

## China – UK, WRDMAP Integrated Water Resources Management Document Series

### Example 5.4: Tariff Setting for Beipiao Water Supply Company

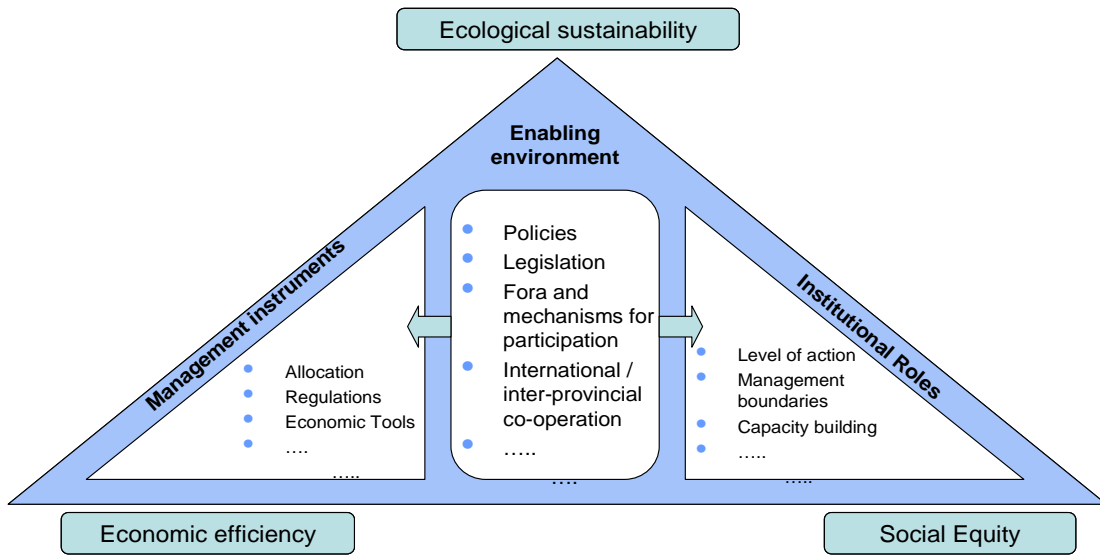
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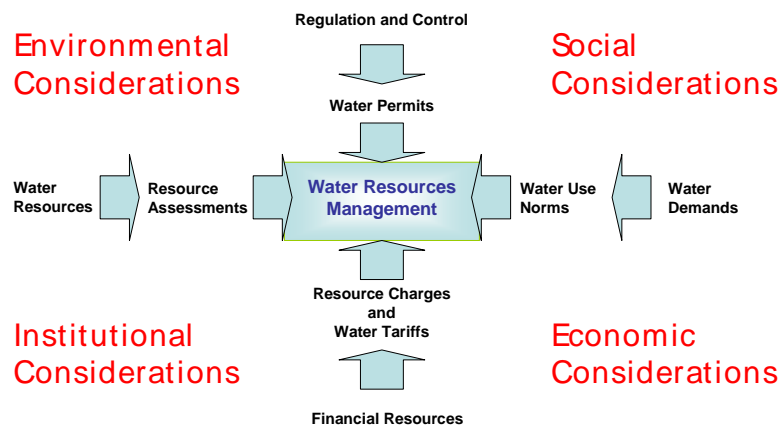


# Integrated Water Resources Management (IWRM)

*(Basics after Global Water Partnership)*



## Driving Elements of Integrated Water Resources Management



*(Second figure after WRDMAP)*

**Summary:** Water pricing can be an effective means to reduce demand for, and improve the economic efficiency of, water use. In Beipiao, Liaoning Province, the Water Supply Company (WSC) was generating insufficient revenue, making it difficult to maintain infrastructure and improve services. In fact, water stress in the source aquifer combined with poor maintenance meant that the WSC could only provide water 4-6 hours a day to consumers.

The tariff review described in this Example document was undertaken with the support of the Water Resources Demand Management Assistance Project in 2007.

Guidance in the form of an Advisory Note and this Example was developed by the Ministry of Water Resources to help the management of small to medium size water supply companies (WSCs) adopt demand management strategies as part of the ongoing development of Water Saving Society. Tariff setting is also an area of interest to WAB and WRD responsible for achieving demand management targets.

The example covers the following topics:

- Present tariffs
- Tariff objectives
- Data basis for tariff estimates
- Willingness to pay for water
- Domestic block tariff
- Non-domestic tariff
- Price and income effects
- Affordability
- Water pricing policy

The Ministry of Water Resources have supported the Water Resources Demand Management Assistance Project (WRDMAP) to develop this series to support WRD/WAB at provincial, municipal and county levels in their efforts to achieve sustainable water use.

## 1 Introduction

This document describes a tariff review by Beipiao Water Supply Company in Liaoning Province. The review was undertaken in 2007 with the support of the Water Resources Demand Management Assistance Project (WRDMAP).

Further guidance on tariff setting is available in Advisory Note 5.4 'Tariff Setting for a Small to Medium Size Water Supply Company'.

Beipiao Water Supply Company (WSC) currently provides water services to a population of some 130,000 people through an estimated 44,120 connections. The principal water source is a number of wells within a radius of 15 kilometres from the town centre. After disinfection with chlorine, water is pumped directly into the distribution networks. There are four service areas: Beipiao 1, Beipiao 2, Taiji and Sanbao.

