2007-08

15th Induction Training Report

Water And Land Management Institute, Aurangabad

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Abbreviations

Avg Per	Average performance
AIC Akola	Akola Irrigation Circle, Akola
BCM	Billion Cubic Metre
BCR	Benefit-Cost Ratio
BIPC Buldhana	Buldhana Irrigation Project Circle, Buldhana
CAD	Command Area Development
CADA A'bad	Command Area Development Authority, Aurangabad
CBIP	Central Board of Irrigation & Power
CCA	Culturable Command Area
CIPC Chandrapur	Chandrapur Irrigation Project Circle, Chandrapur
COT	Cut-Off Trench
CRT	Converted Regular Temporary
DIRD	Directorate of Irrigation Research & Development
ERR	Economic Rate of Return
EAP	Emergency Action Plan
FAO	Food & Agriculture Organisation
FRL	Full Reservoir Level
FRR	Financial Rate of Return
FY Avg	Five years average
GCA	Gross Command Area
GOI	Government of India
GOM	Government of Maharashtra
GOS	Gate Operation Schedule
Ha	Hectare
HW	Hot weather
ICID	International Commission on Irrigation & Drainage
IMD	Indian Meteorological Department
INCID	Indian National Committee on Irrigation & Drainage
IPTRID	International Programme for Technology and Research in Irrigation and Drainage
IRR	Internal Rate of Return
IWMI	International Water Management Institute
JIPC Jalgaon	Jalgaon Irrigation Project circle, Jalgaon
KIC Ratnagiri	Konkan Irrigation Circle, Ratnagiri
M	Metre
M cum / Mm3	Million Cubic metre
MDDL	Minimum Draw Down Level
MERI	Maharashtra Engineering Research Institute, Nashik
Mha	Million Hectare
MKVDC	Maharashtra Krishna Valley Development Corporation
MKVWRC	Maharashtra Krishna Valley Water Resources Corporation
Mm	Millimetre

MWIC	Maharashtra Water & Irrigation Commission
NIC Nagpur	Nagpur Irrigation Circle, Nagpur
NIC Nanded	Nanded Irrigation Circle, Nanded
NIPC Dhule	Nashik Irrigation Project Circle, Dhule
NKIPC Thane	North Konkan Irrigation Project Circle, Thane
NPV	Net Present Value
O & M	Operation & Maintenance
Past Max	Maximum value observed in Past
Past Min	Minimum value observed in Past
PIC Pune	Pune Irrigation Circle, Pune
PIM	Participatory Irrigation Management
PIP	Preliminary Irrigation Programme
PLBC	Paithan Left Bank Canal
PRBC	Paithan Right Bank Canal
RBL	Reservoir Bed Level
PWD	Public Works Department
ROS	Reservoir Operation Schedule
RoR	Rate of Return
SIC Sangli	Sangli Irrigation Circle, Sangli
Sq km	Square Kilometre
State Tar	State target
SGRY	Sampurna Gramin Rojgar Yojna
TIC Thane	Thane Irrigation Circle, Thane
UWPC Amravati	Upper Wardha Project Circle, Amravati
WALMI	Water And Land Management Institute, Aurangabad
WRD	Water Resources Department
WUA	Water Users' Association
WUE	Water use efficiency
YIC Yeotmal	Yeotmal Irrigation Circle, Yeotmal

15th Induction Course: Trainee Officers

1	KOLHE PRAVIN SHIVAJI	Assistant Executive Engineer
2	SHINDE JAYWANT SADASHIV	Assistant Executive Engineer
3	NALAWADE SANDEEP RAMCHANDRA	Assistant Executive Engineer
4	GADE BAPUSAHEB JAGANNATH	Assistant Executive Engineer
5	CHISHTI ILIYAS MOHAMADPASHA	Assistant Executive Engineer
6	THORAT VIJAYKUMAR BALIRAM	Assistant Executive Engineer
7	KHANDEKAR SUBIRVENDRA SAKHARAM	Assistant Executive Engineer
8	GONDCHAR JAYA NAMOEORAO	Assistant Executive Engineer
9	PATIL SAVITA BALGONDA	Assistant Executive Engineer
10	SANGALE SANTOSH MARUTI	Assistant Executive Engineer
11	BHOIR NILESH GURUNATH	Assistant Executive Engineer
12	THAKARE RASHMI RAMESHCHANDRA	Assistant Executive Engineer
13	DABHADE YOGESH RAMDAS	Assistant Executive Engineer
14	BHADANE YASHAVANTRAO KASHINATH	Assistant Executive Engineer
15	KHALATE PRASHANT KRISHNARAO	Assistant Engineer I
16	BAGADI SHIVPRASAD PURUSHOTTAM	Assistant Engineer I
17	DUBAL DIGAMBAR MAHADEO	Assistant Engineer I
18	UPADHYE VASUDEV RAGHUNATH	Assistant Engineer I
19	HARUGADE ABHINANDAN VISHNUPANT	Assistant Engineer I
20	PATHAN KARIMKHAN MOHIDINKHAN	Assistant Engineer I
21	JADHAV PRAKASH DATTATRAY	Assistant Engineer I
22	KADAM MAHADEV SHRIRANG	Assistant Engineer I
23	DALVI SHRIKANT DILIPRAO	Assistant Engineer I
24	AGRAWAL DEVENDRA PUNAMCHAND	Assistant Engineer I
25	HAJARE SHRIRAM VIJAY	Assistant Engineer I
26	PHALKE VAIBHAV HANAMANTRAO	Assistant Engineer I
27	NIKAM AMOL PANDITRAO	Assistant Engineer I
28	GAIKWAD PRAKASH BAPUSAHEB	Assistant Engineer I
29	SHINDE DEVAPPA DATTATRAY	Assistant Engineer I
30	PANDIT AMOL ARUNRAO	Assistant Engineer I
31	NAGARKAR GIRISH VIJAY	Assistant Engineer I
32	HARSURE SOMSHEKHAR KARBASAPPA	Assistant Engineer I
33	SURYAWANSHI AMARSINHA PRATAPRAO	Assistant Engineer I
34	KHANDARE SHRIKANT DATTATRYA	Assistant Engineer I
35	GUJAR MANOJ MANIK	Assistant Engineer I
36	KADAM ANNA CHANDRAKANT	Assistant Engineer I
37	SHINDE YOGESH SITARAM	Assistant Engineer I
38	AWATE SALIM SAYYED GAFUR	Assistant Engineer I
39	GARUD RUKMANGAD PRALHAD	Assistant Engineer I
40	BHOPE NITIN VIJAY	Assistant Engineer I
41	MANE SAMBHAJI JAGANNATH	Assistant Engineer I

15th Induction Training Course Batch , WALMI
(07.04.2008 to 25.05.2008)

Chapter 1. Main System

1.1 Salient Features of Jayakwadi Project

1.	**Name of project: Jayakwadi Project**	
2.	Location: Paithan; Dist: Aurangabad.	
3	Catchment Area	21750 Sq. Km
4	Gross Storage	2909 Mm^3
5	Maximum height of dam from river bed	37.73 m
6	Length of dam	10280 m
7	Length of Spillway	417 m
6	Type of Dam	Earthen
9	Submergence Area	35,000 Ha
10	Earth Work	13 Mm^3
11	Masonry	0.33 Mm^3
12	Concrete	0.80 Mm^3
13	Gates of Dam	
	a. Number	27
	b. Size	12 x 7.9 m
	c. Type	Radial
	d. Designed Spillway Capacity	6,41,000 cusecs
14	Power Generation	12 MW
15	Lowest River Bed Level[1]	432.206 m
16	Maximum Draw Down Level[2]	455.524 m
17	Spillway Crest Level	455.981 m
18	Full Reservoir Level[3]	463.900 m
19	Maximum Water Level	465.583 m
20	Foundation Level of Masonry Dam	427.640 m
21	Top of Dam	468.980 m
22	Cut-Off Trench[4] Level	419.917 m
23	Sill Level of Canal	452.171 m

[1] Henceforth called as RBL
[2] Henceforth called as MDDL
[3] Henceforth called as FRL
[4] Henceforth called as COT

1.1.1 Related Terminology

[1.] **Carry Over Storage:** Storage left over in a reservoir at the end of the depletion period of a year, which is available for use in later years. This storage is also called 'Over Year Storage'.

[2.] **Conservation Storage:** Water impounded in a reservoir for conservational uses such as irrigation, power generation, industrial use, municipal supply, etc.

[3.] **Dead Storage:** Storage below the lowest outlet level of a reservoir, which is not susceptible to release by usual outlet means.

[4.] **Depletion Period**: The period during which available storage in the reservoir is released or depleted for meeting various water demands. This period lies outside the filling period of a year.

[5.] **Design Flood/Reservoir Design Flood:** The magnitude of flood adopted for design purpose is called design flood. It may be the probable maximum flood (PMF) or the standard project flood (SPF) or a flood corresponding to some desired frequency of occurrence, depending on the type of structure and the extent of calculated risk the designer is prepared to accept.

[6.] **Dry (Bad) Year:** A year during which the precipitation or stream flow is less than that in the normal year.

[7.] **Filling Period:** The period during which inflow into the reservoir is likely to be more than the water demand and the surplus flow is impounded to build up the storage.

[8.] **Flood Control Storage:** Storage space provided in the reservoir for storing flood water temporarily in order to reduce peak discharge and to minimize flooding of downstream locations.

[9.] **Full Reservoir Level (FRL):** The highest reservoir level which can be maintained without spillway discharge or without passing water through under sluices. This level is also called highest controlled water level'.

[10.] **Induced Surcharge Envelope Curve:** This is a curve representing the maximum water level that would be allowed in a reservoir, at different rates of spillway discharges, when operating under the induced surcharge plan. This curve is drawn from a point, corresponding to the maximum permissible flood control release at the FRL, to a point corresponding to the elevation when all spillway gates are fully opened.

[11.] **Induced Surcharge Storage:** The storage between the full reservoir level (FRL) and the maximum water level (MWL) of a reservoir, which may be induced by regulating the outflow rates, after the reservoir is filled up to the FRL.

[12.] **Live Storage:** Storage capacity between the lowest outlet level of reservoir or minimum drawdown level (MDDL) to the highest controlled water level or full reservoir level (FRL). This storage is also called 'Live Capacity'.

[13.] Maximum Water Level (MWL): The level likely to be attained in a reservoir at the dam face, while negotiating the adopted design flood. The

level is also called 'Highest flood level', <Spillway design flood level' or maximum water surface elevation'.

[14.] **Minimum Draw-Down Level (MDDL)** It is the lowest level up to which the reservoir may be depleted for meeting various needs. In power projects, releases are allowable up to MDDL only instead of dead storage level, so as to maintain the minimum head required for power generation.

[15.] **Normal (Average) Year:** A year during which the precipitation or stream flow are within + 20 percent of the long period average value.

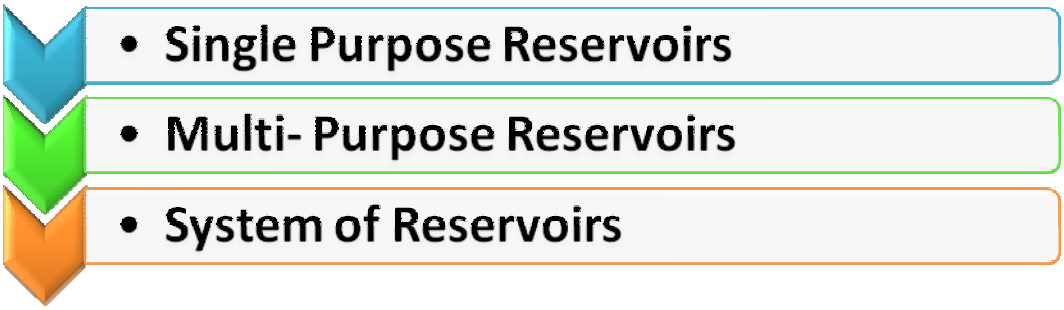
[16.] **Reservoir Routing:** Flood routing is a process of determining theoretically the outflow pattern from reservoirs, for any given pattern of inflow, storage and tail water condition.

[17.] **Rule Curve:** Rule curve is the target level planned to be achieved in a reservoir, under different conditions of probabilities of inflows' and/or demands, during various time period in a year.

[18.] **Wet (Good) Year:** A year during which the precipitation or stream flow is more than that in the normal year.

1.1.2 Classification of Reservoir

For the purpose of regulation, reservoirs are classified into following types:



I. **Single Purpose Reservoirs :**

These reservoirs are developed to serve only one purpose, which may be flood control or any of the conservation uses such as irrigation, power generation, navigation, industrial use, municipal water supply, etc.

II. **Multi-purpose Reservoirs :**

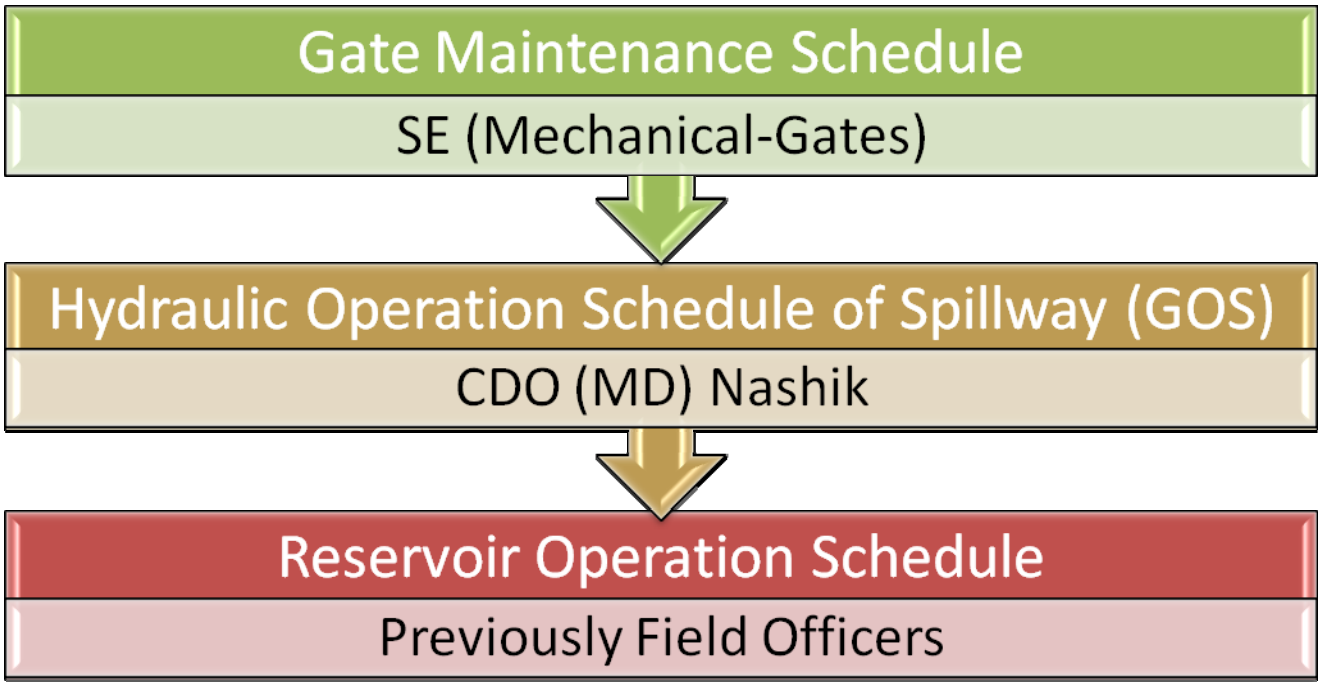
These reservoirs are developed to serve more than one purpose which may be a combination of any of the conservation uses with or without flood control.

III. **System of Reservoirs :**

These consist of a group of single/ multiple purpose reservoirs, which may be operated in an integrated manner for optimum utilization of the water resources of the river system.

1.1.3 Spillway Operation Schedule

Spillway Operation Schedule is divided in three Parts-



1.1.4 Introduction of ROS & EAP[1]

Almost all dams of Maharashtra are primarily meant for storage of water for irrigation, water supply of power generation. While mainlining the required storage in the dam to the safe limit, in case of floods, it is necessary to manage the water level in the reservoir such that the downstream flood can be avoided and reservoir will be completely filled. The reservoir operation involves a careful coordination between the flood disposal and the building up of the conservation storage.

1.2 Introduction to Gate Operation Schedule

The GOS is generally supplied by MERI[2] by model experiments. At present spillway gates are standardized of size (12 x 5 m), (12 x6.5 m) and (12 x 8 m). The discharge rating curve for the above radial gates under free flow condition and under partial opening of gates of gates at various heads have been developed by MERI.
While building up of storage or while planning releases from the reservoir, the outflow for different spillway gate openings and for different heads above the crest can be worked out from the above curves.

[1] Emergency Action Plan
[2] Maharashtra Engineering Research Institute, Nashik

The GOS must be prepared based on site conditions, the results of model studies & the regulation schedule of the reservoir. The GOS should clearly indicate the complete sequence and stages of operations of various gates corresponding to various lake levels and the flood situations. These details should also be incorporated in Standing Operating Procedures of the reservoir along with the regulation schedule and maintenance schedule of gates. A

1.2.1 Necessity of ROS and GOS

1. Water Resources Department had obstructed natural flow by construction of dams across river for irrigation, water supply and for other remarkable benefits.
2. Accumulation of incoming flood in reservoir, safely release of flood without damage to structure and life of people with their property on down stream of dam.
3. Accumulation of incoming flood in reservoir, safely release of flood will be done with the help of Approved Reservoir Operation Schedule, Gate Operation Schedule and Emergency Action Plan.
4. Sectional Engineer and Deputy Engineer with staff related to maintenance of dam must stay at dam during emergency period. i.e. 15th June to 31st Oct. Concern Executive Engineer related to dam keep watch on hourly increase in water level and release of flood during emergency.
5. At the time release of water through dam 48 hours before inform to Emergency Cell. Also inform to Emergency Cell at the time of actual release of water and rate of flow with depth of water and obtain the receipt.

1.2.2 Principle of Operation of Reservoir

Following are some of the common principles of reservoir operation.

I Single Purpose Reservoirs

1. Flood control - Operation of flood control reservoirs is primarily governed by the available flood storage capacity, discharge capacity of outlets, their location and nature of damage centers to be protected, flood characteristics, ability and accuracy of flood/storm forecast and size of the uncontrolled drainage area. A regulation plan to cover all the complicated situations may be difficult to evolve, but generally it should be possible according to one of the following principles:

a. Effective use of available flood control storage - Operation under this principle aims at reducing flood damages of the locations to be protected to the maximum extent possible, by effective use of flood control storage capacity available at the time of each flood event. Since the release under this plan would obviously be lower than those required for controlling the reservoir design flood, there is distinct possibility of having a portion of the flood control space occupied during the occurrence of a subsequent heavy flood. In order to

reduce this element of risk, maintenance of an adequate network of flood forecasting stations both in the upstream and downstream area would be absolutely necessary.

b. Control of reservoir design flood - According to this principle, releases from flood control reservoirs operated on this concept are made on the same hypothesis as adopted for controlling the reservoir design flood that is the full storage capacity would be utilized only when the flood develops into the reservoir design flood. However, as the design flood is usually an extreme event, regulation of minor and major floods, which occur more often, is less satisfactory when this method is applied.
c. Combination of principles (1) and (2) - In this method, a combination of the principles (1) and (2) is followed. The principle (1) is followed for the lower portion of the flood reserve to achieve the maximum benefits by controlling the earlier part of the flood. Thereafter releases are made as scheduled for the reservoir design flood as in principle (2). In most cases this plan will result in the best overall regulation, as it combines the good points of both the methods.
d. Flood control in emergencies -- It is advisable to prepare an emergency release schedule that uses information on reservoir data immediately available to the operator. Such schedule should be available with the operator to enable him to comply with necessary precautions under extreme flood conditions.

