DIASATOR MANAGEMENT PLAN & EMERGENCY ACTION PLAN

7.1 Dam Break Analysis and Flood Plain Mapping

7.1.1. Introduction

The dams are national property constructed for the development of national economy and in which large investments and other resources are deployed. The safety of the dams is very important aspect for safeguarding the national investment and the benefits derived by the nation from the project.

The study of catastrophic flooding that may occur in the event of a dam failure is of great concern and importance because of the risk of life and property in the potentially inundated reaches below the structure. Some of recent disasters have focused attention on the requirement of conducting needful analysis of such cases, however remote they may be, in order to asses probable damage due to dam break. It is necessary to predict not only the possibility and mode of dam failures, but also the flood hydrograph of discharge from the dam break and the propagation of the flood waves. The studies will have to identify the inundated area, flood depth, flow velocity and travel time of the flood waves etc. Dam breach flood analysis is a classic problem of unsteady open channel flow. However, the flood caused by the failure of dam will be of very high magnitude than the magnitude and timing of the dam breach flood for the purposes of dam safety, evacuation planning, and flood forecAshting.

7.1.2. Scope and Objectives

In this study, the problem of simulating the failure of proposed Khuntephal dam is considered, by computing the outflow hydrograph from the breached dam and routing this hydrograph along the downstream channel reaching existing Mehekari dam. Also flood discharge equal to standard project flood or 1.5 times river channel capacity and probable maximum discharge is routed to obtain the maximum water level marks reached during the passage of flood wave. The information regarding inflow hydrograph into the reservoir due to the storm at the time of failure, the structural and the hydraulic characteristics details of the dam, the channel cross sectional details, are available for the study.

The computation of flood wave resulting from various flood discharge scenarios fulfil following objectives.

(1) Flood routing for discharge of about 1.5 times river channel capacity to find stages and discharges at various cross sections as steady state analysis.

(2) Flood routing for discharge of probable maximum flood to find stages and discharges at various cross sections as steady state analysis.

(3) The routing of the flood wave downstream from the breached dams along the river channel and the flow plain as unsteady flow analysis.

(4) The flood hydrograph and water level at desired downstream locations and its time lag with respect to inflow/breach hydrograph at dam site.

(5) Flood plain mapping for various scenarios

(6) Preparation of Emergency action plan.

7.1.3. Theoretical Background

Theoretical background related to hydraulic modelling and routing of river channel flow, dam failure reasons and breach characteristics and flood plain mapping is discussed in this section**.**

7.1.3.1. Flow Routing

Generally, dam break studies can be carried out by either 1) scaled physical hydraulic models or ii) mathematical simulation using computer A modern tool to deal with this problem is the mathematical model which is most cost effective and approximately solves the governing flow equations of continuity and momentum by computer simulation. Sophisticated computer programs have been developed in the recent years that can simulate the dam break hydrographs, and route these hydrographs downstream so that inundated areas, flow depths, flow velocity and travel time of flood waves can be estimated. Mathematical modelling of dam breach floods can be carried out by one dimensional analysis obtaining information about magnitude of flood i.e. discharge and water levels, variation of these with time and velocity of flow through breach in the direction of flow.

The basic theory for dynamic routing in one dimensional analysis consists of two partial differential equations originally derived by Barre De Saint Venant in 1871. The equations are:

i) Conservation of mass (continuity) equation:

$$\delta Q / \delta x + T (\delta y/\delta t) = 0$$

ii) Conservation of momentum equation:

$$(\delta V / \delta t) + V (\delta V/\delta x\} + g (\delta y/\delta x) +(S_0 - S_f) = 0$$

Where Q =discharge, V = velocity of flow, A= active flow area, y = water surface elevation, x distance along waterway, t = time, T= top width, S_f = friction slope, S_0 = bed slope and g= acceleration due to gravity.

7.1.3.2. Causes of Dam Failure

The life of a dam can be threatened by natural "phenomena such as floods, rock slides, earthquake, and deterioration of the foundation and construction materials. The records of failures of dams indicate that earth fill have involved in the largest number of failures followed by gravity dams, rock fills and multiple and single arches. Each type of dam has its own characteristic mode of failure. A gravity dam may collapse only in the section which is over stressed. A buttress dam may fail like a pack of cards through the successive collapse of its buttresses. The rupture of an arch may be sudden and complete. Failure of an embankment may be relatively slow with erosion progressing laterally and downward and accelerating as the flood tears through the breach.

Studies on the failure of Earth and Earth rock dams have revealed that majority of such dams have failed due to one or more of the causes listed below.

1. Embankment slope or foundation material failing due to slips
2. Failure by piping
3. Excessive seepage and toe erosion
4. Excessive settlements
5. Poor junctions with structures or abutments
6. Over topping of Dam crest

The trigger mechanism bringing about failure due to each of the above causes, are explained below.

7.1.3.2.1. Slope or Embankment Failure due to Slips

Slips of the embankment slope or its foundation will occur if the activating forces causing instability exceed the resisting forces bringing about failure. Such a situation may develop owing to development of high pore-pressures within the soil mass or due to extraneous forces not considered in the design of the dam coming into play, e.g., Earthquake forces etc.,

7.1.3.2.2. Failure by Piping within Embankment or Foundation

Failure by piping can be caused by two different processes one by back-ward sub-surface erosion and the other by heave. The piping by heave is termed vertical piping and piping by sub-surface erosion as horizontal piping. Piping by heave takes place due to development of "Quick Sand Condition." In the event of such a formation of the pipe and direct access from the head water, the banks could breach by a sudden subsidence and consequent over-topping of the banks. Burrowing animals like rodents can form a pipe within the embankment brining about failure. Even trees that develop roots which spread wide and deep may also cause pipes to develop along the contact zone of the root with soil.

7.1.3.2.3. Excessive Seepage and Toe Erosion

Excessive uncontrolled seepage and absence of filter to drain the seeping water may cause wetness in the toe regions of the bank and if the wetness continues for long durations will cause sloughing of the toe resulting in the slipping of the slope of the embankment.

7.1.3.2.4. Excessive Settlement of Embankment and its Foundation

High embankments formed without proper and adequate compaction and formed of clay material are likely to fail by excessive settlements after couple of years of completion of Dam. If the settlements are of high order as to exceed the free board allowances made for the dam there would be over-topping resulting in breach.

7.1.3.2.5. Poor Junctions with Structures or Abutments

The junctions of earth embankments with masonry structures/abutments form vulnerable areas for seepage of water.

7.1.3.2.6. Over-Ttopping of Dam Crest

The dams may breach due to over topping caused by any of the reasons like, excessive settlements, subsidence due to piping, Inadequate free board

7.1.3.3. Dam Breach Characteristics

The Bureau of Reclamation (Wahl, 1988) provides additional literature review of breach parameters. Wahl (1998) compiles a list of methods to predict breach parameters. Since estimates of breach parameters vary significantly, Wahl suggested using several methods to establish a range of breach parameters, giving due consideration to the dam's design characteristics. Following a recommendation by Wahl (2008), Xu and Zhang (2009) developed equations to computer breach parameters for earth and rockfill dams. The new equations are based on widely accepted methods developed by Froehlich (1987 and 1995) and empirical data to close the gap between idealized parameters and recorded breach events. The breach parameters needed for the USACE HEC-RAS unsteady-flow model will be the focus of this section.. The parameters affecting outflow include:

- Final Bottom Width (Bb)
- Final Bottom Elevation
- Left/Right Side Slope (Z)
- Breach Weir Coefficient (for Overtopping Breaches)
- Full Formulation Time
- Piping/Orifice Coefficient (for Piping Breaches)
- Initial Piping Elevation
- Failure Trigger
- (Water surface elevation, water surface elevation + duration, or user-defined time)
- Starting Water Surface Elevation

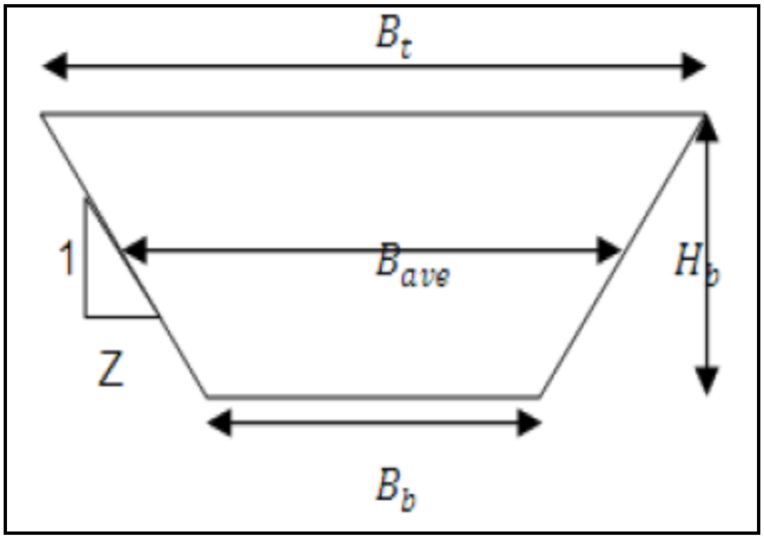


Fig.7.1. Breach Geometry

	Earth Dam	Concrete Gravity Dam	Concrete Arch Dam
Breach Width	1/2 to 4	Some multiple of monolith width	Total dam width
Breach Side Slope	0 to 1	0	Valley wall slope
Failure Time (hrs)	0.5 to 4	0.1 to 0.5	Near instantaneous (≈0.1 hrs)
Pool Failure Elevation	1 to 5 ft. above dam crest	10 to 50 ft. above dam crest	10 to 50 ft. above dam crest

Fig.7.2. Suggested Breach Parameters by USACE and Fread

7.1.3.4. Dam Breach Modelling

There are four critical elements of any breach analysis: 1) breach parameter estimation (breach size/shape and time of failure), 2) breach peak discharge and breach hydrograph estimation, 3) breach flood routing, and 4) estimation of the hydraulic conditions at critical locations.

Empirical Methods

Empirical methods are used to predict time to failure and breach geometry, as well as to predict peak breach discharges. The empirical approach relies on statistical analysis of data obtained from documented failures. The four most widely used and accepted empirically derived enveloping curves and/or equations for predicting breach parameters are: MacDonald & Langridge – Monopolis (1984), USBR (1988), Von Thun and Gillette (1990), and Froehlich (1995 a, 1995 b, 2008). These methods have reasonably good correlation when comparing predicted values to actual observed values.

Physically-Based Models

A physically-based model (also referred to as a "process" or "causal" model) utilizes generally accepted relationships based on physical principles to establish the framework of a model. The model then attempts to solve those relationships for a given input. This is a relatively simple concept, but it can become very complex when the input is changing with time. In the case of dam breach analysis, both the input and physical constraints are changing with time as the dam erodes and the reservoir evacuates. Although several physically-based models have been reported as being in the development stage for research purposes, the National Weather Service's BREACH program (NWS BREACH or BREACH) is currently the only widely available model. BREACH predicts the development of a reach and the resulting outflow using an erosion model based on principles of hydraulics, sediment transport and soil mechanics. It was initially developed in 1987, but has had several upgrades in 1988, 1991, and 2005. The model takes into account several components of a dam and reservoir that are not considered in the empirical methods, such as area versus elevation, dam dimensions, soil properties of the dam, and tailwater effects downstream.

Parametric Models

HEC-1, HEC-HMS and HEC-RAS are parametric computer models that estimate the peak discharge and breach hydrographs from dam breaches based on parameters (breach geometry and breach development time) provided by the user. They can also be used to calculate the flood routing of the hydrograph downstream, and, in the case of HEC-RAS, can be used to estimate the hydraulic conditions at critical downstream locations.

Hydraulic Models

Hydraulic models, in general, are more physically based than hydrologic models since they only have one parameter (the roughness coefficient) to calibrate. The full unsteady flow equations have the capability to simulate the widest range of flow situations and channel characteristics.

The basic data requirements for hydraulic routing techniques include: flow data, channel geometry, roughness coefficients, and internal boundary conditions. Hydraulic modelling is further subdivided into steady flow analysis and unsteady flow analysis. In unsteady flow, time dependent changes in flow rate are analyzed explicitly as a variable, while steady flow analysis models neglect time all together (USACE, 1993). Steady flow analysis can determine a water surface elevation and flow velocity at a given cross section for a given flow using Manning's equation under the assumption of gradually varied flow conditions. Unsteady flow analysis can be used to evaluate the downstream attenuation of the flood wave, providing a more accurate estimate of flood magnitude and velocity at critical locations. HEC-RAS hydraulic model is used to analyse steady and unsteady flow analysis.

7.1.4 Land Use Regulations

The land regulation should aim at

1) To demarcation and define the flood zone into various classes such as regulatory flood away, design flood way and disaster flood limit for the dam break flood condition.

2) To prohibit construction activity and encroachment in the regulatory flood away and permitting restrictive uses in the design flood way fringe and a caution for the disaster flood limit zone for new constructions.

3) To ensure that the existing hazard potential classification of the dam does not change due to any new construction and provide emergency action plan.

As per Government of Maharashtra's circulars and Dam safety manual, **chapter 8.**

(Preparedness for dealing with emergency situation on Dam), paragraph 14, land use regulation in respect of inundation area, the following guidelines are stipulated.

In respect of the inundation area the following type of land use regulation may be adopted.

The Prohibitive zone: (Blue zone) - This is the zone consisting of normal river channel for a discharge of regulatory floods from the reservoir and the free catchment. Normally in case of storage dams the floods being released from the dam for most of the years are highly moderated, this leads to increased encroachment in the river channel where the river passes through the urban areas. The river channel portion required for passing 25 years return flood or a flood equivalent to 1.5 times the capacity of the established river channel whichever is higher should be classified as Prohibitive zone. This area may be used only for the open land type of use such as playgrounds, gardens, river side esplanades, or cultivation of light crops where ever such riparian rights exist.

The restrictive zone (Red Zone)-The area required to pass the maximum design outflow flood should be treated as the restrictive zone. The maximum design flood may be adopted as the maximum outflow corresponding to the spillway design flood together with similar flood from the free catchments. In the restrictive zone the land use regulation may specify the safe height for the plinth level of the lowest floor level and the type of building, method to prevent collapse of the structure during floods. Restrictions on the type of uses of buildings in such zones may also be specified. This will take into account the possibility of floods expected in this zone and also necessity of all prompt evacuation of people, cattle and goods at short notice, to avoid costly flood damages and loss of life. While framing constructions in such zones, compulsory insurance may also have to be considered.

The caution zone- The caution zone may extend beyond the limit of the restrictive zone to the boundary of the dam break flood zone. Flooding in this area may be rare but not altogether impossible. The regulation for land use in this zone should only include a caution about the flood risk and likely flood height in this area and necessary building precautions for safety under such circumstances, wherever a contingency may arise.

