DEPARTMENT OF NATURAL RESOURCES & MINES

Planning Guidelines for Water Supply and Sewerage

Chapter 5

DEMAND/FLOW AND PROJECTIONS

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Demand/Flow and Projections

1.0 Purpose

The accurate assessment of water demand and sewage flow forms the basis of all planning studies. This chapter provides guidance on the assessment of water demand and sewage flows and in particular addresses the assessment of future demand and flow based on historical records and future growth and water usage projections.

2.0 Key Principles

Future water demand and sewage flow including peaking factors should be based on actual system performance, historical records and a consideration of future demand pattern changes.

Existing and future water demand should be separated into internal and external components so that the impact of demand management changes can be properly assessed.

It is essential that planners examine the underlying basis for current and future water demand particularly in terms of the many variables affecting internal and external demand components. Unit water demands or sewage flows should be specified as per equivalent person (EP).

Water demand should be associated with a required water quality, so that the potential magnitude of water recycling from various sources (eg. stormwater, wastewater), or supply from alternate sources (eg. rainwater tanks, bores) can be assessed.

The components of water loss (eg leakage) should be determined. Actions required to reduce these components should be stated, where cost effective.

Peaking factors, particularly for water demand, should take into consideration the likely changes to historical patterns where water recycling is incorporated.

Sewage flow should take into account changes in internal water demand resulting from demand management initiatives. The impacts of infiltration/inflow management programs should also be considered.

Demand projections should be broken down to match sub-catchments where appropriate.

3.0 Why is the Knowledge of Demands and Projections Important?

The knowledge of current and anticipated future water supply demand and/or sewage flow is fundamental to planning. The assumptions used in determining demand or sewage flow have a permanent effect on planning outcomes and subsequent planning decisions. Without a thorough analysis of demand/flow, premature or excessive investment in capital works may result causing unnecessary additional financial impacts on customers. Conversely, inadequate demand management and/or infrastructure investment may result in increasing customer service complaints or environmental impacts.

The service provider needs to know current and future demands/flows in order to determine what spare capacity exists, the weak links in the system, and the ability to accept new or unexpected demands.

4.0 When Should Demand and Projections be Determined?

A service provider should have knowledge of current demand/flow and anticipated future projections at all times. These should be updated at regular intervals, depending on the size of the system, growth rate, etc.

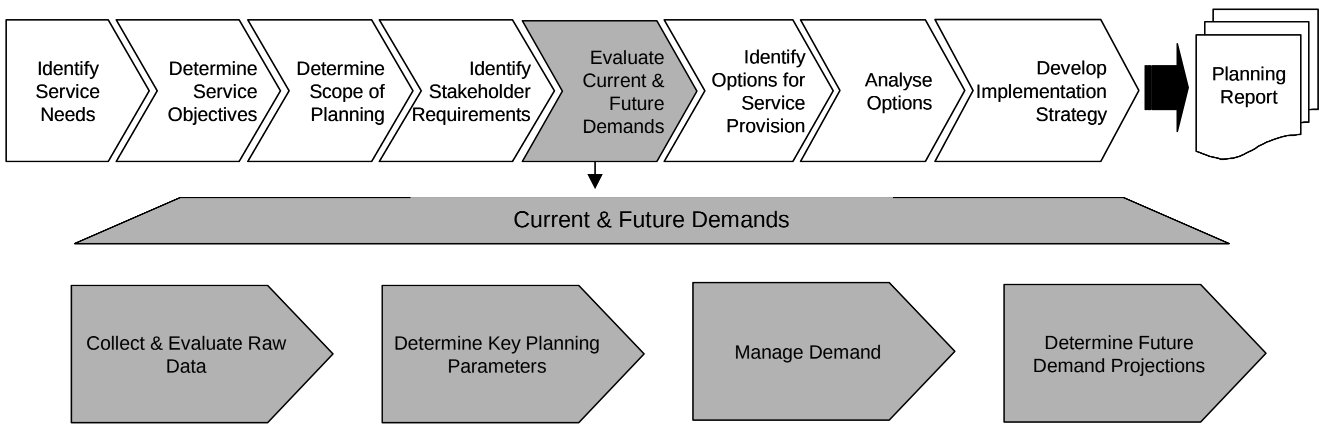
In undertaking a planning study, current and future demands flow should be determined once:

- service needs and objectives have been determined
- stakeholder requirements have been identified
- adequate raw data on existing demands or flows is available.

5.0 Key Elements

The key elements are illustrated in Figure 5.1.

FIGURE 5.1 – Key Elements



5.1 Collect and Evaluate Raw Data

For existing water supply and sewerage systems it is essential that actual demand/flow data is used. Typical raw data requirements are listed in Table 5.1.