2. Conservation -- Reservoirs meant for augmentation of supplies during lean period should usually be operated to fill as early as possible during filling period, while meeting the requirements. All .water in excess of the requirements of the filling period shall be impounded. No spilling of water over the spillway will normally be permitted until the FRL is reached. Should any flood occur when the reservoir is at or near the FRL, release of flood waters should be affected, so as not to exceed the discharge that would have occurred had there been no reservoir. In case the year happens to be dry, the draft for filling period should be curtailed by applying suitable factors. The depletion period should begin thereafter. However, in case the reservoir is planned with carry-over capacity, it is necessary to ensure that the regulation will provide the required carry-over capacity at the end of the depletion period.

II. Multi-purpose Reservoirs

Operation of a multi-purpose reservoir should be governed by the manner in which various uses of the reservoir have been combined. While operating the reservoirs to meet the demands of end users, the priorities for allocation may be used as a guideline. In general five basic zones of reservoir space may be used in operating a reservoir for various functions. Typical storage allocations for various uses are indicated in Fig. I. The various storage zones often identified are:

a. Spill zone - Storage space above the flood control zone between FRL and MWL, is generally referred to as spill zone. This space is occupied mostly

during high floods and the releases from this zone are trade-off between structural safety and downstream flood damages.

b. Flood control zone - This is the storage space earmarked as temporary storage for absorbing high flows for alleviating downstream flood damages. This should be space emptied as soon as possible to negotiate next flood event.
c. Conservation zone - This storage space is used for conservation of water for meeting various future demands. This zone is generally between FRL and dead storage level.
d. Buffer ZOHP -- This is the storage space above dead storage level which is used to satisfy only very essential water needs in case of extreme situation.
e. Dead storage zone -- This is also called inactive zone. This is the lowest zone in which the storage is meant to absorb some of the sediments entering into the reservoir. The storage in this zone is not susceptible to release by the in-built outlet means.

1.2.3 Catchment Area of Paithan Dam

The catchment area of Jayakwadi Project is shown below.

1.2.4 Existing River Gauging Stations

Sr. No	Name of River	River Gauge station	Catchment Area (sq. km)	Distance from dam site	Travelling time form dam
1	Godavari	NMC	4247	154 km	30 hours
2	Pravara	Devgarh	7273	54 km	6 hours
3	Shivana	Solegaon	2505	36	4 hours

1.2.5 Proposed River Gauging Stations

Sr. No	Name of River	River Gauge station	Catchment Area (sq. km)	Distance from dam site	Travelling time form dam
1	Godavari	NAUR	4310	76 km	12 hours
2	Shivana	Lasur	2267	48 km	6 hours
3	Kham	Tembhapuri	613	36 km	5 hours
4	Nani	Wadule	527	33 km	3 hours
5	Dhor	Jalgaon	456	48 km	4 hours

1.2.6 Competent Authority for Approval

Major Project

- ROS & EAP : CE (WRD)
- GOS : SE (MD) CDO, Nashik

Medium Project

- ROS : CE (WRD)
- GOS : SE (MD) CDO, Nashik
- EAP : SE of Project

Minor Project

- ROS & GOS : Not Applicable for Ungated Waste Weir
- EAP : EE of Project

1.2.7 Guidelines for preparing ROS

ROS contains following data-

1. Monthly planning of accumulation of incoming inflow on the basis of observed data of previous years.
    a. July End:
    b. August End:
    c. September End:
    d. October End
2. Reservoir levels were fixed on the basis of observed data at dam site before impounding reservoir. Revision is necessary after 10 years experience of flood accumulation and release.
3. On the basis of observed data prepare10 day runoff series for 90% and 75 % dependability by deducting projected utilization form 10 day runoff.
4. Prepare guide curves for 90% & 75% dependability.
5. Surplus flood can be routed safely without damage to life and property of villages on down stream of dam as per approved ROS.

1.2.8 Guidelines for preparing GOS

Following are general guide lines for the gate operation-

1. If the dam has got stilling basin at two different elevations, then generally the gates with stilling basin at lower level need to be operated first.
2. The end gate should normally be opened first to prevent cross flow striking against guide walls and junctions.
3. At any time during the operation of different gates, the difference in gate opening for any two consecutive gates should not exceed 0.5 m.
4. After opening the end gates, the gate/gates at the centre should be opened and the other gates should be opened in symmetrical manner starting form the centre towards the end through gradual increase in the opening.
5. While closing the gates, the gate that was opened last should be closed first. The procedure to be followed for closing the gates would generally be the reverse of the procedure followed for opening of gates. Complete closure of the gates should be accomplished by gradual lowering of the gates by 0.2 to 0.3 m in the proper sequence.
6. An efficient and reliable system of flood forecasting should be estimated at dam site to facilitated-
    a. Formulation of accurate forecasts of rate of inflow and volume of floods at the dam site and
    b. Regulation of the gates for efficient flood disposal.
7. While surplussing the floods when the reservoir is at or near about the FRL towards the end of mansoon,
    a. The reservoir level should not be allowed to encroach up to free board.

b. No part of conservation storage is allowed to spill towards the later part of the mansoon.

1.2.9 Guidelines for preparing EAP

1. EAP contains location of dam, river details such as slope, drainage area details, approach to dam, note on dam, necessity of EAP.
2. It also contains the list of Departments & action to be taken up during emergency situation (Mainly Irrigation/Revenue)
3. Details of communication system to convey daily and hourly water levels and release of flood to Revenue Department, convey alerts, Action warning system.
4. List of phone numbers related departments of EAP.
5. List of villages with population affected due to normal flood, spillway discharging capacity and dam break flood.
6. Mark affected villages with contour of Normal flood, Spillway discharging Capacity and Dam Break flood on Index Map to the scale 1:50,000 or 2cm=1km. Also shelter village places of stay for affected people and necessary requirements due to loss.

1.2.10 Some Important Points

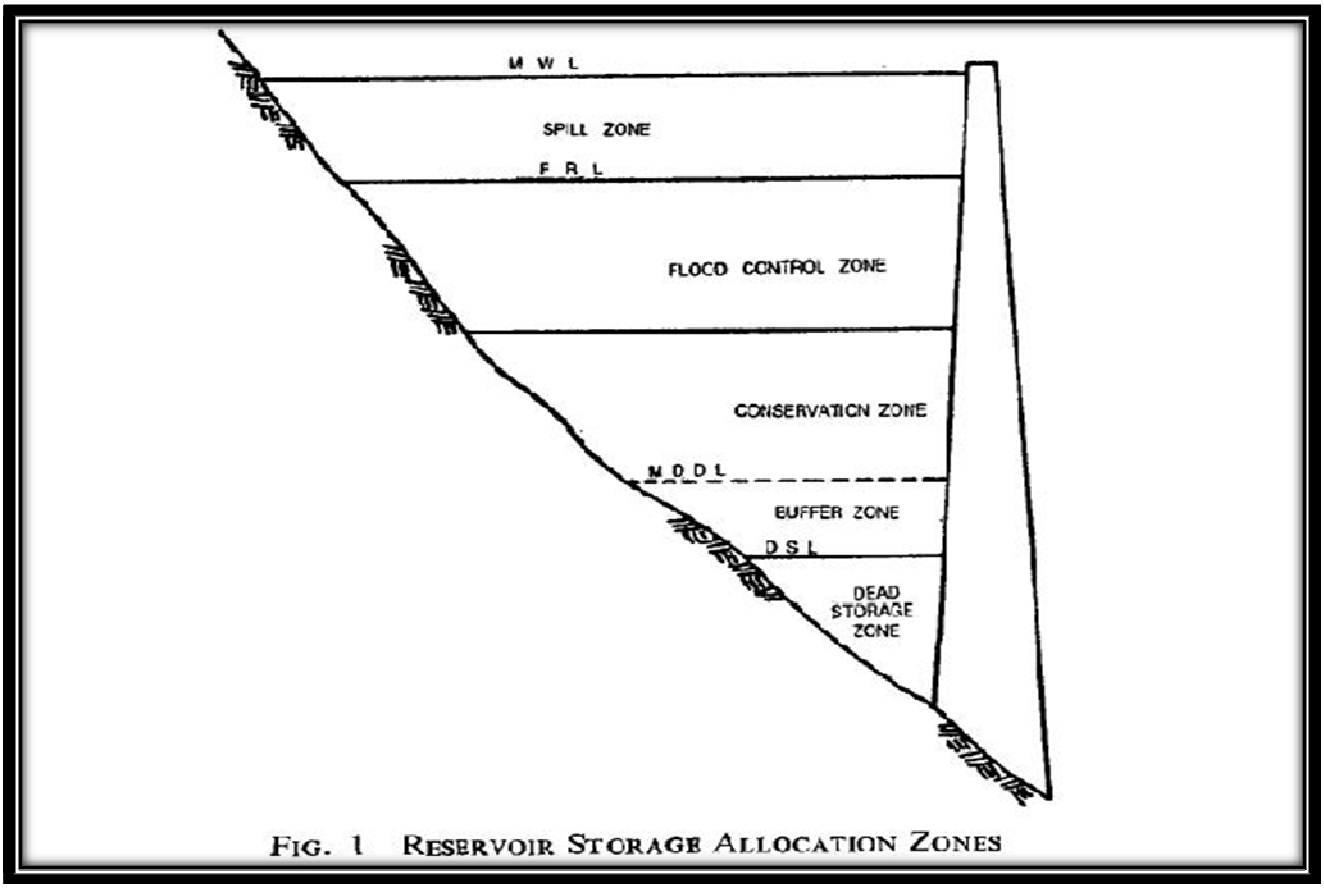


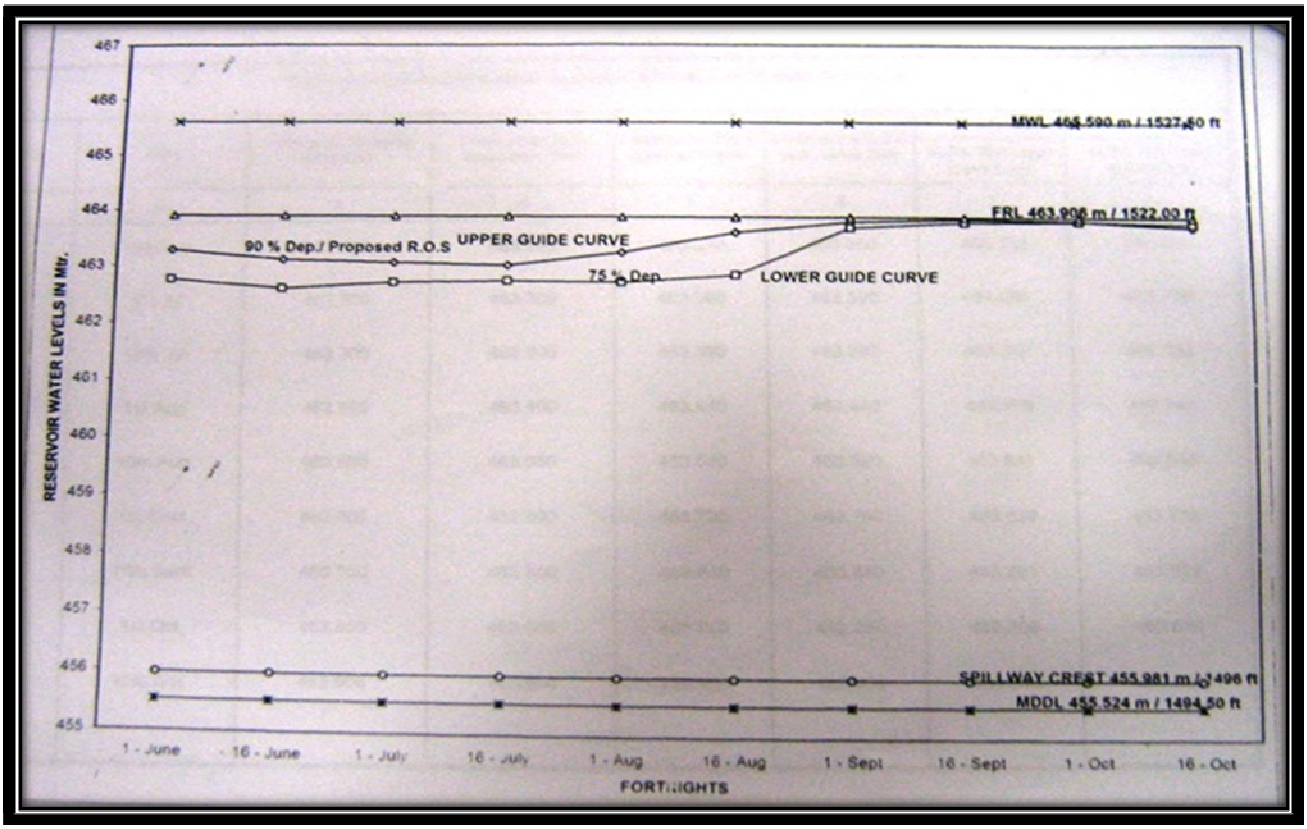
FIG. 1 RESERVOIR STORAGE ALLOCATION ZONES

1. With restraints on downstream channel capacity and likely damage to towns and villages on downstream, the flood releases form the spillway shall have to be planned and regulated judiciously; on respect of forecast warnings of heavy precipitations and/or releases form upstream storage if any, and with due considerations to the reservoir level and flood absorption capacity etc.
2. Based on the discharge rating curves and the general principles of operation of gates given above it will be possible for the field officers to finalize the GOS for individual projects to meet the flood situations.

1.2.11 Real Time Operation of Reservoir

1. The operation of reservoirs based on fixed operation rules, which are developed taking into account the demands and historic/synthetic time series data, often poses difficulties in making appropriate reservoir release decisions due to the uncertainty in the probability of occurrence of the flood event exactly similar to the past event, though the demands could be fairly stable. Operation of reservoirs, therefore, becomes an operation in real time in which water control decisions have to be taken at each instant of time.
2. The real time reservoir operation control decisions are made quickly, for a finite future condition of the system at that instant of time and the forecast of the likely inputs over this time horizon depending on the purpose of the reservoir operation that is flood control,
3. Use of systems engineering techniques using computer technology should be employed and a computer model be developed for real time operation. Some of the important aspects of real time reservoir operation are listed below:
    a. Collection of catchment hydrological data and water demand data and transmission of the data to the operation manager at the control station through suitable logistics such as hydrological sensors, data loggers and telemetry network;
    b. Availability of a computer system at the control station;
    c. A real time data base management system; and
    d. A computer model having capability of flow forecast, control decisions forecast with flexibility for modified data entry and updating, preferably in an interactive mode, in shortest possible execution time.

1.2.12 Guide Curve for ROS



1.2.13 Development of GOS

1. In many earlier projects where the FRL and MWL are the same and even in projects with provision for induced surcharge operation, it may .be imperative to utilize a portion of the storage space below the FRL in order to meet the requirements of 5.5 under operating conditions. The volume of inflow, however, must be predicted before releases can be determined. Although forecasting of runoff from reports of rainfall and river stages/discharges provides a sound basis for operation, schedules for use in spillway design and by operational staff under emergency conditions require a more conservative approach. During very severe floods communications may fail and the only information available at the dam may be reservoir water levels and the rate of rise. The minimum volume of inflow to be expected during flood at any instant may be predicted by assuming that the inflow has crested for computing the volume under the recession curve of the hydrograph. The assumed recession curve should, however, be steeper than the normal observed recession for conservative results and may usually be patterned after the spillway design flood recession. Once the minimum volume expected with a given inflow is known, the outflow required to limit storage to the capacity
2. A complete schedule of releases in the form of a chart may be developed that will allow the outflow to be regulated on the basis of the current inflow

and storage space available by making a series of computations with various assumed values of inflows and amounts of storage available as below:

a. Calculate a constant T_s (in days), that is the time required for the discharge to recede to 112.1 of its initial value, by reading from the assumed recession curve.
b. Compute S_A/Q, values for the project, by multiplying T_S with the S_A/Q_2, values derived by assuming $T_S = 1$. The S_A/Q_2 values corresponding to $T_S = 1$ for a set of Q_1/Q_2 ratios are given below:

Q_1/Q_2	S_A/Q_2 (for $T_S = 1$)
1.2	1 363
1.6	10 023
2.0	23 657
2.5	45 006
3.5	96 163
10'0	548 856

Where S_A is the amount of storage required in cubic meters to impound a flood inflow of Q_1 (in cumecs) with Q_2 (in cumecs) as the constant release from the reservoir.

c. For an assumed range of inflows Q_1 (for example 3 000 m3/s to spillway design flood peak) compute a set of Q_2 for the entire set of Q_1/Q_2 ratios by dividing Q_1 by Q_1/Q_2
d. Lastly compute a set of S_A values for each selected value of Q_1 by multiplying the project S_A/Q_2 values by Q_2.

A convenient computational form is given in Table I.

Table 1 Computation for Spillway Gate Regulation Schedule

[*Clause* A-2.1 (d)]

	Project	Q_1 = 3 000 m³/s		Q_1 = 6 000 m³/s	
Q_1/Q_2	S_A/Q_2	$Q_2 = \frac{Q_1}{\text{col (1)}}$	S_A = col (2) × col (3)	$Q_2 = \frac{Q_1}{\text{col (1)}}$	S_A = col (2) × col (3)
(1)	(2)	(3)	(4)	(5)	(6)

NOTE — Columns will extend with various values of Q_1 considered.