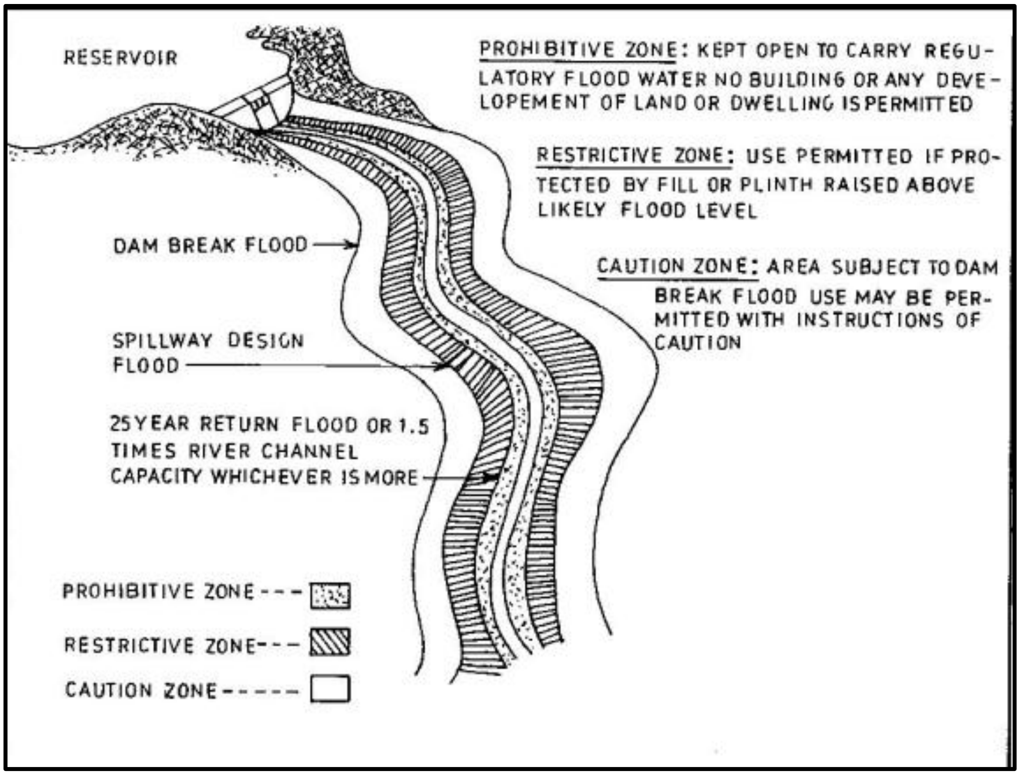


Fig. 7.3: Regulatory Zones

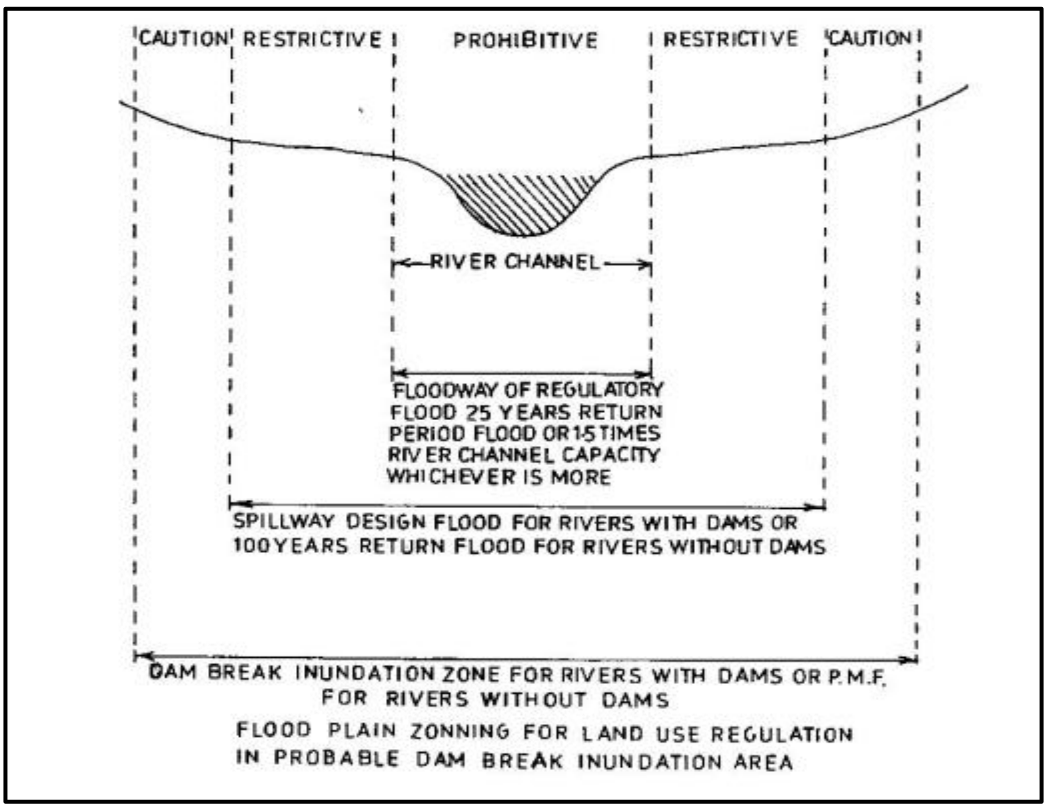


Fig.7.4: Flood Plain Zoning

7.1.5 Data Requirement and Methodology Used

HEC RAS model uses reservoir storage routing (level pool) to compute outflow hydrograph from reservoir with sub – critical dynamic routing of outflow hydrograph through entire length of d/s valley, tail water depth computed by Manning's equation applied to tall water section. In other words, this model simulates the failure of a dam, computes the resultant outflow hydrograph and also simulates movement of the dam break flood wave through the downstream river valley. The model is built around three major capabilities, which are reservoir routing, breach simulation and river routing. After computing the hydrograph of the reservoir outflow, the time of occurrence of flooding in the downstream valley is determined by routing the outflow hydrograph through the valley. The dynamic wave method based on the complete equations of unsteady flow is the appropriate technique to route the dam break flood hydrograph through the downstream valley.

The following minimum data is required for this model:

- Elevation area capacity curve of the reservoir
- River cross sections downstream of a dam at suitable intervals. The river cross section data can be obtained either from actual survey along the river or extracted through a high resolution Digital elevation map
- Rating curve of spillways and sluices
- Design flood hydrograph as upstream boundary condition for the dam
- Rating curve or time series water level for downstream boundary conditions
- Salient Features of all hydraulic structures
- Details of inflow and outflow of all tributaries and branches for the river reach under study
- Manning's roughness coefficient for the site
- Breach geometry (simplified to rectangular or trapezoidal shape parameters)

7.1.6 Project Details and Input Data

The proposed Khuntephal dam is on Mehekari river near village Khuntephal, Ashti Taluka, Beed district of Maharashtra India.

7.1.6.1. Project Details

- The main silent features of the project are
- **Details of Khuntephaldam**

- Location 1 Km DLSsite of KhuntephalVillage

- Latitude $18^0 53^{'} 54^{''}$
- Longitude $74^0 59' 01''$
- Free catchment 325.13 Sq.km
- Total reservoir capacity 131.59 Million m^3
- Total Submergence 1067 ha
- Percentage of submergence to command area 3.87
- Submerged villages Kuntephal, Balewadi, Kumbephal, Solapurwadi and Waghluj
- Length of earthen Dam 1410 m
- Maximum Height (m) 39.50 m
- Standard Maximum Flood 2186.59 m^3 /sec
- Projected Maximum Flood 2186.59 m^3 /sec
- Length of Waste weir 190 m
- Flood release height 3 m
- Ogee type spillway

The existing Mehakari dam is downstream of proposed Khuntephal dam on Mehekari river, Ashti Taluka, Beed District of Maharashtra India.

The main silent features of the project are

Details of Mehekari dam

- Location 5 Km downstream of Khuntephal dam
- Latitude $18^0 50^{'} 00^{''}$
- Longitude $75^0 00' 30''$
- Free catchment 338 Sq.km
- Total reservoir capacity 21.22 Million Cubic meter
- Length of earthen Dam 1098 m

- Maximum Height (m) 21.52 m
- Standard Maximum Flood 2233 m^3 /sec
- Projected Maximum Flood 2233 m^3 /sec
- Length of Waste weir 222.57 m
- Flood release height 2.75 m
- Ogee type spillway
- Standard Levels of Project
- F.T.L. 595.60 m
- M.W.L. 598.35 m
- T.B.L. 600.40 m
- Sill Level 589.00 m

7.1.6.2 Input data for river routing and dam break analysis.

Table 7.1. Khuntephal Reservoir Capacity Data Based D.E.M.

R.L.	Volume in 1000 m^3
630	5308.942
620	3243.164
600	211.942
596	9.811

Table 7.2: Mehekari Reservoir Capacity Data Based ASTERDEM 30 M Resolution

R.L.	Volume in 1000 m^3
600	22000
595	19510
585	10000
580	1000

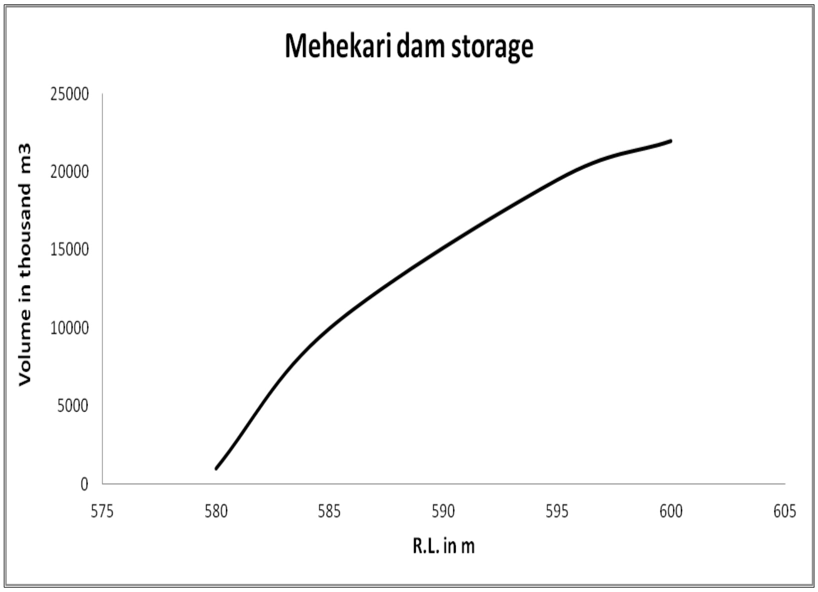


Fig.7.5. Mehekari Reservoir & Capacity

The breach parameters considered for the HEC-RAS Unsteady-Flow model

Khuntephal dam

- Final Bottom Width (Bb) -160 m
- Final Bottom Elevation-592m
- Left/Right Side Slope (Z)-2
- Breach Weir Coefficient (for Overtopping Breaches)-2.6
- Full Formulation Time-2 hrs
- Failure Trigger- user-defined time
- Centre station -577 m

Mehekari dam

- Final Bottom Width (Bb) -88 m
- Final Bottom Elevation- 585 m
- Left/Right Side Slope (Z)-2
- Breach Weir Coefficient (for Overtopping Breaches)-2.6
- Full Formulation Time-2 hrs
- Failure Trigger- user-defined time
- Centre station-599 m

Table 7.3: Typical Cross Section Description (Based ASTERDEM 30 M Resolution)

Sr. No.	Cross section Detail	Distance in m.
1	Khuntephal dam	28360
2	1	28133
3	2	27593
4	3	26588
5	4	26304
6	5	25563
7	Mehekari dam	22733
8	6	21863
9	7	20033
10	8	18973
10	9	17193
11	10	15513
12	11	14030
13	12	12283
14	13	11453
15	14	10343
16	15	9313
17	16	8093
18	17	6863
19	18	5960
20	19	5190
21	20	4470
22	21	3769
23	22	3040
24	23	1650
25	24	630
26	25	0

