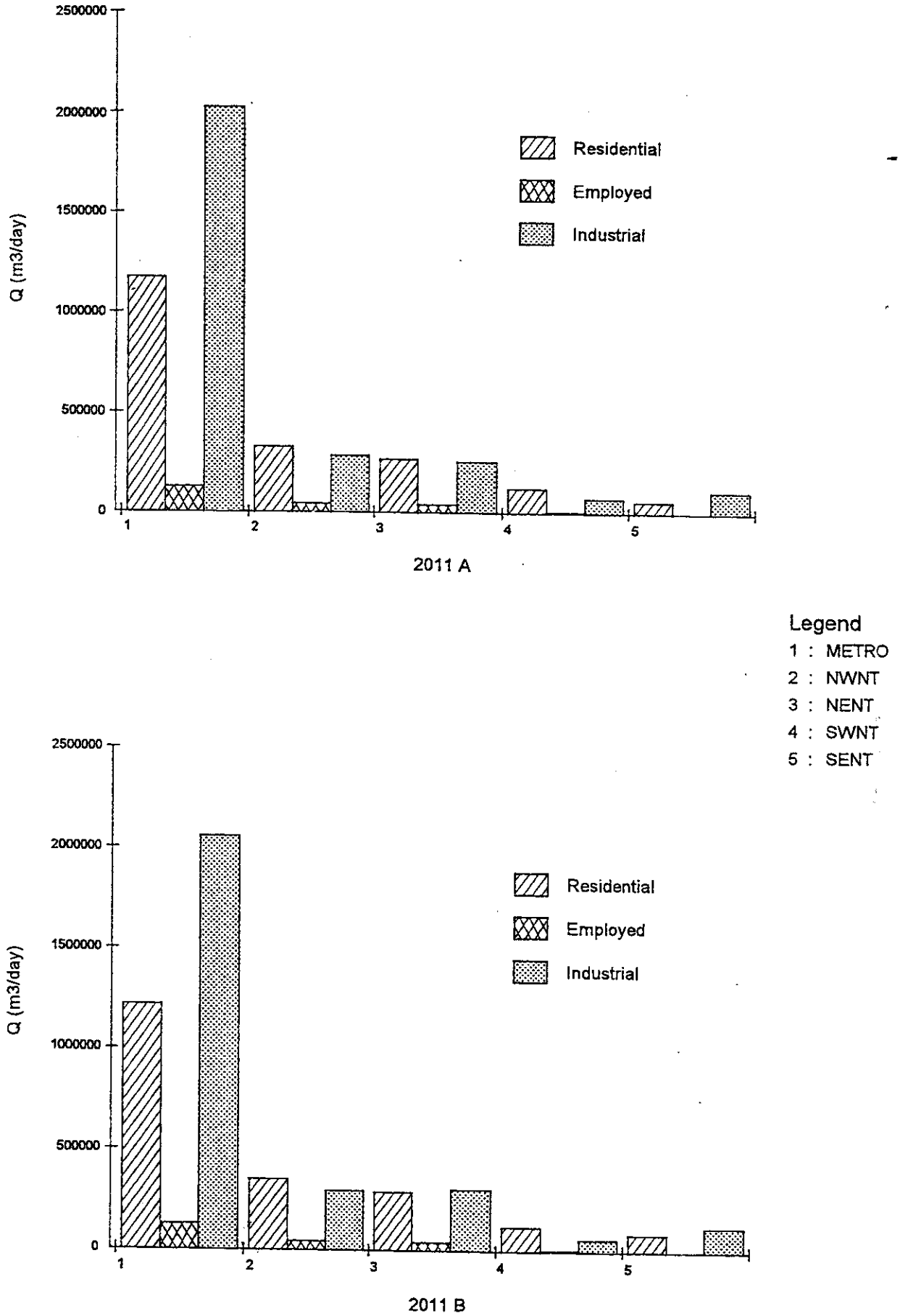
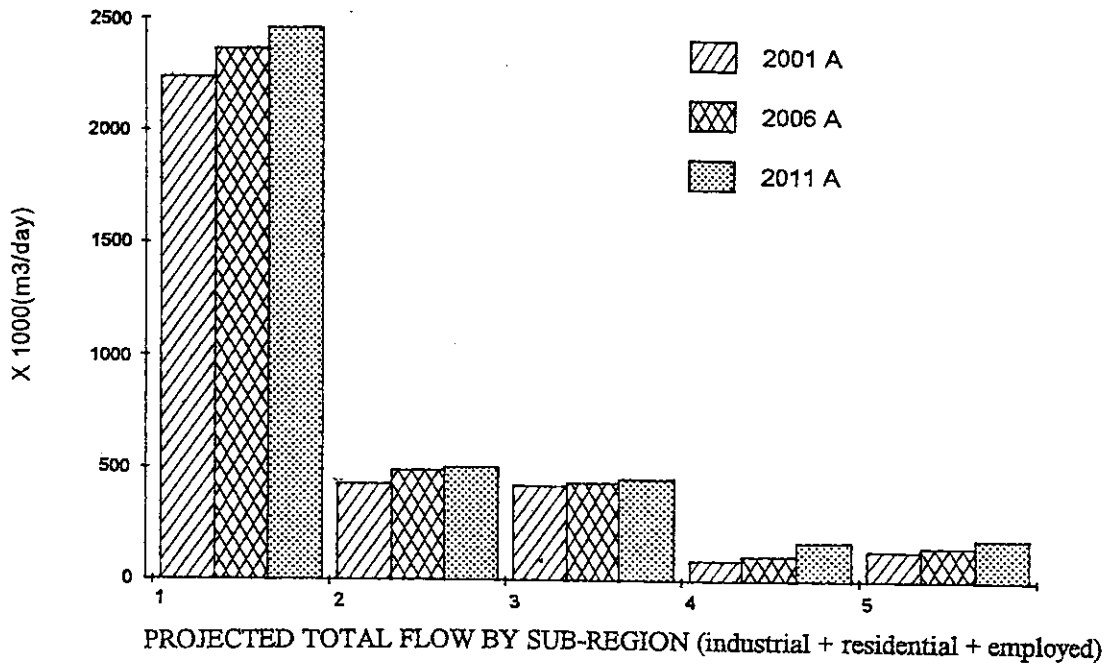


