Approach Paper

On

Developing Regulations for Bulk Water Pricing in the State of Maharashtra

Submitted to

Maharashtra Water Resources Regulatory Authority

September 2008

(*For Circulation*)

TABLE OF CONTENTS

Chapter 1: Introduction

1.1 Background

The Government of Maharashtra enacted the Maharashtra Act No. XVIII of 2005 called as Maharashtra Water Resources Regulatory Authority Act, 2005 (hereinafter 'MWRRA Act, 2005') in June 2005. The MWRRA Act was enacted with the following objectives:

- ***To establish the Maharashtra Water Resources Regulatory Authority (MWRRA)***
- ***To facilitate & ensure judicious, equitable and sustainable management, allocation and utilization of water resources***
- ***To fix rates for the use of water for agriculture, industrial, drinking and other purposes and matters connected therewith***

Accordingly, the Maharashtra Water Resources Regulatory Authority (MWRRA) has been established to regulate the water sector in the State, and is the first such Authority anywhere in the country, with such a specific mandate. The MWRRA Act, 2005 empowers MWRRA to regulate the water resources within the State of Maharashtra, fix the water tariff system at sub-basin, river basin and State level, and frame Regulations and Orders for better management of water resources in the State.

In this context, MWRRA has engaged **ABPS Infrastructure Advisory Private Limited (ABPS Infra)** for providing assistance in developing 'Terms and Conditions of Tariff' Regulations and 'Conduct of Business' Regulations for determination of Bulk Water Tariff. ABPS Infra has in association with Stuart King of IPA Energy + Water Economics and Prof. Eldho .T.I of Civil Engineering Department, IIT Bombay as associate consultants, shall be completing the assignment.

1.2 Terms of Reference

The scope of work for this assignment is to develop the framework for Terms and Conditions of Tariff Regulations and Conduct of Business Regulations. The detailed terms of reference for each Regulation is given below:

<u>'Terms and Conditions of Tariff' Regulations</u>

(1) Review international best practices on water tariff (bulk & on area basis) and analyze their relevance and applicability in the context of the situation in Maharashtra.

(2) Review the tariff structure in some of the States in India where there are substantial areas under irrigation from Government sources, e.g., Andhra Pradesh, UP, Punjab, Haryana, and Tamil Nadu.

(3) Review and assess the provisions relating to water tariff in the MWRRA Act and State Water Policy

(4) Review and assess the progressive increase in tariff structure in the State for irrigation and non irrigation uses.

(5) Review and assess the O&M norms for irrigation in the State and the allocations made for O&M, separately for works and establishment, for last five years.

(6) Review and assess the establishment norms in the State for irrigation management.

(7) Review the water use and water tariff levy and collection in last five years in the State separately for agriculture, industry and drinking water.

(8) Review and assess inter-sectoral cross subsidy and government subsidy as reflected in water tariff assessment vis-à-vis actual O&M expenditure in the last 5 years.

(9) Review and assess existing tariff structure vis-à-vis paying capacity and productive usage by each user category.

(10) The consultant may plan to visit 6 irrigation projects (2 major, 2 medium & 2 minor), 6 water supply schemes (3 urban, 3 rural) and 6 typical industries consuming water for realistic assessment of ground conditions at his own costs.

(11) Review and assess how the provision in Section 12 (11) of the Act linking family size to water tariff should be dealt in volumetric and area based tariff for agriculture and how Water User Association should be advised to fix water charges from Members keeping the provisions in view.

(12) Study the water audit, benchmarking and irrigation status reports brought out annually by Water Resources Department (WRD) and assess the applicability of the data/conclusions made in these reports for tariff Regulations.

(13) Study and assess as to how reliability and timeliness of supplies to the agriculture sector should have a bearing on the tariff structure.

(14) Suggest 4-5 modern technologies for recycling by industries, the adoption of which will qualify the industry for rebate in water tariff. Quantum of rebate to be suggested. Similar suggestion for WUA, drinking water agencies adopting water conservation measures.

(15) Suggest extent of rebate in water tariff for industries adopting effluent treatment and discharging effluent into water courses as per standards prescribed by State Pollution Control Board.

(16) Review and assess the provisions relating to water tariff in other Acts like CP & Berar Act 1931, Maharashtra Irrigation Act 1976, Municipal Act, various River Valley Corporations Act.

(17) Examine whether a two part tariff system comprising a fixed charge for assets created irrespective of water use and a variable charge depending on actual use should be introduced.

(18) Examine whether rebate in tariff should be given for advance/timely payment.

(19) Based on (i) international & national practices, (ii) provisions in the MWRRA Act and State Water Policy, (iii) O&M requirements of irrigation systems, (iv) cross subsidy and subsidy regimes, paying capacity of users and productivity of various usages listed above, the Consultant will prepare first an Approach Paper in two parts:

   a. The first part will present the tariff philosophy or principles and various options available, and
   b. The second part presenting the methodology for tariff determination based on the chosen option.
   c. The Consultant should get the first part of the Approach paper approved before finalizing the second part. On approval of first part, the consultant shall prepare & submit the Terms & Conditions of Tariff Regulations giving detailed step-by-step procedure with illustrative examples.

(20) Based on the Regulations suggested draft of model tariff proposal for the State as a whole for various uses, viz., Bulk Water Tariff for WUAs (irrigation/industries and domestic use) and on area basis for irrigation to be issued by the Authority as a Tariff Order on approval of Regulations.

Conduct of Business Regulations

1. The Consultant will along with the preparation of Terms and Conditions of Bulk Water Tariff Regulations, prepare the Conduct of Business Regulations specifying the process to be adopted by the Authority, including stakeholder consultation while preparing Regulations and before issue of tariff orders.
2. The Consultant will review international and national practices of Conduct of Business Regulations in various sectors.
3. The stakeholder consultation shall be at all important & relevant stages of developing Regulations starting with the Approach Paper and at stage of tariff proposal.
4. The Consultant should weigh and consider various options for stakeholder consultation like display in web site, paper advertisement, public hearing, etc., and suggest a suitable procedure keeping in view how this issue is handled in other regulatory process.
5. Based on the suggestions of the Consultant, and as accepted by MWRRA, the scope of Conduct of Business Regulations shall also cover the Regulations on the following aspects
   - Initiation of proceedings by the Authority, i.e on receipt of Petition or on suo-moto basis
   - Process for filing of Tariff Petition and other Petitions
   - Formats for submission of Tariff Petition and other Petitions

- Process for filing objections or comments and rejoinders on Petitions and draft Regulations
- Process of publication of Petitions
- Process of conducting Public Hearing
- Process of filing of Review Petitions
- Eligibility criteria for filing of Review Petitions

1.3 Assignment Status

Subsequent to the award of Project and signing of the contract by both the parties on March 31, 2008, ABPS Infra draw a detailed plan and mobilised its Expert Consultant team on various aspects so as to complete the Project in a time bound manner. The work completed so far by ABPS Infra team is listed below:

- **Kick-off Meeting:** A team of ABPS Infra delivered a presentation during the kick-off meeting on April 7, 2008, detailing out the work plan, team composition, approach and methodology for tariff determination, and present tariff structure of the Maharashtra water system. ABPS Infra took note of comments/suggestions provided by MWRRA on specific matters for incorporating the same during the execution stage.

- **Preliminary data collection:** A team of ABPS Infra visited MWRRA office for collecting inputs like water sector data, Reports of expert committees constituted by GoM and other Government Orders/Resolutions. Data was released in three sets on April 4, 2008, April 17, 2008 and April 25, 2008. Data on certain aspects is yet to be provided. MWRRA has provided the data for 17 command area development authorities and irrigation circles. Data analysis presented in this Approach Paper can be generalised for whole of the Maharashtra as it has been informed that the data given for 17 circles contributes to almost 95% of the revenue from tariff in the State.

- **Restructuring of data:** Data/information provided by MWRRA was extensive and in raw form. A team of ABPS Infra is working on restructuring the data to decipher the information from the given data. ABPS Infra will submit additional data requirement/data gaps after careful analysis of available data.

- **International Experiences:** As a part of the assignment**,** ABPS Infra has carried out detailed analysis of bulk water tariff structure in selected countries namely, Brazil, Chile, Australia, China and South Africa. The detailed Case Studies are annexed with this Approach Paper as **ANNEXURE I**.

- **Submission of Approach Paper Part I:** ABPS Infra has submitted first part of the Approach Paper on June 4, 2008 for circulation among the MWRRA officials, for their comments and suggestions. In this Approach Paper, we have covered the overview of Maharashtra's bulk water system, issues in present water tariff system, principles to be followed for tariff setting, etc.

- **Submission on consolidated Approach Paper (Part I and II):** In this Draft Approach Paper, we have covered the overview of Maharashtra's bulk water sector, international experiences, Existing legislative provisions for bulk water sector in the State, Frame work for bulk water tariff regulation, present tariff scenario, Revenue requirement for bulk water sector, Tariff simulations etc. The Approach Paper shall be finalised after duly incorporating MWRRA's comments/suggestions.

1.4 Outline of the Approach Paper

ABPS Infra has prepared this Approach Paper as a part of Consultancy Support to MWRRA. In the subsequent Chapters of this Approach Paper, we have covered the following aspects of Bulk Water Pricing in the State of Maharashtra:

In **Chapter 2,** we have covered in detail the Bulk Water Supply Sector in Maharashtra. In this Chapter, we have presented our analysis of some of the data that we have collected during the assignment.

The Terms of Reference specifically required us to cover international experiences in Bulk Water Pricing. ABPS Infra team had associated with Mr. Stuart King of IPA Consulting for this purpose. **Chapter 3:** of the Approach Paper covers this important aspect of the Assignment.

Water is a sensitive issue for an agrarian economy like ours. The Governments have usually been very cautious on the pricing front. Over a period of time, the Governments have set up several Committees to look into the various aspects of water sector. In **Chapter 4:,** we have presented salient features of the various Reports prepared by these Committees established to look at costing and pricing related issues in the water sector.

Chapter 5: covers the existing legal frame work for the bulk water tariff related aspects in the State of Maharashtra. The Chapter highlights the provisions from various Acts like MMISF Rules, 2006, MWRRA Act, 2005, MMISF Act, 2005, Maharashtra Irrigation Act, 1976, etc., along with National and State Water Policy.

In **Chapter 6:,** we have listed the salient features, which any Bulk Water Tariff framework should contain.

Chapter 7: of the Approach Paper suggests the framework within which the bulk water tariff regulation should operate, based on the existing legislative provisions.

For developing the bulk water tariff Regulations in the State, it is essential to review the existing tariffs and tariff structure in the State. **Chapter 8:** analyses the tariffs and discusses the associated issues.

Chapter 9: gives the projections of Operation and Maintenance (O&M) costs for the three-year Control Period from FY 2009-10 to FY 2011-12 based on the recommendations of various Committee Reports. The Chapter also includes recommendations for Maintenance and Repairs (M&R) costs proposed by Water and Land Management Institute (WALMI) with our views on the same.

Chapter 10 gives the proposal for bulk water tariff in the State of Maharashtra.

Chapter 2: Bulk Water Supply Sector in Maharashtra

In India, organised irrigation and water supply began in 1855 with the creation of the Public Works Department by the British Government. Soon after the formation of Maharashtra State in 1960, the State Government gave the highest priority to irrigation, agriculture, and development of rural areas. Building of Koyna dam in 1962 gave a boost to the State irrigation sector, and thereafter Government took several measures under various schemes for expanding and modernizing the canal and allied water supply system for irrigation, drinking and industrial use. In this Chapter, the following aspects of bulk water supply system have been covered:

- Present status of State Water System
- Organisational Structure
- Present Bulk Water Tariff

2.1 Present Status of State Water system

The State of Maharashtra is divided into five river basins, namely Godavari, Krishna, Tapi and Narmada, and westerly flowing rivers in the Konkan Coastal Strip. Total area covered under these basins is 30.88 Million Hectares, of which 22.54 Million hectares can be cultivated. The water availability in these river basins during a 75% dependable year is 131562 Million Cubic Metre (MCM). The statistics for each basin are summarised in the following **Table 2-1**:

Table 2-1 Maharashtra River Basin Snap-shot

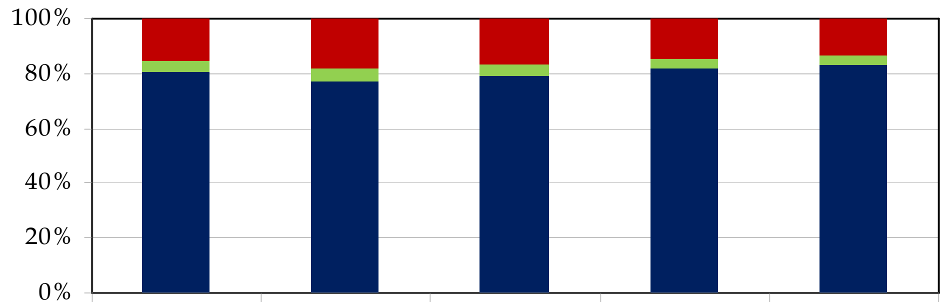
Basin	Geographical area (Million Ha)	Cultivable area (Million Ha)	Water Availability at 75% dependable yield (MCM)
Godavari	15.43	11.26	37300
Tapi	5.12	3.73	6977
Narmada	0.16	0.06	315
Krishna	7.01	5.63	28371
West Flowing Rivers	3.16	1.86	58599
Total	**30.88**	**22.54**	**131562**

To harness the above surface water potential, various major, medium and minor dams have been created. By the end of June, 2005, 32 major, 178 medium and about 2,274 State sector minor irrigation projects had been completed. Ground water constitutes a large part of water supply, especially in rural areas of Maharashtra, where over 50% of the total water use comes from ground water.

Water from the dams is supplied for the different needs of agriculture, domestic and industry. At the strategic level, Water Resource Development (Erstwhile, Irrigation Department, Government of Maharashtra) through five Irrigation Development Corporations (IDCs) is responsible for managing the surface water resources and it allocates water for irrigation, drinking water and sanitation, and industrial purpose. In the event of other users requiring more than 15% of the water resource, a Committee, headed by the Chief Minister, does the allocation. The ground water resources are regulated and monitored by the Water Supply and Sanitation Department, Government of Maharashtra.

Irrigation sector consumes a major part of total water consumption in the State and it has gradually increased from 13985.3 MCM during FY 2002-03 to 16497.89 MCM during the FY 2006-07. In the same period, reduction in water consumption by industrial sector has been noticed. Domestic consumption varied marginally and it increased from 2668.25 MCM during FY 2002-03 to 2807.86 MCM during the FY 2005-06 however it again decreased to 2623.85 MCM during FY 2006-07. Year-wise water consumption by different users are summarised in the following graph:

Figure 2-1 Year-wise Water Consumption by different Users (in MCM)



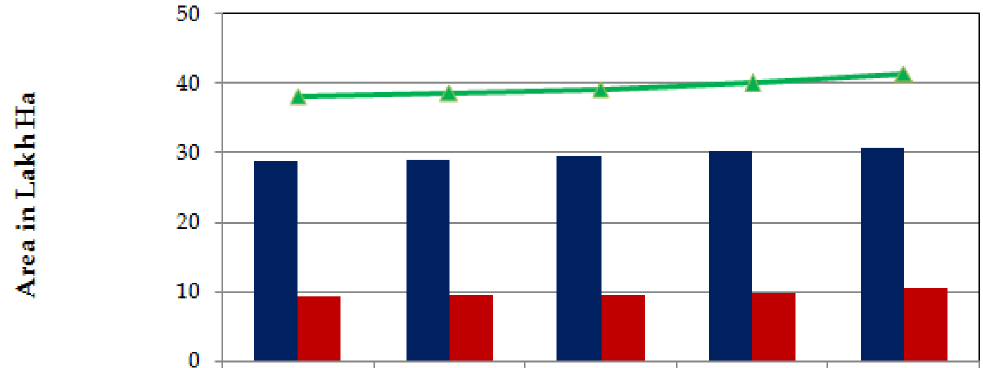
	2002-03	2003-04	2004-05	2005-06	2006-07
Drinking	2668.25	2578.6	2589.99	2807.86	2623.85
Industry	773.03	623.22	656.68	677.45	712.26
Irrigation	13985.2	10959.14	12334.16	15564.49	16497.87

(Source: Based on data provided by MWRRA)

From the above table, it is clearly evident that agriculture sector consumes a major share of the total water availability, and accounts for approximately 80% of the total water consumption in the State. The domestic sector consumes approximately 15%, and the rest is used by the industrial sector.

To be able to supply water to different users, a vast network of open canal channels and pipe lines has been constructed by Irrigation Department, Municipal Corporations and Maharashtra Industrial Development Corporation (MIDC). The Irrigation Department is making continuous effort to harness the total cultivable area though the creation of major, medium and minor canal systems. The cultivable irrigation area developed in the State during the last five years is shown in the following graph:

Figure 2-2 Cultivable Irrigation Command Area Developed (in Lakh Ha)



	2002-03	2003-04	2004-05	2005-06	2006-07
Major and Medium	28.83	29.06	29.52	30.19	30.72
Minor	9.30	9.56	9.61	9.85	10.60
Total	38.12	38.63	39.13	40.03	41.32

(Source: Based on data provided by MWRRA)

To bring discipline into the water sector and to ensure the optimum development of water sector for fulfilling the water needs of different users, the Government of Maharashtra has created an integrated legal framework during the last 50 years. The different Acts which regulate the State water sector are listed below:

- Maharashtra Fisheries Act, 1960
- Water (Prevention and Control of Pollution) Act, 1974
- Maharashtra Irrigation Act, 1976
- Maharashtra Kharland Improvement Act, 1979
- Maharashtra Groundwater (Regulation for Drinking Water Purposes) Act, 1993
- Krishna Valley Development Corporation Act, 1996
- Vidarbha Irrigation Development Corporation Act, 1997
- Tapi Irrigation Development Corporation Act, 1997
- Konkan Irrigation Development Corporation Act, 1997
- Godavari Marathwada Irrigation Development Corporation Act, 1998
- Maharashtra Project-Affected Persons Rehabilitation Act, 2001
- Maharashtra Water Resources Regulatory Authority Act, 2005
- Maharashtra Management of Irrigation Systems by Farmers Act, 2005

2.2 Organisational Structure

Over the years, the Government of Maharashtra (GoM) has set up a complex institutional set up for catering to the irrigation, drinking and industrial water needs. For irrigation sector, dedicated institutions like Irrigation Department and Irrigation Development Corporations at river basin level have been established, while for the domestic sector, Water Supply and Sanitation Department (WSSD), Maharashtra Jeevan Pradhikaran (MJP), and Municipal Corporations are established, MIDC takes care of the industrial water needs in MIDC areas, and in non-MIDC areas, either Municipal Corporations supply water to the industries or the industries themselves manage it through dedicated pipe lines. The Brihanmumbai Municipal Corporation (BMC) has its own dams and maintains the water supply from these reservoirs through dedicated pipe lines to its area of supply. Drinking water supply in rural areas is maintained by Zilla Parishads. For drinking and industrial water supply needs, following institutions are involved:

- Maharashtra Jeevan Pradhikaran (MJP) formulates and executes schemes in rural and urban areas.
- Groundwater Directorate Survey and Development Agency implements schemes based on groundwater resources in rural and semi-urban areas.
- Maharashtra Industrial Development Corporation supplies water to its industrial estates and a few industrial townships.
- Zilla Parishads (ZPs) are responsible for rural water supply schemes.
- Urban Local Bodies such as Municipal Corporations are responsible for the provision of drinking water in cities.

Irrigation water supply is managed through the five Irrigation Development Corporations, namely Konkan Irrigation Development Corporation, Narmada Irrigation Development Corporation, Krishna Irrigation Development Corporation, Tapi Irrigation Development Corporation and Godavari Irrigation Development Corporation. All the Corporations are headed by the officers of the rank of Secretary to Govt. and designated as Executive Directors.

To cover the irrigation needs in a particular river basin area, several Command Area Development Authority (CADA) and Irrigation Circles have been established. CADA maintain the major projects (having irrigation area of more than 40,000 Ha) and its allied canal systems, while medium and minor projects are maintained through the Irrigation Circles.

Government of Maharashtra has established various Command Area Development Authorities in different parts of the State with the objective of bridging the gap between irrigation potential created and that utilised through micro level infrastructure development and efficient farm water management; to enhance agricultural production and productivity; and to improve socio-economic conditions of the farmers. The CADA also looks after 'on farm development' for the selected irrigation projects.

2.3 Institutional Framework of Maharashtra Water Sector

Water sector structure after formation of MWRRA is shown in the following chart:

Figure 2-3 Organisational framework for Water Resources Department, GoM

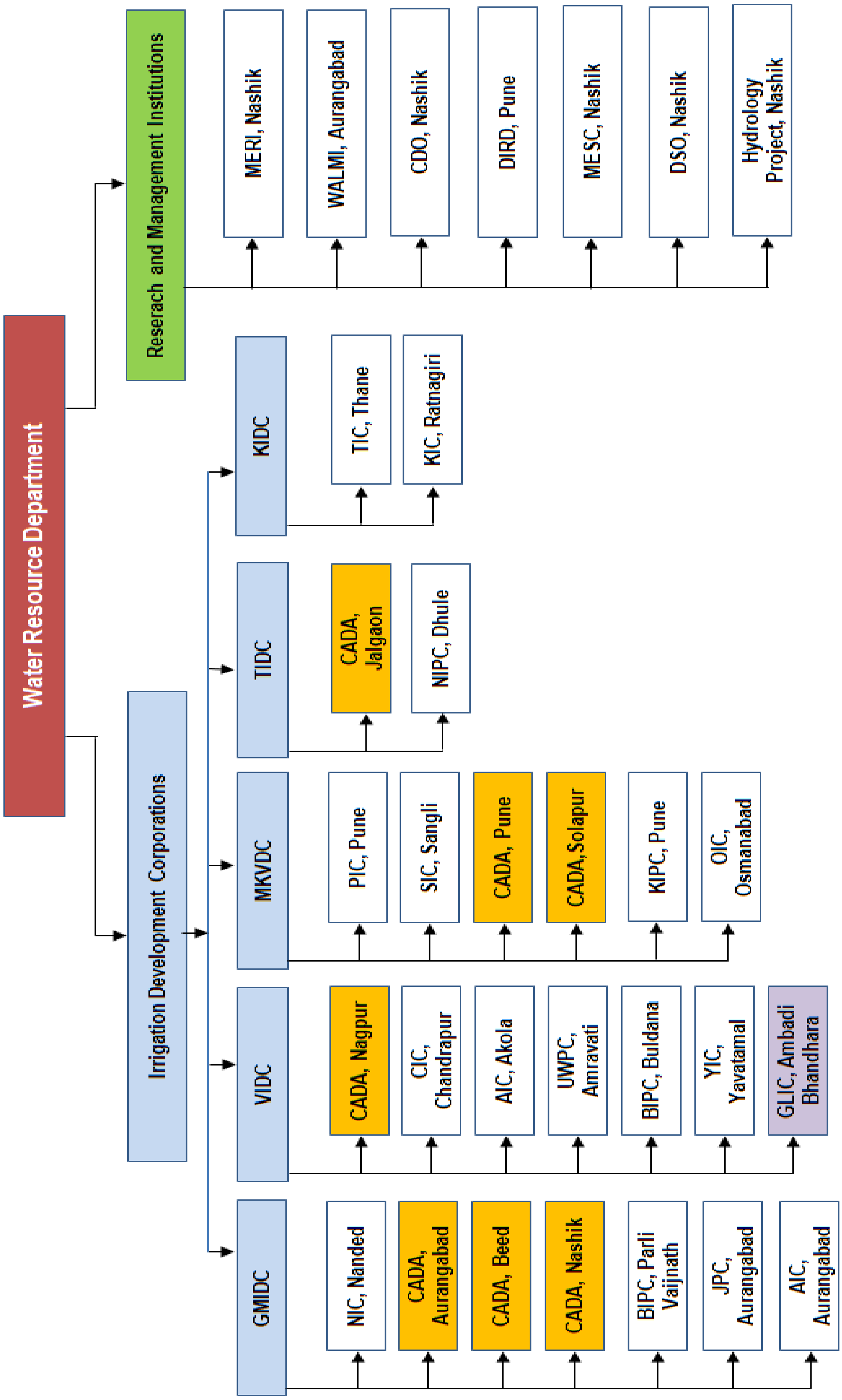
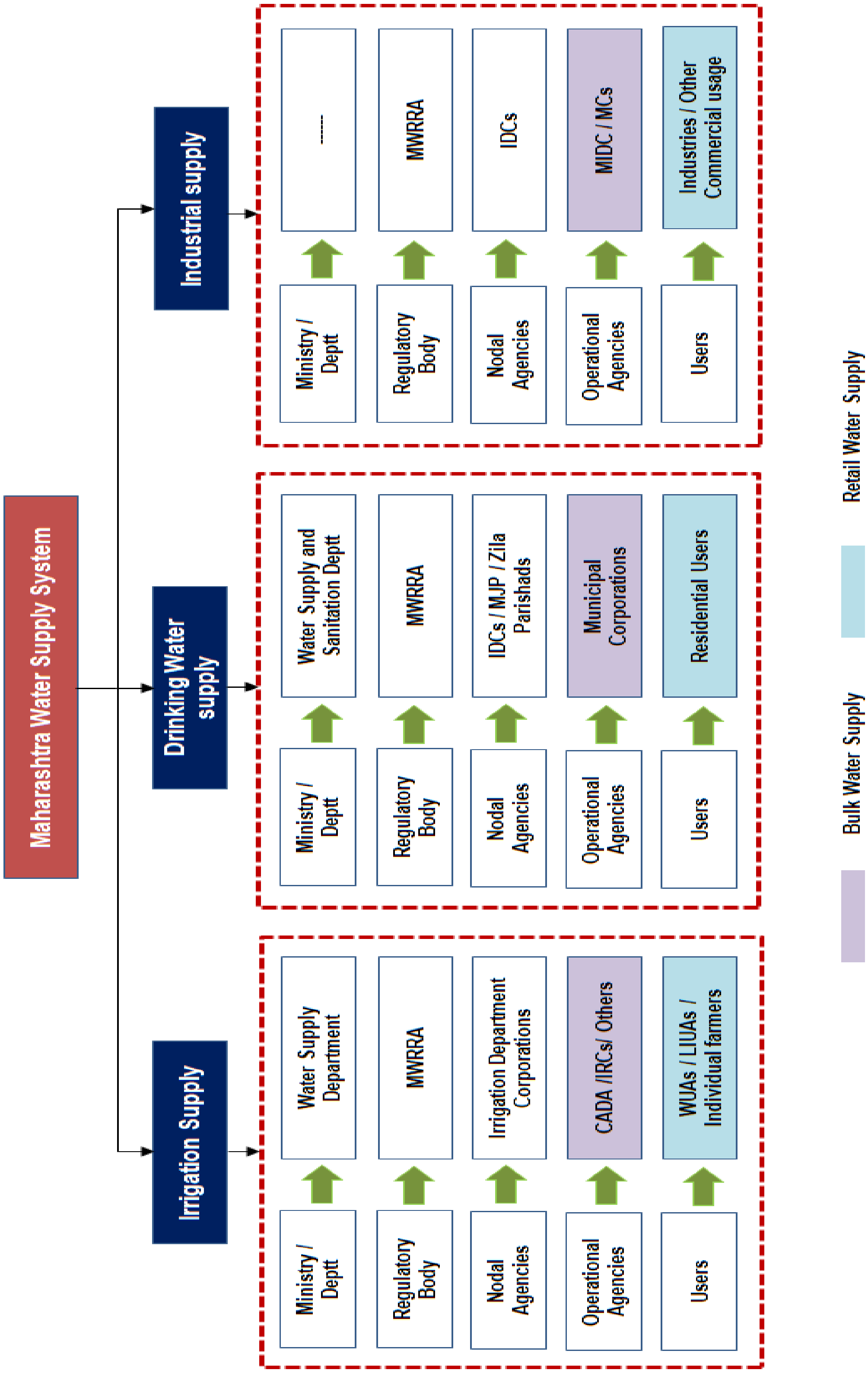


Figure 2-4 Institutional Framework for Maharashtra Water Sector

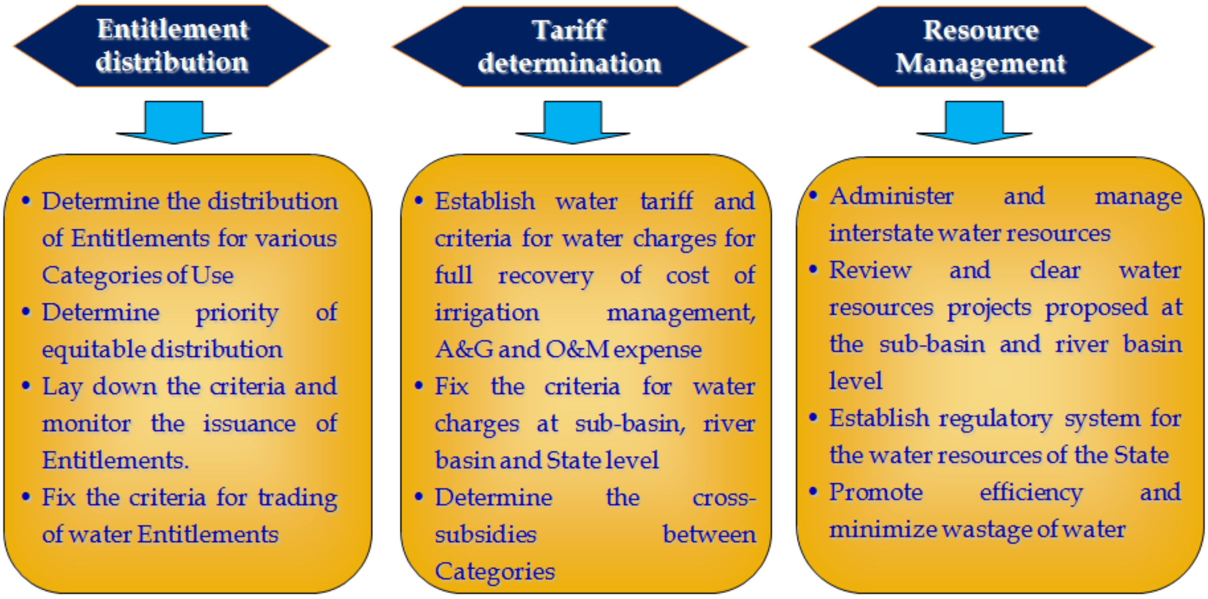


2.3.1 Maharashtra Water Resources Regulatory Authority

Maharashtra Water Resources Regulatory Authority (MWRRA) has been set up under the provisions of Maharashtra Water Resources Regulatory Authority Act, 2005. The MWRRA Act was enacted with the objective of establishing the Maharashtra Water Resources

Regulatory Authority (MWRRA) for facilitating and ensuring the judicious, equitable and sustainable management, allocation, and utilization of water resources and fixing of rates for the use of water for agriculture, industrial, drinking and other purposes. Under the provisions of the MWRRA Act, MWRRA has to play following key roles:

Figure 2-5 Key Functions of MWRRA



MWRRA has to work within the framework of the State Water Policy. One of the important functions of MWRRA is to establish a water tariff system, to fix the criteria for water charges at sub-basin, river basin and State level and to determine the cross-subsidies between categories. Presently, MWRRA is in the process of setting up the framework for its functioning and managing the various operational aspects. In the coming years, it will play a major role in setting the framework for all types of water use and managing the State water resources.

2.3.2 Water Users Associations

It has now been recognized all over the world that involvement of user community especially that in agriculture sector is crucial for sociable, economic and judicious use of water. In India, many states are now giving high emphasis on creation of agencies to promote community participation in water management. Further, many states have stated objective of supplying irrigation water on volumetric basis in their State water policies, However, not many States have taken strong steps to implement these policy objectives. Maharashtra has enacted Maharashtra Management of Irrigation Systems by Farmers Act 2005 (MMISF Act 2005) to create Water User Associations of agricultural consumers. As a result, institutional structure for agriculture water supply in Maharashtra is undergoing fast change. Legal provisions relevant for current study have been discussed in Chapter on 'Legal & Regulatory Framework for Bulk Water Pricing in Maharashtra'.

MMISF Act envisages that water quota or entitlement to the WUAs in terms of quantities of water allocated is determined and then water be delivered on volumetric basis. However now the WUAs are formed and are involved progressively in taking over water management in the area of their jurisdiction. These WUAs now allocate, distribute and charge water fees on volumetric basis. The process is being implemented in phases starting from minor level to main canal in all types of irrigation projects like minor, medium and major projects. In this new system, the numbers of supply points are reduced to a great extent and therefore measuring water flows and billing water by volume to these WUAs has now become possible and feasible in practice both technically and administratively.

As on December 2006, 1127 WUAs had taken over operation and maintenance of the minors in the area of their operation. These WUAs accept the volumetric supply and pay rates charged on volumetric basis. In order to encourage farmers to form Water Users Association, following benefits are being offered:

- Commitment from the Irrigation Department to supply water as per the entitlement as provided in the Agreement.
- Permitted to grow any crop within the allocated water.
- Permitted to use the water seeped through in the ground from the canals or the field channels within their area, without any extra charges.
- Ability to mix water from the canal and the groundwater while delivering water to the farmers so that they can increase area or can grow sensitive and delicate crops needing very high frequency of water.
- Water, if not required in a particular rotation or season can be saved and subsequently demanded in the next rotation or season.

The method of charging the water fees on the basis of crops and area irrigated was evolved when the Irrigation Agency was responsible for allocating and distributing water directly to the individual farmers. The water bill to WUA is issued on the basis of actual quantity of water supplied, instead of old practise of charging on crop area basis.

2.3.2.1Structure and Functions of Water Users Association

As per MMISF Act, 2005, Water Users' Association shall maintain adequately the irrigation system and ensure efficient, economical and equitable distribution and utilization of water to optimize agricultural production and shall actively involve the members inculcating amongst them a sense of ownership of the irrigation system. The MMISF Act, 2005 proposes four levels of Water Users' Association as WUA at minor level, Distributory Level

Association (DLA), Canal Level Association (CLA) and Project Level Association (PLA). WUAs are entitled to get Aggregate Bulk Entitlement on behalf of group of Entitlement holders from River Basin Agencies at the primary unit level, Distributory level and Canal or Project level Associations. Presently there are only minor level WUAs exist in the State and there are not any DLA, CLA and PLA existing in the State. As per MMISF Act, 2005, the following points related to WUAs can be highlighted:

- Four types of WUA to be established in every project, viz. are:
    - WUA at minor level
    - Distributory Level Association (DLA)
    - Canal Level Association (CLA)
    - Project Level Association (PLA)
- WUAs can be registered with WRD to expedite and simplify the process of registration
- Water supply for irrigation can be made through WUAs only and there will not be any individual sanctions for water.
- In order to safeguard the water use entitlements, WUA area of operation to be notified in official Gazette with certified and updated map and list of members.
- All irrigators from the delineated area to be the deemed members of WUA.
- Office-bearers of WUA to be legally empowered like that of Canal Officers.
- Conflict resolution to be done by the WUAs themselves. Provision of Appeal to the next higher level WUA incorporated.
- Volumetric supply of water through WUAs only, for lift irrigation schemes also.
- Clarity and accuracy regarding water use entitlements to WUAs.
- Preliminary irrigation programme to be done by PLA.
- Equitable distribution of water through volumetrically measured bulk supply.
- Volumetrically measured bulk water supply from Water Resources Department to WUAs on subsidized water rates.
- Encouragement to recycle and reuse of irrigation water. Permission to conjunctive use of surface and groundwater.
- Powers to WUA to decide water charges and service taxes in their jurisdiction.

2.3.2.2Powers of Water User Associations

Power of Water User Association as per MMISF Act, 2005 can be noted down as:

- WUA shall have powers and responsibility to charge its member, water rates that may be approved by the General Body of Water user Association.
- WUA shall have power to levy minimum charges for the land for which water is not demanded or used by irrigation members, provided that, water is available as per the sanctioned water use entitlement.

- WUA shall have the powers to levy the water charges for use of recycled water or ground water by members.

WUA is entitled to recover the previous dues from the member in prescribed manner.

2.3.3 Maharashtra Industrial Development Corporation (MIDC)

Maharashtra Industrial Development Corporation (MIDC) was constituted on August 1, 1962 under the provisions of Maharashtra Industrial Development (MID) Act, 1961. Industrial areas managed by MIDC are located in different parts of the States with major industrial centres at Mumbai, Pune, Aurangabad, Nasik, Nagpur and Kolhapur. These industrial areas have been classified as five star industrial area, major industrial area, minor industrial area and growth centres based on certain criteria. The broad objectives of MIDCs are as follows:

- To achieve balanced industrial development of Maharashtra with an emphasis on developing parts and underdeveloped parts of the State
- Infrastructural development of each and every district of Maharashtra and
- Facilitate entrepreneurs in setting up industries at various locations

The MIDC has been declared as an agent of the State Government for carrying out the activities within the framework of the MID Act and the MID Rules. These activities can be divided under following 3 broad categories.

- Acquisition and disposal of land
- Provision of infrastructure facilities
- Providing of services.

In the context of provision of various services, the Corporation provides water supply services to the units in its industrial areas. The investment on the water supply scheme (Head works) made by MIDC as on 31st March, 2002 was over Rs. 731.30 Crore with installed capacity of water supply of 1941 Million Litre per Day (MLD). The annual revenue from water was over Rs 375.96 Crore.

2.3.3.1 Regulation of Water Supply in MIDC Areas

For the purpose of regulating the water supply operations of the Corporation the GoM has prescribed a legal and financial mechanism between them. The salient features of the mechanism are as given below:

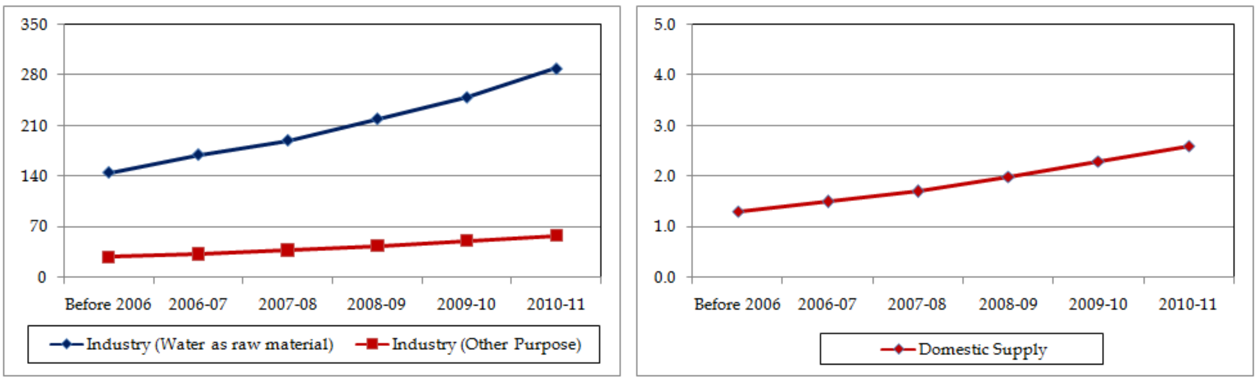
- A water supply scheme providing water to more than one industrial area in grid system is termed as *centralised* water supply scheme, the asset ownership of which remains with the MIDC. On the other hand a water supply scheme catering the need of only one industrial area is termed as *localised* water supply scheme with asset ownership remaining with Government.

- The water supply made either from *centralised* or *localised* water supply scheme is treated as supply made on behalf of Government and the revenue thus collected is shown as revenue accruing to the Government.
- The operating expenditure of *centralised* water supply scheme is debited to the Corporations account while the operating expenditure of *localised* water supply scheme is debited to the account of Government through its function agency.
- The Corporation is allocated the portion of the water revenue so as to meet its net operating and other expenses.
- The surplus/deficit accrued after deducting operating expenses for water supply from the water revenues is borne by the Government.

2.4 Bulk Water Tariff and Revenue from different category of users

During the last 30 years, GoM through different Orders and Resolutions has set the tariff for irrigation, domestic and industrial users. Tariff for irrigation use is set on seasonal basis (Rabi, Hot weather and Kharif) and type of crop cultivated (cash crop or food grain). In line with the State Water Policy, the Government has formulated the water tariff for non-irrigation users (domestic and industry) for next five years. Present tariff structure has been designed for water drawn from dam site, from canal system without storage facility, agency constructed dam at its own expense, and if dam is not constructed at the upstream of river. The following chart provides an overview of water tariff for next five years for the domestic and industrial purpose.

Figure 2-6 Bulk Water Tariff for Non-irrigation Users (Rs/ 10,000 Lt)

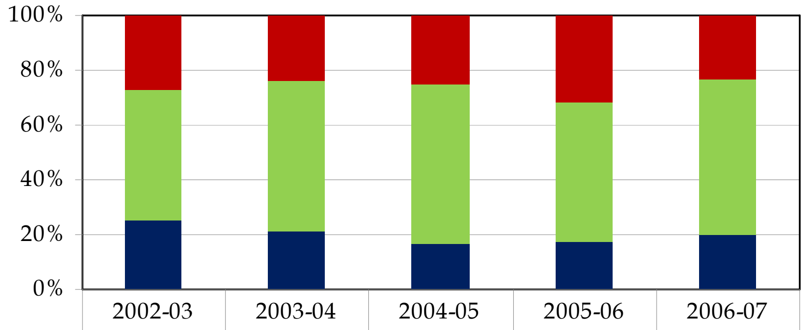


(Source: GoM Resolution, TR 2006/(396/03)-IM(P), dated July 31, 2006)

The present tariff structure is highly skewed towards the industrial consumption. Industrial tariff is far higher than the irrigation tariff and it can easily be analysed by observing the water consumption and tariff levied share. Industrial water consumption constitutes only 5% of the total water consumption however their share in tariff levied is approximately 50%. Irrigation sector, which consumes more than 80% of the water, constitutes a share of only

20% in tariff levied. Drinking water sector consumes nearly 15% of the total water consumption and it constitutes nearly 27% of the total tariff levied. Following figure provides an overview of share of different sectors in total tariff levied:

Figure 2.5: Year wise tariff levied from different sectors (Rs Crore)



	2002-03	2003-04	2004-05	2005-06	2006-07
Drinking Water	97.17	98.69	118.36	124.64	114.04
Industries	174.11	223.14	270.22	204.04	273.08
Irrigation	90.14	88.27	77.30	68.47	97.91

(Based on data provided by MWRRA)

The revenue collection from different sectors has been irregular in past and therefore huge arrear are to be recovered from all sectors. In case of irrigation sector, tariff levied during the FY 2006-07 was Rs 97.91 Crore however revenue realisation without arrear during FY 2006-07 was 45.24 Crore, and with arrear, it was Rs 76.76 Crore.

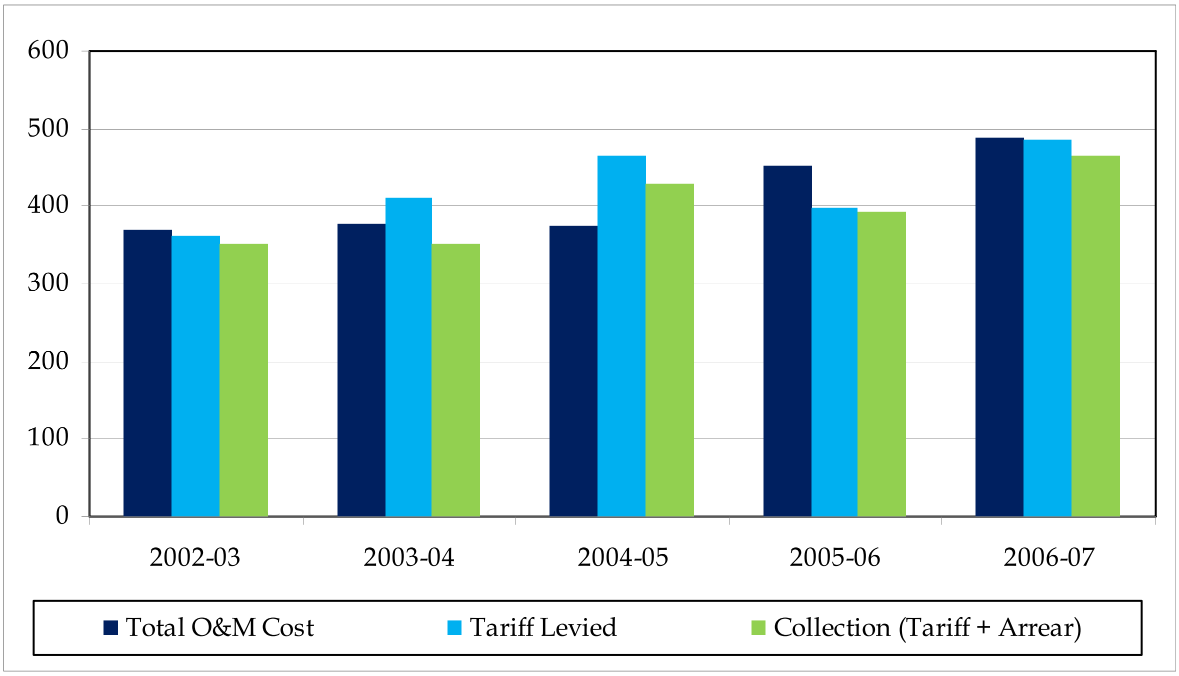
Table 2-2 Revenue Collection from different Consumers

Revenue Collection (Rs Crore)						
Year	Drinking Water		Industries		Irrigation	
	Without Arrear	With Arrear	Without Arrear	With Arrear	Without Arrear	With Arrear
2002-03	55.66	133.87	145.89	181.97	22.31	36.89
2003-04	70.22	110.39	167.91	199.94	23.61	40.17
2004-05	71.36	121.33	235.88	261.10	28.38	47.33
2005-06	79.61	126.41	182.47	200.52	34.79	65.48
2006-07	89.80	112.55	236.90	276.30	45.24	76.76

(Based on data provided by MWRRA)

After taking into consideration the revenue collection from past arrears, the total revenue collection from industries and drinking water supply is nearly equal to the tariff levied from those categories. On aggregate basis, the total revenue collection is approximately matching with the O&M cost. In the following graph, we have shown the year-wise O&M Cost and bulk water tariff levied and realised by all the five Irrigation Development Corporations together, indicating the difference in cost and revenue.

Figure 2-7 Year wise Revenue and O&M Cost (Amount in Rs. Crore)



(Based on Data provided by MWRRA)

During these four years, the water resource department has realised the huge arrears and this is the main reason for good performance however, the real arrear realisation during these four years was negative for irrigation and industrial consumers where it increased by Rs 107 Crore for irrigation sector and Rs 1.56 Crore for industrial sector while net arrear collection from drinking water consumers was positive and it reduced by Rs 40 Crore during these four years period.

2.5 Issues in Bulk Water Supply System

Water is often used uneconomically by its users due to its easy availability, accessibility, and cheaper rate, due to which it is not considered as a valuable resource like other commodities. However, over-exploitation of water resources and insufficient storage capacity has already led to a shortfall in availability of quality water in some parts of the country during certain months of the year. Maharashtra also faces a water shortage problem, especially in metropolitan areas, before the beginning of monsoon period. At the same time, Maharashtra has not been able to fully exploit the available water potential due to the absence of necessary infrastructure. The various issues affecting in the water supply system are:

- Tariff realized is insufficient to meet the O&M Cost
- Poor collection efficiency and backlog of arrears
- Irrigated Command Area - Potential Developed to Utilised
- Norms suggested for Maintenance & Repairs
- Mismatch between tariff categories and user categories
- Measurement of actual water consumption
- Incorrect methodology for computation of water losses
- Lack of investment in the Sector
- Difficulty in implementing the existing irrigation tariff
- Actual revenue without water royalty

2.5.1 Tariff realized is insufficient to meet the O&M Cost

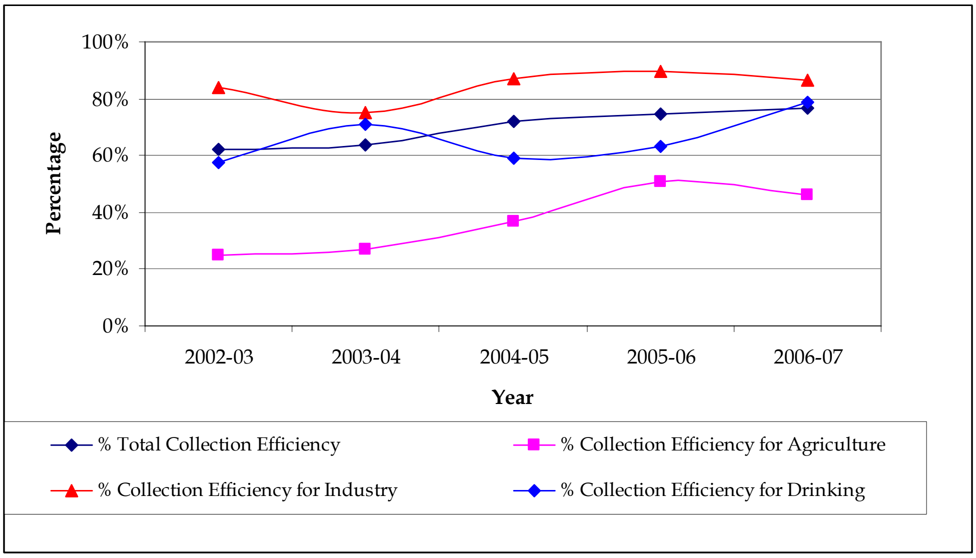
In the initial years of the irrigation system development, the primary objective was to enhance the capacity of the canals, sub-canals and minors so that the maximum agricultural area of the State could be covered, to reduce the dependence on monsoon. Under this philosophy, the infrastructure was created by the State Government with the co-operation of Central Government, however, for operation and maintenance of the canal system, water tariff was levied on the beneficiaries. The philosophy of levying the water tariffs was that the Operation & Maintenance (O&M) cost has to be recovered from the water tariffs, while capital cost is borne by the State Government.

Due to certain social and political compulsions, the institutions, which were responsible for managing the operational aspects of water system, could not increase the water tariff in correlation with the increase in operation and maintenance cost. For a long period of time, a part of O&M cost is being funded by the State Government. In Maharashtra, the water tariff was constant for around 21 years, during the period between 1976 and 1997. In those 21 years, O&M cost increased manifold but the water tariff did not reflect the same increase. Almost all Urban Local Bodies (ULBs) in Maharashtra have tariffs that do not cover costs; cost recovery of O&M cost alone varies from 5 to 83 percent. The rates of many local authorities do not meet minimum norms set by the State, nor are they revised once fixed. Low collections, as low as 25 percent in rural areas and ranging from 25 to 90 percent in urban areas, and inadequate metering, are exacerbating the problem.

2.5.2 Collection Efficiency and Backlog of Arrears

Collection efficiency can be defined as ratio of revenue realised to revenue billed. Higher collection efficiencies are necessary to have a self sustainable system from a long term perspective. Based on the data for the last five years, it is observed that collection has increased from 60% in FY 2002-03 to 75% in FY 2006-07. Collection efficiency for industry is in the range of 90% over the last three years. Collection efficiency from agricultural category has steadily increased from 25% in FY 2002-03 to 50% in FY 2006-07. However, the collection efficiency for drinking water supply has shown a sinusoidal pattern over the 5-year period under consideration. Decline in collection efficiency leads to increase in arrears. As can be seen from the subsequent graph, the arrears realised in FY 2002-03 were 24% of the Arrears levied which has subsequently decreased to 16% in FY 2006-07. Lower collection efficiency and compounding backlog of arrears leads to deferred operation and maintenance expenditure, which again leads to lower standards of service and thus lower revenue realisation, like a vicious circle.

Figure 2-8 Collection Efficiency over Five Year Period

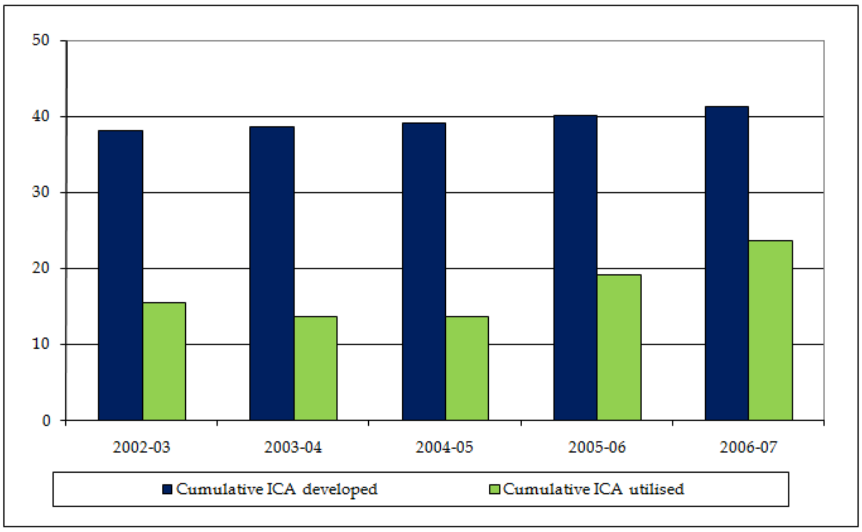


(Source: Data given by MWRRA)

2.5.3 Irrigated Command Area - Potential Developed to Utilised

Irrigated command area potential developed is the area covered under the command after development of the irrigation project including the canal infrastructure and such area is duly gazetted in the records as command area developed. When such command area is used for agriculture, then it is termed as command area utilised. There is a high amount of capital costs involved in developing the command area and its full utilisation is equally essential. High percentage of unutilised command area results in locking up of investments without any returns, and also increase the tariff burden on existing users in the command area as ultimately somebody has to pay for the maintenance works of the canal and associated infrastructure developed but not utilised. As can be seen from the following Graph, the cumulative irrigated command area developed has steadily increased from 31 lakh hectares in FY 2002-03 to 36 lakh hectares in FY 2006-07, while irrigated command area utilised has been around 50% of developed command area. Optimal percentage of command area utilisation is necessary in sharing the O&M expenses of the infrastructure developed.

Figure 2-9 Irrigated Command Area Developed Vs. Utilised (in Lakh Ha)



(Source: Based on data provided by MWRRA)

2.5.4 Maintenance and Repair Norms for Irrigation Projects

Maintenance and repairs for the assets created are unavoidable and in fact essential for proper functioning of the system. Based on the study of 10 pilot projects, Water and Land Management Institute (WALMI) has proposed norms for maintenance and repair works for Canals, Head-works and Kolhapur Type (K.T.) Weirs. The same is attached as Annexure - 1 of the Approach Paper. The basic norm for the Head works has been proposed as Rs. 11,000/- per Mm3 of design live storage. Our view is that maintenance works essentially depends on the length of the dam and quantum of other associated appurtances and not necessarily on the design live storage. Volume of live storage is primarily dependent on the topography of the area like the case of Koyna dam, which is constructed across a deep gorge. Similarly, for canal works, WALMI has proposed maintenance norms as Rs. 380 per hectare of actual irrigated area.

Ideally, the Repair and maintenance of the canal and dam system should be done periodically and cost associated with will be solely charged on the basis of length and storage capacity of the canal and dam system. At present, levying the R&M expense on the basis of per hectare is done across the world as it is an easier approach for bundling the R&M expense as a part of total water tariff. Further, WALMI has developed norms on the basis of existing demands for grants for M&R made for 10 identified projects and not on the basis of physical inspection. As a result, it is possible that the norms are biased towards existing expense pattern. Further, norms may not reflect true M&R requirement as physical survey of various infrastructure facilities has not been carried out. Therefore, in our view it is necessary to carry extensive survey of various infrastructure facilities such as dams, canals, head works should be carried out to develop 'zero based budget' for M&R.

2.5.5 Mismatch between tariff categories and user categories

Government of Maharashtra has been determining tariffs for various uses such as agricultural, domestic and industrial categories, while customer categories have been Urban Local Bodies, Water User Associations, MIDCs, etc. In case of bulk water sales, measurement of water sold is not carried out at the boundary where tariff is charged. Instead, water sold to end consumers is measured (actually estimated) by the bulk water customers and then informed to bulk water provider for the purpose of the bulk water billing. This brings in significant inefficiency and opacity in the measurement and billing of bulk water consumed.

For any efficient tariff mechanism, tariff categories and consumer categories are required to be the same. For e.g. in electricity industry, in case of bulk power pricing, tariffs are determined for licensees and tariffs are not determined in terms of licensee's consumer categories such as domestic, industrial, commercial, street lighting, etc. Bulk power is usually priced in terms of parameters which can be measured, i.e., fixed tariff for peak power or capacity allocated and variable tariff for actual energy consumed.

If bulk water tariff has to become efficient, it will be necessary to have billing parameters, which can be measured at the boundary where bulk water is being provided to the customers (not necessarily end consumers). In short, it would be necessary to move to volumetric measurement for bulk water pricing purposes.

2.5.6 Measurement of actual water consumption

'You can't measure what you can't monitor'

Monitoring and measurement is the primary requirement for accounting of any system and it applies to water sector as well. Presently, 90% of the agriculture consumption is not metered. Measurement of water consumption is complicated due to factors like huge volume to be monitored, capability of metering instruments, cost of metering apparatus, hike in tariff due to additional capital expenditure, meter reading of large number of consumers, etc. Due to these reasons, water measurement has generally been done on a normative basis. For agricultural consumers, volumetric measurement on per hectare basis using the concept of duty (i.e., the total depth of water in cm required by crops to come to maturity) and delta (i.e., number of hectares under particular crop brought to maturity by a constant supply of 1 cubic meter of water per second flowing continuously for the base period of 'B' days) is done while for the residential consumers, per capita availability/consumption is considered for billing purposes. This kind of measurement system presents a distorted picture at individual consumer level. However, industrial water supply in most of the cases is metered, as MIDC has installed meters in all industrial premises, and it has been made possible due to the lesser numbers of industrial consumers.

In the absence of meters, volumetric consumption is arrived at based on duration for which the pump is running and the pump capacity. Considering the present situation and foreseeing the long term developments, installation of accurate metering systems is the need of the hour.

2.5.7 Inadequate metering infrastructure for water accounting

Under normal conditions, water is an abundantly available commodity, which is very cheap or in some cases, free of cost. Therefore, the concerned stakeholders do not take the accounting of water very seriously, and it leads to severe mismatch between the water availability at the dam site to the water availability at the point of use.

Further, water for irrigational purposes is carried through open canals which may or may not have surface lining, and for domestic and industrial purposes, transportation is through cement/cast iron pipes. Both, canal systems as well as pipe line systems incur certain losses during the transport of water, which needs to be taken into consideration for water accounting and auditing. Some of the losses in water distribution and management systems are:

- **Technical losses**
    - Head losses
    - Evaporation losses in case of canal system
    - Seepage losses in case of canal system

- **Commercial loss**
    - Inaccurate Metering system
    - Misuse of Water
    - Non payment of Bills

Technical losses cannot be reduced beyond a certain level due to the inherent properties of the material used for transport, nature of soil, topography of catchment, structure of canal system, climate, etc., while the commercial losses in the water system can be fully mitigated by taking appropriate measures at different levels of the delivery system.

Non-availability of accurate metering systems is the single biggest hurdle in the accounting of the water system. Bulk water metering for irrigation, industrial as well as domestic purpose has not penetrated in all circles of Maharashtra. Only 10-15% of water supply for the irrigation system is measured through the water flow meters, and for the balance 85-90% of supply, the conventional method of measurement like gauge system, and per hectare measurement is in use. This method of measurement is dependent on human judgment and as a result susceptible to errors as well as malpractices. Further, this leaves lot of scope for unaccounted water.

Misuse of water is another area, which has not been given due consideration during the last 50 years. Municipal Corporations having consumer mix of domestic and industrial consumers generally show higher domestic consumption and therefore, pay less bulk water tariff to the Water Resource Department.

2.5.8 Significant commercial losses

Non-payment of bills by the beneficiaries has resulted in huge arrears in all irrigation circles. As demonstrated in the earlier part of this Chapter, difference has been noticed between bulk water tariff levied and actual revenue realised. These arrears get accumulated over the years. Further, it is difficult to calculate the arrears against the tariff categories as the customer categories are different from the tariff categories.