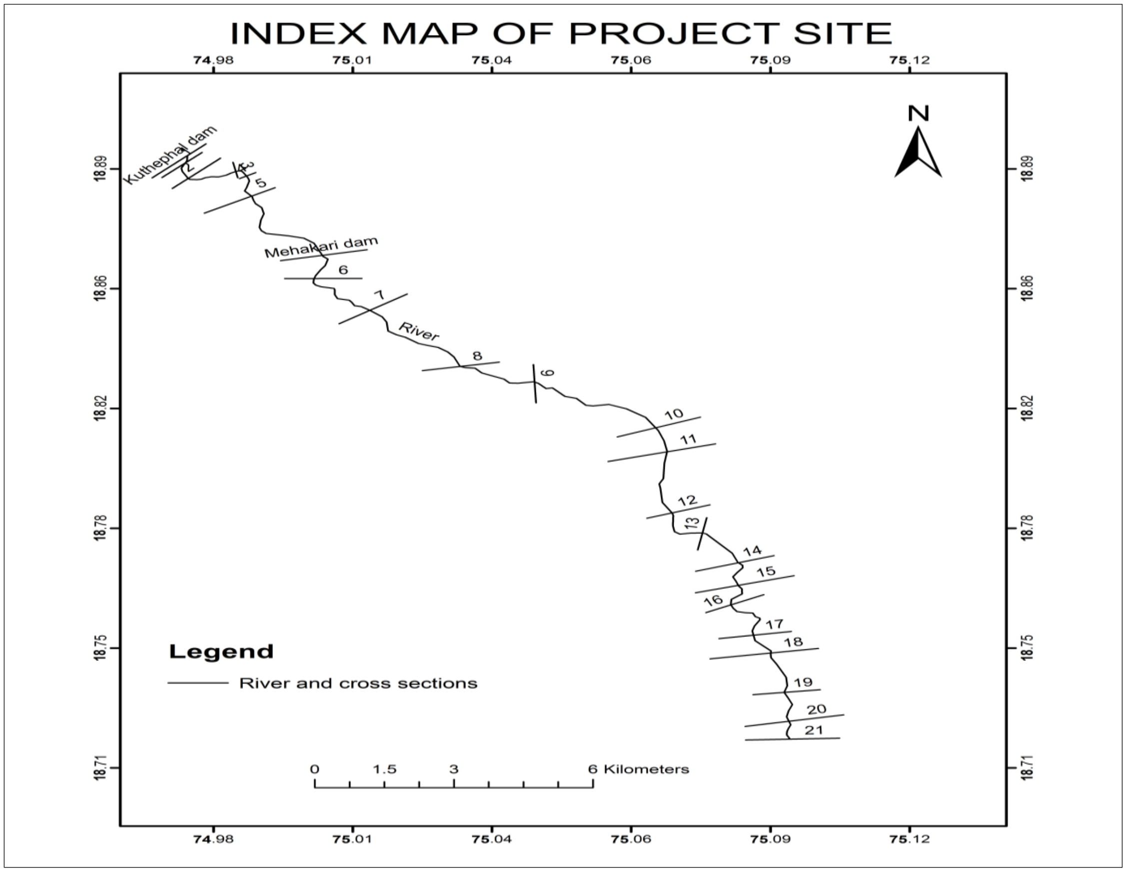


Fig.7.6: Index Map of Location of Typical Cross Sections

Cross section details of modeled dam sections

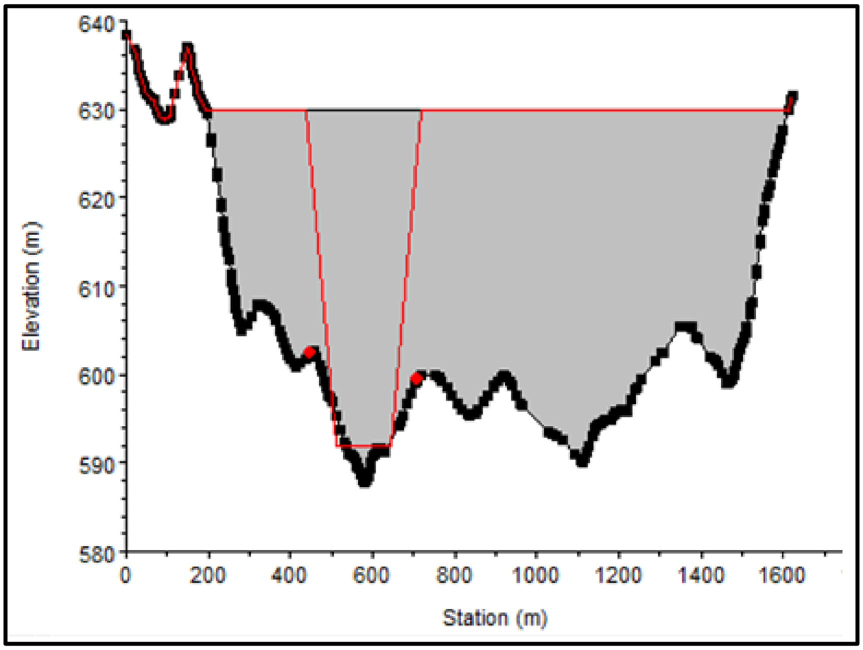


Fig.7.7: Khuntephal Dam Cross Section with Breach Location

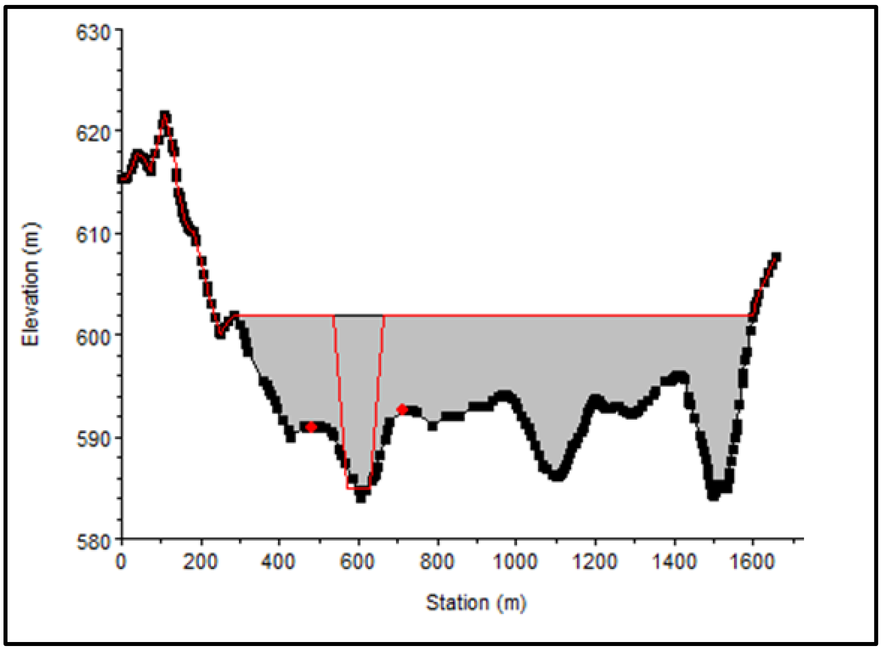
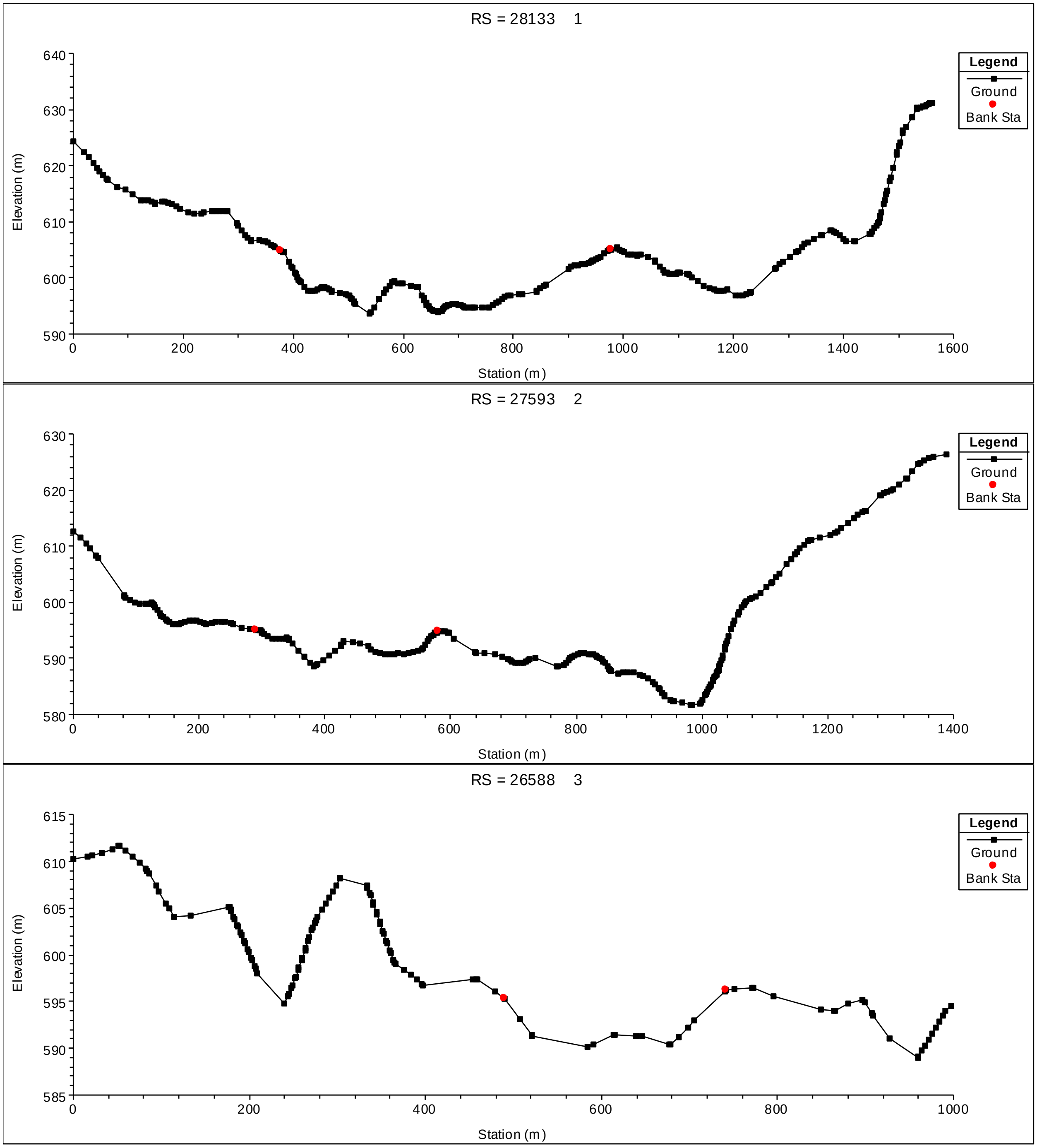
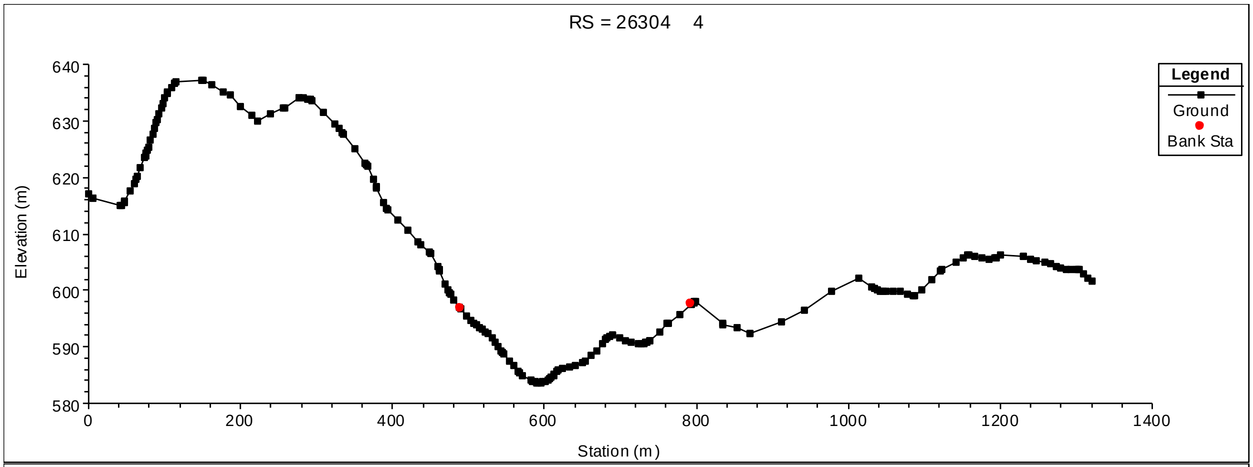
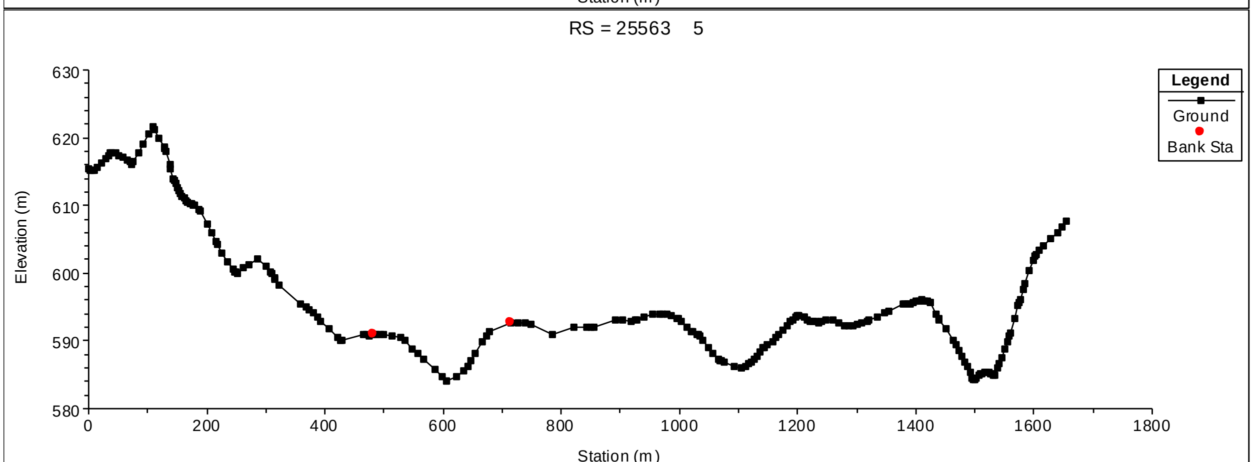


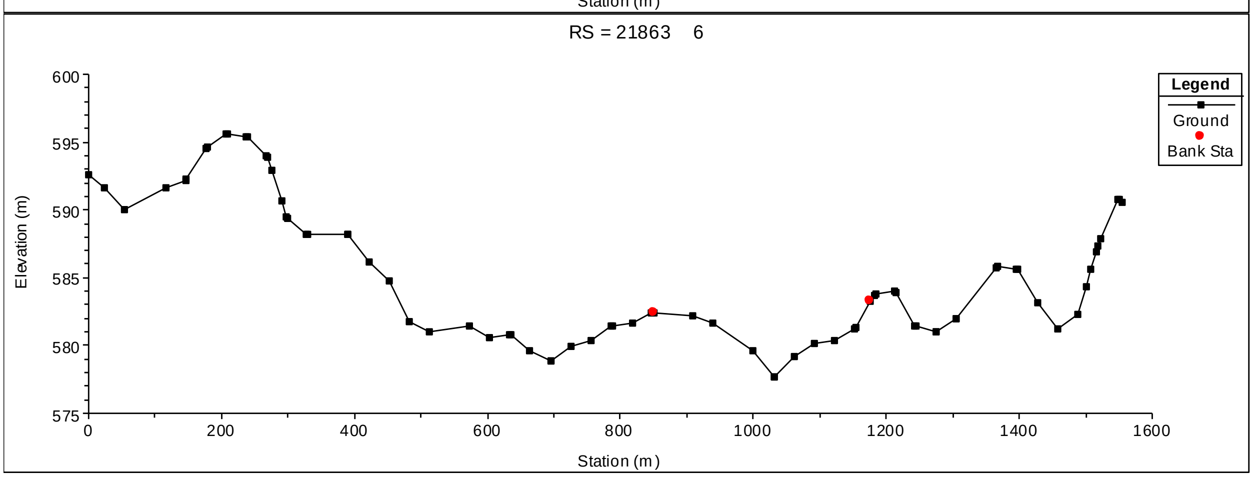
Fig.7.8: Mehekari Dam Cross Section with Breach Location

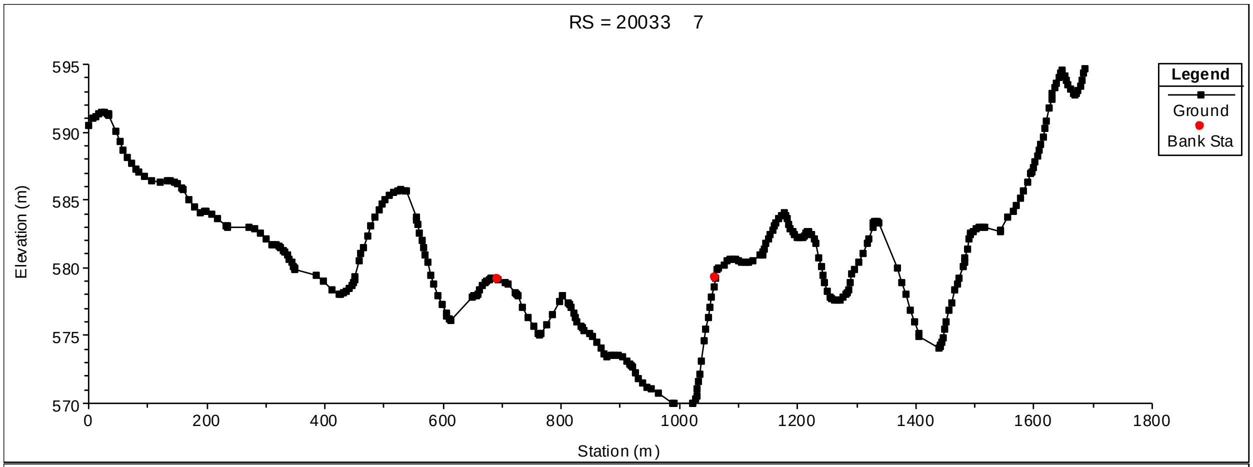
Cross section details of some of the typical sections.

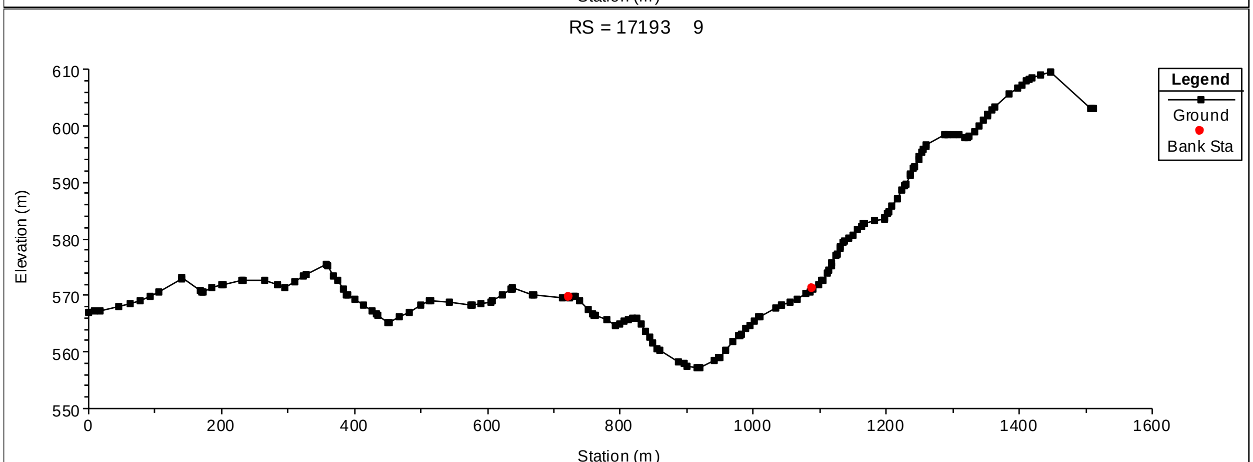


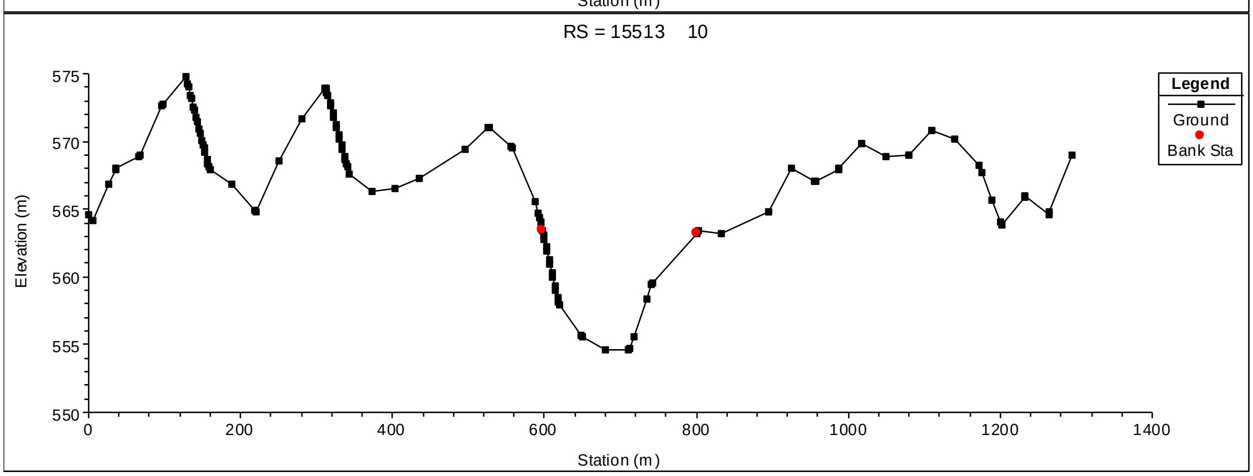

RS = 26304 4
Legend
Ground
Bank Sta
Elevation (m)
Station (m)
640
630
620
610
600
590
580
0
200
400
600
800
1000
1200
1400

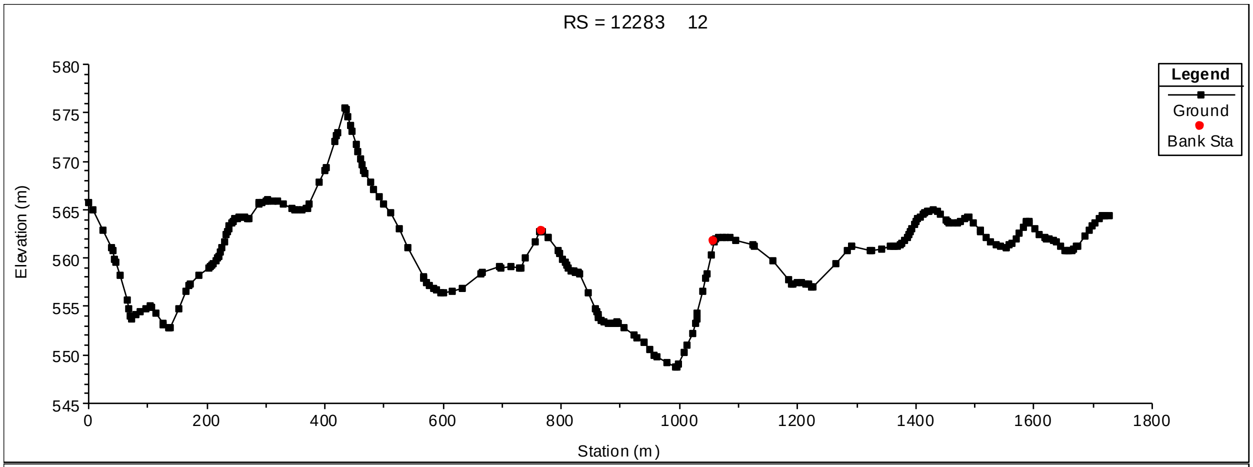

RS = 25563 5
Legend
Ground
Bank Sta
Elevation (m)
Station (m)
630
620
610
600
590
580
0
200
400
600
800
1000
1200
1400
1600
1800

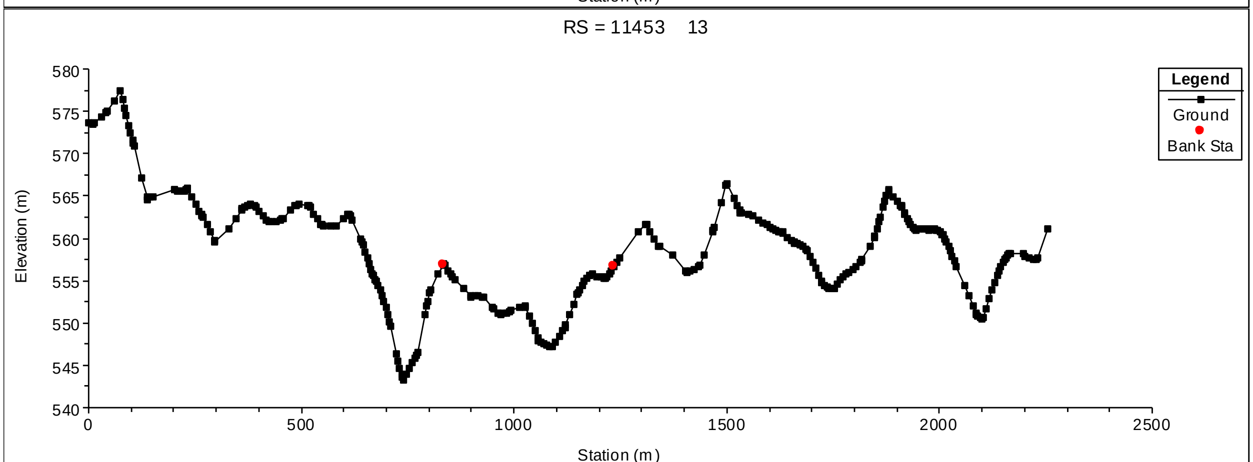

RS = 21863 6
Legend
Ground
Bank Sta
Elevation (m)
Station (m)
600
595
590
585
580
575
0
200
400
600
800
1000
1200
1400
1600