TABLE 5.1 – Raw Data Requirements

Data	Water Supply	Sewerage	Comments
Land use plans	✓	✓	
Priority infrastructure plans	✓	✓	
Land use classification	✓	✓	
Number of connections by customer and land use type including: ▪ Existing developed; ▪ Existing undeveloped; and ▪ Future potential developments.	✓	✓	Customer type could include residential, rural residential, commercial, industrial, etc.
Occupancy ratio	✓	✓	This is the average household size as determined from census data or other means.
Census data	✓	✓	Census data should be noted as well as the census boundaries.
Daily demand/flow	✓	✓	The planner should determine meter accuracy and the level of confidence in this data
Customer water meter readings	✓		The planner should determine meter accuracy and the level of confidence in this data
Diurnal demand/flow patterns	✓	✓	Patterns for different customer types may be necessary (ie residential, commercial, industrial).
Seasonal demand/flow patterns	✓	✓	Particularly relevant where large tourist/transient population exists, some industrial activities or distinct climate change influences demand.
Daily rainfall	✓	✓	The planner should determine meter accuracy and level of confidence in this data.
Daily temperature	✓		The planner should determine meter accuracy and level of confidence in this data.
Climate change	✓		Likely to impact on future demands.
Internal water use (by type)	✓	✓	
External water use	✓		
Duration and extent of water restrictions	✓		
History of demand management initiatives	✓		How effective was each strategy (eg two part tariffs, rain water tank subsidies, water efficient devices etc).
Tariff (including historical changes)	✓	✓	Would be applicable to sewerage if sewerage charge is based on metered water consumption.
Trade waste (quantity and quality)		✓	
Wastewater composition		✓	

5.2 Determine Key Planning Parameters

All unit water consumption or wastewater flow should be specified as per EP (equivalent person). Equivalent person is defined as "water supply demand or the quantity and/or quality of sewage discharge for a person resident in a detached house". The term equivalent person is also applied to:

- The number of persons who would have a water demand equivalent to the establishment being considered.
- The number of persons who would contribute the same quantity and/or quality of domestic sewage as the establishment being considered.

5.2.1 Water Supply

Key planning parameters to be determined are listed in Table 5.2

TABLE 5.2 – Water Supply Planning Parameters

Parameter	Abbreviation	Comments
Average Day Demand	AD	Separate out into internal and external demand.
Mean Day Maximum Month	MDMM	This is the highest 30 day moving average daily water demand during a year. Parameter used in Queensland only to reflect demand persistence in response to climatic conditions.
Peak Day Demand	PD	Previous guideline used the term Maximum Day Demand (MD).
Peak Hour Demand	PH	Previous guideline used the term Maximum Hour Demand (MH).
Non-revenue water	NRW	Refer to IWA "best practice" standard approach to water balance calculations. Components include real losses, apparent losses and unbilled authorised consumption.
Fireflow		Refer to Chapter 6.

A number of studies have been undertaken in recent years concerning internal residential consumption. Typical ranges of consumption are listed in Table 5.3. These figures would apply to typical household sizes of 2 to 4. More detailed studies (Water Corporation 2003, IPART 2004 refer to section 7.0 – Bibliography) should be consulted for further information.

TABLE 5.3 – Typical Household (2-4 persons) Internal Water Use

	Range	**Typical % of Internal Use**
Toilets	110-180 L/d	26%
Baths/Showers	170-220 L/d	34%
Kitchen	45-90 L/d	13%
Laundry	100-140 L/d	22%
Other	15-50 L/d	5%

Internal residential consumption will depend on the extent of demand management initiatives adopted (eg tariff structure, dual flush cisterns, water efficient devices etc) and household size. Sewage ADWF from residential areas will provide an indication of internal water usage.

Evaporative air conditioners can significantly add to water demand. Evaporative air conditioners can use up to 75L/hr in the summer months. These units use between 10% and 25% of the total annual residential consumption in hot and dry climates. Quoted average household water usage from evaporative air conditioners are:

Western communities	250-300 kL/annum
Darling Downs	70-115 kL/annum

External water usage will depend on:

- the nature of the development (detached residential, multi unit development etc)
- lot size
- location
- rainfall patterns
- pricing
- level of water restrictions
- moisture deficit.

Water demands from commercial/industrial premises can be measured from meter readings. Table A provides an indication of average water demands and wastewater flows from a range of developments. However, these figures are for indicative and comparative purposes only. Caution should be exercised in the use of this data.