Losses due to leakage are estimated at some 40% which, when coupled with water stress in the aquifers, means that the WSC is unable to provide a 24 hour service. In response to these constraints, the WSC rations the supply of water to about 4 to 6 hours per day with different areas being supplied in rotation.

In the 2006 financial year the WSC collected revenue amounting to some RMB 8.50 million. Approximately 80% of this revenue was spent on power for pumping and water treatment (disinfection only), with the remainder spent on maintenance and repairs. The municipality contributed some RMB 2.4 million to cover salary and other costs.

## 2 Present Tariffs

### 2.1 Present water tariff in Beipiao

The objectives of the present water tariff are to cover the Beipiao Water Supply Company's operating costs and to ensure that water is affordable for the population. While achieving the latter objective to some extent, it does not fully achieve the former.

Tariff revenues make no contribution to the capital costs of the water utility as

infrastructure investments are funded with grants from the local government. Furthermore, as presently structured, the tariff has no role in water demand management, except in so far as it has higher rates for non-domestic than for domestic customers.

The present Beipiao WSC tariff was approved in September 2003 and has been applied since then. This tariff has four tariff rates for domestic and non-domestic customers. It is a volumetric tariff with a flat rate for each consumer category regardless of level of consumption (Table 1).

Table 1: Current tariff rates for Beipiao (March 2008)

Category	Rate (RMB/m <sup>3</sup> )		Ratio to domestic rate	
	Before	Since	Before	Since
	September 03	September 03	September 03	September 03
Domestic	1.00	1.50	1.00	1.00
Industry	2.20	2.80	2.20	1.87
Government & public institutions	2.50	3.00	2.50	2.00
Commercial & small businesses	2.50	3.00	2.50	2.00
Restaurants, public baths, etc.	5.50	5.50	5.50	3.67

Source: Beipiao Water Supply Company

The table also shows the rates applicable prior to September 2003. This last adjustment in tariff rates involved an increase of 50% in the domestic tariff rate but smaller increases of 27% for industry and 20% for institutions and the commercial sector. There was no change, on this occasion, in the tariff rate for the high volume commercial customers.

Over time the accumulated effect of inflation erodes the revenue base by reducing its purchasing power, especially for a public utility such as the WSC which cannot adjust selling prices at will. After four years of using Beipiao's 2003-approved tariff rates, total domestic price inflation amounted to 18%.

Application has now been made to the Price Bureau for a new tariff increase and structure.

### 2.2 Current tariffs in other cities in Liaoning

The tariffs of water companies in China typically have separate rates for domestic and non-domestic customers, with non-domestic customers being divided into industrial, institutional (including government offices and agencies, schools, hospitals and other public sector agencies), commercial, and special services (see Table 1 above). The latter are usually services that are large users of water such as car washing and bath houses. Some companies divide commercial users

into low volume users with a relatively lower rate and high volume users (such as restaurants and beauty salons) with a rate between the normal commercial rate and the special services rate.

The domestic rate is typically set so that the basic needs of poor households can be met at an affordable price, and financial objectives for the water company are met through the higher non-domestic tariff rates. The existing tariff of the Beipiao WSC is of this type. Table 2 has some examples of this type of tariff currently applied in other cities in Liaoning Province. Beipiao rates are

generally slightly below the average for this group of cities.

Block tariffs with increasing prices for successive blocks for domestic customers are becoming more common and some cities also have block tariffs for non-domestic consumers or penalty rates (e.g. a percentage surcharge) for consumption above some agreed limit. A number of cities in Liaoning have already adopted rising block tariffs for domestic consumption; some examples are given in Table 3. In setting block tariffs, it is important that the tariff blocks are designed to help the WSC achieve its financial, social and water conservation objectives.

Table 2: Current tariff rates for cities in Liaoning, in RMB (March 2008)

City	Domestic	Institutional & Commercial	Industrial	Services	Special Sector
Beipiao	1.5	3.0	2.8	5.5	5.5
Chaoyang	1.6 <sup>2)</sup>	2.3 / 3.0	2.6	5.0	10.0
Linyuan	1.3	1.8	1.9	2.2	5.3
Tieling	1.95 <sup>2)</sup>	2.2	2.2	10.0	10.0
Dingta	1.8	3.3	4.3	5.3	6.0
Anshan	1.6	2.2	2.9	5.8	12.3
Dashiqiao	2.3	3.6	3.6	7.6	9.4
Gaizhou	2.2	3.5	3.5	7.5	9.4
Linghai	2.1	2.6	2.6	7.0	14.0
Average <sup>1)</sup>	1.79	2.72	2.93	5.37	8.39

Notes: 1) Simple average for the cities listed in the table. 2) Rate for first block

Table 3: Domestic block tariffs for cities in Liaoning, in RMB (March 2008)

m <sup>3</sup> /month	Jinzhou <sup>1)</sup>	Yingkou <sup>1)</sup>	Fushan <sup>1)</sup>	m <sup>3</sup> /month	Buxing <sup>2)</sup>
0 – 9	2.45	2.15	1.35	0 – 9	1.65
9.01 – 15	3.45	3.70	2.00	9.01 – 12	3.30
>15	4.45	4.80	3.00	12.01 – 14	4.95
				> 14	6.60

Notes:

1) The blocks for Jinzhou, Yingkou and Fushan are relatively large and may not be appropriate for Beipiao where household consumption is almost always less than 10 m<sup>3</sup> per month.