It should be noted that collection inefficiency is in addition to metering and billing inefficiencies. For efficient bulk water system, priority should be given to improve the efficiencies of the metering (assessment) as well as billing and collection systems.

2.5.9 Lack of investment in the sector

Availability of funds has always been a constraint in managing the whole irrigation and allied system. The bulk water tariff charged by the Irrigation Development Corporations is not sufficient to meet the O&M cost and therefore, raises the question as to how the Irrigation Department will be able to undertake the capital expenditure for new capacity addition and repair and maintenance of existing systems under these conditions. For a long time, scheduled R&M planning has not been done mainly due to the lack of funds. The R&M work carried out by the Irrigation Department is on an ad-hoc basis, and for funding such programmes, they are generally dependent on the State Government.

Till date, GoM has also supported the irrigation sector through budgetary allocation. However, due to fund constraints, GoM is no longer in a position to provide liberal funding for asset creation as well as towards O&M expenses.

In this regard, it is interesting to note the methodology for accounting of costs and revenue related to Irrigation Department. The GoM, at the beginning of the financial year, allocates funds to IDCs for meeting their O&M expenses for that year based on certain priority areas. The revenue collected by the IDCs in the form of bulk water tariff and water royalty is deposited in the Government Fund. O&M funds to IDCs are not allocated in the proportion of revenue collection or using any other economical method, but on the basis of priority of work to be carried out in any IDC area. In view of the funding constraints, it is feared that O&M expenses incurred are severely constrained and under stated.

2.5.10 Difficulty in implementing the existing irrigation tariff

Present method of water allocation to the irrigation system has certain lacunae. Water requirement of the individual farmers is collected through **'Patkari'** at minor level, and finally it goes to the higher authorities for preparation of Preliminary Irrigation Programme (PIP). Patkari collects the water demand only of those farmers who give their entitlement on ex-ante basis. This type of demand collection procedure leads to following two problems during the PIP implementation period:

- Water consumed by the farmer who has not furnished his water requirement
- Misreporting of crops sown by the farmers vis-à-vis water requirement.

Above two incidents happen frequently and can only be accounted for during verification, and auditing on post-facto basis. However, due to this unscrupulous practice, some genuine farmers suffer the loss, which may be to the extent of non availability of water during scarcity period. Manual interference should be limited by using modern technologies like use of remotely sensed imagery for determination of crop type and crop area. If one views the existing tariff structure, there are 66 different water rates for canal flow type irrigation based on different crop types and seasons. Such an exhaustive tariff schedule gives space for manipulation. The tariff structure should be simple, concise and easy to administer.

2.5.11 Actual revenue excluding water royalty

The present water tariff structure has an in-built water royalty charge, which is paid by all users and collected by the IDCs, and revenue collected as a water royalty is considered as gross revenue of that IDC. The objective behind levying the water royalty charge was that Government being the deemed owner of all the natural resources should get compensation for usage of such resources from the person who uses it. In this context, the ideal practice for treatment of water royalty should be such that IDCs collect the royalty charge from the consumers and reimburse it to the State Government.

Presently, the State Government does not separately collect water royalty charges from IDCs as they are completely owned and funded by the Government itself. While the modification to the mechanism may not have any effect in operational terms, however, in accounting terms, the actual revenue collection will be the net of revenue collected through royalty charges. Thus, actual revenue collection as a percentage of O&M cost will further reduce and

IDCs will have to increase the tariff if they have to recover the full O&M cost through the water charges.

Chapter 3: International Experiences in Bulk Water Pricing

Water sector is a complex sector and each country is unique in the development of its water sector. However, it may be possible to draw some lessons from the experiences of other countries in this regard. With this view, MWRRA had included 'Review of International Experiences in Bulk Water Pricing' within the scope of work for the Consultant.

It may be noted that very few countries have taken specific efforts towards development of bulk water pricing frameworks. In most countries, water is treated as the most basic necessity and it is usually considered as the prime responsibility of the Government to provide it at the cheapest possible price. This is true not only for developing countries but also for many developed countries. Nevertheless, there exist several countries who have taken efforts to develop a framework for bulk water pricing. The following Case Studies have been developed:

1. Australia
    a. Murray Darling Basin
    b. New South Wales
2. South Africa
3. Turkey
4. Mexico

The studies have been prepared using desk based research applied to discussion papers, technical notes and institutional reports from a large variety of sources. In addition, study material and findings for some of the cases (in particular those relating to Australia) are based upon the personal experience of the consultants who prepared the study.

A number of common themes are evident across the Case Studies presented in this Approach Paper, which is interesting because of the very different geographic, economic and environmental climate of the examples provided. These themes include:

- Different bulk water pricing approaches have been adopted in different environments according to the nature of the objectives needed to be achieved in these communities.
- The introduction of a formal bulk water pricing framework has typically required a crisis to occur in terms of the availability of water as a resource before implementation is likely to be achieved. Such crises are important in achieving the cultural transformation of perceiving water as an economic good together with

associated features such as the concept of user payments and the 'polluter pays principle'.

- Should all users pay for bulk water services? In many parts of the world, some categories of customer find themselves exempt from paying bulk water tariffs even where a concerted effort is being adopted to implement a bulk tariff system. This is the case in China where agriculture customers pay little or nothing for irrigation water. More generally, in many environments around the world, the concept of water being a 'free good' has not yet been overturned. It is often the case that acceptance of water pricing (particularly at bulk water level) only becomes acceptable when the sector is in crisis and there is considerable pressure to ensure that an increasingly scarce resource is managed properly.
- Success in implementing bulk water pricing arrangements requires the co-operation and engagement of all key stakeholders. It is particularly important for agriculture and industry representatives to be involved at all stages of the design and implementation process.
- An interesting mix of local and national involvement appears to be required for developing a bulk water pricing framework. The local element relates to issues such as the need to involve regional stakeholders (rather than having decisions imposed from 'above') and the wish to re-invest collected funds in the water basin whose resources are being charged for. The national element relates to issues such as the need for a formal (and ideally transparent) subsidy policy to be implemented alongside the pricing framework as it is unusual for the identified full costs of water allocation to be imposed on all customer groups in the short-term.
- Allied to the previous point, a successful bulk water pricing framework needs to be formally administered and organised – relying purely on market forces (as was tested in Chile) to allocate value to water resources does not work. In addition, the direct involvement of a federal agency helped to balance the interests of different groups whilst still allowing each stakeholder to negotiate terms. This central administration involvement can take many forms, but a robust and independent (as perceived by stakeholders) regulator may be the best alternative.
- Bulk water pricing arrangements need to be accompanied by a well defined water entitlement framework that is flexible enough to adjust rapidly to changing environmental conditions.
- Competitive bidding processes have been found to be valuable at all stages of the water value chain, even in a planning environment.
- In terms of pricing approach, marginal cost pricing (or variants thereof) is generally perceived to be the preferred option. Within this framework, two-part pricing methodologies are commonly adopted in an attempt to send appropriate pricing signals and to help maintain the financial integrity of water utilities.

- One of the important issues is how the revenue earned from the application of bulk water tariff to be used? In some countries, such as China, the law prescribes that all such monies enter into a central fund managed by the Government. However, in other environments, there is a strong belief that bulk water revenues should be re-invested in the river basin and catchment areas from where the water supply was harnessed.

Having discussed common themes across various case studies, we have presented below few international case studies related to water pricing.

3.1 Water Pricing Reforms in Australia

Water pricing reform in Australia began with the establishment of Council of Australian Government (COAG) in 1995 which developed a strategic framework, including a significant number of water sector reforms. The steps required to be undertaken as a part of reform process were:

- Adopt the principles of consumption based pricing
- Full cost recovery
- Removal of cross-subsidies
- Remaining subsidies to be transparent
- States and territories to implement the comprehensive system of water entitlements
- Water property rights are separated from land rights so that entitlements could be transferred between the land titleholders
- Government to achieve structural separation of the roles of water service provision from water resource management, standard setting and regulatory enforcement.
- Water system should adopt two part tariff for urban water
- Introduce arrangement for trading in water entitlements or allocations
- Rural water charges should reflect full cost recovery with transparent subsidies
- Charges should achieve positive real rate of return on the written-down replacement costs of assets.
- Future investment in new irrigation projects or extension to existing project to be done only when appraisal indicates the proposal is economically viable and ecologically sustainable.

A task force established by the Council developed the pricing guidelines, which were accepted at the national level. The guidelines also defined the upper and lower boundaries of cost recovery. To be regarded as viable, water business at a minimum must recover operational, maintenance, and administrative costs; externalities; taxes or their equivalent (excluding income tax); interest cost on debt; and dividends (if any), as well as make provisions for asset maintenance and replacement. At a maximum, and to avoid monopoly rents, water business must not recover more than operational, maintenance, and administrative costs; externalities; taxes or their equivalent; provisions for cost-of-asset consumption; and the weighted average cost of capital. The guidelines note that the final determination of full cost recovery is at the discretion of the appropriate state or territory body. The progress in implementing the water pricing reform in Australia is shown in the following table:

Table 3-1 Progress of water pricing reforms in Australia

Type of Reform	New South Wales	Victoria	Queensland	Western Australia	South Australia	Tasmania	Australia Capital Territory	Nothern Territory
Urban Water								
Two-part tariff	√	√	√	√	√	√	√	√
Full cost recovery	□	√	X	□	□	□	□	√
Reduction/elimination of cross subsidies	X	□	X	□	□	X	□	√
Remaining subsidies made transparent	X	□	X	X	√	X	□	√
Positive rate of return	√	√	□	□	√	X	√	√
Rural water								
Consumpton based pricing	□	□	□	□	□	□	n.a.	□
Full cost recovery	□	□	X	□	□	□	n.a.	□
Reduction/elimination of cross subsidies	□	□	□	□	□	X	n.a.	□
Remaining subsidies made transparent	□	√	□	√	√	X	n.a.	√
Rate of retun	□	√	X	X	□	X	n.a.	□
Sinking fund	□	√	X	X	□	X	n.a.	□

(Source: Productivity Council)

n.a. Not Applicable   √ Implemented

□ Implementing   X Little or no progress

3.1.1 Murray Darling Basin: Water Pricing Principles

Murray-Darling Basin, extends across one-seventh of the continent, is the catchment for the Murray and Darling Rivers and their tributaries, covering the area of South Australia, New South Wales, Victoria and rural Australia. It has a population of nearly two million people and another million people outside the region depends heavily upon its resources. The Basin contains more than twenty major rivers as well as important groundwater systems. It is also an important source of fresh water for domestic consumption, agricultural production and industry, and generates about 40 percent of the national income derived from agriculture and grazing. The total volume of water storage capacity in the Basin is approximately 35,000 gig litres.

Water is shared between New South Wales, Victoria and South Australia according to an agreement first developed in 1914. Details of the agreement have been changed since then but the principles upon which it is based remain the same. To administer the Murray-Darling Basin Agreement, the State governments in the Basin and the Commonwealth established the Murray-Darling Basin Commission. The Commission implements the terms of the Murray-Darling Basin Agreement according to rules defined by the partner governments.

Water sharing arrangement across the beneficiaries

The most important aspects of each State's management of water allocations are as follows:

New South Wales

- Shares River Murray water equally with Victoria
- Maximises water use in each year and carries a minimum of water reserves for the next year
- Adopts a more opportunistic approach to water management, reflecting the high proportion of annual crops grown compared with Victoria
- Use of River Murray water is, on average, higher than Victoria but much lower in times of drought

Victoria

- Shares River Murray water equally with NSW
- Keeps significant volumes of water in reserve at the end of each irrigation season to protect the needs of enterprises that depend on the Murray should there be a prolonged drought
- Reflects the higher proportion of permanent crops grown compared with NSW

- Adopts a more conservative approach to water management meaning that water use is, on average, lower than in NSW but is more reliable in times of drought

For Victoria and NSW it is worth noting that while they share equally in the water available from the Murray system, they manage this share differently between the different diverters. Each State also manages its own tributary flow into the Murray e.g. the Murrumbidgee River in NSW and the Goulburn River in Victoria.

South Australia

- Receives an agreed amount of water from the River Murray each year as a legal entitlement
- Has a very conservative approach to water management because of the type of irrigation enterprises and the need to meet urban water requirements throughout the State
- Has a very high reliability of supply

Principles of Water Pricing

Costs have been allocated based on the separation of assets into relevant lines of business. Specific beneficiaries have been identified and States shares of costs, based on their respective water entitlements, revised and agreed.

Under present arrangements, New South Wales, Victoria and South Australia participate in the development of detailed budgets and receive detailed information on how costs are shared between the participating jurisdictions, including the Commonwealth in the case of capital expenditure.

General Principles

In general, users receives clear price signal and tariff is so designed that it ensures the full cost recovery.

i. Pricing regimes based on the principles of consumption-based pricing, full cost recovery and desirably the removal of cross subsidies which are not consistent with efficient and effective service, use and provision. Where cross-subsidies continue to exist, they are made transparent.
ii. Service deliverers are required to provide water services to classes of customers at less than full cost, the cost of this be fully disclosed and ideally be paid to the service deliverer as a community service obligation

Rural Supply

Rural water supplies are economically and environmentally sustainable and users receive clear price signals.

- Where charges do not currently fully cover the costs of supplying water to users, agree that charges and costs be progressively reviewed so that no later than 2001 they comply with the principle of full-cost recovery with any subsidies made transparent
- To achieve positive real rates of return on the written-down replacement costs of assets in rural water supply
- Future investment in new schemes or extensions to existing schemes be undertaken only after appraisal indicates it is economically viable and ecologically sustainable

Where trading in water could occur across States borders, that pricing and asset valuation arrangements need to be consistent.

3.1.2 New South Wales: Bulk Water Reforms

New South Wales established the Government Pricing Tribunal in 1992 and renamed it to Independent Pricing and Regulatory Tribunal (IPART) in 1996. The tribunal determines the maximum price that government monopolies can charge. Tribunal began determining the bulk water price and identified three services: ensuring sustainable use and water quality, supplying extractive users through river systems and artificial channels and enforcing user standards and license conditions.

The tribunal faced the problem in assigning the costs of functions that delivered more than one service. It employed the basic principle that such cost should be paid by those who benefit from the service in proportion to the benefit received, with the government paying for the cost of public benefits. In the price determination process, data availability was an issue in the initial years. To resolve this issue, IPART released an interim report laying out the principles guiding its enquiry and summarizing the work that was still needed to produce essential data. The tribunal resolved the issue of cost sharing by creating the two part Tariff to recover recorded actual known cost plus half of the renewals annuity to finance future capital and maintenance expenditure. IPART careful consultation with the various stakeholders and transparency in the tariff determination process has moved the system towards the accurate cost assessment.

3.2 South Africa: Irrigation Water Pricing

In 1995, the Ministry of Water Affairs and Forestry (DWAF) coordinated a process of reviewing South Africa’s 1956 water law, with the objective of rationalisation the water distribution in an equitable manner which was earlier limited to mostly to a dominated group. After several discussions with various stakeholders, the National Water Act came into force in 1998 (Act No. 36 of 1998). Under the new Act, the national government act as the custodian of the national water resources. The process of registering the all water use rights, full cost recovery from farmers and introducing the concept of water market is to be completed in a phased manner.

All water in the water cycle is treated as par of common resource. Only the water required to meet basic human needs and maintain environmental sustainability is guaranteed as a right. All other uses of water are recognised only insofar as they are beneficial in the public interest and promote the optimal use for achieving equitable and sustainable economic and social development.

Water pricing Reforms

As a part of legal review, DWAF appointed a policy implementation task team for developing a pricing strategy for raw water usage. The strategy is to design keeping in mind the fund requirement for water resource management, resource development and use of water works and achieve the objective of equitable and efficient allocation of water. The strategy had to consider the social, environmental, financial and economical objectives.

Irrigation Pricing

Irrigation sector has been distinguished between three user categories, Established schemes and commercial farmers, ex-homeland schemes and new irrigation farmers, and irrigators supplied from non government waterworks.

From the established schemes and commercial farmers, full recovery of O&M cost plus catchment management area costs are to be levied through the water tariff in a gradual manner. A provision of surcharge has also made for taking care of any under recovery during draught and an agreed amount to cover the cost of replacements, improvements and drainage works. The maximum increase in annual tariff is limited to the 50% of the previous year tariff.

From ex-homeland schemes and new irrigation farmers, the full cost of water are not initially be levied. A phasing-in period of five years for catchment management plus the use of waterworks charges on state irrigation schemes will apply to align the strategy with current practice on established schemes. Improvement costs at ex-homeland government water schemes supplying new irrigation farmers will initially not be taken into account in pricing. Irrigators not supplied from waterworks owned by the government must be registered for their estimated average annual volumetric water use.

3.3 Turkey: Pricing Irrigation Water

Turkey has 25.85 million ha of irrigable land, but only 33% of it, 8.5 million ha, has been identified as economically feasible to irrigate. Due to climatic conditions, rainfed agriculture is very limited, and irrigation plays an important role in agriculture sector. Presently, 10% of total irrigated area is irrigated by groundwater and rest is done through surface water resources.

Of the total irrigation area developed, approximately 53% is developed by State Hydraulic Works, 22% by General Directorate of Rural Services and rest 25% is by individual farmers. Main irrigation project in Turkey is South-eastern Anatolia Project (GAP) at the downstream of Tigris and Euphrates basin and covers more than 70,000 Sq Km. After full developments, the project will irrigate more than 1.7 million ha.

Similar to India, Turkey has multiple bodies like DSI, GDRS, GDBP and EIE for managing the water resources. Apart from that there are user organisations like irrigation groups, irrigation cooperatives, water user associations and village level entities for water distribution and management purposes. Over a period of time, Turkey has transferred the O&M related work to the user organisations mainly due to the reasons of increasing budgetary burden, combined with general policy climate for privatisation. DSI continues to operate the irrigation systems where no organisation volunteers to take over and does not attempt to transfer schemes that are costly to operate.

Prevailing irrigation water allocation and pricing procedures

There is almost no volumetric system in irrigation while it exists for domestic and industrial use. Farmers pay an annual area based fee for DSI operated irrigation schemes. The charge has two components; the first portion is significant part of total fee and intended to recover the DSI's O&M costs in the previous year, unadjusted for inflation. This fee varies by crop grown and by region. The government has right to adjust the fees.

Investment cost of water projects developed by GDRS are not reimbursable while investment cost developed by DSO has two components; reimbursable and non reimbursable cost. Irrigation, hydroelectric energy and water supply projects are considered reimbursable investment while projects developed for navigation, flood control, recreation and land improvement comes under the category of non reimbursable investment. Water charges calculated by DSI are discussed by inter-ministerial Commission before approval by completion of the project and whole capital cost including the interest cost is recovered within the 50 years.

Revenue Collection varies from 32% to 50%, as there is very less penalty for late payment. User associations works on ex-ante basis, calculate the expected O&M cost and investment cost for the year and collect the fees immediately from the farmers. In real terms, such procedure minimises the negative impact of inflation.

In the context of future water pricing reforms, the speed of price adjustment in western Turkey (which is developed but water scarce) may be faster than in the eastern part (which is water rich but undeveloped) as water has got alternative uses in the west.

3.4 Mexico: Water Pricing Structure

Mexico prepared its first water sector plan in the year 1975 with the help of World Bank and United Nations Development Programme. To address the issues of water scarcity and conserving the natural resources, Congress approved the National Water Law in 1992 and Law's implementing regulations in 1994. The responsibility for fulfilling the mandates lies with Mexico national water authority, the National Water Commission (CNA) with the objective of to regulate the extraction, use, distribution and control of the nation's water as well as preserve their quantity and quality in order to achieve sustainable integral development. Recently, the Mexican government reorganised the CNA organisation structure from state boundaries based to the river basin based structure. The Government and CNA have developed a long term plan for water management in Mexico under which in the next 10 to 20 years river basin councils would provide the nucleus for regional companies that would assume operational and financial responsibilities for water resource management within the river basins.

Water Pricing Reforms

Federal Rights Law provides the legal framework and mechanisms for the federal government to charge for the diversion and use of water, and also for the discharge of water into the water bodies. Registering and regularising the all water users are in the priority area of CNA. Water pricing in Mexico consist of three components: tariffs, fees and markets.

Water tariff are charges directly related to the use of hydraulic infrastructure and includes the operation, maintenance and replacement cost to ensure the sustainability of the system. Mexico has transferred a major part of the irrigation system to the water user associations and the associations collect these charges for carrying out their responsibilities. Bulk water tariff are set to recover the cost of major infrastructure such as dam which is not transferred to the user associations. Due to such reforms, the collection efficiency has increased from 20%to 80% of the operation, maintenance and replacement cost.

Water fees are government charges for the use of nation's water resources and it is designed such that it could recover at least the cost incurred for water resource monitoring, water quantity and quality assessments, river basin planning, water rights administration, and environmental costs caused by use or contamination. The fees are set annually with different rates for industrial and municipal users. Agriculture users are exempt from paying these fees. Industry pays very heavy fees in the rage of 0.73 to 0.93 US$/$m^3$ while for utilities, it is 1/1000th of the industry's fees.

Water market is the mechanism for transferring the water entitlement by one user entity to another user entity. Such concept helps in reducing the need for constructing costly supply-oriented infrastructure and leads to a more rational and economically viable allocation of water resources. Since 1995, CNA has approved more than 57 water transfers amounting to the transfer of 160 million m3 of water. Still the water market concept is in developmental stage and for the markets to function properly and correctly reflect the opportunity cost of water, the water right exchange mechanism needs to be smooth and have low transaction cost.

Chapter 4: Analysis of Recommendations of various Water Pricing Committees

Traditionally Indian economy has been agrarian economy and water is probably the most important part of any agrarian economy. Various governments both at central level as well as state level have made heavy investments over period to time to develop extensive network of irrigation projects in India. Usually water is considered as a social good and supply of it is considered as the basic responsibility of the Government. Further, it is expected that water will be supplied by the Government free of cost. However, the Governments need money not only to create infrastructure but also to maintain the same. However, given political system in India and sensitive nature of water supply issues in Indian economy, the Governments have always found it difficult to recover even fraction of the costs incurred on construction and maintenance of irrigation systems.

Further, involvement of various layers of the Governance complicated matters related to provision of grants and recovery of different costs from the beneficiary. In order to understand and resolve various issues associated with water supply in India, different committees were set up from time to time. These Committees made very insightful recommendations on various aspects such as O&M norms, capital cost recovery, irrigation pricing etc. It will be useful to understand the thinking of various experts while developing principles for Bulk Water Pricing in the State of Maharashtra. As a result, in this chapter, we have summarised the key findings of following eminent Committees in this regard.

- NCAER Study Report
- Maharashtra State Irrigation Commission Report
- Jakhade Committee Report
- Vaidyanathan Committee Report

4.1 National Council of Applied Economic Research Study Report

National Council of Applied Economic Research (NCAER) undertook the study of irrigation sector in the year 1959 with the objective of suggesting the suitable criteria in making investment decisions relating to irrigation projects, and laying down the appropriate principles which ought to govern the fixing of irrigation charges. The study is based on the working of Sarda canal system in Uttar Pradesh. The committee made a remark that study cannot not be generalised for whole country though it can be considered as illustrative case. The key findings of NCAER study report are:

- Existing practice of selecting project on the basis of estimated total amount of revenue anticipated by the Government by way of direct receipts or number of acres of land which can be irrigated in due course is not enough.
- Yield vary from place to place and from region to region and the net benefit of the newly added farm products does not depend on revenue received by way of direct charges or numbers of acres irrigated. It therefore becomes necessary to make a full economical appraisal of every project.
- Appropriate criteria for economic appraisal should be the probable contribution to the national income in terms of social benefits and social costs.
- For selection of any project, the measurement of direct primary benefits is all that is necessary.
- With regard to fixation of water rates, the study had an interesting finding. It observed that the existing system is not based on any scientific principles. It also mentioned that fixing the tariff on the basis of cost of the project is not a good criterion.
- Study suggested that tariff based on the percentage of net benefit accrued to the cultivator would be the sound guiding principle.
- Price of water should be conducive for maximising the net benefits accrued to the cultivator from the use of irrigation facilities.
- Effective management of water distribution system is very important.
- On the basis of benefits available from the canal system, it can be divided into three zones; high, middling and low benefit zone. The water tariff can be different for three

zones after considering the following factors on the basis of broad agronomic and economic survey of the reasons:

  - Nature of Soil
  - Type of crop and season in which cultivation takes place
  - Volume of water required for the crop
  - Transport and marketing conditions
  - Net profit of cultivations

- Rates can be fixed for each crop and each soil type
- For fixing the water rates, a water rate board on the similar lines of wage boards can be constituted either at state level or at canal system level.
- Study recommended two types of tariffs and mentioned that water board should, as far as possible, divide rates into two parts, namely compulsory rates and voluntary rates.
- Relief in water tariff should be given to agriculture sector in case of any calamities.
- Old rates fixed years ago have moved away from their intended relationship to the values of crop raised because of steep rise in agricultural price in the recent past.
- Unless the water rates are fixed on an objective basis, their burden might fall inequitably on the different users of irrigation waters.
- The water rate must cover, at the minimum, the cost of supplying water, if the project is considered as financially sound. The view of the committee was supported by the Taxation Enquiry Commission, which said that charge for water supply must cover the debt charges and overhead charges.
- Recovery of fixed costs cannot be insisted upon in the fixation of water rates. It also made the submission that it does not mean that the fixed cost cannot be recovered or should not be recovered. Water tariff covering the fixed cost can be designed by lining it with additional net benefit and meet the broad social objectives
- Water can not be supplied free of cost to irrigation sector and it must be governed by national benefit. In case of irrigation projects, the direct benefits accrue within a specified area, the beneficiaries can be easily located, their benefits can be measured and hence it is administratively more economical to mobilise the benefits of irrigation through a direct levy rather than through general tax.
- As the supply of water is not inexhaustible, it is necessary to economise its use with a view to maximise net profits on the newly added farm products in the irrigated area.
- Water rates should be fixed on net benefit basis. Since output and prices in agriculture fluctuates considerably, and though it is proposed to base the estimates on the average of the last three or four years, it is advisable to keep a safe margin.
- If a canal is constructed, the water rates for it should always be such that it ensures the full utilisation of its water. When water rates fixed on the basis of net benefit basis are not sufficient to recover the operating expanses, the state must also check the indirect

revenue generation from the canal system. If the total revenue including the indirect revenue is equal to operating expenses, then in such condition water rates should not be changed.

- The committee didn't recommend the volumetric consumption based water rates on the grounds of large initial investment for meter and supervisory staff, chances of tampering the meters, and malpractices on the part of officials etc.

Committee considered the option of water charges on value of crop basis if the extent of additional net benefit is reflected by a certain fraction of the value of the output. Committee raised the concern that high value crop may be associated with high cost of production while low value crop may have low cost of production, leaving high net benefit. After validating this option, committee concluded that it would be more appropriate to base the water rate on the net benefit for each crop rather than on the gross value.

4.2 Maharashtra State Irrigation Commission Report

Maharashtra State Irrigation Commission, 1962 came up with a report on the problems of irrigation and other aspects of water resources development in the State of Maharashtra. One of the terms of reference was to examine the financial returns on existing irrigation works. This section gives the brief of Commission's views on the irrigation water tariff related issues and the principles recommended by the Commission. As per the study of the Commission the fixation of water rates from time to time, for irrigation have been done on ad hoc basis. There was no uniformity in the water rates in the different part of the State. In that contemporary period it was intended to introduce the concept of irrigation cess which was primarily intended to recover the annual recurring expenses (i.e charges for maintenance and repairs and establishment costs) from all the farmers of the Command irrespective of their usage of irrigation water. Since the intention could not be translated into practise irrigation cess during that period was charged as surcharge on the water rates. Betterment levy was imposed by law more than ten years ago however as per the study it was not assessed nor was it recovered. Key tariff related recommendations of the Commission were as follows:

- Water rate structure should be designed so as to recover recurring costs (sum total of charges for maintenance and repairs and the cost of establishment entertained for the management of irrigation)
- For Multipurpose projects the capital cost of the project should be allocated between its major users viz irrigation, power and water supply.
- For the supply of raw water for domestic use it was suggested that uniform rates should be fixed for the entire State for the raw water supplied for the domestic use. It should be fixed on *ad hoc* basis at reasonable level which can be borne by the population at large.

- For pricing water to industries, it was recommended that industries be classified based on the cost of water that enters the final price of the produce.
- Irrigation water rates to be designed in such a way that i) it should not result in non-utilisation of irrigation potential, ii) total recoveries should not be less than annual cost incurred for providing the service and iii) water rate to the crop should be related to its ability to bear it.
- The seasonal rates (i.e. uniform rates for all crops in a season) which were in vogue were to be replaced by crop rate system (i.e. water rates for individual type of crops). This was recommended to make water rates more equitable with reference to differential gross income derived from the crops.
- Same crops to have uniform water rates over the State.
- Water rates may be fixed in the range of 6% to 12% of gross income of the crops.
- Irrigation cess as a surcharge on water rates to be abolished.
- Basis for charging betterment levy should be increase in the productivity of land due to irrigation, in the absence of market price for the land.
- Depreciation charges should be recovered and a consolidated betterment-cum-depreciation charge equivalent to 20% of the water rates to be levied on all irrigators benefiting from Government irrigation works.

4.3 Jakhade Committee Report

Jakhade Committee, 1988 submitted a report on the financial requirements for proper maintenance and management of irrigation projects in India. Committee studied the existing O & M cost for irrigation projects based on the data supplied by State Representatives. Committee had also asked for ideal O&M costs that could be allocated in case of no constraints in budgetary provisions. Based on the analysis of the data received, norms proposed by eighth finance commission, escalation factor and various other provision like special repairs, drainage requirements in the command etc the Committee came up with the following recommendations.

For Major and Medium Surface Irrigation Projects:
O & M grant of Rs. 180/- per hectare per annum of gross irrigated area for the base year of 1988. Out of this, the allocation for head works to be in the range of Rs. 30 to 40 per hectare and Rs. 65 to 90 per hectare of cultivable command area for the component of regular establishment.

Further the Committee report suggested that in major/medium irrigation projects, gestation period for full utilisation of the created irrigation potential is in the range of 3 years or more. The provisions for O & M of unutilised potential are recommended at one-third of O & M grant. The provision for special repairs on account of damage due to rainfall, landslide etc is recommended at 20% of the O & M grant.

For Minor Surface Irrigation Schemes:

Minor irrigation schemes in the hilly areas of Himalayan region are recommended to have a minimum O & M grant of Rs. 900/- per hectare of gross irrigated area at 1988 price levels. This includes the cost of regular establishment. It is recommended that additional 20% of the O&M grant be allocated for special repairs. For the hilly regions in the other States (other than Himalayan region) the O & M grant recommended 30% of O & M grant for Major & Medium Irrigation projects (30% of Rs. 180/- per hectare) in addition to existing O & M grant of Rs. 900/- per hectare applicable to minor surface irrigation scheme.

Lift Irrigation Schemes:

For lift irrigation schemes by pumping from river water and storages type the O & M norms were set in the increasing blocks of water quantum serviced by the schemes which varied from Rs 770/- per hectare of actual irrigation, for schemes servicing water upto 0.15 cumec(m^3/sec) to Rs. 475/ per hectare, for schemes servicing water above 3.00 cumec.

For Lift irrigation schemes from canals the rates recommended were Rs. 550/- per hectare for schemes servicing water up to 3.00 cumec to Rs. 500/ per hectare for schemes servicing water above 15.00 cumec. The O & M expense for irrigation from augmentation tube wells were recommended at Rs. 735/ per hectare of actual irrigation.

It was also recommended that O & M grant for various types of schemes be updated annually for cost escalations in labour, material and equipments based on the All India Consumer Price Index.

4.4 Vaidyanathan Committee Report

In 1992, the Planning Commission constituted a Committee under chairmanship of Dr A. Vaidyanathan for suggesting the options for pricing of irrigation water. The committee was constituted mainly to address the effective pricing mechanisms as the present structure of crop-related water rates was seen to be ineffective in regulating the crop pattern. Further, recovery of water rates was not satisfactory and had resulted in huge under recovery of costs. With these concerns, the committee was constituted for in-depth examination of existing mechanism of water pricing, its level and structure, modalities of improving the recovery of dues, the norms for maintenance and other related issues.

Some of the key findings/recommendations of the committee are as follows:

- Essential information required for the performance assessment of irrigation system is not compiled properly. Action should be taken for building up a reliable data management system.
- Rate per unit volume of water consumption varies significantly across the States and there is a wide scope for rationalisation of the rate structure.
- Revision of water rates has been infrequent, hesitant and very much less than the increase in cost.
- For calculating the full cost of providing irrigation water, the capital outlay for the purpose of calculating interest (as also depreciation) has to be the entire capital outlay for irrigation water for all major, medium and minor projects.
- Attempts to reduce the magnitude of overall subsidies must therefore focus both on improving the efficiency of planning and management of irrigation thereby reducing the effective cost and on increasing the collection of user charges by raising rates and the more effective enforcement of the scheduled rates.
- Engineer in charge of each major/medium/minor project should be made responsible for maintenance of management accounts which may be consolidated at state level.
- The basis for determining the cost of the irrigation services and the desirable level of recovery may be debatable, but not the principle that users of public irrigation must meet the cost of the service.
- Pricing of water for irrigation purpose needs a thorough review for rationalising the tariff structure and raising the efficiency of water use. The under pricing of water has adversely affected the resource management.
- Inadequate allocation for repair and maintenance is a direct consequence of poor financial position of the States.
- A revision in the level and structuring of water rates is thus necessary in the interest of both efficiency and equity. The revision should be such as to achieve the full cost recovery in due course and it should promote saving, create disincentive for waste and a more reliable service.
- Rates for non-agriculture uses (domestic and industrial) should be revised so that cost is fully recovered and arrangement should be made for recovery of past dues.
- Cost recovery should be main consideration in the process of rate determination. Rate should be based on O&M norms and capital charges (interest and depreciation). O&M norms should be revised once in every five years.
- Averaging of rates by region or by the category of project is desirable. On project basis, it can be grouped under major, medium and minor and lift irrigation projects. If there is considerable variation in agro-climatic conditions, the categorisation may be done on the basis of agro-climatic regions.

- Two part tariff mechanism should be adopted. First part should be a flat annual fee determined on per hectare basis and second part would be variable fee, depending upon the extent of service (area or volume) used by each member.
- The committee recommended rationalisation of water pricing on the basis of volumetric measurement and to be done in a phased manner. This task can be completed in three stages with specific objective and milestones.
- State should set up expert groups to work out appropriate norms and a procedure for periodic monitoring and updating for different agro-climatic regions and broad categories of projects.
- At least 10% of the plan provision for major and medium projects should be allocated for renovation and up-gradation of existing system and the recovery of accumulated arrears should be earmarked towards meeting the cost of deferred maintenance/special repairs in the project concerned.
- Committee is of the view that separate Operation & Maintenance (O & M) norms be prescribed for head works, main canals, branches and distributaries.
- There should be mandatory review of norms for maintenance costs of various components, staff costs in relation to actual expenditure, every five years with an opportunity for users to present their views.
- Remote sensing techniques may be used for independent assessment of crop area which would serve as a check with the records of crop area maintained by filed staff.
- The States should consider switching from existing system of supplying water on credit to one of supply against advance payment.
- Based on the O & M norms proposed by Jakhade Committee and adding 25% of the norms as departmental over heads and recovery of additional 1% interest costs on the capital, the average O & M cost works out to Rs. 340 per hectare.
- A basic levy at the rate of Rs. 50 per hectare is recommended for all the lands in the cultivable command of major, medium and minor irrigation projects. This is intended as a fee for the right to get water from the system.

4.5 Maharashtra Water and Irrigation Commission, 1999 (Chitale Commission)

Government of Maharashtra constituted a Commission to do an exhaustive study of Maharashtra Water and Irrigation sector under the chairmanship of Dr. Madhav Chitale, the Commission submitted its report known as Maharashta Water and Irrigation Commission report in the year 1999. Among the detailed analysis of various issues of the sector in the report, issues connected with bulk water tariffs discussed in the report are summarised in this section.

4.5.1 O&M cost recovery in 1996-97

Report cited that in the year 1996-97 the over all Operation and Maintenance (O&M) expenditure was Rs 189 Crore while the tariff levied was Rs. 132 Crore and finally tariff realised was Rs. 94 Crore only. In order to narrow down the difference between tariff levied and realised, it was proposed to take some tough decisions in order to match the expenses and revenues.

Commission observed that during the year 1992-93 to 1996-97 that average Maintenance and Repair (M&R) cost was Rs 178 per Ha. If the establishment costs were included in the above the total works out to Rs. 528 per Ha. The revenue earned from kahrif, rabi, two seasonal, hot weather and Perennial seasons worked out to Rs. 390 per Ha. Hence Commission had proposed reduction in O & M expenses and increase in tariffs so as to match the O&M expense and revenue earned.

4.5.2 Issues in expending M & R expenditure

Commission observed that funds available for Maintenance and Repairs (M&R) expenses were insufficient, which lead to insufficient M&R. This in turn led to improper distribution among the users which ultimately reflects in the water tariffs. Thus the irrigation project gets entangled in the viscous circle. Most of the States provide funds for new irrigation projects but sufficient funds are not allocated for M & R of existing projects. It was observed that most of the M&R funds allocated were silt removal and other road repairs.

4.5.3 Issues in Establishment Cost

It was observed due to inflationary trends over the years and subsequent increase in dearness allowances the Establishment costs accounted for more that 50% of the total O&M costs.

One of the measures proposed to reduce the establishment costs was that operation and management of all small distributaries (canals having carrying capacity < 1 m^3 /sec) be handed over to the beneficiaries.

4.5.4 Design of Water Tariffs

The report recommended the recommendations of National Irrigation Commission (1972) wherein it was suggested that water tariffs for agriculture should be such that they should between 5 to 12% of the gross income of food crops or cash crops.

It also proposed that a distinction should be made between the areas where water requirement is less, areas where water supplied is less than actually required and areas where water is not required at all. Water tariffs in such areas should be lower than that of others. It was proposed that the water tariffs should be revised after every five years.

4.5.5 Existing Water Tariffs Levy and Realisation Scenario

The Commission made observation on the amount of tariffs levied and realised over a period of 8 years from 1989 to 1997 in Maharashtra. Since the water rates were revised in the year 1991, the amounts were bifurcated in two periods 1989-1992 and 1992-1997, to arrive at revenue collection efficiency over the 8 year period. Average % of water tariffs realised to that of levied (collection efficiency is shown in the table below)

Table 4-1 Ratio of water tariffs realised to levied for Maharashtra (in percentage)

Ratio in % of Water tariffs realised to levied , Maharashtra			
Category	**1989-1992**	**1992-1997**	**1989-1997 (Wt. Avg.)**
Irrigation Use	55	72	67
Non-Irrigation Use	71	59	61

It was observed that average revenue collection efficiency over the 8 year period was about 60%. It was suggested new technological tools should be adopted in the system of crop area measurement, tariff levy and tariff realisation so as to minimise corruption and revenue leakages at least in the case of major projects. In fact crop area measurement should be made mandatory for every season.

The Commission made observation that 70% of the revenues from water tariffs levied, were coming from 18% of the irrigated area, for the crops irrigated in perennial season, so crop area measurement could be made for 18% of the irrigated area to begin with.

The Commission observed that from the year 1992-93 to 1996-97 the average O&M expenditure was Rs. 155 Crore while the total tariff levied was Rs. 118 Crore and in that the tariff realised was Rs. 74 Crore. The chief reasons attributed were the year-on-year increase establishment costs, no proportionate increase in tariff rates and reducing collection efficiency.

It was also observed that though Government of Maharashtra (GoM) had increased the water tariff rates from 1991 to 1998 at an average of 12% per year but still none of the crops were near the norm of 6% of gross income of crops as proposed by the National Irrigation Commission (1972).

4.5.6 Principles for Water Tariff Design

The cost components to be considered for design of ideal tariffs, as indicated by the Commission were:

a. Capital and interest cost for head-works, canals and major distributaries
b. Annual Operation and Maintenance expense for head-works
c. Annual Operation and Maintenance expenses for canal and major distributaries
d. Annual O&M expense for minor canals

Committee proposed following principle while determining water tariffs

1. For head-works, canals and major distributaries which essentially are developed for the benefit of public at larges, hence the criteria of capital cost recovery (at 1%) and annual interest expense (up to 10%) should be not be included in the tariff determination process.
2. Water Users' Associations (WUAs) to be given the responsibility of operation and maintenance of small distributaries (carrying capacity up to 1 m^3/sec) and WUAs to be self sufficient to meet their O&M from revenues generated for the supply of water to its members.
3. In case, the Water Resources Department (WRD) department has carried any further developmental works on minor tributaries then capital cost recovery (up to 1%), interest expense (up to 10%) and royalty charges to be made applicable while determining tariffs, in the areas where WUAs have not yet formed.
4. Water tariffs for crop to be determined sub-basin wise based on the different geographic, climatic and soil conditions.
5. In the case of non-irrigation use of water, public bodies like municipal corporations, Maharashtra Jeevan Pradhikaran (MJP), other private and public institutions, industries etc which draw water from various sources (e.g. reservoir, main canal, distributaries etc), the water tariffs should be designed so as to consider capital cost recovery (depreciation) and interest expense in addition to O&M expense for supply of water up to that point. Water tariffs for non-irrigation use should be higher than irrigation use so that farmers are cross subsidised by the other categories and burden of O&M costs on the farmers is reduced.
6. It was recommended that, in the case of non-irrigation use of water by different institutions and industries, the capital investments should be made by such entities in proportion to their water quantum use. In such case water tariffs levied on such entities should only include operation and maintenance costs only.
7. Water royalty charges applicable to power generation utilities for generation of electricity through hydropower technology should be determined based on

proportionate capital cost and O&M costs of the dams and associated facilities provided for power generation.

8. In the case of well irrigation, section 55(b) under the Maharashtra Irrigation Act, 1976 provides for water tariffs only for the wells within 35 meters of the canal and it was observed that farmers misused this arrangement and to took the wells just beyond 35 meters, in the case of which no tariff was applicable. Thus it was suggested by the Commission that all the wells in the command area should be brought under the net of water tariffs.
9. It was observed that the farmers were collectively paying the O&M and other establishment expenses for lift irrigation machinery, to the organisations which were operating the co-operative lift irrigation schemes. In addition to that farmers were also paying crop wise water tariffs to the respective individual organisations as well. Thus when compared with the water tariffs for flow irrigation (levied by WRD Department GoM), it was observed that farmers were paying as much as minimum of three times to as high as ten times (depending upon seasons) of the water tariffs levied by WRD department, GoM for flow irrigation, indicating that farmers had sufficient paying capacity to pay the same.

4.5.7 Deficiencies in Water Tariff Levy Process

1. Farmers in the command area who have not availed the flow irrigation facility should have ideally been charged 50% of the water tariffs, but it was observed by the Committee that same was not being done.
2. Delay in gazetting the area that comes under command area, leads to non-collection of water tariffs from those areas.
3. There exists a provision that in case any Gram-Panchayats, Municipal Corporations, Sugar factories and other institutions lift the water for non-irrigation use without requisite water purchase agreements/individual permission, then they are liable to pay at three times the water tariffs. But in many instances it was observed that water tariffs were collected at normal rates in anticipation that GoM would eventually issue requisite permissions.
4. It necessary for farmers to apply, for water requirements and get necessary approval for the same, without which penal water tariffs are applicable. But in many cases it was observed that no enquiry was initiated in such instances.
5. Last dates for payment of water tariffs for each season are specified, failing which penal water tariffs (at 10 times the normal tariffs), are applicable. But in many cases no enquiry was initiated for on instances.
6. As per the terms and conditions of Water Supply Agreement for non-irrigation use, even if the actual water consumption is less than 90%, water tariffs should be

levied for 90% of the water consumption but in many cases such conditions was not strictly enforced.

7. Accumulated water tariff arrears, in the case of many co-operative sugar factories were not recovered religiously. In case of failure to pay arrears, their power and water connection were also not disconnected.
8. There is no dedicated staff for water tariff levy and collection. Employees in O&M activities double up for the water tariff collection. In the year 1974-75 out of the total O&M expense 30% accounted for establishment costs and 70% for the M&R costs. But over the years due to rising costs, increase in dearness allowances and other expenses, in spite of doubling the water tariffs during the period of 1990 to 1994 still was not adequate. In the year 1994-95 out of the total O&M expenses 65-70% accounted for establishment costs and 30-35% accounted for M&R costs.

4.5.8 Recommendations to Improve the Water Tariff Collection

Following are the recommendations suggested by the Commission

1. Henceforth water for irrigation requirements to be made through volumetric measurements.
2. Water for irrigation use to be supplied to individual farmers through Water Users Associations only.
3. All irrigation management activities beyond minor distributaries like O&M activities, water distribution, water tariff levy and recovery to be handed over to WUAs
4. Canal officers should be given the powers to disconnect water supply to WUAs who have water tariff arrears pending.
5. It was observed that area adjacent to the command area of the project was also benefiting form the irrigation project (by virtue of water leakage and percolation). The same should be verified and appropriate water tariffs need to be levied.

4.5.9 Regulatory Measure for Levy of Water Tariffs

Prior to 1976-77 the water tariff collection was under Revenue Department, however due to problems in collection of data on water tariffs paid, paid for how much area, requirement for next season etc for the Revenue Department, this activity was transferred to Water Resources Department officials. Till the year 1998, even after transferring the responsibilities to WRD officials they were not given the powers enjoyed by Revenue Department officials, in respect of water tariff collection. However till date (publication of the Committee report, 1999) the WRD officer didn't have powers to disconnect power and water supply of the erring consumers. So the measures suggested are:

Water arrear of the respective farmers should be noted in the registers maintained by Revenue officials, which could impede the farmers from taking loans from banking institutions and where by he/she may be forced to pay the water arrears on priority. Water arrears should be treated as arrears of land revenue and WRD officials should be adequately empowered to take action on such cases. WRD officials should be empowered to disconnect water and power supply for any of erring entities.

Chapter 5: Legal Frame work for Bulk Water Sector in Maharashtra

5.1 Introduction

In order to develop pricing framework, it is essential to have strong understanding of the legal and regulatory framework governing the sector as this framework defines the boundary within which the Regulator has to operate. Regulatory framework assumes higher significance in sectors where either market does not exist or markets are not competitive. It assumes even higher significance in the water sector due to its linkages with day to day survival of all human beings.

The objective of this Chapter is to present legal and regulatory provisions currently applicable to the water sector in Maharashtra so as to develop a strong foundation for bulk water tariff framework proposed in this Report. In this Chapter, we have initially presented important provisions in the most recent and the most relevant Acts, i.e., MWRRA Act 2005 and MMISF Act 2005 followed by provisions in other Acts such as Irrigation Development Corporation Act, 1996, 1997 and 1998, Maharashtra Irrigation Act, 1976, Municipal Corporation Act, 1949, and Bombay Canal Rules, 1934. Towards the end of the Chapter, we have also discussed relevant provisions in the National Water Policy, State Water Policy, National Action Plan on Climate Change and legal provisions on rebate for recycling of water.

5.2 Provisions of the MWRRA Act, 2005

The Maharashtra Water Resources Regulatory Authority (MWRRA) has been set up under the provisions of Maharashtra Act No. XVIII of 2005 called as Maharashtra Water Resources Regulatory Authority Act, 2005 (hereinafter 'MWRRA Act, 2005'). This Act provides the functions and powers of the Authority with respect to various issues associated with the water sector in Maharashtra. Under this Act, the Authority has been given powers to determine the entitlements of various water users as well as tariffs applicable to bulk water supplies in the State. The critical provisions related to bulk water pricing are as given below:

5.2.1 Tariff Related Provisions

Under Section 11 of the MWRRA Act, 2005, the Authority has been empowered to regulate the water resources within the State of Maharashtra and also fix rates for the Water User Entity. This Section empowers MWRRA to establish a water tariff system at sub-basin, river basin and State level, as reproduced below:

"11. *The Authority shall exercise the following powers and perform the following functions, namely:-*

…

(d) to establish a water tariff system, and to fix the criteria for water charges at sub-basin, river basin and State level after ascertaining the views of the beneficiary public, based on the principle that the water charges shall reflect the full recovery of the cost of the irrigation management, administration, operation and maintenance of water resources project ;…

…

(q) To promote efficient use of water and to minimize the wastage of water and to fix reasonable use criteria for each Category of Use;

…

(r) to determine and ensure that cross-subsidies between Categories of Use, if any, being given by the Government are totally offset by stable funding from such cross-subsidies or Government payments to assure that the sustainable operation and maintenance of the water management and delivery systems within the State are not jeopardized in any way;

…

(u) the Authority shall review and revise, the water charges after every three years;

…".

Further, Section 12 of the MWRRA Act, 2005 provides that the MWRRA shall work within the framework of the State Water Policy and should encourage and implement water conservation and management practices, as reproduced below:

(1) "The Authority shall work according to the framework of the State Water Policy.

…

(4) The Authority shall, in accordance with State Water Policy, promote and implement sound water conservation and management practices throughout the State."

Section 12 of MWRRA Act empowers MWRRA to apply principle of "the person who pollutes shall pay" and charge the polluter as reproduced below:

(5) "The Authority shall support and aid the enhancement and preservation of water quality within the State in close coordination with the relevant State Agencies and in doing so the principle that ' the person who pollutes shall pay ' shall be followed."

The MWRRA Act also contains certain specific provisions related to applicability of tariffs to certain consumers. The MWRRA Act provides that a person having more than two children shall be required to pay one and half times normal rates of water charges. The said section is reproduced below:

> *"Notwithstanding anything contained in this act, a person having more than two children shall be required to pay one and half times of the normal rates of water charges fixed under clause (d) of section 11 of this Act to get entitlement of water for the purpose of agriculture under this Act*
> *:*
> *Provided that, a person having more than two children on the date of commencement of this Act, shall not be required to pay such one and half times water charges so long as the number of children he had on such date of commencement does not increase :*
> *Provided further that, a child or more than one child born in a single delivery within the period of one year from such date of commencement shall not be taken into consideration for the purpose of this sub-section.*
> *Explanation - For the purpose of this sub-section -*
> *(a) Where a couple has only one child on or after the date of such commencement, any number of children born out of a single subsequent delivery shall be deemed to be one entity;*
> *(b) "child" does not include an adopted child or children.;*

While this section is unique in providing emphasis of the Government of Maharashtra on the two-child norm, practicability of implementation of the same is difficult to ascertain. Further, relevance of this section is difficult to ascertain given that currently, the Act provides for only bulk water pricing and not for retail pricing where the said provision has direct application.

5.2.2 Power to make Regulations

Section 31 of the MWRRA Act empowers MWRRA to make Regulations, as reproduced below:

> *"(1) The Authority may, with the previous approval of the State Government make regulations consistent with this Act and the rules made there under, for all or any of the matters to be provided under this Act by Regulations and generally for all other matters for which provision is, in the opinion of the Authority, necessary for the exercise of its powers and the discharge of its functions under this Act.*
> *(2) Pending making of the regulations by the Authority with the approval of the State Government, the rules and procedures followed by the Irrigation Department shall, mutatis mutandis, be followed by the Authority for carrying out its functions."* (Emphasis added)

This Section prescribes the process for development and approval of the Regulations to be developed by the MWRRA. Further, MWRRA will have to use existing procedures and rules of the Irrigation Department as a guiding factor.

5.2.3 Principles for Bulk Water Tariffs under MWRRA Act 2005

From the discussions above, following principles emerge for bulk water pricing in the State of Maharashtra.

a. Water charges at sub-basin, river-basin or State level
b. Full recovery of O&M Costs
c. Stakeholder consultation process while determining tariffs
d. Efficient use of water
e. Sustainable operations and management of water systems
f. Revision of tariffs every three years
g. Promotion of water conservation and management processes
h. Polluter to pay in case of polluting consumers
i. Higher tariffs for consumers with more than 2 children

5.3 Provisions of MMISF Act, 2005

Maharashtra Act No XXIII of 2005 known as Management of Irrigation Systems by Farmers' Act 2005 (henceforth MMISF Act, 2005) was enacted in order to provide for management of irrigation systems by farmers and the matters connected therewith. In this Chapter, we have discussed only those sections of this Act which have bearing on the present assignment, i.e., bulk water pricing in the State of Maharashtra. This Act deals with important section of water consumers, i.e., agricultural consumers.

5.3.1 Water Tariff applicable to WUAs

Section 26 of the MMISF Act, 2005 prescribes the methodology for application of tariff for water drawn by the Water Users' Association:

> *" (1) Water from the canal system shall be supplied to WUAs at various levels, from tail to head on bulk basis measured volumetrically as per the water entitlements…."*
>
> *(2) The rates for supply of water to a Water Users' Association shall be on the volumetric basis measured at the point of supply.*
>
> *(3) The Appropriate Authority shall have the power to levy the minimum charges as prescribed to Water Users' Association if water is not demanded or used for irrigation by Water Users' Association in a season as per the Applicable Entitlement.*
>
> *(4) The rates for supply of water under sub-section (2) and minimum charges under sub-section (3) shall be such as may be prescribed.*

Section 49 of MMISF Act, 2005 states that in the case of Lift Irrigation Water Users' Association

> *"The Appropriate Authority shall, in accordance with the rules made in this behalf, determine the separate water rates on volumetric basis for Lift Irrigation Water Users' Association, considering the fact that all expenditure for installation and organisation and maintenance of Lift Irrigation scheme is born by Lift Irrigation Water Users' Association."*

5.3.2 Water Tariff applicable to members of WUA

Section 27 of MMISF Act, 2005 prescribes the principles to be adopted by WUA while charging tariffs to its members. These provisions are reproduced below:

> *"27. (1) The Water Users' Association shall have powers and responsibility to charge to its members, water rates as may be approved by the General Body of the Water Users' Association.*
>
> *(2) Water Users' Association shall have the power to levy the minimum charges for the land for which water is not demanded or used for irrigation by members:*
>
> *Provided that, no such minimum charge shall be levied if the water is not available as per the sanctioned Water use entitlement.*
>
> *(3) The Water Users' Association shall also have the power to levy the water charges for use of recycled water or ground water by members.*
>
> *(4) The Water Users' Association shall be entitled to recover the previous dues from its members in the prescribed manner."*

5.3.3 Application of Maharashtra Irrigation Act, 1976

Section 71 of MMISF Act, 2005 under its General Provisions states that:

> *"Section 88 and 89 of Maharashtra Irrigation Act, 1976 shall mutatis mutandis apply to recovery of water charges in areas under the Management of Irrigation Systems by Farmers."*

At the same time, MMISF has repealed most of the tariff related provisions in the Maharashtra Irrigation Act, 1976 for areas under the management of farmers using Water User Associations. Section 77 of MMISF Act, 2005 states:

> *"On the commencement of this Act, in relation to the areas under the Management Irrigation Systems by Farmers, [Sub-section (1) and (2) of section 46,] sections 46 to 48, section 55, sections 57, 58, 60 and 61 to 74 of Maharashtra Irrigation Act, 1976, shall be deemed to have been repealed:…………"*

5.3.4 Principles for Bulk Water Tariffs under MMISF Act 2005

As a result of repeal of the some of the provisions of Maharashtra Irrigation Act, 1976 for areas under management of irrigation by farmers, Water User Associations in the State get distinct advantage in terms of usage of water. The provisions of Maharashtra Irrigation Act 1976, which have been repealed, have been discussed in the next section. Meanwhile, important principles related to bulk water tariff which emerge out of provisions of MMISF Act are as follows:

a. Rate for supply of water to WUAs shall be on volumetric basis
b. Minimum charges may be levied even if water is not demanded or used
c. Separate water rates on volumetric basis shall be determined for Lift Irrigation Water Users' Association.
d. Such rates for lift irrigation WUAs shall take into consideration all expenditure for installation and organisation and maintenance of Lift Irrigation scheme borne by Lift Irrigation Water Users' Association.
e. The Water Users' Association have powers and responsibility to charge to its members, water rates as may be approved by the General Body of WUA.

5.4 Maharashtra Irrigation Act, 1976

Maharashtra Act XXXVIII of 1976 known as Maharashtra Irrigation Act, 1976 (henceforth MIA, 1976) was enacted on August 5, 1976 in order to unify and amend the law relating to irrigation in the State of Maharashtra and to provide water rates for lands under the irrigable command of canals and matters connected therewith.

It may be noted that while some of the provisions of this Act have been repealed under Section 77 of MMISF Act for areas under management of Water User Associations, these provisions continue to apply to areas which are not under management of WUAs. These provisions assume importance from the perspective of MWRRA as it is expected to take into account these provisions while developing bulk water tariffs in the State. In the following paragraphs, ABPS Infra has discussed relevant provisions of the MIA, 1976.

5.4.1 Mode of supply of canal water and Minimum water charges

Section 46 of MIA, 1976 states that

"(1) Water from a canal may be supplied, -

(a) on an application for irrigation or non-irrigation purposes as provided in Chapter II of this Part;

(b) on volumetric basis as provided in Chapter III of this Part

(c) under an irrigation agreement as provided in Chapter IV of this Part; or

(d) *under a scheme in accordance with the provisions of Chapter V of this Part.*

"(3)……..all those holders or occupiers of the land within the irrigable command area of a canal (not being lands irrigated on wells within the irrigable command) who do not avail the facility of water supply during kharif and rabi season (being seasons determined as such by an order of the

State Government) from such canal a water rate equal to fifty per cent of seasonal water rate applicable and in force in that season……."

5.4.2 Power to determine water rates

In respect of determination of rates for supply of canal water, section 59 of MIA, 1976 states that

" (1) Such rates shall be leviable for canal water supplied for purposes of irrigation, or for any other purposes under this Chapter as shall from time to time be determined by the Appropriate Authority……"

MIA, 1976 further defines 'Appropriate Authority' as

"Appropriate Authority", in relation to a canal constructed, maintained, controlled or managed by the State Government or the Company or a Zilla Parishad, means the State Government, the Company or the Zilla Parishad respectively;"

By way of enactment of MWRRA Act 2005, the State Government has given these powers to Maharashtra Water Resources Regulatory Authority.

5.4.3 Supply of water to areas managed by Water Committees

In respect of supply of water on volumetric basis and formation of Water Committee, Section 60 of MIA, 1976 states

(1) Where the holder or occupiers of not less than fifty-one per cent of the land or not less than fifty-one per cent of holders or occupiers of the lands to which supply of water …….to form a Water Committee of all such holders or occupiers for distribution of water on that canal …………

(2) ……….

(6) Such water rates shall be levied for canal water supplied to the holders and occupiers for the purpose of irrigation as may be determined by the Appropriate Authority…."

5.4.4 Supply of water under irrigation agreement

In respect of supply of water under irrigation agreement, Section 63 of MIA, 1976 states

"Where either the holders and occupiers of not less than two-thirds of, or not less than ninety-five percent. of the holder and occupiers of, all the land under the irrigable command of a canal in village or in any other specified area cultivated with crops under the agreement have given their consent to a proposed irrigation agreement, then in accordance with the provisions…….shall be deemed to be an irrigation agreement…………"

In respect of charges for supply of water under Irrigation Agreement, Section 67 of MIA, 1976 states

"The charges for supply of water under irrigation agreement shall be levied at such water rates as may be fixed by Appropriate Authority:

Provided that, no such water rates shall be fixed by any Zilla Parishad or the company except with the previous approval of the State Government."

5.4.5 Percolation and Leakage Rates

In respect of water rates applicable for land deriving benefit from percolation of the water, Section 55 of MIA, 1976 states that

"Any cultivated land receiving water by percolation or leakage from canal or deriving by surface flow, an advantage equivalent to that which would be given by a direct supply of canal water for irrigation or

any cultivated land irrigated by means of a well sunk within the irrigable command of the canal or within 35 meters on either side of the canal,

shall be charged in respect of cultivated land falling under clause (a) a water rate not exceeding that which would ordinarily have been charged for a similar direct supply for the crop or the season during which the water is admitted in the canal, and in respect of cultivated land falling under clause (b), a water rate not exceeding one-half of such rate as determined by Appropriate Authority."

5.4.6 Payment and Recovery of Water Rates

In respect of payment and recovery of water rates, Section 88 of MIA, 1976, states

"……If the water rate is not paid on or before due date, then there (to be read as these) shall be paid at an extra charge not exceeding ten percent amount due as may be prescribed.