A family of curves S_A versus Q_2 such as in Fig. 2 may be then plotted for each assumed values of inflow Q_1

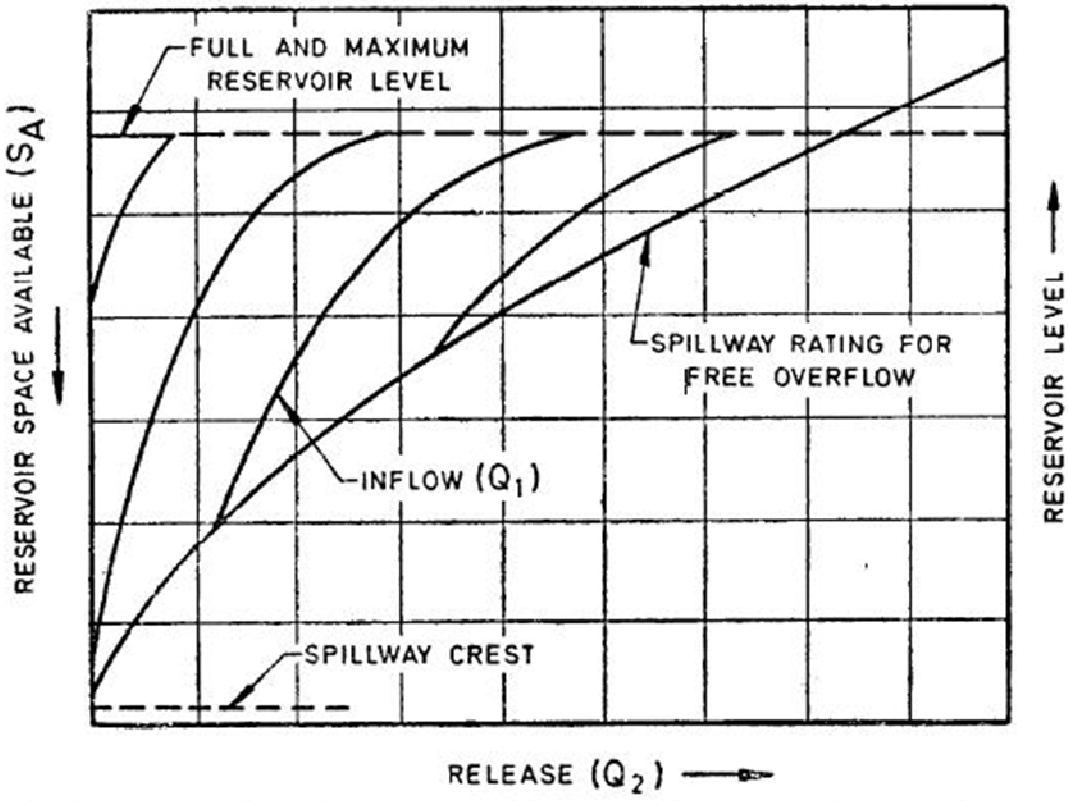


FIG. 2 SPILLWAY GATE REGULATION SCHEDULE WITHOUT INDUCED SURCHARGE

For reservoirs having no induced surcharge storage provision, SA values can be transformed shown in Fig. 3. Thus the point b corresponding into reservoir elevations by subtracting SA to the schedule with induced storage will be obtained by raising point a of the dotted curves values from the storage capacity at FRL and reading corresponding elevation values from (without induced storage) by an amount cd, the amount of surcharge storage at the given the elevation-capacity curves. outflow. In case of reservoir with induced surcharge These curves are useful in deciding the provision, the points located as above may be required releases for reservoir regulation based raised vertically by the amount of surcharge on the inflow and available storage space at storage permissible at the particular outflow as any instant.

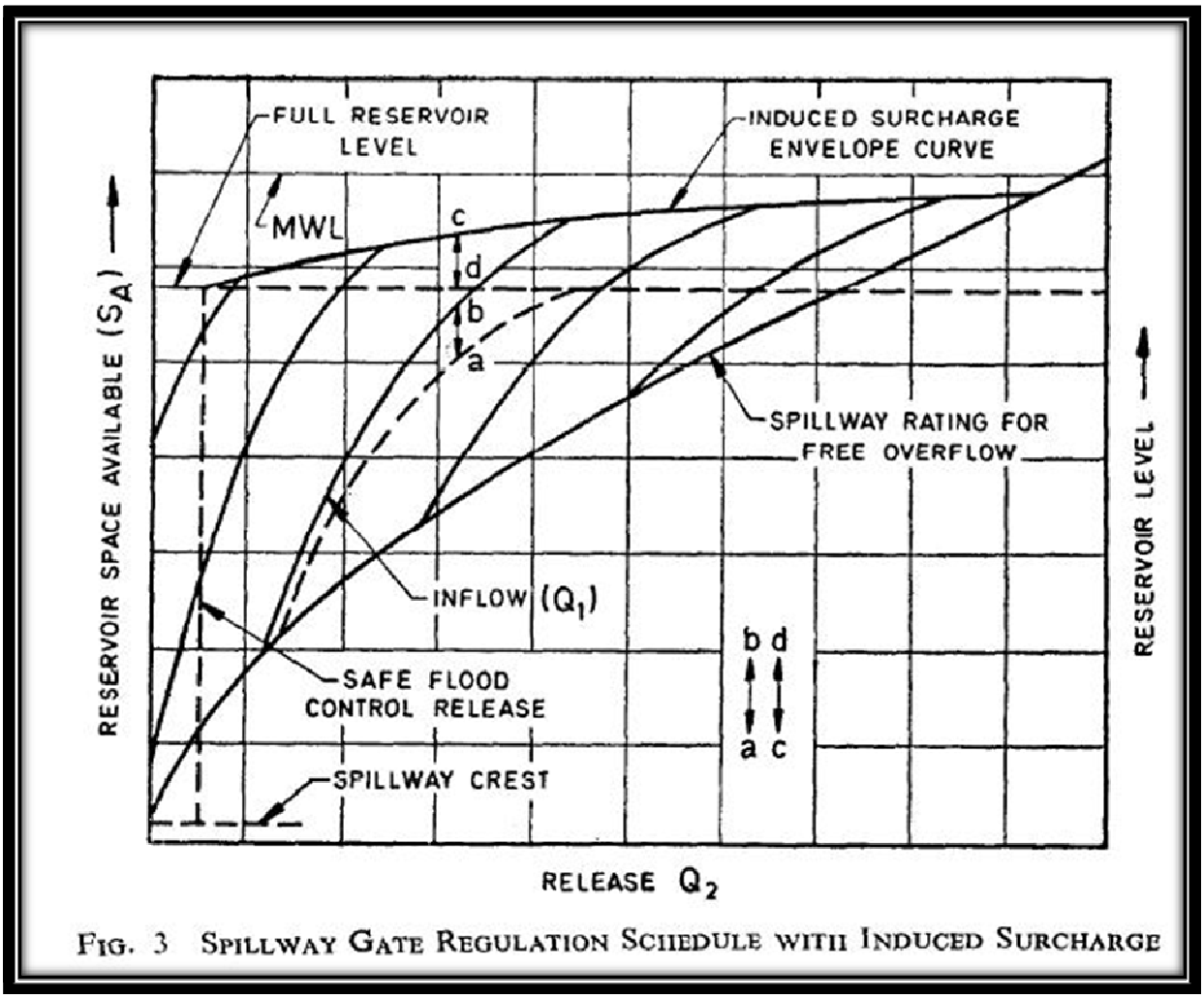
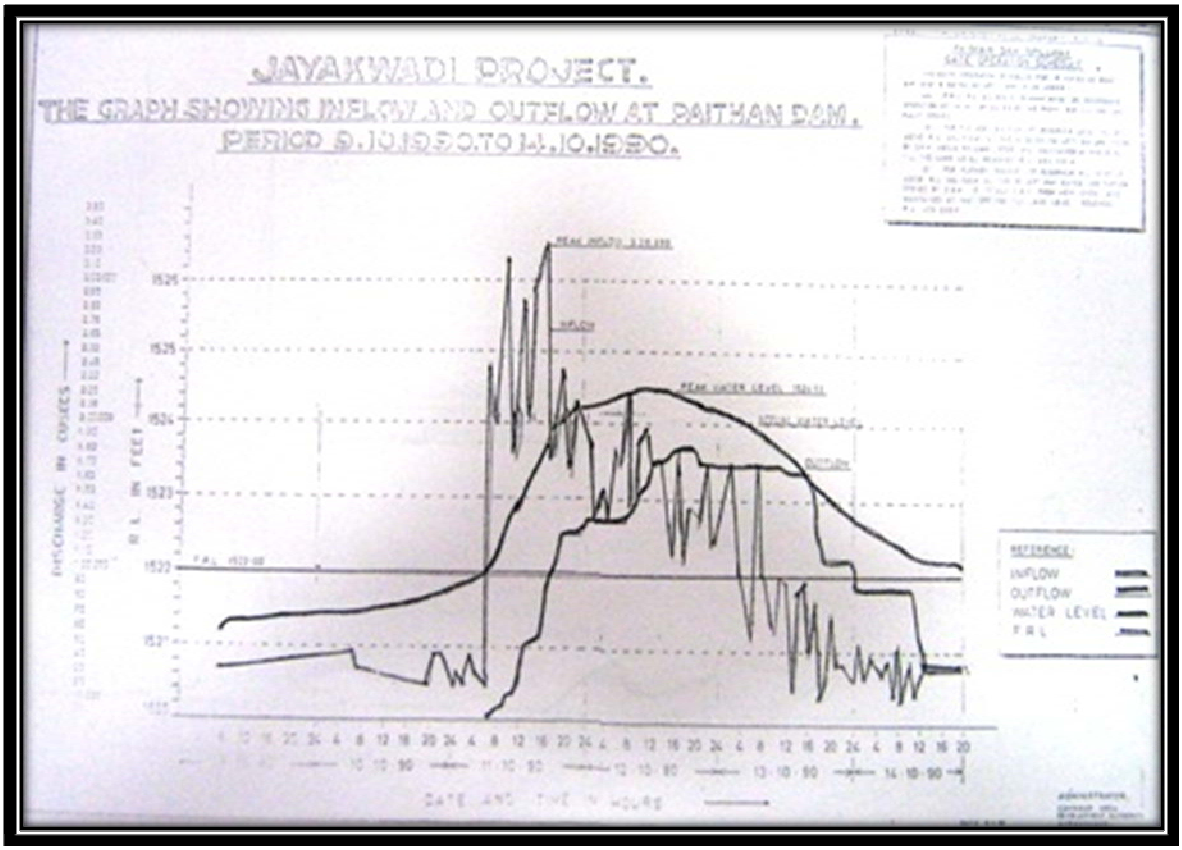


FIG. 3 SPILLWAY GATE REGULATION SCHEDULE WITH INDUCED SURCHARGE

1.3 Approved ROS for Jayakwadi Project

The present sequence of operation of gate is as under-

a. The end gate should be opened first to prevent cross flow striking against the guide walls or divide walls.
b. After opening the end gates, the gate/gates at the centre should be opened and the other gates should be opened symmetrical manner starting from centre towards the end through gradual increase in the opening.
c. Wile closing the gates, the gate that was opened last should be closed first. The procedure to be followed for the closing of gates should be the reverse of procedure followed for opening the gates. Complete closure of gates should be accomplished by gradual lowering of gates by 0.15 to 0.30 m in proper sequence.



d. The GOS will be started when the Reservoir level starts rising above FRL (i.e. 463.906m). All the 18 gates in the right guide bay would be gradually and progressively operated maintaining the water level at FRL till the opening is 4'. The discharge at this stage is 70,362 cusecs that is the river channel capacity.
e. For further tendency of water level to rise above FRL all the 9 gates in the left side bay would be gradually and progressively opened till the opening is 3'. The water level is maintained at FRL all the while discharge over spillway at this stage is 70,362+26,865 = 97,218 cusecs.
f. Now water level in the reservoir is allowed to rise up to RL 464.521m. The discharge passing now is 1,00,089 cusecs. The increase in water level from RL 1522 to 1524 feet would generally take 24 hours even though the inflow is of the over of 2,00,000 cusecs and outflow of about 1,00,000 cusecs. The content between RL 1522 and 1524 is 250.06 Mm^3
g. For further tendency of reservoir to rise above RL 1524 all the 18 gates on Right side bay are further opened so as to give total opening of 20', keeping the water level all the while at RL 1524. The discharge at this stage is 2,71,404+27,657 = 2,99,061 cusecs. This is approximately 3,00,000 cusecs, the 25 years return period.
h. For further tendency of reservoir level to rise all the 9 gates in the left bay are further opened by 3' so as to give total opening of 6' above the crest.

The water level is maintained at RL 1524. The discharge over the spillway at this stage is 2,71,404+52,731 = 3,24,135 cusecs.

i. For further tendency of reservoir level to rise all the 18 gates in the right side bay are fully opened maintaining the water level at RL 1524. The discharge at this stage is 3,11,994+52,731 = 3,64,725 cusecs.

j. Now allow the water level to rise gradually from RL 1524 to RL 1526 feet. The content between these two levels is 273.825 Mm^3. The discharge over spillway would now be 3,31,326+54,198 = 3,85,534 cusecs.

k. For further tendency of reservoir level to rise all the 9 gates in the left bay are fully opened maintaining water level at RL 1526 feet. The discharge at this stage is 3,31,326+1,65,663 = 4,96,989 cusecs.

JAYAKWADI PROJECT : GATE OPERATION SCHEDULE OF PAITHAN DAM.

Sr. No.	Water level in reservoir in feet.	Right side 18 bays gate opening in in feet.	Left side 9 bays gate opening in feet.	Right side Discharge/bay / Total discharge in cusecs.	Left side discharge/ bay / Total discharge in Cusecs.	Total discharge in Cusecs.	Remarks.
1	2	3	4	5	6	7	8
1.	1522	4	-	3909 / 70,362	-	70,362	
2.	1522	4	3	3,909 / 70,362	2,684 / 26,856	97,218	
3.	1524	4	3	4,024 / 72,432	3,073 / 27,657	1,00,089	Water level allowed to rise upto R.L. 1524.00 Feet.
4.	1524	20	3	15,078 / 271404	3,073 / 27,657	299061	
5.	1524	20	6	15,078 / 2,71,404	5,866 / 52,731	3,24,135	
6.	1524	26	6	17,333 / 3,11,994	5,866 / 52,731	3,64,725	
7.	1526	26	6	18,407 / 3,31,326	6,022 / 54,198	3,85,524	Water level allowed to rise upto 1526.00 Fe
8.	1526	26	26	18,407 / 3,31,326	18,407 / 1,65,663	4,96,989	

1.3.1 ROS for Jayakwadi Project

DETAILS OF RESERVOIR OPERATION SCHEDULE

Sr. No.	Date	90% Dependability (Upper Godavari Canal)		Gross Storage (Mm³)	Live Storage (Mm³)	%age of Live Storage
		Level in Mtr	Level in Feet			
1	2	3	4	5	6	7
1	15-Jun	463.125	1519.44	2614.483	1876.377	86.43
2	1-Jul	463.080	1519.29	2598.974	1860.868	85.72
3	15-Jul	463.037	1519.15	2584.330	1846.224	85.04
4	1-Aug	463.275	1519.93	2666.248	1928.142	88.82
5	15-Aug	463.637	1521.12	2803.802	2065.696	95.15
6	Sept.1	463.829	1521.75	2879.310	2141.204	98.63
7	15-Sep	463.881	1521.92	2899.263	2161.157	99.55
8	1-Oct	463.906	1522.00	2909.041	2170.935	100.00
9	15-Oct	463.848	1521.81	2886.248	2148.142	98.95

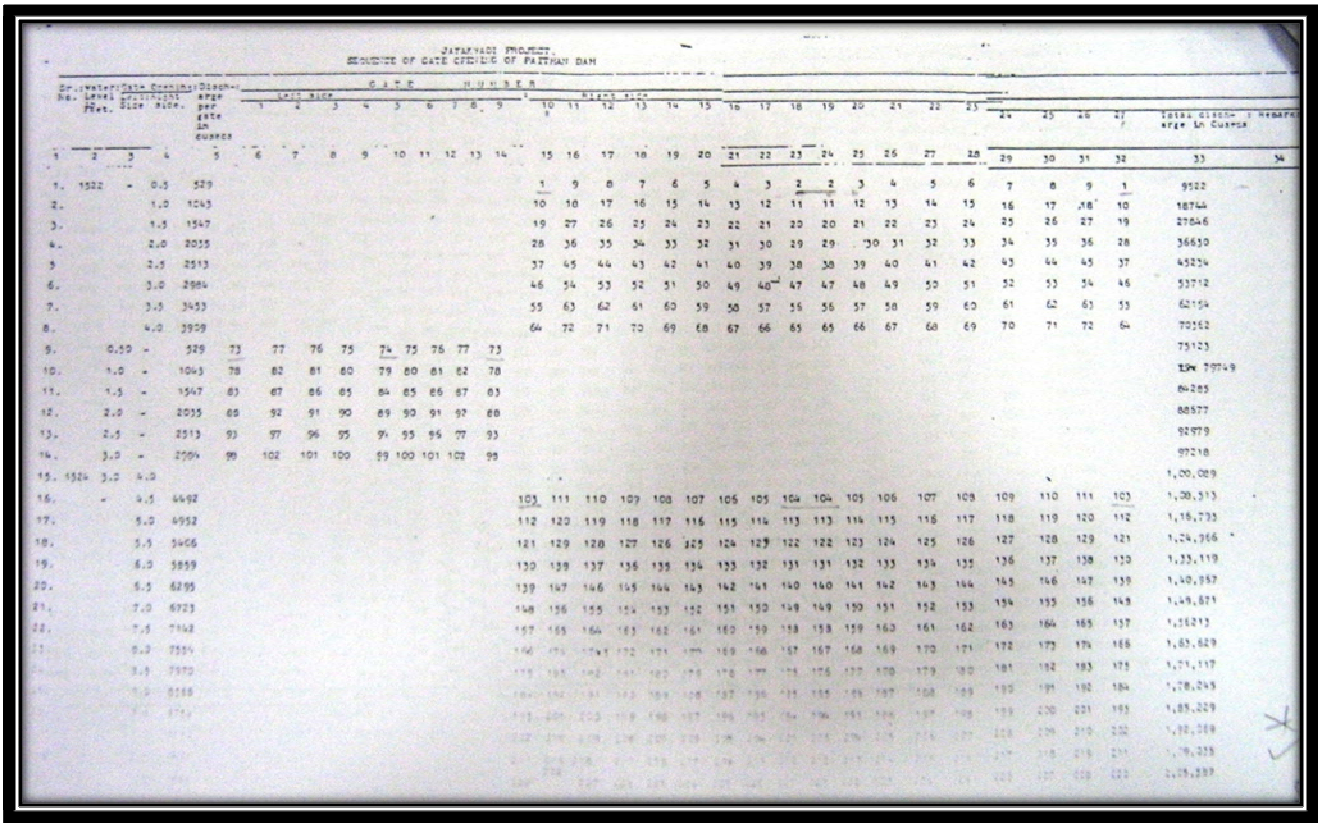
DETAILS OF RESERVOIR OPERATION SCHEDULE

Sr. No.	Date	75% Dependability (Upper Godavari Canal)		Gross Storage (Mm³)	Live Storage (Mm³)	%age of Live Storage
		Level in Mtr	Level in Feet			
1	2	3	4	5	6	7
1	15-Jun	462.604	1517.73	2434.423	1696.317	78.14
2	1-Jul	462.720	1518.11	2474.453	1736.347	79.98
3	15-Jul	462.763	1518.25	2489.887	1751.781	80.69
4	1-Aug	462.747	1518.2	2484.870	1746.764	80.46
5	15-Aug	462.885	1518.65	2531.195	1793.089	82.60
6	Sept.1	463.726	1521.41	2838.711	2100.605	96.76
7	15-Sep	463.823	1521.73	2876.581	2138.475	98.50
8	1-Oct	463.839	1521.78	2882.351	2144.245	98.77
9	15-Oct	463.906	1522.00	2909.041	2170.935	100.00