2) Buxing also has a special rate of RMB0.12/m<sup>3</sup> for low income families consuming less than 1m<sup>3</sup> per person per month

The current domestic tariff blocks for the cities of Chaoyang and Teiling are somewhat smaller from the other Liaoning cities above:

Table 4: Smaller domestic block tariffs

Chaoyang		Teiling	
m <sup>3</sup> /mo.	RMB	m <sup>3</sup> /mo.	RMB
0 – 3	1.60	0 – 3	1.95
3 – 5	2.50	3 – 9	2.50
>5	5.00	>9	3.00

### 3 Tariff Objectives

The structure of the tariff should be designed to assist in achieving the tariff objectives. The priority objectives are:

- Financial sustainability for the Beipiao WSC so that it can continue to meet its obligations to supply water to the community over the long term
- Meeting the basic water needs of the population, in particular of poor households, at an affordable price
- Water demand management and promoting the objective of conserving water in the context of overall water scarcity.

## 4 Data Basis for Tariff Estimates

### 4.1 Data requirements

Data requirements for designing a tariff include:

1. Data on income levels and income distribution, if possible, to assist with setting prices for the domestic consumption blocks and determining affordability

2. An analysis of water consumption (volumes consumed) by existing WSC customers over the last three years to assist with determining tariff blocks for domestic consumers and normal levels of consumption for non-domestic consumers
3. Data on willingness to pay for water of both domestic and non-domestic customers, which can best be obtained through a survey focused on collecting just this information
4. A determination of what proportion of WSC costs should be borne by each tariff category
5. A medium term water demand forecast covering at least the period during the which revised tariff rates are expected to apply
6. Details of the medium term investment programme.

### 4.2 Domestic consumption

Data on consumption for both domestic and non-domestic categories provided by the Beipiao WSC Billing Department was used for tariff design and for estimating the impact of tariffs on company revenue and households. This was supplemented by data on water consumption and spending from a Willingness to Pay (WTP) survey.

Domestic consumption data in Beipiao covers the years 2004 to 2006 and includes a 22% sample of domestic metered connections for 2004, about 18% for 2005 and less for 2006 (as some of the areas included are new and were not part of the supply network in 2004). The data was collected in 2.5 m<sup>3</sup> blocks and subsequently average consumption

was estimated using a single point in each block. At present, almost a quarter of households with metered connections consume less than 2.5 m<sup>3</sup> per month; 68% consume less than 5.0 m<sup>3</sup> per month. No households are reported to be consuming more than 10 m<sup>3</sup> per month. The average household size in Beipiao is about 2.5 persons, so this means that a high proportion of the population connected to the water supply system are consuming 2 m<sup>3</sup> per person per month or less. The overall average consumption in 2006 for this sample was 4.2 m<sup>3</sup> per month - i.e. 1.68 m<sup>3</sup> per person (56 lpcd) for an average household.

A more limited set of data provided by the Beipiao WSC Billing Department in December 2006 included a small proportion of households (about 2%) consuming more than 10 m<sup>3</sup> per month. This has been taken into account in determining the consumption distribution of households for tariff estimation.

Approximately one third of connected households do not have meters. A high proportion of these households are in lower income parts of the city where per capita consumption is relatively low. For the purpose of tariff design, it has been assumed that the consumption of non-metered households is mostly in the 0 – 5 m<sup>3</sup> per month range, with the majority consuming between 2.5 and 5 m<sup>3</sup>. A small proportion (10%) are assumed to consume up to 7.5 m<sup>3</sup>. The result is a similar average consumption for non-metered households as for metered households (about 4 m<sup>3</sup> per household per month). See Table 5.

This general consumption pattern is corroborated by data from the Willingness to Pay (WTP) survey, which gives an overall average monthly consumption of 5.5 m<sup>3</sup> per household per month (75 lpcd for an average household).

Table 5: Beipiao household water consumption sample (m<sup>3</sup>/month)

Consumption Blocks	Number of Households			Distribution of Households		
	2004	2005	2006	2004	2005	2006
0 - 2.5	550	1022	1350	19.0%	21.2%	23.0%
2.51 – 5.0	1090	2100	2660	37.6%	43.6%	45.4%
5.01 – 7.50	836	1146	1306	28.9%	23.8%	22.3%
7.51 – 10.0	420	544	548	14.5%	11.3%	9.4%
10.01 – 12.5	0	0	0	0.0%	0.0%	0.0%
> 12.5	0	0	0	0.0%	0.0%	0.0%
Total in sample	2896	4812	5864	100%	100%	100%
Av. Consumption	4.72	4.38	4.20			

Source: Beipiao WSC Billing Department, sample data

Taking the metered and non-metered households together, the distribution used for the subsequent estimates is shown in Table 7. Because this estimate is based on sample data and single points within each consumption block, total annual domestic

consumption differs from the actual total. The total in the table is 92% of domestic consumption in 2005. However, the estimate is still valid for comparing revenue generated by the different tariff proposals.