The components of NRW including real and apparent losses can be determined using the IWA "best practice" approach to water balance calculations. It is likely that the regulatory requirement for the preparation of System Leakage Management Plans will assist in the determination of the NRW components.

For some smaller urban centres or for new schemes a planner should access water consumption and NRW component data from similar neighbouring schemes making allowance for the age and maintenance of the neighbouring infrastructure.

Planners should determine peaking factors based on actual system performance. For larger schemes, peaking factors for different types of developments (eg residential, multi-unit development, commercial) should be determined.

Changes in reservoir volumes should be considered in determining Peak Day or Peak Hour demand, particularly for smaller schemes.

An indicative range of peaking factors is listed in Table 5.4. These will vary depending on the characteristics of the scheme (eg. level of industrial/commercial demand), climate, pricing regime and extent of water restrictions etc. For smaller schemes higher peaking factors may be required but this will depend on the standard of service available.

TABLE 5.4 – Indicative Ranges of Overall Peaking Factors

Equivalent Persons	MDMM:AD	Peak Day Factor PD:AD	Peak Hour Factor PH:AD
> 5,000	1.4 – 1.5	1.5 – 2.0	3.6 – 4.0
< 5,000	1.5 – 1.7	1.9 – 2.3	3.6 – 4.5
Arid areas (where internal water use is less than 30% of total water consumption)	1.5 – 1.7	1.7 – 2.0	3.6 – 5.0

The water loss components of NRW can be assumed to have a peaking factor of 1.0 unless the service provider has more accurate information.

Typically the process for determining existing demand parameters would be as follows:

- Determine unit water demand (L/EP) for detached residential development based on metered consumption and occupancy ratio. Determine total EP and total demand for detached residential development or land use.
- Determine metered consumption for all (excluding detached residential) land use categories and/ or development/ customer categories. For all categories determine total EP and demands.
- For all categories (particularly those have significant external water use) determine internal and external water demands.
- Determine the components of NRW.
- Determine peaking factors and diurnal flow patterns for total system and various land use classifications.

Fireflows

Refer to Chapter 6 – Network Modelling.

Dual Reticulation

For guidance on dual reticulation (third pipe) systems refer to WSAA (2004), Dual Water Supply Systems.

5.2.2 Sewerage

Key flow parameters to be considered are listed in the Table 5.5.

TABLE 5.5 – Key Sewage Flow Parameters

Parameter	Abbreviation	Comments
Average dry weather flow	ADWF*	This is the combined average daily sanitary flow into a sewer from domestic, commercial and industrial sources (WSAA). Note: this excludes any IIF.
Peak dry weather flow	PDWF*	The most likely peak sanitary flow in a sewer during a normal day. It exhibits a regular diurnal pattern with morning and evening peaks (WSAA).
Peak wet weather flow	PWWF	Includes: PDWF + GWI + IIF
Groundwater infiltration	GWI	Groundwater (non-rainfall dependent) infiltration. Generally exists for sewers laid below groundwater table. Groundwater infiltration enters the system via defective pipes or joints and leaking manhole walls. GWI can generally be estimated as the flow between midnight and 4.00 am during dry periods.
Rainfall dependent inflow & infiltration	IIF	Peak (rainfall dependent) inflow and infiltration. This includes flow discharged into sewer from: • unauthorised roof, ground or stormwater drainage • leaking manhole covers • disconnected sewers • low disconnector traps • indirect infiltration of rainwater entering defective pipes and joints from the surrounding soil. Refer to the WSAA Sewerage Code for further details.

*In some schemes the ADWF and PDWF may include a GWI component throughout the year. This may have an impact on peaking factors.

Planners should determine ADWF, PDWF and PWWF based on:

1. Actual system performance
2. The WSAA Sewerage Code or
3. The historical Queensland approach, where typically

   $PDWF = C_2 \times ADWF$ where $C_2 = 4.7 \times (EP)^{-0.105}$

   $PWWF = (5 \times ADWF)$ or $(C_1 \times ADWF)$, whichever is the larger

   $C_1 = 15 \times (EP)^{-0.1587}$ (note: the minimum value for $C_1 = 3.5$)

   In the above formulae, EP is the total equivalent population in the catchment gravitating to a pump station

For smart sewers IIF can be 50% of calculated IIF for conventional sewers.

Generally ADWF will range between 150-275 L/EP/d. This flow should be consistent with internal household water use.

The process for determining existing demand parameters would typically be as follows:

- Determine unit flow (L/EP) at ADWF for detached residential development based on internal water consumption and/or bulk metering of a residential catchment, and occupancy ratio. Determine total EP and total ADWF for detached residential development or land use.