Any such water rate or instalment thereof which is not paid on the due date, when it becomes due shall be deemed an arrear of land revenue due on the account of land, being either land under the irrigable command of a canal or land for the use of which canal water was supplied or which is benefited by percolation or leakage from any canal and shall be recoverable as such arrear by any of the process specified in section 176 of the Maharashtra Land Revenue Code, 1966, including the forfeiture of the said land."

Section 89 (2) of MIA, 1976, states that

"Where any amount or sum or any instalment thereof payable to the Company, Zilla Parisahd or to any Canal Officer on behalf of the Company or Zilla Parishad by or under this Act is not paid on the date when it becomes due-

(a) and the claim is not disputed, or the amount in dispute does not exceed Rs. 100,………….. the Collector shall recover the sum due or claimed as arrear of land revenue; "

5.4.7 Principles for Bulk Water Tariffs under MI Act 1976

From the deliberations above, following principles emerge for bulk water pricing in Maharashtra.

a. Water from canal system may be supplied on volumetric basis.
b. Even if holders or occupiers of the land within the irrigable command area of a canal do not avail the facility of water supply during kharif and rabi season from such canal, a water rate equal to fifty per cent of applicable seasonal water rate shall be levied provided these lands are not irrigated using wells.
c. Any cultivated land receiving water by percolation or leakage or surface flow or through wells in the vicinity of canal may be charged appropriate water rates even if water is not directly drawn from canal system.
d. Penal charges may be levied if water charges are not paid on due date.
e. Arrear in water rate shall be deemed to be an arrear on land revenue.

5.5 Enactments for Establishment of Irrigation Development Corporations

With a view to accelerate the completion of irrigation projects and to manage the water resources in the five river basins of Maharashtra, GoM established five Irrigation Development Corporations (IDCs) in the State of Maharashtra. These five corporations were formed under the provision of the Corporation Acts enacted in the latter half of 1990s as mentioned below.

- Maharashtra Krishna Valley Development Corporation Act, 1996 (MKVDC Act, 1996)
- Vidarbha Irrigation Development Corporation Act, 1997 (VIDC Act, 1997)
- Mharashtra Tapi Irrigation Development Corporation Act, 1997 (TIDC Act, 1997)
- Konkan Irrigation Development Corporation Act, 1997 (KIDC Act, 1997)
- Maharahstra Godawari Marathwada Irrigation Development Corporation Act, 1998 (GMIDC Act , 1998)

The objective of the above Acts is to make special provisions for promotion and operation of irrigation projects, command area development and schemes for generation of hydro-electric energy and other incidental activities. One of the major objectives of the Irrigation Development Corporation is to plan, investigate, design construct and manage the irrigation project and command area development in the respective river basins.

Broadly, all the five Irrigation Corporations Acts have similar tariff related provisions. Therefore, for the purpose of brevity the relevant provisions of the Maharahstra Godawari Marathwada Irrigation Development Corporation Act, 1998 (GMIDC Act, 1998) Acts have been reproduced below:

5.5.1 Water Charges for irrigation, industrial and domestic purpose

In respect of water charges for supply of water for irrigation, industrial and domestic purpose, Section 20 of the GMIDC Act, 1998 states

> *"The Corporations shall, from time to time determine and levy water charges according to volume, for water supply to irrigation, industrial and domestic purpose to the State Government, local authorities, Government agencies, cultivators and water users associations:*
>
> *Provided that, the levy of water charges shall be such that water charges so recovered shall be sufficient at least to cover the interest charges of the loan raised by the Corporation from the open market."*

5.5.2 Fund of Corporation

In respect of fund of Corporation, Section 30 (1) of the GMIDC Act, 1998 states

"The Corporation shall have and maintain its own fund, to which shall be credited

a. *all moneys received by the Corporation from the State Government by way of grants, subventions, ;loans, advances and loans raised under this Act;*
b. *all fees, costs and charges received by the Corporation under this Act;*
c. *all moneys received by the Corporation from the disposal of lands, buildings and other properties, movable and immovable and other transactions;*
d. *all moneys received by the Corporation by way of water charges, rents and profits or from any other sources."*

5.5.3 Allocation of expenditure based on objectives of the project

In respect of allocation of expenditure chargeable to project on main objects, Section 37 of the GMIDC Act, 1998 states that

"The total capital expenditure chargeable to a project shall be allocated between two main objects, Irrigation Projects and Hydro-Electric Power Projects as follows namely:

a. *Expenditure solely attributable to any one of the said tow (to be read as two) objects , including a proportionate share of overhead and general charges, shall be charged to that object; and*
b. *Expenditure common to both the said objects, including a proportionate share of overhead and general charges, shall be allocated to the said objects in proportion to the expenditure which, according to estimate of the Corporation, would have been in constructing a separate structure for that object less any amount determined under (a) above in respect of that object".*

5.5.4 Profit sharing

In respect of disposal of profits and deficits, Section 42 (1) of the Act states

(1) "Subject to the provisions of sub-section (2) of section 44 of this Act, the net *profits, if any, attributable to cach (to be read as each) of the main objects, namely, irrigation and power shall be fully credited to the Corporation.*

(2) The net deficit, if any, in respect of any of the objects shall be solely born by the State Government."

5.5.5 Apportionment of betterment charges levied by State Government

In respect of apportionment of betterment charges levied by the State Government, Section 45 of the Act states

> *"In the event of any betterment levy being imposed by the State Government the apportionment of proceeds thereof in so far as they are attributable to the operations of the Corporations, shall be credited to the Corporation."*

5.5.6 Dues to be recovered as arrears of land revenue

In respect of dues to be recovered as arrears of land revenue, Section 54 of the Act states

> *"All sums due or payable by any person to the Corporation or recoverable by it on account of any charge, costs, expenses, fees, rent, compensation or any other account under this Act or any rule or regulation made there under or any agreement made with the Corporation and all charges or expenses incurred in connection therewith shall, without prejudice to any other mode of recovery, be recoverable as arrears of land revenue."*

5.5.7 Principles for Bulk Water Tariffs under various Irrigation Acts

Important principles which could be derived from the above discussions for bulk water tariffs are as follows:

a. The Corporations shall determine and levy water charges according to volume, for water supply to irrigation, industrial and domestic purposes.
b. The total capital expenditure chargeable to a project shall be allocated between two main objects i.e. Irrigation Projects and Hydro-Electric Power Projects.
c. The net deficit, if any, in respect of any of the objects shall be solely borne by the State Government
d. The State Government may impose betterment levy, appropriate share of proceeds of which shall be credited to the Corporation.
e. Arrear in water rate shall be deemed to be an arrear on land revenue.

5.6 Mumbai Municipal Corporation Act, 1949

Some of the municipal bodies in the State of Maharashtra have been involved in development, operation and management of water supply schemes for supply of water in their area of jurisdiction. Mumbai Municipal Corporation formed under Mumbai Municipal Corporation Act, 1888 (MMC Act, 1888) is one such municipal body, which owns and operates five dams/lakes in the vicinity of Mumbai for supply of water to the city of Mumbai. Legal provisions related to water supply are covered in the Act under which it is formed, i.e., MMC Act. We have summarised the relevant provisions below.

5.6.1 Duties and Powers of the Municipal Authorities

In respect of obligatory and discretionary duties of the Corporation, Section 61(b) of MMC Act, 1888 states

> *"It shall be incumbent on the corporation to make adequate provision, by any means or measures which it is lawfully competent to them to use or take, for each of the following matters namely:*
>
> *(a) the construction, maintenance and cleansing of drains and drainage works, and of public latrines, urinals and similar conveniences;*
>
> (b) *the construction and maintenance of works and means of providing a supply of water for public and private purposes;*
>
> (c) *……………"*

Under this section, it is obligatory duty of the Corporation to provide water supply to the citizens of Greater Mumbai for domestic, commercial, industrial and other purposes. Section 61(a) mandates the Corporation to provide sewage disposal services as well.

5.6.2 Water Taxes and Charges

In respect of water taxes and charges, Section 169 of MMC Act, 1888 states

> *"Notwithstanding anything contained in section 128, the Standing Committee shall, from time to time, make such rules as shall be necessary for supply of water and for charging for the supply of water and for any fittings, fixtures of services rendered by the Corporation under Chapter X and shall by such rules determine-*
>
> *(i) the .charges for the supply of water by water tax and a water benefit tax levied under section 140 of a percentage of the rateable value of any property provided with a supply of water; or*
>
> *(ii) a water charge in lieu of a water tax, based on a measurement or estimated measurement of the quantity of water supplied; or*
>
> *(iii) combined charge under clause (i) an (ii); or*
>
> i) *A combined charge in lieu of charges under clause (i) and (ii)."*

5.6.3 Principle for Recovery of Water Charges

Though the Act has not clearly enunciated the principles for charging water tax, it states that the same shall be decided as per the directions from Standing Committee of the Corporation. In this respect, Section 140(1)(a) of MMC Act, 1888 states

> (i) *the water tax of so many per centum of their rateable value, as the Standing Committee may consider necessary for providing water-supply;*
>
> *(ii) an additional water tax which shall be called 'the water benefit tax' of so many per centum of their rateable value, as the Standing Committee may consider necessary for meeting the whole or part of the expenditure incurred or to be incurred on the capital*

works for making and improving the facilities of water supply and for maintaining and operating such works;"

5.6.4 Principles for Bulk Water Tariffs under MMC Act

It may be noted that the provisions of the MMC Act 1888 have been covered to give complete picture of the various legislations in the area of water pricing. The provisions under MMC Act are essentially related to water tariffs for non-irrigation use at retail level and are therefore, not directly relevant for bulk water pricing.

5.7 National Water Policy

The National Water Policy was first adopted in September 1987 and since then it has been reviewed and updated, with the latest update being undertaken in the year 2002. Though, the Policy does not have any specific provision for tariff, it deals with the issue of charges and financial viability (Para 11), water conservation (Para 16) and maintenance and modernisation (Para 23) as reproduced below:

5.7.1 Financial and Physical Sustainability

"11. Besides creating additional water resources facilities for various uses, adequate emphasis needs to be given to the physical and financial sustainability of existing facilities. There is, therefore, a need to ensure that the water charges for various uses should be fixed in such a way that they cover at least the operation and maintenance charges of providing the service initially and a part of the capital costs subsequently. These rates should be linked directly to the quality of service provided. The subsidy on water rates to the disadvantaged and poorer sections of the society should be well targeted and transparent.

5.7.2 Conservation of Water

"16. Efficiency of utilisation in all the diverse uses of water should be optimised and an awareness of water as a scarce resource should be fostered. Conservation consciousness should be promoted through education, regulation, incentives and disincentives."

5.7.3 Maintenance and Modernisation

"23.1 Structures and systems created through massive investments should be properly maintained in good health. Appropriate annual provisions should be made for this purpose in the budgets.

23.2 There should be a regular monitoring of structures and systems and necessary rehabilitation and modernisation programmes should be under taken."

5.8 Maharashtra State Water Policy

The objectives of the Maharashtra State Water Policy (MSWP) are to ensure the sustainable development and optimal use and management of the State's water resources to provide the greatest economic and social benefits for the people of the State of Maharashtra in a manner that maintains important ecological values within rivers and adjoining lands.

Some of the more specific objectives of the Maharashtra State Water Policy are

- *"…..the State will restructure the fundamental roles and relationships of the State and water users. To create the incentive for water users to use water more efficiently and productively……..*
- *……..the State will create a new institutional arrangement at the state level and river basin levels to guide and regulate water resources management………*
- *…….the State will adopt three critical items of legislation, including an act to authorise farmers' management of irrigation systems, and act to create the State water authority and river basin authorities."*

Paragraph 4.4 of the Maharashtra State Water Policy deals with the issue of "Bulk Water Supply and Water Charges" as reproduced below:

> *"A transparent system of water tariffs that recuperates the cumulative cost of providing water services from all water user entities in all categories of water use shall be established by the State. Water charges determined on the basis of the approved water tariff system will be levied on a volumetric basis.*
> *Water charges shall be assessed and paid at each appropriate level of management and service provision. They will be sufficient to pay all administration, operation and maintenance costs of delivery and use of water and to recuperate all or portion of capital costs of the infrastructure needed for the storage, delivery and use of that water.*
>
> *Water charges shall be assessed to WUAs and other water user entities on the basis of the volume of water delivered at their respective off takes. WUAs and other water user entities shall be responsible for determining internal water charges and assessing each of its members to obtain funds required for paying water charges, carrying out necessary maintenance and for any other purpose approved by the membership.*
> *In order to alleviate the impact of such charge on those who are unable to pay the complete charge, the State may allow cross-subsidies and allocate Government Funds. In the event that such measures are utilized the aggregate amount of cross-subsidies and the Government funds shall, when combined with the regular water charges, be sufficient to recuperate all management, operation and maintenance costs of the delivery of the water and the capital costs for the infrastructure necessary for the storage and delivery of the water."* (Emphasis added)

5.9 National Water Mission as per National Action Plan on Climate Change (NAPCC)

Climate change is a global challenge and changes in key climate variables, namely temperature, precipitation and humidity, may have significant long-term implications on the quality and quantity of water. National Water Mission is one of the eight missions proposed under the NAPCC which is a plan prepared by Prime Minister's Council on Climate Change, GoI in dealing with the challenges of the climate change. It states

> *"Mission will take into account the provisions of National Water Policy and develop framework to optimize water use by increasing water use efficiency by 20% through regulatory mechanisms with differential entitlements and pricing………"*

Further it is stated

> *"Incentive structures will be designed to promote water-neutral or water-positive technologies, recharging of underground water sources and adoption of large scale irrigation programmes which rely on sprinklers, drip irrigation and ridge and furrow irrigation."*

Some of the specific aspects of water resources based on which National Water Mission has been envisaged are

- Studies on management of surface water resources
- Management and regulation of groundwater resources which also includes
    - *Mandating water harvesting and artificial recharge in relevant urban zones*
    - *Mandatory water assessments and audits; ensuring proper industrial waste disposal.*
    - *Regulation of power tariffs for irrigation.*
- Upgrading storage structures for fresh water and drainage systems for waste water
- Conservation of wetlands which also includes
    - *Formulating and implementing a regulatory regime to ensure wise use of wetlands at the national, the state and district levels*
- Development of desalination technologies

5.10 Legislative provisions on rebate for recycling of water

The need for rebate fundamentally arises when the cost of treatment of grey water/effluent is higher than the raw water costs available through Corporations or Water Resources Department. The following section elaborates the existing rebate related provisions in the legislation.

5.10.1 Existing rebate provisions

Water (Prevention and Control of Pollution) Cess Act, 1977 has been enacted to levy and collect of cess on water consumed by persons carrying on certain industries and by local authorities, with a view to augment the resources of the Central Board and the State Boards for the prevention and control of water pollution constituted under the Water (Prevention and Control of Pollution) Act, 1974.

In the context of existing rebate provisions section 7 of Water (Prevention and Control of Pollution) Cess Act, 1977 also states that

> *"Where any person or local authority, liable to pay the cess under this Act, instals (to be read as installs) any plant for the treatment of sewage or trade effluent, such person or local authority shall from such date as may be prescribed, be entitled to a rebate of twenty five per cent of the cess payable by such person or, as the case may be, local authority."*

Also based on the reports available on the website of MPCB it is observed that there exist certain provisions under which certain CETPs are operating on co-operative basis with industry as its members. The partial capital costs of the treatment plants were borne by MoEF, MIDC and MPCB.

In the above context section 12 (5) of the MWRRA Act 2005 states that

"The Authority shall support and aid enhancement and preservation of water quality within the State in close co-ordination with the relevant State agencies ………"

5.10.2 Rebate Mechanism

The above provision empowers MWRRA to make enabling frame work in the context of prevention and control of water pollution. For creating such enabling frame work there is a need to decide on the mode of rebate mechanism.

- One way could be providing reasonable rebates on the water tariff as a token for the industry for adopting recycling activity under its corporate social responsibility programme, which there by leads to reduced pollution.
- Other way could be actual assessment of treatment costs for various kinds of technologies vis-à-vis the cost of raw water made available. This is to encourage certain set of industries to set up the treatment plants, the operating and capital costs of which shall be partially subsided by the agencies like MWRRA, MPCB, MoEF etc.

Chapter 6: Principles for Tariff Setting Mechanism for Bulk Water

The tariff on water is levied on water users for supply of water, in order to meet the expenses of the water supply system. The water user community primarily comprises drinking water, industrial and agricultural water users. Before we get into the discussion of options for tariff structure, it would be necessary to not only understand the legal framework for bulk water tariffs but also the features which one must incorporate in good tariff framework.

This chapter essentially attempts to fulfil this function by providing legal, policy and regulatory framework under which the current exercise is being undertaken. Further, this chapter will explore the essential features for efficient bulk water pricing.

6.1 Characteristics of good tariff mechanism

In this Section, we have described the characteristics of good tariff mechanisms. It would be our endeavour to incorporate these features in the Bulk Tariff Mechanism to be developed under this assignment.

6.1.1 Full cost recovery in due course

In order to have financial and physical sustainability, the National Water Policy, 2002 mandates that the water charges from various uses should be fixed in such a way that they *at least* cover the operation and maintenance charges for providing service initially and a part of capital costs subsequently. These rates should be directly linked with the quality of service provided. Further, Maharashtra State Water Policy, 2003 emphasises a system of water tariff which can recover the cumulative cost of providing water services from all water user entities in all categories of water use. It also states that water tariff should be levied on volumetric basis. The tariffs will be such that it is sufficient to pay all administration, operation and maintenance costs of the delivery and use of water and to recover all or a portion of the capital costs of the infrastructure needed for the storage, delivery and use of However, Section 11(d) of the MWRRAA which governs the functioning of the Authority, has no reference to capital cost recovery. As a result, even though it would prudent to develop tariff mechanism which will allow at least partial recovery of capital costs, the Authority will be constrained to adopt the mechanism which will allow only recovery of O&M Costs.

6.1.2 No tariff shock to any class of consumer

While Section 11 (d) of the MWRRA Act empowers the Authority to establish water tariff system based on the principles that reflect the full recovery of the cost of irrigation management and operation and maintenance of water resources project, it is essential to ensure that increase in tariff should be such that it can be borne by the users. Also, as agricultural users are currently being charged on area basis, any shift to a metered or volumetric basis may result in the tariff shock to some of the agricultural consumers as tariffs vary significantly for different crops. In order to achieve a smooth transition towards volumetric tariff, the tariff should be so designed during the transition period that there will be an incentive for a consumer to move towards volumetric supply. To encourage the farmers for moving from area based pricing mechanism to volumetric pricing, the tariff can initially be set lower than the existing area wise rates.

6.1.3 Promoting water conservation

Tariff setting mechanism should be such that it encourages efficiency of water utilisation in all the diverse uses of water. The National Water Policy advocates that conservation consciousness should also be promoted through incentive and disincentive mechanism. Further, Maharashtra State Water Policy recommends recycling and reuse of water to be made mandatory for industries. Under Section 12 (4) of the MWRRA Act, the Authority in accordance with State Water Policy has to promote and implement sound water conservation and management practices. As a part of this Study, water recycling and conservation technologies would be identified. Any user category installing any of those technologies would be provided appropriate rebate in water tariffs.

6.1.4 Reliability & Quality of Service

Tariff mechanism should also provide for addressing reliability (timeliness and quantity) of the service. New tariff mechanisms should reduce human involvement in measurement, billing and collection processes. Instead, automatic processes should be promoted. We suggest that, to begin with, performance benchmarks may be developed to measure the performance of the IDCs. Till such time performance benchmarks are defined properly, baselines developed and monitoring systems installed, tariffs should not be linked with the benchmarks. However, provision for linking the same should be made in the Tariff Regulations.

6.1.5 Principles of tariff setting

All tariff principles (tariff reflecting the cost of supply, reduction of cross-subsidy, etc.) should be applied uniformly to all categories of consumers, in order to increase their acceptability. It is also essential that all the principles are applied uniformly to all the utilities within the purview of the regulator.

6.1.6 Minimizing Regulatory Uncertainty

Any tariff methodology should assure long term stability to both, the utility supplying water as well as consumers of water. Further, the tariffs should not be set at unrealistically high levels for any category of consumer, to minimize/prevent the occurrence of wilful default of payment. While regulatory certainty could be increased either by way of Multi-Year Tariffs (as done by Irrigation Department, Government of Maharashtra) or by enunciating a well defined tariff philosophy.

We believe that predictability of tariff philosophy is important. It is experienced in other sectors that consumers are willing to pay higher charges provided they are aware that charges will be increased at regular intervals. Predictability of tariff philosophy is also required by industries for running their business, maintaining profitability and for facilitating long-term business planning.

In case of bulk water pricing in Maharashtra, we believe that the existing tariff structure is not the most suitable structure. We believe significant changes are required to be made to the tariff structure. We believe it is necessary to change the tariff categories to align with the customers to whom water is being supplied. Further, it is necessary to adopt technology for volumetric supply and measurement. These changes could be undertaken in the near future. As a result, we recommend adoption of a long-term tariff philosophy as against adoption of Multi-Year Tariffs, even though the latter would theoretically provide more stability or certainty.

6.1.7 Consistency

Consistency in decisions is very essential to impart confidence to the Irrigation Development Corporations (IDC), Water Users Community and prospective investors (investors in IDCs). It is essential that tariffs should be predictable. The methodology for determination of tariffs should be clear and should help IDC in projecting tariffs over a period of time. A clear direction from the regulators on expected tariff movement will also help the users in planning additional capacity and water consumption.

6.1.8 Transparency

This is a very essential element for the success of the overall tariff strategy. This will also help in building confidence in the Authority, on the part of both the IDCs and the water users. Given the sensitive nature of water tariffs, we would recommend that an elaborate public process involving healthy exchange of views between the IDCs, Authority, Government of Maharashtra and the different categories of users should be undertaken. This will go a long way in increasing the acceptability of the eventual tariff order.

Chapter 7: Framework for Bulk Water Tariff Regulation

Regulations are sub-ordinate legislations and emanate from the authority vested in a particular entity under legislative mandate. It is true for water sector as well. The Regulations drafted by MWRRA must be firmly rooted in legislative mandate given to MWRRA under provisions of various Acts. Therefore, in earlier chapter, we have covered in detail tariff related provisions under various legislations such as MWRRA Act 2005, MMISF Act 2005, MI Act 1976, etc.

Having covered legislative mandate to MWRRA in the last Chapter, in this Chapter we have attempted to discuss various issues of the bulk water tariffs and issues associated with it. An attempt has been made to identify solutions for that particular issue. It is believed such an approach will help MWRRA in development of robust regulatory framework for bulk water sector in the State. In particular we have covered following issues in this Chapter.

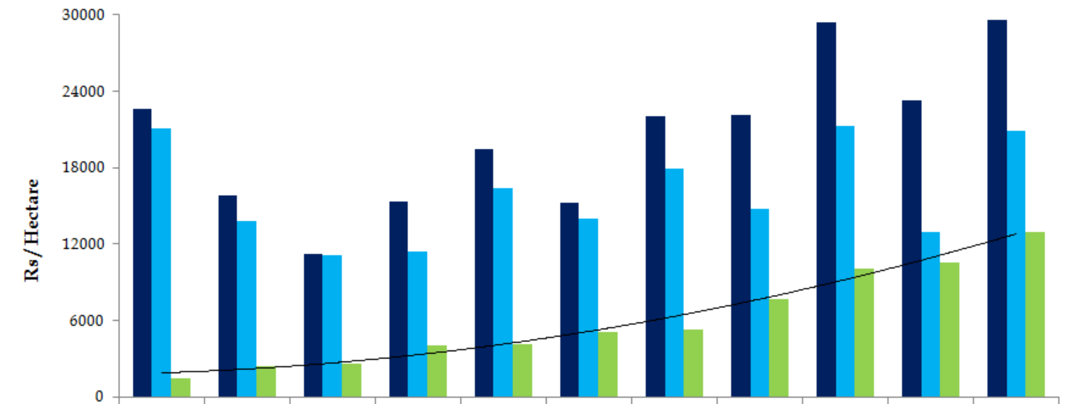
- Ability to Pay v/s Cost based Pricing
- Cost elements to be recovered through tariff
- Basin & Sub-basin wise Tariff v/s single State Tariff
- Average Cost v/s Marginal Cost based Tariff
- Single Part Tariff v/s Two Part Tariff
- Seasonal Pricing
- Agro-climatic based pricing
- Periodicity of tariff revision
- Tariff structure for efficient use of water
- Polluter Pays Principle
- Population Management
- Volumetric measurement for supply to WUAs and LI WUAs
- Powers of WUAs to charge its members
- Mode of water supply
- Minimum charges
- Percolation and leakage rates
- Charges for delayed payments
- Water arrears to be considered as land revenue arrears
- Deficit to be borne by State Government
- Apportionment of betterment levy
- Stake holder consultation process
- Tariff determination process

7.1 Ability to pay v/s Cost based Pricing

7.1.1 Irrigation Use

Various Committees prior to Vaidyanathan Committee, 1992, suggested that farmers' capacity to pay should be considered while determining tariffs. These Committees suggested that water rates be fixed at 25 to 40% of additional net benefits to the farmers. Subsequently, difficulties in quantification of net benefits accrued led to recommendation of proportional water rates. It was suggested that water rates should be linked to certain percentage (5% and 12%) of gross income for cereal crops and cash crops, respectively. However, the gross income of the crop also depends upon plant-breeding practices, fertilizer practices and other meteorological characteristics in the region. Variation in the cost of production of different crops is main issue in calculating the capacity to pay. The following figure shows the variations in price of different crops grown in Kharif season, production cost including the family labour and gross income. It can easily be noticed that the farmers growing maize and udid have higher paying capacity in comparison to other crops but their total cultivation in the state is very less.

Figure 7-1 Profit analysis for different crops (Kharif season)



	Cotton	Soyabeen	Bajra	Moong	Tur	Jawar	Groundnut	Sunflower	Paddy	Udid	Maize
Price of Crop	22625	15804	11281	15321	19460	15254	22071	22194	29400	23267	29660
Cost	21121	13783	11126	11421	16390	13977	17889	14785	21291	12982	20900
Net Profit	1504	2462	2609	4036	4180	5066	5331	7664	10069	10575	12944

(Source: Based on data provided by MWRRA)

Moreover, the overall productivity of crops differs from region to region and determining the water charges based on crop productivity appears to be arbitrary and unscientific. Also, whether 'ability to pay' pricing encourages efficient cropping patterns is doubtful. Further, it is very difficult to apply 'ability to pay' criteria for all categories of users.

Further, various provisions of MWRRA Act as well as MMISF Act promote creation of Water User Associations to ensure community involvement in management of water resources. Further, these Acts require that water is supplied to these WUAs on volumetric basis. The members of any WUA could be cultivating different crops at any given point of time. As a result 'ability to pay' of members of WUA and 'ability to pay' of WUA could be significantly different and difficult to estimate. As a result, it is necessary to develop other principles which could be consistently applied to all WUAs in the State. In this regard, 'cost based pricing' appears to be the most rationale and economically sound principle for determination of water tariffs.

7.1.2 Non-Irrigation Use

Similarly, in case of non-irrigation use, particularly for drinking water sector, it would be difficult to implement 'ability to pay' principle for tariffs as the tariffs are applied to intermediate entities such as Urban Local Bodies or Zilla Parishads. Determination of 'ability to pay' of these urban local bodies or Zilla Parishads will not only be cumbersome exercise but also could be subjective and controversial. As a result, 'ability to pay' can not be used as primary pricing principle. At the same time, 'ability to pay' of consumer can not be completely ignored. Therefore, it would be necessary to develop generic assumptions while designing tariff for drinking water and industrial needs. Current, tariff structure does not distinguish between supply to Municipal Corporations, Municipal Councils and Zilla Parishads or rual water supply schemes. It is generally accepted that 'ability to pay' of consumers in municipal corporations will be more than that in municipal councils which is in turn would be higher than those consumers staying in rural areas. Therefore, it should be possible to design tariff structure which will take into account these differences in 'ability of pay' of different categories of consumers.

At the same time, cost-based pricing methodology is the most common and widely used methodology for pricing infrastructure services, such as electricity, roads, etc. This methodology prohibits the service provider from exhibiting monopoly behaviour while provides certainty of income. Further, cost based pricing could be designed in such a manner that it provides a cushion to utility for any untoward happening.

Here, it may be noted that ABPS Infra is not suggesting identification of costs involved in provision of bulk water to specific categories and therefore recovery of such costs from those categories of consumers. Currently, it is not possible to calculate such costs given poor state of data available with bulk water supply agencies. In view of the lack of data, it would be hazardous to guess tariffs and cross-subsidies involved in such tariffs. However, in future, an attempt must be made to identify costs associated with the provision of water to different categories of consumers and tariffs should be determined accordingly.

It also may be noted that the Vaidyanathan Committee has also recommended cost based pricing should be adopted for bulk water tariff determination purposes. In view of the above, we recommend that 'cost based pricing' should be the primary principle for bulk water pricing while 'ability to pay' may be used to apportion costs between various categories of water users.

7.2 Cost elements to be recovered through tariff

Having suggested 'cost based pricing', it would be necessary to identify the costs involved in bulk water supply and extent of recovery of those costs through bulk water pricing. Typically, costs involved in provision of any service include costs associated with capital assets such as interest, return on equity, depreciation or loan repayment and operational costs such as operation and maintenance costs, establishment expenses, etc.

7.2.1 Recovery of cost elements as per legislative provisions

As discussed in earlier Chapter on legal framework, MWRRA is currently mandated to determine tariffs which will enable recovery of only O&M cost. However, under Clause 4.4 of State Water Policy, provision for recovery of full or a part of capital cost has been made. Recovery of full capital cost will lead to manifold increase in the tariff as the present tariff is not sufficient even to meet the O&M cost. Inclusion of the capital cost component in water tariff raises concern regarding definition of capital cost to be considered in tariff determination; historical capital cost or incremental capital cost?

Here, historical capital cost refers to the gross fixed asset (Dams, canal and allied system, machineries, pipelines, Land and building, etc) of Irrigation Development Corporations (IDCs). Tariff determination on historical capital cost basis will require gross fixed asset data for all the completed and under-construction projects, and depending upon the life of the asset, depreciation will have to be considered. In this method, availability of data is a major concern as some of the projects in Maharashtra are very old and data may be available for such projects. Also, it is likely that debt for these projects would have been paid and as a result depreciated cost of these projects may be very less. Incremental capital cost refers to capital expenditure incurred during that particular year. Incremental capital costs will be very less as compared to the total capital costs of the bulk water system in the State. Further, it would be easier to compute the incremental costs much more accurately than the total capital costs.

Section 11 (d) of the MWRRA Act has specified the power and functions of the Authority under which the Authority is required to fix water tariffs. The said section states that the tariff should be reflecting the full recovery of cost of the irrigation management, administration, and operation and maintenance of the water resources project. Recovery of capital cost through the tariff has not been stated as a principle for determination of tariff. Section 11 (r) of the Act also has a provision of sharing of the costs and provision of subsidy for any user category so that in all cases total costs are met. It may be necessary to review appropriateness of two major components of the O&M costs i.e. maintenance and repairs cost (M&R Costs) and establishment costs. We have dealt with the issue of appropriateness of costs in a subsequent Chapter on Revenue Requirement of Bulk Water Sector in Maharashtra.

Keeping in view the above provisions of the act, it is proposed to fix the bulk water tariffs on the basis of recovery of full O&M costs only with flexibility for sharing of partial or full O&M costs by the GoM for any user category in the form of subsidy. Further, it is suggested that revenue from levy of tariff along with Government subsidy, if any, should be matched with full O&M costs. Arrears, if any should be treated separately and every attempt should be made to ensure 100% realization of tariffs levied.

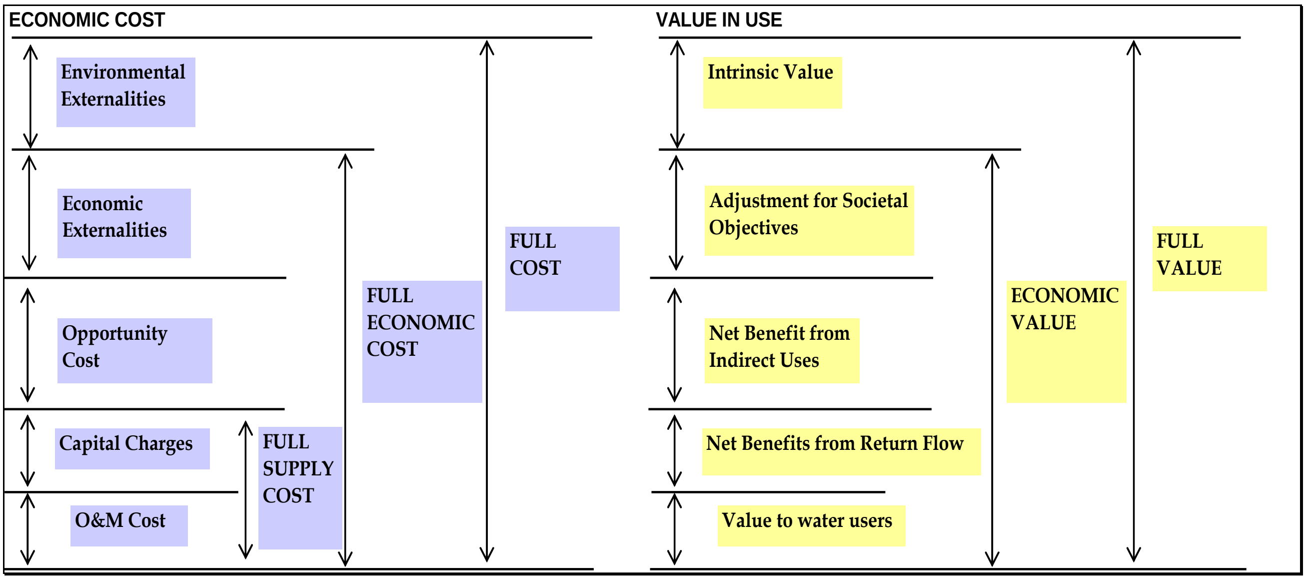
While capital cost recovery is not mandated under MWRRA Act 2005, provisions of the State Water Policy can not be completely ignored. From the provisions of the State Water Policy and general trend in water pricing all over the world, it appears that recovery of capital costs may have to be considered by the regulatory authorities in due course. For this to happen, it is also necessary that recently introduced regulatory reforms in the State Water Sector take root and start showing positive results. During this period, it is strongly recommended that MWRRA develops database of various information related inventory of assets, their financing mechanisms, etc

7.2.2 Recovery of cost elements on economic theory

Principles for determination water charge on the basis of economic theory essentially consists of calculating economic cost of water vis-à-vis value of water to the user considering all tangible and intangible things. One thing is that it is essential to understand the components of costs involved in the provision of water, both directly and indirectly. Other thing is the value that can be derived from the use of water, which obviously depends upon the quality and reliability of water supply. Ideally for sustainable use of water the economic cost and the economic value of the water should be equal

Rogers. P *et al*. (1998) of Technical Advisory Committee (TAC) of the Global Water Partnership have published a background paper titled 'Water as a Social and Economic Good: How to Put the Principle into Practice'. The background paper elaborates the two method on the basis of which water charges can be calculated i) calculating economic cost of water and ii) value of water. In order to have an economic equilibrium, the economic cost of water and value of water should be balanced. The following is section gives the broad principles involved in the above two methods (i.e. economic cost of water and value of water).

Figure 7-2 General Principles for Cost of Water and Value in Use



(Source: Rogers et a, 1998)

Figure 7-2 shows schematic components of cost components and value components for estimating water charge.

Table 7-1 Principles for cost of water and value of water

Basis for calculation of economic cost of water	Basis for calculating value of water
• **O&M** costs are those associated with the daily running of the supply system. • **Capital charges** include capital consumption (depreciation charges) and interest costs associated. • **Opportunity Cost** is associated with the alternate use of the same water resource and the economic externalities imposed upon due to the consumption of the specific actor. Alternatively **Opportunity Cost** is the cost that addresses the fact that by consuming water, the user is depriving another user of the water. The opportunity cost of water is zero only when there is alternative use. For example a	• **Value to users of water**: For industrial and agricultural uses the value of water to them is at least as high as marginal value of the product. Marginal Value is the maximum amount of one good you would give up to get one more unit of a different good. For domestic use, the willingness to pay for water represents the value to its users. • **Net Benefits from return flows**: Let us say a farmer irrigating fields in the West can divert water from a stream and put it on his land, but he's not allowed to capture the water that runs off his fields or seeps through the ground and winds up back in the stream. That is the

Basis for calculation of economic cost of water	Basis for calculating value of water
person who invests Rs.1000 in a stock denies himself/herself the interest that could have been earned by leaving the Rs. 1000 in a bank account instead. The opportunity cost of the decision to invest in stock is the value of the interest. Ignoring the opportunity cost leads to undervaluation of water. • **Economic Externality**: In economics, an externality is an impact on any party not directly involved in an economic decision. An externality occurs when an economic activity causes external costs or external benefits to third party stakeholders who cannot directly affect an economic transaction. The common externalities related to water could be impact on downstream due up stream diversion of the river or say release of pollution on downstream users. There may be positive externalities and negative externalities. • **Environmental Externality**: Those externalities associated with public health and ecosystem maintenance are termed as environmental externalities. However the subtle difference between economic externality and environmental externality is that say, if pollution causes increased production or consumption costs to downstream users, it is an economic externality, but if it causes public health or ecosystem impacts, then it is defined as environmental externality.	"return flow," and it belongs to someone else downstream. Net benefits accrued from such return flow are net benefits from return flow. • **Net benefits from indirect use**: Any benefit say in the case of irrigation schemes that also provide water for domestic (drinking and personal hygiene) and livestock purposes, which can result in improved health and/or higher incomes for rural poor. • **Adjustment for societal objectives**: Adjustment over and above the value of water to the user should be added to reflect various societal objectives such as poverty alleviation, employment and food security. *The estimates of these values are not to be arbitrarily set, but should be determined on the basis of the best available method that gives the real gains to the society from price differentials among other sectors.* • **Intrinsic value**: one of the ways to estimate intrinsic value is to estimate hedonic price indices. Hedonic price indices are based on hedonic regression, which essentially is a method of estimating demand or a value.

Further the background paper gives illustrations for estimation of cost of water and value of water based on the above mentioned principles. The two case studies from India are i) estimation of value and cost of irrigated agriculture in arid zone, Harayana, India ii) Cost and value of water, Subernarekha River Basin, Jamshedpur, India. The complete details of the case studies are available on www.gwpforum.org/gwp/library/TAC2.PDF

7.3 State/Basin/Sub-basin/Project-wise tariff

Tariff for water usage can be fixed at macro level as well as at micro level. At macro level, uniform tariff at State level is fixed and at micro level, different tariff structures in each of river basin, sub-basin and even at the project level can be adopted.

In the context of macro level and micro level tariff setting, we would like to give the example of the electricity sector. In Chhattisgarh, where only one utility (Chhattisgarh State Electricity Board) manages the electricity supply business, electricity tariff for any consumer category is same across the State, while in Maharashtra, tariff for same consumer categories varies depending upon the location of the consumer in different distribution company's licence area. At the same time, in the States of Uttar Pradesh and Orissa, tariff for a particular consumer category is same across the State even though different distribution licensees supply power to different parts of the State and have different cost structures. Variation in tariff structure across the State is due to the philosophy adopted by the State Electricity Regulatory Commissions while setting the tariff framework.

Currently, water tariffs in Maharashtra are uniform across the State. A move towards fixing the tariff at basin and sub-basin level has been made in MWRRA Act, 2005. Section 11 (d) of the MWRRA Act 2005 empowers the Authority to fix the criteria for water charges at sub-basin and river basin level. Tariff fixing at project level has also been discussed in the Vaidyanathan Committee Report, however, there are certain complications associated with this approach. The projects costs depend upon age, design and condition of the structures. Older projects will tend to be cheaper as they were exploited at relatively easier sites and at lower constructions costs, when compared with newer projects. Tariffs for old projects and new projects would vary significantly, if determined for individual project. The grouping of the projects at basin and sub-basin level will result in lesser variation in rates charged to users in different basins as wide variations at project level would be smoothed out during aggregation.

In the present circumstances, determination of tariff at basin level is feasible, though it is not feasible to do so at sub-basin level. It may be noted that though sub-basin areas have already been identified, important commercial activities such as maintenance of the water accounts, revenue and expenditure accounts at sub-basin level are not being practiced.

Considering the present state of non-uniform development of different river basins, we are of the opinion that MWWRRA should fix the uniform tariff across the State during first three years. During this period, it can direct all river basin agencies to maintain the separate accounts at basin level as well as sub-basin level. MWRRA may fix the tariff at basin and sub-basin level when the utilization of potential command area across such basins/sub-basins is satisfactorily.

7.4 Average Cost Tariffs v/s Marginal Cost based Tariffs

A common debate in the literature on water pricing is whether to price water by its average cost or by its marginal cost. When the tariffs are determined on the basis of simple average historic costs incurred by the river basin agencies on account of water supply, the tariffs can be said to have average cost basis. On the contrary, in case of marginal cost of supply, it is the cost incurred to supply an additional unit of water at a particular time. In economic terms, marginal cost represents the cost incurred by society to satisfy the incremental demand.

Marginal cost of supply may be higher or lesser than the average cost of supply depending on the level of saturation in the system. If the additional demand of water can be accommodated within the capacity of present infrastructure, the marginal cost will be less than the average cost of supply. If new infrastructure is required to be created to meet additional demand, the incremental cost will be borne by new customers only and in such case, marginal cost will be much higher than the average cost of supply.

Once the marginal costs are calculated, the revenue realization will be determined assuming that marginal costs are charged as tariff to each class of consumer. The total of this will be compared to the revenue requirement of the State Water Department. The gap in revenue requirement and revenue realization, if any, will have to be met such that the distortions in consumption arising out of the price deviations from marginal costs are minimised. We believe that tariff setting on marginal pricing will not be suitable option in the context of water sector in the State of Maharashtra as the sector is currently not even recovering the operating costs. We believe that when the sector is not recovering even operating costs, marginal pricing which is meant to replicate marginal conditions can not be implemented. We strongly recommend adoption of average cost based methodology for tariff determination purposes. In this regard, it may be noted that the Vaidyanathan Committee Report had also rejected the marginal cost pricing principle.

7.5 Single Part v/s Two Part Tariff Structure

This option deals with structuring of various tariff components. If all the parameters of tariff are clubbed together in a single number, it is a single-part tariff and if tariff is structured in two or more than two components, it is called two-part tariff or multi-part tariff. The prevailing tariff regime in Maharashtra is a single-part tariff, as tariff comprises water charges based on either volumetric consumption or crop area. This kind of mechanism does not ensure any fixed revenue to the supply utility and as a result utility may be vulnerable to even recover fixed costs such as employee expenses.

In two-part tariff mechanism, one component consist of fixed charge, which should be ideally set to recover fixed part of O&M expenses, R&M expense of dam and canal system, etc. The second component or the variable charge may be recovered for actual volumetric consumption. Two-part tariff can serve twin objectives, viz., efficient use of the resources and ensuring regular stream of revenue for Water Corporations.

In this context, we would like to present the case of Communication and Electricity sectors where both single-part as well as two-part tariffs exist for different types of consumers. In the communication sector, pre-paid consumers pay a single-part tariff based on actual talk time while post-paid consumers pay fixed charges as well as variable charges. Monthly rental from the post-paid consumers ensures the recovery of infrastructure cost, while variable charges ensure the recovery of system utilisation cost.

In Electricity sector, two-part tariff mechanism (fixed charge and variable charge) exists primarily in two segments namely, generation and distribution of electricity. Fixed charge is levied on per connection basis or on the basis of contracted demand/sanctioned load and is designed to recover expenditure on depreciation, O&M expenses (which includes Administration and General (A&G) expense, Repair and Maintenance (R&M) expense and Employee expenses), return on equity, and interest on loan. The fixed charge ensures that the utility recovers a significant part of its fixed costs. Variable component primarily consist of fuel cost for generation and power purchase expenses for distribution, and is levied on per unit of consumption.

It may be noted that several variations of the single-part tariff system as well as two-part tariff systems are possible and the best solution based on the ground realities needs to be identified. If consumers are homogeneous, a single two-part tariff may be implemented. However, in the presence of heterogeneous consumers, a menu of two-part tariffs (with trade-offs between the fixed charge and the volumetric charge) will have to developed keeping in mind various other factors such as costs imposed on the system, ability to pay, etc. In case of two part tariffs, following issues will have to be decided.

- Should the variable element in any tariff system be a single number for entire consumption or should have telescopic rates for different consumption levels?

Increasing block system with pre-determined volume blocks of consumption have a different (higher in this case) price attached to them.

- If an increasing (or decreasing) block system is employed, how should the volume blocks and associated prices be determined?

Both the mechanisms have their own advantages and disadvantages. Single part tariff is very easy to implement as it is directly linked with the actual/allotted consumption. However, single part tariff doesn't encourage system efficiency and optimal utilisation of resources and most important of all, certainty of revenue to water utility. Two part tariff system is little complicated as it leads to administrative and accounting complexity though at the same time, ensures fixed cost recovery to the utility and better cash management.

In our opinion, MWRRA should adopt the two-part tariff mechanism in the long run for all types of water users. In such a mechanism, fixed component may be linked to part of O&M expense and levied on the basis of acreage, while variable component based on volumetric usage could recover remaining costs associated with water supply. This type of mechanism will ensure the recovery of repair and maintenance cost of the canal system and establishment costs irrespective of actual water used by its beneficiaries. This is a standard international practice and is in vogue in places like Melbourne Water, Australia, China etc., as given in the report on international experiences in bulk water tariff annexed as **ANNEXURE I.** It would have been ideal if such a system could have been introduced in the first three year tariff period beginning 2009-10. However, given the current lack of data regarding acreage of various categories of crops in the State, it may be difficult to implement such a system. If such a system is implemented without adequate simulation of tariff numbers, it may result in hardship for certain section of farmers which is not desirable. Hence, we recommend that single part tariff may be implemented during the first tariff period and two – part tariff from second tariff period beginning 2012-13. Interim, three year period may be used to develop and strengthen database on acreage and corresponding water usage.

7.6 Betterment Levy

During deliberations with MWRRA as well as with other stakeholders, issue was often raised about benefit getting accrued to those farmers in the area of irrigation system which don't draw water from the irrigation system but are benefited due to either availability of seepage water or increase in land prices due to irrigation system. This argument is valid and has also been accepted legally in the Irrigation Development Corporation Acts.

However, we envisage two issues in implementation of 'Betterment Levy' as a part of this tariff proposal. While one is an implementation issue, other is a legal issue. On implementation issue, betterment levy will have to be levied on the basis of acreage any farmer has. However, as mentioned in earlier paragraph, availability and accuracy of this data with MWRRA is not satisfactory. The reasons for deferring levy of fixed charges during the first tariff period apply equally to deferment of betterment levy. Hence, we recommend that betterment levy may be imposed during the second tariff period beginning 2012-13.

The second issue is legal in nature and therefore more fundamental one. Though Irrigation Development Corporation Acts provide for betterment levy, MWRRA Act does not provide for the same. Section 45 of the GMIDC Act clearly states that "*In the event of any betterment levy being imposed by the State Government the apportionment of proceeds thereof in so far as they are attributable to the operations of the Corporations, shall be credited to the Corporation.*".

It is not clear from either GMIDC Act or MWRRA Act, whether authority to levy betterment levy has been delegated by the Government of Maharashtra to MWRRA. In our view, it is necessary that such authority is delegated to MWRRA for it to start charging betterment levy. Further, in our view, it will be prudent to delegate such powers to MWRRA so that it become sole authority for levy of economic charges related to irrigation systems, water usage and benefit arising out of it.

7.7 Seasonal Pricing

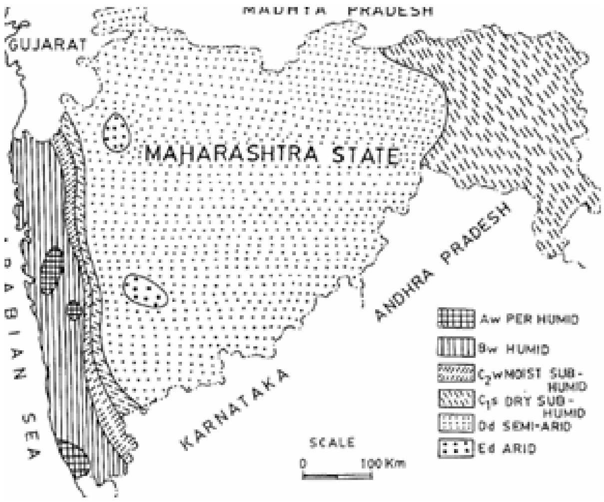
Seasonal pricing refers to the setting of tariffs sensitive to the seasonal variations. Agriculture sector observes three seasons, namely, Rabi, Kharif and hot weather season, and water requirement during these seasons varies significantly depending upon the crop sowed. Water requirement differs according to the crops and soil type. The water requirement of crops is that quantity of water required by the crops within a given period of time for their maturity and it includes losses due to evapo-transpiration plus the unavoidable losses during the application of water and water required for special operations such as land preparation, puddling and leaching.

In Maharashtra, present agricultural tariff is sensitive to the seasonal variation. Hot weather water rates are nearly two to three times the kharif water rate. High rate has been set mainly due to significant evaporation and seepage losses during the hot months (In a typical hot day, water evaporation equivalent to 4-5 mm of depth have been observed across different dam sites in State) and therefore, more water from dam site is required to be released for same level of water requirement at minor level.

We are also of the opinion that seasonal pricing scheme should be continued for the agriculture sector and the irrigation tariff should gradually move on to volumetric consumption basis only. For crops that consume more water, like sugar cane, banana, etc., telescopic tariff slabs can be introduced instead of having crop wise tariffs. Farmers requiring more water will have to pay more charges, based on their incremental consumption. At the same time, a suitable incentive should be given to farmers which adopt drip irrigation scheme or adopt watershed management techniques.

If the argument preferred in the first paragraph is accepted, it would be imperative that the argument is applied consistently for all the categories of consumers. The Authority may consider implementing seasonal tariffs for domestic as well as industrial categories of consumers. This will result in judicious consumption of water during hot weather months, during which water scarcity is experienced in the most parts of the State. This will also ensure that consumers are encouraged to adopt water-harvesting measures, which at present may not be fully be practised.

7.8 Agro-climatic based pricing



An agro-climatic region can be defined as a zone with characteristic interrelationship between agronomy or farming system and climate. Agro-climatic based pricing is an innovative concept and can be applied in the areas where significant variations in climatic conditions are observed within the specified region. In this method, agro - economic zoning of soil/land type, water and climate by category is of central importance. Climate here means weather, i.e., temperature and rainfall levels and variations, while water is both surface and ground water. Based on a study, India has been divided into 18 agro - climatic zones and 44 sub-regions[1].

Maharashtra, based on climatic classification basis, is divided into five regions namely perhumid, humid, moist sub-humid, dry sub-humid and semi arid climatic zones. Of all the climatic types, the semi arid climate predominates in the State. The climatic map of Maharashtra is shown here[2]:

---

[1] Sadasyuk, G. & P. Sengupta, 1968. Economic regionalisation of India: problems and approaches

[2] Subramaniam and Sambasiva Rao, 1987, Scheduling irrigation based on some climatic indices for crops in Maharashtra of western peninsular India

Water requirement for the same crops across all the climatic regions will vary significantly, and therefore, different water tariff can be set across the different climatic zones. However, ABPS Infra is of the opinion that for moving towards Agro-climatic pricing, it will require in-depth analysis of past 15-20 years' data for climatic variations, rainfall, irrigation water consumption, and soil type in all climatic zones, for establishing a climatic pattern and its linkage with irrigation water requirement. Determining irrigation tariff based on agro-climatic conditions is also not feasible with present institutional structure as it will involve redefining the IDCs boundaries, which are primarily based on river basin area. In view of the above, we do not recommend inclusion of 'agro-climatic pricing' factors in the proposed bulk water pricing framework.

7.9 Periodicity of Tariff Revision

In the context of tariff revision section 11(u) of the MWRRA Act, 2005 states that MWRRA shall review and revise the water charges every three years.

In our view the three year control period for tariff revision is reasonable enough, in terms from water user's perspective it gives a surety of water rates for the control period and from utility perspective it provides enough space and time to adequately reflect the inflationary trends and other factors for the next control period. Therefore, we recommend tariffs be determined for the first tariff period of 2009-2012.

Further, we believe significant and more fundamental changes are required to be undertaken during second tariff period. These changes would require significant quantity of quality data about the acreage, land usage, cropping pattern. It has been experienced that without such extensive data, it is not possible to carry out tariff simulation and therefore recommend most suitable tariff structure. If difficulties faced during the current exercise are to be avoided during next tariff determination exercise, it is necessary that the interim three year period is utilised for collection of data. We strongly recommend MWRRA to immediately undertake exercise for development of systems for collection and maintenance of data.

7.10 Tariff Structure for efficient use of water

In the context of efficient water use, Section 12 (4) of the MWRRA Act, 2005 states that MWRRA shall promote and implement sound water conservation and management practices throughout the State.

The Government Resolution (GR) dated July 31, 2006 on the water charges for non-irrigation use has a provision for rebate at the rate of 10% (discount) on the tariff bills of the industries, provided that the industries implement recycling technique and reuse a minimum 25% of their water consumption. Following issues emerge out of the above provision:

a) It was learnt during deliberations with various stakeholder that there was no systematic mechanism for verification of recycling process but the discount of 10% is being granted on the assessment of previous period consumption and current consumption. Here, it may be noted that the intention of the rebate is to incentivise the industrial consumers for their demand management. However there may be situations where the industry may have downsized its operation, reduced the plant capacity etc. It was felt that such cases are also becoming eligible for rebate under the existing mechanism.
b) In case, the cost of treatment of per unit of grey water is less than the cost of purchase of per unit raw water, there is no need for rebate. However in case of other way round, any rebate mechanism to be economically convincing, should be at least the difference in the per unit treatment cost of grey water and per unit cost of raw water.

In our view incentive and disincentive mechanism is essential for effective water resources management. Further sections dwell into the quantum of rebates and its intricacies.

Further, given that agricultural usage constitutes more than 80% usage, it is necessary to design and implement incentive mechanism for water conservation in agricultural usage. Various water conservation techniques for agricultural users have been elaborated in **ANNEXURE II**. In our view the water conservation practices have to be an integral part of the Regulations.

At present, rebates are being offered to only industrial category. In case of water utilities like Municipal Corporations, Urban Local Bodies etc., who act more as a secondary supplier, any water conservation measure will have to be implemented at the retail level. Best practices in demand management will have to be designed by the Municipal Corporations, Urban Local Bodies etc., for the implementation at the retail level.

7.11 Polluter pays principle

Pollution of water sources is a very serious issue and need to be tackled in all earnest. Once polluted, it not pollutes surrounding environment where pollution is taking place but also impacts all downstream users of waters. Section 2 of the Water (Prevention and Control of Pollution) Act, 1974 (hereafter Water (P & CP) Act, 1974) defines pollution as:

"such contamination of water or such alteration of the physical, chemical or biological properties of water or such discharge of any sewage or trade effluent or of any other liquid, gaseous or solid substance into water (whether directly or indirectly) as may, or is likely to, create a nuisance or render such water harmful or injurious to public health or safety, or to domestic, commercial, industrial, agricultural or other legitimate uses, or to the life and health of animals or plants or of aquatic organisers;"

In this context 'polluter pays' is often enunciated and sought to be implemented by agencies responsible for controlling pollution. The Supreme Court of India in its judgment in the Order dated February 4, 2005 in the case of *Indian Council for Enviro-Legal Action v/s UOI (to be read as Union of India) and Others* defined the polluter pays principle as:

"*The Polluter Pays Principle means that absolute liability of harm to the environment extends not only to compensate the victims of pollution, but also to the cost of restoring environmental degradation. Remediation of damaged environment is part of the process of sustainable development.*"

In order to regulate the phenomenon of water pollution in the State, Maharashtra Prevention of Water Pollution Act, 1969 was enacted in the year 1969. Under the specific provisions of the Act Maharashtra Pollution Control Board (MPCB) was formed. Later, MPCB adopted the Water (P & CP) Act, 1974 enacted by the Centre. MPCB is the chief authority for controlling the pollution in the State. Section 41, 42, 43, 44 and 45 of the Water (P & CP) Act, 1974 empowers the State Boards (here MPCB) to penalise the defaulter under above mentioned sections.

MWWRRA Act also embodies the same principle 'Polluter pays' principle to deal with the issue of pollution. Section 12 of MWRRA Act, 2005 states that

"The Authority shall support and aid the enhancement and preservation of water quality within the State in close coordination with the relevant State Agencies and in doing so the principle that ' the person who pollutes shall pay ' shall be follow."

In view of the above specific provision, MWRRA as a water regulatory authority can only create an enabling framework in its Regulations so that they are in conformation with the provisions of the Water (P & CP) Act, 1974. Since MWRRA Act, 2005 does not explicitly empower MWRRA to create penal provisions, the regulatory framework being developed by MWRRA will have to be in the form of incentives for adoption of water recycling and reuse technologies by the industries.

Further, based on the documentation available on the website of MPCB, it has been observed that there are instances of Common Effluent Treatment Plants (CEPT) shared by many industry members. Also, in many such cases the capital cost for the CEPTs has been subsidised by Ministry of Environment and Forest (MoEF), MIDC and MPCB. Such enabling mechanism could be encouraged in the MWRRA regulations in consultation with MPCB.

In this context, ABPS infra has also carried out in-depth study of various water recycling technologies available in India in association with Indian Institute of Technology Bombay (IIT Bombay), Mumbai. This study which details the approximate capital and operational costs associated with each of the technology has been attached as **ANNEXURE III** to this approach paper. Based on this data, in a Chapter on Tariff Simulations, we have attempted to develop incentive framework for industries in the State. MWRRA is urged to conduct consultation with Maharashtra Pollution Control Board before taking final decision in this matter.

7.12 Mechanism to control population

In the context of Government policy for population control, Section 12 (11) of the MWRRA Act, 2005 provides penal rate of 150% of the normal water rate for bulk water consumer with more than two children. This provision was to come into force one year after the commencement of the Act, barring the counting of any adopted child.

However with regard to applicability of this provision to different use categories, it is not very clear whether it is applicable to all bulk user categories or only to agriculture users. In case of WUAs, industrial and Municipal Corporation, implementability is highly questionable. It is also not very clear as to whether such penal rates will be applicable for entire life of the person concerned?

In our view,

- The measure has been adopted under the Act to encourage better family planning and to have a sustainable growth for the State and Country as a whole in the long run. The measure can be applied to only individual farmers (identifiable bulk water users), as it may be possible to identify and implement the measure.

- Before the levy of any penal charges appropriate family size verification mechanism shall have to be undertaken in close co-ordination with the family planning department.

In our view, though specific provision exists in the law, it will be very difficult to implement this provision given the coordination requirement between various departments.

7.13 Mode of Water Supply

In the context of mode of water supply, Section 46 of the MI Act, 1976 states that:

- Water to be supplied to individuals (in relation to agricultural use) on area basis subject to requisite application made or
- On volumetric basis for Water Committee or
- Under Irrigation Agreements duly made as per the provisions of the said Act or
- Water supply under Scheme made as per the provisions of the said Act.

Further, under Section 2 of MWRRA Act 2005, 'Bulk Water Entitlement' has been defined as *"the volumetric entitlement to share the surface water resources produced by a project…….."* and under Section 11 (g)(ii) it has been stated that *" Bulk Water Entitlement shall be issued by the River Basin Agency for irrigation water supply, rural water supply, municipal water supply or industrial water supply………."*

In view of the above three provisions, issue here is whether the water charges for the agricultural category should be on area basis for some and volumetric basis for others or just volumetric basis alone? Here, it may be noted that an important enactment authorizing Irrigation Development Corporation to act River Basin Agencies is pending with the State Legislative Assembly. In view of these issues, we are of the view that the provisions of the MI Act, 1976 with respect to mode of supply as mentioned above may prevail.