Table 6: Estimate of distribution of consumption in Beipiao

Consumption (m <sup>3</sup> /hh/month)		Consumption (m <sup>3</sup> /cap./month)		Distribution		Estimated Consumption	
from	to	from	to	Metered	Non-Metered	Metered	Non-Metered
0.00	2.50	0.00	1.00	21%	10%	8,456	1,972
2.51	5.00	1.00	2.00	42%	80%	45,098	42,077
5.01	7.50	2.00	3.00	24%	10%	41,877	8,547
7.51	10.00	3.00	4.00	10%		24,160	0
10.01	12.50	4.00	5.00	3%		9,261	0
12.51	15.00	5.00	6.00			0	0
>15.0		>6.00					
Total Consumption per month (m <sup>3</sup> )						128,851	52,596
Annual Consumption (m <sup>3</sup> )						1,546,214	631,152
Total Annual Consumption (m <sup>3</sup> )						2,177,367	

Note: Abbreviations used: hh = household, cap. = per capita

### 4.3 Non-domestic consumption

For non-domestic consumption, two sets of data are available. The first of these is based on revenue data for 2004 and 2005 while the second is a summary of data for the years 2004, 2005 and 2006 provided by the Beipiao WSC Billing Department in

April 2007. The latter data set includes a 50% sample for the industrial category, 30% for institutions, 98% for restaurants and bathhouses (i.e. all metered connections) and all connections for the commercial and small business category. These numbers should be the more reliable of the two sets and are used in the tariff calculations.

Table 7: Non-domestic consumption (m<sup>3</sup>/year)

Non-Domestic Tariff Category	Estimated Consumption (m <sup>3</sup> /year)			
	2004/2005 <sup>1)</sup>	%	3 year average <sup>2)</sup>	%
Industrial	382,000	24.3	598,480	30.9
Government & Institutions	978,000	62.2	1,130,968	58.5
Commercial/small business	75,000	4.8	56,668	2.9
Restaurants & Services	137,000	8.7	148,381	7.7
Total	1,572,000	100.0	1,934,497	100.0

Notes: 1) based on revenue data for 2004 and 2005 2) based consumption data for 2004 to 2006

Source: WSC Billing Department

## 5 Willingness to Pay for Water

Surveys of domestic and non-domestic customers of the Beipiao WSC were implemented to assess the willingness of customers to pay for water. These surveys were implemented in May 2007 and collected information on the background of customers, water services and the value of water to customers. The surveys used a contingent valuation question to assess respondents' willingness to pay for water – i.e. respondents were asked to value water services contingent upon a stated level and standard of services being provided. The survey of domestic consumers covered 600 households – 150 selected at random in each of 4 districts, which were selected to reflect high, medium and low income areas of the city. Only households supplied by the WSC, which supplies 50 – 55% of the urban population of Beipiao, were included in the survey. For non-domestic consumers, a random selection was made within each of the tariff categories, but because of time and budget constraints the sample sizes were relatively small.

### 5.1 WTP – domestic customers

Not all households have water meters. At the time of the survey, about a third of all domestic customers of the WSC had non-metered supply. The distribution of metered and non-metered households in the survey is shown in Table 8. Areas where there are more new apartment blocks have fewer non-metered connections than elsewhere and areas with many older, stand alone houses have a very high proportion of non-metered connections.

Non-metered households pay on a per capita basis, at RMB4.50 per person per month which assumes per capita consumption of 3 m<sup>3</sup> per person per month (or 100 lpcd). In Beipiao, households without meters, many in the poorer parts of the city and living in stand alone houses, pay more for water and often use less of it than those with meters. This discrepancy shows the need for changes to the current tariff system.

Overall, respondents reported an average consumption of 75.5 lpcd and an average water payment of RMB1.60 per m<sup>3</sup>, which is greater than the prevailing flat rate tariff of RMB1.50 per m<sup>3</sup> and arises because of the discrepancy between actual consumption and the assumed consumption of non-metered households.

The willingness to pay contingent valuation questions asked respondents to say how much they would be willing to pay for water assuming 24 hour supply with adequate pressure (but no change in water quality). In fact, the level of dissatisfaction reported by the survey with the current service was relatively high with 64% of respondents being dissatisfied, mostly with the regularity of supply, hours of service and water quality.

The survey revealed an average willingness to pay for water of RMB12 per household per month for the whole sample, assuming improved service (see Table 9). This is 37% more than households reported paying, on average, in the survey (see Table 10) and indicates that there is considerable customer acceptance for increasing water charges provided they are associated with improved service.

Table 8: Household connection metering, sample survey of 4 districts in Beipiao (May 2007)

	Total	Nanshan	Shuanghe	Taiji	Sanbao
Metered	282	103	149	21	9
- percent	47%	69%	99%	14%	6%
Not metered	311	40	1	129	141
- percent	53%	31%	1%	86%	94%

Notes: 1) Percentages shown are calculated by column

2) Income status of districts: Nanshan – high; Shuanghe – middle; Taiji & Sanbao – low

Table 9: Willingness to pay for water (RMB/household/quarter)

	Total	Nanshan	Shuanghe	Taiji	Sanbao
Average	36	39	32	31	42
Median	40	40	30	30	40
Range	9 – 150	15 - 60	9 - 150	13.5 - 81	25 – 60

Table 10: Domestic monthly water consumption &amp; quarterly water bills (May 2007)