Figure 5.1 cont. Liquid Waste Forecast (Prototype Preferred Options)



Legend

1 : METRO
2 : NWNT
3 : NENT
4 : SWNT
5 : SENT

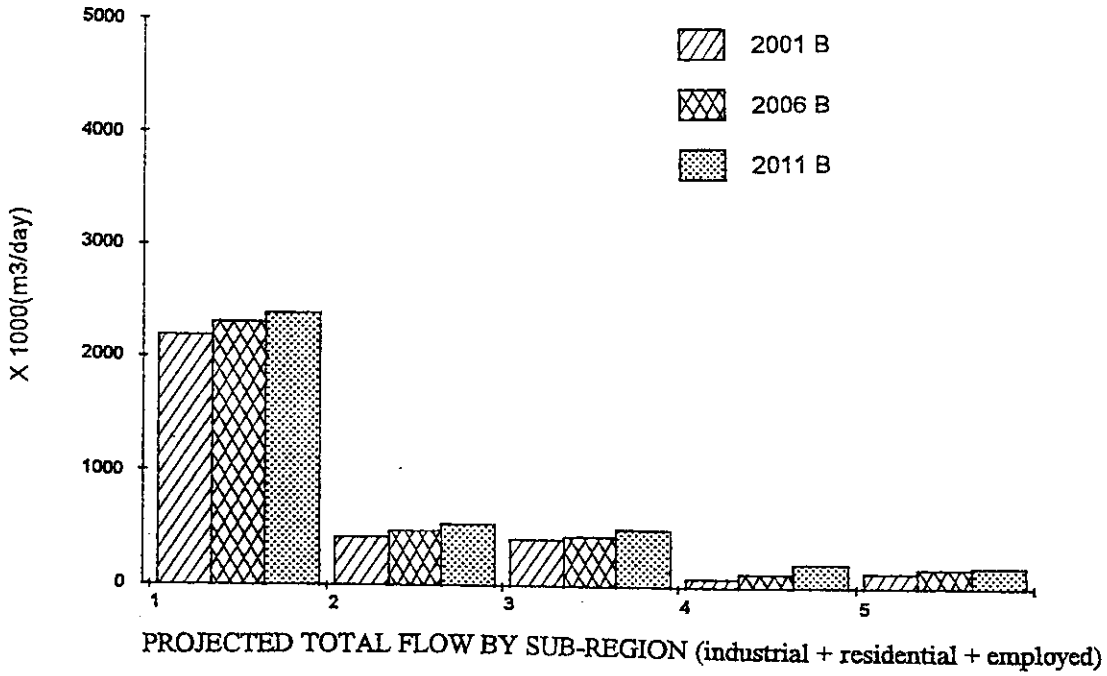