7.14 Volumetric measurement for supply to WUAs and LI WUAs

In the context of mode of supply and measurement of supply, Section 26(1) of MMISF Act, 2005 states that bulk water shall be supplied to WUAs on volumetric basis only. Further, Section 49 of the MMISF Act, 2005 states that water charges for lift irrigation water users association (LI WUAs) shall be determined separately on volumetric basis considering that all the expenditure for installation, organisation and maintenance of lift irrigation shall be borne by the respective water user associations.

Section 20 of GMIDC Act, 1998 states that the corporation shall determine and levy water charges on the basis of volume of water supplied for irrigation, industry and domestic purposes.

The above provisions appear to be consistent with each other in the context of agricultural category for WUAs. However in the case of individual farmers, at present the water tariff is on area basis. In our view, volumetric measurement is recommended on the premise that:

- Volumetric measurement leads to better accountability of water consumed and transparent mechanism for levy of tariff.
- It encourages better water management practices as the WUAs have option to reduce their water consumption and get rewarded in the form of reduced bills. This possibility does not exist in the present area based water tariffs.
- However, this method may not be practicable in the case of individual farmer who have not yet formed any WUAs and in such instances water tariff levy on area basis will have to be continued for some more time.
- The water charges for the lift irrigation water users association shall be more than the other water users associations due to additional costs associated with lift irrigation infrastructure and input power costs.

In this regard, it may be noted that MWRRA Act has no specific provision which mandates MWRRA to determine charges on volumetric basis or area basis. From, the provisions of the Act, it appears to be prerogative of the MWRRA to decide methodology for water tariffs. In this regard, ABPS Infra would like to note that it attempted to collect data for area under cultivation for each crop rate to be able to simulate the tariffs for further rationalization. However, is may be note that such data is not readily available. MWRRA will have to create specific systems to collect such data to be able to determine tariffs in systematic and scientific manner. Hence, in the absence of crucial data regarding area under cultivation for each crop category, economic costing of each crop, it is suggested that MWRRA determines water rates on volumetric basis which may be converted into area wise rates for each crop by the Government of Maharashtra.

7.15 Powers of WUA to charge its members

In the context of water charges to be paid to WUA by its members section 27 of the MMISF Act, 2005 states that WUA shall have the powers and responsibility to charge its members as per the water rates approved by the General Body of WUAs. The issue of water charges within WUA is not within the purview of MWRRA and therefore may be dealt accordingly.

7.16 Levy of minimum water charges irrespective of use

Section 46 (3) of MI Act, 1976 has important tariff related provision. This Section states that in case any person/entity who/that do not avail the water made available for land irrigation through a canal, with the given exceptions in the Act, during kharif rabi seasons, a water rate equal to fifty percent of seasonal water rates as in force, shall be applicable.

However in the case of fully functional WUAs the above provision (i.e. section 46 of MI Act, 1974) has been repealed vide Section 77 of the MMISF Act. Further section 26(3) of the MMISF Act, 2005, states that WUAs shall be charged minimum charges in case water is not demanded for irrigation. Section 2(d) of the said Act defines 'Appropriate Authority' as the State Government, the Company, Zilla Parishad and also includes MWRRA and Irrigation Development Corporations.

In our view levy of minimum water charges shall be necessary in order to ensure stable revenue stream for timely execution of M&R of the project, even if no water could be made available from the irrigation project. The minimum water charges for the individual farmers shall be as per the provisions of the Section **46 (3)** of the MI Act, 1976. In the case of WUAs, section 11(d) of MWRRA Act, 2005, section 26(3) of MMISF Act, 2005 and rule 16 of MMISF Rules, 2006 empowers MWRRA to determine minimum water charges which shall be fifty percent of the average of water bills for that particular period (billing cycle) over past three years.

7.17 Percolation and Leakage rates

In the context of cultivation of land by harnessing the water by way of percolation and leakage of surface water, Section 55 of MI Act, 1976 specifies the rates for cultivation of land receiving water via percolation or leakage the details of which are provided in earlier chapter. However in the case of fully functional WUA, the above provision (i.e. section 55 of MI Act, 1974) has been repealed under Section 77 of MMISF Act, 2005.

Therefore, in our view, in the case of individual farmers, the percolation and leakage rates shall be as per the provisions of section 55 of the MI Act. However in the case of fully functional WUAs section 25 (2) of MMISF Act, 2005 states that WUAs shall have the freedom to use the groundwater in conjunction with canal water. Further rule 15 of MMISF Rules, 2006 states that groundwater should be managed in such a way that groundwater table should be available at not less than 3 meters below the ground level.

7.18 Penal charges for delayed payments

Section 88 of the MI Act, 1976 states that in case of non-payment of bills by any individual or entity, on or before due date, then a maximum of ten percent of the due amount shall be payable as penalty. Section 89 of the said Act gives dispute resolution provision in case the amount is disputed.

However in the case of fully functional WUAs section 71 of MMISF Act, 2005 states that sections 88 and 89 of MI Act, 1976 shall *mutatis mutandis* apply in order to recover water charges.

It is to be noted that section 2(ac) of MMISF Act, 2005 defines 'Previous Dues', in relation to assessment and recovery of water charges, as outstanding dues of members of WUAs pertaining to the period prior to the date of handing over the management of irrigation system. Further rule 17 of MMISF Rule, 2006 states that WUAs at all levels shall be allowed to keep certain percentage of the recovered amount of previous dues, as decided by GoM from time to time.

In view of the above, we are of the opinion that in the case of individual farmers, the provisions of Sections 88 and 89 of the MI Act, 1976 shall prevail. In the case of WUAs section 88 and 89 of MI Act, 1976 shall prevail, only for the recovery of any dues accumulated after existence of a fully functional WUA.

7.19 Water arrears to be considered land revenue arrears

In the context of water arrears section 88 (2) of MI Act, 1976 states that water tariffs for any individual or entity, if unpaid, are to be considered as arrears of land revenue. In the case of fully functional WUAs section 71 of MMISF Act, 2005 states that section 88 of MI Act, 1976 shall *mutatis mutandis* apply in order to recover water arrears.

The same provision is further reiterated in Section 54 of GMIDC Act, 1998 which states that any charges, fees etc., payable to GMIDC, without prejudice to any mode of payment, shall be recoverable as arrears of land revenue.

The above mentioned provisions are unambiguous and MWRRA has no jurisdiction to modify/ alter these provisions. Therefore, these may be merely reproduced as a part of the Bulk Water Regulations.

7.20 Deficit to be borne by State Government

In the context of profit and loss calculation for the Corporation, section 44 (1) and (2) of the GMIDC Act, 1998 states that GMIDC shall make provisions for depreciation as specified by Comptroller and Auditor General of India (CAGI) and net profit shall be determined considering the same. Section 42 of the said Act states that net deficit, if any shall be borne by the State Government. Further the act also states that in the case of net profit made by the Corporation, from its irrigation and hydropower operations, the same shall be attributable to the Corporation.

Given that MWRRA is currently mandated to recover only O&M costs, there is no question of recovering any other costs and that too capital related costs. This issue related to costs and profit & loss of irrigation development corporations, though very important, is not directly linked to Bulk Water Regulations.

7.21 Stake holder consultation process for tariff determination

In the context of stake holder consultation process, section 11 (d) of the MWRRA Act, 2005 states that the views of the beneficiary public shall be ascertained prior to establishment of a water tariff system. Section 12 of the National Water Policy, 2002 states that a participatory approach should be adopted for management of water resources such as by involving stake holders in effective and decisive manner.

Considering the above provisions, the Conduct of Business Regulations (CBR) for MWRRA shall incorporate detailed procedure for the stake holder consultation process. With regards to consultation process for tariff determination, the present approach paper may be published and for public views may be sought before notification of Regulations.

7.22 Tariff determination process

In the context of tariff determination process, it has been observed that internationally the Service Provider has to submit the Petition for tariff determination to the Regulatory, which will then be published for comments and inputs from stakeholders and then the tariff determination process is continued. For instance in the case of Melbourne Water, Australia the Service Provider has to submit the water plans to the Essential Services Commission (ESC) for tariff determination. The details of international practice are annexed as **ANNEXURE I** of the approach paper. Hence in our view MWRRA may adopt this as a standard procedure and suo-motu determination of tariffs by Authority should only be treated as an exception.

Chapter 8: PRESENT TARIFF SCENARIO IN MAHARASHTRA

8.1 Introduction

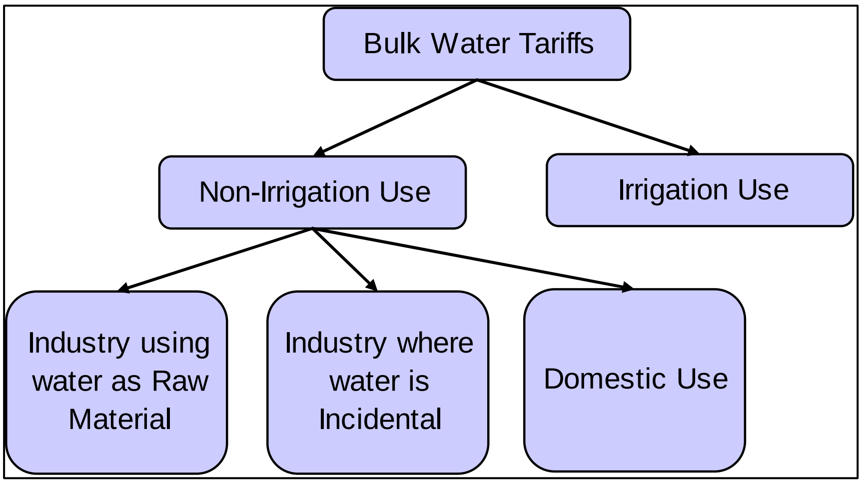
In Maharashtra, the task of bulk water supply is primarily undertaken by the Government of Maharashtra (GoM) through the Water Resources Department (WRD). As explained in an earlier Chapter, WRD acts through Command Area Development Agencies (CADA) and various Irrigation Circles. These agencies currently levy tariff determined by the GoM at the point of bulk water supply.

The objective of this Chapter is to present a brief analysis and observations on the existing tariff structure and rates notified by the GoM vide their GRs dated July 31, 2006 and September 13, 2001. This Chapter primarily discusses the present bulk water tariff structure applicable in the State for industrial, drinking and agricultural consumption.

8.2 Tariff Structure

The tariff structure for Maharashtra can be divided into two parts, viz., tariffs applicable for irrigation use and non-irrigation use, which can be further sub-divided as shown below:

Figure 8-1 Bulk Water Tariff Structure of Maharashtra



8.2.1 Tariff Structure for non-irrigation use

GoM through WRD issued Government Resolution No. WTR 2006/ (396/03)-IM (P) in July 31, 2006, specifying the rates for supply of water for industry and drinking use, for the years 2006 (which came into effect from September 1, 2006), 2007, 2008, 2009 and 2010 (all with effect from April 1 of the respective years).

The increase in water rates vide GR dated July 31, 2006 have been effected on the basis of recommendations of the Finance Commission, Irrigation Commission, and National Water Policy in order to recover the operation, maintenance and repairs costs of irrigation projects from the water charges. The GR had proposed an annual hike of 15% in tariff till FY 2010. However, after the formation of MWRRA under the provisions of MWRRA Act 2005 and in the view of powers vested in MWRRA in the matter of establishing water tariff system, GoM issued another Government Resolution No. WTR 2007/ (442/07)-IM (P) dated March 25, 2007, which freeze the water rates for non-irrigation use as on April 1, 2007 and the same will be applied till MWRRA determines tariff.

Presently, the GR dated July 31, 2006 classifies the water rates for non-irrigation into three categories.

1) Industries using water as a raw material such as Beverage industries, Breweries (beer fermentation plants etc), mineral water units, etc.
2) Industries where water is incidental such as small and big industries, business, all types of small and big factories, Railways, Thermal Power Stations, Mills (including cotton mills), Mines, Condensers, Leather factories, Roof-tiles and bricks manufacturing, Pottery business, Coal and Ice manufacturing business, etc.
3) Domestic use in Grampanchayats, Wadis, Padas, Small habitats, Municipality, Municipal Corporation, Cantonment Boards, etc. Residential colonies which belong to the industries and where separate pipeline and automatic measuring water meter is provided, shall be considered under domestic use category.

Further, each of the above three categories have been sub-divided on the basis of 'Source of supply' the general structure of which is described in the **Table 8-1** below:

Table 8-1 'Source of supply' based sub-classification applicable for all the three non-irrigation use categories

Sr. No.	Sources based Sub-Category
A	**In case dam constructed across river**
A.1	Supply from Reservoir
A.2	From Canal (by gravity or lift)/river on downstream of dam and no storage tank as per yardstick
A.3	Constriction of Dam with their own expense/cost of construction given in proportion to water use
B	**No dam on upstream of point from where water is lifted from river**

Source: GR No. WTR 2006/ (396/03)-IM (P) in July 31, 2006

8.2.2 Incentives for good water management practices

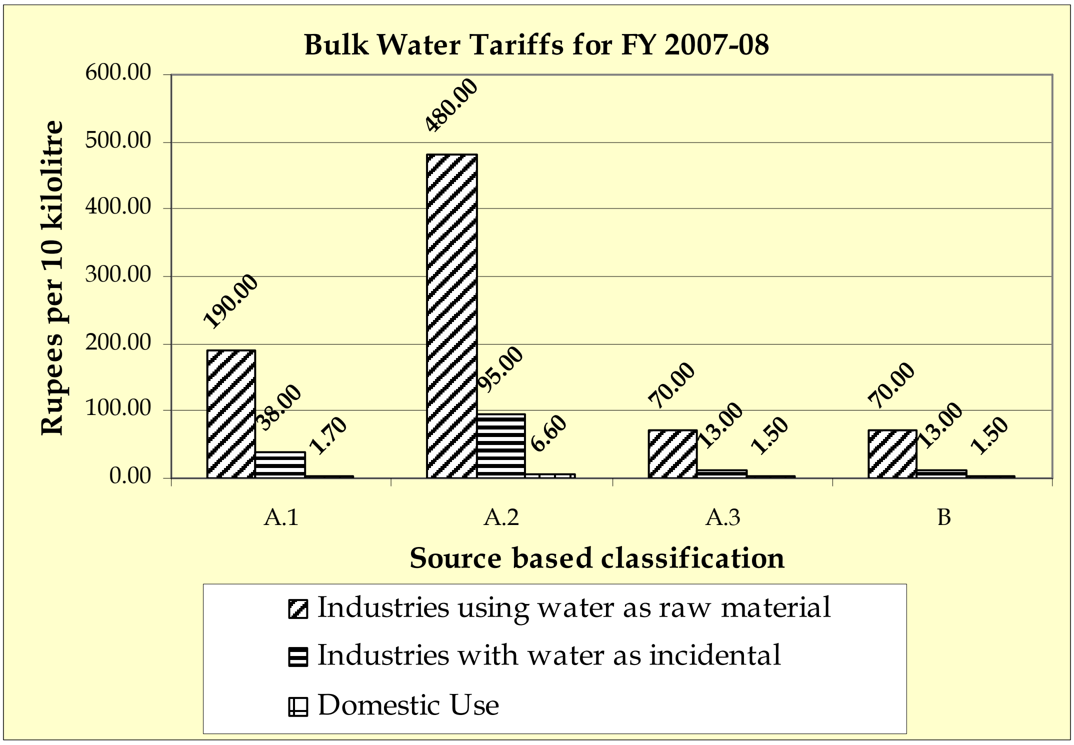
In order to reduce water losses in canals, there is a 20% discount on the applicable water rates for the water user agency, which has a storage tank constructed as per the yard-stick of the WRD, GoM. This incentive is applicable across all the three categories of non-agricultural water usage.

8.2.3 Rebates for Industry

In case the industries/Agencies have installed appropriate machinery for recycling of used water by due processing and have achieved at least 25% saving in normal water use, then they are eligible for a concession of 10% in the water rates.

The tariffs applicable (in Rs. per 10,000 litre or per 10 kilolitre) with effect from April 1, 2007, for each of the three categories are shown in the Figure below. The source wise sub-category shown on the horizontal axis of the graph corresponds with the information (Sr. Nos) shown in the Table above.

Figure 8-2 Bulk Water Tariffs for Non-irrigation use



Source: GR No. WTR 2006/ (396/03)-IM (P) in July 31, 2006

8.2.4 Observations on water rates for non-irrigation use

From the above graph, it can be observed that

- The industries using water as raw material are charged five times as much as industries using incidental water, for respective water supply.
- In case of all the three categories (industry with water as raw material, industry where water is incidental, and domestic), the tariff for source 'A.2' (canal based water supply) is highest, which may be attributable to O&M costs on canal network in addition to O&M costs of head-works. The tariffs for the source 'A.1' (supply from reservoir) is second highest for all the three categories.

- The tariffs for the source 'A.3' (own dam/cost contribution to construction) and 'B' (water lifted from point where no dam on upstream) are the lowest which may be attributable to minimum or nil O&M costs for such projects.
- Currently, industries have been classified on the basis of whether water is one of the raw materials or not. In our opinion, it appears that there is a scope to make the industrial category more granular based on the type of industry. (e.g. process specific like steel industry, pharmaceutical industry, etc.)
- There is common rate for all types of domestic users, be it Grampanchayat or Municipal Corporation. However, in our opinion, the nature of domestic use of water varies between rural and urban class of population. There are various secondary usages of water by urban user, such as use of municipal water for gardening, washing of cars, etc. Higher water rate may be applied for such secondary usage. Hence, there exists a scope to have differential tariffs in the domestic category.

The tariff structure for non-irrigation use has been appended as **ANNEXURE IV** to this report.

8.3 Tariff Structure for Irrigation Use

Water Resources Department (formerly Irrigation Department), GoM issued a GR dated September 13, 2001 revising water rates for different crops grown in different seasons under the canal system with flow/volumetric supply/lift. The revised rates were specified for a period of three years (i.e., 2001-02, 2002-03 and 2003-04) and came into effect from September 1, 2001. Further, WRD, GoM vide its GR No. 2006/(396/03)/IM dated July 31, 2006 notified that water rates for irrigation use as declared for 2003-04 were to continue further till any further notice. The water rate structure for irrigation sector in Maharashtra is shown below

8.3.1 Water Rates on area basis (in Rs. per hectare)

a) Water rates for canal flow water use.
b) Water rates for irrigation by wells (old and new) within 35 meters of the nearest boundary in the command area of the irrigation project as defined in Maharashtra Irrigation Act, 1976.
c) Water rates for private lift irrigation schemes for flow and drip irrigation techniques.
d) Service charges for Government lift irrigation schemes (including those under Irrigation Development Corporations) for lift up to 30 meters and above 30 meters.

8.3.2 Water Rates on volumetric basis (in Rs. per 1000 m3)

Water rates/royalty for water supplied on volumetric basis from canals, reservoirs constructed from the funds of water users.

8.3.3 Water rates for canal flow water use (Area basis, i.e., Rs. Per Ha).

The water rates for sub-category have been based on combinations of crop, season, type of irrigation (flow, drip or sprinkler), etc. These are thirteen sub-categories and in all there are sixty five crop categories for which water rates have been defined. Water rates for supply from major, medium and minor projects are the same.

Water rates across all crop categories for the year 2001 (with effect from September 1, 2001) were increased by 50% in comparison with rates applicable in the year 2000 (i.e., with effect from July 1, 2000). Thereafter the rates for various crops have been increased by 15% on 'year on year' basis till the year 2003 (with effect from July 1, 2003).

Table 8-2 Broad Classification for Flow Irrigation Water Rates

Sr. No	Season	Sr. No	Season
1	Kharif Season	8	Crop Block Rates (flow)
2	Rabi Season	9	Perennials (Drip & Sprinkler)
3	Hot Weather Season	10	Other Perennials (Drip & Sprinkler)
4	Two Seasonal Crop	11	Extended Irrigation (Drip & Sprinkler)
5	Perennials (flow)	12	Crop Block Rates (Drip & Sprinkler)
6	Other perennials (flow)	13	Water rates for sewage water
7	Extended (flow)		

Source: GR No. Water Rates 1001/(5/2001)/IM(Policy) dated September 13, 2001

8.3.4 Water rates for irrigation by Well (Area basis, i.e., Rs. Per Ha).

Section A.8 of the GR dated September 13, 2001 states that

> *"In the command area of an irrigation project as defined in the Maharashtra Irrigation Act 1976, Section 2(3), old and new wells located within 35 m distance from the adjacent boundary of all main canal, branch canal, distributory minor, water courses, field channel, drainage channels, flood bunds, notified river/nalas and seepage and the crops such as sugarcane, fruit crops, vegetables, other perennials and cash crops such as cotton and groundnut and other cash crops such as cotton and groundnut and other cash crops all irrigated on such wells will be assed for 1/2 the rates for flow irrigation. However, the food grain crops such as Wheat, Gram, Jowar (Sorghum), Bajra (Pearl Millet) and Maize grown on such wells will not be assessed for water charges."*

8.3.5 Water rates for Private Lift Irrigation (Area basis, i.e., Rs. per Ha).

Further sub-categories within private lift irrigation schemes are based on the physical location of the lift irrigation scheme as follows:

a) Canal
b) Reservoir/ dam/elevated bandhara
c) Within boundaries of a command area in back water areas of river bandharas where dam water is not released
d) First bandhara on river/nalla or lift irrigation from areas beyond dam, diversion bandhara in kharif.

The water rates for private irrigation schemes were increased at about 10% over the period of three years from 2001 to 2003.

8.3.6 Service charges for Government Lift Irrigation Schemes (Area basis, i.e., Rs. per Ha).

There exist two separate service charges in this category on the basis of lift of water, i.e., lift of water up to 30 meters and above 30 meters of height. In both the cases, further broad categories of classification (based on seasons) are as shown in the table below.

Table 8-3 Category of Classification for Govt. Lift Irrigation Water Rates

Sr. No	Season	Sr. No	Season
1	Two Seasonal Crop	5	Rabi Season
2	Perennials (flow)	6	Hot Weather Season
3	Perennials (Drip)	7	Vegetables
4	Kharif Season	8	Advance and late watering

Source: GR No. Water Rates 1001/ (5/2001)/IM (Policy) dated September 13, 2001

Service charges across all crop categories for the year 2001 (with effect from September 1, 2001) were increased by 50% in comparison with charges applicable in the year 2000 (i.e. with effect from July 1, 2000). Thereafter the service charges have been steadily increased at 15% on year on year basis till the year 2003 (with effect from July 1, 2003). These service charges are in addition to a combined water charge to be levied according to crops grown in different seasons with rates of flow irrigation, as applicable.

8.3.7 Water rates for WUAs (volumetric basis – per 1000 meter^3)

The water rates for WUAs have been specified for three seasons (i.e., Kharif, Rabi and Hot weather) and are classified based on the point of supply as shown below.

Table 8-4 Water rate / Royalty structure for WUAs

Sr. No.	Location	Season
1	From canal at minor head (i.e. water charges)	Kharif
		Rabi
		Hot weather
2	From canal at outlet (i.e water charges)	Kharif
		Rabi
		Hot weather
3	Reservoir constructed by water users (i.e royalty charges)	All seasons

8.3.8 Management Subsidy for WUAs

In case co-operative societies of water users are taking water on volumetric basis and not availing any management subsidy under any other scheme, then they shall be eligible for management subsidy of 20% in the form of rebates in the water rates. However, based on WRD, GoM GR No. 1007/(323/2007)/IM dated June 22 , 2007, the management subsidy has been revised and classified based on the size of projects (major, medium and minor) on which WUAs have been formed.

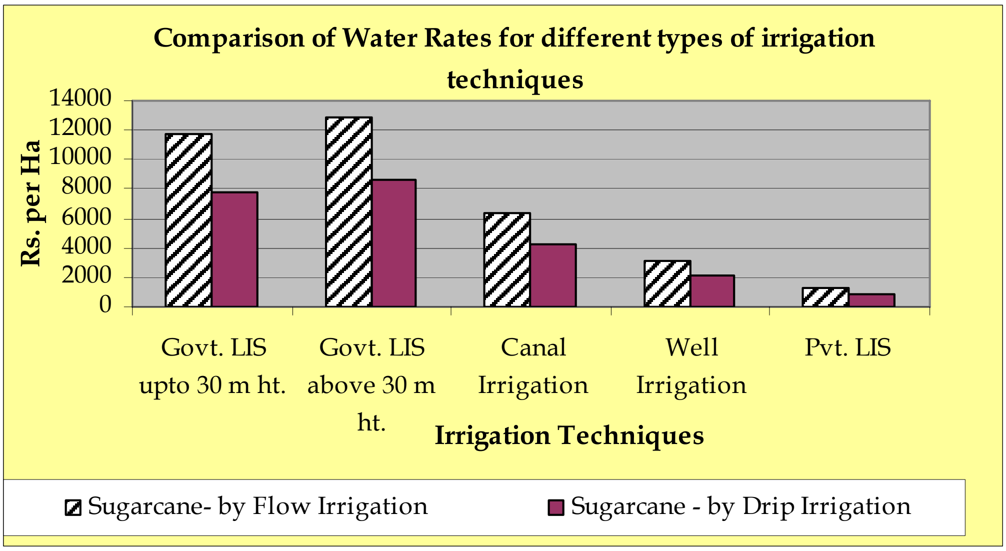
The tariffs as notified by the Government of Maharashtra for irrigation category are appended as **ANNEXURE V**.

8.3.9 Observations on water rates for irrigation use

- There are about 13 broad categories of tariffs based on seasons and irrigation techniques. Further, there are a total of 65 categories of crops for which tariffs are determined and notified. Such complex tariff structure is bound to create ambiguity in the minds of consumers and lot of scope for manipulation of tariff categories. Efforts need to be made to simplify the tariff structure to make it more transparent and easy to implement.
- In case of private lift irrigation schemes, the rates for drip irrigation are 33% lower than flow irrigation which is most probably to send an economic signal to its users regarding use of micro irrigation techniques.
- In case of private lift irrigation schemes, the water rates for lifting water from canal are two hundred percent (200%) of those for a lift from reservoir/dam / elevated bandhara. This probably reflects the additional O&M, effort for water release and water losses.
- In the case of Government lift irrigation scheme, the service charges for lift above 30 m of height are 20% to 40% higher than that for lift up to 30 m of height. This appears to on account of additional power requirement for lifting water above 30 m height.
- In order to do a comparison of water rates using different irrigation techniques, a common crop namely sugarcane (when harvested under flow and drip irrigation) was considered

and the rates in force (with effect from July 1, 2003) were considered. The following graph shows the water rates under different irrigation conditions.

Figure 8-3 Comparison of water rates for sugarcane crop



From the **Figure 8-3**, it can be observed that:

- The water rates for sugarcane by drip irrigation are lower by 33% when compared with sugarcane by flow irrigation across all irrigation techniques.
- The water rates for Government Lift Irrigation Scheme (LIS) are double that of flow irrigation for sugarcane. Such high rates for LIS schemes are attributable to O&M costs and electricity charges for operating LIS scheme, in addition to O&M for canal or head-works.

- In the case of volumetric assessment, there exists a water royalty charge. In our view water royalty charges are to be decided by the State Government and MWRRA has no authority to change the water royalty charges.
- Thus, if one examines the tariff structure for irrigation use, it appears that there exists justification for higher or lower water rates. However, complex tariff structure requires significant amount of data to be maintained for calculation of revenue. Unfortunately, the required data has not been made available to us for verifying whether the revenue billed is in accordance with the tariff rates. This could be either because the data is not maintained by the agencies involved or it is not easily available. As a result, significant difficulties have been faced while estimating the revenue for supply to agricultural categories.

Chapter 9: Revenue Requirement of Bulk Water Sector of Maharashtra

9.1 Introduction

In the previous Chapter, existing bulk water tariff structure was discussed in detail. In this Chapter, an attempt has been made to project various cost elements and to estimate the Revenue Requirement from Bulk Water Tariffs in the State of Maharashtra. In subsequent chapters, suitable tariff structure will be designed, which will help bulk water supplying entities in the State to recover revenue requirement estimated in this Chapter.

9.2 Cost elements in Revenue Requirement

For any business, costs can be divided into two categories, i.e., fixed costs and variable costs. While fixed costs represent the capital related expenses such as interest, depreciation, return on investment, as well as establishment expenses, variable costs represent the costs associated with operations of the business. In infrastructure sectors such as water, power, etc, investments are lumpy resulting in significant fixed costs. Though prudent business practices require all costs to be recovered, it is not necessary and owner of the business may decide to recover part of the costs. This aspect has been discussed at length in an earlier Chapter.

In case of bulk water sector in Maharashtra, Section 11 (d) of the MWRRA Act, 2005 requires MWRRA to determine the tariffs in such a manner that water charges reflect full recovery of the cost of the irrigation management, administration, operation and maintenance of water resources project.

As a consequence, an attempt has been made to estimate the full cost of irrigation management, administration, operations and maintenance of water resources project. In this report, these full costs have been referred to as 'Operations and Maintenance Costs' (O&M Costs). These O&M costs could be aggregated into following two broad subheads:

a. Maintenance and Repairs Costs
b. Establishment Costs

9.3 Approach for O&M Cost Projections

In order to project O&M Costs, ABPS Infra has separately projected two cost components and validated the results with the current costs. While projecting these two cost components, we have used norms developed by various Committees.

For estimation of M&R and establishment costs, norms developed by WALMI and Jakhade Committee have been used, respectively. These norms have been further suitably modified to remove any bias due to inflation. Total O&M Costs have been estimated by adding estimates of these two individual cost components. The O&M Costs so derived have been further compared with the projections carried out using information provided by MWRRA for total O&M costs for entire State during last five years.

The projections have been carried out for a period of three years in line with the mandate of MWRRA to review and revise the water charges every three years. The O&M costs have been projected for a period of three years, i.e., FY 2009-10, FY 2010-11 and FY 2011-12, assuming that the Regulations developed under the present assignment shall be approved before the beginning of the financial year 2009-10.

9.4 M&R Cost Projections

In order to ensure, optimal and continued utilization of the assets created, it is essential to carry out proper maintenance and repairs of the assets. These costs associated with maintenance and repairs are unavoidable and in fact essential for proper functioning of the system. Provisions under MWRRA Act 2005 allow these costs to be recovered fully as a part of bulk water tariffs.

In order to assess M&R cost requirement of the bulk water system in the State, MWRRA had appointed Water and Land Management Institute (WALMI) to study maintenance and repairs practices in the State and develop norms for estimation of M&R costs. WALMI submitted its report to MWRRA in the month of July 2008. ABPS Infra has used this Report as the basis for projection of M&R Costs for three year period defined above.

9.4.1 Methodology adopted by WALMI

WALMI selected 4 Major, 2 Medium, 1 Minor, 1 Govt. Lift Irrigation Scheme (LIS), 42 K.T. Weirs and 5 Storage Tanks projects based on “Purposive Selection Method” for the study. This helped WALMI to confine the study to few projects only, which enabled it to make the study in detail and in-depth. Data for the 10 pilot projects was collected for a period of 10 years (1997-98 to 2006-07), which was considered to be adequate to even out the effects of vagaries of nature, administrative difficulties and project specific constraints. The data was collected for the permissible amount of M&R funds, M&R funds demanded, M&R funds received and Annual expenditure incurred on M&R, for the selected projects.

The Report states that efforts were made to normalize the figures of demands and actual expenditure of M&R costs to one specific year to take into account cost escalation. Since, there was no consistency and uniformity in the demands, budgetary provisions and actual expenditure in the last ten years and there were large variations in all, hence, it was decided to rely on arithmetic average of ten year data.

9.4.2 Findings of WALMI

WALMI, in its Report, has presented following findings:

- It was difficult to co-relate the variations in the demands and actual expenditure on M&R and specific impact on the Irrigation System Performance (ISP) by way of increase or decrease in the irrigation coverage vis-à-vis the expenditure incurred on maintenance.
- Demand for M&R grants were neither as per need-based estimates nor as per the permissible amount worked out in accordance with the applicable M&R Norms. Sometimes, this was inclusive of the balance works from the previous years, which was not taken up due to shortage of funds in those years and thereafter, the cycle repeated every year as the grants released in the subsequent year were also not adequate to undertake all the need based repairs.
- M&R grants, which were requested by the project divisions, were much higher than the limits set by the applicable norms. This perhaps indicated that the prevailing norms were actually on the lower side and hence, inadequate.
- The ratio of average demands for M&R grants to average permissible expenditure on M&R varied from 1.72 to 23.6 with the average being 8.44 and the ratio of average request for M&R grants to average actual expenditure on M&R varied from 1.5 to 2.56; average being 1.95.
- The ratio of average actual expenditure to average permissible expenditure on M&R as per norms varies from 1.15 to 11; the average value of the same being 4.5. It was reported that such high variation in the ratio could be partially attributable to project specific parameters. (E.g. Black cotton (BC) soils, heavy rainfall, older project).
- M&R grants were generally not received on time; M&R works such as de-silting and weed removal were only carried out. Even those works get delayed. Weed removal took place mostly after seed formation and hence, vegetation again sprouted next year.
- Projects in BC soil areas and or in heavy rainfall zones need much more M&R, particularly for distributaries and minors and hence, requirement of M&R Grants increased significantly.

9.4.3 Assumptions adopted by WALMI for Projections

WALMI reported that for the development of M&R norms, brief literature review of earlier studies like Jakhade Committee, Twelfth Finance Commission and XI Five Year Plan was done. The following assumptions have been used by WALMI while developing M&R Norms:

1. The existing M&R Norms are very much short of felt needs and hence, need to be substantially increased.
2. Arithmetical average of M&R expenditure worked out on the basis of last 10 year's reported data indicates the minimum amount needed for M&R.

3. Head-works of irrigation system play a vital role and are of great importance. Their M&R requirement need to be considered separately.
4. Complete canal network in the command area is required to be maintained even if part of command area may not get water for some period.
5. M&R requirements of old irrigation projects and irrigation projects in hilly areas, high rainfall zones and black cotton soil are significantly more.
6. M&R requirements of KT weirs with and without reservoir backup are significantly different. Moreover, M&R needs of KT weirs are co-related to the surface areas of their gates and not to the area being served.
7. The government owned lift schemes have been recently initiated in Maharashtra and experience and adequate data for O&M of such schemes is not available. Hence, Govt. lift irrigation schemes may be treated at par with canal network of flow irrigation projects. Electricity charges and expenditure on maintenance of pump house and rising main may be provided for as per actual.
8. M&R needs of storage tanks may be considered similar to that of head works.
9. Proposed M&R norms may be automatically increased annually by some percentage to be decided by Govt. from time to time till next revision of M&R norms.

9.4.4 M&R Norms proposed by WALMI

WALMI has suggested basic M&R norms for various types of structures along with adjustments for specific conditions as per following heads.

(i) Basic norms
   a. Head-works
   b. Canals
   c. Kolhapur Type weirs
   d. Govt. lift Irrigation schemes
   e. Storage tanks

(ii) Adjustment for specific condition for
   a. Age of the project
   b. Black cotton soil
   c. Hilly area/ high rainfall zone

Basic norms are prepared for M&R requirements of irrigation projects all over the State. However M&R norms would be insufficient in case of old projects, projects in BC soils and hilly area/high rainfall zones. Hence, adjustment factor has been proposed for project specific condition. Each component of the norms have been discussed in the subsequent sections.

9.4.4.1M&R Norms for Head works

Headwork is the most important component in the irrigation project as it serves the following basic purposes:

- Impounding of water
- Flood regulation/moderation
- Regulated delivery of water to canal system and downstream river

Reservoir is a dependable source for number of important schemes for the following purposes:

- Drinking and domestic water supply
- Industrial water supply
- Lift irrigation on the foreshore of the reservoir and on the river downstream side of the dam.

WALMI reported that that the proportion of non-irrigation use of water to the total water use (i.e., irrigation + non-irrigation) for the selected projects was about 38%. This portion of non-irrigation use of water was not dependent on the canal system (i.e., the said water use was mostly from reservoir and/or river). At the State level also, WALMI has found that the portion of non-irrigation and lift irrigation use of water to the total water use from reservoir and/or in respect for 54 major, 182 medium and 1709 minor projects was as much as 50% of the total use in the year 2005-06, which was a normal year as far as rainfall was considered. It was only to be expected that this said percentage would shoot up in a low rainfall year. On this background, WALMI has proposed:

- To consider M&R requirements of head-works separately
- To determine M&R norms for headwork in terms of Rs./Million m^3 of design live storage as its M&R requirements are directly related to volume of water and not that much to the area to be served for irrigation.
- To allocate funds for head-works as per the proposed norms in both good and bad year because even in the bad year, water use, particularly for non irrigation would not only be quite significant but even critical due to the dimensions of storage.
- To provide for M&R of gates, additionally.

The basic norms for head-works, excluding establishment charges were determined, using information on design live storage and average actual expenditure on head works on the selected projects. The average actual expenditure on head-works worked out to be Rs 10,671/Mm^3. This cost was inclusive of cost of M&R of the gates and arrangements such as hoists, motors, wire ropes gantry/cranes, etc., for operating gates. The average M&R cost of gates was calculated based on the data from two projects, viz., Palkhed and Katepurna only, considering non-availability of this data from other projects. The average actual expenditure on gates was Rs. 3196/Mm^3, which was then deducted from Rs. 10,671/Mm^3 to arrive at the net cost of M&R of head-works without gates. The net cost of M&R of head work worked out to be 7475/ Mm^3 with an addition of 50% of the norm to account for cost escalation and other factors. Following rationale has been given for increasing the norm by 50%:

- Data used for analysis was for the duration of 10 years (1997-98 to 2006-07) and the proposed norms were be operative earliest from the financial year 2008-09 and there would be further price rise by that time.
- Royalty charges on soil and stones have been imposed by Revenue Department and needs to be accounted for.

Thus, the basis of M&R norms for head works (excluding gates), worked out to be Rs.11,212/ Mm^3, which was rounded off to 11,000/ Mm^3, excluding establishment charges. The M&R norms for the gates were provided separately, based on type of project as major, medium and small and type of gate as CR gates, curved gates, etc.

9.4.4.2M&R Norms for Canals

Canals and distribution network are the arteries of the irrigation projects and hence, require adequate and timely maintenance and repair of canals and distribution network, inter-alia for the following purposes:

- Flow of design discharge in every reach of canal and up to every last Government control point.
- Restricting the conveyance and operational losses within the design limits.
- Controlling the water flows as per the schedules prepare for distribution of water to different off takes, etc.

Canal network is required to maintained, even if part of command area some times does not get water due to various reasons such as shortage in supply, lack of maintenance, breaches in canals, etc., for some period.

The prevailing M&R norms based on Rs/ha of utilized potential (i.e., actual irrigated area) do not provide incentive to improve the services for increasing the irrigation coverage. Further, M&R of the canal network in the area of unutilized potential suffers because of lack of funds which can even make that part of system unserviceable, needing rehabilitation at a very high cost. Hence, WALMI has proposed:

- To determine M&R norms for canal in terms of Rs/ha of culturable command area (CCA)
- To apply Rs/ha of CCA norms to actual irrigated area with the following details:
    - Actual irrigated area as per average of previous 3 years

- Perennials, other perennial and two seasonal to be counted once
    - Kharif area irrigated to be included in actual irrigated area, only if the project authorities make arrangements to notify the area as per Maharashtra Irrigation Act, 1976 and levy 50% charges for reserving water in the season. In case of projects with command areas in assured rainfall zones, area equal to that of kharif irrigation potential (corresponding to kharif season only) may be included in actual irrigated area only for the purposes of applying maximum permissible funding for a project.
- To apply 50% of "Rs/ha of CCA" norm to the balanced unutilized potential area, i.e., [CCA- actual irrigated area]
- To further allocate amount worked out for M&R of canal network component wise as given below to cater to the requirement of all components of canal network as per their importance and needs.
    - Main/branch canal 40%
    - Distributaries 25%
    - Minors 35%

Average cost of M&R in terms of Rs. per ha of CCA was determined based on the data of CCA and average actual expenditure of the selected projects as Rs 256/ha of CCA. Addition for escalation at 50% was considered to account for effect of price rise and royalty charges. Hence, the basic norms for canals excluding establishment charges worked out to Rs 384/ha of CCA, which was rounded off to 380/ha. This would be applied as shown below:

- Rs 380/ha of actual irrigated area
- Rs 190/ha of balance area, i.e., [CCA – Actual irrigated area]
- Component wise break-up of total amount as 40% to main/branch canal, 25% to distributaries and 35%to minors.

9.4.4.3M&R Norms for Kolhapur Type (KT) weir

The ratio of expenditure on M&R to permissible grants for M&R, as per prevailing norms, over a period of five years works out to 2.58, based on the data collected for 47 KT weirs. This indicated that M&R norms were too inadequate for KT weirs and needed a revision. It was reported that M&R expenditure for KT weir was not related to the extent of area irrigated, hence, the M&R norms for KT weirs were projected on per square meter of gates, as the major portion of M&R cost of a KT weir is incurred on replacement of damaged needles and on repeated operations of removal and placement of needles and M&R expenditure on repairs of civil works is comparatively much lesser. The average annual expenditure and total area of gates is considered to determine average M&R cost per square metre of gate area adding 25% for price escalation. The basic M&R norms for KT weir excluding establishment charges are Rs. 2300/sq. meter of gate area for KT weirs with reservoir back up and Rs. 1450/sq. meter of gate area for KT weirs without reservoir backup.

9.4.4.4M&R Norms for Govt. Lift irrigation schemes

For Government owned Lift Irrigation Schemes, WALMI has proposed that:

- Electricity charges and maintenance of pump house and rising main may be taken as per actual.
- For canals of Govt. LIS, M&R norms suggested for canals may be adopted.

9.4.4.5M& R Norms for Storage tanks

For storage tanks, it was proposed to adopt M&R norms suggested for head-works.
Summary of the M&R norms presented by WALMI is attached as Annexure - 2 of the Approach Paper.

9.5 Observations of ABPS Infra on WALMI Report

Following are brief observations of ABPS Infra on the WALMI report on M&R norms:

- The basic norm for the Head works has been proposed as Rs. 11,000/- per Mm3 of design live storage. In our view, the M&R works essentially depends on the length of the dam and quantum of other associated appurtances and not necessarily on the design live storage. Volume of live storage is also dependent on the topography of the area like the case of Koyna dam, which is constructed across a deep gorge, but having relatively shorter running length.
- Similarly, for canal works, WALMI has proposed maintenance norms as Rs. 380 per hectare of actual irrigated area. Ideally, the M&R of the canal and dam system should be done periodically and cost associated with this will be solely charged on the basis of length and storage capacity of the canal and dam system. At present, levying the M&R expense on the basis of per hectare area is done across the world as it is an easier approach for bundling the R&M expense as a part of total water tariff. In our view, the norms for maintenance works should be linked to canal length as against actual irrigated area, and based on the data availability, MWRRA may take this approach into consideration.
- Our suggestion of developing norms on the basis of nature and quantity of physical infrastructure has also been applied by WALMI to limited extent. WALMI has suggested M&R norms for KT Weirs as well as gates on the basis of physical

infrastructure. The same approach may be extended to develop norms for all physical infrastructures.

- The norm of Rs. 380/ha for canal has been calculated using CCA and has been applied to Actual Irrigated Area. The grant for canal is again allocated among three categories, viz., major, distributaries and minors, with 40%, 25% and 35% share respectively, of total canal M&R grant. No substantive justification has been presented in the report for such allocation.
- WALMI has considered the arithmetical average of actual expenditure in the last 10 years (1997-98 to 2006-07) to arrive at average expenditure per year and then applied an escalation factor of 50% to project M&R cost for year 2008-09. WALMI report does not give any rationale for taking 50% escalation for projecting the average value for 2008-09. In our view, since the average of ten years data has taken, the average norms will represent the expenditure of middle two years (2001-02 and 2002-03). It may be assumed that the average M&R expenditure is applicable to 2001-02 for M&R norms estimation and if one tries to explore the justification for 50% increase in the rise by WALMI, and re-work the percentage increase, it is found that, escalation factor works out to 6%, which is reasonable enough.. It can be observed that, if an escalation factor of 6% per year is applied to the average expenditure, to arrive at the M&R norms for 2008-09, then the projected value is almost the same value as that presented by WALMI. Hence, 6% escalation factor can be used for further projections of M&R costs.

9.6 M&R Projections evolved by ABPS Infra

Based on the data provided by MWRRA, ABPS Infra has developed the projections of M&R costs considering the following approaches:

1. Applying Compounded Annual Growth Rate (CAGR) percentage to past five year data.
2. Applying escalation factor to WALMI norms based on the approach discussed in the previous section.
3. Applying escalation factor to norms recommended by Jakhade Committee Report, 1988.

In the **first approach,** CAGR was applied to the past five years. The past five years data on M&R expenses is presented in the **Table 9-1Error! Reference source not found.**. The same is used for projection of M&R cost based on CAGR. The projected M&R cost for the three year Control Period is presented in the **Error! Reference source not found.**.

Table 9-1 M&R cost over last five years in Maharashtra

Rs. Crore

Particulars	2002-03	2003-04	2004-05	2005-06	2006-07
Canal works	66	56	72	125	131
Head Works	20	17	30	27	34
Total	86	73	101	152	165

Source: MWRRA Data

Table 9-2 M&R cost Projections for three years of Control Period based on CAGR

Rs. Crore

Particulars	Unit	2009-10	2010-2011	2011-12
Canal works	Rs. Crore	219	260	309
Head Works	Rs. Crore	57	65	87
Total	Rs. Crore	275	325	396

Source : MWRRA Data and ABPS Infra Analysis

In the **second approach**, the norms suggested by WALMI are applied to project M&R requirement, by applying an escalation factor of 6%. WALMI has used an effective escalation factor of 6% for arriving at projections for the year 2008-09. Hence the same have been retained for further projections. The projected norms are presented in **Table 9-3** and have been discussed further. The detailed component-wise norms arrived at by WALMI have been attached as **ANNEXURE VI** with the Approach Paper. The financial implication of the M&R norms, for the year 2008-09, proposed by WALMI is attached in **ANNEXURE VII**.

Table 9-3 M&R Cost projections based on 6% escalation factor

Rs. Crore

Project Type	M&R Costs			
	2008-09	2009-10	2010-11	2011-12
Head Works	49	52	55	58
Canals	172	183	194	205
Total	221	235	249	264

Source: MWRRA Data and ABPS Infra Analysis

In the **third approach,** M&R cost is projected using norms recommended by Jakhade Committee Report and applying appropriate escalation factor. The escalation factor is obtained by considering the % CAGR in All India Consumer Price Index (CPI) for Industrial users and All India Whole Sale Price Index for all commodities from 1988 till 2007, with weightages of 70% and 30%, respectively, in line with the Jakhade Committee's considerations and appropriate linking factor. The CAGR of index numbers (CPI and WPI) for the period of nineteen year is 7.17%, which is used for the projections. The M&R cost projections are shown in the **Table 9-4**.

Table 9-4 M&R norms of 1988 and M&R cost projection for 2007 based on index numbers

Project Type	Price Level in the year	M&R Cost in Rs/Ha					
		Head Works			Canal Works		
		Lower Range	Higher Range	Average	Lower Range	Higher Range	Average
Major & Medium Irrigation Projects	1988	30	40	35	50	85	67.5
	2007	112	149	130	186	317	251

Source : Jakhade Committee Report and ABPS Infra Analysis

In order to arrive at the M&R cost projections for the three year Control Period, the average value of M&R cost projections given in **Table 9-4** (i.e., average of the lower and higher range) have been projected for the three years at 7.17 % escalation as mentioned earlier and is shown in **Table 9-5**below.

Table 9-5 M&R cost Projections for three years of control period considering base figure

Particulars	Unit	2009-10	2010-2011	2011-2012
M&R Costs	**Rs. Crore**	**194**	**208**	**223**
Irrigation Potential Created	Lakh Hectare	44	45	46
M&R Costs(Head Works) to maintan per Ha of potential created	Rs./Hectare	151	159	167
M&R Costs(Canal Works) to maintan per Ha of potential created	Rs./Hectare	291	306	321

Source: ABPS Infra Analysis

A comparison of M&R costs for the three year Control Period from the table values from **Table 9-2 Error! Reference source not found.** and **Table 9-5** , is shown in the **Table 9-6**.

Table 9-6 M&R cost Projections for three years of control period by all three approaches

Rs. Crore

Particulars	2009-10	2011-12	2011-12
CAGR Approach	**275**	**325**	**396**
WALMI	235	249	264
Jakhade Committee Recommendations	194	208	223

Source: MWRRA Data and ABPS Infra Analysis

From the table it can be observed that the M&R projections using Jakhade Committee recommendations are lowest. While the values obtained from WALMI norms are in between the CAGR approach and Jakhade Committee recommendations.

The possible reasons attributable for such a variation among the three approaches could be

- Data considered in Jakhade Committee was averaged over India while the data used for other two approaches was Maharashtra specific.

- There is a possibility of fundamental definition of the M&R costs being undergone a change, where in some cost heads previously defined under the head of M&R costs could have been shifted to establishment heads.
- It is also noted that WALMI has carried out the M&R cost study specifically for Maharashtra State with a data set of over 10 year period for selected projects, and the M&R cost arrived from CAGR projections also have some resemblance with WALMI projection for the first year of the Control Period only.

Considering the above **three approaches,** the projections on the basis of actual M&R costs incurred over the period of last five years is recommended. i.e. Projections based on CAGR approach is recommended as they are more realistic and factual unlike the Jakhade Committee norms which are almost twenty years earlier and WALMI study which is limited to selected projects.

9.7 Establishment Costs

Generally, costs associated with establishment like employee costs, administration and general costs are termed as establishment costs. Determination of ideal establishment costs for bulk water sector of Maharashtra would be an extensive exercise in itself, covering various kinds of projects, site visits and detailed understanding of existing organisational setup at the project level.

In view of the above, and the data made available by MWRRA on the establishment costs, two options for arriving at reasonable establishment costs are proposed.

1. Applying escalation factor to norms in Jakhade Committee Report, 1988
2. Applying CAGR to the actual establishment costs in the last five years

The establishment norm proposed by Jakhade Committee, 1988 is tabulated in **Table 9-7**. Also tabulated is the proposed norm for establishment cost by applying the escalation factor on the norm proposed in Jakhade Committee Report. Escalation factor was derived by considering the % increase in All India Consumer Price Index (CPI) for Industrial Workers and All India Whole Sale Price Index for all commodities between 1988 and 2007, with weightage of 70% and 30%, respectively, in line with Jakhade Committee's considerations and appropriate linking factors. The CAGR of index over the period of 19 years has been 7.17%, based on which establishment norms at 2007 price levels have been computed. Further, these norms have been compared with the establishment costs data provided by MWRRA for the last 5 years, which has been discussed in the next section.

Table 9-7 Costs of Regular Establishments at 1988 and 2007 price levels

Project Type	Price Levels in the year	Cost of Regular Establishments (in Rs./Ha)		
		Lower Range	Higher Range	Average
Major & Medium Irrigation Projects	1988	65	90	78
	2007	242	335	289

Source: MWRRA Data and ABPS Infra Analysis

Further, the above establishment costs have been projected for the three years considering an escalation of 7.17%% as shown in the **Table 9-8**, considering the average of higher and lower range.

Table 9-8 Projections for Regular Establishments over three year Control Period considering 2007 base price (from Jakhade Committee recommendations)

Particulars	Unit	2009-10	2010-11	2011-12
Establishment Costs	Rs. Crore	147	157	169

Source: MWRRA Data and ABPS Analysis

9.7.1 Establishment costs in Maharashtra over last five years

MWRRA has provided the data for O&M cost for the period between 2002-03 and 2006-07. MWRRA has also given the data regarding the circle/division wise break-up of total O&M costs into establishment costs and M&R costs, in which the percentage contribution of establishment costs to total O&M costs varies from 77% in the year 2002-03 to 66% in the year 2006-07. Based on these percentages, establishment costs for the period of five years have been tabulated below. It can be seen from **Table 9-9** that the establishment costs for the year 2006-07 is Rs. 787/- per Ha as against Rs. 849/- per Ha, derived by application of escalation factor to norms proposed by Jakhade Committee, 1988. It can be observed that for the year 2006-07, the escalated norms are 8% higher than the existing establishment costs.

Table 9-9 Establishments costs over five year period for Maharashtra

Particulars	Unit	2002-03	2003-04	2004-05	2005-06	2006-07
Establishment Costs	Rs. Crore	284	260	275	301	325
Irrigation Potential Created	Lakh Hectare	38	39	39	40	41
Establishment Costs to maintan per Ha of potential created	Rs./Hectare	745	672	702	753	787
Source: MWRRA Data and ABPS Analysis						

Ideally, the projections for establishment costs should be made based on the number of projects in pipeline, organisational dynamics, and other policy initiatives within the organisation. However, on account of limited data availability, the projections for the three year Control Period from 2009-10 to 2011-12 have been done by applying CAGR on the actual establishment costs as shown below in **Table 9-10**.

Table 9-10 Establishment costs projections for three year Control Period, based on CAGR approach

Particulars	Unit	2009-10	2010-11	2011-12
Establishment Costs	Rs. Crore	360	372	385
Irrigation Potential Created	Lakh Hectare	44	45	46
Establishment Costs to maintan per Ha of potential created	Rs./Hectare	820	831	842

Source: MWRRA Data and ABPS Analysis

Table 9-11 Establishment costs projections for three year Control Period by the above two methods

Rs. Crore

Particulars	2009-10	2010-11	2011-12
Jakhade Committee	147	157	169
CAGR	**360**	**372**	**385**

It can be noted that the Jakhade Committee norms were recommended in 1988 and more over were applicable for all of India. Considering the vintage value of the recommendations, size of the water sector in Maharashtra during that period and the actual expenditure on total establishment costs as on date in Maharashtra, it is recommended that projections for the Control Period using CAGR approach may be considered shown in the **Table 9-11**.

9.8 Operation & Maintenance Costs

As stated earlier, O&M Costs comprise both Maintenance and Repairs (M&R) costs and establishment costs. The methodology for arriving at O&M norms consists of evaluating the ideal requirement of O&M costs vis-à-vis the costs actually allocated due to budgetary constraints.

In view of the above, and the level of data made available by MWRRA on the O&M costs, three options for arriving at reasonable O&M are proposed.

1. Applying CAGR to past five year O&M costs
2. Applying escalation factor to norms in Jakhade Committee Report, 1988
3. Considering average M&R and establishments projection as obtained in the sections **9.6** and **9.7**

9.8.1 O&M costs in Maharashtra over past five years

MWRRA has provided the data on O&M costs over the period of five years from 2002-2003 to 2006-07 which has been tabulated in **Table 9-12Error! Reference source not found.**

Table 9-12 O&M Costs for Maharshtra over five year period

Particulars	Unit	2002-03	2003-04	2004-05	2005-06	2006-07
O&M Costs	Rs. Crore	370	333	376	453	490
Irrigation Potential Created	Lakh Hectare	38	39	39	40	41
O&M Costs to maintan per Ha of potential created	Rs./Hectare	971	862	961	1132	1186
Source: MWRRA Data and ABPS Analysis						

The O&M costs for the 3 year Control Period (2009-10, 2010-11 and 2011-12) have been projected based on Compounded Annual Growth Rate (CAGR) from the year 2007-08. Ideally O&M costs and irrigation potential created should be projected based on the future projects in pipeline, existing and future trends in O&M expenses. However, in absence of the required data, irrigation potential created has been projected based on CAGR for 4 years and is tabulated below. O&M Costs in Rs. per Ha has been arrived based on the projections as shown in the

Table 9-13 .

Table 9-13 O&M Cost projections for three year control period, based on CAGR

Particulars	Unit	2009-10	2010-11	2011-12
O&M Costs	Rs. Crore	605	649	696
Irrigation Potential Created	Lakh Hectare	44	45	46
O&M Costs to maintan per Ha of potential created	Rs./Hectare	1379	1450	1524

Source: ABPS Infra Analysis

9.8.2 Escalation of Norms proposed by Jakhade Committee

The norms for O&M costs proposed by Jakhade Committee Report (1988) are again shown in the following **Table 9-14Error! Reference source not found.**.

Table 9-14 O&M Norms proposed by Jakhade Committee, 1988

Sr. No.	Project Type	O&M Cost in Rs/Ha (At 1988 price levels)
1	Major & Medium Irrigation Projects	180
2	Minor Irrigation Schemes	-
2.1	Himalayan Region	900
2.2	Hilly Region other than Himalayas	954
3	Lift Irrigation Schemes by pumping from River and Storages	591
4	Lift Irrigation Schemes from Canals	523
5	Irrigation from Augumentation Tube Wells	735
6	State Irrigation Tube Wells	665
Note: O&M for Lift Irrigation Schemes includes electricity charges as well		
Source :Jakhade Committee Report, 1988		

Considering the norms given in the **Table 9-14Error! Reference source not found.**, if one were to estimate the costs at 2007 price levels, it would work out to as shown in the **Table 9-15**

Table 9-15 O& M norms on escalation to 2007 price levels for major and medium irrigation projects and lift irrigation schemes

Sr. No.	Project Type	O&M Cost in Rs/Ha (At 2007 price levels)
1	Major & Medium Irrigation Projects	670
3	Lift Irrigation Schemes by pumping from River and Storages	2202
4	Lift Irrigation Schemes from Canals	1949

Note: O&M for Lift Irrigation Schemes includes electricity charges as well
Source :ABPS Infra

The above values of O&M costs are obtained by considering the % increase in All India Consumer Price Index (CPI) for Industrial Workers and All India Whole Sale Price Index for all commodities from 1988 till 2007, with weightages of 70% and 30% respectively and appropriate linking factors as described in the earlier section. The average increase in the index over the period of 19 years has been 7.17%, based on which O&M norms at 2007 price levels have been obtained.

Further, in **Table 9-15**, it can be observed that O&M escalated norms for 2006-07 consists of norms for irrigation projects (major and medium) and norms for lift irrigation projects which vary significantly. In order to arrive at the O&M cost projections for 2006-07, we have given the weightage of 66% for irrigation projects and 34% for lift irrigation projects (i.e., 66% x 670 and 34% x ((2202+1949)/2) as shown in the **Table 9-16** below. This weightage has been considered based on percentage of water consumption through lift irrigation to total water consumption by the agricultural category for the period of five years (based on the data provided by MWRRA).

Table 9-16 O&M cost projections at 2007 price levels (based on Jakhade Committee)

Particulars	Unit	2006-07
Irrigation Potential Created	Lakh Hectare	41
O&M costs for Major & Medium Irrigation Projects	Rs./Hectare	670
Average O&M Lift Irrigation Schemes by pumping from River ,Storages and canals	Rs./Hectare	2076
O&M Costs	**Rs. Crore**	**474**

Further, the cost projections for the three year Control Period has been arrived at considering an 7.17% year-on-year escalation and is shown in the **Table 9-17**

Table 9-17 O& M cost projections for the three year Control Period, based on Jakhade Committee base values

Particulars	Unit	2009-10	2010-2011	2011-2012
O&M Costs	Rs. Crore	584	626	670

On comparison of the O&M norms derived from applying escalation factor as shown in the **Table 9-16** (i.e., Rs. 670 per Ha) and the actual O&M costs for year 2006-07 as shown in the **Table 9-12** (i.e. Rs. 1186 per Ha), it is observed that derived O&M are 40% lower than the existing O&M costs. Reasons for such a large variation could be:

1. The norms arrived in Jakhade Committee were based on all India figures and not representative of any specific State.

O&M costs shown in **Table 9-17** are the actual costs incurred on O&M and not necessarily always the ideal O&M costs required. More often than not O&M cost allocation would be based on budgetary allocations rather that of ideal cost allocations.

9.8.3 Summation of recommended M&R and Establishment norms

In the previous sections (**9.6** and **9.7**) the average projections for M&R and establishment costs have been established for the three years Control Period and have been reproduced in **Table 9-18**. These figures have been further compared with the O&M projections obtained through other methods.

Table 9-18 Summation of average M&R and Establishment cost projections for three year Control Period

Rs. Crore

Particulars	2009-10	2010-2011	2011-2012
Recommended M&R Costs	275	325	396

Recommended Establishment Costs	360	372	385
Total O&M Costs	635	697	781

Further, the O&M costs projections by the three methods has been summarised as shown below in the **Table 9-19**.