	Total	Nanshan	Shuanghe	Taiji	Sanbao
<i>Water consumption:</i>					
- total reported (m <sup>3</sup> /month)	2,325	872	418	942	93
- average per household <sup>1)</sup>	5.50	5.81	5.43	6.28	2.02
- don't know	177		73		104
- average per capita (lpcd)	75.5	74.8	71.0	86.2	31.3
<i>Water payments:</i>					
- total payment (RMB/qtr.)	13,878	3,726	1,740	4,232	4,180
- average / hh / month <sup>1)</sup>	8.79	8.28	7.53	9.40	9.35
- average cost (RMB/m <sup>3</sup> ) <sup>2)</sup>	1.60	1.43	1.39	1.50	4.63
- don't know	74		73		1

Notes: 1) Average for households reporting 2) Calculated from reported consumption and payments

Source: Sample survey of domestic users in Beipiao, May 2007

## 5.2 WTP – non-domestic customers

A total of 95 respondents were included in the survey of non-domestic customers of the Beipiao WSC. Water supply for the majority of the non-domestic customers is metered, but these customers are mostly small businesses, restaurants and public baths. Of the industries and government agencies and institutions, 70% are not metered. This includes two industries and two institutions which pay a flat rate fee per month, regardless of actual consumption.

The consumption levels and monthly payments for water for the surveyed non-domestic customers are shown in Table 11. Since the data includes both metered and non-metered connections, there are discrepancies between the tariff rates for the respective categories and the cost of water calculated from the survey information. These discrepancies are particularly large for the industrial and government and institutions categories – i.e. where a high proportion of connections are not metered. About 60% of these customers expressed some dissatisfaction with the present

water service, with most of those concerned being dissatisfied with the hours of service, regularity of supply and water quality.

For the non-domestic customers, the willingness to pay questions were framed in terms of percentage changes in water bills for the industrial and institutional customers and in terms of changes in tariff rate charged for the small businesses, restaurants

and bath houses. With the exception of the restaurants and bath houses, the average increase these customers were willing to pay is about 10% of their current water bills. In the case of restaurants, the willingness to pay is an increase of less than 5%. In this group, the restaurants were especially unwilling to pay any increase in tariff, even though the rate for this category was not increased when the water tariff was last adjusted in 2003.

Table 11: Non-domestic water consumption and payments from sample survey (May 2007)

Satisfaction	Total	Industries	Government & Institutions	Small Businesses	Restaurants & Public Baths
Sample size	95	7	16	39	33
Metered connections	57	1	5	29	22
<i>Consumption (m<sup>3</sup>/month):</i>					
- total reported	12,835.7	4,218	7,506.7	314	797
- average per customer	154.6	1,054.5	625.6	9.0	24.9
- don't know	9	1	2	4	2
- fixed volume used	4	2	2		
<i>Water payments:</i>					
- total payment (RMB/qtr.)	251,750	121,272	115,406	2890	12,182
- average / month	902.3	5,774.9	2,564.6	25.4	123.1
- average cost (RMB/m <sup>3</sup> ) <sup>1)</sup>		5.48	4.10	2.82	4.94
- don't know	3		1	1	1

Notes: 1) Calculated based on reported consumption and payments

Table 12: Non-domestic customers - willingness to pay

Willingness to Pay	Industries	Government Institutions	Small Businesses (% increase)	Restaurants & Public Baths (RMB/m <sup>3</sup> )
Average	11.4%	8.1%	10%	5.74
Median	10%	10%	10%	5.50
Range	0~20%	0~20%	0 – 40%	4.3 – 7.0

Source: Sample survey in Beipiao, May 2007

## 6 Domestic Block Tariff

### 6.1 Rationale for a block tariff

Block tariffs are promoted by various authorities in China as a way for water companies to achieve financial objectives, promote water conservation

and provide basic water needs to the population at an affordable price. A well designed block tariff can reflect the scarcity value of water and promote efficient use of this scarce resource by households and other users.

The structure of the tariff should be designed to assist in achieving the tariff objectives.

These objectives can be met with a tariff structured as at present with separate categories for domestic and non-domestic customers, but with the addition of a block tariff for domestic consumers. Tariff blocks might also be considered for non-domestic customers as a way to promote water conservation. Alternatively, penalty rates could apply for non-domestic customers for consumption above an agreed level, with the consumption norms being set on a case by case basis depending on the pattern and scale of water use of each customer.

## 6.2 Meeting basic needs

The average per capita water consumption in Beipiao is 56 lpcd based on the data provided by the Billing Department and assuming an average household size of 2.5 persons. The average consumption estimated from the WTP survey data is higher than this at 75 lpcd, but since households without meters estimated consumption for the survey, the estimate is probably less reliable. The average of 56 lpcd is equivalent to 1.7 m<sup>3</sup> per person per month. This is quite a low average level of consumption. Future increases in household income will tend to increase average consumption, but even a doubling in income will increase consumption only by about 50% (see Section 8).

Taking into account both metered and non-metered households, about 60% of households consume at or below the average consumption level. Because it is low, even though it captures a high proportion of domestic consumers, it is reasonable to regard

this level as the basic needs level of consumption of Beipiao. For simplicity and to allow for a certain amount of future growth in consumption during the life of the next tariff revision, the limit of the basic needs block of the tariff structure can reasonably be set at 2 m<sup>3</sup> per person per month (67 lpcd).

In the city of Chaoyang, the first tariff block has been set at 0 – 3 m<sup>3</sup> per person per month (refer back to Table 4). A 'basic needs' block of this size is not appropriate for Beipiao in its present situation as it clearly exceeds what local consumption patterns indicate are basic needs.