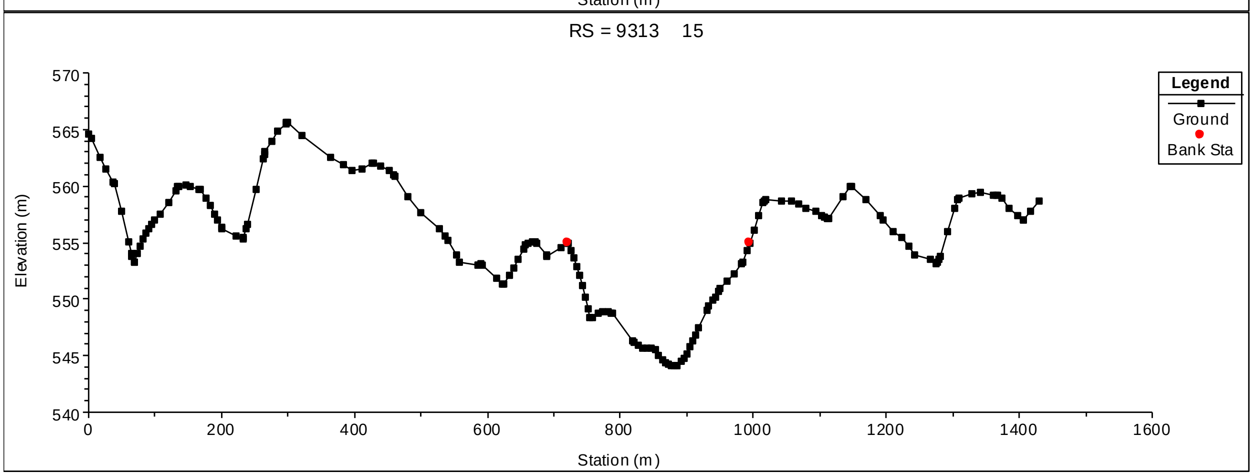

RS = 20033 7
Legend
Ground
Bank Sta
Elevation (m)
Station (m)
595
590
585
580
575
570
0
200
400
600
800
1000
1200
1400
1600
1800

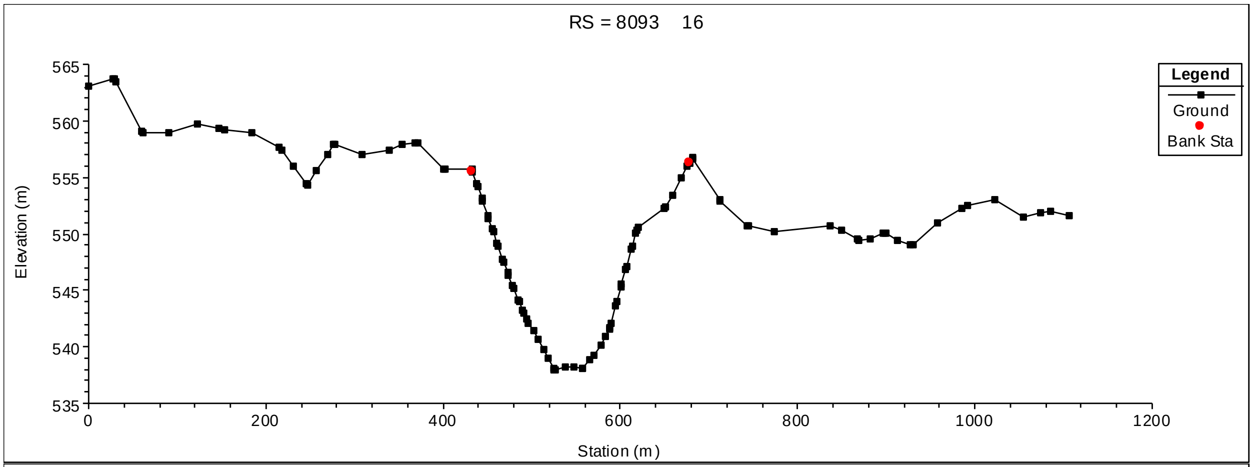

RS = 17193 9
Legend
Ground
Bank Sta
Elevation (m)
Station (m)
610
600
590
580
570
560
550
0
200
400
600
800
1000
1200
1400
1600

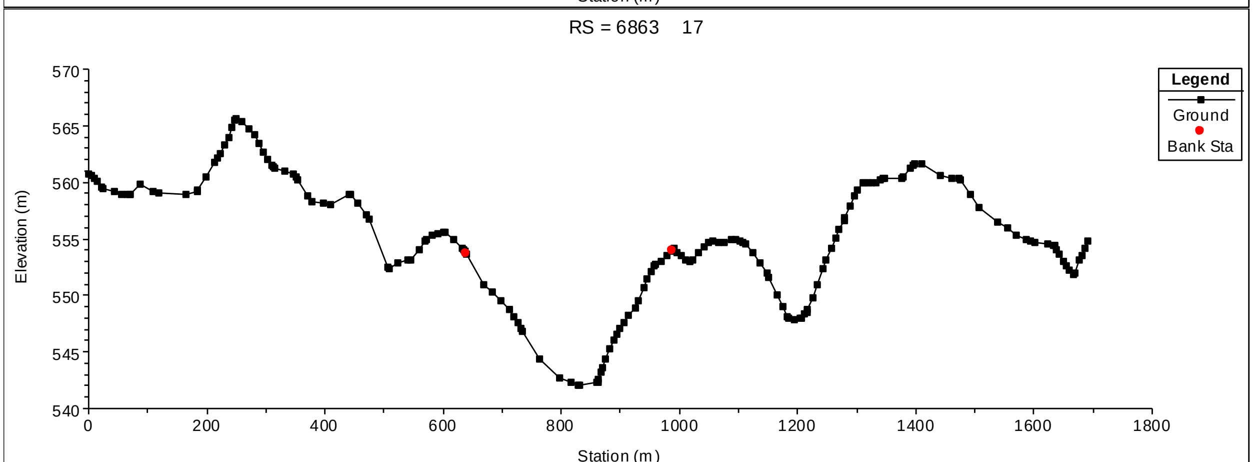

RS = 15513 10
Legend
Ground
Bank Sta
Elevation (m)
Station (m)
575
570
565
560
555
550
0
200
400
600
800
1000
1200
1400

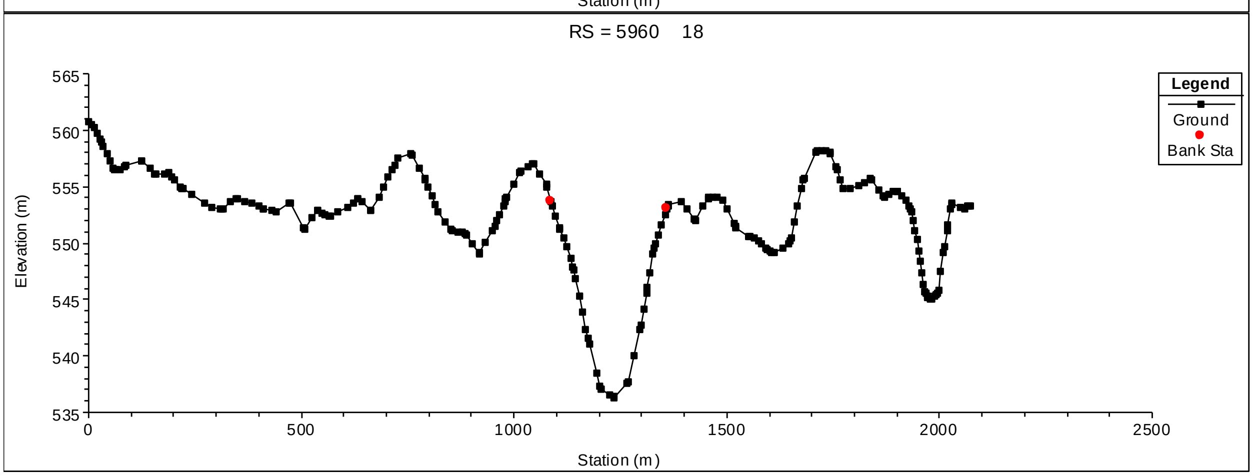

RS = 12283 12
Legend
Ground
Bank Sta
Elevation (m)
Station (m)
580
575
570
565
560
555
550
545
0
200
400
600
800
1000
1200
1400
1600
1800

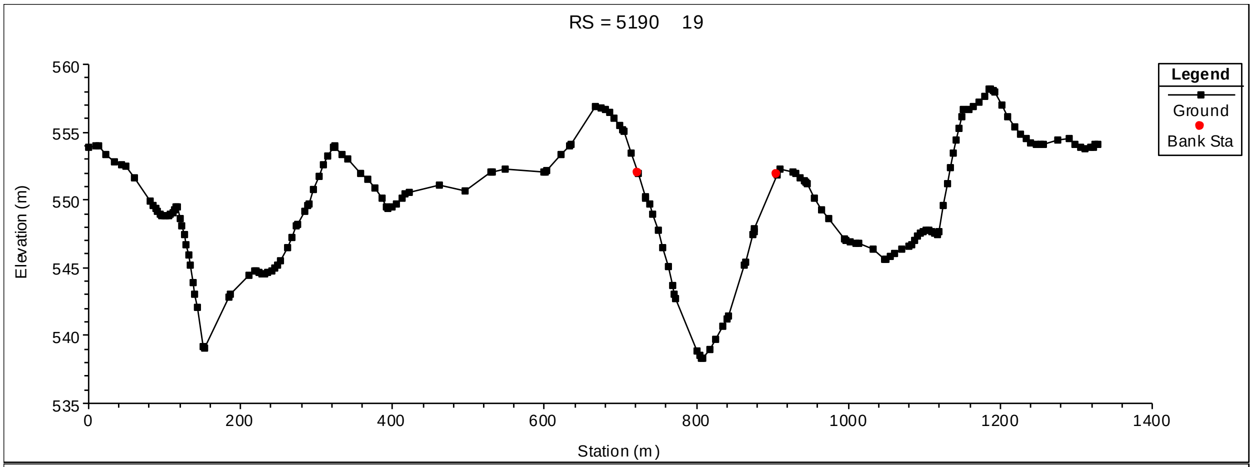

RS = 11453 13
Legend
Ground
Bank Sta
Elevation (m)
Station (m)
580
575
570
565
560
555
550
545
540
0
500
1000
1500
2000
2500

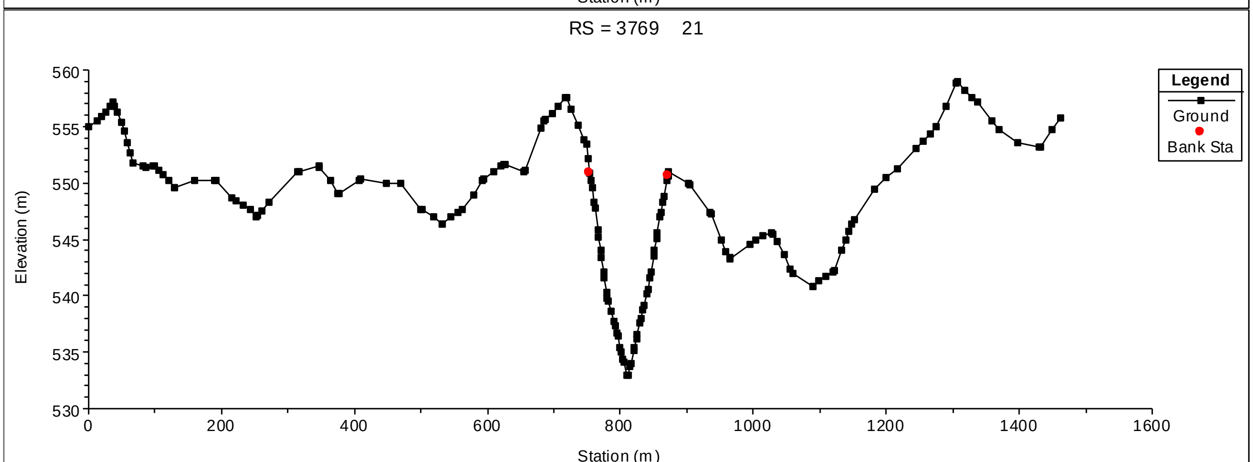

RS = 9313 15
Legend
Ground
Bank Sta
Elevation (m)
Station (m)
570
565
560
555
550
545
540
0
200
400
600
800
1000
1200
1400
1600

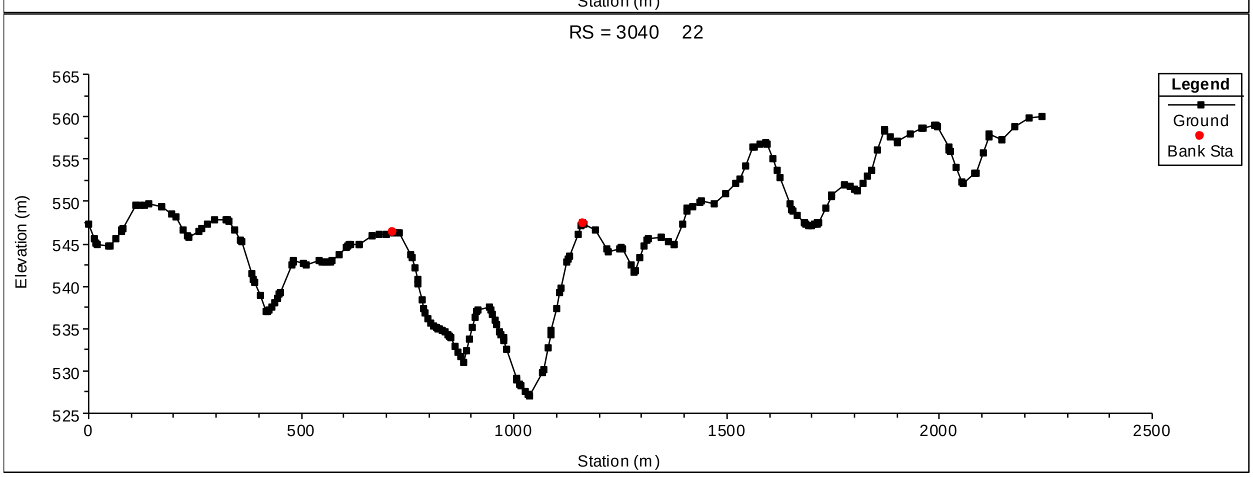

RS = 8093 16
Legend
Ground
Bank Sta
Elevation (m)
Station (m)
565
560
555
550
545
540
535
0
200
400
600
800
1000
1200

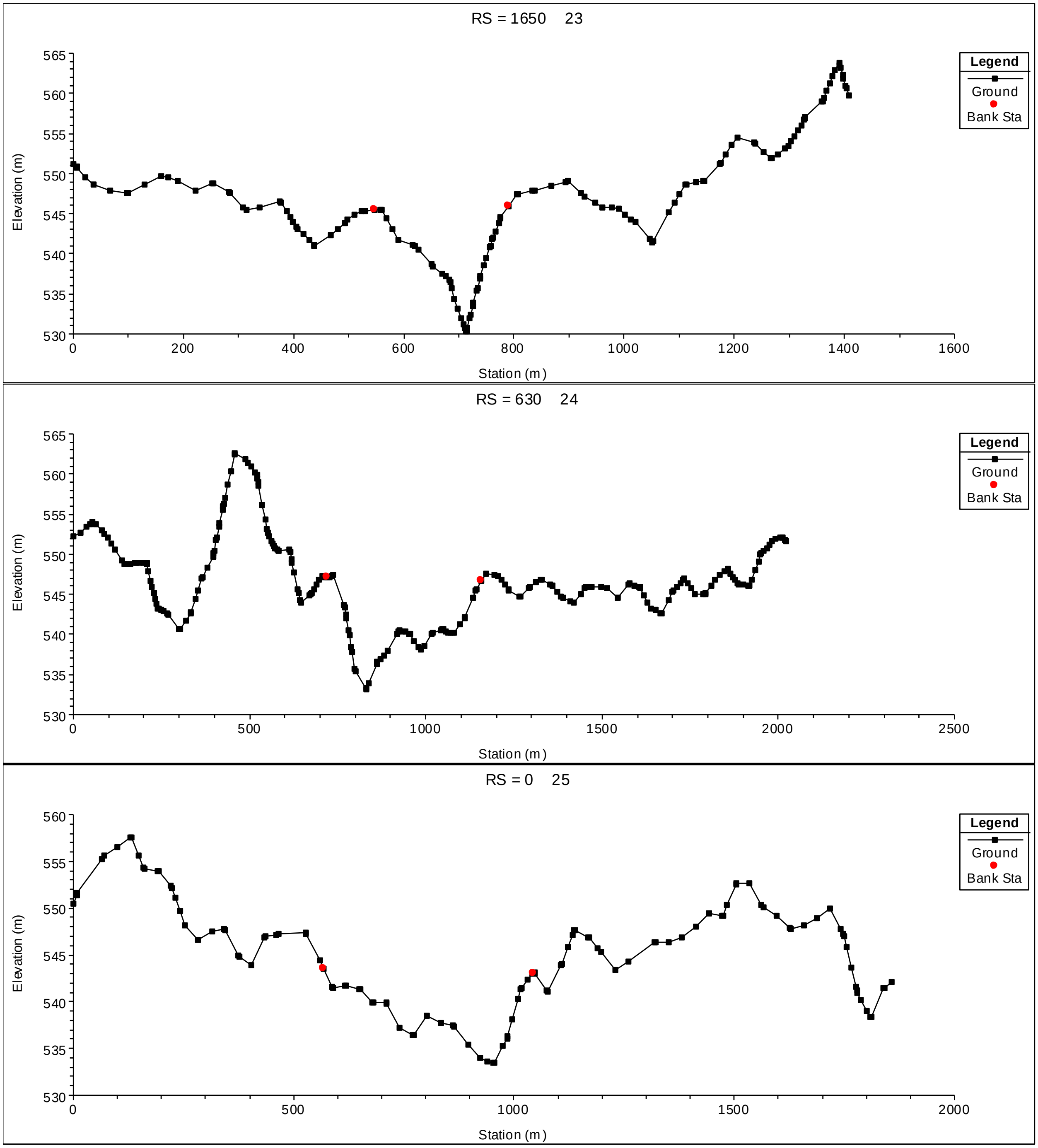

RS = 6863 17
Legend
Ground
Bank Sta
Elevation (m)
Station (m)
570
565
560
555
550
545
540
0
200
400
600
800
1000
1200
1400
1600
1800


RS = 5960 18
Legend
Ground
Bank Sta
Elevation (m)
Station (m)
565
560
555
550
545
540
535
0
500
1000
1500
2000
2500


RS = 5190 19
Elevation (m)
Station (m)
Legend
Ground
Bank Sta
560
555
550
545
540
535
0
200
400
600
800
1000
1200
1400


RS = 3769 21
Elevation (m)
Station (m)
Legend
Ground
Bank Sta
560
555
550
545
540
535
530
0
200
400
600
800
1000
1200
1400
1600


RS = 3040 22
Elevation (m)
Station (m)
Legend
Ground
Bank Sta
565
560
555
550
545
540
535
530
525
0
500
1000
1500
2000
2500



Hydrological & Hydraulic Data Input

The hydraulic data consists of Manning's constant "n", initial boundary condition, flood hydrographs, P.M.F., S.P.F., Dam breach parameters, gate opening properties etc. The Manning's constant assumed is 0.03 for river portion and 0.035 for bank portions. The initial boundary conditions are initial water levels in reservoir, and at various cross section locations. Initial flow equal to 100 Cumecs is also given at u/s boundary for initiations of the model. The routing period considered is 24 hours.