Table 9-19 Comparison of O&M cost projections for three year Control Period by all three methods

Rs. Crore

Particulars	2009-10	2010-11	2011-12
Jakhade Committee	**584**	**626**	**670**
CAGR Method	**605**	**649**	**696**
Recommended M&R and establishment costs (refer Table 9-18)	**635**	**697**	**781**

From the above Table, it can be seen that the total of M&R and establishment costs are greater than the cost projections based on Jakhade Committee and CAGR method. The values (of O&M norms) in the third row of the **Table 9-19** have not been projected as a single number, but have been broken into two parts (M&R and establishment) and then projected separately and hence, may be more realistic than other values in the **Table 9-19**. However the above exercise has been adopted due to absence of any detailed recommendation on establishment norms. It is recommended that an exhaustive exercise is necessary in order to study the existing establishment costs, proposed ideal costs, based on which total O&M norms could be proposed.

Hence, in the view of above O&M cost projected by ABPS Infra for the three years Control Period is as follows.

Table 9-20 O&M cost projections by ABPS Infra for the Control Period

Rs. Crore

Particulars	2009-10	2010-11	2011-12
Total of M&R and establishment costs (refer Table 9-18)	**635**	**697**	**781**

Chapter 10: Proposal for Bulk Water Tariff in Maharashtra

10.1 Introduction

In the previous Chapter, ABPS Infra had estimated the Operation and Maintenance Costs for the three-year period beginning 2009-10. In this Chapter, we have attempted to determine bulk water tariffs for the said three-year period. While determining tariffs, we have adopted various principles discussed and developed throughout this Report.

While determining tariff, we have attempted to assess sensitivity of tariff with respect to consumption numbers. Tariff simulation models are very helpful if exercise of restructuring of the tariff categories or tariff rates is to be undertaken to meet specific objectives. Once developed and adopted, these models are useful to evaluate sensitivity of revenue with respect to various parameters such as volumetric entitlements, rebates/penalties for recycling/conservation, change in cropping pattern, etc. The objective of this Chapter is to develop the tariff simulation model that may be adopted by MWRRA, in the context of bulk water tariffs in Maharashtra and discuss the issues associated, if any, with model outputs.

It may be noted that due to non-availability of key data, the model is not fully populated. As and when the data is available, assumptions as well as data granularity may be increased to ensure that the model represents the reality as accurately as possible.

10.2 Requirements of a good tariff simulation model

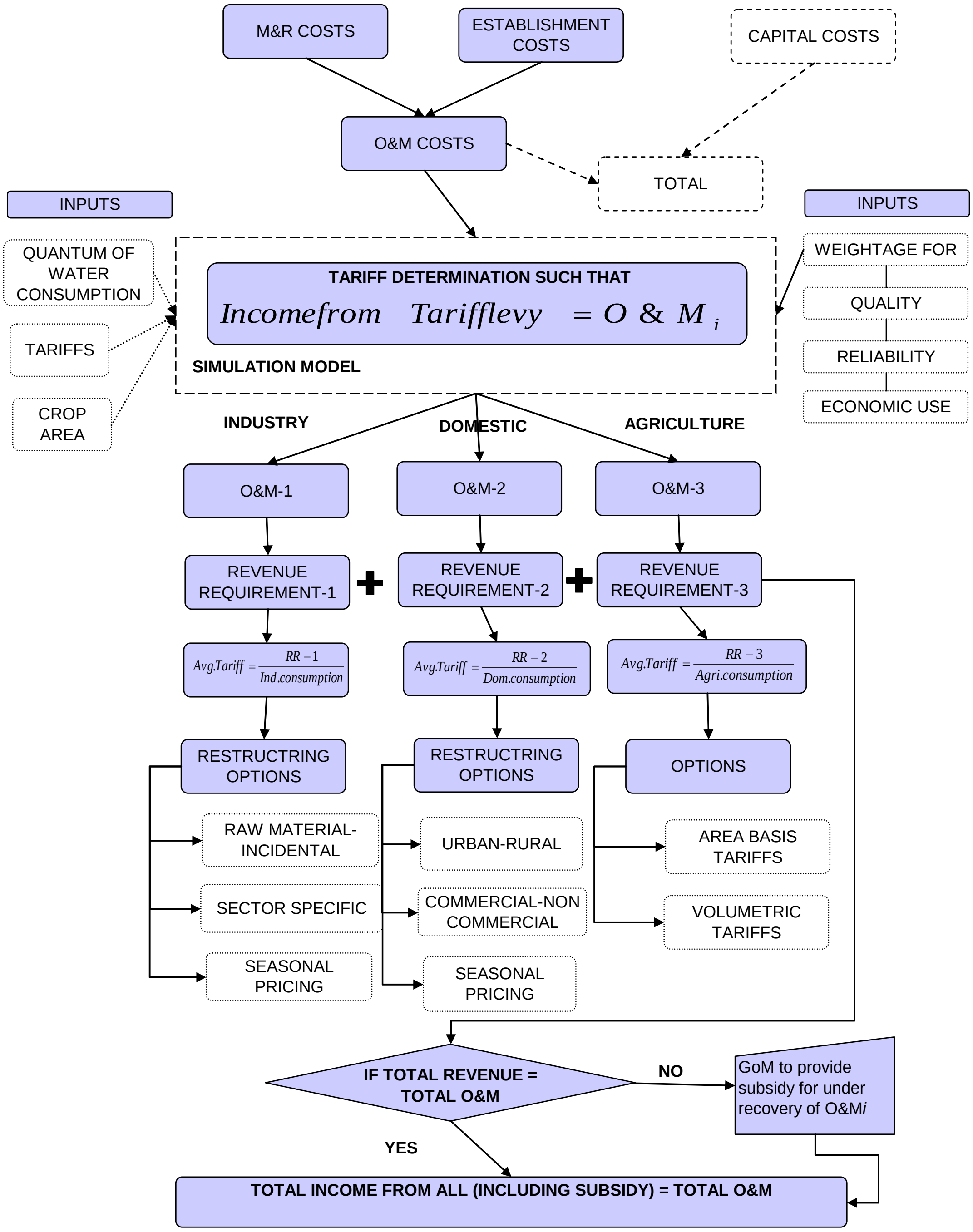
A wide variety of options are available while developing the simulation Model for any tariff determination exercise. We have adopted data intensive mathematical approach for development of tariff simulation model for MWRRA. Further, owing to simplicity in usage and wide availability, Microsoft Excel has been used to develop the tariff simulation model for MWRRA. ABPS Infra believes that the following are essential characteristics of any tariff model:

- Model should be simple and user friendly
- Adequate flexibilities should be built into the model
- Model should be based on reasonable assumptions

10.3 Tariff simulation process

The Flow Chart for bulk water tariff simulation process in Maharashtra has been presented below in **Figure 10-1**.

Figure 10-1 Flow chart for tariff simulation process using 'ABPS Infra model'



10.3.1 Model constraints

Before taking up discussion on the outputs from 'ABPS Infra model' presented in the Flowchart above, it is necessary to discuss the limitations of the model. We have listed below various constraints faced while developing the model:

- Data on the quantum of water usage made available by MWRRA did not have the desired granularity, in order to undertake simulation without any in-built assumptions. As a result, the Model has several reasonable in-built assumptions (discussed subsequently).

- Categories of usage considered in the data format used for collection by MWRRA are not in line with consumer categories specified in tariffs published by WRD, GoM vide its applicable GRs, viz., GR dated September 13, 2001 and GR dated July 31, 2006.
- The problems faced were acute while simulating tariff and revenue requirement for agricultural category, as current tariff structure has more than 65 tariff categories, which are further divided on the basis of seasons. For any reasonable model, data on water usage and crop acreage for each tariff category is a must. MWRRA must initiate immediate action to collect such data.
- Considering the time frame to procure such granular level data and timelines for the assignment, it was considered prudent to present the simulation model with reasonable assumptions.
- In the context of tariff recovery principles adopted by the model, three basic parameters have been adopted, viz., quality of water supply, reliability of water supply and economic use of water supply (which is proportional to ability to pay).
- While above mentioned three factors have been taken into account while developing the tariff model, it may be noted that the model does not reflect the 'Cost to Serve'principle, as the costs associated with each category of use have not been calculated. The Cost to Serve principle requires that each and every cost associated with every possible use is identified and allocated to that particular use. Only those costs that cannot be identified and allocated directly may be allocated to any usage using the most appropriate principle for that cost. No such exercise has been carried out in this context.

10.3.2 Apportionment of Revenue Requirement

The first step in the tariff determination process involves the apportionment of the total revenue requirement of bulk water sector in Maharashtra amongst the principal users of water, viz., industries, domestic and agriculture. Their shares are indicated as RR-1, RR-2 and RR-3, respectively, in the Flowchart. In the ABPS Infra model, we have proposed to allocate the Revenue Requirement using various factors as discussed above and presented below:

  - Quality of water supply
  - Reliability of water supply
  - Economic utilisation of water supplied

While we have proposed to allocate the revenue requirement using above factors, it is also possible to allocate the revenue requirement amongst users purely on the basis of quantum of water consumed. However, this approach is highly rigid as it does not take into account the other factors associated with supply of water such as quality and reliability, which may be important for some categories and not as important for others. This method also does not take into account the economic utilisation of the water supplied, which in our opinion is also directly related to the paying capacity (i.e., higher the economic utilisation of water, higher is the paying capacity). Hence, in order to incorporate such variations while apportioning Revenue Requirement, a matrix incorporating these parameters has been developed which is part of the proposed model.

Table 10-1 Matrix of 'ABPS Infra model' factors

Particulars	**'ABPS Infra model' factor**			**Average of each factor**	**Equivalent weightage W*i* *(in %)***
(a)	**(b)**	**(c)**	**(d)**	**(e)=(b+c+d)/3**	**(f)=(e)/**$\sum col(5)$
Category	**Quality**	**Reliability**	**Economic use**		
Industry	W_{iq}	W_{ir}	W_{ie}	W_{av1}	W1
Domestic	W_{dq}	W_{dr}	W_{de}	W_{av2}	W2
Agriculture	W_{aq}	W_{ar}	W_{ae}	W_{av3}	W3

Such that $\sum_{i=1}^{3} W_i \leq 1$ (1)

Where c represents category $i, d, a,$ representing *i*ndustry, *d*omestic and *a*griculture and v represents 'ABPS Infra model' factors $q, r, e,$ representing *q*uality, *r*eliability and *e*conomic use, respectively.

10.4 Conditions for determination of the factor

The primary reason behind undertaking this exercise is to develop a framework for arriving at a reasonable apportionment of the Revenue Requirement between the three categories of users by providing certain quantitative weightages to three parameters, viz., quality, reliability and economic use. The weights for the above matrix have been determined using the approach given in following paragraphs.

- Maximum weight of five has been considered for each of the three parameters.
- Weights have been assigned for each category based on the perception of that parameter for that category. For eg. in case of 'Quality' as a parameter, it has been assumed that quality requirement of domestic and industry would either be similar or industrial quality requirement could be slightly higher than that of domestic category, while agriculture draws general raw water. Therefore, the relationship between the factors across columns should be such that the factor for Industry ≥ Domestic > Agriculture (i.e., $W_{iq} \geq W_{dq} > W_{aq}$).

- In the context of priority of usage, Section 4 of the Maharashtra State Water Policy give first preference of meeting water demand to domestic category followed by industry and then irrigation, so for reliability as a parameter, the relationship across columns should be such that factor for Domestic > Industry > Agriculture (i.e., W_{dr} > W_{ir} > W_{ar}). However, it cannot be denied that reliability of water supply for agriculture is as important as for industry if not more, as the reliability of water supply has significant impact on the yield of the crop.
- For economic use parameter, the factor for Industry > Agriculture > Domestic (i.e., $W_{ie} > W_{ae} > W_{de}$)

Based on the above, the following qualitative ABPS Infra model factors have been proposed with the corresponding weightages for apportionment of O&M costs.

Table 10-2 Matrix of ABPS Infra model factors

Particulars	**'ABPS Infra model' Factor**			**Average of each factor**	**Equivalent weightage W*i***
(a)	**(b)**	**(c)**	**(d)**	**(e)=(b+c+d)/3**	
Category	**Quality**	**Reliability**	**Economic use**		
Industry	3	3	5	3.67	48%
Domestic	2	3.5	1	2.17	28%
Agriculture	0.5	2.5	2.5	1.83	24%

The weightages work out as 48%, 28% and 24% for industry, domestic and agriculture category, respectively, which have been used for apportioning the O&M costs.

10.5 Cross-subsidy

In simple terms, cross-subsidy is said to exist if a group of consumers are paying more than the allocated cost of water, such that another group of consumers is paying less than the allocated cost of water. More specifically, a group cross-subsidises other consumers if it faces prices which exceed the costs which it would have paid had it been alone, i.e., if it pays more than its *stand alone* costs.

In the context of the above discussion, cross subsidy shall be said to prevail if any tariffs proposed are higher than the tariffs, which have been obtained by applying weightages for the apportionment of O&M costs.

10.6 Tariff Determination

Tariff determination for all the three categories shall be done on the basis of recovery of revenue requirement of bulk water sector in Maharashtra. Once the process is stream-lined, the issue of recovery of capital costs may be considered. If the Government of Maharashtra (GoM) would like to levy tariffs that are lower than the tariffs so determined by MWRRA, it may do so by paying subsidies to share the burden of partial revenue requirement of bulk water sector. GoM should endeavour to ensure that the revenue requirement is recovered through tariffs.

10.7 Reconciliation of Revenue with Tariff categories by ABPS Infra

Before using any tariff model for the purpose of determining tariffs for future period, it is always necessary to validate the model using existing data. ABPS Infra undertook the exercise of reconciling revenue numbers using other data such as water rates, quantum of consumption, and category wise tariff levied. All information used in the model was primarily made available by MWRRA.

10.7.1 Data used in the reconciliation process

Following data/data sources were used during the reconciliation process:

<u>Water rates:</u> The water rates were referred from GRs in force, dated September 13, 2001 and July 31, 2006 on water rates for irrigation and non-irrigation use, respectively

<u>Consumption:</u> The data for quantum of consumption by industry and domestic category was made available by MWRRA. While the data for the cropped area for major crops were available in 'Sinchan Stithi Ahawal, 2006-07'.

<u>Tariff levied:</u> The data on actual tariff levied for the year 2006-07 was made available by MWRRA;

As stated earlier the data made available was scanty for us to undertake complete simulation. Further, the formats used for data collection were not exactly in line with tariff categories adopted in the GRs even for domestic and industrial category. As a result, the results obtained from the model were not as encouraging as there was significant variation between the actual revenue and revenue derived from the simulations.

10.8 Volumetric Tariffs for the Control Period

In this Section, we have presented proposed Bulk Water Tariffs for the State of Maharashtra for the first three-year Control Period from FY 2009-10 to FY 2011-12. We have presented results of the model developed by us based on the estimated water usage during each year of the Control Period. The Bulk Water Tariffs have been computed on volumetric basis for all three consumption categories.

10.8.1 Water Consumption

The first step in determination of water tariffs involves the estimation of water usage during the Control Period. Currently, quantum of water consumption by the agriculture category accounts for 83% of the total water consumption. Only 17% of total water is consumed by the remaining two categories, i.e., domestic and industrial.

Water consumption of industrial and domestic category consumers during the five-year period (2002-03 to 2006-07) has been shown in Error! Reference source not found., while the consumption of agricultural category has been shown in Error! Reference source not found.. Water consumption by agricultural category has been increasing at CAGR of 4.21%. During the same period, consumption by industry and domestic category has reduced at CAGR of 2.02% and 0.56%, respectively.

Figure 10-2 Quantum of water consumption by Industrial and Domestic Categories

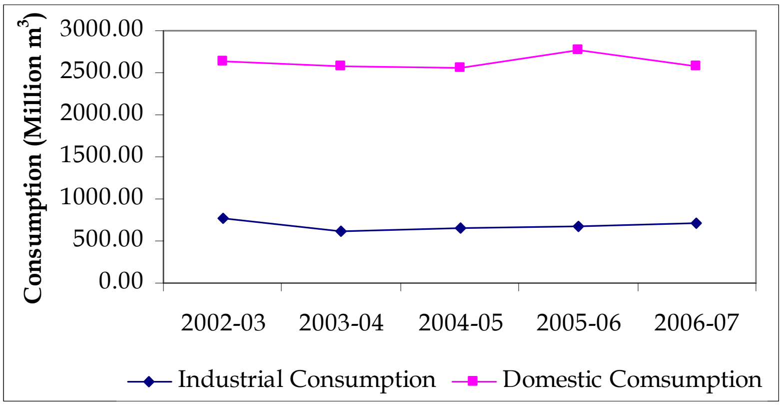
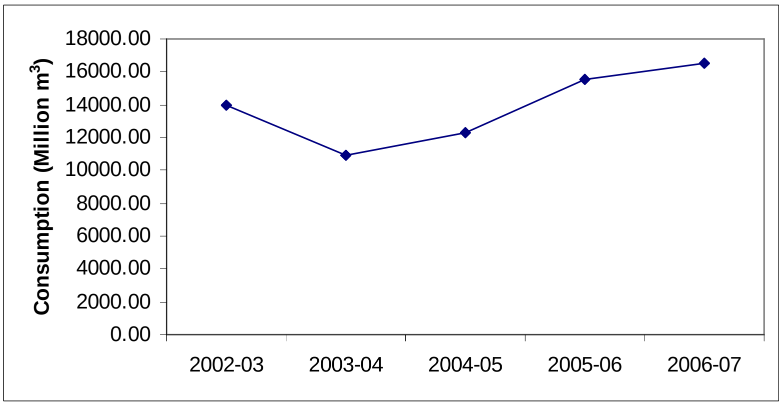


Figure 10-3 Quantum of water consumption by Agriculture Category



Projection for water consumption

Though water consumption by industry and domestic categories has shown reduction in absolute terms during the last five years, this information does not appear to be correct. Given the economic upturn during this period, it appears highly unlikely that consumption by these categories would have reduced during this period. It is suggested that MWRRA puts in place robust systems to collect such information.

In view of expanding economy and rapid urbanization witnessed in Maharashtra, we have assumed increase in water consumption by domestic and industrial categories at CAGR of 2%. We have assumed CAGR of 4.21% while estimating water consumption by agricultural category consumers. **Table 10-3** gives the water consumption of 23907 million m^3 in the year 2011-12.

Table 10-3 Projections for water consumption for the Control Period (2009-10 to 2011-12)

Million m^3

Sector	2007-08	2008-09	2009-10	2010-11	2011-12
Irrigation	17185	17908	18662	19448	20267
Industrial Consumption	727	741	756	771	786
Domestic Consumption	2636	2689	2743	2798	2854
Total	20548	21339	22161	23017	23907

10.8.2 Effective volumetric tariffs for 2006-07

Effective volumetric rates per 1000 m^3 have been determined by dividing the Revenue Billed during the year 2006-07 by the consumption of each category as shown in the **Table 10-4** below:

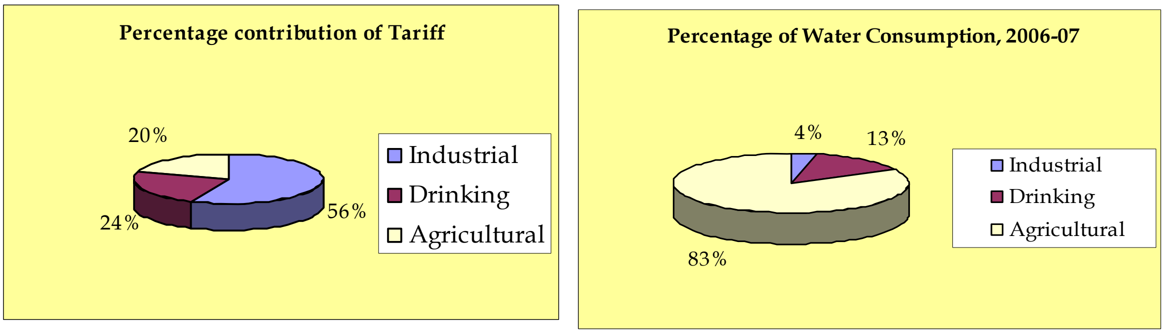
Table 10-4 Effective Volumetric Rates for 2006-07

Category	Year 2006-07			
	O&M Cost (Rs. Crore)	Revenue Billed (Rs. Crore)	Water Consumption (Million m^3)	Effective Vol. Rates (Rs./ 1000 m^3)
(1)	(2)	(3)	(4)	(5)
Industrial	490	273	712	3834
Drinking		114	2624	435
Agricultural		98	16498	59
Total	**490**	**485**	**19834**	**-**

(Source: MWRRA data and ABPS Infra Analysis)

From Columns 2 and 3 of **Table 10-4,** it can be seen that revenue billed is very close to recover entire O&M costs incurred in that year. In fact, tariff levied is just short by about Rs. 5 Crore. It may be noted that 56% of the tariff levied or revenue was earned from industries, while 24% and 20% was earned from domestic and agriculture supply, respectively. The percentage contribution in tariff and consumption for the three categories is shown in **Figure 10-4**.

Figure 10-4 Percentage contribution in tariff and consumption of three categories in tariff levy, year 2006-07



10.8.3 Proposed volumetric rates for the Control Period from 2009-10 to 2011-12

In an earlier section, the revenue requirement from each of the consuming sectors has been calculated. In order to recover this revenue requirement from that category, it is necessary to levy tariff over entire volumetric consumption. Thus, the volumetric rates for all three consuming categories have been computed by dividing revenue requirement by volumetric consumption of that category. The effective volumetric rates thus calculated have been presented in **Table 10-5**

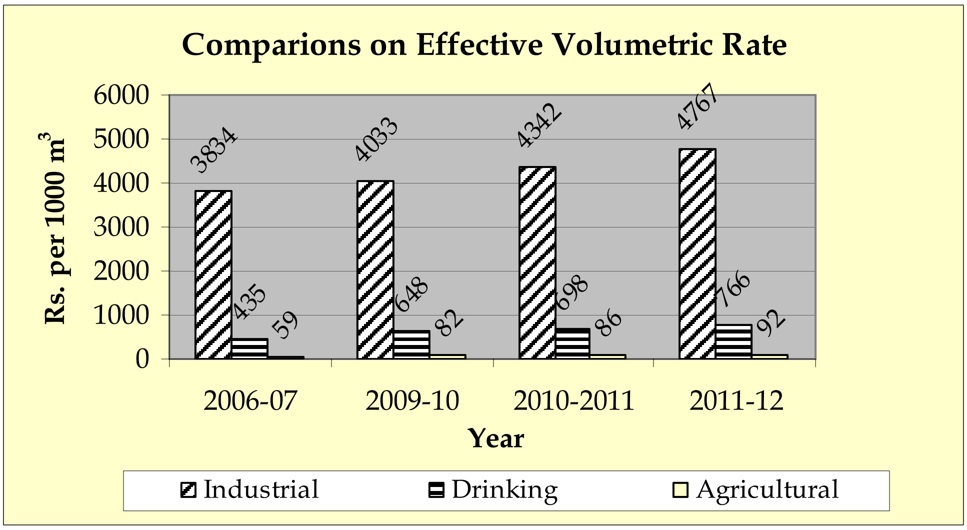
Table 10-5 Effective volumetric rates

Particulars	**Unit**	**2009-10**	**2010-11**	**2011-12**
O&M Cost Projections	Rs. Crore	635	697	781
Revenue Projections	Rs. Crore			
Industrial Category	*48%*	305	335	375
Drinking Category	*28%*	178	195	219
Agricultural Category	*24%*	152	167	187
Projected Consumption	**Million m^3**			
Industrial Category		756	771	786
Drinking Category		2743	2798	2854
Agricultural Category		18662	19448	20267
Effective Vol. Rates	**Rs./1000 m^3**			

Industrial Category		**4033**	**4342**	**4767**
Drinking Category		**648**	**698**	**766**
Agricultural Category		**82**	**86**	**92**

The above computed volumetric rates have been shown in **Figure 10-5** below. It can be seen from **Figure 10-5** that effective volumetric tariffs for the Control Period have considerably reduced when compared with the rates applicable for the year 2006-07 for the industrial category. This is mainly due to conservative O&M cost projections for the Control Period.

Figure 10-5 Comparison of effective volumetric rates



10.9 Rationalisation of Tariff Structure

Once the revenue requirement from each user category has been identified (RR-1: Industry, RR-2: Domestic, RR-3: Agriculture), average tariffs could be computed for water usage by that category. These tariffs could be further rationalized by applying various other parameters. Three possible ways for restructuring of tariffs are:

- Season based pricing for industrial and domestic category
- Re-categorisation of some tariffs, particularly for domestic category
- Possibility of introduction of tariff slabs

These pricing principles and their application have been discussed in following paragraphs.

10.9.1 Seasonal Pricing

Seasonal pricing already exists for agricultural category in the State of Maharashtra. Water tariff for hot weather is higher than that for Rabi season, which in turn is higher than that for Kharif season. With reference to GR dated September 13, 2001 on water charges for irrigation use, it can be observed that:

- Water rates for canal flow irrigation (refer Annexure No.1 of GR) the average crop rates for Rabi season are 1.5 times that of Kharif season and for hot weather season they are 3 times that of Kharif season. Similar is the case for volumetric supply of water to WUAs (refer Annexure No. 2 of GR).
- In the case of private and Government lift irrigation schemes, the water charges or service charges (as the case may be) for the Rabi season are about 1.5 times that of Kharif season and for hot weather season, the charges are about 2 times that of Kharif season.

The same principle may be applied for water supply to domestic and industrial category, thereby giving proper economic signals regarding scarcity of water. It is proposed that rates for domestic and industry during hot weather season may be specified as 1.5 times the normal rates.

10.9.2 Re-categorisation of domestic and industrial supply

Currently, water for domestic, commercial and industrial use is lifted by the urban or rural local body and is supplied to various end users. Bulk Water Tariff is levied on these urban or rural local bodies on the basis of declaration by the said body to bulk water supplier. This practice need to be changed and these urban/rural local bodies may be charged on the basis of volume of water lifted by them. Here, it may be noted that these local bodies act as Water User Associations for these end users. When volumetric tariff principle is being applied for water user associations in case of agriculture consumers, there is no reason why such a principle should not be applied to urban/rural local bodies. If accepted and implemented, the local body will be responsible for water lifted by it irrespective of the usage. Further, the local body may be given discretionary powers (within ambit of State Water Policy and MWRRA guidelines) to decide on allocation of water to different categories of users.

If this principle is accepted, separate tariffs may be determined for urban and rural local bodies reflecting different 'ability to pay' of these categories. Based on the consumption pattern of the individual Grampanchayats, Municipal Corporations, introduction of tariff slabs may also be considered as a measure to encourage demand management of the bulk water consumers.

10.9.3 Volumetric Tariff for Agricultural Category

As stated earlier, crop-wise area irrigated or volume of water supplied to different crops is not currently available. This creates practical difficulty in determination of agricultural tariffs on per hectare basis. Therefore, it is suggested that area based tariffs may be decided by the Government of Maharashtra. The tariffs may be determined in such a manner that the revenue from such tariffs should not be less than the revenue requirement (RR-3 as per flow chart) apportioned to agricultural category. In case, revenue from tariff so determined by the GoM is less than RR-3, the GoM will make specific provision for subsidy to compensate bulk water supplier for shortfall in revenue requirement.

10.10 Rebates for water conservation and recycling

In order to promote water conservation and prevention of water pollution, it is essential to create an enabling framework that will encourage consumers to adopt water conservation and water recycling techniques. In the previous Chapter on legal and regulatory framework (refer Chapter 5), we have dealt with the legal provisions related to promotion of water conservation measures. Rebate and penalties would be essential aspects of such a framework, which must be considered while developing Tariff Regulations. Several methodologies could be adopted for promotion of adoption of water recycling technologies by the industry. While voluntary adoption of water recycling could be one extreme, strict penalties could be another extreme. Generally, 'carrot and stick' approach is considered as the most suitable option for implementation of such policy initiatives.

As per provisions of the MWRRA Act, 2005, MWRRA is required to work in consultation with other concerned agencies on issues related to pollution and water recycling. The MWRRA Act, 2005, does not have any explicit provision under which, MWRRA could levy penalties for pollution or non-adoption of water recycling techniques. Hence, it is necessary to develop suitable incentive structure, which will encourage industry to install water recycling systems.

In order to develop such a mechanism, it is necessary to understand costs and benefits of various water conservation and recycling technologies. In this regard, ABPS Infra had associated with Indian Institute of Technology, Mumbai which studied several water conservation and recycling technologies. A report submitted by IIT, Mumbai is enclosed as **Annexure III in Volume 2** of this Report. In this Report, we have presented brief summary of our findings and application of the same for bulk water pricing in Maharashtra.

10.10.1 Assessment of treatment costs v/s raw water costs

Before we undertake assessment of treatment costs and costs of raw material, it is necessary to delve into some other issues closely associated with nature of industry, which have a bearing on policies being framed for the consumer industry.

- Heterogeneous nature of the industry makes uniform application difficult.
- Economics of any technology would vary with the nature of industry.
- Suitability of particular technology depends of the nature of base industry.
- Possible limitation of choice between the plant capacity and plant technology.

As mentioned earlier, the details about various water recycling technologies available in India have been provided in **ANNEXURE III**. The Report also provides information about the technologies; their applicability, approximate capital costs and O&M cost requirements for per unit of water treated. Based on this information and data about costing for non-beverage industries provided by MWRRA, an attempt has been made to compare the per unit treatment costs vis-à-vis per unit raw water costs to assess the level of rebates required, if any. For the purpose of analysis, a typical non-beverage industry has been chosen and the water consumption details of the industry are presented in **Table 10-6**.

Table 10-6 Costing details for Typical Non Beverage Industry

Name of Industry & location	Not disclosed
Product Manufactured	Soyabean De-oiled cake/meal and oil.
Total annual drawal of water (Mm^3) with source (excluding ground water use if any)	0.1882 Million m3 Drawal from the nearby river of lower Wanna attached to Irrigation Department.
Total royalty paid annually for above (Rs.) in FY 2006-07	Rs. 5,77,256/
Royalty paid for water as a percent of total input costs (raw material, power, labour etc.)	N.A.
Maximum Retail Price (MRP) of finished product	No MRP as it is reported to be an export item
Cost of raw water as percentage of MRP.	N.A.
Approximate cost of production (total and unit wise)	Solvent Plant Rs.750/-MT& Refinery Rs. 3000/-M.T.
Cost of raw water as % of total cost	0.0168% (Approx)

Assumptions

- Amount of waste water production is assumed as 30% of the water supplied.

- 100% of the waste water generated in the process is treated.
- Plant operates for 24 days in a month with a life cycle of 25 years.
- Approximate capital cost and O&M cost per unit of treated water for most of the water recycling technologies as given in ANNEXURE III.
- Per month consumption of the industry : 15.68 million litres per month
- Raw water purchase rates: Rs. 30.67 per 10,000 litres
- Water charges per month: Rs. 48,105/-
- Treatment plant capacity: Requirement to treat 4.705 million litres per month (30% of 15.68 ML), hence, plant capacity to be 0.2 MLD.

The total capital costs and O&M costs for recycling 4.705 million litres water per month with various technologies per month for various technologies have been shown in **Table 10-7**.

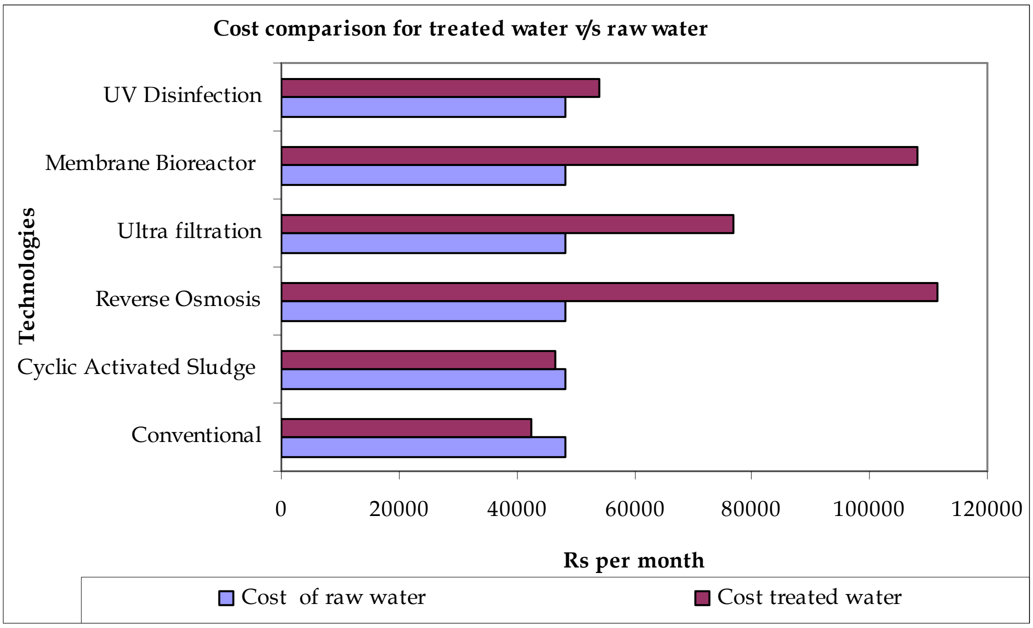
Table 10-7 Sample costs of waste water recycling for 0.2 MLD for various technologies

(Rs /Month)

Technique	Cost (Rs /Month)						
	Capital Cost			Maintenance Cost			Total Cost
	Lower Range	Higher Range	Average	Lower Range	Higher Range	Average	
Conventional	1533	4000	2767	188	11763	5975	8742
Cyclic Activated Sludge (C –tech)	6535	13069	9802	94	5881	2988	12790
Reverse Osmosis	4182	10456	7319	47050	94100	70575	77894
Ultra filtration	5228	10456	7842	23525	47050	35288	43129
Membrane Bioreactor (MBR)	10456	20911	15683	23525	94100	58813	74496
UV Disinfection	2614	5228	3921	9410	23525	16468	20388

The treatment cost for raw water vis-à-vis cost of treated water is shown below.

Figure 10-6 Cost of water per month with 30% recycled water



From **Figure 10-6** above, it appears that cyclic activated sludge and conventional water recycling technologies, if implemented, would result in saving for industry and therefore, should not require any rebate or incentive mechanism. However, it may be noted that this is a hypothetical case and there could be different constraints associated with technologies (like technical feasibility, which has not been considered in the sample). Further, it may be noted that the cost of water recycling with conventional techniques appears to be least in the above **Figure 10-6**; however, this technique calls for additional costs in terms of land requirement, which is not included in capital cost of the technology.

In view of above discussions, further detailed study needs to be carried out for few major industries in specific sectors like pharmaceutical, steel, textile, leather, beverages, etc., in the State with real data for source of water and effluent release, applicability of relevant water reuse and recycling technologies. Costing of theses technologies could be procured from the suppliers. Then, on the basis of comparison of cost of treated water vis-à-vis that of raw water, appropriate rebate mechanism could be developed.

Bibliography

Acts

- Maharashtra Fisheries Act, 1960
- Water (Prevention and Control of Pollution) Act, 1974
- Maharashtra Irrigation Act, 1976
- The Water (Prevention and Control of Pollution) Cess Act, 1977
- Maharashtra Kharland Improvement Act, 1979
- Maharashtra Groundwater (Regulation for Drinking Water Purposes) Act, 1993
- Maharashtra Krishna Valley Development Corporation Act, 1996
- Vidarbha Irrigation Development Corporation Act, 1996
- Maharashtra Tapi Irrigation Development Corporation Act, 1997
- Konkan Irrigation Development Corporation Act, 1997
- Maharashtra Godavari Marathwada Irrigation Development Corporation Act, 1998
- Maharashtra Project-Affected Persons Rehabilitation Act, 2001
- Maharashtra Water Resources Regulatory Authority Act, 2005
- Maharashtra Management of Irrigation Systems by Farmers Act, 2005

Rules

- The Bombay Canal Rules, 1934
- Water (Prevention and Control of Pollution) Rules, 1975
- Water (Prevention and Control of Pollution) Cess Rules, 1978
- Maharashtra Management of Irrigation by Farmers Rules, 2006

Reports

- "Report of Study on Revision of Maintenance and Repairs Norms for Irrigation Projects in Maharashtra", (July 2008), by Water and Land Management Institute (WALMI), Aurangabad.
- "Water: A shared Responsibility", (2006), The United Nations World Water Development Report 2
- "Report of the Jakhade Committee to Study the Financial Requirements for Proper Maintenance and Management of Irrigation Projects", (1988)
- "Maharashtra State Irrigation Commission Report", (1962)
- "International Paper's on Water Pricing",(May 2005)
- "Sinchan Stithi Darshak Ahawal 2006-07 Maharashtra Rajya", (September 2007)
- "Report of the Committee on Pricing on Irrigation Water", (September 1992), Planning Commission, Government of India, New Delhi
- "Federal ENERGY Management Program" report (2002), Washington DC.

- CWC, Report (2005), "General Guidelines for Water Audit and Water Conservation", Ministry of Water Resources, New Delhi.

Books

- "Pricing Irrigation Water: Principles and Case from Developing Countries", (2004), Yacov Tsur, Terry Roe, Rachid Doukkli and Ariel Dinar
- "Criteria for Fixation of Water Rates and selection of Irrigation Projects", (February 1959), Asia Publishing House, National Council of Applied Economic Research, New Delhi Arceivala,
- S.J., and Asolekar, S.R., (2007), "Wastewater Treatment for Pollution Control and Reuse", Tata-McGraw-Hill, New Delhi.

Government Resolution

- Government of Maharashtra, Water Resources Department, Government Resolution No. WTR 2006/ (396/03) –IM(P),dated July 31, 2006
- Government of Maharashtra, Irrigation Department, Government Resolution No. Water Rates 1001/(5/2001)/IM(Policy),dated September 2001
- Government of Maharashtra, Water Resources Department, Government Resolution No. WTR 1007/ (323/2007)/IM(P),dated June 22, 2007
- Government of Maharashtra, Water Resources Department, Government Resolution No. WTR 2007/ (442/07)/IM(P),dated March 25, 2007

Publications

- Rogers P, Bhatia R and Huber A.. "Water as a Social and Economic Good: How to Put the Principle into Practice" (1998), Technical Advisory Committee (TAC), Global Water Partnership.

Proceedings of Workshop

- "Volumetric Supply and Pricing of Irrigation Water: Scenario in Maharashtra" (2006) Proceeding of Workshop on Volumetric Supply and Pricing of Irrigation Water, 17-19 December, 2006.
- S. N. Lele and S. B. Sane, "Volumetric Water Supply to Water User Associations", (2006) Proceedings of Workshop on Volumetric Supply and Pricing of Irrigation Water, 17-19 December, 2006.

Websites

- MPCB Website: http://mpcb.mah.nic.in/
- MWRRA Website: http://www.mwrra.org/

- MOWR Website: www.wrmin.nic.in.
- USEPA Website: www.epa.gov
- WRD Website: http://www.mahagovid.org/
- http://www.eere.energy.gov/

ANNEXURE I	**A Report on International Approaches to Calculating Bulk Water Tariffs & Implications for the Maharashtra Water Resources Regulatory Authority**
ANNEXURE II	**A Report on Water Conservation Technologies**
ANNEXURE III	**A Report on Water Recycling Technologies**
ANNEXURE IV	**Current Water Tariffs applicable for non-irrigation use**
ANNEXURE V	**Current Water Tariffs applicable for irrigation use**
ANNEXURE VI	**M & R Norms proposed by WALMI**
ANNEXURE VII	**Financial implications of M & R Norms proposed by WALMI at State level**

Approach Paper

On

Developing Regulations for Bulk Water Pricing in the State of Maharashtra

Volume - II

Submitted to

Maharashtra Water Resources Regulatory Authority

(September 2008)

ANNEXURE – I

(INTERNATIONAL APPROACHES TO CALCULATING BULK WATER TARIFFS & IMPLICATIONS FOR THE MAHARASHTRA WATER RESOURCES REGULATORY AUTHORITY)

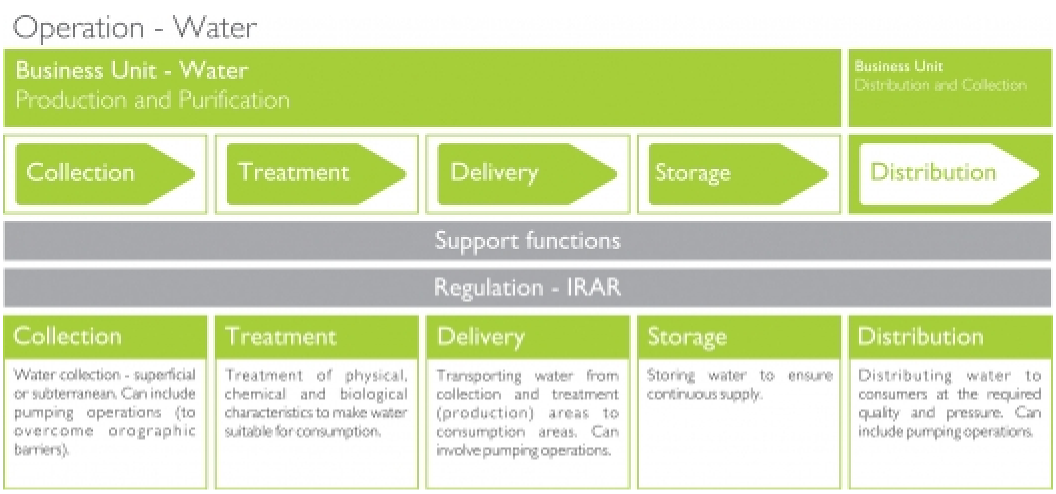
Annexure- I: A Report on International Approaches to Calculating Bulk Water Tariffs & Implications for the Maharashtra Water Resources Regulatory Authority

1. Introduction

1.1. What is Bulk Water?

The phrase 'bulk water' or 'wholesale water' normally refers to the process of transferring water either from one company to another or from one resource zone to another. The costs incurred in providing such a service include abstraction costs (e.g. associated with drilling boreholes or developing storage infrastructure), water treatment costs which will include the variable costs of chemicals and power (as well as the possible upgrading or expansion of a company's existing treatment capacity) and transportation costs.

The figure below (produced by South Africa's Department of Water Affairs) illustrates the water value chain. The bulk water process therefore encompasses the Collection, Treatment, delivery and Storage components.



In summary, bulk water charges are typically expected to cover the following costs:

- Raw water costs.
- Water treatment costs
- Storage infrastructure costs.
- Transportation infrastructure costs (to the point of delivery to the customer).
- Water losses.
- Chemical costs.

- Electricity costs (the majority of which is typically associated with pumping).

In addition, the bulk water provider is also entitled to earn a return on its investment (i.e. a level of profit which may be determined by the regulator, where one exists, with this profit amount typically being calculated by applying a calculated rate of return – say 7% - to the asset base of the company).

Finally, there may well be other cost components that will form part of the bulk water tariff. Such components may include:

- A provision to finance subsidies for disadvantaged consumers.
- Contributions to an investment fund.
- Regulatory fees.
- Payments to a pollution control / environmental protection fund.

1.2. Why Introduce a Bulk Water Tariff Framework?

A number of outcomes may be targeted from introducing bulk water pricing. Hanemann (1999) proposes the following primary objectives for implementing a rate structure:

- Raising revenue (for financial sustainability).
- Allocation of costs among different users (for social equity or political reasons).
- Changing behaviour (by providing incentives to users).
- Promoting economic efficiency (both in the use of water and in regard to new investment).

Two secondary objectives relate to:

- Ease of administration (transparency, simplicity, etc.)
- Avoiding negative environmental externalities and promoting environmental sustainability.

Any or all of these objectives may be applicable in different circumstances. The problem of course is that these objectives have conflicting implications for how rates are actually designed. For example:

- Reducing what users pay will meet the welfare objective but diminishes the incentive for efficient water usage and lowers revenue.
- Fixed charges promote stability and predictability but diminish incentives for efficient use of water.
- Charges based on consumption promote conservation and efficiency but cause uncertainties in the revenue stream.

In short, there is no universal best design but rather the optimal choice of pricing framework will be that which reaches an acceptable compromise among those objectives. In addition, there are a number of tariff design considerations to consider. A brief summary of some of the more important of these issues is presented below. In addition, many of the same concerns arise in the case study discussions presented in Section 2.

1.3. Marginal or Average Cost Pricing?

A common debate in the literature on water pricing is whether to price water by its average cost (based on financial reasons of cost recovery) or by its marginal cost (based on the economic reasoning of promoting an efficient use of the resource).

In order that consumers can reveal their willingness to pay for the water they consume (and thus its value), it is necessary that they be charged a price that reflects the real economic cost of using it. This requires that the cost be defined, not simply as the average historic cost of supply incurred by the water utility, but as the cost of producing additional or marginal supplies, which are required as demand increases. Such a pricing policy provides a signal as to whether investment in additional capacity is justified – a critical function where the cost of water is escalating rapidly.

In practice, therefore, long-run marginal cost should be used as a basis for cost recovery in order to avoid frequent price fluctuations that would otherwise be implied where investments in additional capacity do not follow a smooth trend over time. Long-run marginal cost in such cases can be approximated by discounting the future stream of unit costs (or costs per cubic meter), a concept sometimes referred to as "discounted unit cost" or "average incremental cost". A key implication of this approach is that where unit costs of water rise rapidly, marginal costs by definition are greater than average costs, and so a policy based on this principle would require tariff levels considerably in excess of those required for financial cost recovery alone.

However, although the consensual result in reviewing water pricing literature is that efficiency requires marginal cost pricing in contrast to the widely used average cost pricing practices of many water utilities, it is also accepted that pure marginal cost pricing may not be feasible or even desirable because of financial, fairness, political or legal reasons.

From a financial perspective, marginal cost pricing does not ensure that the water utility generates enough, and just enough, revenues to cover costs (including a reasonable amount of profit to guarantee the involvement of private firms in the industry). Some economists warn that marginal costs may fall below average costs, which is the situation to be expected in capital-intensive industries like water supply. Others point out that despite the fact that water utilities are commonly viewed as a natural monopoly due to capital costs, it is not straightforward that the marginal cost falls below the average cost. Because cheaper sources of water are naturally used before other more expensive sources, marginal cost can rise above the average cost of water supply.

Therefore, marginal cost pricing can raise a problem to the water utility and its regulators, not because of insufficient revenue, but because it would generate excessive profits. Using marginal cost pricing in a situation where average cost is lower than marginal cost can be an efficient way to raise revenues. Nevertheless, it is generally not allowed, namely because it has a "regressive incidence", hurting the poor the most, since water expenses have a greater weight in their budget. Balancing the budget of the water utility is therefore an objective on the same level of importance as achieving economic efficiency.

This raises the question of aiming at efficiency while respecting a revenue requirement. The most common ways of combining these two objectives are through the use of two-part tariffs, adjusting the fixed charge to meet the revenue requirement, or through second-best pricing, collecting the necessary extra revenue where it can be done more efficiently, that is to say, from customers with less elastic demands.

1.4. Marginal Opportunity Cost Pricing

Marginal Opportunity Cost Pricing (MOPC) goes beyond marginal cost pricing by including in the tariff calculation process all other, relevant, costs that may be associated with bulk water delivery. For example, the supply of water may involve a variety of environmental costs. These are typically very difficult to estimate precisely but may include issues such as the ecological impact arising from the construction of reservoirs or cross-country transmission pipelines.

Even with tariff levels based on long-run marginal costs of supply including environmental costs, there might still be absolute water shortages. In principle, efficient pricing in such cases requires tariffs to be raised to ration existing capacity so that consumers are required to pay a price for water equal to its value in the highest alternative use known as the opportunity cost. Therefore, when a community runs into absolute supply constraints, economically efficient water consumption requires that in addition to marginal production and environmental costs, the price of water should also include depletion or scarcity costs.

1.5. Tariff Design – Single or Two Part Tariffs?

For many economists, the optimal water tariff design is a two-part tariff – a variable element to recover operating costs and a fixed element to cover administrative and other non-variable costs.

If consumers are homogeneous a single two-part tariff may be implemented. However, in the presence of heterogeneous consumers a menu of two-part tariffs (with trade-offs between the fixed charge and the volumetric charge) must be implemented to reflect the different costs each imposes upon the service provider and also to respond to their differing abilities to pay i.e. poorer customers are unlikely to be able to afford to pay both a fixed and a variable fee component.

Assuming a heterogeneous two-part tariff approach has been agreed upon, further rate design considerations will include:

- Should the variable element of any tariff system be a flat rate or should increasing / decreasing rates be applied to different consumption levels? Many countries employ an increasing block system whereby pre-determined volume blocks of consumption have a different (higher in this case) price attached to them.

- If an increasing (or decreasing) block system is employed, how should the volume blocks and associated prices be determined?
- Other possible variations are the differentiation of price structures according to customer classes or seasons. Even the adoption of time-of-day pricing has been advocated for the water industry, although it is more frequent in the electric power industry.

1.6. Other Bulk Water Tariff Considerations

As illustrated by the case studies presented in Section 2, there are also a number of other tariff determination decisions that need to be made. These include:

- How is the revenue earned from the application of bulk water tariff to be used? In some countries, such as China, the law prescribes that all such monies enter into a central fund managed by the government. However, in other environments there is a strong belief that bulk water revenues should be reinvested in the river basin and catchment areas from where the water supply was harnessed.

- Should all users pay for bulk water services? In many parts of the world, some categories of customer find themselves exempt from paying bulk water tariffs even where a concerted effort is being adopted to implement a bulk tariff system. This is the case in China where agriculture customers pay little or nothing for irrigation water. More generally, in many environments around the world, the concept of water as being a 'free good' has not yet been overturned. It is often the case that acceptance of water pricing (particularly at bulk water level) only becomes acceptable when the sector is in crisis and there is considerable pressure to ensure that an increasingly scarce resource is managed properly.

2. CASE STUDIES

2.1. Case Study Introduction

The case studies presented below describe how different bulk water pricing approaches have been adopted in different environments according to the nature of the objectives needed to be achieved in these communities.

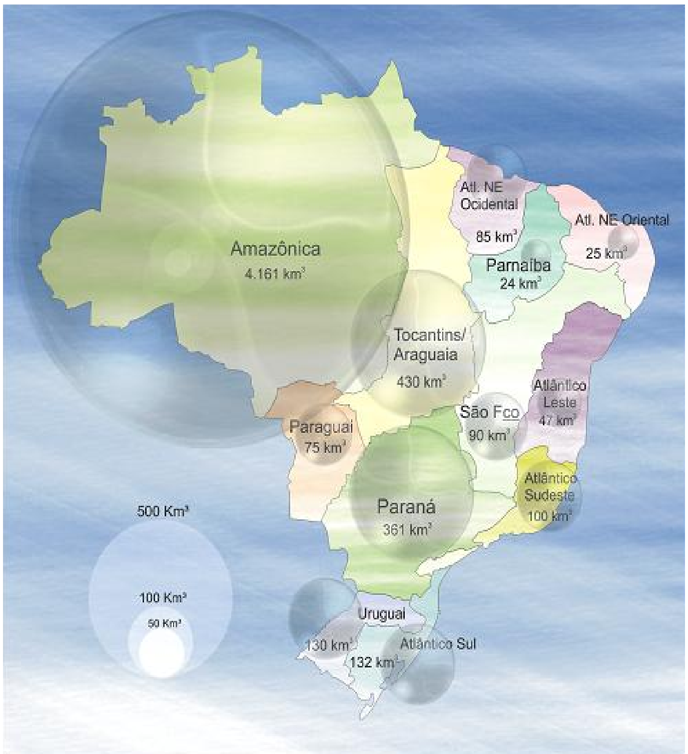
The studies were prepared using desk based research applied to discussion papers, technical notes and institutional reports from a large variety of sources. At the end of this Report a reference list is provided. In addition, study material and findings for some of the cases (in particular those relating to Australia) is based upon the personal experience of the consultants who prepared the study.

2.2. Brazil

2.2.1. Background

A great deal of work has taken place in Brazil to create an effective bulk water pricing framework. At first this may appear unusual as the country contains 12% of the world's fresh water supply. However, this statistic is misleading as 70% of the water is in the Amazon Basin where only 7% of the population lives. The remaining 93% of the country's population depends on only 30% of the available supply. The per capita availability of water therefore varies from 1,460 m3 per person / per year in the semi-arid Northeast to 634,887 m3 per person / per year in the Amazon region.

Water Yield km3



Source – ANA presentation

More specifically, water supplies in four different geographic regions present a major contrast. The North, including the Amazon basin with abundant freshwater resources, is sparsely populated but poor. The Northeast, which is semi-arid with a constant threat of severe droughts, struggles to sustain a population of 40 million people living in oppressive conditions. The West, with two dominating ecosystems, the savanna and the wetlands, is devoted to cattle raising and intensive agricultural development. The South, which is the industrial and financial hub of the country, is noted for its unbalanced water supply/demand relation, due to excessive consumption and pollution in the larger, urbanized areas.

In addition, the combined pressures exerted by a growing population and a rapidly expanding industrial base mean that bulk water pricing has become a necessity in order to finance infrastructure provision and to send appropriate price signals to stakeholders with respect to allocation and use of the resource. Pricing was also expected to impact upon resource usage efficiency through encouraging a reduction in water losses (via better maintenance of distribution systems) and better monitoring of water quality.

In the face of all these pressures, the Brazilian government, in 1984, opened discussion on what should be the country's water policy. However, the major change did not occur until 1997 with the promulgation of the National Water Resources Management Act which established the National Water Resources Policy and the National Water Resources Management System.

2.2.2. Institutional Framework

Administrative Arrangements

Brazil is organised as a Federative Republic, consisting of the Federal District and 26 states (further divided into approximately 5600 municipalities).

The legislative power and legal framework governing the relationship between the Federal government, the States and the municipalities is defined in The Federal Constitution of 1988. As a public good, the Constitution considers water from all rivers which crosses state boundaries and waters used to generate electricity as property of the Federal government and all other rivers and lakes as property of the States. The prerogative to grant concessions to use this water lies exclusively with the Federal government and the States.

Brazil Constitution – 1988 – Key Water related Articles

Article 20 [Propriety of the Union]
The following is property of the Union:
IV. river and lake islands in zones bordering on other countries, sea beaches, ocean and shore islands, the latter excluding the areas referred to in Article 26 II.

Article 21 [Powers and responsibilities of the Union]
XIX. to institute a national system for the management of hydric resources and define criteria for granting rights to the use thereof.
XII. operate, directly or through authorization, concession or permission:
b) electric services and facilities and energetic use of water courses, in cooperation with the States in the hydroenergetic potentials are located.

Article 22 [Legislative exclusivity]
It is incumbent exclusively upon the Union to legislate on:
IV. waters, energy, informatics, telecommunications, and radio broadcasting.

Article 24 [Concurrent Legislation]
It is incumbent upon the Union, the States, and the Federal District to legislate concurrently on:
VI. forests, hunting, fishing, fauna, reservation of nature, defence of the soil and natural resources, protection of the environment, and pollution control.

Article 26 [Property of the States]
III. river and lake islands which do not belong to the Republic.

This 1988 Constitution, for the first time, established a national water resource management system and began the formulation of a water resource national policy to coordinate cooperation between the different levels of government, as well as between different water users.

After a number of years of discussions and numerous redrafting the aims, principles and guidelines of the Water Resource National Policy were defined in Federal Law 9.433/97 (National Water Resources Policy law). This law was heavily influences by the French water resource model.

LAW Nº 9,433 DATED JANUARY 8, 1997

TITLE 1 - NATIONAL WATER RESOURCES POLICY

CHAPTER I - BASES

Article 1 The National Water Resources Policy is based on the following grounds:
I - water is an asset falling within the public domain.
II - water is a limited natural resource endowed with economic value.
III - in shortage situations, the top-priority use of water resources is for human consumption and watering animals.
IV - the management of water resources should always foster multiple water uses.
V - the river basin is the territorial unit for the implementation of the National Water Resources Policy and the activities of the National Water Resources Management System.
VI - the management of water resources should be decentralized, and include the participation of the Government Authorities, users and communities.

CHAPTER II - PURPOSES

Article 2 The purposes of the National Water Resources Policy are:
I - to ensure necessary amounts of water available to current and future generations, at quality standards adequate to the respective uses thereof.
II - the rational, integrated use of water resources, including water-borne transportation, fostering sustainable development.
III - prevention and defence against critical hydrological events, whether natural in origin or deriving from improper use of natural resources.

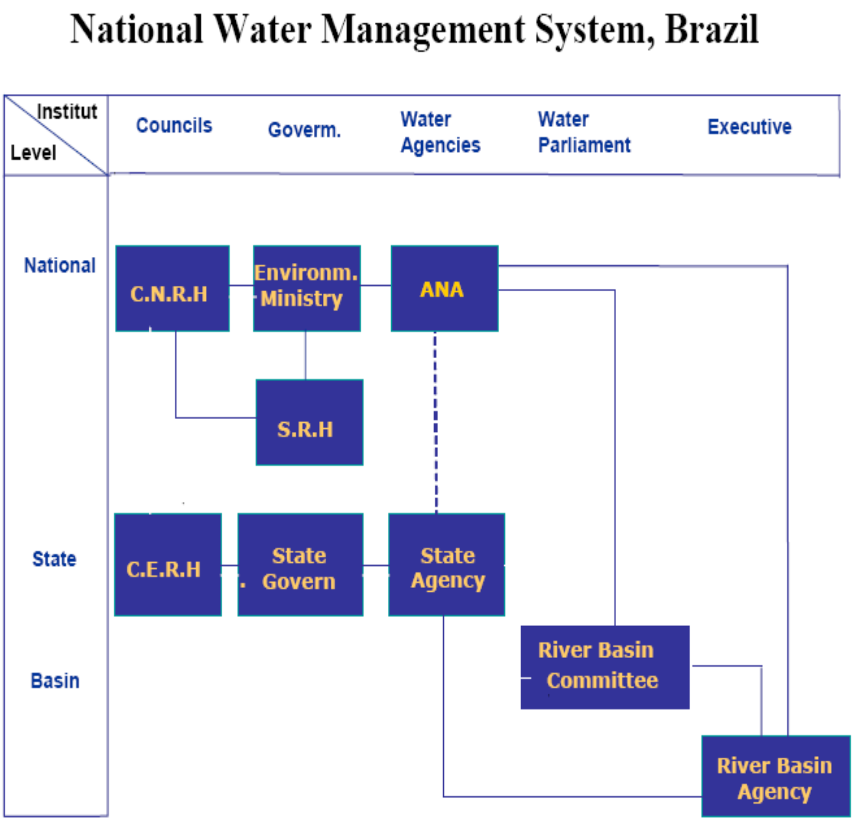
The National Water Resources Policy law set out the following key principles:

- **River basin as the territorial unit for the implementation of the National Water Resource policy** – despite some opposition from the States, it was agreed that the river basin was the most suitable unit for water resource planning.
- **Management of water should allow for multiple uses of water** – historically, priority was given to the use of water for electricity generation. With the increase in demand for water from sanitation, irrigation, industrial and other sectors, the need for equality of opportunity amongst users was recognised.
- **Water is a limited resource, which has economic value –** as a scarce economic resource, the efficient use of water would be encouraged through the introduction of tariffs.
- **Management of water resources should be decentralised and should involve participation by the government, the users and the community -** no decision should be taken at a higher level of government when it could be decided satisfactorily at an appropriate lower level.

- **When there is a shortage of water, priority is given to human consumption and watering of animals –** this lays down basic principles for periods of extreme water scarcity.

ANA – National Water Agency

In 2000, the ANA – National Water Agency (Agenvia Nacionel de Aguas) was established to enforce the National Policy on Water Resources (NPWR) set out in Federal Law n. 9.433/97. ANA is mandated to regulate and manage the water sector and has a key role in mediating between water users.



CNRH – National Water Resource Council

CERH – State Council on Water Resources

SRH – National Water Secretariat

ANA – National Water Agency (Agenvia Nacionel de Aguas)

River Basin Committees

Below the National Water Resource Council (CNRH) and State Council on Water Resources (CERH), Brazil currently has six River Basin Committees which, through assistance from the ANA, approve and implementing long run river basin Water Resources Plans. The River Basin Committees include representatives of the various stakeholders in the water sector. A typical River Basin committee comprises:

30% – Civil society representatives (NGO's, universities, etc).
30% – Users (industry, water utilities and farmers).
40% – Municipality, states and federal government representatives.

