

Water Auditing of Water Resources Projects

[Blank line 11 pt]

H. T. Mendhegiri & G. V. Vyawahare

Water and Land Management Institute, Aurangabad, India

hiralal.mendhegiri@gmail.com

[Blank Line 9 pt]

H. T. Mendhegiri

Shivaji University, Kolhapur, India

[Blank Line 9 pt]

H. T. Mendhegiri

Ministry of Water Resources, Maharashtra, India

G. V. Vyawahare

Ministry of Water Resources, Maharashtra, India

[Blank Line 9 pt] [You can insert more rows for more authors here]

[Blank line 10 pt]

[Blank line 10 pt]

KEYWORDS

WaterAudit, Irrigation, Evaporation, Performance, Inspection

[Blank line 10 pt]

[Blank line 10 pt]

ABSTRACT

Observation and keeping close watch on area irrigated per unit of water use at Distributory/ Minor head, preparation of preliminary irrigation programme & Completed Irrigation Report at the end of season are the main features of planning & accounting of water utilised for irrigation in early period after independence. The process of scrutiny of water accounts at circle level (Superintending Engineer) is a part of water audit. This water audit system is of an internal and periodical type.

Enormous growth in population, changing standard of living and the industrialisation have led to increase in the overall demand of water for domestic consumption, industrial use and hydroelectric generation. The all-out demand for water has made it imperative to prioritise requirements for diverse purposes such as domestic, industrial use etc. Health and environment-consciousness have led to heightened expectations about the quality of water and attested its importance in the water management. Therefore, the Water Resources Projects are constructed as multipurpose projects. These water storages are now being considered as source for drinking water & industrial supply schemes for most of the cities, towns and even rural water supply schemes. This has resulted in lesser availability of water for irrigation. As irrigation use entails about 80 to 85 percent of the quantity, a marginal improvement in the water use efficiency in irrigation will result in saving substantial quantity thereby enhanced food / fibre production. For achieving this goal, one of the methods is auditing of water use & its accounts ie. Water Auditing.

[Blank line 10 pt]

[Blank line 10 pt]

1.0 WHAT IS WATER AUDITING?

Water auditing is a systematic & scientific examination of water accounts of the projects. It is an intelligent & critical examination by independent organisation. It is a critical review of system of accounting. Water auditing is checking: a) sector wise water use against planning, b) Irrigation system performance and c) losses. As far as irrigation sector is concerned, water audit shall give comparison of planned versus actual irrigation system performance i.e. Hectares per Milliom cubic metres (Ha/Mcum).

Broadly water auditing involves the checking the following parameters:

- 1) Actual water use in various sectors against planning,
- 2) Whether water use for irrigation in every season is as per planning & checking the irrigation system performance (Ha/Mcum)
- 3) Checking whether the prescribed procedure for irrigation management is followed or not.
- 4) Whether proper records are maintained or not.

2.0 BENEFITS OF WATER AUDIT

The benefits of water audit include improved knowledge and documentation of the distribution system including problem and risk areas. Water auditing will lead to: (a) an efficient use of available water resources, (b) reduced water losses, (c) transparency in overall process, (d) accountability of field officers, (e) an enhanced knowledge of the distribution system, (f) improved financial performance and (g) improved, level of service to customers.

3.0 WATER AUDIT PROCEDURE

Water audit is not merely checking the water accounts by third party but it starts right at sub division level of a division entrusted with management work. The rotation-wise accounts of section officer are checked by Sub divisional Engineer. Timely submission of account of water use after every rotation is necessary in order to enable the Sub Divisional Engineer, to monitor the irrigation management in ensuing rotations. Similarly timely submission of information in prescribed proformae (I to V annexed) by sub division to division will enable the Executive Engineer to monitor the management. Seasonal/annual water accounts are prepared in the division & submitted to the circle office for further submission to Water Audit office.

The scrutiny at circle level will involve;

- a) Comparing water use for irrigation as well as non-irrigation uses with those contemplated in the project report/ Preliminary Irrigation Programme (PIP).
- b) Season wise water use with reference to planning.
- c) Losses (evaporation, leakages etc).
- d) Irrigation System Performance (ISP).
- e) Arithmetical checking of the accounts.