7.1.6.3 Various Scenarios Considered in Analysis

Following scenarios are considered while analyzing dam break as well as non dam break flood routing.

- Flow of 1500 cumecs through the channel, surpassing maximum river channel capacity for prohibitive zone mapping, by running steady flow river routing model for various discharges with increment of 100 cumecs.
- Probable maximum flood of 2233 cumecs through river for restrictive zone mapping.
- Various scenarios are possible for dam break analysis with failure either due to overtopping or piping. Failure of Khuntephal dam at reservoir full condition due to overtopping with trapezoidal breach formation with maximum breach width equal to weir width and leading to failure of Mehekari dam due to overtopping also with reservoir full condition is the worst possible scenario. Other scenarios could be sunny day failure of any one of the dam or both dams, simultaneous failure of both dam due to piping. Dam break over flow with water surface elevation at M.W.L. at Khuntephal dam with occurrence of breach formation for breach width of 190 m for failure time of 2 hrs followed by overtopping failure of Mehekari dam with breach width of 223 m for failure time of 2 hours, dynamic flow routing is considered for cautious zone mapping.

7.1.7 Results

- Flow of 1500 cumecs through the channel, surpassing maximum river channel capacity for prohibitive zone mapping.

Table7.4. Steady Flow Output Data for 1500 Cumecs @ 1.5 Times River Channel Capacity

River Station	Min Ch. El.	E.G. Elev	E.G. Slope	Vel. Chnl.	W. S. Elev.	Flow Area	Top Width	Froude No.
	(m)	(m)	(m/m)	(m/s)	(m)	(m^2)	(m)	
28133	593.63	598.36	0.009315	4.17	593.63	560.31	352	0.97
27593	588.66	594.17	0.000068	0.43	588.66	3284.97	741	0.09
26588	590.18	593.94	0.009385	4.2	590.18	529.82	463	0.98
26304	583.68	591.21	0.003694	4.31	583.68	533.28	167	0.69
25563	584.03	589.23	0.008736	4.64	584.03	516.32	335	0.98

River Station	Min Ch. El.	E.G. Elev	E.G. Slope	Vel. Chnl.	W. S. Elev.	Flow Area	Top Width	Froude No.
22733	581.95	586.43	0.003742	2.48	581.95	775.06	784	0.61
21863	577.64	582.19	0.008853	3.82	577.64	711.02	691	0.94
20033	570	576.49	0.001632	2.57	570	928.41	361	0.45
17193	557.24	565.42	0.03816	9.5	557.24	242.2	317	2.03
15513	554.58	563.92	0.000467	1.97	554.58	1186.52	434	0.26
12283	548.72	556.22	0.001358	2.69	548.72	928.64	404	0.42
11453	547.23	556	0.000116	0.75	547.23	2792.21	709	0.12
9313	544.09	551.07	0.022719	7.65	544.09	300.52	445	1.58
8093	537.9	548.4	0.000538	2.35	537.9	979.81	256	0.29
6863	542.02	548.07	0.003751	3.94	542.02	583.2	165	0.68
5960	536.32	547.65	0.000258	1.72	536.32	1387.43	223	0.2
5190	538.29	547.48	0.000624	2.14	538.29	1241.61	364	0.3
3769	533.01	544.22	0.00866	7.2	533.01	331.71	313	1.07
3040	527.05	542.16	0.000043	0.76	527.05	3175.91	390	0.08
1650	530.3	542.04	0.002178	3.46	530.3	668.56	193	0.54
630	533.1	541.39	0.002759	2.82	533.1	816.09	421	0.56
0	533.49	539.29	0.009501	4.48	533.49	513.82	293	1

- Probable maximum flood of 2233 Cumecs through river for restrictive zone mapping.

Table 7.5: Steady Flow Output Data for 2233 Cumecs i.e. P.M.F. Discharge

River Station	Min Ch. El.	W.S. Elev	E.G. Elev.	E.G. Slope	Vel.	Flow Area	Top Width	Froude No.
	(m)	(m)	(m)	(m/m)	(m/s)	(m2)	(m)	
28133	593.63	598.07	599.02	0.008643	4.35	785.58	468	0.96
27593	588.66	594.96	595	0.00009	0.58	3877.52	796	0.1
26588	590.18	593.52	594.71	0.009018	4.74	684.1	693	1.1
26304	583.68	591.19	592.4	0.005023	4.89	675.28	391	0.8

River Station	Min Ch. El.	W.S. Elev	E.G. Elev.	E.G. Slope	Vel.	Flow Area	Top Width	Froude No.
25563	584.03	588.82	590.04	0.008671	5.07	674.45	565	1.1
22733	581.95	586.42	587.06	0.004034	3	965.96	790	0.66
21863	577.64	581.93	582.63	0.009	4.11	932.13	950	0.96
20033	570	576.82	577.26	0.001967	3	1152.2	517	0.5
17193	557.24	561.56	566.76	0.032533	10.1	326.62	417	1.94
15513	554.58	564.53	564.83	0.000605	2.44	1414.87	623	0.31
12283	548.72	556.6	557.06	0.001572	3.14	1144.55	584	0.47
11453	547.23	556.74	556.79	0.000149	0.94	3378.88	810	0.14
9313	544.09	548.9	552.1	0.024605	7.93	416.36	536	1.65
8093	537.9	549.08	549.52	0.000754	2.94	1123.37	345	0.35
6863	542.02	547.98	549.08	0.004559	4.64	711.53	264	0.77
5960	536.32	548.25	548.49	0.000398	2.21	1559.88	445	0.25
5190	538.29	547.96	548.24	0.000817	2.56	1505.18	482	0.34
3769	533.01	543.25	545.37	0.005816	6.75	558.48	441	0.91
3040	527.05	543.11	543.16	0.000063	0.97	3676.05	583	0.1
1650	530.3	542.08	542.98	0.003069	4.23	800.11	386	0.64
630	533.1	541.63	542.16	0.00277	3.21	1040.71	640	0.58
0	533.49	538.86	540.08	0.009038	4.89	677.85	384	1.1

- **Dam break analysis**

Table 7.6: Maximum Stage Reached Along River Cross Sections

c/s	River Station	Q Total	Min Ch. El.	W.S. Elev	Vel. Chnl.	Flow Area	Top Width	Froude No.
		(m^3/s)	(m)	(m)	(m/s)	(m^2)	(m)	
dam	28360		587.74	625				
1	28133	4407.295	593.63	610.9	0.1	44072.95	1405	0.009683

c/s	River Station	Q Total	Min Ch. El.	W.S. Elev	Vel. Chnl.	Flow Area	Top Width	Froude No.
2	27593	14703.85	588.66	608.6	0.3	49012.84	1148	0.03145
3	26588	7026.136	590.18	605.4	0.2	35130.68	1070	0.023677
4	26304	12580.14	583.68	604	0.36	34944.82	1110	0.025498
5	25563	4814.463	584.03	603.1	0.1	48144.63	871	0.009311
dam	22733		581.95	597.2			1200	
6	21863	12987.91	577.64	596.8	2.8	4638.54	1290	0.23453
7	20033	20263.14	570	588.35	2.9	6987.29	1270	0.271325
8	17193	10905.44	557.24	583.8	2.14	5096	1104	0.165761
9	15513	6745.738	554.58	578	0.84	8030.64	1152	0.075418
10	12283	2976.217	548.72	561	0.14	21258.69	1694	0.032755
11	11453	3436.52	547.23	556.1	0.11	31241.09	1480	0.021792
12	9313	5840.918	544.09	550.77	0.33	17699.75	1510	0.004706
13	8093	3845.933	537.9	549.91	0.25	15383.73	1475	0.043032
14	6863	23811.25	542.02	548.9	3.02	7884.52	598	0.76277
15	5960	5639.052	536.32	548	0.4	14097.63	1240	0.003803
16	5190	7250.376	538.29	545.1	0.6	12083.96	1414	0.002223
17	3769	17549.5	533.01	542.87	7.73	2270.31	729	0.795971
18	3040	38074.97	527.05	541.7	4.2	9065.47	1280	0.390345
19	1650	16089.57	530.3	541.4	5.4	2979.55	755	0.67485
20	630	16102.86	533.1	541	3.24	4970.02	1280	0.418042
21	0	14600.61	533.49	542.6	2.66	5488.95	965	0.311377

Table 7.7 A: Stage v/s Time for Various Cross Sections

Cross section number	Cross section distance	Time in Hours						
		1	2	3	4	5	6	7
dam	28360	625	620	615.6	608	605	604	601.3
1	28133	608.5	610.9	607.3	605.1	603.5	600.8	599.1
2	27593	602.02	605	608.6	605.8	603.7	602.7	598.6
3	26588	600.35	604.9	605.4	603.8	601.5	601.2	598.4
4	26304	600.62	603.7	604	603.4	600	598.8	596
5	25563	601.1	602.2	602.6	603.1	599.8	598.6	596.4
dam	22733	596	595.6	597	597.2	594.3	595	595.2
6	21863	590.5	593.8	596.5	596.2	593.1	596.8	594.2
7	20033	574.88	577	583.74	588.35	587.5	585.2	586.9
8	17193	564.39	566.7	575.9	582.7	578.11	583.8	579.9
9	15513	560.76	563.3	568.23	574	572.5	578	575.7
10	12283	553.1	553.9	558.5	560.4	557.9	556	556.4
11	11453	550.7	552.5	553	554.3	554.9	551.3	548.7
12	9313	546	546	546.1	546.3	546.3	546.7	546.9
13	8093	540.2	540.2	540.2	541.9	542.5	544.8	544
14	6863	543.2	544.04	543.03	543.03	543.03	543.03	543.03
15	5960	539.2	539.8	539.8	540	541	541.4	541.4
16	5190	539	539.3	539.4	539.4	539.4	539.4	540
17	3769	538.21	538.22	538.22	538.22	538.22	538.22	538.22
18	3040	531.7	532.9	532.8	532.9	533.2	533.2	533.2
19	1650	532.2	532.2	532.2	532.2	532.2	532.2	533.3
20	630	534	534.1	534.1	534.1	534.1	534.1	534.1
21	0	535.5	535.2	535.53	535.51	535.51	535.4	536.64

Table 7.7 B: Stage v/s Time for Various Cross Sections

Cross section number	Cross section distance	Time in Hours						
		8	9	10	11	12	13	14
1	28133	598.4	596.7	595.2	593.65	593.68	594.43	593.93
2	27593	596.4	593.8	591.8	590.4	591	590.5	590.3
3	26588	596.4	594	592	590.78	590.78	590.78	590.78
4	26304	594.8	591.9	588.8	588	585	585.9	585.8
5	25563	595.5	590.6	588	587.8	584.7	584.7	584.7
dam	22733	592.7	589.2	587.5	587.2	584.5	584.5	584.5
6	21863	590	585	582	581.18	577.95	580.11	580.74
7	20033	584.7	580.9	578.7	575.3	573.9	573.7	573.2
8	17193	573.4	575.9	570.1	564.8	562.5	561.4	560.7
9	15513	572.3	570.2	566.5	562.9	560.2	557.8	556.6
10	12283	557.9	561	554.3	552.19	551.53	548.73	548.74
11	11453	550.4	552.4	556.1	551.7	551.14	551.14	551.14
12	9313	546	547	548	550.77	549.9	547.1	547.3
13	8093	544.1	546.1	543.8	544	549.91	549.39	546.8
14	6863	543.03	543.03	543.03	545.6	548.6	548.9	545.9
15	5960	541.6	541.8	541.9	543	546	548	545
16	5190	540	541	541.8	541.6	543	544.9	545.1
17	3769	538.22	538.22	538.22	538.5	540.1	542.87	539
18	3040	536	536	537	537.4	538	541.7	540.3
19	1650	534.1	535.2	535.4	535.9	540	541.4	540
20	630	534.1	534.1	534.1	534.4	538.6	541	539.7
21	0	536.1	537	537.53	536.3	537	541.73	542.6

Table 7.7 C. Stage v/s Time for Various Cross Sections

Cross section number	**Cross section distance**	**Time in Hours**						
		15	16	17	18	19	20	21
1	28133	593.65	593.76	593.82	594.11	593.65	593.83	594.84
2	27593	590.3	590.2	590.43	590.9	590.8	590.8	590.8
3	26588	590.78	590.78	590.78	590.78	590.78	590.78	590.78
4	26304	585.7	585.7	585.7	585.7	585.8	585.6	585.6
5	25563	584.7	584.7	584.7	584.7	584.7	584.7	584.54
dam	22733	584.5	584.5	584.3	584.2	584.1	584.5	584.6
6	21863	579.39	578.8	578.64	578.3	578.3	578.3	578.76
7	20033	573	573.3	573.3	573.3	573.59	571.06	572.97
8	17193	560.3	560.3	560.2	560.2	561	560.2	560.2
9	15513	556	556.1	556	556.03	556.69	557.4	556.3
10	12283	548.75	548.79	549.74	552.13	553.05	551.12	548.74
11	11453	551.14	551.14	549.06	551.89	552.69	548.55	548.55
12	9313	547.1	547.1	547.1	547.1	547.4	548.57	546.82
13	8093	543.3	541.7	541.2	541.2	541.2	541.2	540
14	6863	543.2	543.2	543.2	543.2	543.2	543.2	543.2
15	5960	540.7	540	540.4	540.2	540.3	540.2	540
16	5190	541.3	541.2	541.2	541.2	541.2	541.2	541.2
17	3769	536.7	536.3	536.3	536.3	536.3	536.5	536.4
18	3040	539.6	537	536.3	535.6	535.6	535.6	536.1
19	1650	539.2	538	535.2	535.1	535	535.3	534.8
20	630	539	536.9	536.7	536.7	536.7	536.7	536.7
21	0	535.55	535.5	535.52	535.54	535.51	535.5	535.1