Furthermore, a 'basic needs' block would include 74% of present metered domestic consumption, an estimated 82% of total domestic consumption and 91% of all domestic customers. Such a block would restrict the ability to generate revenue for the WSC from higher blocks or to have much impact on water use efficiency. Nevertheless, a first block of this size may be appropriate for Beipiao at some point in the future when overall consumption has increased significantly.

## 6.3 Un-metered consumption

At present households without meters, or those with meters that are not functioning, are charged for 3 m<sup>3</sup> per person per month (RMB4.5 per person under the current tariff). This is almost twice the average per capita consumption in Beipiao. Under this arrangement households without meters, which are disproportionately in the poorer areas of the city, are subsidising better off households in other parts of the city.

With reform of the water tariff, the charge for un-metered households should be the same as the first tariff block – i.e. 2 m<sup>3</sup> per person per month

– in order to bring it more in line with reality and to make it more equitable. This will also support the objective of making basic water needs available to low income households at an affordable price. However, as low income household tariffs begin to reflect actual consumption, overall tariffs would need to increase to accommodate for the resulting revenue reduction.

## 6.4 Other blocks

Three alternative block structures are assessed, as shown in Table 13.

Option A is based on a first block of 2 m<sup>3</sup> per person per month and second block of the same size – i.e. for consumption between 2 and 4 m<sup>3</sup> per person. Based on present consumption patterns, the first block would account for 41.6% of metered consumption, the second block for 51.2%, and the third block for 7.2%.

Option B is the same as the new block structure for Chaoyang city. However,

for Beipiao the first block would account for 74.1% of present metered consumption and the second block for the remaining 25.9%. At present there would be no consumption under the third block as there are no households consuming more than 5 m<sup>3</sup> per person per month. Some households would move into the third block eventually, as incomes rise, but it seems this block would only account for a very small percentage of consumption in the foreseeable future.

Option C is essentially the same as Option B, except that the second block is for consumption between 3 and 6 m<sup>3</sup> and the third block for consumption above 6 m<sup>3</sup> per person. The distribution of current consumption is the same as for Option B but, since the second block is larger, the third block would be redundant for longer. This is Option C, in a way, a logical extension of the present situation where non-metered households are charged for 3 m<sup>3</sup> per person per month, implying a 3 m<sup>3</sup> basic block of consumption.

Table 13: Block Structure Options (m<sup>3</sup>/person/month)

Block	Option A	Option B	Option C
1	0 – 2	0 – 3	0 – 3
2	2 – 4	3 – 5	3 – 6
3	>4	>5	>6
Un-metered	2	2	2

## 6.5 Block pricing (tariff rates)

The pricing objectives of the tariff blocks are:

- For the first block, providing basic water needs at a price that is affordable, in particular affordable for low income households
- For the second block, generating revenue for the water company

- For the third block, promoting water saving and efficient use of water.

The current tariff rate for domestic customers is RMB1.50 per m<sup>3</sup>. The rate for the first block will be based on this current rate. Taking into consideration the results of the WTP survey and other factors, it seems

unlikely that the (base) rate for the first block should be set much more than 20% above the current rate (i.e. RMB1.80/m<sup>3</sup>) without clear service improvements.

An important consideration from the WSC's point of view is that total inflation, based on the CPI, since the last adjustment of the Beipiao WSC tariff in 2003 has been about 18%. Since inflation erodes the real value of the tariff rates and the company revenue, an adjustment of at least this amount is needed to maintain the real value of the tariff rate for basic consumption (of at least the 2003 level). For households who have been benefiting from the fall in water costs (in real terms) it would restore the costs of basic consumption to what they were paying after the last tariff adjustment in September 2003.

To set the second and third block prices, acceptable ratios for these blocks compared with the base rate (the first block) need to be considered. The second block should still be affordable for most households but should also generate a significant proportion of WSC revenue.

The price for the third block should be set to discourage consumption in this block and to encourage households to save water and use it more efficiently. However, the third block can only be effective in achieving these tasks if at

least some customers are subject to its high price and if others are at risk of consuming at this level. There will be no water saving effect in the tariff if the third block is set at a consumption level that few, or no, households are likely to enter.

Table 14 shows the distribution of domestic consumption revenue by tariff block for two block structure options and two options for the ratios between block prices. (For each combination, the percentage distribution of revenue remains the same regardless of the base rate for the first block.) The un-metered block in the table is based on 2 m<sup>3</sup> per person per month. With Option A, the first block generates between 21% and 23% of revenue for the two tariff rate ratios shown and the second block between about 39% and 44%. If the un-metered consumption is combined with the first block, then 46% to 51% of revenue some from this low consumption group. About 9% comes from the third block. With Option B, about twice the proportion of total revenue comes from the first block and around 75% of revenue if the un-metered customers are included. In other words, this block structure produces a pattern of revenue much closer to the present situation than Option A. Furthermore, households would graduate into the second block only slowly, and only rarely into the third block.

Table 14: Distribution of revenue for block & tariff rate structures

Blocks	Option A		Option B	
	1 : 1.5 : 3	1 : 2 : 3	1 : 1.5 : 3	1 : 2 : 3
1	23.1%	20.9%	46.3%	43.9%
2	38.9%	44.4%	21.8%	25.9%
3	9.6%	9.0%	0%	0%
un-metered	28.4%	25.7%	31.9%	30.2%

The pattern for Option C is very similar to Option B.