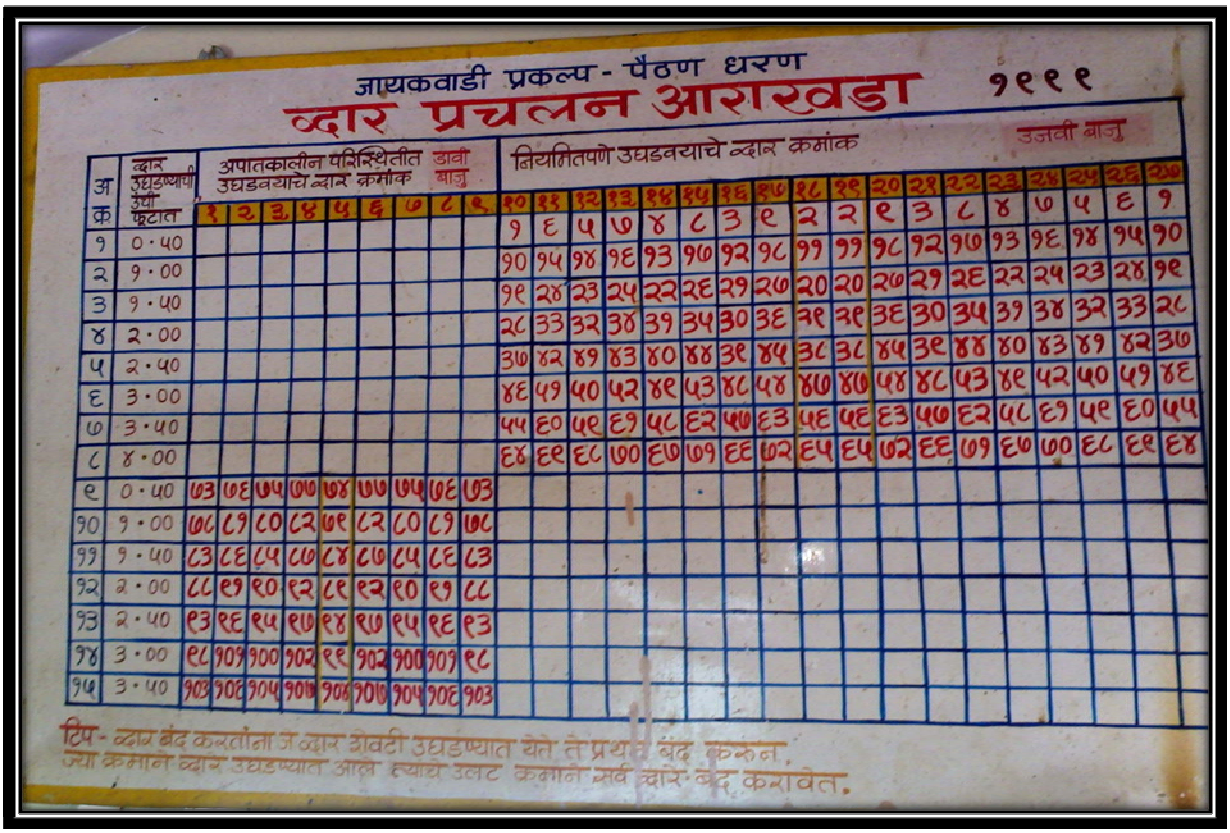
Statement showing Reservoir operation Schedule of Paithan Reservoir

Sr.No.	Date	Level as per approved ROS.1992	Levels as per ROS approved in 1997	Levels as per R.O.S. approved in 1999	Levels as per R.O.S. approved in 2006	Levels as per calculations for 2007	
						As Per 90% Upper Guide Curve	As Per 75% Lower Guide Curve
1	2	3	4	5	6	7	8
1	15th Jun	463.300	463.300	463.350	463.350	463.125	462.604
2	1st Jul	463.300	463.300	463.390	463.390	463.080	462.720
3	15th Jul"	463.300	463.300	463.390	463.390	463.037	462.763
4	1st Aug	463.400	463.400	463.440	463.440	463.275	462.747
5	15th Aug	463.550	463.550	463.580	463.580	463.637	462.885
6	1st Sept	463.800	463.800	463.790	463.790	463.829	463.726
7	15th Sept	463.850	463.850	463.840	463.840	463.881	463.823
8	1st Oct	463.850	463.850	463.880	463.880	**463.906**	463.839
9	**15th Oct**	**463.906**	**463.906**	**463.906**	**463.906**	463.848	**463.906**

1.3.2 Approved GOS for Jayakwadi Project



1.3.3 Existing GOS for Jayakwadi Project



1.3.4 Advantage of this ROS

1. In the initial stage the outflow is restricted in the river channel and when a stage is reached where outflow and inflow is more than 1,00,000 cusecs, the reservoir level is allowed to rise by 2 feet. This gives a warning time of about24 hours for the Paithan town, even when inflow is 2,00,000 cusecs (2,00,000 cusecs inflow is normal capacity inflow for a duration of 24 hours)
2. The gates in the left bay are not allowed to be over topped.

1.3.5 Standard Performa

Proforma 1 — Rainfall and Streamflow Data

Name and Location of
Raingauge.....
River gauge.....
R. L. of Zero of gauge .....

Date	Time in Hours	Observed Rainfall in mm			Catchment Rainfall	Gauge in Metres	Discharge Estimated/Observed m^3/s	Remarks
		Stn- 1	Stn. 2	Stn.3				

Proforma 2 — Forecast Computation Sheet

(Using Rainfall, Runoff co-axial relations and unit hydrographs)

Stream and Station	Runoff Computations	Discharge in m³/s
		Date 6 7 8 9 10 11 12
		8AM 8PM 8AM 8PM 8AM 8PM 8AM 8PM 8AM 8PM 8AM 8PM 8AM 8PM
Station A on river X	Antecedent precipitation ....cm	Hydrograph (Prev. Period)
	Total duration.....h	12-h unit hydrograph
	Total rain.. ..... cm	Direct
	Total runoff..... cm	Runoff
	Prev. runoff . .....cm	Total flow
	Runoff increment.....cm	
Local area between station A and B	Antecedent precipitation .... cm	Hydrograph (Prev. Period)
	Total duration. .... h	12-h unit hydrograph
	Total rain .....cm	Direct
	Total runoff..... .....cm	Runoff
	Prev. runoff.....cm	Total flow
	Runoff increment.....cm	
Local area between station A and B	Antecedent precipitation .... cm	Hydrograph (Prev. Period)
	Total duration. .... h	12-h unit hydrograph
	Total rain .....cm	Direct
	Total runoff..... .....cm	Runoff
	Prev. runoff.....cm	Total flow
	Runoff increment.....cm	
Station B on river X	Routing	Routed flow from Station A
		Local flow
		Total flow
		Adjusted flood

..... (Basin)

Computed.....For storm beginning .....Computed by .....
(Month) (Date) (Year) (Hour) (Month) (Date) Checked by.....Time.....

Proforma 3 — Daily Reservoir Operation Data

(*Clause* 7.11)

Date	Time in h	Pool Elevation in Metres above MSL	Withdrawals m^3/s	Spillway Discharge[1)]	Estimated Inflow	Dam Site Weather					Remarks
						Precipitation, mm	Temperature		Wind		
							Max	*Min*	Speed km/h	Direction	
1	2	3	4	5	6	7	8	9	10	11	12

1.3.6 Concluding Remarks

1. The GOS for designed capacity is not yet tested.
2. Although ROS is generally prepared in case of Flood situations, it might be useful in case of water deficiency.
3. It is observed that the ROS is prepared by referring the past data which is based on the old methods of analysis.
4. Now a days rainfall prediction is possible with help of satellite observations and by performing rigorous analysis of meteorological data, using high speed computer, accurate prediction is of yield possible. Such techniques should be preferred for ROS and GOS.

1.3.7 References

[1.] Chief Engineer Circular No. MIP 2273/21473-IP(3) Dt: 25.06.1974

[2.] Dam Safety Manual Chapter-7: "Flood Forecasting, Reservoir Operation and gate Operation," 1984

[3.] Discharge Characteristics of Spillway Radial Gates in Maharashtra based on Model Data Analysis-Paper Presented to 52nd Annual Session of CBIP by MERI Officers.

1.4 Walk Through of Minor No.1, of Dy. No.10, PLBC

WALK THROUGH SURVEY
PAITHAN LEFT BANK CANAL
DISTRIBUTORY NO. 10
MINOR NO.1 (0.00 TO 5500 M)
GENERAL REPORT

The Minor no. 1 is of taking from @ 0.27 KM (DY. 10 of PLBC) & The DY no. 10 is of taking from @ 24.5 KM (PLBC)

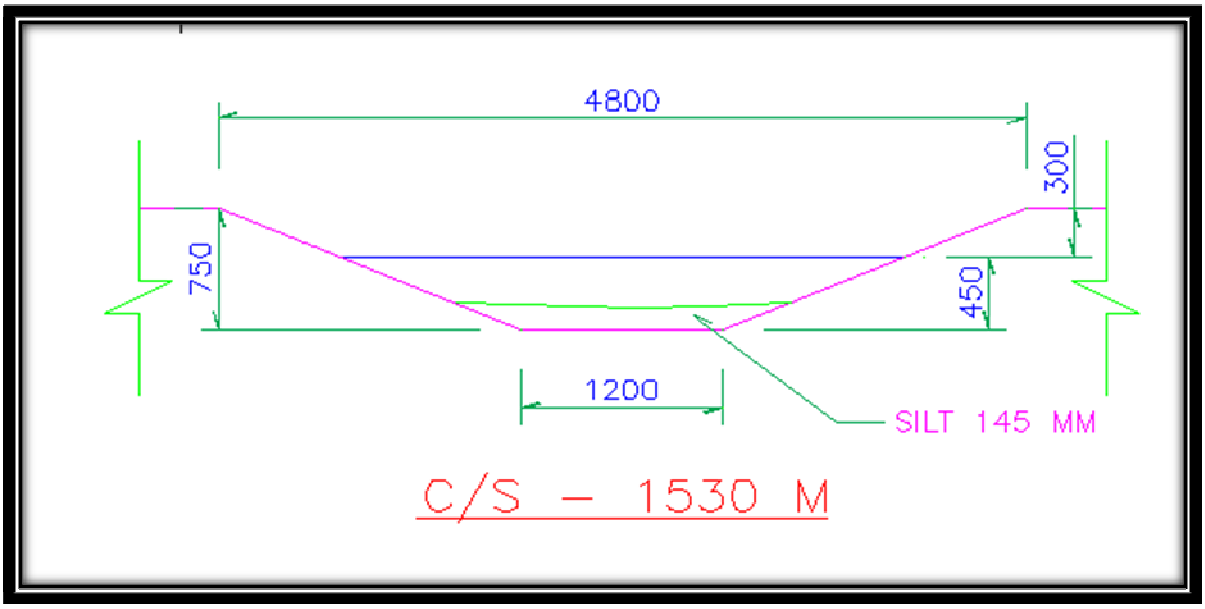
1.4.1 Details of minor No 1 are as follows:

• **Length of Minor**	**:**	**5500 m**
• **Total no. of structures**	**:**	**38**
• **HR**	**:**	**01**
• **SWF**	**:**	**01**
• **OUTLETS**	**:**	**29**
• **H.P.C.**	**:**	**01**
• **V.R.B.**	**:**	**06**

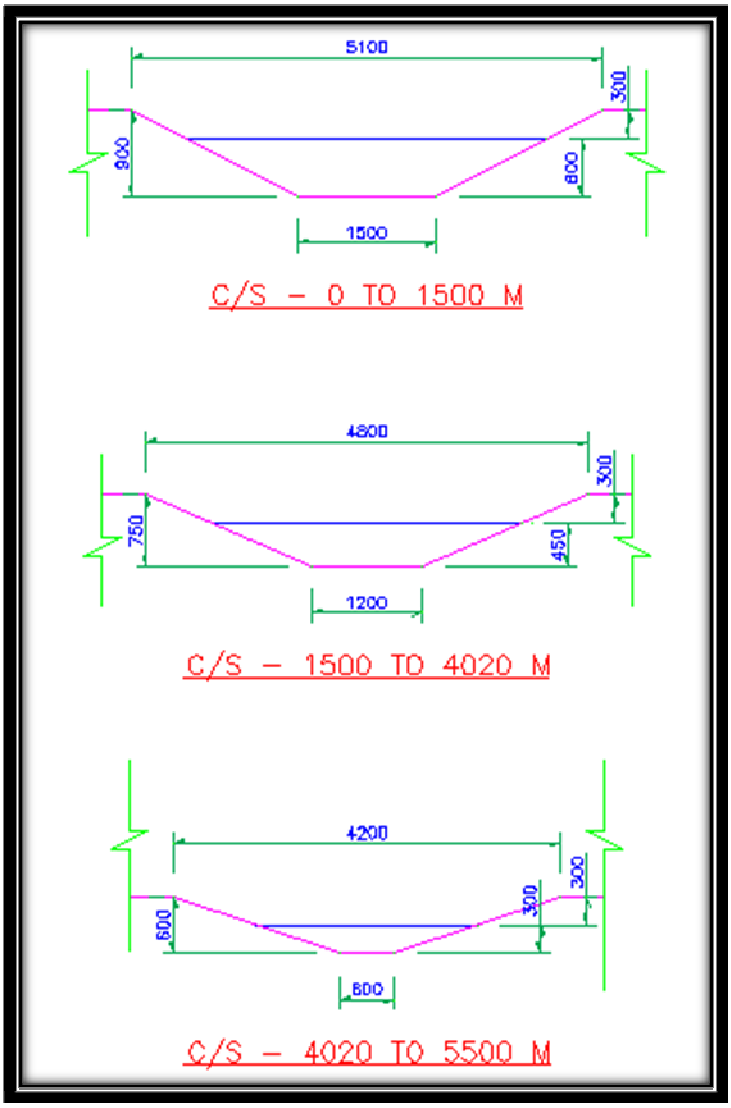
1.4.2 Design details of Minor No. 1

Sr, No.	*Chainage*	*BW*	*FSD*	*FB*	*SS*	*BG*	*N*	*Q*
B	m	m	m	m	H:V			Cusec
1	0 to 1500	1.5	0.6	0.3	2:1	1:2000	0.02	32
2	1500 to 4020	1.2	0.45	0.3	2:1	1:3000	0.02	24
3	4020 to 5500	0.6	0.3	0.3	2:1	1:3000	0.02	13

1.4.3. Existing Cross-Section of Minor No. 1



1.4.3 Cross-Section as per Design



1.4.6 Cross Regulator & Head Regulator Of Minor N0-1

1.4.7 LINING IN GOOD CONDITION IN INITIAL STRETCH

1.4.8 Damaged Canal Lining

1.4.9 Silting and Stagnation of Water

1.1.10 MS Gate in Damaged Condition

1.4.11 Un-gated Outlet

1.4.12 Slight Silting With Vegetation

1.4.13 Breach of Canal Section

1.4.14 Stagnation of Water Due to Weed Growth

1.4.15 H.P Drain Silting

1.4.16 Heavy Silting Observed

1.4.17 Vegetation on Unlined Portion of Canal

SR.NO.	TYPE OF STRUCTURE	LOCATION RD. IN M.	Condition		
			Good	Repairable	Unserviceable
1	HEAD REGULATOR	0	---	✓	---
2	STANDING WAVE FLUME	60	---	✓	---
3	OUTLET OR-1	60	---	✓	---
4	OUTLET OR-2	270	---	---	✓
5	OUTLET OR-3	350		✓	---
6	VILLAGE ROAD BRIDGE	650	---	✓	---
7	OUTLET OL-1	660	---	---	✓
8	OUTLET OR-4	720	---	✓	---
9	OUTLET OR-5	1280	---	✓	---
10	OUTLET OR-6	1450	---	✓	---
11	H.P DRAIN	1550	---	✓	---
12	VILLAGE ROAD BRIDGE	1600	✓	---	---
13	OUTLET OR-7	1620	✓	---	---
14	OUTLET OR-8	1770	✓	---	✓
15	OUTLET OR-9	2010	---		---
16	OUTLET OR-10	2110	---	---	✓
17	OUTLET OR-11	2200	✓	---	---
18	VILLAGE ROAD BRIDGE	2300	---	✓	---
19	OUTLET OR-12	2450	---	---	✓
20	OUTLET OR-13	2610	---	✓	---
21	OUTLET OL-2	2660	---	---	✓
22	VILLAGE ROAD BRIDGE	2770	---	✓	---
23	OUTLET OR-14	2880	---	✓	---
24	VILLAGE ROAD BRIDGE	3000	---	✓	---
25	OUTLET OL-3	3010	---	✓	---
26	OUTLET OR-15	3210	✓	---	---
27	OUTLET OL-4	3220	✓	---	---
28	OUTLET OR-16	3750	---	✓	---
29	OUTLET OL-5	3840	✓	---	---
30	OUTLET OR-17	4140	✓	---	---
31	VILLAGE ROAD	4170	✓	---	---

	BRIDGE				
32	OUTLET OL-6	4320	✓	---	---
33	OUTLET OR-18	4590	✓	---	---
34	OUTLET OL-7	4980	---	✓	---
35	CANAL FALL	4980	---	---	✓
36	CANAL FALL	5070	---	---	✓
37	OUTLET OR-19	5130	---	---	✓
38	OUTLET OL-8	5200	---	✓	---
39	OUTLET OR-20	5280	✓	---	---
40	OUTLET OL-9	5280	✓	---	---

1.4.18 Abstract of Vegetation

SR.NO	Heavy Vegetation		Medium Vegetation		Slight Vegetation	
	Chainage/RD (m)	Total Length (m)	Chainage/RD (m)	Total Length (m)	Chainage/RD (m)	Total Length (m)
1					0-60	50
2			60-510	300		
3			510-990	340		
4			990-1560	325		
5					1560-2010	250
6					2010-2490	380
7			2490-3000	410		
8	3000-3480	250				
9					3480-4170	350
10					4170-4980	340
11			4980-5200	200		
TOTAL		250		1575		1370
PERCENTAGE WITH RESPECT TO TOTAL LENGTH		4.70%		29.80%		25.90%

1.4.19 Abstract of Weeds

SR. NO	Heavy Vegetation		Medium Vegetation		Slight Vegetation	
	Chainage/RD (m)	Total Length (m)	Chainage/RD (m)	Total Length (m)	Chainage/RD (m)	Total Length (m)
1					0-60	5
2					60-510	110
3					510-990	190
4			990-1560	90		
5	1560-2010	80				
6	2010-2490	60				
7			2490-3000	140		
8	3000-3480	50				
9			3480-4170	100		
10			4170-4980	185		
11			4980-5280	210		
TOTAL		190		725		305
PERCENTAGE WITH RESPECT TO TOTAL LENGTH		3.60%		13.70%		5.80%

1.4.20 Abstract of Silting

Sr. No.	Heavy Vegetation		Medium Vegetation		Slight Vegetation	
	Chainage/RD (m)	Total Length (m)	Chainage/RD (m)	Total Length (m)	Chainage/RD (m)	Total Length (m)
1					0-270	270
2			270-720	210		
3	720-900	180				
4					990-1530	540
5	1530-1980	250				
6			1980-2700	330	2010-2490	480
7	2700-3000	300				
8			3000-3480	330		
9			3480-4170	240		
10			4170-4980	270		
11	4980-5280	300				
TOTAL		1030		1380		1290
% w.r.t Total Length		19.51		26.14		24.43

1.4.21 Priority of Repairs for Earthwork

Sr. No.	Particulars	RD (From-To)	M&R	Special Repairs	Priority
1	REMOVAL OF SILT	270 -900, 1530-5280	✓	-	I
2	REMOVAL OF VEGTATION & WEEDS	60-1560, 2490-3480, 4980-5200	✓	-	II
3	RESECTIONING OF CANAL	1700-1900	✓	-	I
4	EARTH FILLING IN CANAL BANKS(S.R./I.P.)	500-520 650-660,	✓	-	I
5	LINING REPAIRS	30-60. 250-260, 370-380, 720-780, 1380-1410	-	✓	II
6	FIXING CHAINAGE STONES,BOUNDRY STONES	THROUGHT THE MINOR	-	✓	III
7	FIXING INFORMATION BOARD	1 NOS.	-	✓	III
9	REMOVAL OF ENCROACHMENT	Almost throught the length on IP Side.	✓	-	II

1.4.22 Priority of Repairs for Structures

Sr. No.	Particulars	No.	M&R	Special Repairs	Priority
1	Head Regulator	1	1	---	II
2	SWF	1	1	---	II
3	VRB	6	4	0	II
4	Outlets	29	8	8	I
5	Fall	2	0	Proposed New	I

1.4.23 Recommendations

- Urgent removal of silt, vegetation & Weeds.
- Murum topping on service road.
- Repairs to structure, Reconstruction of damaged structure (Earthwork).
- It is Proposed to construct SR Outlet where reconstruction is required.
- Repairs to Existing Damaged Lining.
- Resectioning & Lining of remaining length
- Providing chainage, boundary stones and information board on minor.
- Encroachment of Agri. farming on the minor network should be removed.