The River Basin Committees are responsible for setting out guidelines and criteria for the issuing of water permits and water tariffs:

- **Water permits –** awards the right to use water, with the water remaining a public good. A permit can only be issued by the responsible authority in the executive branch of the Federal government or the State.
- **Water Tariffs –** as water is considered to be an economic good, tariffs are seen as a means to encourage its efficient use of water and as a means of raising revenue for financing programmes and activities within the water resource plans. To overcome concerns that tariff would be used as 'another tax', revenue from tariff are required to be invested in the River Basin in which they were generated and a maximum of 7.5% of tariff revenue can be used to cover administrative overheads.

Paraíba do Sul River Basin (PSRB)

The Paraíba do Sul River Basin in the South-East of Brazil represents one of Brazil most developed regions. The high level of urbanisation and industrialisation of the region has contributed to an increase demand for water and has contributed to high levels of water pollution, with untreated urban sewage and industrial effluent major problems.

These issues concerning water pollution and declining water quality forced a debate to take place on the introduction of bulk water tariffs. In 1996, the Paraíba do Sul River Basin committee (CEIVAP) was set-up, comprising 60 members, to analyse the investment needs of the river basin and to determine a bulk tariff structure. In September 2002, the water resource plan adopted by CEIVAP envisioned an investment programme of R$ 3 Billion over 20 years (R$ 150 Million /

year). The plan was also accompanied by a bulk water pricing methodology as described in the next section.

2.2.3. Bulk Water Pricing Framework

The negotiation of bulk water prices in PSRB evolved in two separate stages:

- February to December 2001 – discussion and approval for charges for industrial and municipal users ratified by the National Water Resource council (CNRH) in March 2002.

- February to October 2002 – tariff extended to all other users (although they were still considered transitory and were approved for just three years).

Although the length of time needed to negotiate the new tariffs was longer than anticipated, the level of expected opposition from powerful vested interests such as industrial users and the public water and sanitation organisations was less than expected due to their involvement in the tariff design and setting process from the beginning. The following tariff methodology was finally accepted.

Each use is expressed in measured or estimated flows (m^3/s). For each flow abstracted, consumed or released, a corresponding charge is defined starting from a unit price (PPU – *Preço Público Unitário*) modified by use-specific coefficients.

$$C = \underbrace{Q_{cap} \times K_0 \times \mathrm{PPU}}_{\text{Withdrawal}} + \underbrace{[Q_{cap} \times K_1] \times \mathrm{PPU}}_{\text{Consumption}} + \underbrace{[Q_{cap} \times (1 - K_1)] \times [(1 - K_2 K_3) \times \mathrm{PPU}]}_{\text{Effluent dilution (BOD)}}$$

Where:

Q_{cap} = Abstracted flow (m^3/s). Data provided by user.
K_0 = Withdrawal unit price multiplier. Defined by CEIVAP.
K_1 = Consumption coefficient by activity.Provided by user.
K_2 = Treated share (%) of effluent volume (industrial and municipal effluent treatment coverage). Provided by user.
K_3 = BOD reduction effectiveness of effluent treatment process. Provided by user.
PPU = Public unit price (R\$/m^3). Defined by CEIVAP.

Essentially, therefore, monthly water charges are based upon a combination of:

- Volume of water diverted.
- Volume of effective consumed water.
- Volume of water required to dilute the effluents.

Each group of users are charged the following price units (PPU).

Bulk Water Price

	PPU (R$/m3)-(US$/m3)
Water Supply	0.02 – 0.0083
Industrial	0.02 – 0.0083
Irrigation	0.0005 – 0.000021
Aquiculture	0.0004 – 0.000017

The two main objectives driving the tariff methodology are, firstly, the need to raise sufficient revenue to finance investment in maintaining the required infrastructure, and secondly, the need to promote the efficient use of water as a resource i.e. to allocate water to the highest valued use.

As can be seen above, the eventual tariff methodology adopted in PSRB was relatively simple in form which allowed it to be clearly understood by all parties but was also effective in raising revenue. That said, revenue levels are still considerably below the full requirements of the water resource plan which means the government subvention is still required. This represents the main disadvantage of the adopted tariff methodology – because it was created through a process of compromise, the final accepted tariff does not truly reflect marginal costs i.e. they are not fully effectively in encouraging the efficient use of water nor in raising sufficient finance to fund all necessary incremental investment. Economic efficiency was 'sacrificed' to ensure the system was implemented and was acceptable to all users.

Bulk Water Tariff Revenue

YEAR	**REVENUE (R$)/(US$)**
2003	5.904.038
2004	6.316.321

2005	5.925.837

2.2.4. Outcome and Lessons to be Learned

Although Brazil has a relatively fragmented institutional framework, it successfully managed to introduce a bulk tariff pricing system that included industrial and agricultural users, the two sectors that are traditional most reluctant to participate in such schemes. A number of factors contributed to this achievement:

- The negotiation process was inclusive and open, rather than being imposed from the top.

- The process was flexible and allowed for institutional adaptation.

- The direct involvement of a federal agency helped to balance the interests of different groups whilst still allowing each stakeholder to negotiate terms.

- A condition of the participants for adopting the tariff framework was that the collected funds should be reinvested in the basin rather than being spent by the federal government.

- An important transformation took place in which water was perceived as an economic good rather that a free good (a "gift from God"). This was accompanied by acceptance of the concept of user payments and the 'polluter pays principle'.

- Users recognized that they were at a crossroads in which action was need to guarantee the long term sustainability of the water system.

- The technical capacity for implementing the framework was already in place.

2.3. Melbourne Water

2.3.1. Background

Institutional Arrangements

Melbourne Water was established in its current form in 1995. Previously, Melbourne Water was a vertically integrated monopoly provider of water supply and wastewater services for the Melbourne region. In 1995 the industry was disaggregated into:

- Three retailers (City West Water, South East Water and Yarra Valley Water).
- A wholesale supplier of water and wastewater services (Melbourne Water).
- Melbourne Parks and Waterways.

Melbourne Water and the three retailers are statutory corporations, fully owned by the Victorian government. The retailers operate under licence and their relationship to the bulk supplier (Melbourne Water) is governed both by regulatory arrangements and bilateral water and wastewater agreements.

Each retailer provides water and wastewater services in a defined geographical areas within the Melbourne region. The retailers operate the water reticulation system and non trunk wastewater network, provide meter reading and billing services and handle call centre inquiries and complaints. The retailers also provide trade waste services to commercial and industrial customers. Most wastewater treatment is undertaken by Melbourne Water, although the retailers own and operate a number of small wastewater treatment plants.

Melbourne Water provides bulk water and wastewater services to five retail water businesses (Western Water and Gippsland Water as well as the three Melbourne retailers). It provides 60% of Victoria's potable water and 11% of water supplied in Victoria for urban and rural purposes. Melbourne Water harvests raw water, stores, treats to potable standard and transfers water to the retail businesses.

Four ministers have particular responsibilities relating to the water sector:

- The Minister for Water, supported by the Department of Sustainability and Environment (DSE), is responsible for developing water policy and administering Victoria's water legislation.

- The Minister for Health, supported by the Department of Human Services, is responsible for legislative and regulatory arrangements relating to drinking water quality.

- The Minister for the Environment, supported by the EPA and DSE, has responsibilities relating to the sector's environmental performance.

- The Treasurer, supported by the Department of Treasury and Finance (DTF), shares responsibility with the Minister of Water for corporate governance of Melbourne Water and the retailers.

The key regulatory instruments used to govern the metropolitan water sector are:

- Retail licences, through which the Minister imposes conditions on the retailers.

- Statements of obligation, which specify obligations on water corporations and retailers in performing their functions. The Minister for Water, in consultation with the Treasurer and the Essential Services Commission (ESC), can specify obligations relating to governance, quality and performance standards, community service obligations, sustainability principles and customer and community consultation.

- The Water Industry Regulatory Order (WIRO), which specifies the services to be regulated by the ESC and the approach that is to be adopted by the ESC in regulating prices.

- The corporate planning process, whereby Melbourne Water and the retailers are required to submit a three year corporate plan to both the Minister and the Treasurer. The plans set out the proposed strategic direction for the businesses and projected financial and non financial performance.

- Customer service codes, developed by the ESC, which specify customer service standards for urban and rural water supply services.

The ESC is the independent economic regulator for the water sector. Under their statement of obligations, the retailers and Melbourne Water are required to submit water plans to the ESC to inform the ESC's determination of prices. The plans provide the basis for retailers to consult with customers, regulators and the DSE. They identify the outcomes expected to be delivered, the projects or programs required to achieve the outcomes, the operating and capital expenditure involved, the revenue required to fund the expenditure and the prices proposed to deliver the revenue requirement.

The Minister for Water is responsible for long term resource planning and the preparation of a sustainable water strategy. Each water business is required to develop a program of works to manage its demand supply balance, consistent with the sustainable water strategy.

Drought/Climate Change

Low rainfall in recent years has resulted in a significant reduction in inflows to Melbourne Water's reservoirs. Inflows for 2006 were the lowest on record, and average flows for the ten years to 2006/7 were about 35% less than the long term average.

The Minister released the Central Region Sustainable Water Strategy (CRSWS) in October 2006, which set the agenda for water resource management going forward. The CRSWS stated that the potential impact of climate change needed to be recognised and that supplies could not be managed on the basis of assuming a return to long term average conditions.

In response to continuing drought and further reductions in reserves, the State government released, in June 2007, "Our Water Our Future: The Next Stage of the Government's Water Plan". The Plan identified a range of system augmentations and demand management programs that would diversify and boost water supplies. These included the construction of a seawater desalination plant, an interconnector pipeline to link the Melbourne system with the Goulburn River, rehabilitating the Goulburn irrigation system to reduce irrigation water losses, adding a new treatment plant and upgrading the Eastern Treatment Plant to tertiary standard to facilitate increased water recycling. The expenditure required for these augmentation projects will drive a rapid increase in future costs and prices of bulk water supplies.

Bulk Water Supply Arrangements

Since the passage of the Water Act in 1989, there has been a program of converting the historical, imprecise, rights of water supply authorities into tradeable bulk water entitlements.

In October 2006, Melbourne's bulk water entitlements were transferred to the three retailers on a pooled basis. Melbourne Water and the retailers make up a bulk entitlement management committee which acts as the decision-making body in respect of a range of issues relating to the bulk entitlements. Caps on the amount of water able to be extracted were introduced also: 400 GL per annum from the Yarra and 555 GL per annum from the total system.

Melbourne Water's bulk supplies are governed by bulk water supply agreements that are negotiated on a commercial basis with the retail water companies. The level and structure of bulk supply prices are subject to regulation by the ESC and the customers service standards specified in the agreement must be consistent with the Rural Water Customer Service Code. Service standards specified in the code cover complaints, billing, payments, collection, works and maintenance, guaranteed service levels, customer charters and information provision. The bulk water supply agreements also specify required standards on pressure, microbiological standards, disinfection products, and aesthetic standards for turbidity and aluminium.

As part of the rural reforms required by the National Water Initiative, water entitlements in Northern Victoria have been unbundled into a water share, a delivery share and a water use licence or registration. Water entitlements on regulated systems in Southern Victoria will be unbundled in July 2008. Unbundling provides greater flexibility, making water shares easier to trade, able to be mortgaged separately and leased, and held without land. As the unbundling of entitlements is directed at improving rural water trading, it is not directly relevant to Melbourne Water which supplies bulk water for urban uses.

2.3.2. Bulk Water Pricing Framework

Level of Bulk Water Prices

The ESC conducted its first water price review in 2004 to determine prices for water and sewerage services in metropolitan Melbourne and regional Victoria. Prices were set so that they delivered the revenue requirement forecast for each business, where the revenue requirement comprised operating costs, depreciation, a return on the regulatory asset value and an allowance for taxation.

The revenue requirement determined for Melbourne Water was based on an initial regulatory asset value (RAV) of A$4.2 billion as at 1 July 2004. The ESC determined the value as being consistent with Melbourne Water's profitability prior to the new regime. The RAV was rolled forward by adding capital expenditure, deducting depreciation on the RAV, disposals and capital contributions, and adjusting for inflation. For the period 2004/5 to 2007/8 forecast rather than actual expenditures were used to roll forward the RAV. The opening regulatory asset base for the next regulatory period will be adjusted to take account of any differences between actual and forecast expenditure. The ESC determined the vanilla WACC to be 5.2% real.

Melbourne Water uses a detailed average cost model to allocate costs between the five retail water businesses it supplies. Costs are identified separately for headworks (water harvesting and storage) and the transfer system (pipes and pumping stations). The total costs to be recovered include a return and depreciation on the RAV allocated to each part of the supply system, along with direct operating costs and an allocation of overheads.

Costs are allocated between the water businesses on the basis of their usage of different parts of Melbourne water supply system. The allocations are done on the basis of the principal drivers of water supply costs, volume and distance. Sunk costs are allocated on the basis of demand shares based on 1998 volumes.

Overall a retailer pays more if the business:

- Is geographically remote from water sources to the East of Melbourne.

- Uses higher volumes from more expensive sources (e.g. filtered water from the lower Yarra).

- Uses more water overall.

Structure of Bulk Water Prices

Once the cost charges have been allocated, the fixed and variable components of the charges are established. Variable charges are calculated on the basis of the long run marginal cost of supply to each business. Long run marginal cost comprises short term costs such as power and chemicals and long run costs such as brought-forward capital costs associated with augmenting supply and increasing transfer capacity. Fixed charges are calculated as the difference between the total revenue requirement allocated to the business and the revenue expected from variable charges.

The ESC required Melbourne Water to separately identify charges for storage operation and treatment from the charges for transportation of bulk water in order to clearly signal the costs involved and to facilitate the trade of bulk water entitlements.

Melbourne Water charges separately for headworks and transfer services, with a fixed service charge and variable charge specified for each. The table below shows the tariffs proposed by Melbourne Water in its 2008 draft water plan submission to the ESC.

Melbourne Water – Bulk Water Tariffs

		City West	South East	Yarra Valley
Storage and bulk water service - headworks	$m per month	1.60	0.82	1.96

Storage and bulk water service - transfer	$m per month	0.34	0.34	0.90
Storage and bulk water usage - headworks	$ per ML	425	425	425
Storage and bulk water usage - transfer	$ per ML	110	91	69
Direct connections for bulk water services usage	$ per ML	476	240	215

Recycled Water Prices

The Statement of Obligations requires Melbourne Water to comply with the Metropolitan Water Conservation and Recycling Plan and with the obligations set out in its recycled water agreements with the retail businesses. The draft version of the recycling plan specifies a target of recycling 20% of Melbourne's effluent by 2010. There were also potable substitution targets of 6.2 GL per year by 2015 and 10 GL per year by 2030, with requirements to investigate additional opportunities for reuse for non drinking purposes as well as storm-water recycling.

In the first water price review, the ESC determined principles for pricing recycled water which must be applied by the water businesses. These principles stated that recycled water prices should:

- Maximise revenue earned from recycled water services having regard to the price of any alternative substitutes and customers' willingness to pay.
- Include a variable component to provide appropriate signals to recycled water customers to manage the resource.
- Cover the full cost of providing the service, subject to exceptions.

The Commission recognised that government recycling targets may mean that businesses are unable to recover the full costs of recycled water from recycled water customers. Where there is a revenue shortfall, the ESC argued that the basis on which it is recovered from the broader customer base should have regard to the drivers or beneficiaries of the proposed project. Also, customers should be consulted about their willingness to pay for the benefits of recycled water.

In its draft 2008 water plan, Melbourne Water proposed that the anticipated revenue shortfall be recovered from sewerage customers which is consistent with the 'polluter pays principle' and the fact that sewage salinity is constraining recycled water opportunities.

2.3.3. Outcome and Lessons to be Learned

The second pricing review for Melbourne Water and the three retailers began in 2007, alongside the review for the regional urban and rural water authorities. However, the draft plans submitted by the retailers and Melbourne Water proposed price rises that were in some cases significantly above the level that the government was expecting. (Following the release of the government's Water Plan, "Our Water Our Future", the government indicated that prices would double over five years.)

The Minister asked the Victorian Competition and Efficiency Commission (VCEC) to examine options to improve the structure of the metropolitan retail sector to best ensure the efficient and least cost provision of water services, to examine alternatives to reduce costs and to investigate any related improvements to governance and industry structure. The ESC's price review for the metropolitan sector was put on hold while VCEC conducted its inquiry.

VCEC produced a draft report in December 2007 and has submitted a final report to the Treasurer but this has not yet been released publicly. The draft report concluded:

- There were only small net benefits in moving to a single retailer, which would be outweighed by potential costs and risks from the merger.

- The Commission sought comments on two other structural options: reducing the number of retailers to two, or retaining three retailers but introducing a shared services arrangement to improve the efficiency of competitive tendering.

- Sunk costs should be allocated between retailers on the basis of more recent 2004/5 volumes, that being the year that the independent regulatory process commenced. Future bulk water and sewerage costs should be allocated according to forecast volumetric demand.

- The ESC's second price review, when conducted, would be likely to further reduce the proposed price increases.

- If further adjustments are required, VCEC favoured deferring regulatory depreciation for the retailers to achieve pricing parity and the required level of prices.

VCEC also examined a range of governance reforms and whether there was scope for greater competition. The Commission made a range of recommendations, including the development of a state based access regime, amendments to bulk entitlements to reflect new water sources, and longer term options such as whether a centrally determined economic water value model could be developed to replicate the operation of a competitive urban water market, whether a market mechanism could contribute to system management and whether a grid manager and/or independent procurement agency should be established.

Further reforms are also being advocated by the National Water Commission (NWC) and the Productivity Commission. In its first biennial assessment of progress in the implementation of the National Water Initiative, the NWC made a wide range of recommendations, including:

- Continued expansion of water trading, with governments building the necessary institutions and conditions for markets to function smoothly.

- Government contributions to the costs of urban water infrastructure and water pricing should be managed to minimise distortions to water prices.

- Recent failures in urban water planning (evidence by urban water shortages during the drought and the rush to invest in new infrastructure) should be remedied by an enhanced set of urban reform commitments to:

  - Lift the standard of urban water planning.
  - Remove policy bans on water supply options (such as indirect potable re-use).
  - Encourage diversification towards less climate dependent water supply options.
  - Encourage fundamental reforms to institutional and market arrangements for water supply, including new water supply products that offer consumers a choice of water reliability, clearer specification of entitlement for new water sources such as recycled water, allocation of tradeable entitlements to major urban water users, structural reform to create competitive pressure for water supply and delivery, and greater private sector investment opportunities.

The March 2008 Productivity Commission (PC) report "Towards Urban Water Reform: A Discussion Paper" also emphasised the potential benefits of further structural and institutional reforms. The PC particularly criticised charging regimes that recover operating costs and a return on assets but do not reflect the scarcity of water in times of shortage. Demand is managed through restrictions rather than prices, imposing costs on households that amount to billions of dollars.

Similarly, policies that restrict interaction between urban and rural water users limit the opportunities for inter-sectoral trade. This distorts water use and infrastructure investment decisions.

The Productivity Commission also endorsed the importance of improving water supply decision making, through the application of decision frameworks that better address climate-related uncertainty.

In addition the Productivity Commission recommended structural changes to introduce competition in the development of alternative supply sources. Private involvement could be expanded through innovative forms of competitive procurement. Options include outcomes based approaches and/or the use of an independent procurement agency. More ambitious reform would involve separating monopoly distribution functions from upstream and downstream activities.

The key lessons to be learned from Melbourne Water include:

- The importance of having robust pricing oversight undertaken by an independent regulator, and the desirability of removing pricing decisions from political influence.
- Water shortages put pressure on pricing (and institutional) arrangements. Robust processes are needed to avoid knee-jerk reactions.
- The potential benefits of scarcity pricing, but also the difficulty of implementing appropriate signals as to the true opportunity cost of resources in times of water shortages. While approaches to scarcity pricing have been under discussion in Australia for some time, no jurisdiction has yet implemented anything approaching a scarcity based approach. Moreover the widely used the revenue building block approach to setting the level of tariffs is not conducive to the development of scarcity tariffs.
- The importance of well defined water entitlements, structured in a way that facilitates water trading. Appropriate water entitlements need to be developed for new water sources (such as recycling and desalination) as well as for traditional surface and groundwater sources.

2.4. South Africa

2.4.1. Background

Pricing of raw water in South Africa is governed by the Department of Water Affairs and Forestry (DWAF) who, in turn, base their decisions upon a regulation entitled "Pricing Strategy for Raw Water Use Charges (November 1999)" which appears as Section 56(1) of the National Water Act (Act No. 36 of 1998). Water is supplied to Local Councils or water services authorities (WSA) through contracts governed by the Water Services Act (Act No. 108 of 1997).

This Case Study presents two examples of the application of these principles: the **City of Cape Town** and the **Trans-Caledon Tunnel Authority (TCTA)**.

The City of Cape Town's Bulk Water Department is responsible for the bulk supply of potable water to the Cape Metropolitan Area and to Local Councils who are dependent on the City of Cape Town for all or part of their water supplies. Services include the storage of raw water in dams, the conveyance and treatment of raw water from these and Government Water Schemes and the distribution and bulk storage of the treated water. The Customers of the Bulk Water Department include the internal reticulating department(s) responsible for distribution to end-users.

The Trans-Caledon Tunnel Authority (TCTA) is a state-owned entity mandated by the Minister of Water Affairs and Forestry to implement and fund raw bulk water infrastructure to supply areas with limited water resources. TCTA implements bulk water infrastructure, with a key focus on sustainability. It is responsible for three major projects: the Lesotho Highlands Water Project (LHWP), the Berg Water Project (BWP), and the Vaal Eastern Sub-system Augmentation Project (VRESAP). TCTA also carries out other services as required by DWAF, including providing assistance to Umgeni Water.

LHWP is the largest project ever undertaken in Southern Africa and entails diverting water from the Senqu River system in Lesotho to the water-stressed Gauteng region of South Africa. It is a bi-national project implemented by TCTA, within South Africa, and the Lesotho Highlands Development Authority (LHDA), within Lesotho, overseen by the Lesotho Highlands Water Commission (LHWC). The oversight role of the LHWC is defined in Protocol VI to the Treaty. South Africa is responsible for all the costs incurred on the water transfer component of the project. TCTA has been mandated to finance and manage the liability of the water transfer component, while LHDA is responsible for the loans on the hydropower component to the Lesotho government. Repayment of the water transfer debt relies on the revenue stream from water sales to Vaal River system water users. This revenue is based on a tariff charged for actual water usage and was phased in over time.

BWP is designed to capture the winter rainfall and store it for supply to the City of Cape Town during the dry summer months. BWP is the first bulk water resource development project that was directly linked to water demand management. BWP increased the yield of the Western Cape Water System (WCWS) by 81 million m^3 or 18% to 523 million m^3 a year by 2007. The project impounded the Berg River in June 2007 and began delivery of water to Cape Town at the end of 2007. BWP is a public-public partnership between DWAF, City of Cape Town and TCTA. The agreements were signed in April 2003.

VRESAP, also known as the Vaal Pipeline Project, is being implemented to meet the growing water demands of Eskom and Sasol in the Mpumalanga Highveld region. The scheme will transfer water via a 121 km pipeline from the Vaal Dam near Vaal Marina to the Knoppiesfontein diversion structure which discharges into either the Trichardtsfontein or Bosjesspruit dams near Secunda. VRESAP will augment the yield of the Vaal River Eastern Sub-system (VRESS) by 160 million m^3 per year. VRESAP is a separately ring-fenced project without a government guarantee, implemented and financed by TCTA. The borrowings are in TCTA's name with recourse against the income stream from the project.

Target employment percentages have been defined for the various Contracts under VRESAP to maximize employment opportunities for the local communities and minimise the utilisation of imported labour. The project is also expected to maximize contracting, training and development opportunities for local businesses, HDI-owned businesses and SMMEs so as to ensure maximum procurement opportunities. The performance of the contractor against the targets is monitored on a monthly basis. The project is expected to provide 750 temporary jobs during construction and 20 permanent ones during the operation and maintenance phase.

The relationship between TCTA and Umgeni Water was formalized in a two-year service level agreement on 11 July 2001. During July 2003 this agreement was extended for two years or until Umgeni Water could function independently. On 17 May 2004, the Minister confirmed that TCTA had completed its intervention role and that following a capacity-building and handover programme, TCTA and Umgeni Water should negotiate a commercial contract. The capacity-building and handover programme was completed in January 2005. In June 2005, TCTA and Umgeni Water signed a new service level agreement according to which TCTA provides assistance on:

- Tariffs.
- Funding and debt management.
- Risk and ALCO management.
- Reviewing treasury operational issues.
- Formulating interest rate views.
- Ad-hoc services.

2.4.2. Bulk Water Pricing Framework

City of Cape Town

The bulk water tariff is charged to external bulk consumers and internal consumers on the same basis. The Bulk Water Department also has various tariffs for non-bulk consumers and charges for non-core functions.

The general principles upon which the calculation of the bulk water tariff is based are:

- Full cost recovery.
- Long-term sustainability of the service.
- Financial ring-fencing of the service.

The bulk water tariff is determined each financial year by dividing an estimate of the net expenditure of the Bulk Water Department by an estimate of the expected total volume of water less the water allocated by special agreements and unaccounted-for water. The estimate of the total amount of water produced is based on short- and long-term water demand projections including areas external to the Cape Metropolitan Area. The effect of Water Demand Management Programmes are taken into account in determining the water demand projections.

Total expenditure for these purposes comprises the following:

- The cost of raw water purchased from the Department of Water Affairs and Forestry (DWAF).

- Water treatment costs and all other operational costs associated with the bulk water system. The bulk water system is defined as the infrastructure (including dam catchment management costs).

- The repayment of loans taken out to finance capital costs.

- Contributions to a Bulk Water Reserve Fund to finance future capital infrastructure requirements.

- Contributions to a Water Demand Management Fund to assist distributors with their Water Demand Management initiatives.

- Contributions to a Stabilisation Fund to ensure tariff stability.

Miscellaneous income and income from special agreements are subtracted from the total expenditure to give the net expenditure. An additional charge is added to the bulk water tariff to cover the levy payable to the Water Research Commission. In order to facilitate long term planning and to ensure that the proposed tariff will enable the Bulk Water Department to sustain its proposed operating and capital expenditure over the following 10 year period, an affordability model is used. Capital expenditure in the Bulk Water Department is cyclical and the affordability model is also utilised to assist in tariff smoothing by drawing from or contributing to the stabilisation fund on a yearly basis. Further inputs into the affordability model are the envisaged 10 year capital and operating budgets, as well as any additional payments which will have to be made to the Department of Water Affairs and Forestry for capital infrastructure development.

The Bulk Water Department may also increase its bulk water tariff in certain circumstances: during periods of water restrictions, following the introduction of more stringent water quality standards and when construction of new water supply schemes by the Department of Water Affairs and Forestry so warrants. Financial ring-fencing of the service ensures that no cross-subsidisation of the service to external bulk consumers and vice-versa takes place. The tariff is determined on an annual basis, except where adjustments are necessitated by water restrictions etc.

TCTA

In 1988, a levy was introduced to fund part of the development costs of LHWP until it started to deliver water in 1998. The levy partially financed costs during the initial construction period and started at two cents per cubic metre in 1988. The total revenue generated in levies was R1 688 million and in tariffs to date is R12 108 million (2006: R10 157 million).

The bulk raw water tariff for the Vaal River system, and hence for LHWP, is now determined by a pricing policy that attempts to peg the price of raw water in real terms. It takes into account the demand for water and further Vaal River System augmentation schemes. The water tariff charged to end users comprises the following elements:

- Bulk raw water that includes the Lesotho Highlands Water Project (charged by the Department of Water Affairs and Forestry).

- Bulk purified water (charged by Water Boards).

- Reticulated water (charged by local authorities).

Revenue for LHWP comprises a portion of the bulk raw water tariff collected by DWAF. This revenue is generated over the life of the project and is sufficient to pay for the construction, maintenance, operation, royalty and finance costs of the water delivery component of the Project, within 20 years of completion of the construction of each sub-phase. On 3 August 2001, TCTA entered into an Income Agreement with the Department of Water Affairs and Forestry, whereby the tariff is adjusted annually by the year-on-year CPIX. Should the annual CPIX adjustment exceed 7.5%, or be lower than 4.5%, the adjustment to the tariff is negotiated. Other than these annual adjustments, negotiated adjustments can also be triggered by changes in water demand, changes in timing and capital expenditure for further augmentation.

Revenue generated in 2007 by the sale of 1,385 million m^3 (2006: 1,349 million m^3) of raw water was R 1,951 million (2006: R 1,775 million). This revenue was based on a 2007 bulk raw water tariff of 140.83 cents per cubic metre (2006: 131.60 cents per cubic metre). The higher revenue reflected a 7.03% increase in the water tariff and a 2.7% increase in water volume[1].

Despite these tariff adjustments, LHWP still has a net deficit after interest. Income is sufficient to repay all water transfer costs within approximately 20 years after completion of each subphase. However, interest is capitalised for the first years of operation to permit end-user affordability and tariff stability.

A financial model was agreed between DWAF and the City of Cape Town for financing the Berg Water project. A phased-in tariff commencing on 1 July 2003 until the commissioning of the project in 2007 was added to the City's Bulk Water Tariff. Water users in the City of Cape Town will repay this through a Berg Water Charge to be added to the tariff charged by DWAF on water supplied from the Western Cape Water System. This charge is based on water used by consumers and not by water delivered into the system. The charge

[1] TCTA Annual Report 2007, p39

will be phased in over a 4-year period to minimize the annual impact on consumers. The estimated cost of the project in January 2002 was R 1.4 billion and will amount to R 1.85 billion in 2008 at an escalation of 6% per annum.

The Berg Water Project was awarded an excellent Fitch credit rating (AA+). The R 1.5 billion funding for construction was negotiated successfully with three major financial institutions. The long-term loans will be repaid over a 20-year period from revenue generated by the sale of water to the City of Cape Town. The project debt will peak at R 1.3 billion in 2008 and will be repaid by 2028.

The estimated final cost of VRESAP was R 2.5 billion. It was funded on an off-budget basis; the capital costs are to be recovered from the revenue generated from the sale of water to Eskom and Sasol. The VRESAP tariffs are based on the total water required by Sasol and Eskom from VRESS (the overall system). There are differentiated tariffs for each user, levied on existing infrastructure usage and an augmentation tariff levied on the total usage per user out of VRESS.

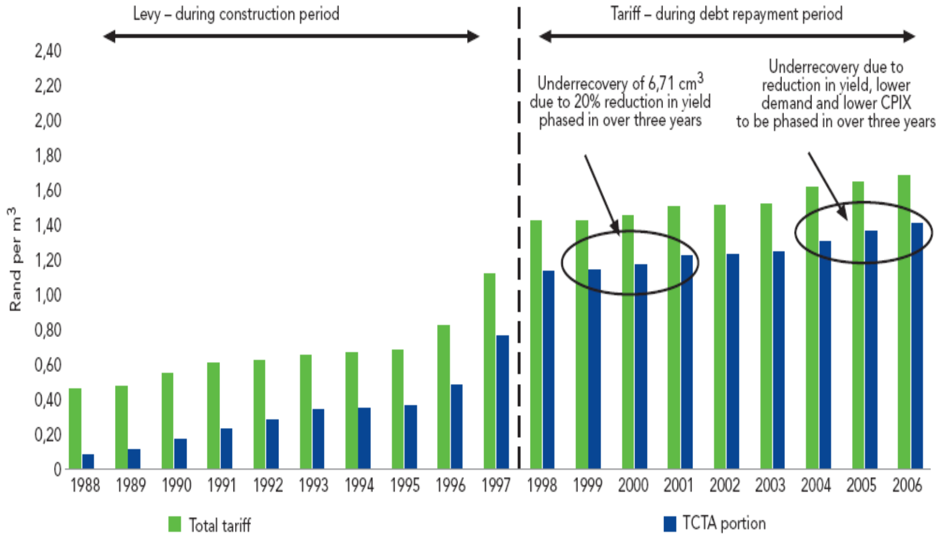
The TCTA 2007 Annual Report provides detail of the way in which tariffs are adjusted as new information becomes available. For example, during the 2000/01 tariff determination, the yield of the Vaal River system was determined to be lower than originally anticipated by DWAF. This resulted in an under-recovery in the tariff of 6.71 cents per cubic metre, which triggered a negotiated adjustment to be phased in over a three year period. During the tariff revision in 2006, a 5.5% increase in the yield of the Vaal and a slight upward revision in water demand, plus higher inflation and lower average real interest rates were all allowed for.

The table below provides detail of the agreed increases between 2000 and 2008.

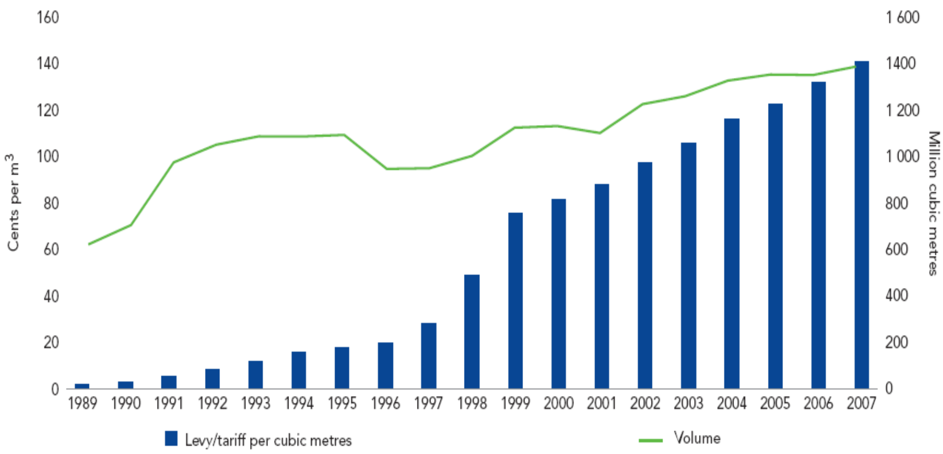
Vaal River tariff for augmentation schemes	Increase c/m³	% increase due to CPIX	% increase due to triggers	Total % increase
2000/01 tariff:	88,14			
Phase in portion one	2,11		2,39	
CPIX adjustment	7,05	8,00		
2001/02 tariff:	97,30			10,39
Income agreement signed August 2001				
Phase in portion two	2,33		2,53	
CPIX automatic adjustment	5,97	6,00		
2002/03 tariff:	105,60			8,53
Phase in portion three	2,57		2,43	
CPIX negotiated adjustment capped	7,93	7,50		
2003/04 tariff:	116,10			9,93
CPIX automatic adjustment	6,30	5,40		
2004/05 tariff:	122,40			5,40
CPIX automatic adjustment	6,14	5,00		
Phase in portion one of three	3,06		2,50	
2005/06 tariff:	131,60			7,50
CPIX negotiated adjustment	5,92	4,50		
Phase in portion two of three	3,33		2,53	
2006/07 tariff:	140,83			7,03
CPIX automatic adjustment	6,76	4,80		
Phase in portion three of three (waived)	–		–	
2007/08 tariff:	147,59			4,80

Source: TCTA Annual Report 2007 p40

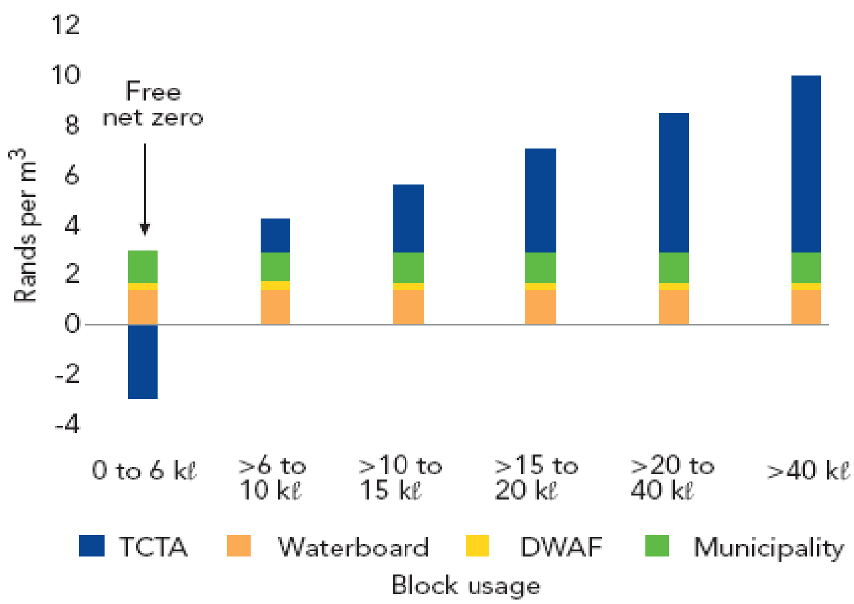
The figure below shows TCTA's share of total raw water tariff in 2006 prices.



The figure below shows the actual tariff charged each year for bulk water and the volume of sales on which the tariff was charged, highlighting the effective phasing-in of tariffs.



Finally, the figure below shows the composition of final tariff for domestic usage in the 2006/7 financial year.



2.4.3. Outcome and Lessons to be Learned

The rise in water tariffs in South Africa has caused concern among consumers as the commercialisation of water utilities in the country already has made clean water unaffordable to many poor households. Poverty and high water tariffs were blamed for the 2001 cholera epidemic in Johannesburg as many poor household were disconnected from water supply after failing to pay for the service. To help alleviate such concerns, municipal water authorities are implementing pro-poor policy measures. For example, Johannesburg Water supplies the first 6,000 litres free to every household.

With respect to the bulk water tariff framework, the following factors may be pointed to as being key factors in strategy development:

- Success in developing relationships between various public bodies and in ensuring 'level playing field' between internal and external stakeholders.

- Ability to achieve high credit ratings for major schemes through detailed financial models and tariff agreements.

- TCTA has been successful in adjusting tariffs to meet financial needs, following extensive stakeholder and major user consultation.

However, it should be noted that TCTA is not always successful in reaching tariff agreements. For example it was asked to participate in a dispute with the Impala Water Users and concluded that the tariffs were insufficient to finance the infrastructure, following which it withdrew from the discussions.

2.5. China

2.5.1. Background

China has major problems with water supply and pollution. China has as much water overall as Canada, but has 100 times more people. China's per capita water reserves of 2,500 m3 are one-fourth the global average. China's economic growth, industrialization, and urbanization, coupled with inadequate investment in basic water supply and treatment infrastructure, have resulted in widespread water pollution. Groundwater sources are polluted and dwindling, especially in the North China Plain.

2.5.2. Legal and Institutional Framework

The main laws which affect the China water sector are:

- Water Law of the PRC.
- Law of the PRC on the prevention and control of water pollution.
- Flood Control Law of the PRC.
- Law of the PRC on Water and Soil Conservation.

The 11th Five Year Plan (for 2006 to 2010) reflects the over-riding theme of the recent NPC towards 'Scientific Development' and sustainability. The key economic targets in the plan include shifting to an efficient growth model; upgrading the industrial structure; boosting the rural economy; improving resource allocation; achieving balanced spatial development (i.e. improving the relative performance of Central and Western Provinces); and improving public services. There is also an increasing focus on environmental protection.

A number of River Basin Commissions have been created for watershed management. In the late 1990's[2], they also given more responsibility for water quality, but still had difficulty implementing water use policies in some provinces. By the end of October 2004, institutional reform of water affairs management had been implemented in 30 PARs and 1,251 agencies – either in the form of newly established water affairs bureaux or as original water resources administrations – had begun to implement integrated water affairs management (in which 950 were water affairs bureaus), covering 53% of administrative regions at county level and above in China.

On April 19, 2004, the General Office of the State Council issued the *"Notice on Promoting Water Pricing Reform and Conservation and Protection of Water Resources"*, which paved the way for water pricing reform. The Notice specifies the reform of water resources fees, wastewater treatment fees, water prices for water resources projects, prices of urban water supply and the price of reclaimed water. Regulation or implementation rules on water pricing were initially issued in the seven PARs of Hunan, Yunnan, Hubei, Guangxi, Jiangxi, Chongqing and Heilongjiang. A progressive block pricing structure has been adopted in more than ten PARs such as Hebei and Guangxi, and pilot projects have been implemented on the reform of agricultural water pricing in Hubei, Yunnan, Heilongjiang, etc.

The Ministry of Water Resources has recently been replaced by the Ministry of Construction as the leading agency for the water and wastewater sectors, because of the importance of developing new infrastructure, and this has also reduced the role of the State Environmental Protection Agency (SEPA). Municipal governments are primarily responsible for providing and regulating water and wastewater treatment services, owning and managing more than sixty per cent of capacity. Recently, many municipalities have restructured their water utilities as fully publicly-owned companies, with autonomous accounting structures, some of which have listed

[2] Following quality emergencies in 1995

publicly. Municipalities have been encouraged to commercialise local wastewater companies and to seek foreign investment. Central and local governments have introduced various policies to support commercialisation. These include the provision of land for wastewater facilities, tax breaks, electricity and credit guarantees for private investors.

Since 1992, Suez has gained 18 bulk water contracts in high income areas such as Hainan, the Chinese equivalence of Hawaii. Veolia is involved in 13 projects and has signed a 50-year management contract in Pudong in 2002. Thames and Berlinwasser are also involved, with the latter recently winning a $58 million contract in the eastern city of Hefei. In southern China, direct negotiations between firms and municipalities are being replaced by a competitive bidding process. The multinationals often find themselves bidding against a proliferation of local companies, who are inexperienced, but offer far lower prices (20% to 30% cheaper).

An unusual feature of BOT-style projects in China has been that the intake and outflow assets are transferred to Chinese water authorities at no cost. The capital expenditure incurred in constructing these assets is absorbed within the overall project financing costs, becoming merely an aspect of the tariff charged under the off-take agreement. The tariff includes the capital and funding costs of the intake and outflow pipelines, as well as the capital, funding and operating costs of the water plant. The separation of asset ownership and tariff liability gives the water supply authority free intake facilities, while imposing additional costs on the relevant water off-taker.

2.5.3. Bulk Water Pricing Framework

The *Administrative Regulation on Urban Water Supply Pricing*, introduced in 1998, provides a legal basis for water supply pricing in China. The regulation states that:

- The general principles of setting water tariffs are "cost recovery, reasonable revenue, water conservation and social equity".

- Municipalities are responsible for approving water tariffs.

- Tariffs should cover operation and maintenance, depreciation, and interest costs.

- Tariffs should allow for an 8 – 10% return on the net value of fixed assets, depending on the sources of funds.

- Tariffs should be appropriate to local characteristics and social affordability.

- A two-part tariff consisting of a fixed demand charge and a volumetric charge or increasing block tariff (IBT) should be gradually adopted.

- The first block of IBT should meet the basic living need of residents.

- Public hearings and notices should be conducted in the decision making process of setting water tariffs.

Currently, typical large-sized and mega-cities in China charge between 1.00 – 3.00 (and sometimes over) RMB/cubic meter of water for residential use. The wastewater treatment fee ranges between 0.25 – 1.00 RMB/cubic meter[3]. Cross-subsidization between consumer classes is common, with industrial and commercial consumers typically paying 1.5 times as much per cubic meter than households.

In addition to tariffs for the water supply and wastewater facilities, water bills typically include a water resource fee and a water development fee, based upon the allocated cost of the raw water supply infrastructure. Guided by the *Ordinance of Water Permits and Water Resource Fee Management*, which replaced the old water permit management ordinance and became effective in April 2006, water resource fees are determined by the local government(s) concerned. Different areas have different levels based on the actual status of

[3] Water Supply Pricing In China: Economic Efficiency, Environment, and Social Affordability. World Bank Policy Note December 2007.

water resources. Beijing now charges 1.10 RMB for its water resource fee but Chongqing charges only 0.10 RMB.

Government guidelines require that municipalities establish a water pricing system that promotes water conservation. At the end of 2003, Wang Jirong, vice-director of SEPA, reaffirmed the government's position on this issue when releasing the annual Statement on China's Environment, *"Despite the severe shortage, water is too cheap to be used economically. Only a raised price could motivate consumers to conserve"*.

Water tariffs in China have been rising steadily in recent years and are usually set at a local level. Budgetary constraints and falling subsidies, along with the increasing necessity to attract private investors, is making municipalities more and more aware of the necessity to increase water tariffs, start charging wastewater fees and introduce progressive billing for large customers.
Tariffs vary with category of user and most municipalities have a complex matrix of tariffs for different user types, reflecting social and political concerns. Enterprises or departments responsible for service provision make a written application for a price increase to the municipal government. This application must include information on the following:

- Justification for the price increase.
- Proposed amount of the increase.
- Estimation of the likely impact on consumers.
- Information on production and operating costs over the last three years, together with any other detailed information specified by the local Price Office.
- An independent audit report on the company's financial position.

The local Price Office considers the price application on behalf of the municipal government and decides whether the application should go to a public hearing. The Price Office may consult other organs of government or interested parties and ask for clarification or additional information before reaching a decision. The Price Office should make an initial response to the applicant within 20 days. If the price application is considered to have reasonable merit by the Price Office, a public hearing is convened within three months. Public hearings are open to the ordinary public and are advertised by the Price Office.

It is only where foreign investors have agreements which specify bulk tariffs that China provides direct evidence. Bulk tariffs in recent BOT agreements have often been higher than the tariff charged to residential users. For example, the bulk water tariff paid to the Chengdu No 6 project by the Chengdu water company was RMB 0.98 per cubic meter, higher than the water tariff charged to residential users, which stood at RMB 0.65 per cubic meter when the agreement was made.

Bulk tariffs charged on specific BOT projects (RMB per m^3)[4]:

Chengdu No 6	0.98	1998
Lianjiang	1.25	1999
Zhongshan Dafeng	0.77	2002
Baoding	0.61	2000
Nanchang	1.05	2002
Siping	0.84	2002
Shenyang No 8	1.09	2002
Changtu	1.1	2003

The price of water in Beijing, for example, reflects a number of different cost items[5]. For example, the tariff in 2003 was 2.9 RMB/cubic meter. This tariff consisted of a water resource fee (for both surface and groundwater) of 0.6 RMB/cubic meter, a sewage treatment fee of 0.6 RMB/cubic meter, a tap water fee of 1.7 RMB/cubic meter to cover the fixed and variable (capital and O&M) costs of the water supply company, and a tax of 0.33 RMB/cubic meter paid to the Beijing municipality. This reflects the structure

[4] Data from 'Water Market China' by Olivia Jensen and Frederic Blanc-Brude, Global Water Intelligence 2004

[5] This paragraph taken from Water Supply Pricing In China: Economic Efficiency, Environment, and Social Affordability. World Bank Analytical and Advisory Assistance (AAA) Program China, 2007

stipulated in China's Price Law and the National Guidelines on Water Tariffs. At present, the price of water in Beijing is the highest in all the cities in China and recent price adjustments for the residential sector have been focused on the sewage treatment fee and water resource charge, rather than the tap water tariff. Despite these reforms, including a further increase in the residential water tariff to 3.7 RMB/cubic meter in 2004, water and sewerage in Beijing remain subsidised.

Increasing block tariffs are used quite widely in China. For example, the water tariff scheme adopted in Lijiang City (2005 figures) has first block up to 25 cubic meters per household per month charged at 1.40 RMB/cubic meter (excluding 0.40 RMB/cubic meter for wastewater treatment), the second block from 25 to 35 cubic meters at 2.10 RMB and the third and final block above 35 cubic meters at 2.80 RMB/cubic meter.

2.5.4. Outcome and Lessons to be Learned

Some of the key features of China's water pricing strategy that may be relevant in other environments include:

- Recognition both at central and local levels of importance of price in rationing quality.
- Extensive consultative processes over water tariffs.
- Authority at local level to set tariffs.
- Inclusion of water resource feeds and water development fees.
- Intake and outflow assets transferred to state at no cost.
- Competitive bidding processes found to be valuable even in a planning environment.

A recent study of water pricing in China[6] provided the following key messages:

a) *Pricing policy is an essential tool to improve the efficiency of water use, protect the water environment, and address water scarcity problems.*

b) *Given the magnitude of water scarcity in China, the country should aggressively implement tariff reforms based upon the Marginal Opportunity Cost (MOC) concept.*

c) *Public acceptability of price reform and affordability of water by the poor are important concerns although these can be resolved by appropriate water tariff structures and community outreach programs.*

d) *Since international experience offers limited guidance in this area, China should exercise its own leadership before the water crisis in the country becomes unmanageable.*

The MOC pricing approach has been investigated by the China Council for International Cooperation on Environment and Development (CCICED). The rapidly escalating costs of water and its disposal demonstrated the need for prices in excess of those required to cover the purely financial costs7 in order to reflect environmental and scarcity factors.

An example from the Hai River Basin.is given in the World Bank water pricing report. This region has severe water resource problems. The study states:

While water production costs, at 5.08 RMB/ cubic meter, are relatively high, they are minimal in comparison with the potential costs of a water shortage in the region. The study estimates the economic value of water (EVW) – or opportunity cost – in terms of value added in alternative industrial or agricultural uses, and finds that the average

[6] Water Supply Pricing In China: Economic Efficiency, Environment, and Social Affordability. World Bank Analytical and Advisory Assistance (AAA) Program China, 2007

[7] Warford, Jeremy and Li Yining (eds), Economics of the Environment in China, CCICED 2002

EVW for economic sectors based on integrated water withdrawal in eight study areas to be 41.8 RMB/cubic meter, in which that for tertiary industry is as high as 208 RMB/cubic meter, the next highest is for construction at 180 RMB/cubic meter, the third is for mining and quarrying at 114 RMB/cubic meter and the lowest is for various agricultural uses, ranging between 3–16 RMB/cubic meter. There is considerable variation in EVW between different areas, with the average EVW in Beijing being the highest and that in Xinxiang is lowest.

China has also been successful in reducing public opposition to tariff increases as shown in the following case study taken from the World Bank pricing report:

An attempt to obtain public support for price increases that were required to provide funding for improvement and expansion of facilities in Chongqing received a hostile reception at public hearings. Consequently, the Chongqing municipal government conducted a research effort to facilitate a public awareness campaign. This was aimed at educating the population about the costs of supplying water and managing wastewater generated in the city and the impact on service quality if the municipal water supply system was unable to increase revenues. It showed that the primary losers when prices are too low were the poor, whose service standards remained inadequate. Indeed, the wealthier consumers, who consumed the most water, were the biggest beneficiaries from the subsidies involved.

In addition to the educational process, and in recognition of the problems the poor had in paying higher water prices, the Chongqing municipality decided to implement a number of parallel subsidies for disadvantaged groups including the unemployed which would be sufficient to maintain basic living standards which included paying the increased water bills. The study also recognized that a step-by-step approach must be used, and a schedule for gradual increases in prices over a number of years was introduced. Since the public was made aware of the findings of the study and in particular the rationale for the price increase, subsequent public hearings attended by representatives of disadvantaged groups were very constructive. The whole process was instrumental in making the required price increases socially *acceptable, and the reforms have apparently been effective in reducing water consumption in the city.*

Finally, the World Bank pricing report makes a number of useful recommendations:

a) *Utilities should be required to estimate the long run marginal cost of their own operations (investment and operating costs) over say a 20- year period. Such estimates should be monitored and updated on a continuous basis, requiring an expanded long-term planning capability.*

b) *Local governments should develop the capacity to assess the environmental consequences of alternative water development programs and estimate the costs of environmental damage, including the costs of environmental protection measures where appropriate.*

c) *Local governments should also develop the capacity to estimate water depletion costs on a regional level.*

d) *Estimated environmental and depletion costs should be charged to the concerned utility by the local authority, and, in addition to the long run marginal supply cost, be the components of a pricing policy based upon MOC.*

e) *Water tariffs for commerce and industry should cover full MOC; for residential consumers, the first block should be about 40 litres per capita per day, with the second block gradually increasing to full MOC.*

f) *Utilities should be required to submit strategies to concerned local government so they can fully implement MOC pricing within a time frame, which will be based upon costs, incomes, and public acceptability; the strategies should involve a program of public education and stakeholder involvement.*

g) *A system should be devised in which such MOC estimates can be integrated into regional and national water management and economic planning systems.*

h) *Parallel pricing reforms should be carried out for other water uses, in particular for agricultural use and large scale industrial abstraction.*

i) *Existing policy is to meter individual industrial, commercial, and residential consumers on a case-by-case basis, but this will need to be accelerated as water supply costs increase.*

j) *Utilities should study demographic and income patterns in their area, while continually updating such information, in order to devise efficient and equitable cost recovery mechanisms using non-price mechanisms if metering is not justified.*

2.6. Harvey Water (Western Australia)

2.6.1. Background

Institutional Arrangements

The supply of water and wastewater services in Western Australia (WA) is dominated by the Water Corporation, which is a government owned entity. The Water Corporation supplies potable water to the major metropolitan area of Perth and surrounds, as well as the majority of regional centres and towns.

The towns of Busselton and Bunbury are served by separate water suppliers (Busselton Water and AQWEST), with local governments and mining towns also responsible for supplies in specific areas. The Water Corporation supplies the vast majority of potable water (97%). In addition, large volumes of non potable water are used by agriculture, mining and other industry. The vast majority of non potable supplies are self-sourced (largely from groundwater supplies).

Water resources are managed within a broad policy framework set at the national level. The Council of Australian Governments (COAG) has agreed a series of water reforms implemented through the National Water Initiative (NWI). The NWI addresses issues such as urban and rural water pricing, water trading, water access entitlements and water resource accounting. The two key national agencies responsible for implementing the reforms are the Department of Environment and Water Resources and the National Water Commission.

Within WA, the Department of Water oversees water policy development. The Economic Regulation Authority (ERA) has responsibility for overseeing the determination of prices for water and wastewater services supplied by Water Corporation, AQUEST and Busselton Water. Various agencies are involved in the regulation of water quality including the EPA and the Swan River Trust for river water quality and the Department of Health for drinking water quality.

Water Corporation supplies Perth through the Integrated Water Supply Scheme (IWSS). The IWSS also supplies water to towns in the South West, the Perth Hills and to towns along the goldfields pipeline to Kalgoorlie.

Water Corporation is a corporatized body, formed through the 1995 Water Corporation Act. In 1996, the Corporation transferred its South West irrigation distribution system to the South West Irrigation Management Co-operative which now trades as Harvey Water. At that time, a ten-year water storage agreement was entered into.

Water Corporation owns and operates the eight dams in the South West that are used to provide water to farmers and private industry (supplied through Harvey Water's distribution system) and customers in Perth and elsewhere via the IWSS. While the Corporation owns and operates the dams, Harvey Water was granted water access entitlements to the majority of water in the dams. Thus, the Corporation does not charge for the water itself but only the costs of storing the water.

Harvey Water owns and manages three separate irrigation systems – Waroona, Harvey and Collie – supplied by water from eight dams. In 2005/6, Harvey Water had a total allocation of 152 GL. However, water trading between Harvey Water and the Corporation will reduce this to 136 GL by 2009/10. The Waroona and Harvey Irrigation Schemes are linked to the IWSS via the Stirling Trunk Main.

Bulk Water Supply Agreement

The Bulk Water Supply Agreement (BSWA) entered into in 1996 specifies the terms and conditions under which the Corporation provided water storage services to Harvey Water. The BWSA also provided for Harvey Water to meet a share of the future costs of safety improvements on the South West irrigation dams.

Water storage charges to Harvey Water were set on the basis that 85% of the future operating and renewal costs for dam headworks would be recovered from Harvey Water and other direct users, with the remaining 15% of costs paid for by government (on behalf of other beneficiaries such as recreational users).

In 2004/5 water charges amounted to around $0.8 million, of which $0.39 million was for dam safety, $0.25 million for storing water for Harvey Water and $0.16 million for storage for non irrigation users. The government made a Community Service Obligation (CSO) payment to the Corporation to cover the difference between its water storage costs and revenue recovered, and the CSO provides the Corporation with a return on the dam assets that were in place at the time of the transfer.

The BWSA expired in mid June 2006 and the agreement has been rolled forward under the existing terms and conditions since then. ERA was asked to undertake an inquiry into the appropriate level and structure of water storage charges to Harvey Water and completed its inquiry in June 2007.

In conducting the Inquiry, ERA had regard to a number of issues including:

- The long term reduction in rainfall compared to the historical average experienced in South West WA.
- The significantly higher than expected expenditures on dam safety required to meet the ANCOLD dam safety guidelines.
- Obligations under the NWI that require the State government to ensure that charges for water supply services lie within the lower and upper bound pricing limits determined by the COAG agreement.

ERA recognised that, in setting a new bulk supply agreement, it was necessary to apply pricing frameworks that were consistent with current policy and regulatory approaches and that these had changed significantly from the time of the original agreement. Doing this involved interpreting the intent of the original agreement to maintain equity to those involved, while taking account of changed circumstances and providing appropriate incentives to customers.

2.6.2. Bulk Water Pricing Framework

Recommended Level of Charges

Under the NWI, lower bound prices are intended to ensure that a water supplier remains financially viable. To this end, prices are required to recover at least operational, maintenance and administrative costs, externalities, taxes or tax equivalents, the interest cost on debt, dividends (if any) and make provision for future asset refurbishment/replacement.

Upper bound pricing is designed to prevent water businesses from earning a monopoly rent. It requires that the business recover no more than operational, maintenance and administrative costs, externalities, taxes or tax equivalent rates, provision for the cost of asset consumption and cost of capital (calculated using a WACC). The deprival value methodology is to be used for asset valuation unless a specific circumstance justifies another method.

The NWI requires that urban water prices be based on the upper bound, and that rural water prices at least meet the lower bound and move towards the upper bound where practical.

In line with this recommendation, ERA determined a revenue requirement that was based on the upper bound pricing principle. This involved determining an appropriate asset value, on which a return and depreciation would be allowed as part of the revenue requirement. Using deprival value principles, ERA determined that the initial asset value at the signing of the original agreement should be rolled forward by adding appropriate dam safety (and other) expenditures incurred since by Water Corporation, subtracting inflation and adjusting for inflation. The initial value was set at zero for the purpose of setting dam storage charges for Harvey Water's irrigation water and written down replacement value for the purpose of calculating the dam storage charges for Harvey Water's non irrigation water.

Issues for Discussion

A number of issues were considered by ERA in the course of the inquiry. These included:

- Whether a scarcity value should be assigned to the water.
- Whether lower bound or upper bound pricing principles should be applied and how these should be defined.
- Whether a depreciated optimised replacement cost (DORC) approach to valuation should be applied.
- The level of future dam safety expenditure to be included in the revenue requirement for the duration of the new BSWA.
- The allocation of costs between beneficiaries (including customers, recreational users and government).
- Approaches to revenue smoothing.

These factors are each examined in turn in the following sections.

Scarcity Value

ERA recognised that entitlements to the water in the dams are held by the Corporation and Harvey Water. This means that customers of the storage service already own the water and are free to trade the water should they wish to do this. Given these institutional arrangements, ERA considered that it would be inappropriate to assign a scarcity value to the water and charge this value to customers.

Lower Bound vs. Upper Bound Pricing

ERA considered that lower bound pricing would be inappropriate. Lower bound pricing could be defined by setting tariffs to cover future costs only (and allowing for asset renewal), but ignoring the return on assets that had been constructed over the period of the first BWSA. ERA considered that it would be inconsistent with the original BWSA to ignore the return on this investment. Accordingly ERA found that upper bound pricing was appropriate.

Choice of Initial Value

DORC valuation involves estimating the cost of replacing the dams, optimised for the latest engineering standards and depreciated to be consistent with the current service level. The WA Department of Treasury and Finance stated a preference for the application of a DORC methodology, on the grounds that it is utilised by many regulators[8] and is appropriate for long lived assets.

ERA considered that estimating a DORC asset value for the South West dams would be a complex and expensive exercise that would need to be repeated at the outset of each new BWSA. Also DORC valuations involve a substantial amount of judgement with regard to the costing and optimisation process. ERA noted that the estimation process needs to take account of the costs that a new entrant would incur in providing equivalent dam services and that an entrant building a new dam from scratch would incur lower costs than the Corporation would spend in retrofitting the existing dams. How much less, however, was a matter of contention.

ERA was of the view that the deprival value method of valuation offered advantages over the DORC method or written down replacement cost. The deprival value method is consistent with the pricing principles of the NWI. It is also consistent with the original BWSA. Deprival value avoids the cost and complexity of a DORC valuation and offers flexibility in dealing with the allocation of dam safety costs (rather than the all of the costs faced by a new entrant being incorporated into a DROC valuation).