Detailed scrutiny note by Superintending Engineer, analysing in detail all the above-mentioned items shall be enclosed with the water accounts.

4.0 ROLE OF WATER AUDIT UNITS

The water audit units established in State Water Audit Office and headed by the Executive Engineer, will be responsible for auditing of water accounts in their respective regions (i. e. six revenue regions in Maharashtra). It will be the duty of the field Superintending Engineer in charge of circles, having irrigation management, to promptly comply the preliminary remarks in scrutiny of water accounts communicated by Water Audit office. Yearly inspection of division, sub division and section offices is a part of water audit. The Water Audit office will prepare yearly inspection programme for divisions. The remarks of inspection will be treated as Water Audit paras. Year-wise record of water audit paras will be maintained in the Water Audit office.

Audit paras can be dropped after receipt of satisfactory compliance report from the concerned field officers. The competent authorities at different levels will take action in this respect.

5.0 DUTIES OF FIELD OFFICERS

The field officers will be responsible for

1. Collection, validation & preservation of data relevant to water account;
2. Submission of water accounts on scheduled dates.
3. Compliance of preliminary remarks & water audit paragraphs;
4. Making available records to audit units during inspections;
5. Respond to yearly inspection programme
6. To prepare action plans for improving performance of projects i.e. for major projects by Chief Engineer, for medium projects by Superintending Engineer & for minor projects by Executive Engineer;
7. Targets & achievements in respect of area irrigated, Water Users' Associations formation and functioning, recovery of water charges, Irrigation System Performance (ISP), etc shall be considered while writing annual confidential reports of concerned field officers and staff.
8. The concerned field Superintending Engineer shall check periodically the water accounts and take a review of compliance of remarks on water accounts by Water Audit office.

6.0 USE OF COMPUTER IN WATER ACCOUNTING

Manual handling of water account data of all the projects in the state is difficult. Therefore, use of computers for storing the data is inevitable. At the same time the analysis of data can be conveniently done by using computers. Submission of accounts using template files specially designed for the purpose would help to eliminating calculation errors.

Even the data such as daily evaporation & prescribed proformae can be submitted directly by sub-divisions to Water Audit office using the programmes available for the purpose. Seasonal and Annual water accounts can be generated by compilation of the proformae submitted by field offices during the season/year. Analysis, presentation & preparation of annual Water Audit Reports is convenient by using computer programming. Online submission of data & accounts is possible by using software designed for the purpose.

7.0 WATER AUDIT REPORT

The half margin paragraphs raised during inspections will be replied by the concerned field officers. The decision of dropping of half margin paragraphs will be taken by the team leader during memo reading with the field officers.

The water audit report comprises of the complied and uncomplied remarks of water audit. The inspection remarks will be communicated to the concerned Executive Engineer. The decision of the Chief Engineer of Water Audit Office, on dropping / keeping the remarks / paras proposed by the Inspection Unit will be final and binding on the concerned division.

The field Superintending Engineer will take monthly review of the pending Inspection paragraphs during monthly meetings and give special attention to clear the paragraphs.

Regional field Chief Engineer will take review of the pending inspection paras of the Circle / Division under his jurisdiction, bimonthly and issue suitable instructions to the field officers to clear them. The Action Taken Report on this subject be intimated to the Chief Engineer, Water Audit Office.

8.0 CONCLUSIONS

To have realistic evaporation data, it is suggested to verify the procedure adopted for collection of evaporation data and coefficients used while calculating the loss. Where the evaporimeter is yet to be installed, the data collected at nearby meteorological station from the same climatological zone can be used as an interim arrangement.

Proper action should be taken to calibrate the Standing Wave Flumes at canal as well as distributory head, to have realistic data about irrigation water use. Silt survey of major projects of age more than 15 years may be taken in hand, so that net water availability (making suitable deduction for silt) for

different water uses can be worked out while preparing the PIP and water account will also be more realistic.