1.4.24. Conclusion

- Urgent removal of silt, vegetation & Weeds.
- Murum topping on service road.
- Repairs to structure, Reconstruction of damaged structure (Earthwork).
- It is Proposed to construct SR Outlet where reconstruction is required.
- Repairs to Existing Damaged Lining.
- Resectioning & Lining of remaining length
- Providing chainage, boundary stones and information board on minor.
- Encroachment of Agri. farming on the minor network should be removed.

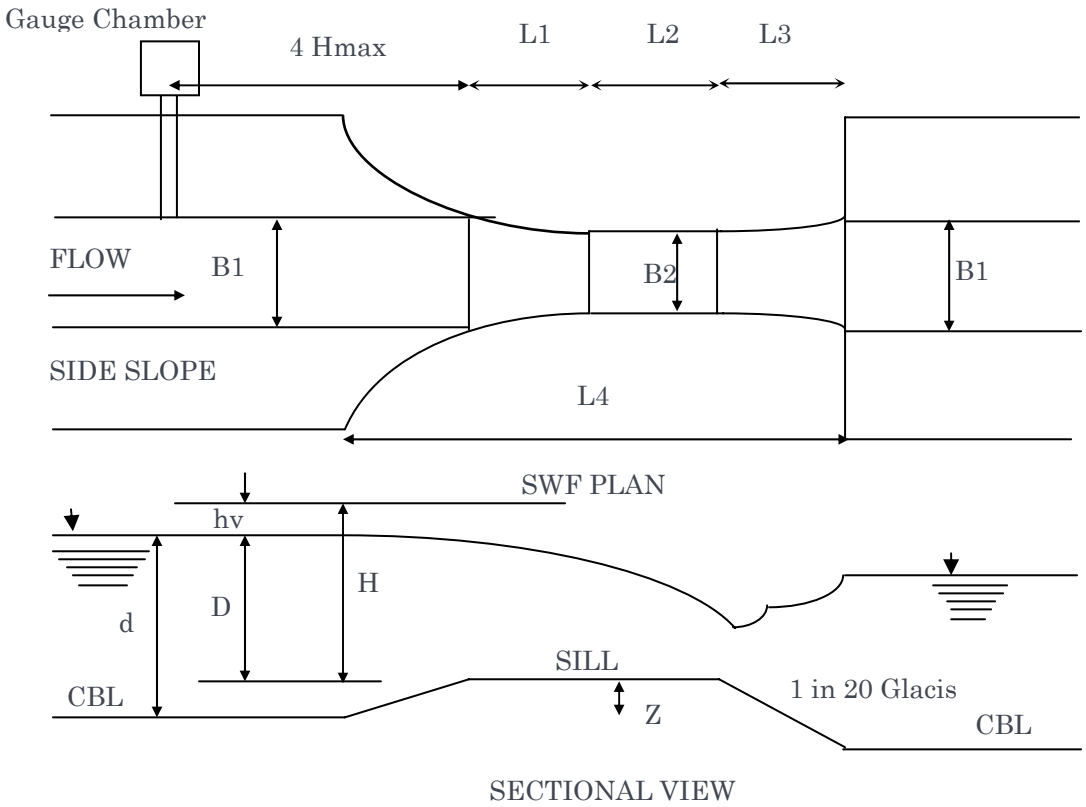
Chapter 2. Evaluation of Standing Wave Flume (SWF)

2.1 Introduction

Flow measurement is important aspect in irrigation water management. Generally Standing Wave Flume (SWF is used to measure the flow. It is designed using procedure given in IS Code No. 6063 – 1971. This procedure is tedious and time consuming. It involves computation of height of hump by establishing the stage discharge relationship of a given cross section maximum head, throat width and then remaining dimensions using long formulae and limits. Similarly, after construction if proper hydraulic conditions are not maintained for proper functioning of SWF, it gives incorrect results. It is therefore necessary to evaluate the performance of such SWF periodically and improvements / rectification are made to bring back the flume to function properly. It involves some computation. Sometimes discharge table of the flume is not available.

(1) Design of SWF
(2) Rectification of SWF by increasing hump height
(3) Preparing discharge table of SWF.

2.2 Methodology



SECTIONAL VIEW

2.3 Design of Standing Wave Flume as per IS Code:

Step No 1: The Canal data viz design discharge, normal depth, cross sectional details of channel, bed slope, Mannings N ,upstream & Downstream canal bed level etc must be given in metric units.

Step No 2: Decide discharge range for which flume is to be designed (full to ½,Full to 1/3,Full to ¼ etc).

Step No 3: Assume Loss of Head 15% or 20 %.

Step No 4: First of all a stage discharge relation i.e. Q = c*d ^x is established for a given cross section by calculating the discharges for various depth of flows and calculating the value of X by the following formula.

X = S(Log Q . Log d) - ((S Log Q) (S Log d)/M)

S(Log d)^2 - ((S Log d)^2)/M

Where, d = Normal depth of flow in metric

Q = Discharge in cumec

M = No. of depths of flow considered

Step No. 5: Calculations of Height of Hump

The height of hump depends on the normal depth for the design discharge fraction of the design discharge considered in establishing the stage discharge relation.

Q = Cd^x and the exponent X, calculated from the above formula and is given by the following formula.

Z1 = DN . m^(1/x) *(1 - (1/m^(1/x) - 1)/(1/m^(2/3) - 1))

Step No. 6: Computation of Maximum Head (Hmax):

The gauge reading and maximum head for the design discharge are calculated as follows.

1. Area of flow corresponding to the normal depth of flow and design discharge

   A = B1*DN+Z*DN^2

2. Velocity of Approach

   VA = Design Discharge/Area of Flow

3. Approach Velocity Head = (Velocity of Approach)^2/15.2

4. Gauge Reading = Normal depth - Height of Hump

5. Maximum Head = Gauge Reading + Approach Velocity Head (Hmax)

Step No. 7: Computation of Throat Width:

The standing wave flume being a modified broad crested weir, the discharge equation is as follows.

Q = 2/3 * v2/3 g * CF*B2*H^1.5

Where Q = discharge in Cumecs

g = acceleration due to gravity

CF = Coefficient of function its value depends on the discharge Q

Knowing Qmax and Hmax, the throat width is calculated, by substituting the values of Qmax, Hmax, coefficient of discharge in the above equation.

The throat width is calculated using,

$$Q = 1.705 \quad Cf \quad B2 \; H_{max}^{3/2}$$

$$B2=Q/(1.705*Cf*H_{max}^{3/2})$$

Step No.8: Checks for throat width:

Whether $B_2 > 1.5\ H_{max}$

Fluming ratio i.e. $B_2/B_1 < 60\%$

Step No.9: Converging the inlet portion:

The radius of the bell mouth entrance is given as

R = 3.6 Hmax ^1.5 when Hmax > .3 m

R = 2 Hmax when Hmax < .3 m

Step No.10: The length of the converging section :

L1 = Sqrt(2R-B1-B2/2) (B1-B2)/2

Step No.11: The length of the Throat section & level of Hump:

L2 = 2.5 Hmax

The level of Hump = Upstream C.B.L. + Height of Hump

Step No.12: Length of Diverging Outlet Portion:

The length of diverging outlet portion is given as

L3 = 4 Hmax

Step No.13: Calculation of Diverging hyperbolic expansion:

The side walls of this portion are given hyperbolic expansion, to join the d/s channel for better function of flume. The width of the diverging section at a distance y from the throat is given by.

By = B1*B2*L3/B1*L3-(B1-B2)^y

Step No.14: Downstream CBL:

Level of Toe of Glacis = D/s C.B.L. = U/S C.B.L. - Loss of head (fraction)*Hmax

Step No 15: Sloping Glacis:

(1) The slope of glacis is fixed by the following considerations 1. When 4 Hmax > 20 height of hump above the toe of glacis. The provided slope of glacis is flatter than 1 in 20 where height of hump above the toe of glacis = Level of hump - D/S C.B.L.

(2) When 4 Hmax < 20 *(Height of hump above the toe of glacis) then for half the length of diverging portion a slope of 1 in 20 is provided. Beyond this a slope steeper than 1 in 20 is provided.

Step No 16: Location of Gauge Chamber & zero setting:

The gauge chamber is located at a distance of 4 Hmax upstream from the start of converging section. The zero of the gauge is at the sill level of the hump.

Step No 17: Preparing Discharge table:

$$Q = 1.705 \quad Cf \quad B2 \; H^{3/2}$$

Where Q = discharge in Cumecs

Cf = Coefficient of friction its value depends on the discharge Q

H= head

2.4 Evaluation & Improvement of Standing Wave Flume:

It is observed, in most of the cases, that Standing Wave Flumes are not hydraulically functioning properly due to some defects either, in construction or maintenance. If the hydraulics of the flume is disturbed, it gives incorrect discharge. It is, therefore, necessary to evaluate the performance of SWF periodically and identify the problems related to non-functioning of the same so that remedial measures can be taken to improve the performance. The procedure for evaluation and one case study for improvement is given below.

2.5 Procedure for Evaluation and Improvement of Existing Standing Wave Flume:

1) Obtain original drawing and discharge table of SWF.
2) Before releasing the water in the channel, take actual dimensions of all the components of the SWF and draw plan.
3) Take control levels from U/S to D/s, which should include U/s CBL, entry and exit levels of converging inlet, hump level at three locations, entry and exit levels of diverging outlet, D/s CBL, level of the zero of gauge.

4) Check whether there is any obstruction on d/s of flume for considerable length (like silting, rock out crop, bund, CR, bridge, CD work, etc.). Take details of the same i.e. distance, its afflux etc. Check whether the affluxed full supply level has been considered while designing the SWF. Sometimes some structures are added on the d/s after the SWF is constructed. This may result in affluxed water level, which increases the submergence of SWF, and thereby accuracy is affected.
5) Collect the details of the gauge chamber with reference to its location, physical condition, connecting pipes, scale, etc.(Gauge should be located at 4 h max. U/s of the flume)
6) Check zero setting of the gauge i.e. compare hump level and level of the zero of the scale in the gauge chamber. Actually they should be at the same level, if there is any difference, it will give incorrect discharge.
7) Compare actual dimensions with the design one particularly throat width, hump height and gauge location. If actual throat width is different than the designed width, same discharge table will give incorrect discharge. Similarly if gauge location is not correct, it will result into incorrect discharge.
8) Compare existing U/s and D/s conditions with the original one. Afflux due to silting or any other obstruction on D/s side results into increased submergence. Similarly, silting on U/s side reduces hump height, increases approach velocity and fluming ratio thereby increases submergence.
9) Verify original discharge formula and table i.e. whether correct discharge coefficients, actual throat width etc. have been used or otherwise?
10) After releasing water, observe formation of standing wave or hydraulic jump i.e. whether the jump is formed or not. Formation of standing wave indicates that flume is functioning well hydraulically i.e. it is under free flow condition. Take water level on U/s and D/s of the flume. Calculate depth of water above the hump on U/s and D/s. side calculate h1 & h2. Calculate actual submergence i.e. h2/h1. If actual submergence is more than 85%, the functioning of the flume is not proper i.e. it is under submerged condition and it will not give correct discharge.(discharge recorded is more than actual under submerged condition).
11) Read the discharge from the available table. If actual submergence is less than or equal to 85%, compare this discharge with the computed one using discharge equation of SWF, putting correct coefficient and actual throat width. If jump or wave is not seen and actual submergence is more than 85%, discharge measured is not correct. Rectify the defects and prepare new discharge table.

After evaluation, all the data and results are to be analyzed to find out defects/deviations so that remedial measures can be suggested, if necessary. Following are the common deviation/defects.

2.6 Common deviation / defects:

- Variation in throat width and height of hump
- Incorrect gauge location
- Difference between hump level and zero of the gauge
- Damaged gauge plate, silting in gauge chamber, and chocked pipes
- Non-availability of discharge table
- Non formation of hydraulic jump

The deviations/defects other than non-formation of hydraulic jump are easy to rectify and should be rectified immediately. However if hydraulic jump is not formed or it is very weak, it is necessary to improve the functioning by adopting remedial measure, so that jump is formed. Following remedial measures can be taken, in this case.

1. Removing slit and weeds from U/s and D/s so that required hump height is available.
2. Removing obstruction on d/s side e.g. balanced rock cutting, temporary bunding/crossing etc.
3. If obstruction on d/s side cannot be removed, increase humps height keeping throat width same which is economical and can be done within short time during closure period.

2.7 Preparation of Discharge Table:

If the flume is functioning properly i.e. hydraulic jump is formed and discharge table is not available, the same can be prepared using actual throat width.

2.8 Common Problems and Solutions

PROBLEM	SOLUTIONS
Non availability of discharge table	**Prepare new discharge table using Actual Throat Width (provided hydraulic jump is Formed)**
Gauge is not at proper location	**Water level from proper location be connected Gauge**

	Chamber through pipes .
Damaged gauge plate	**Repaint / Replace the gauge plate**
Zero setting not proper	**Correct the zero setting by shifting the gauge Plate**
Actual Throat width and Throat Width used in the discharge	**Prepare new discharge table using actual throat width Formula are not same (Provided jump is formed**

Thus the maintenance of the flume is neither difficult nor expensive. What is needed is careful observations and timely actions. Ignorance or lack of commitment or malafied intention for not keeping the proper water account results into non-maintenance and non-functioning of the device.

2.8 Design of SWF Based on Procedure in IS-Code

(This Procedure assumes provision of loss of head in canal)

Name of Project :		Jaikwadi					
Name of canal :		M-1 Dy -10 Of PLBC		Chainage :	60	Mtr	

DATA :

a)	Full Supply discharge (Qmax)		0.906	m^3/s	

		=				
b)	Full Supply Depth (d)	=	0.6	m		
c)	Bed Width of canal (B_1)	=	1.5	m		
d)	Canal side slope	=	2	:1		
e)	Canal bed slope (S)	=	1	in	2000	
f)	Manning Ruogosity Coeff (n)	=	0.02			
g)	u/s canal bed level	=	100	m		
h)	Gauge Interval For Discharge Table	=	0.01	m		
g)	Discharge range for which Flume is to be designed(1 to .25)	=	0.25	**Depth**	0.279942	**mtr**
h)	Loss of Head	=	15	%		

2.9 Data Collection

	PARAMETER		DATA	Units	

a)	Full Supply discharge (Qmax)		=	0.906	m^3/s	
b)	Full Supply Depth (d)		=	0.6	m	
c)	Bed Width of canal (B_1)		=	1.5	m	
d)	Canal side slope		=	2		
e)	Canal bed slope (S)		=	1	in	2000
f)	Manning Ruogosity Coeff (n)		=	0.02		
g)	u/s canal bed level		=	100	m	
h)	Gauge Interval For Discharge Table		=	0.01	m	
Step 2						
g)	Discharge range for which Flume is to be designed(1 to .25)		=	0.25	depth	0.2799
Step 3						
h)	Loss of Head			15	%	

2.10 Step 4: Calculations of X from Stage Dischagre relationship

Sr	d (m)	Q m^3/s	Log d	(Log d)^2	Log Q	Log Q x Log d
1	0.6	0.962	-0.2218	0.0492	-0.0167	0.0037
2	0.564438	0.853	-0.2484	0.0617	-0.0690	0.0171
3	0.528876	0.751	-0.2766	0.0765	-0.1243	0.0344
4	0.4933139	0.656	-0.3069	0.0942	-0.1829	0.0561
5	0.4577519	0.568	-0.3394	0.1152	-0.2454	0.0833
6	0.4221899	0.487	-0.3745	0.1402	-0.3123	0.1169
7	0.3866279	0.413	-0.4127	0.1703	-0.3843	0.1586
8	0.3510659	0.345	-0.4546	0.2067	-0.4625	0.2103
9	0.3155038	0.283	-0.5010	0.2510	-0.5482	0.2747
10	0.2799418	0.227	-0.5529	0.3057	-0.6431	0.3556
		Total	-3.6889	1.4708	-2.9886	1.3107

2.11 Introduction

M = Number of sets
= 10

To establish discharge relationship with respect to d

$Q = C \times d^x$

$$X = \frac{\sum(\text{Log Q} \times \text{Log d}) - \frac{\sum(\text{Log Q}) \times \sum(\text{Log d})}{M}}{\sum(\text{Log d})^2 - \frac{\sum(\text{Log d})^2}{M}}$$

X = 1.890

Step 5

Calculations of Hump height Z

Z = 0.082945 Mtr

Step 6

Rounding Z to next fraction

Z= 0.09 Mtr

Step 7

Calculation for Total head (Hmax) :

Velocity of approach (Va) = $\frac{Q}{A}$ = 0.5940 m/s

Approach velocity head (hv) = $\frac{(Va)^2}{15.2}$ = 0.023 m

At Qmax gauge reading
D = d - z = 0.510 m

Total head (H_{max}) = D + hv = **0.533 m**

Step8

Computation of Throat Width B_2 :

$$Q_{max} = \frac{2}{3}\sqrt{2 \times g}\ \frac{2}{3} \times C_f \times B_2 \times (H_{max})^{1.5}$$

Where, C_f = Coeff of friction

C_f	=	0.97	For Q =	0.05	to	0.3	m^3/s
C_f	=	0.98	For Q =	0.3	to	1.5	m^3/s
C_f	=	0.99	For Q =	1.5	to	15	m^3/s
C_f	=	1	For Q =	15	and above		m^3/s

Step 9

Condition 1: B2 should be at least 1.5 x Hmax

Minimum B_2 = 1.5 x Hmax = **0.79982** m

Throat width O.K.