The Authority considered that zero was an appropriate initial asset value given the original BWSA, which envisaged that future revenue would offset future costs. Both Harvey Water and the Corporation endorsed this approach for irrigation services. However the Corporation argued that the Corporation recoups a higher charge from Harvey Water for its non irrigation water sales, and that such customers should pay the full cost based on the written down replacement value of assets. Under this method customers would still obtain the benefit of the relatively cheap existing water sources (which

[8] In fact DORC is used more in electricity and gas than in water within Australia

are cheap relative to the cost of procuring new water sources for the IWSS).

The higher charge for non irrigation water reflected a State government desire to maintain consistency with other major customers, and ERA agreed that the new BWSA should broadly reflect the terms and conditions of the original BWSA. Accordingly, ERA determined that written down replacement value should be applied for the purpose of calculating the dam storage charges for Harvey Water's non irrigation customers.

Efficient Dam Safety Expenditures

A major element of ERA's inquiry concerned the amount of dam safety expenditure to be undertaken by the Water Corporation and included in the revenue requirement for charges to Harvey Water.

When the original BSWA was negotiated, an estimated cost of $17 million for dam safety upgrades was mentioned, although it was recognised that this estimate was highly uncertain. Subsequent work undertaken by Water Corporation gave 2002 estimates of dam safety upgrade costs of $101 million. By the time of the inquiry, Water Corporations capital budget for safety improvements had reached $136 million. This huge increase in estimated costs followed from improvements in the quality of the risk analysis undertaken by Water Corporation.

ERA concluded that most of the proposed expenditures were justified under the Australian National Committee on Large Dams (ANCOLD) Guidelines, subject to some technical reassessments that were to be confirmed prior to resigning the BWSA.

The Authority presented two options for charging Harvey Water. The first was to apply the ANCOLD framework and pass through the compliance costs to customers. Under this option, charges to Harvey Water would increase from an average of $6.66 per Megalitre (ML) to $34.43 per ML (in real dollars at 30 June 2006). ERA considered that it would be appropriate to phase in the charges over a long period, such as ten years. The phase in would be funded by a CSO payment to the Corporation.

The second option recognised the possibility of the Government moving to manage the wider portfolio of risks facing the Western Australian community on a whole of government basis. This would recognise that the dam safety costs associated with Stirling, Drakes Brook and Samson Brook dams would be expected to be deferred in favour of more effective options for reducing risk to life. Only the dam safety costs associated with Wellington dam and Stage One of remedial works on Waroona dam would be expected to proceed and be recovered from customers. Under the second option, charges to Harvey Water would increase from $6.66 per ML to $21.10 per ML. Again ERA considered that it would be appropriate to phase in the increase in charges.

Cost Allocation

In considering the costs to be allocated to Harvey Water, the Authority had regard to legacy costs, the classes of beneficiaries and the value derived from dam services by the different beneficiaries. Costs attributable to identifiable private beneficiaries (such as water supply customers) were shared between Harvey Water and the Corporation.

Legacy costs are costs that are resulted from the activities of past users, and ERA considered that it would be unfair if they are charged to current and future users. Harvey Water maintained that the cost of restoring the dams to ANCOLD standards which prevailed at the time of signing of BWSA in 1995 should be viewed as legacy costs. However, Water Corporation maintained that there were no legacy costs associated with the original agreement as Water Corporation was obliged to meet the ANCOLD standards and Harvey Water was expected to meet its share of future costs.

The Authority determined that dam safety expenditure could possibly be regarded as a legacy cost, given an implicit understanding at the time of the original BWSA that charges to irrigators needed to be affordable. However, ERA argued that the decision to use water from irrigation dams should be based on the costs of accessing that water, which appropriately includes the efficient costs of dam safety. Therefore ERA determined that dam safety costs incurred after the signing of the original BWSA should not be regarded as a legacy cost and should be recovered from customers.

ERA considered how the costs of operating the dams should be apportioned among the beneficiaries. The Authority determined three classes of beneficiaries:

- Identifiable private beneficiaries. These include farmers using irrigation water and Corporation customers in the IWSS. They are private beneficiaries because they have identifiable property rights over the water in the dams.
- Identifiable public beneficiaries. These include recreational users such as water skiers and bush walkers whose enjoyment of the dam does not diminish the value that accrues to others. Traditionally such users have not been charged for their usage although in theory it would be possible to preclude them from using the dams.
- Non identifiable public beneficiaries. These beneficiaries gain from the existence of the dam in an indirect communal sense and cannot be excluded from obtaining benefit from the dams. They include local residents who benefit from reduced risk of natural flooding, local communities who benefit from the maintenance of the structural integrity of the dam, and those who enjoy the aesthetic and environmental attributes of the local countryside that result from the dams.

ERA used a number of studies to assess a value of recreational benefits from the dams. Based on these studies, the Authority concluded that recreational benefits were of the order of $1m per annum or around 20% of total benefits. Thus ERA determined that the total costs of providing dam storage services should be reduced by 20% and that Harvey Water should be allocated its share of costs after this deduction has been made. The value assigned to recreational benefits is funded by a CSO payment to Water Corporation.

As there are positive and negative aspects to aesthetic benefits of dams and natural flood mitigation, ERA determined that no further allocation of costs should be attributed to the government.

All of the parties agreed that costs should be allocated between customers on the basis of annual water entitlements (rather than annual volumes actually taken). Thus, for each of the Waroona, Logue Brook, Drakes Brook, Wellington, Samson Brook and Samson Brook Pipehead dams, costs were allocated between the Corporation and Harvey Water on the basis of water entitlements from each dam. Past reconfigurations of the dam system and transfers of entitlements between the Harvey, Stirling and Wokalup dams resulted in a disagreement between the parties on the appropriate basis of allocation of costs for Stirling dam. ERA determined that the costs of Stirling dam should be allocated on the basis of the share of entitlements to the water in the entire Harvey, Stirling and Wokalup system.

Smoothing

ERA considered whether the payment schedule should be smoothed or not (i.e. whether the revenue requirement should be constant from year to year). Where significant expenditure is anticipated at some relatively distant time, smoothing provides security that there will be sufficient revenue to fund the expenditures. However where the expenditure is imminent (as in this case), smoothing allows customers to defer their payments.

Smoothing can also inhibit efficiency, as annuities based on long run forecasts of expenditure tend to be very uncertain and lead to conservative estimates. In addition smoothing can commit a company to a particular capital works program, even if the economic case for that program weakens subsequently.

Irrigation cooperatives have tended to prefer a smoothed approach to charging. ERA decided that the timing of revenue recovery should be left to Harvey Water and the Corporation to agree, and both supported a smoothed approach. ERA considered that the new

BSWA should be for a period of five years, at which point the future capital expenditure profile would be reconsidered.

Recommended Structure of Charges

Under the original BWSA water storage charges to Harvey Water comprised a fixed annual charge and a variable component based on price per ML of water used. In 2005/6 the fixed charge accounted for 30% of the total payment.

The parties were agreed that water storage costs incurred by the Corporation are largely fixed by nature and generally independent of the volume of water delivered. Harvey Water submitted that charges should relate to the entitlements held in the dams.

ERA argued that the structure of water storage charges is unlikely to be relevant for ensuring that water is allocated to its most valued use because an effective water trading market will achieve this result. While water trading within the irrigation co-operative is working well, ERA considered that trade between the co-operative and other potential purchasers, such as the Corporation, could be more effective. As the government had announced that it intended reviewing the water trading legislation, ERA concluded there was no need for the government to prescribe the structure of the charges that the Corporation levies on Harvey Water.

Instead the structure of charges was left for the Corporation and Harvey Water to negotiate commercially. ERA considered that the mix of fixed and variable charges was primarily a commercial issue to do with managing the volume risk of uncertain annual streamflows.

2.6.3. Outcome and Lessons to be Learned

Water Corporation and Harvey Water agreed with the main principles used by ERA to propose a revised pricing agreement. In particular, they agreed with the revenue requirement framework, the choice of a zero initial value for the purpose of setting prices to irrigators, the basis of allocating costs between parties and the use of water entitlements as the basis of charges.

The Department of Treasury and Finance was keen to address the issue of dam safety standards in order to reduce the dam safety expenditures required. However, DTF have been unable to gain traction with other areas of government in WA and, in the absence of formal direction from government, Water Corporation is obliged to continue with its existing dam safety expenditure program.

ERA has no formal jurisdiction over the bulk water charges, having completed its inquiry and provided its advice to government. Water Corporation is in discussions with Harvey Water, and expect to sign a revised BWSA at some stage soon. By default this is likely to involve Option 1 (i.e. the higher level of dam safety expenditures), and Harvey Water may well seek additional CSO funding from government to cushion the impact of the price rises on its farmers.

The key lessons to be learned from the Harvey Water case study are:

- The importance of ensuring that bulk supply customers face appropriate incentives in terms of the cost consequences of their decision to continue to take water supplies. Thus, ERA considered that all future dam safety costs should be incorporated within the costs to be recovered from beneficiaries.

- The importance of ensuring that future costs are efficient and warranted. Strict application of the ANCOLD guidelines would result in safety benefits that are small relative to those that could be gained in other spending areas (such as transport). Government is in a position to alleviate Water Corporation's strict legal liability by interpreting the ANCOLD requirements within WA. Doing so would greatly improve the affordability of future dam safety activities for water customers.

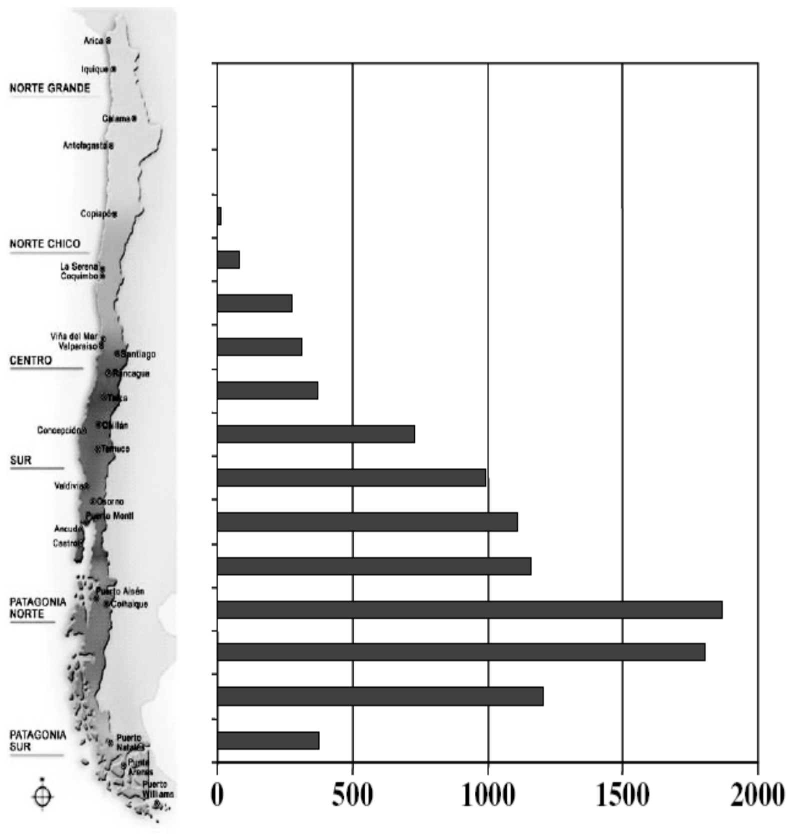
- The treatment of sunk costs is governed largely by equity considerations. Thus the value attributed to assets in existence at the start of original BWSA reflected their value to the water supplier (Water Corporation), given the existing level of charges. This value can be very low – zero in the case of irrigation customers – if this is consistent with the starting level of charges.

- The allocation and recovery of costs should be transparent. Where charges are reduced to particular groups (such as recreational users or water customers) these costs should not be recovered through cross subsidies from other customers. Rather the government should make available a transparent CSO.

2.7. Chile

2.7.1. Background

Chile's unique geographical position provides for a wide range of climatic conditions ranging from near zero precipitation levels in the north to annual rainfall greater than 2,000 mm in the south. Generally the climate is hot and dry in the north and becomes increasingly colder and wetter in the south. Chile contains a number of small rivers and valley system feed by water from the Andes. The countries arid agricultural centre is highly productive through the use of irrigation which accounts for 85% of the countries total water consumption. The construction of canal and the irrigation system began with private canal users associations during the colonial era and the concept of water use right as protected property rights were included in the 1855 civil code and further developed in the 1930 and 1951 Water Codes.



Map of Chile and average rainfall (mm/yr).

In the 1960's, Chile pursued a more 'statist' polices to help protect the emerging working classes during industrialisation and to increase agricultural production by redistributing large landholding to small landholders. The Agrarian Reform Law and the 1967 Water Code increased the States authority over water rights.

The overthrow of the Allende's government in 1973 saw a reversal of these policies. With the new military government adopting radical free-market policies, that curtailed the power of the state and encouraged the role of the private sector.

The 1981 National Water Code, reflects the military governments overall economic and political objectives, as it reduced the role of the state and increased the legal status of private water rights. The military government wished to encourage more efficient use of water through the use of market mechanisms. Inefficiencies in the use of water would be reduced by allowing the sale and transfer of water rights to higher valued users in the agricultural sector or other sectors of the economy. Although water was still seen as public property, once the state has granted a party the right to use water, this entitlement was then fully protected as private property rights under the Constitution and could be subsequently freely bought and sold like other forms of real estate. For the first time, water rights were separated from land ownership allowing water to be freely tradable by being sold, bought, mortgaged and inherited.

The 1981 National Water Code is laissez-faire, being built around the principles of a free market with strong private property rights, strong private economic freedoms and weak government regulations.

Administrative Arrangements

The entitlement to extract water from streams is issued by an administrative authority, the General Directorate for Water (DGA– a part of the Ministry of Public Works). The DGA issues these rights free of charge and has no discretion to deny request for the right to use water where sufficient resource is available i.e. the DGA cannot establish priorities amongst different users as this should be determined by private parties and the free market.

To deal with multiple requests for rights for scarce water, the DGA holds public auctions and sells the right to use the water to the highest bidder. As a technical and administrative agency that is responsible for preparing studies and plans that require the approval of other branches of government, the powers of the DGA are limited and it can only exercise authority over private water use during periods of water emergencies.

The issuing of water rights is seen as a means of facilitating the market for the transfer of water. However, as the process of water rights registration has proved burdensome for many small farmers, many entitlements have remained unregistered.

The expected increase in efficiency in water use through the transfer of water to higher value users (e.g. from agriculture towards urban usage) has also been curtailed by the hoarding of water rights by farmers who wish to protect themselves in times of drought. In addition, there has also been speculative hoarding of water rights in the expectation that the value of these entitlements will rise in the future.

The trading of water has been more prevalent in areas of relative water scarcity, such as the upper Mapocho watershed, where water is traded between Water User Associations (WUA) and housing association. More generally, although the trade in water rights remains quite limited it is becoming more frequent in areas of high economic growth.

The success of Chile's economy in the last three decades has placed greater demand upon its water resources especially from companies operating in export oriented markets. Demand for water from the mining, fresh fruit and wine sectors has increased water extraction in many water poor basins. The rising value of water in these areas has led to increase in the investment in sophisticated water management and better irrigation systems.

Although the government intended for investment in all areas of the water sector to be led by the private sector, the issuing of property rights and incentives to irrigators have not always been sufficiently strong to encourage increased investment. In an explicit recognition of the weakness of the market led approach, the government began to subsidise private investment in irrigation through the National Commission of Irrigation (CNR) from 1985 onwards.

2.7.2. Bulk Water Pricing Framework – Urban Utilities

The reform of public water utilities occurred in three main steps:

The national agency Servicio Nacional de Obras Sanitarias (SENDOS) was set up to carry out the production, commercialisation, regulation and supervisory functions of the water utilities. The main aims of SENDOS were to introduce modern management tools, eliminate cross subsidies and rationalise investment in the sector.

1989-1998
A greater role was given to the private sector in terms of water utility management with public sector spending being limited to those areas where the private sector was unlikely to be interested. The regulatory and supervisory functions of the water utilities were separated and independent regional utilities with geographic concessions established. These state owned water and sanitation companies were then subject to the same rules as those governing public traded corporations.

1999-2004
Privatisation of the main water and sanitation utilities took place.

As natural monopolies, these private water utilities are subject to price controls that limit the maximum tariff that they are able to charge. The procedure for determining tariffs is set by the Office of Water Services which tries to ensure that companies are able to generate sufficient profit to ensure their long term viability.

In determining tariff levels, the Office of Water Services considered the cost that a 'model company' would incur by calculating separate investment costs for each component of the water service value chain (extraction, production and distribution of potable water and disposal of wastewater) and then prices were set so as to meet the long run marginal cost of provision of these services.

A 'model company' is considered to be a utility that provides water and wastewater services in the most efficient manner given a particular set of regulation, geographical and technological constraints.

The tariff methodology and formula adopted for each utility is valid for five years. In the interim, if the tariffs set for that utility are determined to be insufficient to generate sufficient income to cover the long run total costs of the company, then an adjustment is made to cover these costs.

Estimation of Marginal Cost

For each element of the water service chain, fixed costs, variable costs for peak periods, variable costs for non-peak periods and costs associated with the capacity of the company are calculated (with peak periods representing the 4 or 6 months of high consumption).

Table 1. Individual marginal costs for water services, per phase

Phase of the service	Fixed cost $/m³	Volume assoc. costs non-peak	Volume assoc. costs, peak	Capacity assoc. costs $/m³	Average costs $/m³
Drinking water production	-	CVP1 O&M costs of prod. Vol. non-peak	CVP2 O&M costs of prod. Vol. peak	CVP3 Investment in production development plan	-
Drinking water distribution	CFP = Admn. expenses per household CFC = Admn. expenses per consumers	CVD 1 O&M costs of distr. Vol. non-peak	CVD2 O&M costs of dist. Vol. peak	CVD3 Investment in distribution development plan	-
Sewage collection	CFR = O&M expenses per household	-	-	-	CVR O&M costs, total volume
Sewage treatment and disposal	-	-	-	-	CVT O&M costs, total volume

Source: Concepts Of The Chilean Sanitation Legislation: Efficient Charges And Targeted Subsidies - Damaris Orphanópoulos

The calculated marginal costs are then transformed into an 'efficient tariff' using the following formulae:

- Fixed costs – no transformation formula.

- Variable tariffs (CVinp) = Variable Costs (CVi1) + Np/12 * Capacity cost (CVi3) (non-peak).

- Variable cost (CVip) = Variable Cost (CVi2) + Np/12 * Capacity cost (CVi3) (peak).

  (Where np = number of peak months in each year).

The difference between average consumption during non-peak periods and peak periods is used to calculate the value of over-consumption. The variable tariff associated with the over-consumption volume, CVOC, is obtained using the following formula:

- Over consumption (CVOC) = variable cost (CVi2) + capacity cost (CVi3)

The calculated tariffs are adjusted to allow them to generate total income sufficient to cover a utility's total cost and the law allows for a price index to be used to automatically allow tariff adjustments during the five year period of the price control.

Presented below are some of the actual charges levied by the main water companies.

Charges levied by a selection of water companies in Chile CH$/m^3

Charge	A	B	C	D	E
Company	Fixed Charges	Charge per m^3 Non-Peak Drinking Water	Charge per m^3 Peak Drinking Water	Over-Consumption Peak Drinking Water	Charge per m^3 Sewage
ESSAT S.A I Region	570	505	548	1070	188
A. Andina Metropolitan Region	442	201	192	495	117
Maipú Metropolitan Region	506	153	150	376	143
Aguas Décima S.A. X region	354	217	215	550	381

2.7.3. Outcome and Lessons to be Learned

The Chilean approach to the allocation of bulk water in the 1981 Water Code represents a relative extreme with water being regarded as an 'economic good' to be freely trading in an unregulated market with its economic value determined to be the same as its free market price. This is in contrast to the more traditional approach adopted in many other parts of the world in which water is regarded as an essential human right which needs to be isolated from market forces.

The 'success' of this economic approach can be seen in certain parts of the economy, particularly in the urban water sector where there has been significant progress in extending access to water and wastewater services as well as improvements in water quality. This has lead Chile to be put forward as the leading example of the free-market approach to water resource management. However, some exaggerated claims of success in this market lead approach has resulted in a more realistic realisation of some of the shortcomings of this strategy.

The Water Code Reform, passed in 2005 aims to correct many of the problems of the 1981 Water Code by pursuing a more balancing approach to water management that takes into account the need to guarantee property rights, to provide stronger economic incentives for encouraging investment and, at the same time, to protect public interests by granting a greater role to government in the management of water resources.

Some of the key features of the Water Code reform include:

- The President is given the right to exclude water resources from economic competition where it is necessary to protect the public interest.

- DGA is required to take into account issues of sustainability when establishing new water rights.

- A license fee is charged for unused water rights so as to discourage hoarding and speculation.

3. CONCLUSIONS

A number of common themes are evident across the case studies presented in this Report which is interesting because of the very different geographic, economic and environmental climate of the examples provided. These themes include:

- The introduction a formal bulk water pricing framework typically requires a crisis to occur in terms of the availability of water as a resource before implementation is likely to be achieved. Such crises are important in achieving the cultural transformation of perceiving water as an economic good together with associated features such as the concept of user payments and the 'polluter pays principle'. In the context of the case studies presented in this Report, Chile may be seen to be the exception to this rule as the country introduced a pricing model before having to deal with a significant scarcity of water.

- Success in implementing bulk water pricing arrangements requires the cooperation and engagement of all key stakeholders. It is particularly important for agriculture and industry representatives to be involved at all stages of the design and implementation process.

- An interesting mix of local and national involvement appears to be required for developing a bulk water pricing framework. The local element relates to issues such as the need to involve regional stakeholders (rather than having decisions imposed from 'above') and the wish to reinvest collected funds in the water basin whose resources are being charged for. The national element relates to issues such as the need for a formal (and ideally transparent) subsidy policy to be implemented alongside the pricing framework as it is unusual for the identified full costs of water allocation to be imposed on all customer groups in the short term.

- Allied to the previous point, a successful bulk water pricing framework needs to be formally administered and organised – relying purely on market forces (as was tested in Chile) to allocate value to water resources does not work. In addition, the direct involvement of a federal agency helped to balance the interests of different groups whilst still allowing each stakeholder to negotiate terms. This central administration involvement can take many forms, but a robust and independent (as perceived by stakeholders) regulator may be the best alternative.

- Bulk water pricing arrangements need to be accompanied by a well defined water entitlement framework that is flexible enough to adjust rapidly to changing environmental conditions.

- Competitive bidding processes have been found to be valuable at all stages of the water value chain, even in a planning environment.

- In terms of pricing approach, marginal cost pricing (or variants thereof) is generally perceived to be the preferred option. Within this framework, two part pricing methodologies are commonly adopted in an attempt to send appropriate pricing signals and to help maintain the financial integrity of water utilities.

4. APPENDIX 1
ACKNOWLEDGEMENTS AND SOURCES

Introduction

"Water Pricing: From Theory to Practice", Francesc Hernández-Sancho, Nicolas Renard, Heimo Theuretzbacher-Fritz, 2007
"Water Pricing and Public-Private Partnerships in the Americas", Third World Centre for Water Management for Inter-American Development Bank, 2003
"Water Pricing Experiences: An International Perspective", Ariel Dinar and Ashok Subramanian, 1999
"Water Pricing Models: A Survey", Henrique Monteiro,2005

Brazil Case Study

"Water Resources Policy in Brazil", Monica Porto
"The Politics of Bulk Water Pricing in Brazil: Lessons from the Paraı´ba do Sul Basin", Rosa Maria Formiga-Johnssona, Lori Kumlerb and Maria Carmen Lemos
"Bulk Water Pricing in Brazil", World Bank Technical Paper, Musa Asad, Luiz Gabriel Azevedo, Karin E. Kemper, Larry D. Simpson
"Water Resources National Policy in Brazil", Raymundo Garrido Ministry of Environment, Brazil
"Brazil River Basin Experience", Jose Leomax dos Santos (Former Director, AGEVAP, Paraiba do Sul, Brasil)
"River Basin Management In Brazil – The Paraiba Do Sul Case", B.P.F. Braga Director Agência Nacional de Águas

Melbourne Water Case Study

"Water Plan", Melbourne Water, 2007
"Melbourne Water Determination", Essential Services Commission, 2005

South Africa Case Study

“Trans-Caledon Tunnel Authority Annual Reports”, 2005 – 2007
“Water Accounting: Experiences from Southern Africa”, Glenn-Marie Lange, The Earth Institute at Columbia University
“Building Expertise, Sharing Knowledge, Improving Quality of Life”, Water Institute of Southern Africa
“Berg Water Project Agreement”, City of Cape Town Media Release, 2003
“Bulk Water Tariff Policy”, City of Cape Town Annex A
“Pricing Strategy for Raw Water”, Government Gazette 2005
“Strategic Framework for Water Services”, Ministry of Water Affairs and Forestry, 2003
“Vaal Pipeline Agreements”, Department of Water Affairs and Forestry Media Release, 2005

China Case Study

”Water Market China”, Olivia Jensen and Frederic Blanc-Brude, Global Water Intelligence 2004

“Water Supply Pricing In China: Economic Efficiency, Environment, and Social Affordability”, World Bank Analytical and Advisory Assistance (AAA) Program China, 2007

“Economics of the Environment in China”, Jeremy Warford and Li Yining (eds), CCICED 2002

Harvey Water (Western Australia) Case Study

”Harvey Water Supply System: Notes on Pricing Frameworks”, Economic Regulation Authority, 2006

“Revised Final Report: Inquiry on Harvey Water Bulk Water Pricing”, Economic Regulation Authority, 2007

Chile Case Study

“Regulating Water Services”, Gabriel Bitrán

“Sending the Right Signals to Utilities in Chile”, Pamela Arellano

“Water and Sustainable Development: Lessons from Chile – Policy Brief 2”

“Water Institutional Reforms in Chile”, Robert R. Hearnea and Guillermo Donoso

“Key Issues and Experience In U.S. Water Services Privatization”, Jeffrey W. Jacobs and Charles W. Howe

“Results of Chilean Water Markets: Empirical Research since 1990”, Carl J. Bauer

ANNEXURE – II
(A REPORT ON WATER CONSERVATION TECHNOLOGIES)

Annexure II: A Report on Water Conservation Technologies

1. Introduction

Rapid industrialization and urbanization coupled with continuous decline in per capita water availability is putting a lot of pressure on the available water resources in India. As per the Central Water Commission (India) estimates, the future water requirements for meeting the demands of various sections in India would be about 1093 BCM for the year 2025 and 1447 BCM for the year 2050. The increasing gap between water availability and demand highlights the need for conservation of water. To meet the increasing demand, the efficiency of utilization in all the diverse uses of water should be optimized and an awareness of water as a scarce resources should be fostered. Water conservation means putting the available water resources for the best beneficial use with all the technologies at our command. Water conservation is needed, not only to restore the fast deteriorating eco-system but also to meet the inevitable emergency of shortage even for drinking and domestic water in the near future. Water conservation basically aims at matching demand and supply. The strategies for water conservation may be either demand oriented or supply oriented.

Water resources are theoretically "renewable" through hydrological cycle. However, what is renewable is only the quantity, but pollution, contamination, climate change, temporal and seasonal variations have affected the water quality and reduced the amount of 'usable water'. The water conservation practices especially in urban areas by industries, municipal uses and domestic uses can reduce the demand as much as by one third, in addition to minimizing pollution of surface and groundwater resources.

2. Efficient Water Use and Conservation

Efficient water use means reducing the demand by improving personal habits; reducing wastes; creating an adequate rate schedule; deriving benefits from technical developments as well as from water management techniques, coordinating the management of hydraulic resources with that of the land and economical and social aspects; promoting norms and regulations. In short, efficient water use consists of optimizing water usage. There is absolute efficiency, to use the least amount of water possible; economic efficiency, which seeks to derive maximum economical benefits; social efficiency, which strives to fulfil the needs of the user community; ecological efficiency, which guarantees natural resources conservation; and institutional efficiency, which qualifies the function of an institution regarding its water related tasks.

2.1 Efficient water use in industry

There are various avenues where industry can use water more efficiently. Machinery, industrial processes and related support services require large quantities of water which can be reduced significantly by introducing water efficient technologies. The quality of water required depends not only on the type of Industry, but also on its use within the processes, so that a single industrial plant may need different qualities of water for different processes. Generally industrial water use can be grouped into three main categories: heat transfer, power generation and use in industrial processes.

The main methods for water efficiency in Industry are: recycling, reuse and reduction in consumption. Two basic activities are necessary in all three cases: measuring the amount and monitoring the quality of the water. Metering is the most basic activity for any efficient-use program in the industrial sector and practiced to get the consumption rate. All industrial processes or related areas do not require the same water quality. Hence recycling, reuse or reduction at each stage in the industrial process is absolutely essential.

One way in which recycling is used in Industry is to cool equipment that generates heat. In this case, water is recycled through cooling towers, which cool the water by partial evaporation. Recycling is also used in washing processes. In reuse system, the outflow from one process whether treated or untreated, is used in another requiring a different quality of water. For example water used in washing processes can be reused in others requiring a lower quality, such as cooling systems. Also it is possible to optimize processes, improve operations or modify the equipment or the attitude of users.

3. Reuse in Industry to meet water shortages

The usual objective of industrial reuse is to meet chronic water supply shortages. The solution usually starts with simple water conservation (just careful usage) and follows the principle that the greater the extent of reuse one wants, the higher the degree of treatment that will need to be given. The typical strategy followed by industries is as follows:

- First, practise as much conservation of water as possible.
- Second, recycle only that fraction of wastewater which is in a relatively good condition and can be recycled back with little or no treatment.

- Thirdly, arrange more 'reuse' after some treatment to make the industry's own wastewater fit for reuse.
- Finally, if still more reuse is needed, get external source of wastewater.

3.1 Measures of Water Conservation in Industries

Many of the Indian Industries practice some form of water conservation, recycle or reuse in response to shortage of water supply or high cost of fresh public supply or high cost of waste disposal. Some of the more common measures undertaken to conserve water in industries are of the 'reduce-recycle' type such as the following:

- Use of pressure reducing orifices in water supply piping to reduce the rate of flow; otherwise workers tend to overuse water.
- Recycle of steam condensates back to the boiler.
- Adoption of counter-current washing where washing is done in 3 or 4 successive compartments. As the wash waters from the last compartment are relatively clean and can be directly recycled to the first compartment.
- Use of closed-circuit cooling systems wherever feasible so that re-circulating waters are not lost in evaporation.
- Adoption of 'dry' cleaning systems wherever possible.
- Recycling of water used for conveying materials.
- Adopt modern 'cleaner' technologies in manufacture that use less water and / or produce less waste in the wastewater.
- Lay out separately the drains carrying wastewaters from different processes, purposefully, so as to make recycle / reuse more feasible, and at lesser cost.
- Create and reward awareness among workmen.

4. Action Plan for Water Conservation

For conservation water in agriculture, industry, municipal and domestic use, a number of schemes are available. Some of the important action plans for water conservation are the following (MOWR, 2008).

- Conservation of surface water resources – create new storages and renovate existing tanks and water bodies.
- Conservation of groundwater resources – increase groundwater recharge and stop groundwater outflows by sub-surface dams, watershed management measures etc.
- Rainwater harvesting – collection and storage of rainwater at the surface or in sub-surface aquifers, before it is lost as surface runoff.

- Protection of water quality – due to increase in environmental pollution, "utilizable water resources" is decreasing; hence protection of existing water resources from pollution is a vital aspect of water conservation.

An important component of water conservation involves minimizing water losses, prevention of water wastage and increasing efficiency in water use. The action plans for conservation in different sectors are different and explained below.

4.1 Irrigation Sector: Some of the important action plans towards the irrigation sectors are the following:

- Performance improvement of irrigation system and water utilization – proper and timely system maintenance; rehabilitation and restoration of damaged / silted system; reduce seepage losses by lining; restoration / provision of appropriate control structures; renovation and modernization of existing irrigation systems; provision of adequate water measuring structure
- Conjunctive use of surface and groundwater – especially in the areas where there is threat of water logging.
- Adopting efficient irrigation systems such as sprinkler and drip irrigation, wherever suitable.
- Preparation of a realistic and scientific system operation plan – based on availability of water and crop water requirement; minimize water logging and water loss.
- Scientific farming – revision of cropping pattern; training of farmers on excess water use; mixed cropping pattern; rotational cropping.
- Rationalization of water rate to make the system self-sustainable; formation of water user associations and transfer of management to them; promote multiple and efficient use of water.

4.2 Domestic and Municipal Sector: Some of the important action plans towards the domestic and municipal sectors are the following:

- Measures towards reduction of conveyance losses; management of supply through proper meter.
- Intermittent domestic water supply to reduce wasteful usage.
- Realization of appropriate water charges for sustainable supply and reduce wastage.
- Creation of awareness to make attitudinal change.
- Modification in design of accessories such as flushing system, taps etc.
- Possibility of recycling and reuse.

4.3 Industrial Sector: Some of the important action plans towards the industrial sectors are the following:

- Modernising of industrial process to reduce water requirement.
- Setting-up of norms for water budgeting.
- Recycling water – especially re-circulating cooling system.
- Proper processing of effluents by industrial units to adhere to the norms for disposal.
- Rational pricing of industrial water requirement to ensure consciousness / action for adopting water saving technologies.

5. Water Conservation Possibilities

It is imperative that users from all sectors of water use, stakeholders including state and central governments, agencies, institutions, organizations, NGOs, municipalities, village panchayats, public-sector undertakings and other agencies providing services to the users, may need to be involved for making integrated and continuous efforts for creating mass awareness towards importance of saving and conservation of water, and duties and responsibilities of individuals as well as organizations and institutions towards judicious and optimal use of water. Some of the possible ways for water conservation in industries and domestic and municipal uses are briefly described below (CWC Report, 2005).

5.1 Industrial Use

Some of the important possibilities for water conservation in industry are:

- Using fogging nozzle to cool product;
- Installing in-line strainers on all spray headers; regular inspection of nozzles for clogging;
- Adjusting pump cooling and water flushing to the minimum required level;
- Determine whether discharge from any one operation can be substituted for the fresh water supply to another operation;
- Choosing conveying system that use water more efficiently;
- Handling waste materials in a dry mode wherever possible;
- Replacing high-volume hoses with high-pressure, low volume cleaning systems; equipping all hoses with spring loaded shutoff nozzles; instruct employees to use hoses only when necessary;
- Replacing worn-out equipments with water-saving models;
- Turning off all flows during shutdowns unless flows are essential for cleanup; adjusting flows in sprays and other lines to meet minimum requirements;

- Sweeping and shovelling may be practiced instead of hosing down the floors, driveways, loading docks, parking areas etc; washing cars / trucks/ buses less often;
- Avoiding runoff and making sure that sprinklers are used in gardens/ lawns

5.2 Domestic and Municipal Use

- Timely detection and repair of all leaks;
- Minimize use of water for all domestic uses such as bathing, brushing, shaving, washing etc. by various means;
- Avoid water wastage in cooking, drinking, washing floors etc.
- Minimum use of water for watering of lawns and gardens;
- Installation of high-pressure, low volume nozzles on spray washers; installation of float controlled valves on the make-up line; washing vehicles less often;
- Use of recycled water.

In case of big establishments like hotels, large offices and industrial complexes, community centres etc. dual piped water supply may be insisted upon. Under such arrangement, one supply may carry fresh water for drinking, bathing and other human consumptions whereas recycled water from second line may be utilized for flushing of human solid wastes. Similarly, water harvesting through storing of water runoff including rainwater harvesting in all new buildings on plots of 100 sq.m and above may be made mandatory.

6. Role of Water Users' Association (WUA) and Water Audit

Water User's Association is an association of water users, generally prevalent in irrigation sector. It is considered that involvement of farmers in water management will facilitate equitable and judicious allocation of irrigation waters among farmers of head, middle and tail reaches and improve collection of water charges from users. It is felt that with improvement in collection of water charges, irrigation projects may not languish for maintenance for want of funds and in this way overall efficiency of irrigation systems will improve. This will help saving of water and optimum utilization of water.

WUA concept of involvement of users in the distribution and management process may also be extended in domestic and industrial sectors of water use. In domestic sector, WUA can help in finding illegal tapping of water from supply lines, identifying leakages and losses and other illegal activities. Similarly in case of industrial sectors, WUA can identify the cases of illegal discharge of industrial effluents to water bodies and help in conservation of water. WUAs may be duly empowered through legalization to punish the errant water users.

Water audit determines the amount of water lost from a distribution system due to leakage and other reasons such as theft, unauthorized or illegal withdrawals from the system and the cost of such losses to the utility. Comprehensive water audit gives a detailed profile of the distribution system and water users, thereby facilitating easier and effective management of the resources with improved reliability. It helps in correct diagnosis of the problem faced in order to suggest optimum solutions. It is also an effective tool for realistic understanding and assessment of the present performance level and efficiency of the services and the adaptability of the system for future expansion and rectification of faults during modernization.

Elements of water audit include a record of the amount of water produced (total water supply), water delivered to metered users, water delivered to un-metered users, water loss and suggested measures to address water loss. Water audit improves the knowledge and documentation of the distribution system, problem and risk areas and a better understanding of what is happening to the water after it leaves the source point. A water audit report may invariably, contain: a) amount of water earmarked/ made available to the service; b) amount of water utilized, both through metered and un-metered supplies; c) water loss and efficiency of the system along with reasons for such water losses; d) suggested measures to check water loss and improve efficiency.

An effective water audit report may be purposeful in detection of leak in distribution system, taking timely action for plugging such leaks and thereby reducing conveyance losses of water and improving efficiency of the system. Water audit of the system should be undertaken at regular interval of time, at least on an annual basis.

Water audit is an important management tool for effective conservation of water. Broadly water audit should be conducted categorically in two systems, resource audit or supply side audit and the other one as consumption audit on demand side. All efforts should be made for improvement of not only water use efficiency and distribution system, but also on the efficient development and management of the source of water.

7. Water Conservation Technologies

7.1 Agricultural water conservation

Ninety percent of agricultural water consumption is used for irrigation and the rest is used for forestry, animal husbandry, fishery and drinking water for rural people and domestic animals. Developing highly efficient water conserving agriculture is a fundamental strategy of the country.

7.1.1 Optimizing water dispatch technology for agriculture

Water resources for agricultural consumption consists of precipitation, surface water, underground water, soil water and return water, briny water and regenerated water that has been treated to bring it up to the water quality standard. By means of engineering measures and non-engineering measures, optimizing various water resources is the basic requirement for realizing planned water consumption, water conservation and enhancing the efficiency of agricultural water consumption. Following are some of the techniques for optimizing water for agriculture.

- Actively develop technology to unify dispatching of water from multiple resources. Greatly popularize various agricultural water-consuming projects control and dispatching methods, use surface water with high efficiency.

- Gradually push forward the controls over the total amount and quota management of agricultural water consumption. Speed up setting the total amount indicators for agricultural water consumption for different regions in different precipitation years, setting irrigation water consumption quotas for different plants under different irrigation methods and conditions. Reasonably adjust the water consumption proportion for farming, forestry, animal husbandry, sideline production and fishery.

- Based on the conditions of local water, soil, sunshine and heat resources, and based on the high efficiency and water conservation principle, crops should be decided by water conditions. Reasonably arrange the crop planting structure and irrigation scales.

- Develop the combined irrigation technology of wells and ditches. Popularize and apply unified adjustment and control technology for surface water and underground water. Advocate dual-irrigation from wells and ditches.

- Develop soil moisture and drought supervision and forecasting technology. Actively research and develop soil moisture, drought supervision instruments and facilities.

7.1.2 Highly efficient water transfer and dispatching technology

Agriculture-use water loss during the process of transfer and dispatching occupies a great proportion of water used. It is the main focus of agricultural water conservation to enhance the efficiency of water transfer.

- Give priority in taking anti-leakage measures to ditches and branch ditches that cause great loss and low-efficiency in water transfer. Advocate overall anti-leakage to fix ditches that are not required to supplement the irrigation water from wells.
- Develop pipeline water transfer technology. When renovating relatively small volume ditches, low-pressure pipeline water transfer and dispatch technology should be given priority.
- Popularize the adoption of low-cost anti-seepage materials. Advocate the use of cement, stones and other local materials.
- Develop anti-seepage ditch cross sectional scale and structure optimization design technology. Large and medium-sized anti-seepage ditches should adopt non-standard cross sections with sloped or arced bottoms. Small ditches should use the U-shaped cross section. Medium and small-scale ditches should use concrete anti-seepage stone laying.
- Develop and apply real-time irrigation forecasting technology.
- Encourage the research, development and popularization of small water measuring facilities that are highly accurate, low in cost, strong in application, easy of operation, and convenient for managing and maintaining.
- Develop ageing prevention technology for water transfer projects. Actively research technologies of ageing prevention for water transfer constructions, disease diagnosis and corrosion prevention, restoration and leakage-blocking technologies.

7.1.3 Field irrigation technology

Field irrigation is the last sector for enhancing the utilization rate of irrigation water. It is also the basis for water diversion, transfer and dispatch. It is the key part of agricultural water conservation for improving field irrigation technology.

- Scientifically control the irrigation factors affecting water volume into the strips (furrows), water intake and irrigation quotas, and the proportion of water volume changes.
- Greatly popularize water management technology that is based on rice-field dry-wet alternate irrigation. Advocate square fields in rice irrigation areas and adopt rice shallow-wet control irrigation techniques. Advocate the combined technique of rice soaking and tilling. Develop the technique of rice "three-drought" tillage, drought breeding and rarefaction plant and seedlings tossing.
- Suit the development and applications of sprinkler irrigation technique to local conditions. Actively encourage the application of sprinkler irrigation techniques in commercial crop planting areas, suburban agriculture areas and concentrated scaled management areas.
- Encourage the development of micro-irrigation techniques. Widely popularize micro-sprinkler irrigation and drip irrigation techniques in fruit tree planting areas and in areas where agriculture requires facility support, offers quick returns and earns foreign exchange.

7.1.4 Biological water conservation and agronomic water conservation techniques

Biological measures and agronomic measures can help enhance the utilization rate and production rate of water content so as to save on the volume of irrigation. It is a main water conservation measure for agriculture.

- Encourage research into the application of water/fertilizer coupling techniques. Advocate the reasonable application of a combination of irrigation and manure in terms of times, amounts and methods to adjust the fertilizer with water and apply water and mature together so as to enhance the utilization rate of water and fertilizer.
- Advocate water storage and soil moisture preservation techniques such as deep ploughing and loosening, and biological soil nourishment techniques. Improve the soil structure and enhance the water-storage, water-preserving and water- supplying ability of soil.
- In the areas where the soil is light, the ground has a big slope or the amount of precipitation is not great, actively popularize protective ploughing techniques.
- Develop and apply transpiration and evaporation inhibition techniques.

7.1.5 Precipitation and return water utilization techniques

Enhancing the utilization rate of precipitation and the repeated utilization rate of return water can directly reduce the water volume of irrigation. It is the most basic content of the agricultural water conservation program.

- Popularize the utilization technique of precipitation storage. In drought-resistant crop zones, popularize field leveling techniques and improved ploughing techniques that aim to restore natural precipitation.
- Popularize techniques of utilizing return water for irrigation. Actively develop irrigation-drainage unified management techniques. In areas that have no saline and alkaline threat, prohibit ineffective water receding and low-effective drainage irrigation water management techniques. In areas where the quality of irrigation return water is not up to the standard of irrigation water, actively develop the simple "mixed watering of salty and fresh water" irrigation return water safe utilization technique.

7.1.6 Breeding sector water conservation techniques

Developing breeding sector water conservation techniques, enhancing water consumption efficiency in the breeding sector for forage grass irrigation, animal and domestic fowl drinking water, washing water at animal and domestic fowl breeding sites, temperature reduction water and aquatic products breeding water are all important aspects.

- Speed up the development of drought-resistant (drought-enduring) water conservation quality forage grass species selection and breeding techniques.
- Greatly popularize artificial grassland water conservation irrigation techniques. Popularize grassland water conservation irrigation systems. Adapt the development of grassland irrigation ditch anti-seepage liner and pipeline water-transfer irrigation techniques to local conditions.
- Popularize breeding wastewater treatment and repeated utilization techniques. Popularize breeding wastewater re-use technique after anaerobic treatment and the recycling utilization technique after deep treatment and disinfection for washing sties.

7.1.7 Seasonal Variations and Water Conservation

In India, mainly two crops are practiced by the farmers: Khariff crop during monsoon season and Rabi crop during the post monsoon season. In some places, a third summer crop is also practiced. Hence water conservation should be implemented crop wise. Following are some of the suggestions in this regard.

- For the Khariff crops, as monsoon rainwater and other nearby surface water will be available other than the water supplied through canals, the farmers should be encouraged to use the locally available water.
- Promote conjunctive use of surface water and groundwater for the Rabi and summer crops.
- Provide incentives to the farmers who use groundwater/ other nearby surface water/ conjunctive use practices.
- Provide incentives to the farmers who adopt rainwater harvesting techniques in their farmlands.
- Promote modern technologies in irrigation such as drip irrigation/ sprinkler irrigation by giving subsidies/ incentives.
- Provide incentives to the farmers who adopt scientific farming/ irrigation in their fields and use less water for farming.

7.2 Domestic Water Conservation Technologies

For domestic water conservation, large number of methodologies are available and practiced in many places (*discussed in earlier report*). Here some of the latest available technologies are described for the domestic water conservation.

7.2.1 Low-flow sensored faucets

Faucet aerators are so inexpensive and save so much water and money that they are cost effective in nearly all applications. Low-flow (1.9 lpm) faucet aerators can be especially cost-effective in restrooms and kitchen areas in government housing, hospitals, and office buildings.

7.2.2 Low-flow showerheads

Several models have flow rates of 3.8–5.7 lpm or less. A venturi effect is built into the design; this creates a strong spray pattern at a high velocity and low flow rate. And they are especially appropriate for use in hospitals, recreation areas and centers, and prisons.

7.2.3 Horizontal-axis clothes washers

One of the most effective water-saving mechanisms in clothes washers is a horizontal-axis tub or drum. These kinds of machines can clean as many clothes as comparable vertical-axis or "agitator" washers, but with less water. Manufacturers' estimates of the water savings obtainable with horizontal axis washing machines range from one-third to one-half the water and energy used by conventional, vertical-axis machines.

7.2.4 Low flow urinals, toilets and waterless urinals

Water-saving toilets and urinals are efficient because they either (1) reduce the amount of water available per flush, (2) use compressed air to increase the force of the flush, (3) refine the design of the fixture so more waste is washed away per flush, or (4) are completely redesigned, for example, as a composting toilet or waterless urinal. The fourth option can virtually eliminate the need for water to operate the fixture, though some water is usually required to clean it. According to the Rocky Mountain Institute studies in USA, replacing an older conventional toilet that uses 11.4–18.9 lpf (liters per flush) with a low-flush model can reduce residential water use per capita by 30–83 liters per day, depending on the number of uses. Estimates for savings obtainable with waterless urinals range from about 37,854 –170,344 liters of water per unit each year.

For some of the domestic water conservation technologies discussed above, the price range and installation process in the US market is described in the following table 1.

Table 1: Cost Ranges for Domestic Water Conservation Technologies

Technology	Estimated Installed Approximate Average Cost Range	Approximate Average Installed Price
Low-flow sensored faucets	$100–$1,300	$330
Low-flow showerheads	$15–$75	$31
Pressure-reducing valve		$100
Horizontal-axis clothes washer, residential size	$600–$1,000	$850
Water-efficient dishwasher,	$200–$1,600	$700

residential size		
Low-flush tank toilets	$150–$1,000	$240
Low-flush flushometer toilets	$300–$800	$450
Low-flow urinals	$300–$800	$450
Waterless urinals	$600–$800	

8. Concluding Remarks

- Water conservation is prime and challenging concern. Due to lack of proper operation and maintenance in irrigation, industry and domestic water distribution system, there is huge loss of water. Hence it is emphasized to improve the operation and maintenance.
- For developing the water resources, age-old traditional water conservation methods need to be judiciously adopted in conjunction with the latest modern conservation technology. Rain water harvesting, revival of traditional water storages, check dams and other similar structures need to be adopted. Building byelaws should be suitably modified to introduce mandatory roof top rain water harvesting.
- In order to conserve water, recycling of wastewater may be incorporated wherever feasible.
- Timely and need based irrigation should be done to minimize loss of water.
- Strategic mass awareness campaign should be conducted regularly to cover all stakeholders, including service providers and consumers, for water conservation in irrigation, domestic and industrial sectors.

ANNEXURE - III
(WATER RECYCLING TECHNOLOGIES AND BULK WATER TARIFF)

Annexure-III: Water Recycling Technologies and Bulk Water Tariff

1. Introduction

Water recycling is reusing treated wastewater for beneficial purposes such as agricultural and landscape irrigation, industrial processes, toilet flushing and groundwater recharge. Water is sometimes recycled and reused onsite; for example when an industrial facility recycles water used for cooling processes. A common type of recycled water is water that has been reclaimed from municipal wastewater, or sewage.

Through the natural water cycle, the earth has recycled and reused water for millions of years. Water recycling, though, generally refers to projects that use technology to speed up these natural processes. Water recycling is often characterized as “unplanned” or “planned”. A common example of unplanned water recycling occurs when cities draw their water supplies from rivers that receive wastewater upstream from those cities. Water from these rivers has been reused, treated, and piped into the water supply a number of times before the last downstream user withdraws the water. Planned projects are those that are developed with the goal of beneficially reusing a recycled water supply.

The water reuse may be for agricultural purposes, industrial purposes or domestic purposes. For agricultural reuse, the wastewater may need to undergo the usual preliminary, primary and secondary treatment steps, generally undertaken to make the wastewater fit for discharge to the environment. For certain industrial reuse, further treatment called tertiary treatment may have to be employed to remove the more residual pollutants, especially the dissolved and refractory (non-biodegradable) substances and micro-organisms depending on the use contemplated.

2. Types of wastewater reuse

Recycled water is most commonly used for non-potable purposes such as agriculture, landscape, public parks, and golf course irrigation. Other non-potable applications include cooling water for power plants and oil refineries, industrial process water for paper mills, carpet dyers, dust control, construction activities etc. The practice of reuse can be grouped under five major groupings as follows.

1. Reuse of urban wastewater in agriculture and horticulture from sewered areas.
2. Reuse of urban wastewater from polluted nallahs draining unsewered areas.
3. Reuse in industrial and commercial establishments to meet the water shortage.
4. Reuse in industry to meet various other objectives besides relief from water shortage such as ‘zero discharge’.
5. Reuse for major urban and community development purposes say for example to augment public water supplies.

3. Stages of Wastewater Treatment

Wastewater treatment systems are characterized by the level of treatment they provide.

a) **Preliminary treatment**: This involves removal of heavy solids like wood, rags and grit. This is usually done by passing the inkling wastewater through a screen with bars 25-50 mm apart.

b) **Primary treatment:** This involves slowing the wastewater down. Generally settlement chambers or sedimentation tanks are used for this purpose. In domestic situation, septic tank can be used as a settlement chamber, which may remove about 30-50 % of the BOD and suspended solids.

c) **Secondary treatment:** This process generally known as biological treatment (use of micro organisms) removes the remaining BOD and suspended solids. During the later stage of secondary treatment, the nitrification process begins. This is when the ammonia present in the waste water is transformed into nitrate.

d) **Tertiary treatment:** Tertiary treatment involves, taking the wastewater through a further biological, physical or chemical steps. This involves further removal of BOD, suspended solids, nitrogen, phosphorous and pathogens. Fig.1 shows the treatment methods in tertiary treatment.

Tertiary treatment for industrial reuse is usually done by using mechanized, physio-chemical processes selected out as given below.

- Activated carbon treatment (powdered or granular)
- Chemical oxidation and other advanced oxidation processes
- Multi-media filtration
- Softening (lime soda or zeolite)
- Demineralization (ion exchange)
- Disinfection (chlorine, hypochlorine, ozone, U-V)
- Membrane processes (microfiltration, ultrafiltration and reverse osmosis).

Generally, the tertiary treatment can also be provided by using 'natural systems' of treatment such as ponds, lagoons, constructed wetlands, and such methods where adequate extent of land is available. However other than few agro-industries located in rural areas, land availability is a big problem, thus forcing industries to adopt mechanized methods.

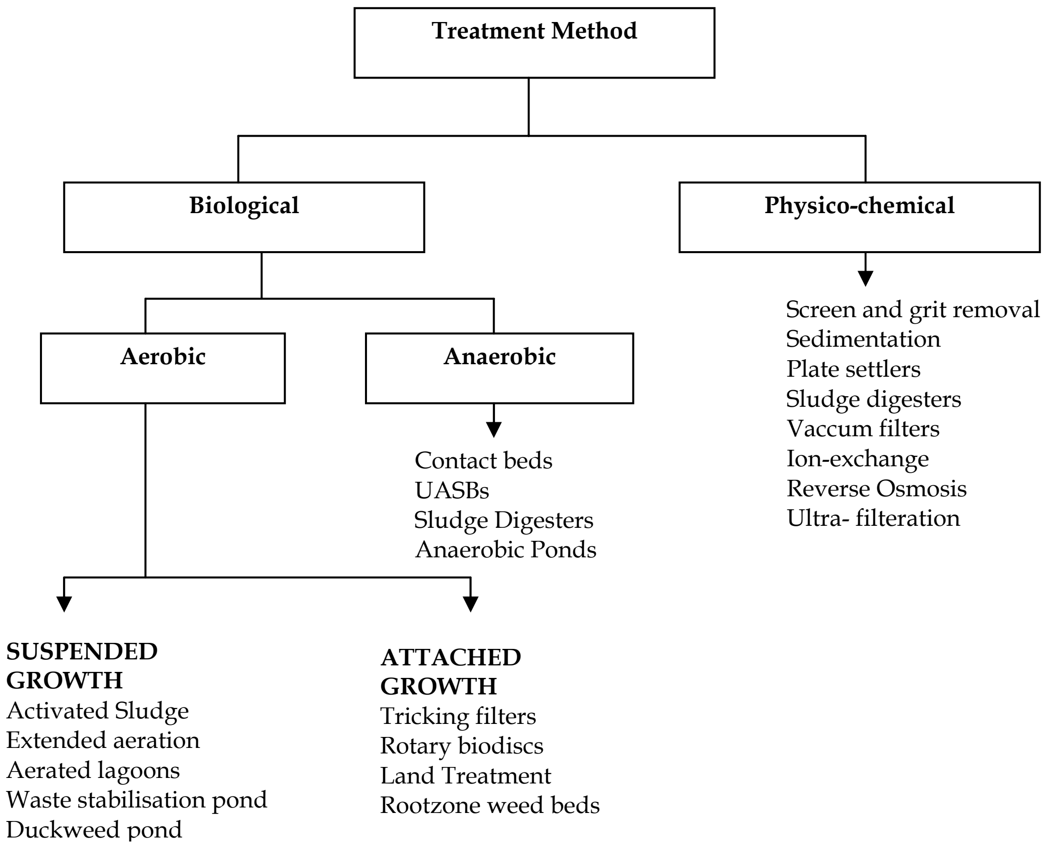


Fig.1: Tertiary treatment methods

The conventional waste water treatment systems using biological processes can remove around 90-95 % BOD (Biological Oxygen demand), COD (Chemical Oxygen Demand), coliforms and sediment solids. When greater removals approaching 99% or more are required, the use of one or more of the above discussed tertiary treatment systems are necessary. Also when substances such as dissolved solids, trace organics, nitrogen, phosphorus etc., may need to be removed, appropriate tertiary systems may be used.

4. Overview of Water Recycling Practices

Water recycling is a growing practice in many regions of the world including USA, Western Europe, Australia, Israel etc. An estimated 13 million m^3/d is reused in USA, which is only a small fraction of the total volume of wastewater generated. Thus out of the 132 million m^3/d, only about 9.7% of wastewater is recycled, suggesting the potential of recycling (USEPA, website). Recycled water use on a volume basis is growing at an estimated 15% per year in the US. All evidences suggest that water recycling will play an expanded role in the water management in the 21st century. In US, at a compound annual growth rate of 15%, the volume of recycled water would amount to 45 million m^3/d by the year 2015.

In many states in the US, agricultural reuse is mandatory wherever tertiary treatment is required before disposal. Similarly for industries, the National Association of Manufactures, USA reported from a survey some years ago that the potential for reuse in industries existed as given in Table 1 (Arcevala and Asolekar, 2007). According to this survey, the scope of reuse lay from 15% to as much as 52% mostly from the direct reuse of cooling waters and wash waters. The survey also reported that over 3000 plants reused their wastewaters and a few plants used municipal sewage after necessary treatment for reuse.

Table 1: Potential for direct reuse in industries in USA (National Association of Manufacturers, USA)

Industry	Water reuse potential (%)
Pulp and paper	52
Chemicals and drugs	35
Automobile	25
Iron and steel	25
Food and beverage	22
Non-ferrous metals	18
Textiles	15

In India, presently water recycling is not so common. However, some of the Industries and Hotels have started to reuse wastewater after suitable treatment. Presently in India, some of the methodologies adopted include (Arcevala and Asolerkar, 2007):

- Plain water conservation
- Reuse without any treatment
- Reuse after treatment using on-site toilet waters and some easily treated industrial wastewaters
- Reuse after treatment using off-site sources of municipal wastewater

A study of the reuse of waste water in India shows that the reuse has achieved in affordable costs and some industries have in fact, saved money by reusing their wastewaters.

5. Reuse in Industries

Generally, the objective of industrial reuse is to meet chronic water supply shortages. In most of the cases, the solution usually starts with simple water conservation (just careful usage) and follows the principle that the greater the extent of reuse one wants, the higher the degree of treatment that will need to be given. The typical strategy followed by most of the industries is as follows:

- Firstly, practice as much conservation of water as possible.
- Secondly, recycle the fraction of waste water which is in relatively good condition and can be recycled back with little or no treatment.
- Thirdly, arrange more 'reuse' after some treatment to make the industry's own wastewater fit for reuse.
- Lastly, if more reuse is needed, get the external sources of wastewater, such as municipal sewage.