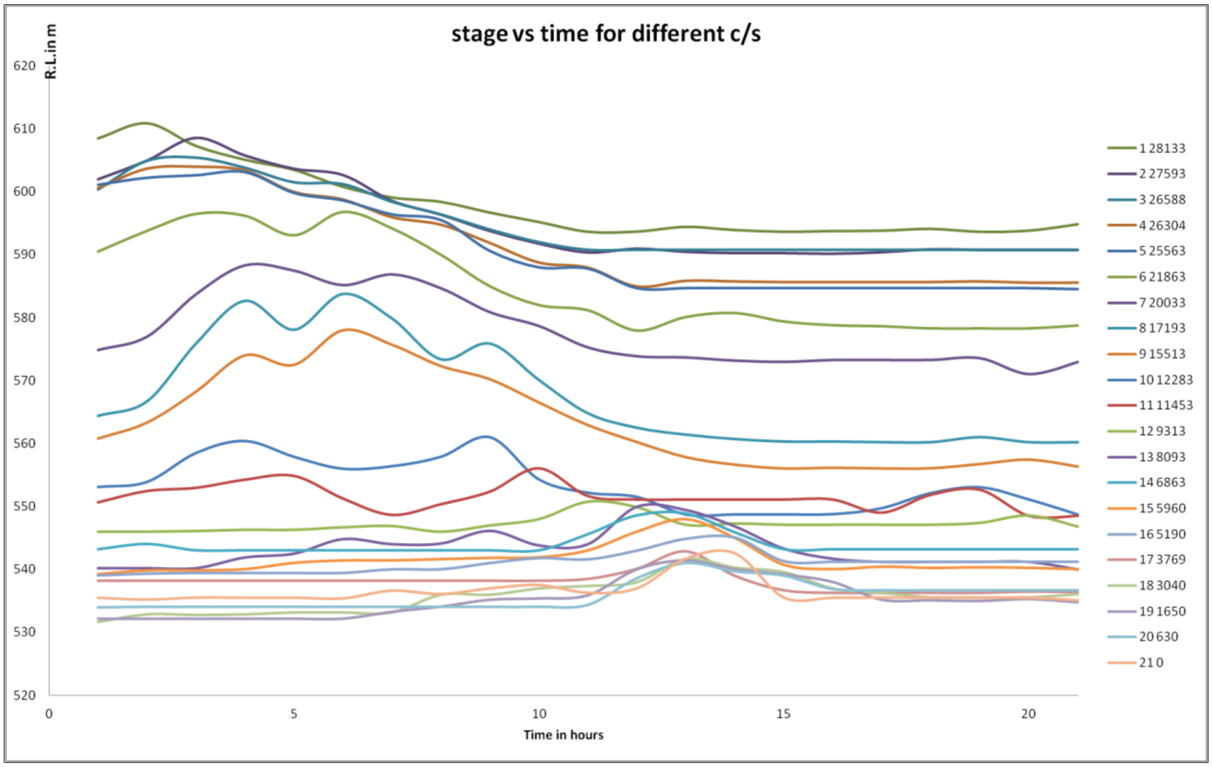


Fig.7.9. Stage v/s Time for Various Cross Sections

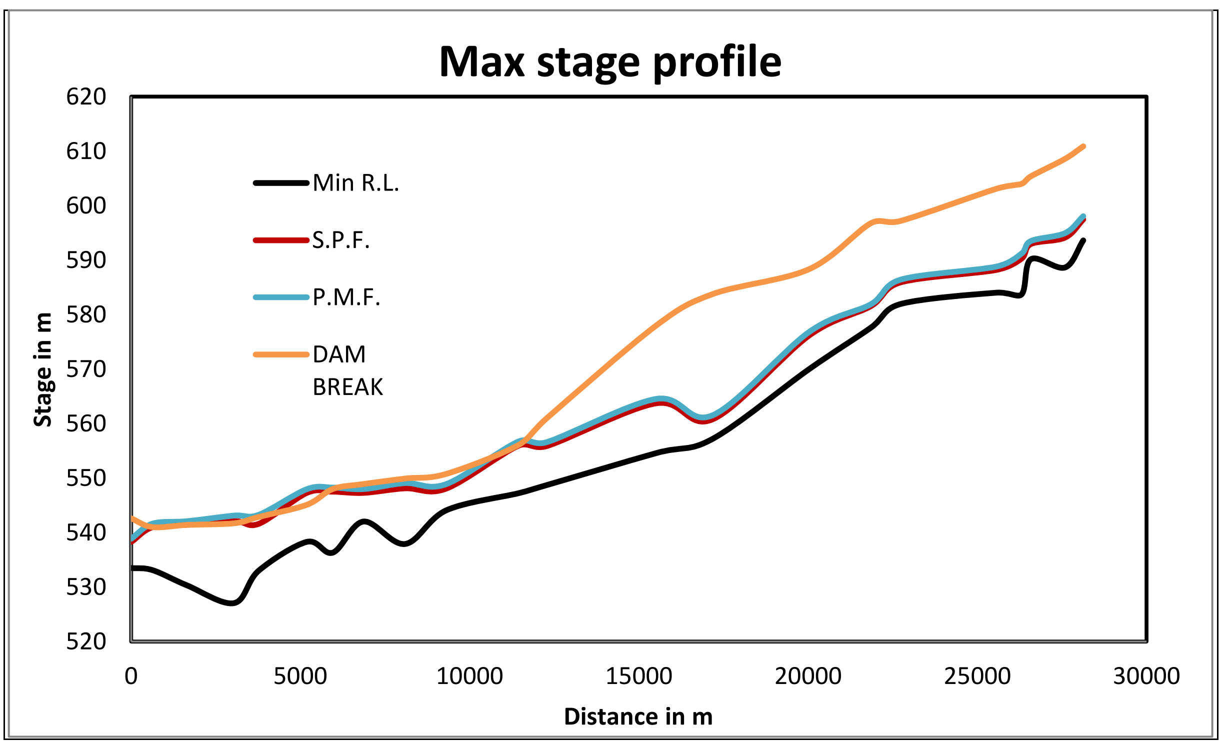


Fig. 7.10: Maximum Stage Reached for Flow Conditions

7.1.8 Conclusions

From various scenarios analysed, prohibitive zone map can be generated based on running steady flow routing model for various discharges starting from 100 cumecs to 2233 cumecs, finalising river channel capacity at 1500 cumecs. Restrictive zone mapping is generated based on P.M.F. discharge of 2233 cumecs. For cautious zone mapping worst scenario of dam failure of both dams as documented previously is considered. Emergency action plan can be prepared considering travel time, maximum stage reached to identify properties, population, roads and railway lines inundated and safe places and roads for shifting.

7.2 Emergency Action Plan

7.2.1 Introduction

The Emergency Action Plan (E.A.P.) is prepared as per the guidelines set down in Chapter No 8 of the Dam Safety Manual of the Department of Water Resources. Emergency action Plan is prepared considering the possibility of failure of Khunthephal dam due to major causes such as overtopping, foundation defect, and Piping and seepage cause. The maximum flood level is taken into account for generating emergency action scenarios.

7.2.2 Hazard Potential of Dam

The proposed project will bring assured irrigation facility to the area and thereby enhance the income from the agriculture based activities. This will boost the social as well as economic conditions of the farmers. In order to make this possible, the proposed 'Ashti Lift irrigation Scheme' intends to use 5.68 TMC of water. The hazard potential of the dam in case of failure is related to the possible extent of loss of life and property. Looking at the extent of likely damage to the life and property, project can be categorized as a dam of low hazard potential. The extent of likely damage depends upon the size of population and the values of property situated in the flood affected zone.

7.2.3 Preparation of Emergency Action Plan

The aim of Emergency Action is to identify, in advance, the type of emergencies, which are likely to occur in connection with operation of any reservoirs. This will include identification of probable areas, population, or structures and installations likely to be affected adversely due to water stored in the reservoir or due to flood water let from the reservoir or the likely catastrophic floods in the event of failure of dam. This plan further includes making advance plans and preparations for handling efficiently and to the best extent possible, the expected adverse situations especially to avoid loss of human life.

7.2.4 Evaluation of Emergency Potential

This is done on the considerations of evaluation of likely downstream inundation due to dam break floods and the extent of population and property or vital installations located in the likely inundation area.

Size of likely breach and magnitude of flood

As per guidelines given in manual, the size of breach may be adopted as a trapezoidal cut in the dam with specified dimensions in the previous sections.. The breach may occur at the location where the height is maximum. At the time of failure, the reservoir capacity may be considered at maximum water level.

Extent of inundation due to dam break floods

From the type and size of dam, and size of storage and topography of the valley on downstream, the extent of area that would get inundated in the event of failure of dam is decided. Dam break floods are considered to be the same as worked out in most likely breach failure. Based on this flood, maps of likely inundation area due to dam floods are prepared.

7.2.5 Action to Prevent Risk of Failure

Vigilance by Technically Qualified Personal

The first step in the prevention of emergency is to minimize the risk of failure of structure by proper vigilance and surveillance.

Following is the list of technical staff on dam site.

1. Sub Divisional Engineer, in-charge of dam

2. Sectional Engineers, in-charge of dam.

It is necessary that, during rainy season i.e. from 1st June to 15th October every year, that a strict vigilance on the dam is kept round the clock is maintained, all staff relating to the safety of dam are well trained and wireless station installed at dam site.

Increased Vigilance during Critical Periods

It is instructed to the technical personals to keep increased vigilance during following situations.

i) During the periods of intense rainfall in the catchment of dam.

ii) During the periods of excessive floods.

iii) About month following critical earthquake event in the region.

Wherever the signs of adverse behaviour are observed then, the deficiencies are rectified until normal behaviour is confirmed.

Keeping Stock Piles of Suitable Construction Materials for Emergency Use

The Following quantity of materials is stock piled at dam place for emergency use.

1 Murum

2 Impervious soils

3 Gravel or Metal (40 mm)

4 Sand (Max. size 6 mm)

5 Rubble

6 Empty Cement bags

The Sectional Engineer o Sub Divisional Engineer are keeping close watch on the dam behaviour.

Machinery

Following machinery is kept ready at dam site for use during critical periods.

Tipper

Tanker

Jeep

7.2.6 Structure of Emergency Action Plan

The List of Officers with Telephone No. and Fax Number are provided in the Appendix I.

The details on the positions, titles, addresses and telephone numbers of all officers and authorities connected with the implementation of Emergency Action Plan (EAP) with similar information of all the alternates is appended in Appendix II. Instructions about orders from these officers will be noticed.

Khunthephal Dam and Mehekari dams are an earthen dam. During emergency condition, the dam may fail slowly, rapidly or practically instantaneously. So there is a need for developing the emergency action plan structure for each case above mentioned.

The Key personnel for Co-ordination of whole plan will be:

The Executive Engineer,

N.M.C. no 2 Valjapur Hq. Aurangabad, TQ. Aurangabad

District: Aurangabad

A. Slowly developing failure

Notification Prior to Dam Failure

If the failure is imminent then the technical officer of Sub Divisional Office, **M. I.** Sub Division, bhum hq. Ashti will report to **The Executive Engineer, N.M.C. no 2 Valjapur Hq. Aurangabad, TQ. Aurangabad District: Aurangabad** about emergency conditions prevailing on dam site. Then the Sub Divisional Engineer, **M. I.** Sub Division, bhum hq. Ashti **will** rush to the site immediately. He will undertake the supervision of repair work started already with available material and labour. One of the persons on the site will immediately rush to the Sarpanch of concerned villages for alerting the villagers and wireless message will be given to Tahsildar, Beed. However the message will not be passed for evacuation of life and property as a slow failure of dam will not raise much flood water level in the downstream river. However the **The Executive Engineer, N.M.C. no 2 Valjapur Hq. Aurangabad, TQ. Aurangabad** will pass alert signals to Tahsildar, Ashti as per the conditions and message received from site in-charge Engineer, necessary order for evacuation of lives and property will pass on **The Executive Engineer, N.M.C. no 2 Valjapur Hq. Aurangabad, TQ. Aurangabad** in consultation with Tahsildar, Ashti and Police authorities. However the evacuation will not be required in case of slowly failure of dam.

Notification after Dam Failure

The Executive Engineer,N.M.C. no 2 Valjapur Hq. Aurangabad, TQ. Aurangabad

will convey "*Alert*" signal to Tahsildar, Ashti after receiving necessary information from the site in-charge Engineer. Tahsildar, Ashti will convey immediately this message to the Chairman of Emergency Action Plan (E.A.P.) committees in concerned villages. The people in these villages that are very near on

river bank will be warned to remain alert against flood water level and will be asked to keep close vigilance on slowly raising water level. However in case of slowly failure of dam, it is estimated that water level in river course will not rise beyond serious level to evacuate lives and property.

Following important addresses are given regarding responsible personals for maintaining

dam and conducting emergency action plan.

a) Executive Engineer

The Executive Engineer,

N.M.C. no 2 Valjapur Hq. Aurangabad, TQ.Aurangabad

District – Aurangabad

b) Sub Divisional Engineer

M.I. Subdivision, Bhum Hq,TQ. Ashti

District – Beed

c) Tahsildar, Ashti

District – Beed

B. Rapidly Developing Failure and Practically Sudden Failure

Notification prior to Dam Failure

If the failure of the dam is imminent then the technical staff present on dam will communicate this fact by means of wireless to the **The Executive Engineer, N.M.C. no 2 Valjapur Hq. Aurangabad, TQ. Aurangabad** Immediately after receiving information, **N.M.C. no 2 Valjapur Hq. Aurangabad,** will pass the “Alert” signal to Tahsildar, Ashti. The Tahsildar, Ashti will convey this message to EAP committees of concerned villages. Meanwhile the highest technical person present on the dam site will start the immediate repair work with the available labour and material on dam site. One of the people available will rush to the concerned villages for alerting the villagers in the immediate down stream. Sub Divisional Engineer / Assistant Engineer on dam site will pass on “Alert” signal to Executive Engineer, **N.M.C. no 2 Valjapur Hq. Aurangabad,** by wireless. The “Crash” message will be given under code word “Cobra”.

The Executive Engineer, **N.M.C. no 2 Valjapur Hq. Aurangabad,** will pass on this message to:

i) Secretary, Irrigation Department

ii) Chief Engineer (WR), Aurangabad

iii) Collector, Beed

iv)The District Superintendent of Police, Beed

v) Chief Executive Officer, Beed Zilla Parishad.

After receiving of “Alert” signal the Police force will storm their beats conveying warning to the villagers including village flood committee. The Police force will convey the “Alert” and “De Alert” signal, as the case may be. The village officers ensure beating of a drum for indicating the “Alert” and “De Alert” signals. On receiving of “Alert” signal the Tahsildar, Ashti will go to the dam site & camp there till “De Alert” signal is given. The Sub Divisional Engineer, Khunthephal Project Sub Division, Beed will direct the Police Sub Inspector, Beed Police Station to move the Police parties. The *Aval Karkoon*will halt at Tehsil Office, Beed. On receipt or “Alert” signal the District Superintendent or Police will inform District & Taluka .Home guard Commandants simultaneously and instruct them to be in readiness for under taking evacuation operations when it becomes imminent. The Collector of Beed will remain at headquarters and exercise overall supervision. Onreceipt of “Alert” signal, the Superintending Engineer, Aurangabad irrigation

Circle,, Aurangabad and the Executive Engineer **N.M.C. no 2 Valjapur Hq. Aurangabad,** will proceed to the dam site immediately to direct the repair operation.

Notification after Dam Failure

If the Sub Divisional Engineer, Project Sub Division, Beed is of the opinion that the situation has worsened and the breach is apprehended, he will give "Alert" signal to the officers. Sub Divisional Engineer Project Sub Division, Beed will give further intimation in the same manner of the breach and anticipated flood to the Collector, Beed. On receipt of "Action" signal the Collector, Beed will take full control of the evacuation and relief operations and direct supervision.

The District Superintendent of Police, Beed will accompany the Collector, Beed and assist him in all the operations. The list of key supervisory personnel and action flow is shown in **Appendix-I, II and III**.

7.2.7 Actions Following Discovery of Problems

A well trained Sub Divisional Engineer and Sectional Engineers are posted for maintenance and to keep close vigilance on Khunthephal Dam. These staffs are sufficiently trained to handle emergency situation if any, which may arise at dam site.

The above site staff working on Khunthephal Dam has to be trained for constructive repairs if required. After evaluation of emergency situations these staffs are instructed to convey, the emergency situation to **N.M.C. no 2 Valjapur Hq. Aurangabad,** and Tahsildar, Beed, by wireless message. Then after receiving emergency information the Executive Engineer will convey the "Alert" signal to the Chairman of Emergency Action Committee. The wireless station has to be working on Dam site, round the clock.

Then after receiving emergency information, the Sub Divisional Engineer, **M . I.** Sub Division, Bhum Hq. Ashti will rush to Dam site and convey the message to the Executive Engineer **N.M.C. no 2 Valjapur Hq. Aurangabad,** by means of wireless. Any unusual developments noticed on the dam are informed to the concerned Sectional Engineer / Sub Divisional Engineer available on spot who will then take actions for notification and constructive repairs depending upon the seriousness of the development.

Suitable Pre–determined remedial Action

a. Operation Vigilance

The staff posted for vigilance on the dam is adequately trained to handle various emergency situations that may arise on the dam, due to the various operating systems and devices gates and devices gates and control structures and the instrumentation observations. This can ensure that they can evaluate the nature of the problem and type of emergent remedial actions to be taken and can indicate the correct remedial action.

b. Lowering the Pool

By operation of radial gates it is possible to lower the lever of reservoir, which would reduce the danger to dam substantially. If overflow of Khunthephal Dam is moderated, 24% of water storage will be released. However in the present case, the reservoir is un-gated.

c. Determine Need for Public Notification

After evaluation of emergency situations then the Executive Engineer, **N.M.C. no 2 Valjapur Hq. Aurangabad,** will convey the emergency conditions to the Officers responsible for implementation of the Emergency Action Plan. If the conditions are severe and failure is imminent or has already begun, then direct notification of the condition of the emergency will be issued by Executive Engineer, **N.M.C. no 2 Valjapur Hq. Aurangabad,** or his assistant at the dam site to all the officers designated in the Emergency Action Plan, as well as then population likely to be affected for taking immediate necessary steps. If the conditions are such that sufficient time can be available even if the failure is likely to develop, then the need for public notification will be decided by Executive Engineer, **N.M.C. no 2 Valjapur Hq. Aurangabad,**.

7.2.8 Type of Emergencies

The Engineers in charge of maintenance of dam must have thorough knowledge of common types of emergencies and methods of remedial measures so that they can strive to save the structure from imminent failure. Following are the common types of emergencies. A copy of this report is required to be handy at dam site.

Overtopping

Overtopping has always been one of the major causes of dam failure and accounts for nearly three fourth of the recorded failure of dams. The most common cause for over topping is the inadequate spillway capacity. This type of emergency is caused due to inadequate hydraulic data and design. The other causes of overtopping can be insufficient free board, improper gate operation or failure of spillway gates operating mechanism. It is usual to provide the spillway capacity for safely routing the maximum anticipated inflow. This type of emergency can be avoided by preparing guide curves.

Embankment and Foundation Piping

Piping or progressive erosion of concentrated leaks which has caused large number of catastrophic failures may occur if the pressure head of seepage water at the exit is sufficiently high to dislodge the soil particles at the exit causing serious internal erosion along the path of seepage.

Boils

The boils may occur due to precious foundation strata like the layers of alluvium, sand and gravel on which the embankment rest. Boils may leads to piping if not properly treated. The most effective and practicable method of controlling individual large boils is to provide a ring bund of sand bags. If the phenomenon of piping is observed on a dam, the same must be tackled on emergency footing by adopting the following immediate as well as long-term measures.

- Laying inverted filter over the discharge face.
- Emergency lowering of the reservoir.
- Dumping of soil, murum and rock on the upstream.
- Preventing overtopping by raising the crest.
- Providing relief wills.
- Providing drainage trenches.
- Providing upstream impervious blanket.
- Grouting of the defected barriers.

Leak through an Earth Dam

When unusual leakage is observed on dams, the following action should be taken.

a) If clear water is coming through a leak

The situation is more serious. The discharge should be measured and the leakage is reported immediately to the Executive Engineer and copy to the Superintending Engineer.

b) If turbid water is coming out through a leak

The matter is serious and may develop into a dangerous situation. The full facts should be telegraphically communicated to the Executive Engineer, the Superintending Engineer, the Chief Engineer, the Chief Engineer and the Secretary, Irrigation Department.