Calculated B_2 = **1.39** **m**

Condition 2: B2/B1 should be less tha 60%

Designed B_2 = 0.9 m B2/B1= 92.89 %

B2 is reduced to 60% of bed width

Step 10

Calculations of Radious Of Bell mouth portion:

If $H_{max} > 0.3$ m, $R = 3.6 \times H_{max}^{1.5}$ **R= 1.40171**

or

If $H_{max} < 0.3$ m, $R = 2 \times H_{max}$

Step 11

L1 = Length of converging section

$$= \sqrt{\left[\quad\right]} \qquad = \left(2R - \frac{(B1 - B2)}{2}\right) \times \frac{(B1 - B2)}{2}$$

= **0.867 m** 2.503413208

Step 12

Design of Throat section

L_2 = Length of Throat section = $2.5 \times H_{max}$

L_2 = 1.33 m

Step 13

Design of diverging section

1) L_3 = Length of Diverging section = $4 \times H_{max}$

L_3 = 2.13 m

Step 14

Design of Fluming section (By)

$$B_y = \frac{B1 \times B2 \times L3}{(B1 \times L3) - (B1 - B2) \times Y}$$

Sr. No	Location	Width (B_y)
1	0 x L_3	**0.90**
2	0.25 x L_3	**1.00**
3	0.5 x L_3	**1.13**
4	0.75 x L_3	**1.29**
5	1 x L_3	**1.50**

Step 15

Down stream CBL

D/S CBL =U/S CBL - (Loss of Head x Hmax)

D/S CBL
= 99.92001762

Level of Hump =U/S CBL + height of hump

100.09

Step 16

Height Of hump Above toe of glacis

=Level of hump - D/S/ CBL

100.09	-	99.92001762	**0.16998238**	mtr

20 time of Height of hump above galcis		=	3.39965	mtr
4 H max	=4 X	0.533	=	2.13286 mtr

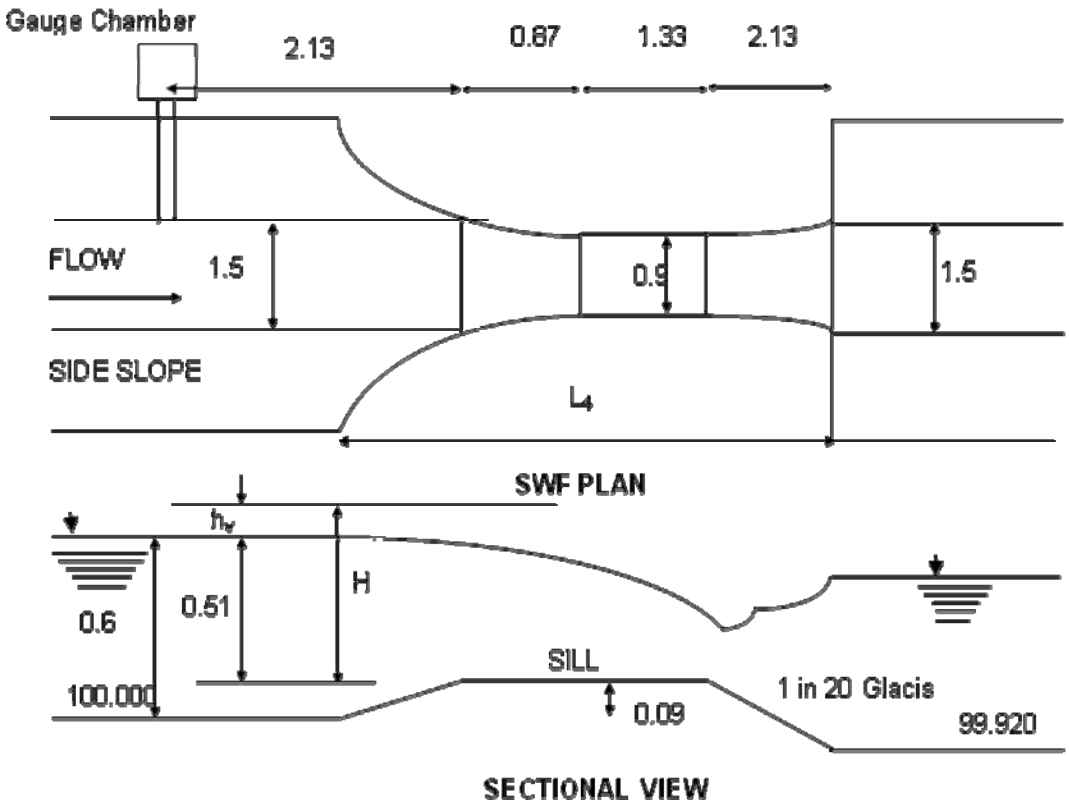
Drop provided in first half of glacis

2H max/20	0.05332159	mtr
Remaining level difference=	0.11666079	mtr

Step 17

Location of gauge chamber = 4 x H max

2.1328635 mtr



Gauge Reading (m)	Dichagre Cumecs	Gauge Reading (cm)	Dichagre Cumecs
00.100	00.052	00.480	00.535
00.110	00.060	00.490	00.552
00.120	00.068	00.500	00.568
00.130	00.076	00.510	00.586
00.140	00.085	00.520	00.603
00.150	00.094	00.530	00.620
00.160	00.103	00.540	00.638
00.170	00.113	00.550	00.655
00.180	00.123	00.560	00.673
00.190	00.133	00.570	00.691
00.200	00.144	00.580	00.710
00.210	00.155	00.590	00.728
00.220	00.166	00.600	00.747
00.230	00.177	00.610	00.765
00.240	00.191		
00.250	00.202		
00.260	00.215		

00.270	00.227		
00.280	00.240		
00.290	00.252		
00.300	00.265		
00.310	00.279		
00.320	00.292		
00.330	00.306		
00.340	00.320		
00.350	00.334		
00.360	00.348		
00.370	00.363		
00.380	00.377		
00.390	00.392		
00.400	00.407		
00.410	00.423		
00.420	00.438		
00.430	00.454		
00.440	00.470		
00.450	00.486		
00.460	00.502		
00.470	00.518		

2.12 Proforma

WALMI, AURANGABAD

PROFORMA

Evaluation and Improvement of flow measurement device(SWF)
Canal / Dy. / Minor: PLBC, Dy NO 10, MINOR NO 1
Project JAYAKWADI .
SWF at Ch.: 0/59
zate: 17/05/2008 .

Design details:

Type of canal (Lined/Unlined)- partial lined /unlined
Design details of canal
Capacity -0.906cumec=32cusec.
Bed Width -1.50m.
Side Slope-2:1
Full Supply depth-0.60 m.

Bed Slope -1 in 2000.
Manning's n =0.02.
Original design and drawing of SWF – Not available.
Discharge table of SWF -yes
Discharge equation used for preparing table –N.A
Whether Velocity head considered while preparing table?- N.A
Measurements and observations:
Distance from HR -59.70 m
Availability of straight and uniform reach on U/s and D/s-u/s 59.7 and D/s 100 m
U/s bed width (5 m U/s) -1-50 m
Converging section:
Length (L1) -1.00m
Width on U/s side.-1.50m
Throat:
Length (L2) -1.30 m
Width (m) -Avg width 0.90 m

	Bottom	Top
U/s end	0.87 m	0.91 m
Middle	0.91 m	0.91 m
D/s end	0.89 m	0.91 m

Diverging section:
Length (L3) - 2.10 m
Width on D/s side - 1.50 m
D/s bed width (5 m d/s) - 1.50 m
Guage chamber: No guage chamber
Location - nil
Size -nil
Silted or clear -nil
Condition of guage plate –painted wrongly and placed at start of converging section
No. of connecting pipes and dia - nil
Pipes silted or clear -nil
Details of Obstruction on D/s side:
Type of obstruction - Silt, weeds ,immediate turn
(Silt, weeds, bunding, CD work, rock, CR, etc.)
Location -D/S 85 m
Afflux - N. A
Reduced Levels:
U/s CBL (5 m U/s) -98.265 m
U/s TBL -99.325 m
U/s start of converging section – 98.310 m
Throat
U/s end -98.390 m
Middle -98.390 m
D/s end -98.390 m

D/s end of diverging section -98.250 m
D/s CBL (5 m D/s) -98.210 m
Zero of guage - -----
Intake pipes -
Formation of hydraulic jump - no formation of hydraulic jump
Water level:
– 5 m U/s –nil
– 5 m D/s -nil
Guage reading and discharge using available guage & table.
Physical condition of SWF structure.

2.13 Comparison

Particulars	Design Requirement	Actual	Variation
• Hump height	0.09m	0.04m	0.05m
• Throat width	0.90	0.90m	o.k
• Guage location	4 H Max=2.24m	Painted on converging section.	Gauge on wrong location.
• Availability of guage plate	Must required	-	
• Hydraulic jump	Must form	Not observed	Not observed.
• Fluming ratio	B2/B1=0.9/1.5 =0.6		
• Submergence ratio	H2/H1		
• Zero setting			
• Length of converging section	0.38m	1.00m	0.62m
• Length of Throat	1.33m	1.30m	3cm.
• Length of Diverging section	2.13m	2.10m	3cm.
• D/s obstruction	-	Immediate outlet,turn at 85m d/s.	
• Availability of Discharge table	Must be available	Yes.	
• Whether velocity head considered, while preparing	Yes		

discharge table?			

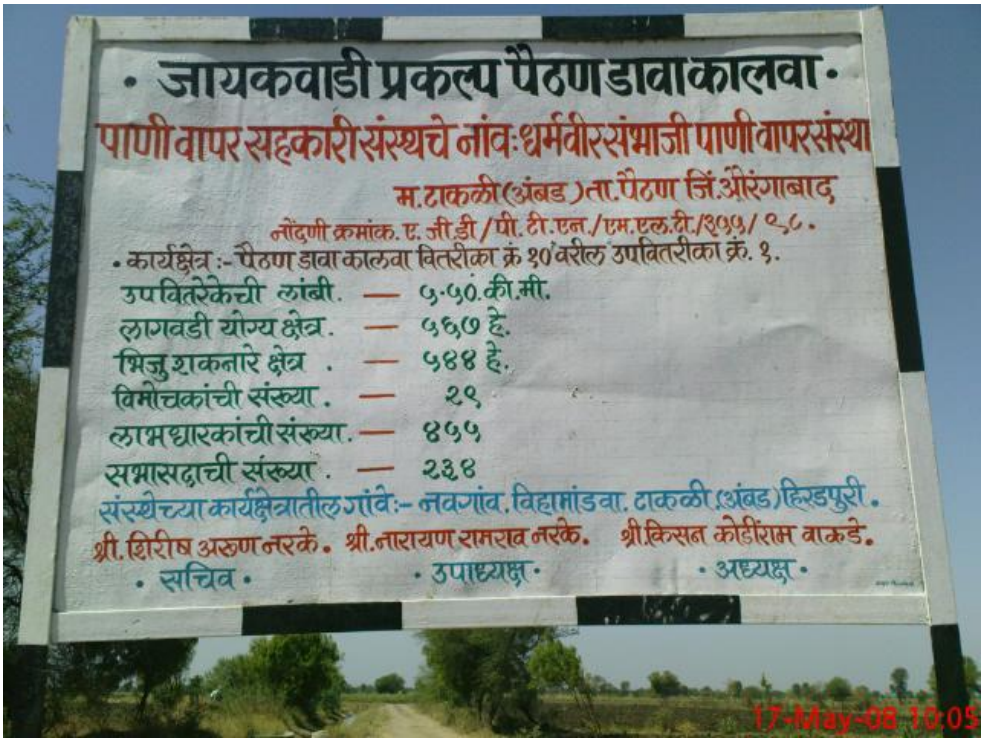
2.14 Problems / defects Identified:

- SWF not constructed according to I.S code design.
- Submerged flow condition due to heavy silt and weeds on the down stream side.
- Bed gradient in between chainage 0 to 0/100 is observed reversed.
- Location of gauge plate is not proper.
- Hump height is less than the designed hump height.

2.15 Remedial measures suggested:

- SWF should be constructed as per I.S code design.
- Silt and weeds on the down stream side and on up stream side up to H.R should be removed.
- Bed gradient should provide properly.
- Gauge plate must be provided at the distance 4Hmax from the start of the converging section.
- Hump should be constructed as per the design.

2.16 Photo Gallery

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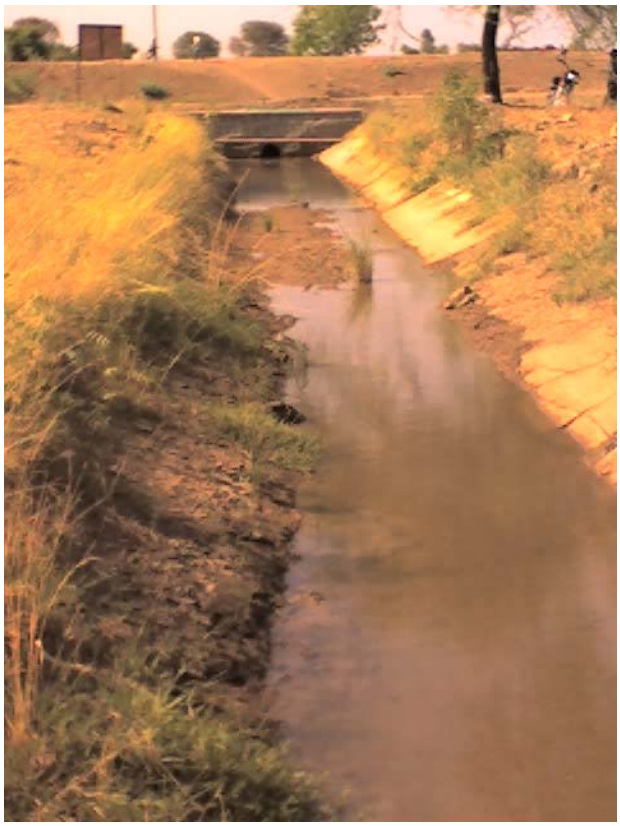



0·70
0·65
0·60
0·55
0·50
0·45
0·15

2.17 Conclusion

1. Maintenance of SWF & CANAL in which it is located should be carried out regularly for its proper functioning.
2. It should be ensured that the SWF is constructed according to its design.
3. Training should be imparted to the field engineers to maintain SWF properly.
4. To ensure proper maintenance, periodic inspection at suitable interval should be made.

2.18 References

1. "FLOW MEASUREMENTS IN IRRIGATION CANALS", 5th EDITION, PUBLICATION NO. 36
2. "METHOD OF MEASUREMENT OF FLOW OF WATER IN OPEN CHANNEL USING STANDING WAVE FLUME", IS CODE NO. 6063-1971
3. "SMALL HYDYAULIC STRUCTURE", FAO 26/2
4. "P.W.D. HANDBOOK VOLUME II SECTION IV-VIII", GOVERNMENT OF MAHARASHTRA

5. "MANUAL OF MINOR IRRIGATION WORKS, WRD", GOVERNMENT OF MAHARASHTRA

Chapter 3. On Farm System

3.1 Theory

- On Farm Development (OFD) it includes all the works below out let. There are two distinct part of it.
- The work of Field Channel which carries the water to a specific area, and in second part development of the area it self.
- Once we decided the criteria for chak, we have to study the CA and divide it into small pieces called Chak.
- Then according to the topography, the size, shape of Chak we have to decide the position of OL
- From OL alignment of FC is laid so that there will be minimum water loss and maximum area covered, with soil conservation aspect.
- As per alignment the FC is to be constructed with standard C/S and structures required as per the layout e.g. TO, Falls, Road Crossing, Escapes etc.

3.2 Salient Features

A)	**Chak No.**	**OL-3A**
B)	Chainage	1/350 m.
C)	C.C.A.	30.75 Ha.
D)	Chak Map	Attached Seperately.
E)	Structures	One Road Crossing.
F)	Gate	300mm Lift type.
G)	Condition Of Gate	Working Condition
H)	Measuring Devices	Not Existing.
I)	No. of Beneficiates	34 Nos.
J)	Field Channel Length	1020 m.
K)	Last Irrigation Rotation	HW 2007-08.
L)	No. Of Wells	2 Nos.
M)	R.W.S. Functioning	Yes.

3.3 Reconnaissance Survey and Observations

1. Outlet No. OL-3(A) of Minor No. 1 has 300mm dia. Pipe with a gate of size 300mm x 300mm. The head wall on U/S and D/S of Outlet are constructed in masonary (UCR) and found in good condition.
2. The section of FC for the whole length silted and more vegetation, bank work of FC is improper and is not uniform.
3. The regular irrigation is partly carried out through operation with outlet and the farmers taking water by breaching the earthwork of FC.
4. The existing bed gradient of FC is nearly about 1: 500 , the actual discharge carrying capacity of FC could not be observed due to non availability of measuring device.
5. Chak boundaries under OL-3(A) are verified and are well approachable by road.
6. The irrigation under OL-3(A) lies under the jurisdiction of Dharamveer Sambhaji WUA, Takli, Tal. Paithan, Dist. Aurangabad.
7. There are two open wells in the chak under the command of OL-3(A). Farmers do not use the well water for irrigation.