Figure 5.2 Volume of Effluent Generated Under Refined Perferred Options

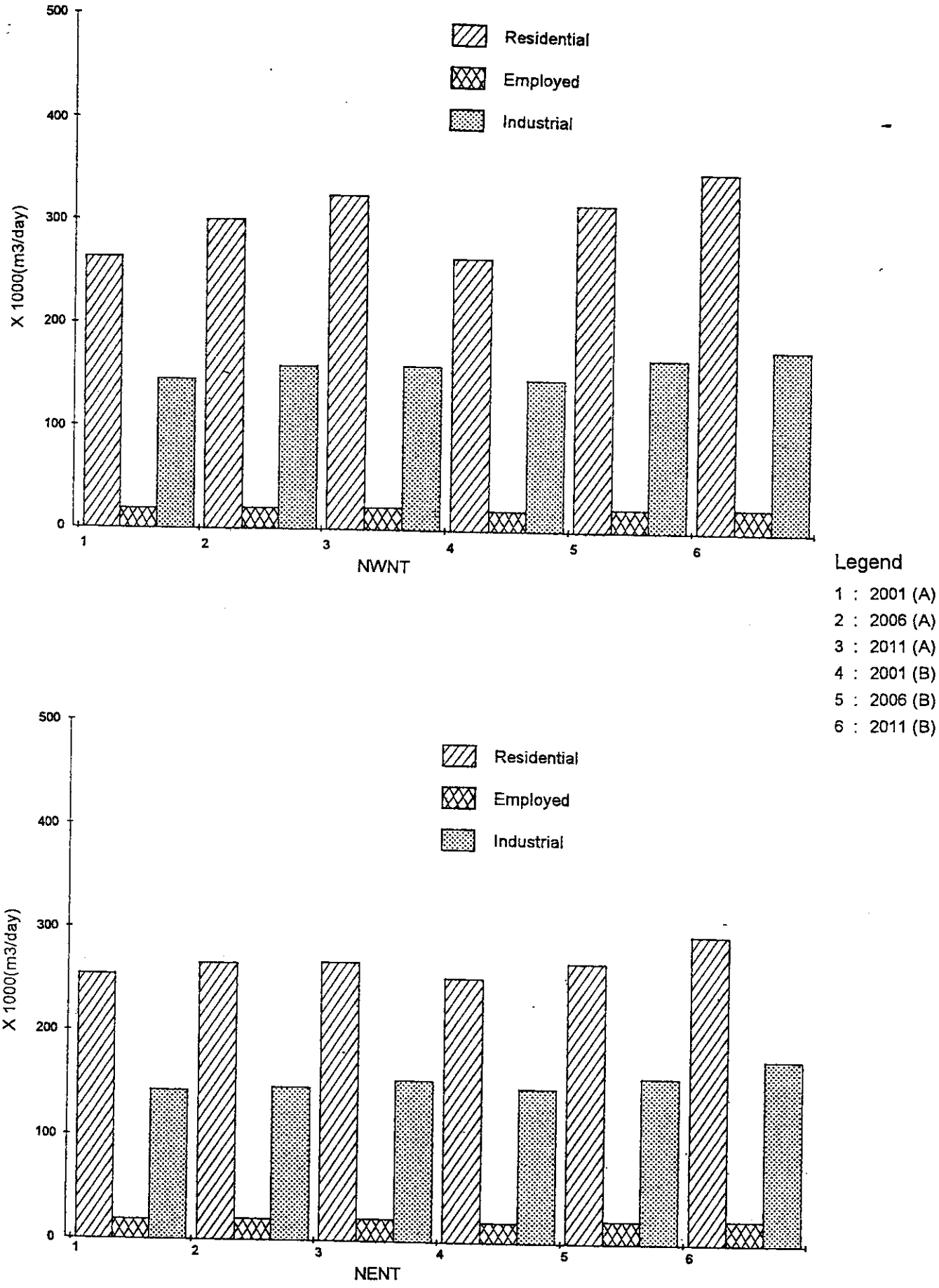


Figure 5.2 cont. Composition of Effluent Budget for Refined Perferred Options in NWNT and NENT