The fact of having done so should be communicated telegraphically to the Executive Engineer, the Superintending Engineer, the Chief Engineer and the Secretary Irrigation Department. The clear water discharge should be kept under constant observation throughout the period until the lake is drained.

Foundation Slides

Many slides are caused by weak foundations. Foundation failure may take place due to excessive water pressure in confined silt or sand seams.

Slides in Embankment Slopes

Embankment slides can occur on either the upstream or downstream face if the slope is too steep for the strength of the soil.

Longitudinal and Transverse Cracks in Embankment

They are caused by differential settlement between adjacent length of embankment, usually between the portion located at the abutment and portion in the centre of the valley. Following measures need be taken immediately whenever cracks are observed in the embankment.

1) Find approximate depth of crack.

2) Carry out water test.

3) Cracked portion should be excavated in the form of trench up to bottom of crack and trench filled by well-compacted soil.

For cracks more than two meters deep clay cement mix grouting may be adopted.

Junctions and Outlets

Junction and outlets are often sources of serious troubles in the earth dams. The method of emergency treatment in this case is almost similar to piping.

7.2.9 Constitution of Emergency Action Committee

If the dam breaches instantaneously then the following villages and city are likely to be affected by sudden floods.

Table 7.8: Villages That May Be Likely To Be Affected

Sr. No.	Village	Taluka	District
1	Pundi	Ashti	Beed
2	Shirapur	Ashti	Beed
3	Pimpalgaon Dani	Ashti	Beed
4	Kanadi Kh.	Ashti	Beed
5	Dhirdi	Ashti	Beed
6	Saratewadgaon	Ashti	Beed
7	Nimgaon Chaubha	Ashti	Beed
8	Anandwadi	Ashti	Beed
9	Rui Nalkol	Ashti	Beed
10	Nanda	Ashti	Beed
11	Shiral	Ashti	Beed
12	Hanumantgaon	Ashti	Beed
13	Takalsing	Ashti	Beed
14	Daithan	Ashti	Beed
15	Hingni	Ashti	Beed

In all above villages, the residential houses and places are likely to be affected. Thus it is very essential to save lives and properties of the peoples of these villages. After sudden failure of the dam, it will take following minimum time to reach the flood waterto respective places.

Table 7.9: Existing Properties Coming Under Prohibitive, Restrictive And Cautions Zones

Sr. No.	NAME	Flood Zone		
		Restrictive zone	Prohibitive zone	Cautious zone
1	Pundi	12	9	200
2	Shirapur	0	0	0
3	Pimpalgaon Dani	0	0	0
4	Kanadi Kh.	0	0	125
5	Dhirdi	50	0	75
6	Saratewadgaon	20	50	35
7	Nimgaon Chaubha	1	3	46
8	Anandwadi	0	0	5
9	Rui Nalkol	0	26	225
10	Nanda	15	90	35
11	Shiral	150	200	100

Sr. No.	NAME	Flood Zone		
		Restrictive zone	Prohibitive zone	Cautious zone
12	Hanumantgaon	10	0	96
13	Takalsing	0	0	3
14	Daithan	19	25	91
15	Hingni	0	5	2

So in the meanwhile, people of these villages and city can be shifted to safer places. Thus considering the gravity of the fact, it is necessary to form Emergency Action Committee (E.A.C.) to act against situation arising due to dam breaches. This committee will help communications during emergencies prior to dam breach or may help for evaluation ofpeoples and properties prior to get affected.

So as to form emergency action committees at Tahsildar level, proposal is to be given to Tahsildar, Ashti by **N.M.C. no 2 Valjapur Hq. Aurangabad,** for the above said villages. The overall formation of committee will be as follows:

Chairman – Tahsildar, Beed

Vice Chairman – Police Inspector, Police Station Beed

Members – Sarpanch & Police Patil of concerned villages.

Also for important cities and towns, EAC may be constituted with the District Collector being the Chairman of EAC

If there is any occurrence, which is likely to involve danger to the dam, the Executive Engineer, Sub Divisional Engineer besides taking remedial measures, should report the fact

to the following officers by wireless.

1) Secretary, Irrigation Department.

2) Chief Engineer

3) Commissioner of Revenue

4) Collector of the District

5) Chief Executive Officer, Zilla Parishad

6) Superintending Engineer

7) District Superintendent of Police

8) Station Master of nearest Railway Station

9) Sub Divisional Officer (Revenue)

10) Tahsildar

7.2.10 Special Preparedness before first Filing of Reservoir

Many failures of the earth dams have occurred at the time of first filling of reservoirs. The period of first filling and two to three cycles of filling is a critical period in the life of dams. It is very essential to watch carefully the performance of the dam during this period. The preparedness as given below is therefore very essential for the first filling of the reservoir.

Emergency Action Plan

Before starting the first filling of reservoir the emergency action plan of such individual project should be completed and Emergency Action Committee (E.A.P.) must be constituted.

Completion of gate installation

The Installation of spillway gates and gate for head regulators including emergency gates, stop logs, hoisting arrangements, emergency power etc. must be completed before monsoon i.e. 30th April.

Special Inspection

The Superintending Engineer, Executive Engineer or Sub Divisional Engineer in charge of the dam should complete the special pre monsoon inspection of the dam before 31st May. The inspection report must be submitted to the Chief Engineer and the Superintending Engineer, Dam Safety Organization, Nashik.

Reservoir filling Schedule

Executive Engineer in charge of the dam should prepare the schedule for first filling of the reservoir and get it approved from the Superintending Engineer before start of monsoon, every year. The copy of schedule should also be sent to the Chief Engineer and Superintending Engineer, Dam Safety Organization, Nashik.

Flood lighting of dam for vigilance

The lighting facilities on the dam should be provided before start of monsoon for close vigilance during the night time also. A generator should also be installed for emergency use.

Communications

Arrangements should also be made to contact the dam site with the headquarters of the Executive Engineer by wireless. The wireless must be out of flood zone.

Access roads

Access roads should be established to all vulnerable locations of dam as well as downstream toe of dam, for movement of machinery. The temporary roads from stock piling of materials to the dam should also be prepared before onset of monsoon.

Stock piling of repairs materials

The total stock piling will be 50 Cu m of stone metal and 50 Cu m of rubble. About 2500 bags (empty cement bags) filled with Murum should be kept ready on the crest of the dam.

Machinery

Machinery like tippers, trucks and excavators or dozer should be kept at the site.

Labour

At least 50 labours should be available on either flank to start remedial measures at a half hour notice.

7.2.11 Vigilance during the First Year of Filling of Reservoir

During the first year of commissioning of earth dams, careful watch needs to be kept particularly at outlets, junctions and in gorge portion. Dams are categorized as under for the purpose of vigilance. Height Storage capacity

- **Category 'A' -**More than 30 m. -**More than 100 M cum.**
- **Category 'B' -**More than 15 m -.**More than 20 M cum.**
- **Category 'C' -**Up to 15 m. -**Up to 20 M cum**

The Superintending Engineer should list up all the dams of category A and B in his charge. In case the new gorge filling works, he must insure that it is possible to complete the gorge filling before the 30th April.

The Executive Engineer must take similar precaution in respect of all the dams of category ‘C’.

All the dams of category ‘A’ and ‘B’ should be flood lighted and round the clock vigilance should be maintained by making special patrolling arrangements.

A responsible engineer of appropriate rank should stay at dam site camp during the first monsoon so as to inspect it regularly and intensively every day.

The first inspection should be carried out in the month of July or all the onset first heavy rains. The second inspection should be carried out at half storage capacity. The third inspection should be carried out when the spillway is about to flow.

Any sweat, subsidence leakage, cracking or sign of slipping of slopes should be immediately brought to the notice of immediate superior officer by the patrolmen or the engineers responsible for vigilance or periodical inspections as soon as such phenomena is noticed.

Daily reports about stage of lake filling and condition and behaviour of the dam must be submitted by the engineer responsible for continuous vigilance of the dam to his immediate superior.

Reports about stage of lake filling and condition and behaviour of the dam must be submitted by the engineer to his superior.

The Executive Engineer should however visit all important dams in category ‘C’, at least once when F.S.L. is reached for the first time.

The Superintending Engineer should however visit all the dams of Category “A’ and “B” at least once when the F.S.L. is reached for the first time.

The above procedure of vigilance should also be followed for the second and third yearof filling for all new dams.

7. 2.12 Vigilance of Dam during monsoon after Third Year of Filling

Round the clock patrolling should be maintained during filling of the dam. The Sectional Engineer / Assistant Engineer (Gr. II) in charge of the dam should stay atthe dam site throughout the monsoon and should inspect it regularly and intensively. The Sub Divisional Engineer concerned should visit the dam, when it is filled half the height up to F.S.L. during heavy rains, and when the waste weir is about to overflow. The Executive Engineer concerned should inspect important dams when the F.S.L. is reached and even earlier if possible having regard to the member of dams in his charge requiring vigilance.

The Superintending Engineer should inspect the dam at his direction. Stock piling of construction materials for emergency use such as filter materials like Sand, Metal or Rubble and stocks of Murum at various valuable places for emergency use as collected at the time of first filling of the dam should be maintained. The stock pile at each of the vulnerable part of the dam should comprise of:

- Sand 10 Cum
- Metal 10 Cum
- Rubble 10 Cum

At least 20 able bodied labours should be kept at the site for any emergent repairs.

In case of earth dam which although not being commissioned for the first time, have never the less been known to behave abnormally in the past, special watch should be kept during the monsoon to observe the effect of remedial measures taken and in any case to ensure safety of the dams.

The Emergency Action Plan of the dam should be kept up to date and operative during the monsoon period.

7.2.13 Actions in Dealing with the Public Safety during Emergencies

Preparatory measures

The Tahsildar, Ashti will form flood committee immediately in the villages likely to be affected by the floods.

The committee will consists of following persons:

1) Sarpanch of the Village Panchayat

2) Police Patil

3) Chairman of Co-operative Society.

4) President of the Village Farmer's Co-operative Society

5) Head Master of Village School

a) These village committees are to be informed that they are formed for the purpose of warning the villagers on receipt of information regarding coming of any flood arising out of any mishap to Khunthephal Dam. They will also be instructed as to their duties on receiving Intimation of flood and also on receiving instructions for evacuation. They should also be informed that in case of evacuation is to be undertaken, they will use their own transport available in the village. The able bodied men and women should carry their belonging by themselves and the old, infant and children should be taken to the places of safety in the bullock cart available in the village.

b) The Tahsildar of Ashti will fix the safe places in consultation with villages to which villages should go on their being asked to evacuate with their cattle and belongings. The fixing of the places of safety as well as the indication of the flood line according to village map by Sub Divisional Engineer, **M. I.** Sub Division, Bhum Hq. Ashti Sub Division.

c) The village food committee will be informed that these arrangements are precautionary measures and there is no need of being panicked on account of these precautionary measures.

The village flood committee will arrange as and when necessary for putting shelters at the place of safety as also for immediate needs of food, water and clothing etc. The supply of sheets for shelter will be arranged by the Collector, Beed through the Tahsildar, Ashti and kept at central places within easy reach of the proposed evacuation centers.

d) The arrangements made by Tahsildar, Ashti in regards to points (a) to (c) above, will be reported to the Commissioner, Aurangabad Region. The Superintending Engineer, Beed Irrigation Project Circle, Beed and Collector, Beed and District Superintendent of Police of Beed and the Executive Engineer **N.M.C. no 2 Valjapur Hq. Aurangabad,** will also be required to be informed by the 25th June every year. Two Police teams/parties will be provided for the project. Each will consist of one head constable and two constables. One will be stationed at the dam site and the other Police party will be located at city area. The Sub inspector of police, Beed should assign duties to each police party in consultation with the Executive Engineer, **N.M.C. no 2 Valjapur Hq. Aurangabad,** The Chief Executive Officer of Beed Zilla Parishad will instruct

Block Development Officer, Beed to spare jeeps as and when required for evacuation and other relief works. The Chief Executive Officer should issue instructions to all staff to render assistance when called up on by the Tahsildar, Beed. A copy of instructions issued by the Chief Executive Officer should be endorsed to the respective officer, *Prant* Officer, Tahsildar Beed. The Superintending Engineer, Aurangabad irrigation Circle, Aurangabad, Aurangabad irrigation Circle may spare a jeep for the Prant Officer, Aurangabad if available. The Executive Engineer, **N.M.C. no 2 Valjapur Hq. Aurangabad,** will supply copies of the maps showing flood zone along with the following:

i) List of villages likely to be affected.

ii) List of Special Installations.

iii) List of public properties such as railway and road bridges, railway lines

Inspection bungalows etc. and

iv) Road liable to be submerged under flood water with alternative diversions tothe under mentioned officers:

1) The Commissioner, Aurangabad Division

2) The Chief Engineer (WR) Aurangabad

3) The Collector of Beed

4) The Superintending Engineer, Aurangabad irrigation Circle, Aurangabad.

5) The Chief Executive Officer, Zilla Parishad, Beed.

6) The Sub Divisional Officer, Beed

7) The Tahsildar, Beed

8) The Superintending Engineer, Aurangabad irrigation Circle, Aurangabad, will ensure storage of adequate quantities of repair material. The material is to be staked on dam site.

9) The Tahsildar, Ashti will prepare a list of 100 able bodied person from nearby villages and he should give the copy to the same to Sub Divisional Engineer, Project.

7.2.14 Alert Signal

a) Sub Divisional Engineer, **M. I.** Sub Division, Bhum Hq. Ashti or his Sectional Engineer is instructed to give message to Executive Engineer, **N.M.C. no 2 Valjapur Hq**, Aurangabad, as soon as there is any occurrence, which is likely to involve the dam in danger. Then Executive Engineer, **N.M.C. no 2 Valjapur Hq. Aurangabad,** arrange to deliver the message to the officers mentioned:

-Chief Engineer, Aurangabad

-Commissioner, Aurangabad Region

-Collector of Beed

-Superintending Engineer, Aurangabad irrigation Circle, Aurangabad.

-Deputy Inspector General of Police, Beed

-Superintendent of Police, Beed District.

-Chief Executive Officer, Zilla Parishad, Beed

-Tahsildar, Beed

b) On receipt of the "Alert" Signal the Tahsildar, Beed, will go to dam site and camp there, till a "Clear" signal is given. The Sub Divisional Engineer, Project Sub Division, Ashti will direct the Sub Inspector of Police to move the Police Parties. The Aval Karkoon will halt at Tehsil Office.

c) On receipt of "Alert" signal the District Superintendent of Police, Beed will alert Taluka Home Guards commandants and Instruct Sub Division Police Officer, Beed.

d) The Collector of Beed will take full control of evacuation and relief operations and direct and supervise them.

e) Superintending Engineer, Aurangabad irrigation Circle, Aurangabad to convey "Alert" signal to organize staff assistance and direct repair operations and to request commissioner for Army assistance.

f) The Sub Divisional Engineer, **M . I.** Sub Division, Bhum Hq. Ashti will inform to Police Party to alert the people and mobilize the labour for repair work. He will give hourly messages of the precise factual conditions of the dam until a "De alert" signal or the action warning is given to wireless operator who will transmit it to the officers mentioned above.

g) If as a result of repairs, the danger is averted, then Sub Divisional Engineer, **M. I.** Sub Division, Bhum Hq. Ashti will give “De-alert” signal to officers to whom the “Alert”

signal was given in the same manner as before.

7.2.15 Signals for Actions in case of Breach

a) Sub Divisional Engineer, **M. I.** Sub Division, Bhum Hq. Ashti will give “Action” signal in the same manner as “Alert” signal, if, of the opinion that the situation has worsened and a breach is apprehended.

b) Sub Divisional Engineer, **M. I.** Sub Division, Bhum Hq. Ashti will give further information of the breach and anticipated timing of flood reaching each of concerned villages.

c) On receipt of “Action” signal Collector, Beed will supervise arrangements on site.

d) The District Superintendent of Police, Beed will assist Collector.

7.2.16 Control Measures for Prevention of Damage

The extent of damage will be very less if demarcation and classification of dam break flood zone is carried out and restricting the construction activities in various classified areas to certain specified types of use.

7.2.17 Land and Regulations

The Prohibitive zone

As per Dam Safety Manual Chapter 8, page No. 28, Prohibitive zone consists of normal discharge of regulatory flood from reservoir and free catchment. The prohibitive zone may be used only for open land type of use such as playground garden or cultivation of light crops. The calculated maximum flood is 1500cumecs for prohibitive zone. Detailed map is provided.

The Restrictive Zone

As per Dam Safety Manual Chapter 8 page No. 28, Restrictive Zone is the maximum outflow corresponding to spillway design flood together with similar flood from the free catchment. The calculated maximum flood is 2233cumecs for restrictive zone. In the restrictive zone the land use regulation may specify the safe height for the plinth level of the lowest flood level. Restrictions on the type of use of building in such zone may also be specified. While framing construction in such zone, compulsory insurance may also have to be considered. Detailed map is provided.