More emphasis shall be given to install Water meters on Non Irrigation (NI) water supply as well as Lift Irrigation Schemes so that lapses in flow measurements of these schemes will not affect the data about canal water use. Project authorities are advised to prepare action plan for securing improvement in water use efficiency and reducing the transit losses. Project authorities are required to concentrate on full utilization of available water. Following are some of the reasons for low irrigation use;

- i) Low Kharif utilisation.
- ii) Low water availability in reservoirs.
- iii) Diversion of irrigation water to non irrigation use.
- iv) Water remained unutilized in some projects

Proforma 2

Discharge measurement at various locations of canal in the Irrigation Subdiv

Project:

Cir

Canal:

Reach:

to

Divis

Irrigation Year:

Season:

Subdivis

Rotation No. _____

Period: _____

to

Date	Time	Starting point of SubDn		Intermediate Gauge		Intermediate Gauge	
		Gauge Reading (m)	Discharge (cumec)	Gauge Reading (m)	Discharge (cumec)	Gauge Reading (m)	Discharge (cumec)
1	2	3	4	5	6	7	8

Note: 1) Discharge shall be measured at start point, intermediate locations and end point of Section.

2) The proforma may be extended in case of intermediate points are more than two.

3) For distinct clarification between guage readings and Measuring Device's readings. Measuring Device's readings sh

4) If Escape is located in the reach of Subdivision, depth of water and discharge at u/s escape shall be measured.

Proforma 3

Water Utilised and Area Irrigated in Irrigation

Project:

Canal:

Reach to

Season:

Rotation No.

Period: to

Source of Irrigation	Water released (daycumec) for Section	Canal losses in the Section	Water Utilised for			Seasonal / T.S. Crops (ha)
			Irrigation Purpose (daycumec)	Domestic Purpose (daycumec)	Industrial Purpose (daycumec)	
1	2	3	4	5	6	7
A) Flow Irrigation						
Section No. 1						
Section No. 2						
Section No. 3						
Section No. 4						
Total (A):						
B) Lift Irrigation:						
Section No. 1						
Section No. 2						
Section No. 3						
Section No. 4						
Total (B):						
C) Others						
Section No. 1						
Section No. 2						
Section No. 3						
Section No. 4						
Total (C)						
Grand Total (A+B+C)						

Proforma 4

Discharge released through escapes / scouring sluices in the jurisdiction of Irrigation Subdivision

Project:

Circle

Canal

Reach:

Division

Irrigation Year

Subdivision

Season

Rotation No

Period

Sr. No.		Section No	Section No	Section No	Section No	Remark
1	2	3	4	5	6	7
1	Gross total of all escapes (As per Proforma 4A, Sr. No.8) (Day cumec)					
2	Water released (As per Col. 4, Proforma 3A) (Daycumec)					
3	Percentage of water loss ($1 \times 100/2$)					

Subdivisional Officer

_____ Subdivision

Proforma 5

Rainfall and Evaporation Data of Irrigation Subdivision

Project _____ Circle _____
Canal _____ Reach _____ to _____ Division _____
Irrigation Year _____ Subdivision _____
Season _____

Rotation No		Period			to	
Date	Rainfall (mm) at Raingauge Station			Pan Evapo- ration (mm) at-----	Remarks	
	Station No1 at-----	Station No2 at -----	Station No3 at-----			

Subdivisional Officer
-----Sub division

1. GENERAL INSTRUCTIONS

[Blank line 10 pt]

The text should fit exactly into the type area (160 x 247 mm). For A4 size paper the margin settings are: Top: 2.5 cm; Bottom: 2.5 cm; Left: 2.5 cm; Right: 2.5 cm. Line spacing throughout the text to be maintained at Single line spacing.

[Blank line 10 pt]

Use Arial 10 point size and single line spacing. Never use bold, except for the headings, as described below and never underline any text. Use the smaller font (9 points) for tables, figure captions and the acknowledgement and references.

[Blank line 10 pt]

Paper length is to be not longer than 10 pages including abstract, main text, all images, figures, tables and references. Manuscript file in **.docx** (Microsoft Word 2007) format is to be not more than 15 MB.