Many different block price ratios could be considered but the two in the table are in the range of what seems most likely to be practicable. In the new Chaoyang city tariff, the ratio between blocks is 1:1.56:3.12, similar to the first of the two structures in the table. Some other cities in Liaoning have also adopted domestic block tariff structures, usually 3 or 4 blocks. Examples include:

- Fushun 1 : 1.48 : 2.22
- Yingkou 1 : 1.72 : 2.23
- Jinzhou 1 : 1.41 : 1.82
- Buxing 1 : 2 : 3 : 4

The advantage of such price ratios is that they should provide adequate encouragement to households to save water and minimise consumption within the third block.

## 6.6 Recommended tariff rates for Beipiao WSC

Of the three block structures considered above, Option A is

Table 15: Tariff Rates for Block Option A

Block (m <sup>3</sup> /person/month)	Ratio – 1 : 1.5 : 3		Ratio – 1 : 2 : 3	
	Rates	Revenue (RMB/year)	Rates	Revenue (RMB/year)
0 – 2	1.75	1,124,628	1.75	1,124,628
2 – 4	2.63	1,888,476	3.50	2,390,184
> 4	5.25	465,072	5.25	481,980
Non-metered	3.50	1,380,648	3.50	1,380,648
Total revenue		4,858,824		5,377,448
Average tariff (RMB/m <sup>3</sup> )		2.23		2.47

If Option B were applied with the same base rate of RMB1.75/m<sup>3</sup> and block ratios of 1:1.5:3 and 1:2:3, then the average domestic tariffs are RMB1.99/m<sup>3</sup> and RMB2.10/m<sup>3</sup> and the annual revenue generated from

preferred because it provides a better match with actual consumption in Beipiao, allows for equitable treatment of households, and is so designed that the second block captures a realistic portion of consumption and will provide a significant proportion of company revenue.

With regard to domestic tariff rates, a base rate for the first block of RMB1.75 per m<sup>3</sup> would restore the real value of the tariff to the same level as after the last tariff adjustment and would be affordable for low income households. With this as the base rate, estimated outcomes for the WSC are shown in Table 15.

With the block price ratios of 1:1.5:3 estimated revenue from the domestic tariff is 19% higher than the estimated revenue of RMB4.094 million generated from the existing tariff, despite the reduction in the volume charge for non-metered households. With the 1:2:3 ratio, the increase in revenue and average tariff is 31%.

domestic customers would be RMB 4,327,512 and RMB 4,568,504 respectively. The revenue from these tariff options would be 5.7% or 11.6% greater than with the present tariff, depending on the ratios applied, but

only 89% or 85% of the corresponding Option A tariffs.

These tariff options have been tested in the financial management model prepared for the Beipiao WSC and as result Option A with block ratio 1:1.5:3 is preferred.

## 7 Non-Domestic Tariff

The ratios between the present domestic and non-domestic tariff rates are given in Table 16. In general terms, these ratios are similar to ratios

found in the tariffs of other cities in Liaoning and other provinces. There does not seem to be any reason to change these ratios. With the introduction of a block tariff for domestic consumers, the ratio between non-domestic and domestic rates would be maintained with the domestic tariff base rate (i.e. the rate for the first block). This is the basis for all subsequent tariff calculations in this paper.

Table 16: Non-domestic tariff

Category	Present Tariff	Ratio to Domestic Tariff
Domestic	1.5	1.0
Industry	2.8	1.87
Institutions	3.0	2.0
Small business, commercial	3.0	2.0
Restaurants & Bath houses	5.5	3.67

However, it is suggested that for industrial and institutional customers, who together account for about 90% of non-domestic water sales, consideration could be given in future to a system of agreed consumption norms, as has been introduced in Chaoyang city under their new tariff. For each consumer, a consumption norm per billing period would be agreed between the WSC and the customer and consumption above the norm would be billed at penalty rates. Such a system presupposes the use of meters. Currently most industrial and institutional customers do not have meters and some are billed at a flat rate per billing period – this needs to be rectified.

Under the Chaoyang tariff, consumption up to 10% over the agreed norm is charged at twice the

tariff rate for the category, from 10% to 20% it is charged at three times the rate, from 20% to 30% at 4 times the rate, and so on. Penalties structured in this way could have a strong impact on water use efficiency, assuming the basic consumption norms are set appropriately. A similar system could be established for Beipiao, with suitable penalty rates.

A tariff system of this type for large non-domestic customers would promote water conservation, water use efficiency and should assist in maximising revenue for the water company. However, the precise effect on WSC revenue cannot be estimated with the available data and would depend on how the norms and penalties are set.

## 8 Price and Income Effects

Reform of the tariff structure and increasing the price of water will naturally tend to decrease the consumption of water by households. Similarly, rising household incomes generally lead to increase in water consumed – the higher people's income, the more water they use.

A study from the Water Resources and Hydrology Institute, published in 1999, found a price elasticity for water consumption in northeast China of -0.1295. This means that for every 10% increase in the water price, the quantity of water consumed can be expected to fall by 1.3%. In the same study, the income elasticity of demand for water was found to be 0.5168 for northeast China. In this case, a 10% increase in income can be expected to lead to a 5% increase in water consumption. Given the rapidly changing economy in China, the values of these elasticities may well have changed since this study was made in 1999. The appropriate values may also vary between larger and smaller urban areas. However, they do provide an indication of changes in consumption that might be expected if water prices in Beipiao are increased.