3.4 Field Channel Walk Through and Levelling

Sr. No.	Chainage	Reading			Rise	Fall	RL	Remark
1	0	1.550					100.000	Canal Bed Level at OR3 Add
2	30		1.625		0.000	-0.075	99.925	Channel in Embankment
3	60		1.710		0.000	-0.085	99.840	Channel in Embankment
4	90		1.770		0.000	-0.060	99.780	FC C/S widened
5	105		1.810		0.000	-0.040	99.740	Turn Out 1 structure doesn't exist
6	120		1.835		0.000	-0.025	99.715	
7	150		1.875		0.000	-0.040	99.675	Vegetation in FC

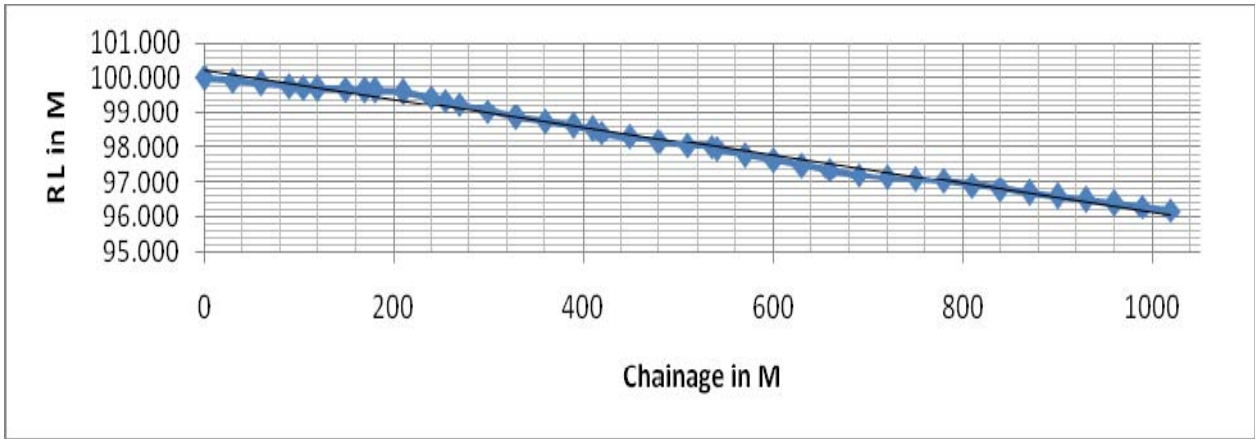
8	170		1.900		0.000	-0.025	99.650	Turn Out 2 structure doesn't exist
9	180		1.905		0.000	-0.005	99.645	Vegetation in FC
10	210		1.930		0.000	-0.025	99.620	Turn Out 3 structure doesn't exist
11	240		2.100		0.000	-0.170	99.450	FC C/S widened
12	255	1.320		2.200	0.000	-0.100	99.350	Turn Out 4 structure doesn't exist
13	270		1.420		0.000	-0.100	99.250	
14	300		1.615		0.000	-0.195	99.055	
15	330		1.800		0.000	-0.185	98.870	Turn Out 5 structure doesn't exist
16	360		1.910		0.000	-0.110	98.760	
17	390		2.025		0.000	-0.115	98.645	
18	410		2.130		0.000	-0.105	98.540	Turn Out 6 structure doesn't exist
19	420		2.255		0.000	-0.125	98.415	FC C/S widened
20	450		2.380		0.000	-0.125	98.290	Vegetation in FC

3.5 Field Channel Walk Through and Levelling

Sr. No.	Chainage	Reading			Rise	Fall	RL	Remark
21	480		2.505		0.000	-0.125	98.165	
22	510		2.630		0.000	-0.125	98.040	
23	535	0.860		2.650	0.000	-0.020	98.020	Turn Out 7 structure doesn't exist
24	540		0.935		0.000	-0.075	97.945	
25	570		1.085		0.000	-0.150	97.795	

26	600		1.240		0.000	-0.155	97.640	
27	630		1.390		0.000	-0.150	97.490	
28	660		1.540		0.000	-0.150	97.340	
29	690		1.685		0.000	-0.145	97.195	Turn Out 8 structure doesn't exist
30	720		1.750		0.000	-0.065	97.130	
31	750		1.810		0.000	-0.060	97.070	
32	780		1.860		0.000	-0.050	97.020	Turn Out 9 structure doesn't exist
33	810		1.980		0.000	-0.120	96.900	
34	840	1.200		2.080	0.000	-0.100	96.800	Turn Out 10 structure doesn't exist
35	870		1.300		0.000	-0.100	96.700	Tail Channel and escape to nalla
36	900		1.405		0.000	-0.105	96.595	
37	930		1.500		0.000	-0.095	96.500	
38	960		1.610		0.000	-0.110	96.390	
39	990		1.720		0.000	-0.110	96.280	
40	1020			1.825	1.720	-0.105	97.895	

3.6 L-Section of FC



3.8 Definition of Evaluation of Land Forming Works

It is the process of developing surface of land to a planned grade to provide better water application, drainage and soil conservation.

3.9 Purpose of Land Forming Techniques

- Uniform distribution of water over the field
- Economic use of water
- Draining of excess water, either from rain or from irrigation, without damage to the crops or soils.
- Uniform distribution of fertilizers along with irrigation water if necessary.
- Bringing some uncommanded portion under irrigation by moving soil to the lower elevations.
- Increasing yield and quality of crops incidentally.
- Obtaining better and more uniform plant population.
- Effecting saving of labour in all farming operations.

3.10 LAND FORMING is applicable to

1. FLAT LAND
2. IRRIGATED CROPS
3. MEDIUM TO DEEP SOILS
4. MEDIUM TO FINE SOIL TEXTURE
5. ADEQUATE WATER AVAILABLE
6. NO MUCH LOSS OF SOIL FERTILITY
7. BASIN, BORDER AND STRAIGHT FURROWS

3.11 LAND FORMING is not applicable to

1. SHALLOW SOIL DEPTH
2. COARSE SOIL TEXTURE
3. STEEP LAND SLOPES
4. HIGHER COST THAN SPRINKLER AND DRIP SYSTEMS
5. DRY LAND AGRICULTURE

3.12 LAND FORMING TECHNIQUES

A. LAND SMOOTHENING
B. LAND GRADING
C. LAND LEVELLING

3.13 LAND FORMING TECHNIQUES is based on

1. CROPING PATTERN
2. WATER AVAILABLE
3. METHOD OF SURFACE IRRIGATION

3.14 LAND FORMING PLANNING PROCESS

- SOIL SURVEY: SOIL TEXTURE & DEPTH
- CONTOUR SURVEY
- IRRIGATION DIRECTION
- EQUALIZER ALIGNMENT
- ALIGNMENT OF FARM DRAIN
- DECIDE IRRIGATION & CROSS SLOPE
-

3.15 CRITERIA FOR SUB DIVISION OF FIELD FOR LAND FORMING

SR.	Land Slope along Field Channel or Equalizer	Width of Sub field along the equilizer
1.	0.0 – 0.5	90 – 120
2.	0.5 – 1.0	60 – 90
3.	1.0 – 2.0	30 – 60
4.	2.0 – 3.0	15 – 30
5.	3.0 – 4.0	10 – 15

3.16 DESIRED SLOPE CRITERIA FOR LAND SMOOTHENING TECHNIQUE

Sr. No.	Soil Texture	Irrigation	Cross Slope
1.	COURSE	≤ 0.3	≤ 3.0
2.	MEDIUM	≤ 0.2	≤ 3.0
3.	FINE	≤ 0.1	≤ 3.0

(MAINLY USED FOR STRAIGHT RIDGES & FURROWS)

3.17 DESIRED SLOPE CRITERIA FOR LAND GRADING TECHNIQUE

Sr. No.	Soil texture	Irrigation	Cross slope, %
1.	COURSE	≤ 0.6	≤ 0.2
2.	MEDIUM	≤ 0.4	≤ 0.2
3.	FINE	≤ 0.3	≤ 0.2

(MAINLY USED FOR BORDER IRRIGATION)

3.18 Optimizing cuts and fill

- Earth Cut
- Earth Fill
- Earth Transport

Cut-fill Ratio (Compaction Factor)		
Sr. No.	**Soil Type**	**Cut-fill Ratio**
1.	Course Texture	1.1 – 1.2
2.	Medium texture	1.2 – 1.3
3.	Fine Texture	1.3 – 1.5

3.19 DESIGN OBJECTIVES

- Minimum quantity of soil handling
- Minimum distance of soil transport

3.20 DESIGN METHODS

- Uniform slope in direction of irrigation
- Uniform slope in both the direction
- Non uniform slope in both the direction
- Zero slope in both directions

3.21 Calculation for Land Smoothening Of Gat No. 486 of Village Vihamandva

(All other calculations are attached separately)

- Total Cutting (Excavation) = Sum of Cut X 10 X 10
  = 571 Cu.M.

3.22 Hence cost of Land Smoothening

- Area of Land to be Smoothened = 80 X 130
  = 10,400 Sq.m = 1.04 ha
- Assuming rate of cutting Rs.15/Cu.M
- Therefore Total Cost = 571 X 15
  = Rs. 8565/-

3.23 CONCLUSION

- The field channel alignment is proper.
- The FC is not maintained properly hence there are heavy losses.
- TO should be constructed and maintained properly.
- The equalizer should be constructed in N-S direction and furrows are to be E-W direction. These are shown on map

Chapter 4. Soil and Cropping System

4.1 Introduction

Soil survey is a procedure for the orderly examination & classification of soils in the field location of soil boundaries plotting them on a map.
Soil survey is essential as it provides detail information on soil condition in the command for evaluation & improvement of an irrigation system,

4.2 objective of soil survey

- To determine extent of irrigable area
- To determine overall land levelling needs.
- To determine drainage needs of specific soil types
- To determine land reclaimation needs of specific soil types
- To design irrigation scheduling programmes
- To determine suitable cropping pattern in project area

soil survey of PLBC –DY-10,M-1,OR-3 was conducted .
Survey no map of the command is used as a base map , soil texture is identified by surface field technique and is confirmed in lab by mechanical analysis

- During field exercise soil & water samples are collected & thereafter tested in laboratory.
- Interactions with farmers regarding existing cropping pattern

It is found that the textural classes are-

1. Clay – 31.26 %
2. Silt – 53.70 %
3. Sand - 15.02 %

Soil depth is varify by discussion with farmers and by observing wells from command area.
Depth of soil is 18 m
Dominant soil boundary is silt clay loam very deep
Soil samples for determination of physical & chemical properties collected by core method from 0- 30 cm depth
All physical & chemical properties are determined in lab; they are presented in table no 1
Field capacity, permanent wilting point, moisture content is determined by pressure plate apparatus

- The field capacity – 29.88%
- Permanent wilting point – 12.56 %
- Bulk density – 1.27 gm/cc

Available water capacity of soil is determined by following equation
Awc =((field capacity – permanent wilting point)/100)*
Bulk density * soil depth
= ((29.88-12.56)/100) * 1.27 * 100
= 21.99 cm/m
= 219.9 mm/m

4.3 Fertility status of soil

It is determined in lab by IARI soil testing kit

- Nitrogen content in soil is low
- Phosphorus content in soil is low
- Potassium content in soil is very high

4.4 Salinity

Electric conductivity of soil is determined by conductivity bridge method
It is 0.35 mMhos/cm

4.5 Sodicity

Sodicity
It is determined by PH meter and it is 7.93

4.6 TABLE NO 1: Determination of soil irrigability class

Sr No	Soil characteristic	Credit allotted	Observed Soil properties	Irrigability Classes	Marks to irritability classes	Total marks earned
1	Effective. Soil depth	5	More than 90 cm	A	5	**25**
2	Dominance soil texture	5	Silty clay	B	4	**20**
3	Available water capacity	5	219.9 mm	A	5	**25**
4	Salinity	3	0.35 mMhos/cm	A	5	**15**
5	Sodicity	3	7.93	B	4	**12**
6	Coarse fragment	3	Approx.10 %	B	4	**12**
7	Erosion	3	1 %	A	5	**15**
TOTAL		27	TOTAL			124

Aggregate index = (total marks earned/ total credit alloted)
= (124/27)
= 4.59

Soil irrigability classes
Aggregate index- 5-4 =A
Aggregate index- 4-3 =B
Aggregate index -3-2 =C
Aggregate index- 2-1 =D
Aggregate index-<1 =E
SO IRRIGABILITY CLASS OF THE SOIL IS =A

This means soil has none to slight limitation under sustained use under irrigation

4.7 LAND IRRIGABILITY CLASS

Sr. no.	Soil characteristics	Land classification					
		I	II	III	IV	V	VI
1	Soil irrigability class	A	AB	ABC	ABCD	Temp-orarily undeci-ded	More than 15
2	Topography (% slope)	<1	1-3	3-5	5-10	10-15	>15
3	Depth to ground water table	More than 3	2-3	1-2	<1	-	-

Soil irrigability class is - A
% slope is - 1%
Depth of ground water table – below 3 m
For the above land land irrigability class – II
This means moderate soil limitations for sustained use under irrigation

4.8 Quality of Water

Water source	PH	Ec mmhos/cm	CO3 meq/lit	HCO3 meq/lit	Ca+Mg meq/lit	Na meq/lit	RSC meq/lit	SAR
Dug well	7.76	0.24	1.15	1.7	1.9	2.17	0.95	2.2
Canal	7.90	0.14	1.10	2.20	2.10	1.96	1.20	1.92

From the above table it is clear that water from the command area is safe for irrigation purposes.

4.9 Values

- Soil from command area is medium in texture
- Soil from command area is very deep
- Available water content of soil is more than 21 cm
- Depth of ground water table is more than 3 m
- Soils are rich in available potassium content
- Soils are free from salinity and sodicity problem
- Quality of water is good for irrigation

4.10 Constraints

- Soils from command area are low in available phosphorus and nitrogen content
- Moderate soil limitation under sustained soil irrigation.

4.11 Recommendation

1. soils from command area are very deep and medium texture. To maintain physical properties of soil and fertility status, ph of soil farmers should apply recommended doses of organic manures to sustain the crop production and crop growth.

2. To get optimum yields of the crop farmers should increase 25 % more recommended doses of phosphorus and nitrogen and may reduce by 25% recommended doses of potassium.

Crop Survey

4.12 Objective of crop survey

- To evaluate the performance of various crops w.r.t. existing soils & availability of water in the command area
- To study existing package of different crop followed by farmers
- Assessment of crop yields

4.13 Name of Crop: Sugarcane (Pre-seasonal)

Sr. No	Particulars	Farmer's Practices	Recommended Practices
01	Varieties used	Co-86032	Co-86032,94012,VSI-434,
02	Date of sowing	November	November
03	Seed rate (kg/ha)	25000 three eye Budded setts	25000 three eye Budded setts
04	Spacing (cm)	90	90
05	Method of sowing	Planting	Planting
06	Plant population (/ha)	120000	100000
07	Fertilizers used(Kg.NPK/ha)	125:325:325	350:170:170
08	Method of fertilizer application	Placement	Placement
09	Organic Manures used(q/ha)	10.0	20.0
10	No. of irrigations	20	20-25
11	Method of irrigation	Ridges and furrows	Ridges and furrows
12	Irrigation interval	25 days	15-20 days
13	Crop yield (t/ha)	65	90

Values:

1. Date of sowing, seed rate and spacing used by the farmers was appropriate.
2. Method of irrigation and no. Of irrigation was appropriate.

Constrains:

1. Organic and inorganic manure supplied were inadequate.

4.14 Name of Crop: Wheat

Sr. No	Particulars	Farmer's Practices	Recommended Practices
01	Varieties used	HD(M)2189,G-496	HD-2189,2489,Lok-1,DWR-162
02	Date of sowing	November	November
03	Seed rate (kg/ha)	125	100-125
04	Spacing (cm)	20.5	22.5
05	Method of sowing	Drilling	Drilling
06	Plant population (/ha)	2000000	1600000-2000000

07	Fertilizers used(Kg.NPK/ha)	27:69	150:50:50
08	Method of fertilizer application	Broad casting/Drilling	Drilling
09	Organic Manures used(q/ha)	2.0	10.0
10	No. of irrigations	5	6
11	Method of irrigation	Border	Border
12	Irrigation interval	21 days	21 days
13	Crop yield (t/ha)	16.0	30.0-35.0

Values:

1. Date of sowing was correct,
2. Method of irrigation was appropriate.

Constraints:

1. Use of organic and inorganic fertilizer was less,
2. No. Of irrigation given were inadequate,
3. Seed rate used was high.

4.15 Name of Crop: Gram

Sr. No	Particulars	Farmer's Practices	Recommended Practices
01	Varieties used	Kabuli,vijay,local	Vijay ,virat,PKV-Kabuli-2 Phule-G-5
02	Date of sowing	December	November
03	Seed rate (kg/ha)	50	70
04	Spacing (cm)	45x15	45x15
05	Method of sowing	Drilling	Drilling
06	Plant population (/ha)	150000	150000
07	Fertilizers used(Kg.NPK/ha)	6.25:16.5:16.5	25:50
08	Method of fertilizer application	Drilling	Drilling
09	Organic Manures used(q/ha)	1.5	5.0
10	No. of irrigations	2	3-4
11	Method of irrigation	Border	Border
12	Irrigation interval	30 days	25-30 days
13	Crop yield (t/ha)	3.75	20.0

Values

1. Method of sowing and irrigation was appropriate.

Constraints:

1. Date of sowing was late,
2. Seed rate used was less,
3. Use of organic and inorganic fertilizer was inadequate.

4.16 Name of Crop: Cotton

Sr.No	Particulars	Farmer's Practices	Recommended Practices
01	Varieties used	B.T-Banni	H-10,NHH-44,B.T-Rashi,Banni
02	Date of sowing	June	June
03	Seed rate (kg/ha)	1.9	2
04	Spacing (cm)	120x90	120x90
05	Method of sowing	Dibbling	Dibbling
06	Plant population (/ha)	9260	10000
07	Fertilizers used(Kg.NPK/ha)	37.5:37.5:37.5	100:50:50
08	Method of fertilizer application	Ring Method	Ring Method
09	Organic Manures used(q/ha)	1.0	15.0
10	No. of irrigations	5	5
11	Method of irrigation	Ridges and furrows	Ridges and furrows
12	Irrigation interval	20 days	20 days
13	Crop yield (t/ha)	20	25.0-30.0

Values:

1. Date of sowing, seed rate and spacing used by the farmers was appropriate,
2. No. Of irrigation and method of irrigation was also correct.

Constraints:

1. Use of organic and inorganic manure was inadequate.

4.17 Designed crop pattern for Jayakwadi project and Existing cropping pattern of Dharamveer water users society, Navgaon (Dy.No.10, Minor No.1) PLBC, Jaykwadi Project.

Sr.No	Crops	Designed Percent Area	Existing Percent Area
I	KHARIF SEASONAL		
1	Bajara	12.00	46.00
II	RABI SEASONAL		
2	Wheat	25.00	39.00
3	Jawar	15.00	5.29
4	Gram	5.00	1.45
III	TWO SEASONAL		
5	Cotton	25.00	9.00
6	Tur	-	2.00
IV	H.W.SEASONAL		
7	Bajara	-	5.43
8	Fodder	-	3.62
9	Ground-nut	3.00	2.00
10	Maize (grain)	-	1.00
V	PERENNIALS		
11	Sugarcane	31.00	43.50
	TOTAL	116.00	158.29
	CROPPING INTENSITY	116.00%	158.29%

From above table it is clear that designed cropping intensity was 116.00% and existing cropping intensity is 158.29%.

4.18 Conclusion

- Overall cropping intensity under existing cropping pattern has been up to 158.29% which was 116% in the design crop pattern.
- The area under the crops namely Wheat ,Kharif-Bajara, Groundnut,Maize has been significantly increased.
- This may be because of adequate availability of water
- Application of water user association

५.१ प्रस्तावना :-

जायकवाडी पाटबंधारे प्रकल्प अंतर्गत पैठण डावा कालव्याच्या वितरीका क्रमांक १० लघुवितरीका १ वरील पाणी वापर संस्थेचे मूल्यमापन दि.१६ व १७ मे,२००८ रोजी प्रत्यक्ष कार्यक्षेत्रावर जाऊन संस्थेचे चेअरमन व सभासद यांचे समवेत चर्चा करुन करण्यात आले. सदरचे मूल्यमापन श्री.तु.स.गायके,सहाय्यक प्राध्यापक,वाल्मी, औरंगाबाद व वरील प्रशिक्षणार्थी यांचे उपस्थित करण्यात आले.