[Blank line 10 pt]

1.1. Title, author and affiliation

[Blank line 10 pt]

Use bold Arial 14 point size, centring and single line spacing for the title. The title has not be longer than 150 characters including blank spaces and should be fitted in the second and third two rows of the above table. The layout of the above table (rows heights and column widths) is fixed and must not be altered. This table will be used programmatically for extracting the paper information as well as the abstract text for print publication. Any tampering with the layout will render the paper unusable.

[Blank line 10 pt]

Use bold Arial 11 point size, centring and single line spacing for the name of the first author (first the initials and then the last name). Leave one blank line before first line of authors. If any of the co-authors have the same affiliation as the first author, add his name after an & (or a comma if more names follow). Type the correct affiliation in the line below the author's name using italic Arial 9 point size. Type the email address of only the first author in the line below the author's affiliation using italic Arial 9 point size and single line spacing. Leave one blank line 9 pt beneath this line. If there are authors linked to other institutes, type the name(s) of the author(s) and after a return the affiliation. Repeat this procedure until all affiliations have been typed.

[Blank line 10 pt]

[Blank line 10 pt]

2. SECTION HEADING (10PT BOLD AND ALL CAPS)

[Blank line 10 pt]

Section headings are to be in 10pt bold and full caps. Number the headings consecutively. Leave two blank lines before Section Heading and one blank line between the heading and the first line of text.

[Blank line 10 pt]

Between paragraphs of text leave one blank line gap. Paragraphs are not to have any indents. Text should be single spaced, alignment-justified.

[Blank line 10 pt]

Define all abbreviations at their first mention in the text. Ensure consistency of abbreviations throughout the article.

[Blank line 10 pt]

Footnotes must be avoided. Do not include footnotes in the reference list.

[Blank line 10 pt]

References must be cited in the text in the brackets (Harvard style) for example: (Chisti,1989), (Gavrilescu and Roman, 1996), (Moo-Young et al.,1987). Reference list must be arranged in alphabetical order as per the first name of the author/book.

[Blank line 10 pt]

2.1. Secondary Heading or Sub-headings (10 pt bold, in Title Case)

[Blank line 10 pt]

Sub-headings are printed in 10pt bold. Use upper and lower case letters. Leave one blank line above a sub-heading and one blank line between sub-heading and the first line of the text.

[Blank line 10 pt]

2.1.1. Tertiary headings

Tertiary headings are printed in 10pt italics, and numbered. Leave one blank line above and no blank line below tertiary headings. Any further lower ranking headings to follow the tertiary heading format.

[Blank line 10 pt]

[Blank line 10 pt]

3. TABLES

[Blank line 10 pt]

Authors may choose how they wish to format the table layout. Use Arial 9 pt for Table heading and for table text. Table heading should be centred. Number the Table headings and please be consistent throughout your manuscript. Leave one blank line before the table heading and one blank line after the table, as shown below. The table border must be single line ½ pt thick.

[Blank line 10 pt]

Table 1. (9pt bold) Data for Analysis (9pt regular)

Sub 1	A	B	C	D
Row 2	1	2	3	4
Row 3	Text	Text	Text	Text
Row 4	123	123	123	123

[Blank line 10pt]

Text after the table.

[Blank line 10 pt]

[Blank line 10 pt]

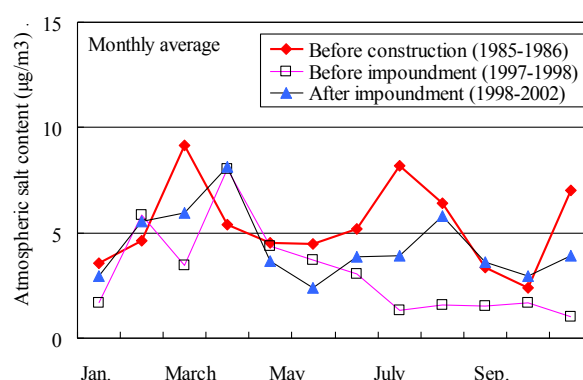
4. ILLUSTRATIONS, DIAGRAMS AND PHOTOGRAPHS

[Blank line 10 pt]

Illustrations are to be centred, with the caption below the figure having one blank line 9 pt. Type as follows: 'Figure 1. Caption', Arial 9 pt. The lettering used in the illustrations should not be too small. Illustrations are to be referred to as figures, and must be quoted in the text, e.g. see Fig. 1. One blank line should be left between the text and figure, as well as the figure caption and the next paragraph. Please ensure that all figures are of the highest quality. Keep figures as simple as possible. Avoid

excessive notes. Photographs must have a resolution of at least 250 dpi. All photos and scanned figures shall be in .jpg format and the size of the image should not exceed the typing area of a single page. Graphics which are disproportionately large shall not be accepted.