In the current situation of strong economic growth and rising household incomes, it would seem that the income effect leading to increased consumption is very likely to outweigh any price effect tending to decrease consumption. Net water demand in Beipiao is therefore expected to increase.

## 9 Affordability

It is an important objective of the tariff that basic water needs will be affordable for low income households. In Table 17, the preferred tariff from Section 6.6 above is tested for affordability for households with monthly incomes of RMB500, RMB750 and RMB1,000 per month. At the levels of consumption usual in low income households (generally 2 m<sup>3</sup>/person/month or less), this tariff is certainly affordable with the monthly water cost being between 1% and 2% of household income. For households without meters, this tariff would introduce a monthly saving of RMB3.60 (for a 3 person household), bringing what they are charged more in line with actual consumption, and for low income metered households there would be only a modest increase in cost, of about 10%.

Table 17: Affordability for Low Income Household (% of income)

	Un-Metered	Consumption / person / month		
		1.5m <sup>3</sup>	3.0m <sup>3</sup>	4.5m <sup>3</sup>
Water cost (RMB)	10.50	7.88	18.39	34.16
Income/month				
- RMB500	2.1%	1.6%	3.7%	6.8%
- RMB750	1.4%	1.1%	2.5%	4.6%
- RMB1,000	1.1%	0.8%	1.8%	3.4%

Note: Assumes a 3 person household.

## 10 Water Pricing Policy (within national guidelines)

### *General issues for consideration*

Pricing policy should normally have three key objectives, namely:

- Tariff levels should be sufficient to cover operation and maintenance costs, to meet the cost of system expansion to serve new customers and to cover the larger of debt service or depreciation.
- The water tariff should contribute to economic efficiency within the national economy.
- The tariff structure should support social equity (promote widespread access to water, affordability to all income groups, and billing and collection from all users).

It is important to note that the incremental cost of supplying water to new or sparsely populated areas is likely to be higher than increasing supplies in already established areas. This is because the new areas usually do not benefit from economies of scale, existing facilities or high population densities. Under these circumstances decisions have to be made regarding the optimum strategy to adopt in order to ensure the long-term sustainability of water supply. One of a number of strategies could be considered, including:

- The provision of a government subsidy to ensure the proper operation of facilities and adequate levels of service in high cost water supply areas. However, the sustainability of this practice would in itself have to be carefully assessed.

- With a uniform regional tariff level, an increased average tariff to cover the enlarged overall average cost due to new supplies. Under this approach, customers in lower cost areas will subsidise those in higher cost areas, which may cause objections. However, it could have the effect of redistributing incomes from urban areas to the relatively poorer rural areas.
- Introduction of differential tariffs to reflect the actual costs of providing water in the higher cost areas. This will undoubtedly result in objections from those affected on the grounds that a uniform standard of water supply should be provided for all at a uniform price. Additionally this approach could lead to affordability problems amongst the less well off in higher cost areas. The introduction of a more comprehensive increasing block tariff designed to ensure that even the poorest consumers are able to afford enough water to meet their basic needs is a possible structural adjustment that could be utilised under a differential tariff system to address affordability problems.
- Acceptance that the standard of water supply service in small secondary and tertiary centres can be reduced to lower the cost of service. A reduced standard of service is likely to be more acceptable than no service at all.

Whatever strategy is adopted for pricing, water supply system operating revenues (or non-operating revenues in the case of a subsidy) should not be allowed to fall below the operating costs associated with maintaining an adequate level of service.

## Document Reference Sheet

### Glossary:

Price elasticity	Responsiveness of the demand for water to the increase or decrease in its price. Normally, sales increase with a drop in prices and decrease with a rise in prices. As water tariffs rise demand for water (except for that portion used for basic needs such as drinking and cooking) would fall if incomes do not rise also
Income elasticity	Proportionate change in the demand for water in response to a change in income. It is reflected in how people change their consumption habits with changes in their income levels. As incomes rise in China, per capita demand for water rises accordingly
Ability to Pay (ATP)	The capacity of a household or business to make payments for water supply services. ATP is about affordability, especially for low income users.
Willingness to Pay (WTP)	The maximum amount that an individual states he or she is <b>prepared to pay</b> for a good or service

### Bibliography:

Beipiao Water Supply Company, Billing Department and Statistical Yearbook 2006  
Sample Surveys by WRMAP in Beipiao in May 2007

### Related materials from the MWR IWRM Document Series:

Thematic Paper 3.2	Urban Water Supply Demand Management
Advisory Note 5.4	Tariff Setting for Small to Medium Size Water Supply Company
Advisory Note 5.5	Willingness to Pay Surveys (Urban Water Supply)
Example 5.5	Willingness to Pay Survey for Beipiao Water Supply Company
Thematic Paper 5.7	Financial Management and Modelling in Small and Medium Water Supply Companies
Manual 5.7	The Development and Use of a Model for Financial Analysis of a Small to Medium Size Water Supply Company in China

### Where to find more information on IWRM – recommended websites:

Ministry of Water Resources: [www.mwr.gov.cn](http://www.mwr.gov.cn)

Global Water Partnership: [www.gwpforum.org](http://www.gwpforum.org)

WRDMAP Project Website: [www.wrdmap.com](http://www.wrdmap.com)

## China – UK, WRDMAP

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WRDMAP Project Website: [www.wrdmap.com](http://www.wrdmap.com)

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