- Determine unit flow (L/EP) at ADWF for all (excluding detached residential) land use categories and/ or development/ customer categories. For all categories determine total EP and ADWF.

- Determine total ADWF from treatment plant and catchment metering. Calibrate ADWF calculated from treatment plant or catchment metering against the calculated ADWF based on L/EP based land use categories.

- Determine peaking factors and diurnal flow patterns for total system and various land use classifications.

5.2.3 Schemes with High Transient or Tourist Populations

For schemes with a significant component of non-permanent residential population (eg tourist centres), planners will need to consider the appropriate peaking factors to be applied for both water and sewerage.

Planners need to ensure that double counting does not occur when taking into account holiday season loadings at communities subject to a significant increase in population. For instance, adopting both peak population numbers and excessive peaking factors to determine planning and design parameters.

Designing a sewerage scheme with an excessive peaking factor to cope with a 3-4 week peak tourist season could have adverse operational impacts during other parts of the year.

5.3 Determine Future Demand or Flow Projections

5.3.1 The Planning Horizon

The planning horizon would depend on a number of factors including:

- lead time including approvals to construct infrastructure
- growth rates
- possible infrastructure staging options.

For water services the overall planning horizon for major resource and system components should be 50 years.

For the detailed planning of new infrastructure a planning horizon of 20 years is appropriate provided it is consistent with the overall resource planning horizon of 50 years.

An ultimate development scenario based on a stated population density, should be considered particularly in relation to identifying:

- the location of essential infrastructure for early procurement of land/easements

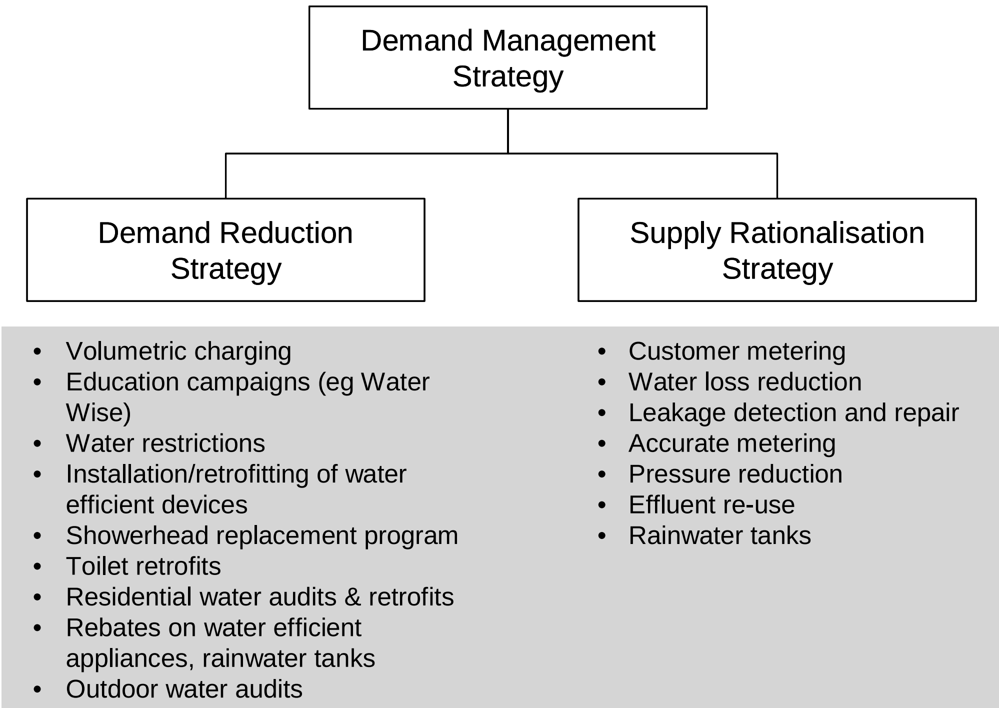
- long term constraints (eg pipeline corridors that may only accommodate one main)
- optimal staging strategies.

5.3.2 Demand Management

The service provider's current and future demand management strategy should be given serious consideration before determining demand/flow projections. This could be an iterative process. The strategies may need to be re-evaluated once the implications of increasing demand become apparent later on in the planning study. The sustainability of a demand management strategy over the longer term should also be considered.

Demand management strategies are listed below in Figure 5.3. More detailed information is available in Section 7.0 - Bibliography.

FIGURE 5.3 – Demand Management Strategies



Demand management strategies should also have an impact on reducing sewage ADWF. However, PWWF may remain unchanged where high infiltration/inflow levels exist.