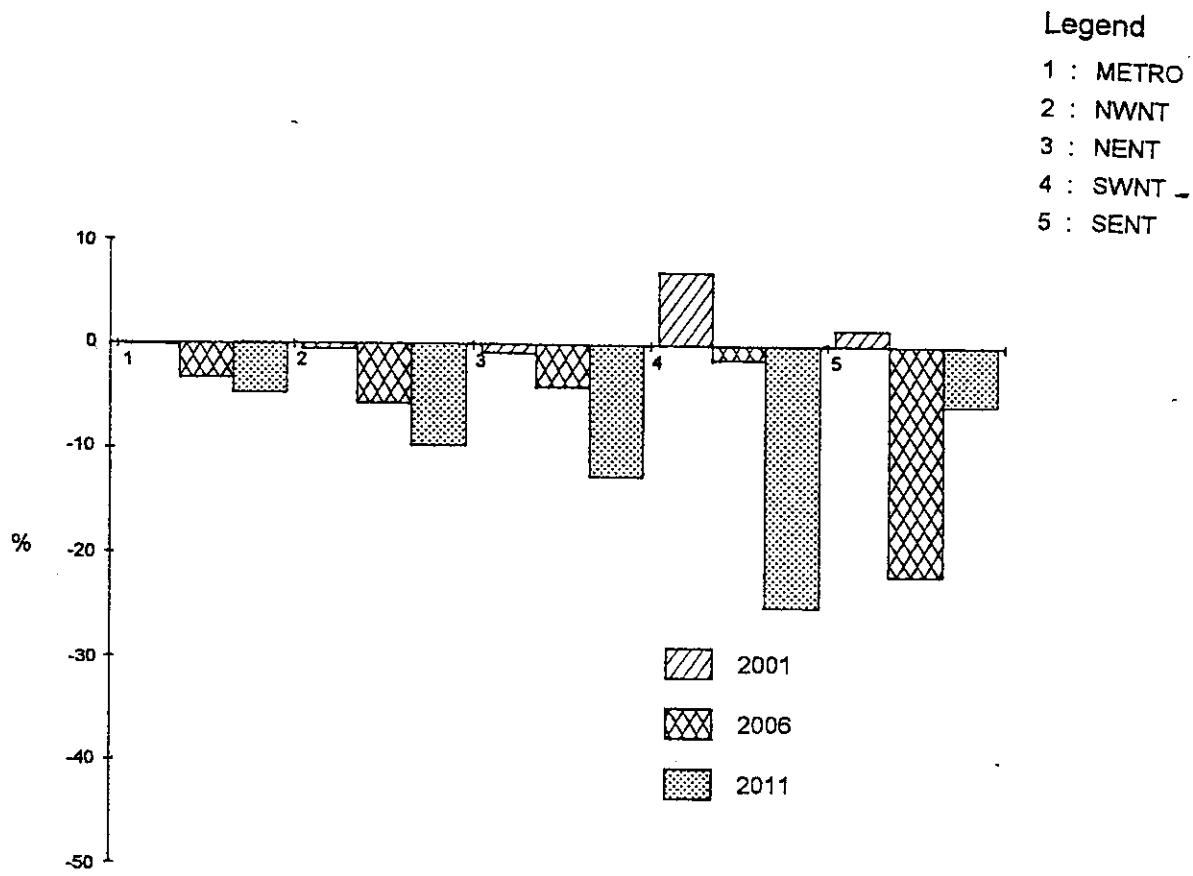