6. Review of Water Recycling in India

1) ***Direct reuse in Industries without Treatment:*** In India, water recycling has first begun in Mumbai in 1964-65, by textile industry, when it was shown that nearly 15-20 % of water can be recycled without any pre-treatment (Arceivala, 1998). The cost of providing direct reuse was relatively small say holding tanks, pumps and pipes. Hence the cost/benefit ratios are fairly high and cost recovery periods is low. The recycling was carried out in as many as 22 mills of Mumbai and later few more industries started recycling.
2) ***Reuse in Commercial Buildings Using on-site Sources of Wastewater:*** In Mumbai, due to water shortage, many of the large commercial establishments started water recycling in 1970s, by reusing their toilet waters after suitable treatment to produce good quality water to meet cooling system requirements. The Air India Building in Mumbai was the first one to treat the building's toilet waters for reuse as cooling water for centralized air-conditioning system. All over India, about 30 plants of similar type have been built (Arceivala, 1998). A typical treatment scheme for toilet waters for reuse in cooling water make-up is as follows: *Wastewater -> Screening -> Extended aeration -> Chemical dosing + Flocculation -> Sand filtration -> Zeolite softening + acid correction + occasional chlorine shock dose -> make-up water to cooling towers*. The sludge and other wastewaters were returned to the municipal sewer line.
3) ***Reuse in Large Industries after Treatment:*** In Industries where large volumes of reuse water are required, other than using their own resources, wastewater has to be obtained from off-site sources such as city sewers. This may necessitates complicated treatment systems depending on the nature of the wastewater and reuse proposed. The examples of four large industrial reuse are described in the following sections.

a. ***Oswal Agro (Union Carbide Plant), Chembur, Mumbai:*** This was the first tertiary treatment plant to be built in India in 1968-69 for sewage water reclamation with capacity of 5 Mld with a scope to expand to 10 Mld. The raw sewage was obtained from Mumbai Municipal Corporation at a nominal cost. The sewer was considered as a dependable source of water. The treat water was used for cooling purpose (Arceivala, 1998). The treatment scheme include the following: *Wastewater -> Screening -> Grit removal -> Extended aeration -> Chemical dosing + Flocculation -> Sand filtration -> Zeolite softening + acid correction + occasional chlorine shock dose -> make-up water to cooling towers.* The scheme was very economical and the reuse plant met the industry's water requirement for many years until industry itself closed down.

b. ***Rashtriya Chemicals & Fertilizers (RCF) Plant, Chembur, Mumbai:*** RCF has a water reuse plant of 23 Mld capacity built in 2000 with a plant cost of Rs. 40 crores. It has a more complicated treatment process including reverse osmosis because the municipal sewage is more polluted with various industrial wastes. In 2005, the operating cost was Rs. 39 per m^3. With the passage of time and the success of recycling schemes, the Municipal charge levied also became higher at Rs. 6/- of m^3 raw wastewater. The plant in RCF has the following flow sheet (Arceivala and Asolekar, 2007): *Wastewater -> Screening -> Grit removal -> Activated Sludge System -> Clarifier -> Sand Filter -> Pressure Filter-> Cartridge Filters ->Reverse Osmosis -> Degasser to Remove CO2 -> Reuse in Industry.*

c. ***Madras Refineries Ltd. & Madras Fertilizers Ltd., Chennai:*** Chennai is perennially short of water and due to the heavy shortage of water, Madras Refineries is producing 12 Mld of reusable water and Madras Fertilizer is producing 16 Mld of reusable water since 1991. Here the Chennai Metro Water Board supplies secondary treated sewage (with about 120 mg/L BOD) and the Industries provide the further required treatment depending on their end-use. The treatment include the following: *Secondary Treated Wastewater -> Additional Secondary Biological Treatment -> Chemically Aided Settling + Pressure Filtration + Ammonia Stripping, Carbonation, Clarification, Pressure Filtration-> Chlorination -> Sodium Bisulfite Dosing -> Multimedia Filtration -> Cartridge Filtration ->Reverse Osmosis -> Permeate for Reuse in Industry.* The rejects containing high TDS are disposed to the sea through a submerged outfall. In 1991, the capital cost of MRL was Rs. 24 crores. The operating are reported to be about Rs. 35/- per 1000 litres (against Rs. 60 per 1000 litres for fresh water supplied to Industries). The Metro Water Board charges Rs. 5.20 per 1000 litres to cover the initial treatments.

d. ***Vadodara Pilot Plant, Gujarat:*** This plant uses highly polluted wastewater from a "effluent disposal channel" into which several industries (such as refineries, fertilizers, petrochemicals) discharge their raw wastes with a capacity of 3 Mld freshwater. The plant shows that at least 75% of wastewater could be made reusable at an operating cost of Rs. 36/ 1000 litres. The flow sheet adopted in the plant include: *Wastewater -> Chem-feeds (Lime, Polyelec, Soda Ash) -> Clarification-> HCl -> Pressure Filtration -> Sodium Biosulfite -> Cartridge Filters ->Reverse Osmosis -> Degasser to Remove* CO_2 *-> for Reuse in Industry.*

7. Benefits of Water Recycling

Recycled water has numerous benefits, including a local dependable water supply that is drought resistant and under local control, reduction of treated wastewater discharge to sensitive or impaired surface waters, reduction of imported water and avoided costs associated with importing water; environmental benefits and that it represents a sustainable water resource. Recycled water can also be used to create or enhance wetlands and riparian habitats. Some of the other specific benefits include:

- Conservation of other resources besides water (e.g. steam recovery because both water and heat are recovered; Chromium removal from leather industry).
- Reuse at little extra cost over that required for pollution abatement.
- Savings on water abstraction costs and on "Cess" charges
- Reduced dependence on vagaries of river flows.
- Gaining tax advantages in arid and designated zones.
- Reduction in effluent discharge volume (even approaching "Zero" discharge).

For example, the following flow sheet for treatment can be used to achieve "zero" discharge in a textile industry, depending on water requirement.

Textile wastewater -> Chemical Dosing + Clarifier -> Aeration-> Tube-settlers -> Pre-treatment + Cartridge Filter -> Reverse Osmosis -> Recycle to Process.

8. Methods of Treating Wastewater

8.1 Conventional way of Treating Wastewater

The conventional treatment methodologies are suitable for small scale wastewater treatment such as domestic/ hotels/ small scale industries etc. Following are some of the commonly used technologies for small scale wastewater treatment.

a) ***Cesspools (Containment, decentralized)****:* A cess pool is a big tank of at least 18 cubic metres. It has an inlet but no outlet. Cesspools do not treat wastewater, but simply store it until it is removed by a sludge tanker. In places where the location is unsuitable for discharging effluent and where no stream or river course is available, cesspools are the main conventional solutions. Due to the environmental pollution especially to groundwater, cesspools are not preferred in the urban environment.

b) ***Septic tanks (primary treatment, decentralized):*** Unlike cesspools, septic tanks have both an inlet and outlet. They are much smaller because they retain only the amount of sewage generated in a day. Septic tanks are suitable for small scale waste water treatment and they can be adopted for domestic/ hotels sewage treatment. Septic tanks provide primary treatment and so should be followed by a soak pit or leach field.

c) ***Leach fields (Secondary, tertiary and dispersal– centralized/ decentralized)****:* A leach field is the last stage of a conventional treatment system. It is usually preceded by a septic tank and this combination is often referred to as a 'septic tank system'. A leach field is a series of perforated pipes, surrounded by gravel, that run in underground trenches. With a well designed leach field in suitable soil, the wastewater is thoroughly cleaned by passing it through a one-metre thick layer of soil.

d) ***Waste stabilization ponds (all stages possible, centralized/ decentralized):*** These are also known as solar ponds, settlement ponds, lagoons or sewage ponds. It may be with a small anaerobic pond in the beginning, followed by larger aerobic ponds. These ponds are placed in tandem with reed beds, making system more attractive. For this type of system, a large surface area is required to ensure sufficient treatment.

e) ***Constructed wetlands (centralized/ decentralized):*** These are human made wetlands, developed in areas where they do not occur naturally. Treatment of wastewater in wetlands is a relatively recent technology. The constructed wetlands can be designed to closely imitate the treatment functions that occur in a natural wetland ecosystem. They operate on ambient solar energy and require low external energy input.

f) ***Duckweed pond (centralized/ decentralized):*** Duckweed is a green coloured small plants which grows in sewage holding ponds. The weeds feed on the organic elements in the wastewater for growth. A duckweed-based sewage treatment plant could often be in the form of a single pond, which may be used for the treatment of low-strength community wastewater. It function as an anaerobic pond except in the top layer where aerobic conditions prevail. The duckweeds create an environment for treatment, but contribute very little directly to removal of BOD. Duckweeds help in removing nutrients and heavy metals by absorbing nitrogen, phosphorous, sulphur and trace elements.

g) ***Trickling filters (secondary treatment, decentralized):*** Trickling filters are always preceded by a primary settlement stage, usually a septic tank, and followed by a humus tank. They are also known as percolating filters, biological filters and filter beds. A trickling filter is a container, usually filled with blast furnace clinker or stones, called as media. Sewage is distributed over the surface of this media and drains freely to the base. The method is relatively robust, tolerant of peak loadings and does not require power, if a fall is available.

8.2 Improvised way of Treating Wastewater

a) ***Decentralized Wastewater Treatment Systems (DEWATS):*** DEWATS is based on different natural treatment techniques, put together in different combinations according to need. In this method, the reed bed system acts as a secondary treatment unit, which is preceded by baffled reactor where most of the treatment takes place. In the DEWATS, both anaerobic and aerobic techniques are applied. Its applications are based on four basic treatment modules, which are combined according to specific requirements. The modules are: i) pre-treatment and sedimentation in settlement tank or in septic tank; ii) secondary anaerobic treatment in baffled reactors; iii) post-treatment aerobic/ anaerobic treatment in reed bed system; iv) post treatment aerobic treatment in ponds. In India, DEWATS is practiced by the Auroville Centre for Scientific Research (CSR), Pondicherry.

b) ***Soil biotechnology (SBT):*** SBT involves removal of organics by adsorption followed by biological degradation (conversion to CO_2) and oxygen supply by natural aeration. The suspended solids are removed by filtration as the wastewater travels in the soil media. Dissolved solids are removed by filtration and biodegradation. The under drain serves as a liquid hold up media and additives provide sites for chemical and biological transformation. The SBT requires low operation and maintenance costs. This technology was developed by Prof. Shankar of IIT Bombay.

c) ***Soil aquifer treatment (SAT)****:* The process of purifying and reclaiming water by allowing it to pass through the soil and aquifer is referred as SAT. In SAT systems, the soil layer above the aquifer acts as a natural filter that removes the pollutants and other impurities from the wastewater by physical, chemical and biological processes, as it moves down to the groundwater.

d) ***Rotary biological contactors:*** Also called bio disks, these hold a series of high surface area plastic discs, mounted on a horizontal shaft driven slowly by a motor a bio film develops on the surface of the disks which dip into the sewage. As they turn, the bio film is exposed to air, providing oxygen for aerobic degradation of the sewage.

e) ***Activated sludge package plants:*** These units make use of several processes commonly used in large-scale municipal treatment works. It involves blowing air bubbles through the incoming sewage. The oxygen is rapidly used to degrade organic matter and this process creates a slurry which contains micro organisms in the most rapid phase of growth, and ideal for sewage breakdown.

8.3 Additives for treating wastewater

a) ***Biosanitiser:*** The idea of treating wastewater using biosanitizer or biocatalyst was developed by Dr. Udai S. Bhawalakr at IIT Bombay, in 1996. The biocatalyst included two products namely Vermi++, and Sujala. As claimed by the inventor, these products are for one time use, once incorporated in the system; they stay inside the treatment unit and treat the wastewater. This is used for small scale water recycling such as domestic/ hotels where the water from kitchen, bathroom and toilet can be cleaned and recycled for gardening or irrigation purpose. The technology is very cheap with approximately Rs. 400/- for one time, say for a family of 5 members.

b) ***Effective micro organisms (EM):*** It denotes a liquid mixture of several micro organisms in a molasses based medium. It was developed by Prof. Tero Higa, Ryukyus University, Japan in 1982. EM contains micro organisms which are mostly used in food processing like lactobacilli. The product in the market is a liquid in a one-litre bottle costing approximately Rs. 200/-. It is to be activated with the help of a sugar solution. One litre of EM solution can treat upto 200,000 litres of effluent depending on the effluent. This technology is used by many industries including rubber, textile, tanneries etc.

c) ***Bioclean:*** It involves treating the industrial effluent using naturally occurring bacteria in soil. Each gramme of the product contains up to four billion microbes and there are up to 76 different strains of bacteria in each Bioclean product. These microbes increase the efficiency of treatment plants without the need for increasing its capacity. This technology is developed and promoted by Organica Biotech, a Mumbai based company.

8.4 Modern technologies for treating wastewater

a) ***Upflow anaerobic sludge blanket reactor (UASBR)*****:** This technology is manufactured by Naik Environmental Engineers, Mumbai. The treatment plant is shop assembled and it is a skid mounted package unit and requires minimal civil construction works. A sludge blanket cultured in the lower portion of the UASBR very effectively traps suspended and dissolved organic matter. The Rotating Biodisc Contactor (RBC), which is the second unit in the series, takes the atmospheric oxygen. An attached growth anoxic reactor is built into the upper portion of the UASBR for conversion of nitrites and nitrates into nitrogen gas. The entire operation is simple and the system once stabilized, can be left to itself without much human intervention. The treated water may be used for irrigation purpose, depending on the nature of the waste water. This system is used by many small scale industries in India now.

b) ***Cyclic activated sludge process (c-tech):*** The c-tech is a cyclic activated wastewater treatment process whereby carbon oxidation, nitrification, denitrification and bio-phosphorous removal are carried out simultaneously. This technology ensures that all the effluent processes like equalization, aeration, settling and decanting are carried out in a single tank. Most importantly the system treats the effluent to a level specified by authorities for irrigation or discharge into open water sources like rivers. The treated effluent has the characteristics such as BOD< 30 mg/l, COD<150 mg/l and ammonia nitrate less than 5mg/l etc. The system is marked by Ion Exchange company in India and used by many small scale industries. The technology is automatic and found to be economical.

c) ***Submerged aerobic fixed film process (SAFF):*** The SAFF reactor comprise PVC fill media that facilitate attached fixed film growth of the micro organisms. The aerobic environment in the SAFF reactor is achieved by using fine bubble diffused aeration. After some time, the treated wastewater overflows into a clarifier where the sludge and treated water separate. The clarifier consists of specially designed tubular synthetic media with the property of enhanced settling rate and hence reduced size of the unit over a conventional clarifier. The settled sludge passes on to an aerobic sludge digestor-cum-thickner. The clarified water is then let to the chlorinated contact tank. The chlorinated water is further filtered in pressure filter to remove suspended matter. This ensures complete and safe effluent having zero BOD and suspended solids less than 5mg/l. The treated water can be used for the make up water in cooling towers and for horticulture.

d) ***Fluidised bioreactor (FAB):*** The FAB reactor is based on the concept of suspended growth as well as attached growth processes. The media has a specific gravity less than that of water. Hydraulic currents set by aeration facilitate fluidisation of the media. The advantages of the system include: no moving parts, wide treatment range (25 – 20,000 cub.m/ day), no sludge recycling required and totally closed system for small capacities. The technology is ideal for treating the sewage from municipalities, hotels, hospitals, IT parks and commercial complexes.

9. Membrane Processes

Membranes are semi-permeable materials designed to separate particulate, colloidal and dissolved substances from liquid solutes. Essentially, they allow substances smaller than the membrane pores to flow through, while holding back substances larger than the pores.

The use of membrane technologies in wastewater was earlier mainly limited to reverse osmosis. Due to the development in polymer chemistry in the last few years, a variety of membranes are now available including "membrane bioreactors". In many countries such as US and European countries, more stringent public water supply requirement make the use of membrane processes, increasingly necessary. Moreover, the membrane technologies are being increasingly considered where reuse of the treated wastewater is envisaged. Membranes are produced from a wide variety of materials such as cellulose acetate, polyamides, polysulfones, polypropylene, nylon, polyvinyl alcohol etc. They are manufactured to remove down to the smallest desired material which is normally stated as molecular weight cut-off. The four most common configurations are: tubular, plate and frame, spiral wound and hollow fibre. Of these, the hollow membranes are the most commonly used in water recycling, because they have the highest membrane surface area for a given footprint. Membrane replacement is generally required every 3-5 years.

Membrane systems are generally all pressure systems and for wastewater treatment, they are divided into four classifications depending on their pore size and molecular weight cut-off as: Microfiltration, Ultrafiltration, Nanofiltration and Reverse Osmosis.

Microfiltration (MF): MF membranes (pores > 50 nm (nano-metre)) are the least expensive membranes and have been used in wastewater treatment for turbidity removal, solids separation after biological treatment, as in Membrane Bioreactors (MBRs), removal of helminth ova, other organisms etc. Operation pressures are generally below 350 kPa. Their flux rates average between 400-1600 $L/m^2/d$. They are often used in MBRs for producing recycled water for non-potable purposes.

Ultrafiltration (UF): UF membranes (pore sizes 2-50 nm) have been used in wastewater treatment for many of the same applications as MF membranes except that UF systems give a better separation of finer colloids, bacteria, viruses etc. They are also used in MBRs to separate bio solids after activated sludge process. Operating pressures vary from 350-690 kPa and flux rates vary from 400-600 $L/ m^2/d$.

Nanofiltration (NF): In NF membranes, the pores should be less than 2 nm. The pressures vary between 520-1400 kPa and flux rates vary from 200-800 $L/ m^2/d$. They are used in water purification for potable purpose and can remove viruses. They are often used to treat waters pre-treated by microinfiltration or ultrainfiltration to produce waters for indirect potable reuse applications such as groundwater injection.

Reverse Osmosis (RO): In RO systems, the membranes have pores < 2nm and have the lowest molecular weight cut-off. They require a relatively high operating pressures of > 1400 kPa and flux rates vary from 300 – 500 $L/ m^2/d$. They are used in desalination operations to remove ionic species from solution. They also remove sodium, nitrates, sulphates, heavy metals etc. RO can be used in further treating of waters pre-treated by MF and UF to produce waters of high quality for indirect reuse applications.

10. Modern Technologies for Recycling by Industries

As discussed above, a number of technologies are available for wastewater treatment. However the modern technologies used by Industries for recycling of wastewater include: Combined biological and physico-chemical methods (conventional), Ultrafiltration technology, Membrane Bioreactor (MBR), Reverse Osmosis (RO) and Ultraviolet (UV) disinfections. A brief description of these modern technologies and there uses are discussed in the following sections.

10.1 Combined Biological & Physico-Chemical Method

A combination of biological and physico-chemical methods has to be used where a high quality of reusable water has to be produced. The biological treatment methods generally include activated sludge method or one of its modifications. The effluent is further treated by physico-chemical methods such as activated carbon, multi media filtration, zeolite softening, pH correction etc. The flow sheet of a typical combined biological and physico chemical method (conventional method) include the following:

Wastewater -> Biological Treatment (activated sludge + clarification and sludge return) -> Alum dosing -> Clarification -> Sand Filtration -> Softening -> Chlorination -> Reuse.

The typical flowsheet for a conventional treatment with Combined Biological & Physico-chemical method is shown in Fig.2.

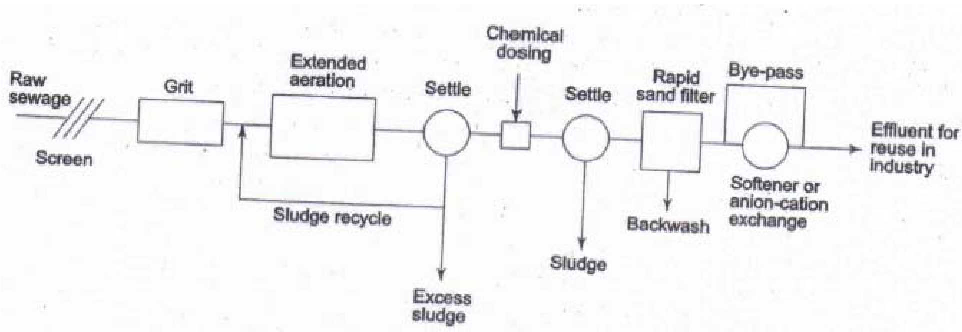


Fig.2: Typical Flow sheet of combined biological and physico-chemical for non-potable reuse.

10.2 Ultrafiltration Technology

Ultrafiltration is nowadays used in conjunction with biological treatment to give a very high quality water for reuse. Biological treatment along with ultrafiltration simplifies the flowsheet by replacing all the clarification, sand filtration and other units. This gives a much reduced footprint and simplicity in operation. It provides a more positive means of solid-liquid separation by preventing any loss of solids in the effluent, and therefore allowing a high concentration of biomass (MLSS) to be built up in the reactor. This gives a longer time for the bio solids (SRT) which enables a more complete bio-degradation to occur. With ultrafiltration, complete disinfection as well as removal of micro-pollutants are achieved which is particularly useful for recycling. A simplified flow sheet with ultrafiltration would be as follows.

Wastewater -> Preliminary Screening, Grit removal, oil separation -> Activated Sludge, Extended Aeration -> Ultrafiltration module -> Permeate to Storage -> Water Recycled for use -> Solids Recycled Back to Reactor.

The typical flowsheet with ultrafiltration is shown in Fig.3.

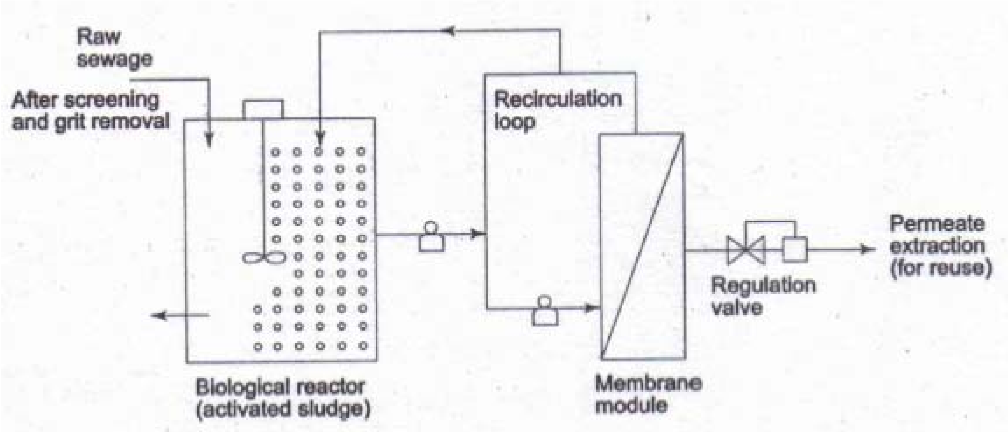


Fig.3 Typical Flow sheet of biological treatment with ultrafiltration unit

10.3 Membrane Bioreactor (MBR)

Membrane bioreactor is designed to produce high quality treated water from wastewater. It is available in standard and customized modules to treat domestic sewage and industrial effluent. The characteristics of the MBR process is the use of revolutionary submerged membranes in the biological process water tank. Some MBRs incorporate the MF system (e.g., Kubota, Mitsubishi, US filter, Siemens) while some others (e.g., Zenon) incorporates the UF system. MBR using UF system give a better final water quality than those using MF system.

Compared to the conventional system discussed in section 10.1, MBR required only one fourth space. The typical flow chart for MBR include:
Wastewater -> Biological Treatment (aeration only) + MF or UF -> Reusable water

The use of microfiltration or ultrafiltration systems has simplified the flow sheet by replacing all the clarification, sand filtration and other units. The membrane is used instead of the clarifier to separate the solids from the liquid so effectively that sand filtration and other steps become unnecessary and the foot-print of the plant is greatly reduced. The membrane step provides a positive means of liquid-solid separation after biological treatment by preventing any loss of biological solids in the effluent and therefore allowing a high concentration of biomass to be held in the reactor. Longer solids retention time is obtained which enables more complete bio-degradation of pollutants to occur. Sludge production is thus reduced. With MBR, complete disinfection of wastewater can be achieved, together with removal of micro-pollutants, which is particularly useful for reuse applications. Cleaning of MBR is done in two steps: first is called 'maintenance cleaning' and is done automatically every 10-15 minutes to manage membrane fouling and minimize permeability decline and this is done automatically. The second is called ‘recovery cleaning’ and is done once in a few months using chemicals to restore permeability. Fig. 4 shows a typical schematic of a MBR system. Fig. 5 shows a typical module of MBR.

MBRs are increasingly being used in USA, Europe, Japan and Australia to give tertiary treatment to municipal sewage and industrial wastewater to produce high quality effluents for reuse of water. The capacity of MBR may vary from 5 Ml/d to 45 Ml/d.

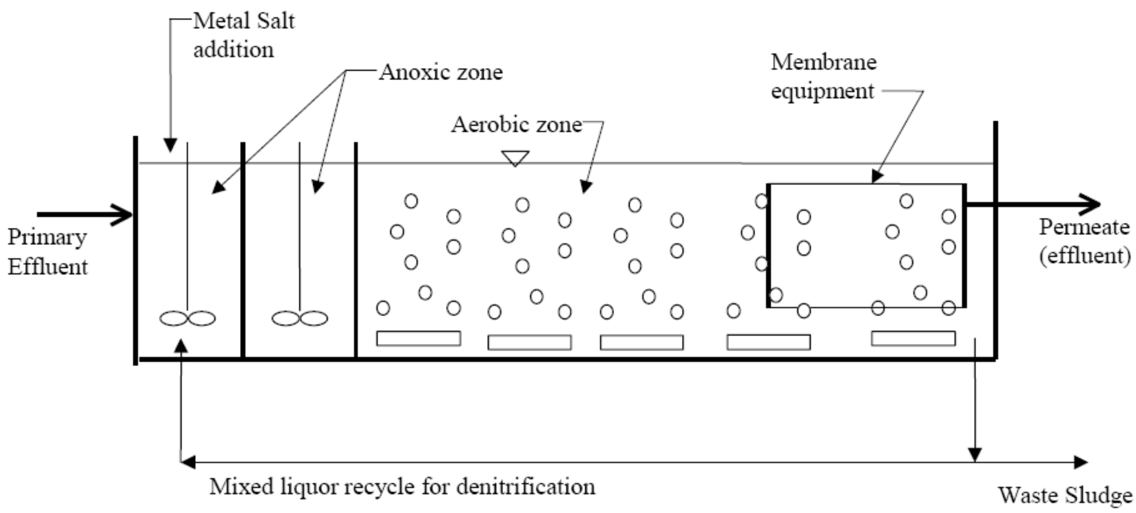


Fig.4 Typical schematic for MBR System

In India, Zenon has installed MBR in Bangalore to treat municipal wastewater for reuse in 2005. Other manufacturers also supply similar MBR units. Ion Exchange, Mumbai, India, supply MBRs with MF or UF according to requirements of industries or domestic users. Various studies on MBRs show that the cost of the system can be recovered in less than 3 years.

Fig.5 Typical MBR module

10.4 Reverse Osmosis (RO) System for Water Recycling

Reverse Osmosis is generally required where microfiltration and ultrafiltration are not adequate for the purpose. Generally, MF and UF are often used to give pre-treatment to wastewaters to prepare them for application to RO system. The RO can give adequate treatment to pre-treated wastewaters to make them fit for reuse in high-pressure boilers and for various non-potable uses/ reuses in industry. RO units are really required where Total Dissolved Solids (TDS) are to be reduced. Their use in treating brackish waters and sea waters is well known. The flow sheet for RO is as follows.

Wastewater -> Conventional pre-treatment -> Pre-treatment by UF -> Reverse Osmosis system -> Permeate aerate / stabilized as necessary -> Reusable water

For RO system, the membranes are made from cellulose acetate or polyamides or other materials and have flux rates and operating pressures as mentioned earlier in section 9. Due to high pressure in RO, special manufacturing techniques are to be adopted and manufacturers ascertain the extent of pre-treatment. The power requirement in RO is about 10 kWh/cub.m.

In India, a large number of RO systems are being installed at various parts of the country for last 25 years. Most of these plants produce feed water for high-pressure boilers while few of them produce water for reuse, where so called "zero" discharge is required.

10.5 Ultraviolet (UV) Disinfection

Disinfection is considered to be the primary mechanism for the inactivation/ destruction of pathogenic organisms. It is important that wastewater be adequately treated prior to disinfection in order for any disinfectant to be effective. An Ultraviolet (UV) disinfection system transfers electromagnetic energy from a mercury arc lamp to an organism's genetic material (DNA & RNA) and destroys the cell's ability to reproduce. The effectiveness of a UV disinfection system depends on the characteristics of the wastewater, the intensity of UV radiation, the amount of time the micro organisms are exposed to radiation, and the reactor configuration. For any one treatment plant, disinfection success is directly related to the concentration of colloidal and particulate constituents in the wastewater.

The main components of a UV disinfection system are mercury lamps, a reactor, and ballasts. The source of UV radiation is either the low-pressure or medium pressure mercury arc lamp with low or high intensities. The optimum wavelength to effectively inactivate micro organisms is in the range of 250 to 270 nm. The intensity of the radiation emitted by the lamp dissipates as the distance from the lamp increases. There are two types of UV disinfection reactor configurations that exist: contact types and non-contact types. In both types, wastewater can flow either perpendicular or parallel to the lamps. Fig. 6 shows two UV contact reactors with submerged lamps placed parallel and perpendicular to the direction of the wastewater flow. Flap gates or weirs are used to control the level of the wastewater.

Some of the advantages of UV disinfection include: it is effective at inactivating most viruses, spores and cysts; UV disinfection is a physical process rather than a chemical disinfectant; there is no residual effect that can be harmful to humans or aquatic life; it is user friendly, needs short contact time and required less space than other methods. The disadvantages include: pre-treatment required; low dosage may not be effective and turbidity and suspended solids may make UV disinfection ineffective. Siemens, Germany offers a wide range of UV disinfection system for wastewater recycling.

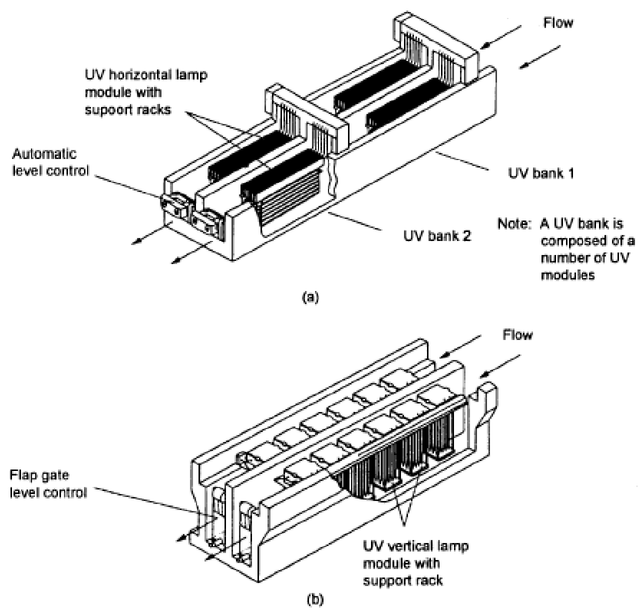


Fig. 6: UV Contact reactors configuration with submerged lams places parallel and perpendicular to the direction of flow

11. Water Recycling Modern Technologies – Feasibility, Costs and comparison

11.1. Conventional Technologies

1) Conventional Wastewater Treatment (activated sludge process):

a) Area requirement in sq.m per mld (daily flow): 400 to 1000 (depending on size)
b) Capital investment per mld – Rs. 23 – 60 Lakhs/- (depending on size)
c) Operation and maintenance cost per cum – Rs. 0.40 to 2.5/- (approx.)
d) Technical Feasibility – Applicable for recycling of both 'grey' and 'black' municipal/ domestic wastewater.
e) Implementing Agency: Different components by different agencies
f) Case study examples: Large number of cases implemented – (e.g. Textile Mills in Mumbai; Air India Building, Mumbai; treated water used for reuse).

2) DEWATS (Decentralized Wastewater Treatment Systems):

g) Area requirement in sq.m per cum (cubic meter) (daily flow):10 to 12
h) Capital investment per cum – Rs. 25,000 - 50,000/-
i) Operation and maintenance cost (annual) – Rs. 1000/- (approx.)
j) Technical Feasibility – Applicable for recycling of both 'grey' and 'black' municipal/ domestic wastewater.
k) Implementing Agency: Centre for Scientific Research, Pondicherry
l) Case study examples: About 50 cases implemented – (e.g. Arvind Eye Hospital, Pondicherry – investment: Rs. 1.2 Crores; Capacity about 300 Cum/day; treated water used for irrigation).

3. Cyclic Activated Sludge Process (c-tech):

a) Area requirement in sq.m per Mld : about 50% conventional sewage treatment plants.
b) Capital investment per cum – Rs. 10,000 - 20,000/-
c) Operation and maintenance cost per cum – about 50% conventional sewage treatment plants.
d) Technical Feasibility – Applicable for recycling of domestic/ industrial wastewater.

e) Implementing Agency: Ion Exchange India
f) Case study example: (e.g. Manav Breweries, Ghaziabad, First in India – investment: Rs. 1 Crore; Capacity about 1200 Cum/day in four cycles of six hours each per day; treated water used for irrigation/ discharged to streams).

11.2. Modern Technologies

1) Reverse Osmosis:

a) Area requirement in sq.m per cum (cubic meter) (daily flow): depends on total capacity
b) Capital investment: Rs 8 to 20 /lpd (Capacity>500,000 lpd)
c) Operation and maintenance cost per cum – Rs 10-20/- (approx.)
d) Technical Feasibility – Applicable for recycling of all types of wastewater including brackish and sea waters.
e) Implementing Agency: Various agencies supplying membrane technologies, as mentioned below.
f) Case study examples: Large number of examples – (e.g. RCF Chembur, Mumbai – investment: Rs. 40 Crores in 1998; Capacity about 23 Million liters/day; treated water used for all industrial use).

2) Ultrafiltration:

a) Area requirement in sq.m per cum (cubic meter) (daily flow): depends on total capacity
b) Capital investment: Rs 10 to Rs 20 / lpd (depending on the total Capacity)
c) Operation and maintenance cost per cum – Rs. 5 - 10/- (approx.)
d) Technical Feasibility – Applicable for recycling of all types of wastewater for industrial reuse.
e) Implementing Agency: Various agencies supplying membrane technologies, as mentioned below.
f) Case study examples: Large number of examples all over the world.

Note: BARC Mumbai also recently developed an ultrafiltration technique for water recycling (Head, Technology Transfer & Collaboration Division, BHABHA ATOMIC RESEARCH CENTRE, TROMBAY, MUMBAI - 400 085).

3) Membrane Bioreactor (MBR)

a) Area requirement in sq.m per cum (cubic meter) (daily flow): depends on total capacity
b) Capital investment: Rs 15 to Rs 35/ lpd (depending on the total Capacity)
c) Operation and maintenance cost per cum – Rs.15 -25 /- (approx.)
d) Technical Feasibility – Biological treatment with membrane separation; Exceptional treatment efficiency with reduced foot print; Applicable for recycling of all types of wastewater for industrial reuse with high quality output.
e) Implementing Agency: Various agencies supplying membrane technologies, as mentioned below.
f) Case study examples: Large number of examples all over the world – (e.g.Nordkanal, Germany with 45 Ml/d; Bangalore Development Authority, Bangalore).

4) UV Disinfection:

a) Area requirement in sq.m per cum (cubic meter) (daily flow): depends on total capacity
b) Capital investment: Rs 5 to Rs 10 / lpd (depending on the total Capacity)
c) Operation and maintenance cost per cum – Rs. 2 - 5/- (approx.) (this does not include the costs of other treatments)
d) Technical Feasibility – Powerful disinfection solution without chemicals; Applicable for recycling of all types of wastewater for industrial reuse with high quality output.
e) Implementing Agency: Siemens, Germany, Hatch Mott MacDonald, USA etc.
f) Case study examples: Large number of examples all over the world.

A comparison between the methods are given in Table 1.

Table 1: Comparison of technologies for wastewater treatment & water recycling

Recycling Method	Technical feasibility	Cost	Remarks

Convent-ional	Side effects due to chemicals; more time for treatment; high water quality difficult to achieve	Based on chemical and power cost; Capital investment per mld: Rs. 23 – 60 Lakhs/- (depending on size); Operation and maintenance (O&M) cost per cum – Rs. 0.40 to 2.5/- (approx.)	Larger area requirement; huge conveyance & power consumption costs; water may not be of high quality for reuse in industry
DEWATS	Applicable for recycling of both 'grey' and 'black' municipal/ domestic wastewater	Capital investment per cum – Rs. 25,000 - 50,000/-; Annual O &M cost – Rs. 1000/- (approx.)	Less dependent on electricity; space requirement more; water quality better than of conventional
c-tech	Applicable for recycling of domestic/ industrial wastewater	Capital investment per cum – Rs. 10,000 - 20,000/-; O& M – 50% of conventional; system	Less energy requirement; less space; water quality better than of conventional
Ultrafiltr-ation	Adaptable for high turbidity industrial water; Applicable for recycling of all types of wastewater for industrial reuse; Good quality of water for reuse	Capital investment: Rs 10 to Rs 20 / lpd; O & M Rs. 5 - 10/- (approx.)	Eco-friendly as no chemicals are used 97% water recovery; high quality water for reuse
MBR	Biological treatment with membrane separation; Exceptional treatment efficiency with reduced foot print;	Capital investment: Rs 15 to Rs 35/ lpd ; O & M: Rs.15 -25 /- (approx.)	No side effects, no need of chemicals; high quality water for reuse

RO	Feasible for bulk quantities of water; Applicable for recycling of all types of wastewater including brackish and sea waters.	Capital investment: Rs 8 to 20 /lpd (Capacity>500,000 lpd) O & M costs: Rs 10-20/- (approx.)	Recovery of salts for reuse; Savings are more than operating costs; 93% water recovery; high quality water for reuse
UV Disinfection	UV water treatment technology 99.99% of all pathogens in water without the addition of chemicals or harmful side effects	Capital investment: Rs 5 to Rs 10 / lpd (depending on the total Capacity); O &M : Rs. 2 - 5/- (approx.) (this does not include the costs of other treatments)	Increase in lamp life and decrease in energy consumption using modern methods; high quality water

11.3 Agencies for Water Recycling Installation

1. VA TECH WABAG LTD, India

HEAD OFFICE : VA TECH WABAG LIMITED
11, Murray's Gate Road Alwarpet, CHENNAI - 600 018, TAMILNADU , INDIA
Phone : 91 + 44 + 42232323 **FAX :** 91 + 44 +42232324
Email : wabag@bdwt.com
Regional Office - Pune
VA TECH WABAG LIMITED
Bhakti Plaza, 2nd Floor, Near Aundh Police Chowki, Auundhgao, Pune – 411007
Phone: 020-66424900 / 66424901, **Fax** : 020-66424949
Offerings:

- Reverse Osmosis
- Ultra filtration
- Micro filtration
- Membrane Bio reactor

Technology References
Indian Oil Corporation Ltd., Panipat

- Six -stream recycling plant
- Capacity of 150 m3/hr/stream
- Based on Ultra filtration and Reverse osmosis technology
- One of world's largest plant with 90% recovery
- Automatic PLC based

Indian Oil Corporation Ltd, Naptha Cracker Project, Panipat

- Complex naptha cracker effluent recycled
- Capacity -1 x 900 m3/hr
- Based on Ultra filtration and Reverse osmosis technology in combination with solid contact clarification and resin based processes
- Automatic PLC based

Travancore Titanium Products Limited (TTPL), Trivandrum

- Neutralization cum effluent recycle plant for a highly acidic waste with heavy metal contaminants
- Capacity 6000 m3/day
- Based on microfiltration and reverse osmosis in combination with chemical treatment
- Gypsum is obtained as a by product and is worthy of commercial use
- Semiautomatic PLC based

2. Delta Technologies

Contact: Mr. Shankar, 101, Ranjeet Towers, Dilsukhnagar, : Hyderabad

Phone: 040-55468278; Fax: 040-55468378; email: deltatechnik@yahoo.co.in; Mobile: 9948171469; http://www.deltaionexchange.net

Available technologies: UV disinfection and Reverse Osmosis plants

3. ***Unicom Skytech Ltd.***

ddress : 8, Arab House, 12th Khetwadi, Lane, Mumbai – 400004 ,

Tel. (022) 23883469 / 23898787; Fax : (022) 23880226

Email : response@unicom.co.in , ultraguard@vsnl.com

WebSite: www.unicom.co.in

Available technologies: Standard and Customised Models for specific customer need are available from 60 liters per hour to 3 lakh liters per hour.(UV disinfection and Filters)

4. ***Veolia water solutions and technologies, France***

Available technologies: MBR and Ultraviolet Disinfection; Range of flow rates: 2 to more than $60m^3/hr$; UV-Star™ - Ultraviolet Disinfection (Separate Brochure available) ; UV-Star™ provides final disinfection for both domestic and industrial effluent prior to discharge into the natural environment. Flow rates from 100 m^3/hr to several thousand m^3/hr

Other Agencies supplying Membrane Technologies in India and worldwide:

a) Ion Exchange India, Ionics USA
b) Siemens, Germany
c) Nu-Chem, USA
d) Thermax, USA,
e) Memberatek
f) Pall (Asahi), Australia and USA
g) KOCH Membrane Systems – PURON Submerged Membranes, Germany
h) NORIT Membrane Technology, The Netherlands.
i) Kubota Systems, Japan, Germany & Netherlands
j) Mitsubishi, Japan
k) Zenon Environmental (ZeeWeed), USA, Canada, Europe (500 tp 19,000 m^3/d).
l) US Filter
m) Dynatec Systems, USA
n) Microfilt India, Vikhroli, Mumbai for Ultrafiltration.

12. Water Tariff Rebate Mechanism for Industries

As discussed earlier, there are large number modern water recycling technologies available in market. If any of these technologies are implemented by Industries, depending on the type of Industry, characteristics of effluent, investments possibilities, good amount of wastewater can be recycled and reused, as demonstrated by few Industries.

Regarding any water tariff rebate for Industries opting for water recycling, there is no known case studies / published works are available in literature. It may be possible that if some incentives are provided for water recycling, more Industries may come forward for wastewater recycling and reuse.

Hence while formulating the bulk water tariff for Industries, rebates should be provided for quantum of water recycled and not for water being supplied. Say for example, let an Industry is taking ‘x’ units of water per day for its use from the main supply and it produces ‘y’ units of wastewater (effluent) after all process. If the Industry is treating wastewater and make 'z' units of water per day for 'reuse', then a rebate may be given for the 'z' units of water from the 'x' units supplied. The Industry may declare about the units of water it recycles for 'reuse' on monthly wise and some agencies may check whether it is correct on a regular basis.

The rebate may be on a percentage wise on the tariff imposed on the Industry for the water supplied. Say for example, the percentage rebate may vary from 10 to 20% depending on the percentage reuse by the concerned Industry.

Notes:

1. It may be noted that the installation and operation and maintenance costs mentioned are approximated based on the available installed plants. However the real costs of installation, operation and maintenance depends on the manufacturer, the site, the capacity of the plant, the characteristics of the wastewater to be treated, the primary treatment given and the quality of water required for reuse.
2. As per the available information, there are no fixed mandatory norms by MPCB for water recycling/ water reuse by Industries. If any Industry is presently recycling or reusing the water, it is on their own interest either due to less availability of water or cost saving by reuse.
3. To work out a suitable rebate mechanism suitable, more discussion with the concerned officials may be required.

13. Concluding Remarks

Water recycling has proven to be effective and successful in creating a new and reliable water supply, while not compromising public health, especially in industries. Non-potable reuse is widely accepted practice that will grow. Advances in wastewater treatment technology and health studies of indirect potable reuse have led many to predict that planned reuse will become more common. The treatment of wastewater for reuse and the installation of distribution systems can be initially expensive, however can be sustainable and cost effective in the long term.

Other than the conventional treatment processes discussed, the modern technologies such as filtration technologies, membrane bioreactors, reverse osmosis and UV disinfection are the most promising technologies for the water recycling. These technologies are under further development. As water demands and environmental needs grow, water recycling will play a greater role in our overall water supply.

ANNEXURE - IV

(WATER RATES FOR NON IRRIGATION (INDUSTRIAL AND DRINKING) PURPOSE)

Annexure IV – Water Rates for Non Irrigation (Industrial and Drinking) purpose

Present water rates with effect from April 1, 2007, in Maharashtra, for industrial use where water is used as raw material, industrial use where water use is incidental and for drinking purpose, as per Government Resolution No. WTR 2006/ (396/03)-IM (P) in July 31, 2006 are presented Table 1, Table 1 and Table 3 respectively.

Table 1: Water Rates for water supply by Water Resources Department to industrial use where water is used as raw material (e.g., cold drinks, breweries, mineral water or similar use for drinking purposes)

	Type of use	**Water Rates (Rs./10,000 litre)**
A)	If dam is constructed across the river	
1	From the reservoir	190
2	From the Canal (by gravity or lift)/river on downstream of the dam and if there is no storage tank as per yardsticks	480
3	If water using agency has constructed the dam with their own expenses / cost of construction given by user in proportion of water use.	70

B)	If there is no dam on upstream op point from where water is lifted from river	
	From river	70

Table 2: Water Rates for water supply by Water Resources Department to Industrial use (except drinking purpose etc.)

	Type of use	Water Rates (Rs./10,000 litre)
A)	If dam is constructed across the river	
1	From the reservoir	38
2	From the Canal (by gravity or lift)/river on downstream of the dam and if there is no storage tank as per yardsticks	95
3	If water using agency has constructed the dam with their own expenses / cost of construction given by user in proportion of water use.	13
B)	If there is no dam on upstream op point from where water is lifted from river	
	From river	13

Table 3: Water Rates for water supply by Water Resources Department for Domestic Use

	Type of Use	Water Rates (Rs./ 10,000 litre)
A)	If dam is constructed across the river	
1	From the reservoir	1.70
2	From the Canal (by gravity or lift)/river on downstream of the dam and if there is no storage tank as per yardsticks	6.60

3	If water using agency has constructed the dam with their own expenses / cost of construction given by user in proportion of water use.	1.50
B)	If there is no dam on upstream op point from where water is lifted from river	
	From river	1.50

ANNEXURE - V

(WATER RATES FOR IRRIGATION PURPOSE (CANAL FLOW WATER CHARGE, SERVICE CHARGE FOR LIFT IRRIGATION, WATER RATES FOR WATER SUPPLIED ON VOLUMETRIC BASIS AND WATER RATES FOR PRIVATE LIFT IRRIGATION SCHEMES))

Annexure V – Water Rates for Irrigation purpose (Canal flow water charge, service charges for lift irrigation, water rates for water supplied on volumetric basis and water rates for private lift irrigation schemes)

1. Water Rates for canal flow water

Present water rates in Maharashtra for canal flow water use by different crops under different seasons with effect form July 01, 2003, as per Government Resolution No. Water Rates 1001/ (5/2001)-IM (Policy) in September 13, 2001 are presented in below given Table 1:

Table 1: Water Rates for canal flow use by different crops under different seasons

Sr. No.	Name of Crop of Season	Water Rates (Rs./hectare)
A)	**Kharif season**	
1	Kharif seasonals (including hybrid), Kharif rice (on contract)	238
2	Kharif rice (on demand), Kharif groundnut hybrid seeds and kharif support crops	476
3	Advanced watering (in kharif season for rabi crops)	119
B)	**Rabi crops**	
4	Rabi seasonals (excluding wheat and groundnut)	357
5	Rabi wheat	476
6	Kharif and rabi cotton, rabi groundnut, rabi-HW rice, hybrid seeds and rabi support crops	724
7	Late watering (given for kharif crops in rabi seasons	119
C)	**Hot weather seasons**	
8	Hot weather seasonals	724
9	HW groundnut, HW cotton (from April 1)	1438
10	HW cotton (from March 1)	1924
11	Advanced watering (1 watering given in Hot weather	357

	season)	
12	Late watering (1 watering given in HW for rabi crops)	178
D)	**Two seasonal crops**	
13	Two seasonals e.g. Tur, Potato etc	
	In Kharif & Rabi	357
	In rabi and hot weather	605
E)	**Perennials (flow)**	
14	Sugarcane and Banana	6297
F)	**Other perennials (flow)**	
15	Fruit crops, lucerne etc.	6297
16	Sugarbeet (excluding advance and late irrigation given), rabi vegetables	1081
17	Kharif vegetables	724
18	Hot weather vegetables	2697
19	Onion in kharif and rabi seasons, Onion in kharif and rabi seasons given with one late irrigation	1805
20	Onion in Kharif and rabi seasons and in HW season given more than one irrigation	2519
21	Onion in rabi and HW seasons	2876
G)	**Extended (flow)**	
22	Adsali upto December for every month	
	Kharif	307
	Rabi	526
23	Adsali in January	1259
24	Adsali in February	1368
25	Adsali in March	2380
26	Adsali in April	2955
27	Suru upto February for every month	526
28	Suru in March	1805
29	Suru in April	2092
H)	**Crop block rates (flow)**	
30	Sugarcane block 1 : 4	2073
31	Fruit block	6297
32	Garden block	2449
33	Garden seasonal block	2628
34	Three seasonal block, two seasonal block	902
35	Rabi block	635
I)	**Perennials (Drip and Sprinkler)**	

36	Sugarcane and banana	4205
J)	**Other perennials (Drip and Sprinkler)**	
37	Fruit crops, lucerne etc.	4205
38	Sugarbeet (excluding advanced and late irrigation given)	724
39	Kharif vegetables	476
40	Rabi vegetables	724
41	Hot weather vegetables	1805
42	Onion in kharif and Rabi seasons	1200
43	Onion in kharif and Rabi seasons given with one late irrigation	1319
44	Onion in kharif and Rabi seasons given more than one irrigation	1686
45	Onion in Rabi and HW seasons	1924
K)	**Extended irrigation (Drip and Sprinkler)**	
46	Adsali upto December for every month	
	Kharif	208
	Rabi	347
47	Adsali in January	843
48	Adsali in February	912
49	Adsali in March	1587
50	Adsali in April	1963
51	Suru upto February for every month	347
52	Suru in March	1200
53	Suru in April	1398
L)	**Crop block rates (drip and sprinkler)**	
54	Sugarcane block 1: 4	1388
55	Fruit block	4205
56	Garden block	1636
57	Garden seasonal block	1755
58	Three seasonal block, two seasonal block	605
59	Rabi block	426
N)	**Water rates for sewage water**	
60	Sugarcane	11701
61	Other perennials	9897
62	Kharif seasonals	476
63	Rabi seasonals	724
64	Wheat	1021
65	Hot weather crops, rice (follow on)	1805

66	Cotton, groundnut	2519

2. Service charges for lift irrigation

Present Service charges for lift Irrigation schemes below 30m and above 30m, with effect form July 01, 2003 under jurisdiction of Irrigation Department and Irrigation Development Corporation as per Government Resolution No. Water Rates 1001/ (5/2001)-IM (Policy) in September 13, 2001 are presented in Table 2 and Table 3 respectively.

Table 2: Service Charges for lift Irrigation schemes below 30m under jurisdiction of Irrigation Department and Irrigation Development Corporation

Sr. No.	Season and crop name	Water Rates (Rs./hectare)
1	**Two seasonal crops**	
1	Tur	476
2	Turmeric / chilies	664
3	LS cotton and groundnut (hot weather & kharif)	1200
2	**Perennial crops (flow)**	
1	Sugarcane / Banana	5405
2	Other perennial crops	3729
3	Extended cane and banana (rate for one watering)	178.5
3	**Perennial crops (drip)**	
1	Sugarcane / Banana	3600
2	Other perennial crops	2489
3	Extended cane and banana (rate for one watering)	119
4	**Kharif crops**	
1	Rice	357
2	Other food grain and fodder crops	297
3	Other cash crops	416
5	**Rabi crops**	
1	Wheat	357
2	Other food grain and fodder crops	297
3	Other cash crops	416
6	**Hot weather crops**	
1	Hot weather food grains / hybrid jowar	724
2	Cash crops	1200
3	Follow on hot weather rice	902
7	**Vegetables**	

1	Kharif	535
2	Rabi crops	846
3	Hot weather	1200
8	**Advanced and late weathering (each watering)**	
1	Food grain crops	99.2
2	Cash crops	128.9

Table 3: Service Charges for lift Irrigation schemes above 30m under jurisdiction of Irrigation Department and Irrigation Development Corporation

Sr. No.	Season and crop name	Water Rates (Rs./hectare)
1	**Two seasonal crops**	
1	Tur	496
2	Turmeric / chilies	685
3	LS cotton and groundnut (hot weather & kharif)	1439
2	**Perennial crops (flow)**	
1	Sugarcane / Banana	6531
2	Other perennial crops	4546
3	Extended cane and banana (rate for one watering)	228
3	**Perennial crops (drip)**	
1	Sugarcane / Banana	4357
2	Other perennial crops	3027
3	Extended cane and banana (rate for one watering)	149
4	**Kharif crops**	
1	Rice	526
2	Other food grain and fodder crops	298
3	Other cash crops	417
5	**Rabi crops**	
1	Wheat	665
2	Other food grain and fodder crops	397
3	Other cash crops	844
6	**Hot weather crops**	
1	Cash crops	1439
2	Follow on hot weather rice	168
7	**Vegetables**	
1	Kharif	556
2	Rabi crops	844

3	Hot weather	1439
8	**Advanced and late weathering (each watering)**	
1	Food grain crops	99.2
2	Cash crops	128.9

3. Water rates for water supplied on volumetric basis

Present water rates/ royalty rates for water supplied on volumetric basis from canals/reservoir from funds of water users with effect form July 01, 2003, as per Government Resolution No. Water Rates 1001/ (5/2001)-IM (Policy) in September 13, 2001 are presented in below given Table 4.

Table 4: Water rates/ royalty charges for water supplied on volumetric basis from canals/ from reservoir constructed from funds of water users

Sr. No.	Location	Rs./1000 m
1	**From canal at minor head (water rates)**	
1	Kharif	47.6
2	Rabi	71.4
3	Hot weather	144.8
2	**From canal at outlet (water rates)**	
1	Kharif	53.6
2	Rabi	79.4
3	Hot weather	158.7
3	**Reservoir constructed by water users (royalty charges)**	
	For all seasons	23.8

4. Water rates for private lift irrigation schemes

Present water rates for lift irrigation schemes with effect from July 1, 2002 as per Government Resolution No. Water Rates 1001/ (5/2001)-IM (Policy) in September 13, 2001 for water use of private life irrigation scheme are presented in Table 5 and water rates for water use by private lift irrigation schemes on Kolhapur type weir and lift from river course for sugarcane irrigation is presented in Table 6 under the same Government Resolution.

Table 5: Water rates for lift irrigation schemes from 01-07-2002 for water use of private lift irrigation scheme

Sr. No.	Locatoin of lift Irrigation	Rs./ha
	Canal	
	Kharif Crops	75
	Rabi crops	110
	Hot weather Crops	220
	Sugarcane and Banana	
	Flow	1645
	Drip irrigation	1095
	Other perennials	
	Flow	1090
	Drip	730
	Reservoir/ dam/ elevated bandana	
	Kharif Crops	35
	Rabi crops	55
	Hot weather Crops	110
	Sugarcane and Banana	
	Flow	825
	Drip irrigation	555
	Other perennials	
	Flow	550
	Drip	365
	Within boundaries of command area in back water areas of river bandharas where dam water in not released	
	Kharif Crops	30
	Rabi crops	30
	Hot weather Crops	55
	Sugarcane and Banana	
	Flow	410
	Drip irrigation	280
	Other perennials	
	Flow	280
	Drip	180
	First bandhara in river/ nalla or lift irrigation from beyond dam, diversion bandhara in khariff	
	Kharif Crops	nil
	Rabi crops	20
	Hot weather Crops	20

	Sugarcane and Banana	
	Flow	135
	Drip irrigation	80
	Other perennials	
	Flow	90
	Drip	60

Table 6: Water rates for water use by private lift irrigation schemes on Kalhapur type weir, lift from river course for sugarcane irrigation including extended (from planting till harvesting)

Sr. No.	Location of River lift	Water Rates Rs./ha
1	**Notified river where water is released for the entire year from dam reservoir**	
1	Flow	1030
2	Drip	680
2	**River where Kolhapur type weirs are there but water is not released from dam reservoirs**	
1	Flow	720
2	Drip	475
3	**From rivers where the benefit of storage is not available**	
1	Flow	170
2	Drip	110

ANNEXURE - VI

(M & R NORMS PROPOSED BY WALMI)

Annexure VI – M & R Norms proposed by WALMI

Following are the proposed norms for Repair and Maintenance developed by Water and Land Management Institute (WALMI), Aurangabad based on study of pilot projects spread over Maharashtra. (Letter reference WALMI/ENGG/M&R Norms/484/2008 dated May 2, 2008)

Norms for Maintenance and Repairs proposed by WALMI

1	**Basic Norms**			
	1.1	**Head Works**		
		Rs.	11000	Per Million m^3 of Design Live Storage
				Subject to
				:-Provisions for M&R of gates shall be additional as suggested by Chief Engineer, Mechanical, Nasik
				:-Irrespective of good or bad year
	1.2	**Canal Works**		
	(a)	Rs.	380	Per Hectare of actual irrigated area
				Subject to
				:-Actual irrigated area as per average of last 3 years
				:-Perennials, Other Perennials and Two Seasonals counted once

:-Area irrigated on wells not to be considered

:- In a project, if steps for levying 50% of water fees on the kharif crops are taken and guarantee of supply of water provided, kharif irrigation may be included in the irrigated area.

(b) Rs. 190 Per Hectare of balance area

Subject to

:- Balance Area = CCA (Culturable Command Area)- Actual area irrigated

Total amount worked out as per (a) & (b) above may further be allocated component wise as given below

(c)	40%	Main/Branch Canal
	25%	Distributaries
	35%	Minors

1.3 K.T Weir (Kolhapur Type Weir)

(a)	Rs.	2300	Per Sq. Meter of gate area for K.T Weir **with** reservoir backup
(b)	Rs.	1450	Per Sq. Meter of gate area for K.T Weir **without** reservoir backup

1.4 Government Lift Irrigation Scheme (LIS)

(a)	-	Electricity charges & maintenance of pump house & rising mains : As per actuals
(b)	-	For Canals of LIS as per item 1.2 above

1.5 Storage Tanks

Refer item 1.1 above

2 Adjustment for specific conditions

(i.e. increase over & above basic norms, if and as applicable)

2.1 Age of the Project

7.50%	Age 35 to 70 years
15%	Age above 70 years

Subject to
If any modernization or rehabilitation of the concerned component has been carried out within last 35 years, then additional provisions indicated above shall not be admissible

2.2 Black Cotton Soils

(Applicable if dominant soil type (percentage >50%) of the project is B.C soils)

Add to basic norms worked out as per 1.2 (c) above	Project	Add in respect to
-	Major	Minors only
100%	Medium	Distributaries & Minors only
100%	Minor	Main/ Branch Canal, Distributory Minors

2.3 Project Situated in Hilly Areas/ High Rainfall Zone

(Average rainfall > 2000 mm /year)

Add 100% to Basic Norms on all components of the project, i.e.

:- Add 100% to the amount worked out as per item 1.1 for Head Works (Not applicable is dam is fully masonry/concrete dam)

:-Add 100 % to the amount worked out as per item 1.2 (c) for Main/Branch Canal, Distributaries & Minors

Note : Item 2.2 & 2.3 not applicable to KT Weir

ANNEXURE - VII

(FINANCIAL IMPLICATIONS OF M & R NORMS PROPOSED BY WALMI AT STATE LEVEL)

Annexure VII – Financial implications of M & R Norms proposed by WALMI at State level

Following are the financial implication of the norms for Repair and Maintenance developed by Water and Land Management Institute (WALMI), Aurangabad. (Letter reference WALMI/ENGG/M&R Norms/484/2008 dated May 2, 2008). These implications do not include establishment charges, special repairs, emergency maintenance and extension & improvement.

A.	**Head Works**		
1)	Total live storage of completed state sector irrigation projects (Mm^3)	:	29531
2)	basis M&R Norms for head works excluding Gates (Rs/Mm^3)	:	11000
3)	Annual basic M&R grants for head-works excluding gate (Rs. Million) (3) = [(1) * (2)]	:	324.8
4)	Add 30% for M&R of Gates of head-works (Rs. Million) (4) = [(3) * 0.30]	:	97.44
5)	Annual basis M&R grants for head-works including gates (Rs. Million) (5) = [(3) + (4)]	:	422.24
6)	Add 16% for adjustments in respect of age factor, BC soils, hilly area/ high rainfall zone (Rs. Million) [Note: same is assumed to be applicable at State level] (6) = [(5) * 0.16]	:	67.56
7)	Total annual M&R grants for head-works (Rs. Million) (7) = [(5) + (6)]	:	489.80

B.	**Canals**		
1)	Irrigation potential created (L. ha)*	:	41.32
2)	Culturable command area (Lakh .ha) (41.32 * 1.45)	:	59.91
3)	Area actually irrigated (L. ha)*	:	18.35
4)	Balance area (L.ha) (4) = [(2) –(3)]	:	41.56
5)	Basis M&R norms for canals 5(a) : Rs. 380/ha of actual irrigated area 5(b) : Rs. 190/ha of balance area		

6) Annual M&R grants for canals (Rs. Million)

	6(a) = (3) * Rs. 380 /ha	: 697.30
	6(b) = (4) * Rs. 190/ha	: 789.60
	Total 6(a) + 6(b)	:1486.90
7)	ADD 16% for adjustments (Rs. Million)	: 237.90
	(Please refer note at sr. no. A-6)	
	[(7) = Rs. 1486.90 * 0.16]	
8)	Total annual M&R grants for canals (Rs. Million)	:1724.80
	[(8) = 1486.90 + 237.90]	

As per Irrigation Status Report, September 2007

C. Project

Rs. 489.80 (head-works) + Rs. 1724.80 (Canals) = Rs. 2214.60 Million

=Rs. 221.46 Crores

i.e. =Rs. 369.65/ha of CCA

say Rs. 370/ha of CCA