5.3.3 Estimating Future Demands/Flows

In estimating future demands/flow it is necessary to understand the underlying cause of current and historical demands/flows. This will necessitate collecting and analysing the data listed in Table 5.1. Consideration should be given to the following in estimating future demands/flows per EP:

- State/regional consumption targets
- internal and external demand and impacts of demand management on the various components of these demands

- changing household occupancy ratios
- changing development types (eg increasing multi-unit development and small lot developments)
- the impact of climatic change
- impacts of ageing infrastructure (eg increasing inflow/infiltration)
- impacts of I/I reduction strategies
- the impacts of various asset options (eg rainwater tanks).

Population projections should be based on population planning information available from a local government. Broad local government growth projections are also available from the State Government. Census information is also a good source of data on occupancy ratios and population growth trends. However, census data should be carefully interpreted as it may represent broad statistics of an area where the actual customers of a system may be a statistical minority.

The process for estimating future water demand or sewage flow projections would include the following:

- Determine future growth by land use categories and/or development/ customer categories within zones or catchments.
- Determine growth or reduction in per EP demand/ flow by land use categories and/or development/ customer categories taking into account impacts of various demand management initiatives.
- Determine anticipated changes in the components of NRW in response to water loss reduction strategies.
- Calculate total water demand or sewage flow.
- Determine future peaking factors and diurnal flow patterns based on anticipated impacts of various demand management initiatives and, in the case of sewage, I/I reduction strategies.

A scenario analysis should be undertaken to assess the impacts of changing variables on the resulting demand/flow projections.

6.0 Checklist

What confidence do you have in the raw data?

What have you done to ensure the reliability of the raw data?

Do you really understand the underlying cause of water demand?

To what extent has demand management been considered?

Is there a commitment by the service provider to implement demand management strategies?

Have State/regional water consumption targets been considered? Can they be met?

Have the benefits of demand management been quantified and presented in a planning study?

Have the components of NRW been accurately determined?

What is the strategy to reduce NRW?

What is the basis of the peaking factors?

How consistent is the internal household demand with sewage ADWF? Are there any reasons for the difference?

Is the planning horizon appropriate for the study?

What are the demand/flow projections based on?

What level of scenario analysis has been undertaken?

Have the impacts of changing any variable been assessed?

Are you confident that the projections form a sound foundation to the planning study?

What have you done to ensure this level of confidence?

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TABLE A – Indicative Average Demands/Flows from Commercial/Institutional Developments (litres/day)

Development	Water Demand	Sewage Flow	Unit
Apartment/Home Unit	300 to 500	225 to 450	1 bed
	550 to 750	300 to 600	2 bed
	700 to 900	400 to 750	3 bed
Caravan Park – Van	550 to 750	300 to 675	site
Caravan Park – Tent	150 to 250	150 to 250	site
Central Business	14000 to 20000	11250 to 20000	ha
Child Care Centre	40 to 70	25 to 45	staff & pupils
Commercial Premises	500 to 800	150 to 300	100 sqm GFA*
Convalescent Home	600 to 1100	300 to 450	bed
Crematorium	500 to 700	250 to 500	100 sqm GFA
Education – Primary School	50 to 80	25 to 45	staff & pupils
Education – Secondary School	90 to 150	50 to 90	staff & pupils
Education – Tertiary Institution	90 to 150	50 to 90	staff & pupils
Fast Food Store	1400 to 4200	1200 to 2000	100 sqm GFA
Food Services	1200 to 2000	900 to 1200	100 sqm GFA
Heavy Industry	10000 to 35000	10000 to 13500	ha
Hospital	500 to 1800	400 to 800	bed
Hostel Accommodation	200 to 600	150 to 400	bed
Hotel	700 to 1200	300 to 600	100 sqm GFA
Light Industry	10000 to 35000	10000 to 13500	ha
Major Shopping Development	300 to 800	200 to 550	100 sqm GFA
Medical Centre	400 to 700	250 to 675	100 sqm GFA
Motel	300 to 600	225 to 500	room
Multiple Units	500 to 700	225 to 450	1 bed
	800 to 1000	300 to 600	2 bed
	1000 to 1400	400 to 750	3 bed
Place of Worship	200 to 400	100 to 180	100 sqm GFA
Public Building	500 to 600	280 to 450	100 sqm GFA
Restaurant	800 to 1800	550 to 600	100 sqm GFA
Retirement Village	300 to 700	225 to 450	1 bed
	500 to 1000	300 to 550	2 bed
	700 to 1400	450 to 750	3 bed
Service Station	500 to 700	250 to 350	100 sqm GFA
Shop	600 to 800	280 to 450	100 sqm GFA

(* GFA – Gross Floor Area)

These figures are for indicative and comparative purposes only. Caution should be exercised in the use of this data.