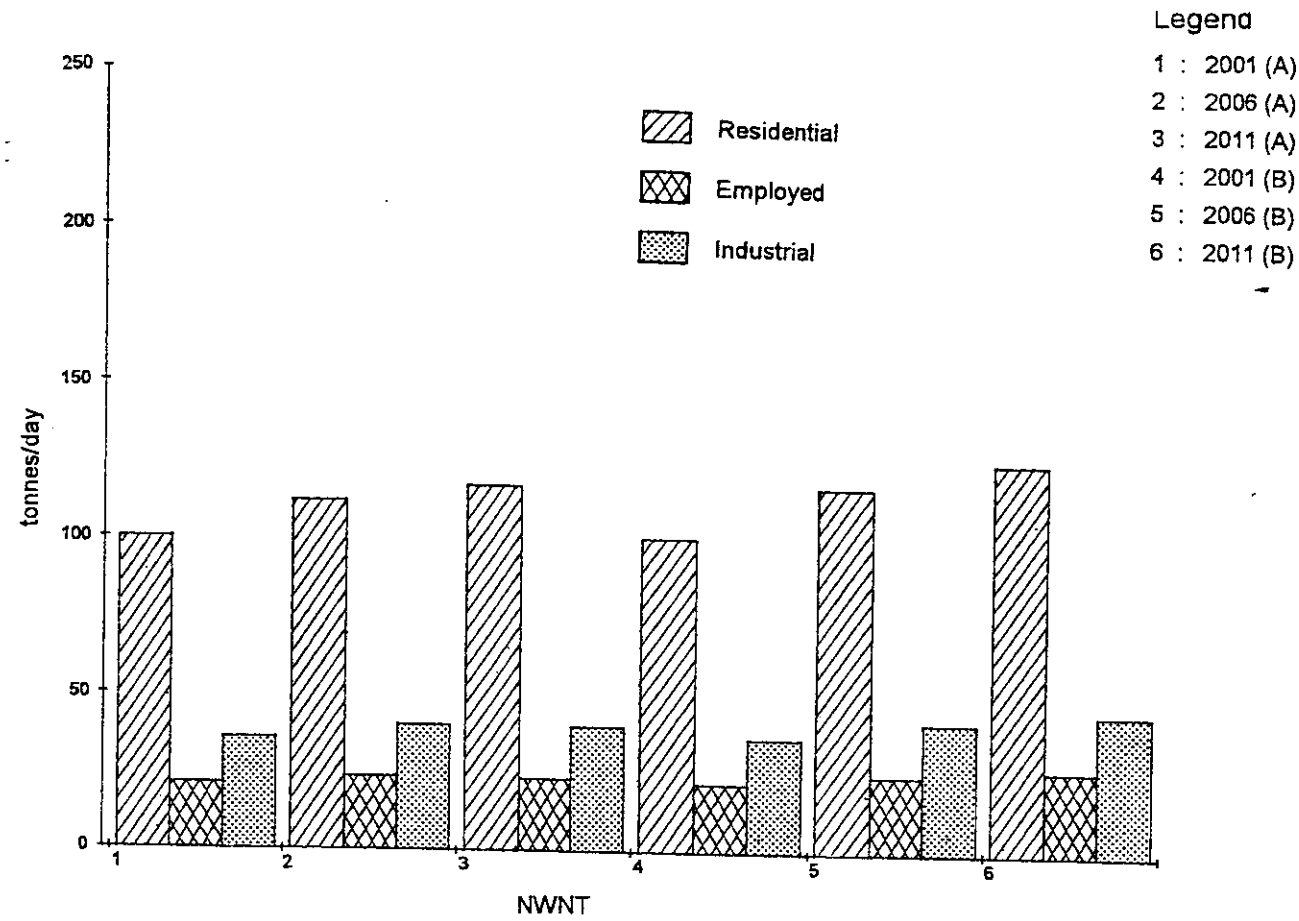