[Blank line 10 pt]



[Blank line 10 pt]

Figure 1. (9pt bold) Trend of salt content (9pt regular)

[Blank line 10 pt]

Text after the figure.

[Blank line 10 pt]

[Blank line 10 pt]

5. EQUATIONS

[Blank line 10 pt]

Use the equation editor of the selected word processing programme. Equations are indented 6 mm from the left margin. Number equations consecutively and place the equation number with the tab key at the end of the line, between parentheses. Refer to equations by these numbers. Leave one blank line above and also below any equation. Equation references are in the form of "equation number" and should be referred to in the text in the form Eq. 1. All symbols of equations should be explained within the text of your manuscript.

[Blank line 10 pt]

$$(x + a)^n = \sum_{k=0}^n \binom{n}{k} x^k a^{n-k} \quad (1)$$

[Blank line 10 pt]

Text after the equation.

[Blank line 10 pt]

[Blank line 10 pt]

ACKNOWLEDGEMENT(9PT BOLD AND ALL CAPS)

Acknowledgement heading is to be typed using Arial 9 pt bold and with all caps, but not numbered. Text of the acknowledgement should be typed using Arial 9 pt regular and justified. No blank line should be left between the heading and the text. Leave two blank lines after the text 9 pt size.

[Blank line 9 pt]

[Blank line 9 pt]

REFERENCES (9PT BOLD AND ALL CAPS)

[Blank line 9 pt]

Author name/s. (year): Paper title, Journal title, Journal volume: issue, pages.

Suzuki, H., Kim, D. and Hamada, S. (2004): Effect of dynamic water pressure acting on dam body upon behavior of dam during earthquakes, Journal of Dam Engineering, 24:2, pp. 123-136.

Author name/s. (year): Paper title, Conference title, Proceedings volume: pages.

Brown, A.D. and White, G.Y. (2004): Structural Retrofitting of A Dam, Fifth International Conference on Dam Structural Engineering, Vol. II: pp. 96-124.

Author name/s. (year): Book title, Publisher

Imai, D. and Tokunaga, A. (2003): Dam Engineering, Oxford, U.K.

Web references: The full URL should be given in text as a citation, if no other data are known. If the authors, year, title of the documents are known and the reference is taken from a website, the URL address has to be mentioned after these data.

Burja C., Burja V., (2008), Adapting the Romanian rural economy to the European agricultural policy from the perspective of sustainable development, MPRA, Munich Personal RePEc Archive, On line at: http://mpra.ub.uni-muenchen.de/7989/1/MPRA_paper_7989.pdf

Web references must not be listed separately, after the reference list.

Reference heading is to be in bold Arial 9 pt and with all caps, but not numbered. Leave two blank lines before Reference Heading and one blank line between the heading and the first reference. The references should be typed in 9 pt Arial and second and further lines should be indented 3.0 mm. The list shall be ordered in alphabetical order with respect to the first author, book name, web site name etc.

SUBMISSION OF PAPER TO THE ORGANIZING COMMITTEE

The completed full paper prepared in docx (Word 2007 format) file (**not more than 15MB**) created by Microsoft Word 2007 or later version should be uploaded at the web site below by one author who is registered at the portal: <http://www.indiawaterweek.in>

Please note that the paper should be submitted through uploading on the web site only. NO OTHER MODE OF SUBMISSION WILL BE ACCEPTED AND NO ACKNOWLEDGEMENTS WILL BE ISSUED OTHER THAN THOSE ISSUED BY THE WEB PORTAL.