५.२ मूल्यमापनातील बाबी :-

मूल्यमापना साठी प्रश्नावली तयार करण्यात आली आहे.

पाणी वापर संस्थेचा अभ्यास

(वितरीका क्रमांक १० वरील लघुवितरीका क्र. १ ची माहिती)

अ) सर्व साधारण माहिती

१) संस्थेचे नांव :- श्री धर्मवीर संभाजी पाणी वापर संस्था मर्यादित, टाकळी अंबड

२) संस्थेचा पत्ता :- टाकळी अंबड ता.पैठण जि. औरंगाबाद.

३) संस्थेचा नोंदणीचा दिनांक :-

४) संस्था हस्तांतरण केल्याचा दिनांक :- ६/३/२००६

५) संस्थेच्या अध्यक्षांचे नांव :- श्री.किसन कोंडिराम वाकडे

पत्ता :- टाकळी अंबड ता.पैठण जि. औरंगाबाद.

६) संचालक मंडळाची संख्या :- ११

७) प्रकल्पाचे नांव :- जायकवाडी प्रकल्प (नाथसागर),पैठण

८) मुख्य कालवा :- डावा

९) मुख्य कालव्यापासून संस्था २१ ते २२ किलोमीटरमध्ये येते.

१०) वितरिकेपासून मायनर पर्यंतचे अंतर :- २७० मीटर.

११) मायनरची लांबी किलोमीटर :- ५.५० की. मी.

१२) मायनरचा (डिझाइनड) विसर्ग :- ३२ क्यूसेक्स.

१३) या मायणरमधुन नेहमी मिळणारा प्रत्यक्ष विसर्ग :- २० क्यूसेक्स.

१४) एकूण विमोचकांची संख्या :- २९.

१५) संस्थेचे एकूण कार्यक्षेत्र :-

१. लागवडी योग्य ५६७ हेक्टर.

२. सिचंन योग्य ५४४ हेक्टर.

१६) एकूण लाभधारक ४५५.

एकूण सभासद २३४ पैकी ५१ जनांचे शेअर्स आहेत.

१७) निवडणूका नियमितपणे झाल्या आहेत.

१८) भाग भांडवल जमा रु. २६०१/-

१९) प्रत्येक हंगामात संस्थेला पाण्याचे किती पाणी पाळया (रोटेशन) मिळाले.

(१ unit = १००० m^3)

अ.क्र.	**वर्ष हंगाम**	**हंगाम निहाय पाण्याचा मंजूर कोटा**	**प्रत्यक्ष वापरलेले पाणी**	**संस्थेला मिळालेले रोटेशन**	**संस्थेला मिळालेले हंगाम निहाय पाणी**
	मागील १ वर्ष	unit	unit	Nos.	Unit
१	खरीप २००७-०८	५६७	११०	१	११०
२	रब्बी २००७-०८	२०२४	७००	४	७००
३	उन्हाळी २००७-०८	५६७	३००	४	३००

२०) शासनातर्फे संस्थेला मिळालेली अनुदाने :-

अ.क्र.	वर्ष	व्यवस्थापकीय अनुदान(रु.)	देखभाल दुरुस्ती अनुदान(रु.)	देखभाल दुरुस्तीवर प्रत्यक्षात केलेला खर्च (रु.)*
१	२००७-२००८	-----	-----	१,२०,०००/-
२	२००६-२००७	-----	-----	१,००,०००/-
३	२००५-२००६	-----	-----	१,००,०००/-
४	२००४-२००५	-----	-----	-----
५	२००३-२००४	-----	-----	-----

* देखभाल दुरुस्तीवर प्रत्यक्षात केलेला खर्च संस्थेने स्वत: केलेला आहे.

२१) संस्थेच्या लाभक्षेत्रातील विहिरीचीं संख्या

अ.क्र.	विहिरीचा प्रकार	संस्था स्थापनेपूर्वी संख्या	संस्था स्थापनेनंतर संख्या
१	हंगामी विहिरी	२	------
२	बारमाही विहिरी	८	------

२२) संस्थेच्या लाभक्षेत्रातील पिक रचने संबंधी माहिती

अ.क्र.	हंगाम	पूर्वीची पिके	नंतर पिके
(अ) सोसायटी पूर्वी / नंतर	उन्हाळी २००७	ऊस,ज्वारी	गहु,हरभरा,कापूस, भूईमुग,बाजरी,पडवळ
	खरीप २००७		
	रब्बी २००७		

२३) संस्थेच्या प्रगतीचा वार्षिक आलेख.

अ.क्र.	तपशिल	स्थापनेवेळी	२००७-२००८	शेरा
१	सभासद संख्या	५१		
२	वसूल भाग भांडवल	२६०१/-		
३	वार्षिक नफा	------		
४	वार्षिक उलाढाल	३,००,०००/-		
५	पाणी पट्टी आकारणी (शासनातर्फे)			
६	पाणी पट्टी आकारणी संस्थे तर्फे लाभधारकानां)			
७	पाणी पट्टी वसूली			
८	संस्थेला ५ टक्के सूट (मिळाली असल्यास)			
९	संस्थेचा खर्च			
१०	ऑडिट वर्ग			

संस्थेबाबत इतर अनुषंगिंक बाबी.

१. संस्था सुरु झाल्यानंतर ए.आय./डी.सी. (हे./द.ल.घ.मी.)वाढली आहे काय ? **होय.**

२. रब्बी हंगामात पाणी वाचवून तुम्ही ते उन्हाळी हंगामात वापरता काय? **होय.**

३. संस्था स्थापनेनंतर आतापावेतो आपली सभासद संख्या वाढली आहे काय? **नाही.**

४. संस्था सद्या आर्थिक दृष्टया फायदयात आहे काय? **नाही.**

५. संस्थेचा हिशोब व नोदीं नियमितपणे ठेवल्या जातात काय? **होय.**

६. संस्था पाटबंधारे खात्याकडे वेळेवर नियमीतपणे पाणीपट्टीचा भरणा करुन ५ टक्के सूट मिळविते काय? **नाही.**

७. संस्थेच्या वार्षिक सर्वसाधारण सभा तसेच संचालकांच्या सभा योग्य त्या वेळी नियमितपणे होतात काय? **होय.**

८. संस्थेचे लेखा परीक्षण व तपासणी (सहकार खात्यामार्फत) आतापर्यंत नियमित झाली आहे काय ? **होय.**

९. संस्थेमुळे कालवा आणि विहिरीच्या पाण्याचा संयुक्त वापर वाढला आहे असे आपणास वाटते काय? **होय.**

१०. संस्थेने कांही नवीन उपक्रम हाती घेतले आहेत काय? **नाही.**

११. संबंधीत पाटबंधारे/कडा मधील अधिकारी व लाभधारक यांच्यामधील एक दुवा म्हणून कार्य करण्यात आपली संस्था यशस्वी झाली आहे काय ? **होय.**

१२. या पुढे भविष्यात पाणी वापर संस्थेची नोंदणी पाटबंधारे खात्याकडे करणे योग्य राहील असे आपले मत आहे काय ? **होय.**

१३. संस्थेला घनमापन पध्दतीने खात्यातर्फे दिल्या जाणा-या पाण्याचा कोटा पुरेसा आहे असे आपणास वाटते काय ? **होय.**

१४. नाही असल्यास त्यात सुधारणा करावी काय ? **होय.**

१५. आपल्या जवळपास पाणी वापर संस्था स्थापन व्हाव्यात यासाठी आपण काही प्रयत्न करता काय ? **होय.**

पाणी वापर संस्था : संस्थात्मक बाबी

१) पाणी वापर सहकारी संस्था झाल्यानंतर सिचंनाच्या क्षेत्रात वाढ झाली आहे काय ? **होय.**

२) पाणी वापर सहकारी संस्था स्थापनेनंतर पीक पध्दतीमध्ये बदल झाला आहे काय ? **होय.**

३) संस्था स्थापनेनंतर शेतचा-यांची देखभाल व दुरुस्ती संस्थेमार्फत प्रत्येक हंगामाच्या सुरुवातीस केली जाते काय ? **होय.**

४) संस्थेमार्फत लघु वितरीकेची (मायनर) देखभाल व दुरुस्ती नियमितपणे केली जाते काय ? **होय.**

५) संस्थेमुळे सभासदामध्ये सहकार्याची तसेच समजोतीची भावना वाढली आहे काय ? **होय.**

६) संबंधीत पाटबंधारे / कडा मधील अधिकारी व लाभधारक यांच्या मधील एक दुवा म्हणून कार्य करण्यात आपली संस्था यशस्वी झाली आहे काय ? **होय.**

७) संस्थेमुळे आपले कोणकोणते फायदे झाले ते सांगावेत. : **टेल पर्यंत पाणी पोहोचते. पाणी वेळेवर मिळाल्याने शेती उत्पन्न क्षमता वाढल्याचे आढळले.**

८) संस्था चांगली चालविण्यासाठी स्थानिक नेतृत्वाचे योगदान आहे काय ? **होय.**

९) महिला संचालक संस्थेच्या समितीमध्ये आहेत काय ? **होय.**

१०) संस्थेचे सचिव नेमलेले आहेत काय ? **होय.**

५.३ वितरीकेवरील पाणी वापर करणा-या शेतक-यांशी खालील मुध्दयावर चर्चा केली.

१ पाणी टेल पर्यंत मिळते का ?

टेलचे शेतकरी श्री.पिराजी मोरे, OL४ यांच्याशी चर्चा करता लघुवितरीकेच्या ५.५ कि.मी. एकूण लांबी पैकी पाणी वापर संस्थेकडे हस्तातंरणापूर्वी अंदाजे २.५ कि.मी. लांबी पर्यंत पाणी मिळत होते.परंतु पाणी वापर संस्थेकडे हस्तातंरण झाल्या नंतर अंदाजे ४.५ कि.मी.लांबी पर्यंत पाणी मिळते त्यामुळे भिजणा-या क्षेत्रात वाढ झालेली आहे.

२. पिकामधील झालेले बदल .

पाण्याच्या उपलब्धतेनुसार पीक रचना सभेत ठरवली जाते. हस्तातंरणापूर्वी ऊसाचे क्षेत्र मोठया प्रमाणात होते परंतु हस्तातंरणानंतर त्यात घट झालेली आहे.याची कारणे खालीलप्रमाणे आहेत.

a. मागील दोन वर्षात ऊस कारखाने पूर्ण ऊस नेऊ शकलेले नाहीत.
b. ऊसाचा दर व त्यामुळे मिळणा-या उत्पन्नात घट झालेली आहे.

३ पाण्याचा अपव्यय टाळला जातो का ?

शासन लघु वितरीकेच्या मुखाशी पाणी मोजून देते व त्यावरच पाण्याची आकारणी होते. त्यामुळे पाणी वापर संस्था पाण्याचा अपव्यय होणार नाही याची दक्षता घेते. त्याकरीता रात्र पाळीत गस्त घालणे, शेतक-यानां पाणी नाश करणेपासून परावृत्त करणे इत्यादी बाबी केल्या जातात.

४. पाणी वापर संस्थेस विरोध आहे का ?

काही शेतक-यानी सुरवातीस पाणी वापर संस्थ्रेस प्रखर विरोध केला. त्यानंतर ठरावीक शेतक-यानां वाल्मी, औरंगाबाद येथे प्रशिक्षणास पाठविण्यात आले.त्यांचे प्रशिक्ष्णानंतर पूर्ण मत परिवर्तन झाले व आज ते पाणी वापर संस्थेमध्ये सक्रीय आहेत.

५. लघुवितरीकेच्या कि.मी.४.५ ते ५.५ मध्ये पाणी जात नसल्याने त्यातील शेतकरी कोणते पीक घेतात ?

शेतकरी खरीप हंगामानंतर रब्बी गहू पेरतात व हेडमधील शेतक-यांचे ऊसाचे प्रमाण कमी झाल्याने त्यानां पाणी कमी लागत असल्याने गव्हासाठी पाणी उपलब्ध होते. कि.मी.४.५ ते ५.५ मध्ये शेतकरी रब्बी गहूच पेरतात व एखाद दुसरं पाणी मिळाल्यास त्यावर पीक घेतात.

६. लघु वितरीकेमध्ये काही ठिकाणी कचरा पडला असून जाणे येणेसाठी लोकानी वाटा केल्या आहेत.

पाणी वापर संस्था व काही शेतकरी हे लघु वितरीकेमधील कचरा काढण्यास लोकानां विनंती करतात व उपलब्ध असणा-या एका मजुराकडून काहीप्रमाणात लघुवितरीका स्वच्छ ठेवण्याचा प्रयत्न करतात.

७. शेतक-यामध्ये पिके घेण्याबाबत उदासिनता का आहे?

ज्यावेळी शासनामार्फत लघुवितरीकीचे नियोजन व व्यवस्थापन होते त्यावेळी सात दिवस पाणी मिळायचे व चौदा दिवस पाणी बंद असायचे.त्यावेळी भुईमुगासारखी पिके उत्तमरित्या घेतली जायची व शेतक-यानां चांगले पैसे मिळायचे. परंतु आता महिन्यातून एकदा पाणी मिळत असल्यामुळे पिकांचा उतारा कमी मिळू लागला आहे.विशेष पैसे मिळत नसल्यामुळे शेतक-यामध्ये पिकाबाबत उदासिनता दिसून येते.

५.४ वितरिकेवरील पाणी वापर करणा-या संस्थेचे चेअरमन यांचेशी खालील मुद्यावर चर्चा केली.

१. **शेतक-यांच्याकडून पाणीपट्टी वसुल होते का ?**

पाणीपट्टी वसुलीत थोडा वेळ लागतो परंतु वसुली होते.काही शेतकरी पैठण व इत्यादी दूरच्या ठिकाणी रहातात त्यामुळे वसुलीत अढथळे येतात.

२. **दुरुस्तीची कामे कोण करतात व त्याचे आर्थिक नियोजन काय ?**

दुरुस्तीचीकामे पाणी वापर संस्थेने स्वखर्चाने केलेली आहेत. व त्याचे अनुदान शासनाकडून पाणी वापर संस्थेस अद्याप मिळालेले नाही.

३. **संस्थेकडे पाणीपटटी थकबाकी आहे काय ?**

शासनाचे धोरणानुसार १००% पाणीपटटी शासनाकडे भरलेनंतर त्यातील ५०% रक्कम शासन संस्थेस परत करते. परंतु संस्थेचे म्हणणे आहे की, मिळालेल्या पाणी पटटीतूनच संस्थेचा खर्च उदा: कर्मचारी खर्च, वसुली खर्च इत्यादी केला जातो. त्यामुळे संस्था १००% पाणीपटटी भरुच शकत नाही. तसेच काही संस्थांनी दोन हंगामाची १००% पाणीपटटी भरुन सुध्दा अद्याप ५०% रक्कम परत शासना कडुन मिळालेली नाही. त्यामुळे शासनाने संस्थेकडून ५०% पाणीपटटीचीच रक्कम भरुन घ्यावी असे संस्थेचे म्हणणे आहे. त्यामुळे संस्थेने अद्याप पाणी पटटी भरलेली नाही त्यामुळे संस्थेकडे पाणीपटटीची थकबाकी आहे.

४. **वेळेवर पाणीपटटी भरलेनंतर शासन ५% रिबीट देते ते संस्थेस मिळाले आहे काय ?**

मागील हंगामाची पाणीपटटी वेळेवर भरुन सुध्दा शासनाने अद्याप ५% रिबेटची रक्कम परत दिलेली नाही.

५. **संस्थेचा खर्च कोणकोणता आहे ?**

संस्था पाण्याच्या आवर्तना वेळी कर्मचारी रोजंदारीवर घेते, पाणीपटटी वसुलीसाठी विविध ठिकाणी फिरण्यास खर्च होतो, स्टेशनरी तसेच विमोचकांना लावणेसाठी कुलूप इत्यादी बाबींवर संस्थेचा खर्च होतो.

६. शासकीय अधिका-याकडून सहकार्य मिळते काय?

शासकीय अधिका-याकडून पूर्ण सहकार्य मिळते. शासकीय अधिका-यांनी संस्थेच्या अध्यक्षाच्यां बैठका घेऊ संस्थेच्या अडचणी समजावून घ्याव्यात तसेच संस्थेच्या पत्रानां शासकीय अधिका-यानी प्रतीसाद दयाव्या अशी संस्थेची विनंती होती. तसेच संस्थेची नोंदणी सहकार्य खात्याऐवजी पाटबंधारे खात्याकडे करणेत यावी.

७. पाणी पट्टीची आकारणी कशी केलेली आहे ?

संस्थेने हंगामवार वेगवेगळया दराने पाणी पट्टीची आकारणी केलेली आहे. शेतक-यानी पूर्ण हंगामाऐवजी एक किंवा दोन पाणी गरजे प्रमाणे घेतल्यास त्याप्रमाणातचं पाणी पट्टीची आकारणी केली जाते. विहिरीवरील सिंचन क्षेत्रासाठी सुध्दा पाणी पट्टीची आकारणी केलेली आहे. परंतु अदयाप वसुली झालेली नाही.

५.५ वितरिकेवरील शासकीय अधिका-यांशी खालील मुद्यावर चर्चा केली.

१) पाणी पट्टीवसुलीत वाढ झाली आहे का ?

वितरिकेच्या हस्तातंरानंतर पाणी पट्टी वसुलीत थोडी घट झालेली आहे.परंतु संस्था नवीन असल्यामुळे ही घट दिसून येते. भविष्यात वसुलीत हळूहळु वाढ होईल.

५.६ निष्कर्ष :

१. पाणी वापर संस्थेकडे वितरिका हस्तांतरीत झाल्यानंतर पाण्याचा अपव्यय कमी झालेला आहे. त्यामुळे सिंचन क्षेत्रात वाढ झालेली आहे.

२. लोकांनीच पाणी वाटपाचे व्यवस्थापन करावयाचे असल्याने चांगल्या पध्दतीने पाणी वाटप होते.

३. टेल ते हेड सर्व शेतक-यांना पाणी मिळण्याची हमी मिळली आहे त्यामुळे शेतकरी पिकांची निवड करु शकतात.

४. भविष्यात शासनाच्या व्यवस्थापन खर्चात बचत होणार आहे.

५. शेतक-यांकडून वितरीकेची देखभाल चांगल्या प्रकारे होते.

६. वितरीकेची पुरेशा प्रमाणात दुरुस्ती झालेली नाही. दुरुस्तीची कामे पूर्ण झाल्यानंतर पुर्ण लांबीत पाणी जाऊ शकते.

७. एकंदरीत ही पाणी वापर संस्था भविष्यात एक यशस्वी पाणी वापर संस्था होईल यात मुळीच शंका नाही.