Figure 5.2 cont. Percentage Difference Between Refined Scenario A and Scenario B



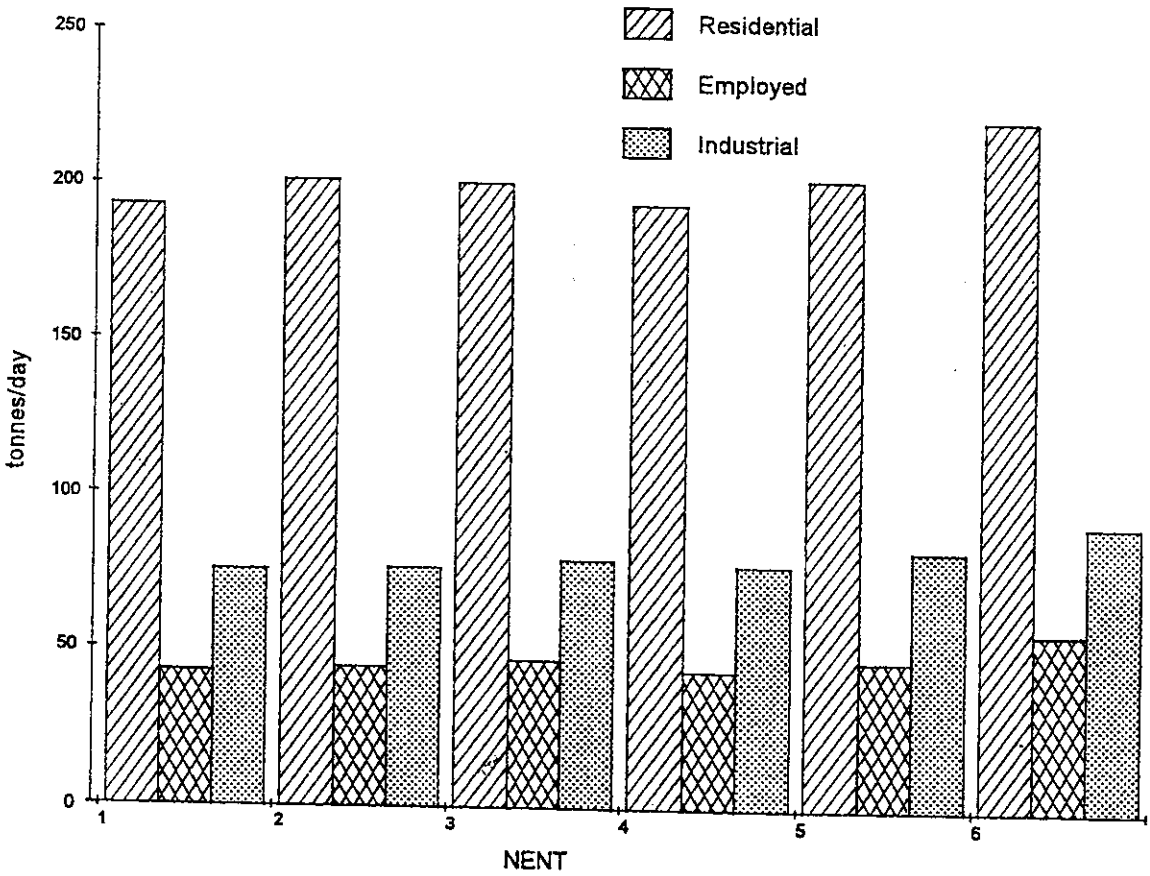


Figure 5.3 Projected Daily COD Loads By District