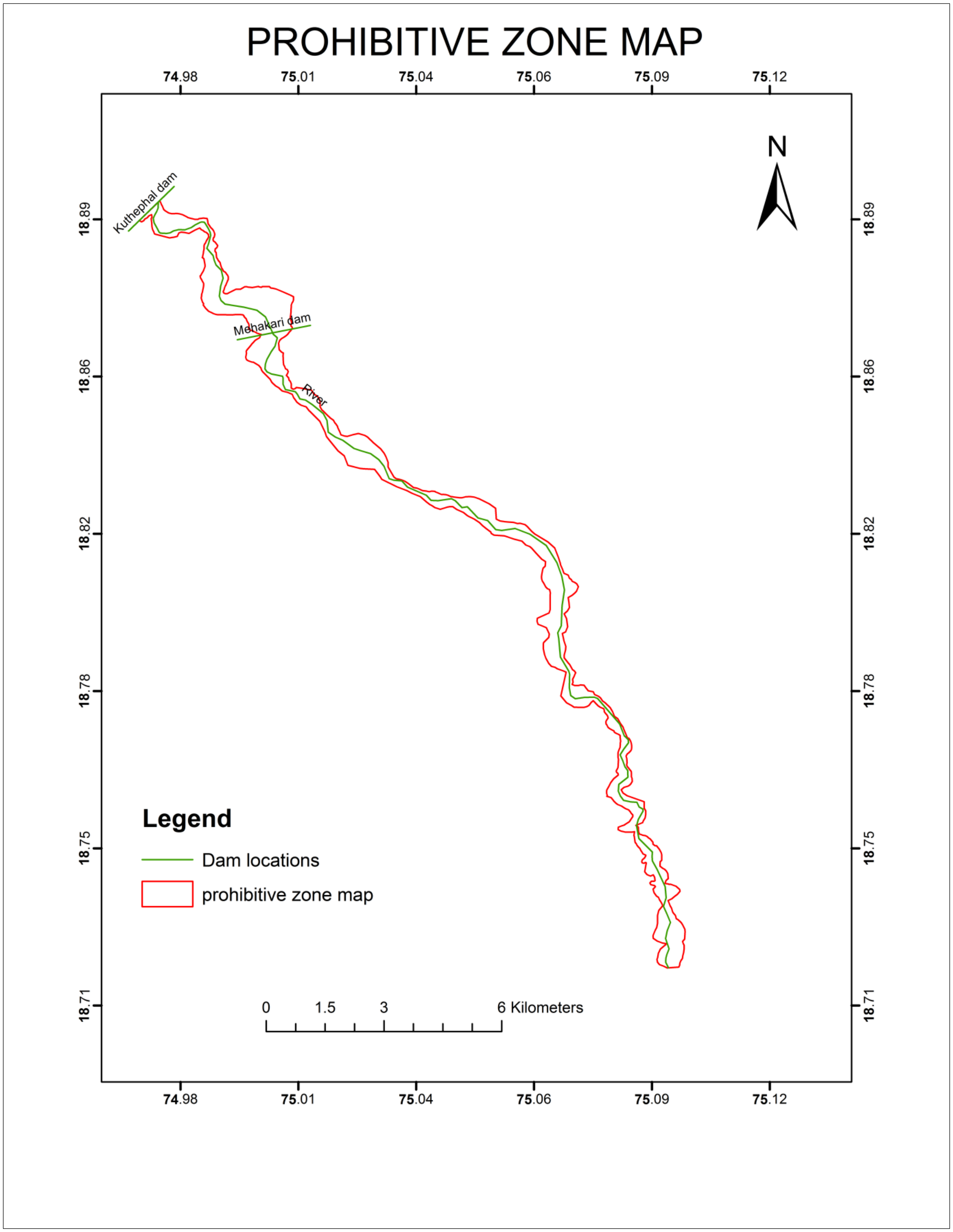
The Cautious Zone

The cautious zone for earthen dam is defined as a dam breach flood. Flooding in this area may be rare but not altogether impossible. The regulation for land use in this zone should only include caution about the flood risk. Detailed map is provided.

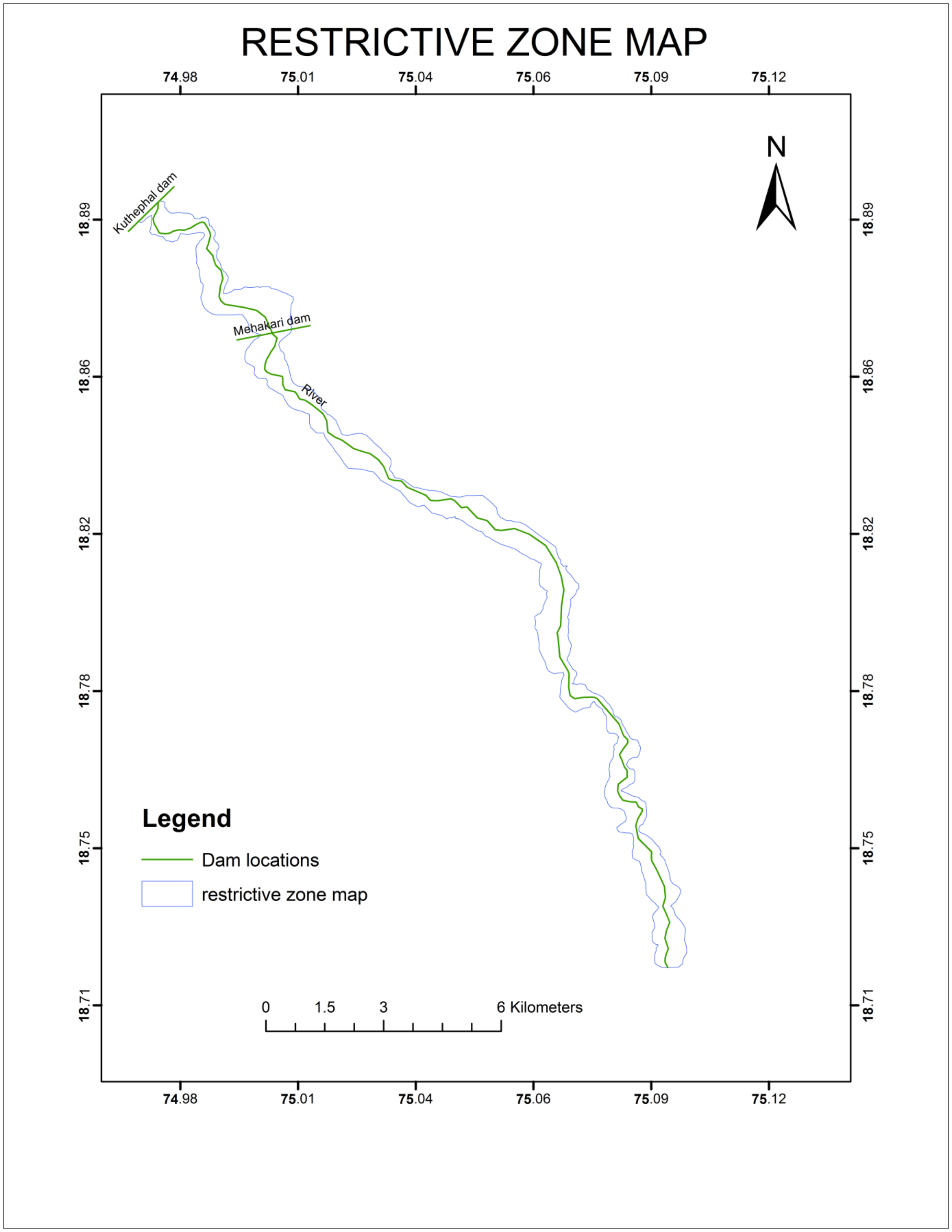
7.2.18 Preparation of Flood Zone Maps

The zoning maps are prepared. Different zones are shown**.** The detailed zoning maps viz. Prohibitive, Restrictive and Cautious are provided in the Dam Break Analysis report. The Prohibitive zone is demarcated by ***RED*** colour line, restrictive zone is demarcated by ***BLU*****E** colour and cautious zone is demarcated by ***GREEN*** colour in the maps. Refer Appendix I for the Flood Zone Map.

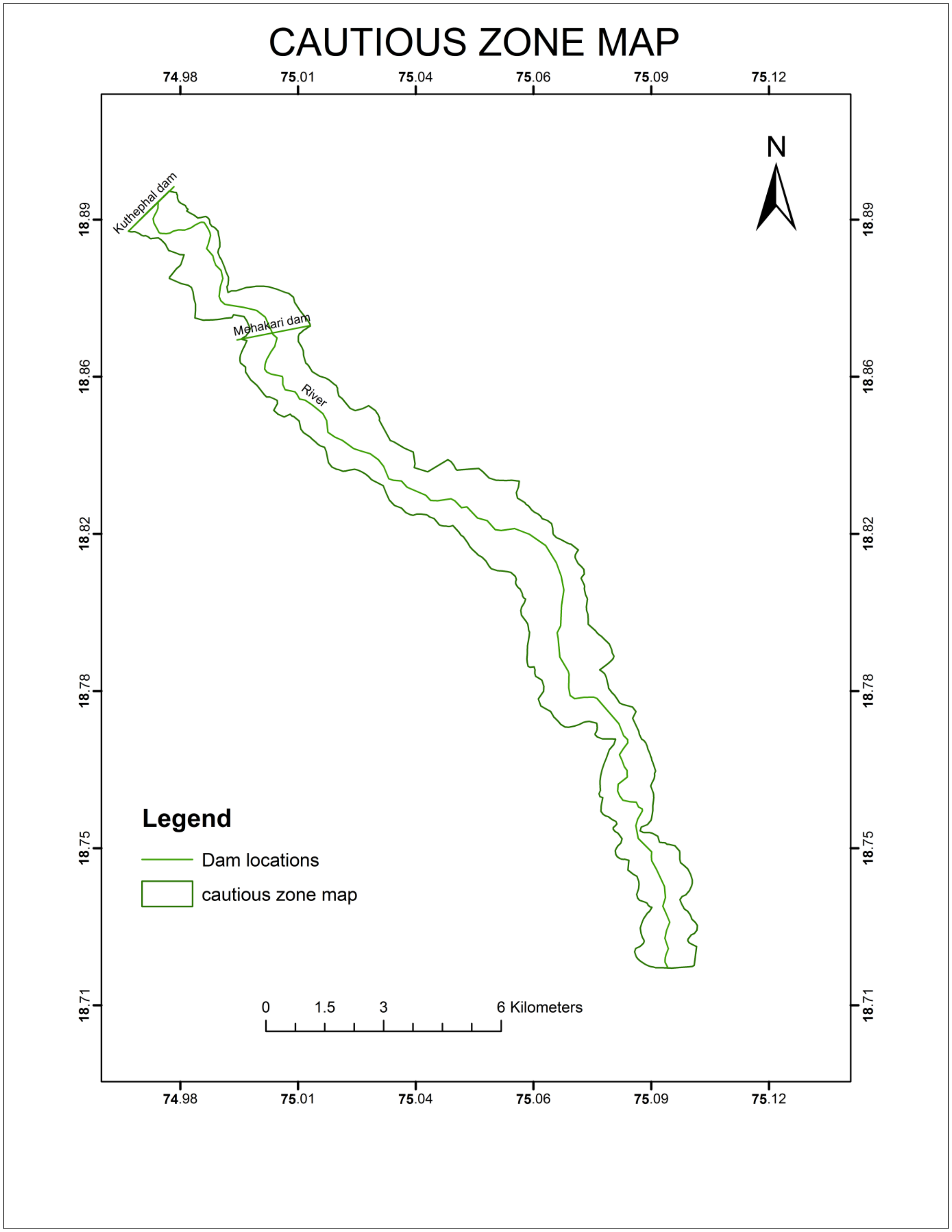
APPENDIX I

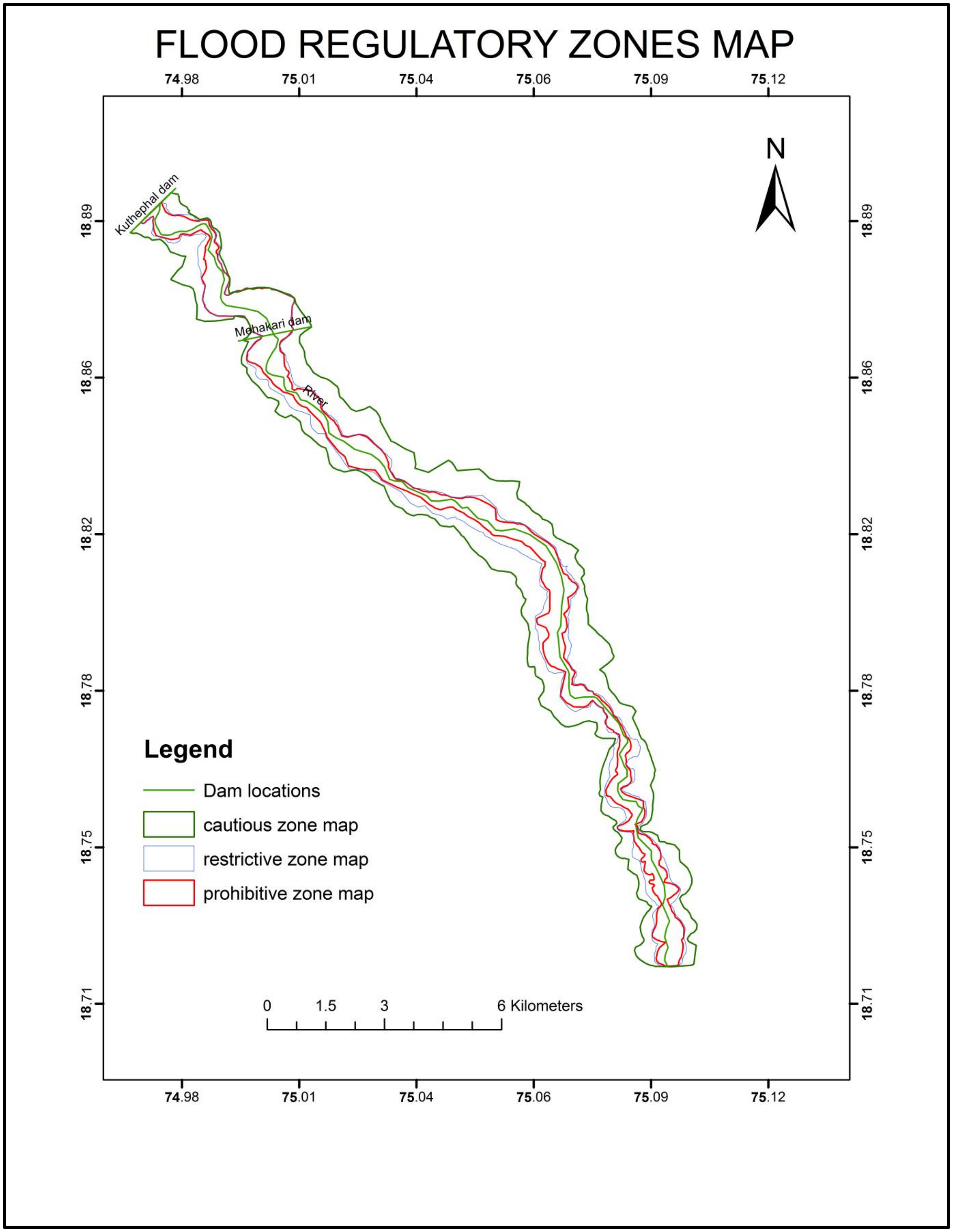


PROHIBITIVE ZONE MAP
74.98
75.01
75.04
75.06
75.09
75.12
18.89
18.86
18.82
18.78
18.75
18.71
N
Kuthephal dam
Mehakari dam
River
Legend
Dam locations
prohibitive zone map
0
1.5
3
6 Kilometers



RESTRICTIVE ZONE MAP
74.98
75.01
75.04
75.06
75.09
75.12
18.89
18.86
18.82
18.78
18.75
18.71
N
Kuthephal dam
Mehakari dam
River
Legend
Dam locations
restrictive zone map
0
1.5
3
6 Kilometers


CAUTIOUS ZONE MAP
74.98
75.01
75.04
75.06
75.09
75.12
18.89
18.86
18.82
18.78
18.75
18.71
N
Kuthephal dam
Mehakari dam
River
Legend
Dam locations
cautious zone map
0
1.5
3
6 Kilometers


FLOOD REGULATORY ZONES MAP
74.98
75.01
75.04
75.06
75.09
75.12
18.89
18.86
18.82
18.78
18.75
18.71
N
Kuthephal dam
Mehakari dam
River
Legend
Dam locations
cautious zone map
restrictive zone map
prohibitive zone map
0
1.5
3
6 Kilometers

APPENDIX –II

The List of Officers with Telephone No. and Fax No.

S.No.	Office Name	Address	Phone
1	Sarpanch of the Village Panchayat	Respective village	-
2	Gram Sevak	Respective village	-
3	Police Patil	Respective village	-
4	Chairman of Co-operative Society.	Respective village	-
5	Head Master of the village school	Respective village	-
6	Local Police station	Respective village	-
7	Nearest Post and Telegraph Department	Respective village	-
8	Nearest Railway Station	Respective village	-
9	State Transport Department	Respective village	-
10	Panchayat Samiti, Ashti	Ashti	-
11	Tahasildar, Ashti	Ashti	-
12	District Collector	Beed	-
13	Commissioner of Revenue	Beed	-
14	District Superintendent of Police	Beed	-
15	Chief Executive Officer, Zilla Parishad	Beed	-
16	District Commandant of Home Guards	Beed	-
17	District Health Officer	Beed	-
18	District Publicity Officer	Beed	-
19	Secretary, Irrigation Department.	Aurangabad	-
20	Commissioner, Aurangabad Division	Aurangabad	-
21	Superintending Engineer, Aurangabad irrigation Circle, Aurangabad.	Aurangabad	-
22	Executive Engineer (Irrigation)	Aurangabad	-
23	Executive Engineer (P. W. and Housing)	Aurangabad	-
24	Chief Engineer (WR) Aurangabad	Aurangabad	-
25	Sub Divisional Officer, Beed	Ashti	-

APPENDIX – III

Emergency Action Committee of the following officer may be constituted for important Cities / Towns by the District Collector.

(Formation of Committee at Collector level)

- District Collector
- Chief Executive Officer of the Zilla Parishad
- Superintendent of Police of the District
- Executive Engineer (Irrigation)

- Executive Engineer (P. W. and Housing)
- A Representative of the Post and Telegraph Department
- A representative of the Railway if and railway line in inundation
- A representative of the State Transport Department
- District Health Officer
- District Commandant of Home Guards
- District Publicity Officer

The District Collector will be the Chairman of the Committee. He may nominate any additional person considered to be useful in the effective implementation of the emergency Action Plan to act as member of the committee.

(Formation of Committee at Tahsildar level)

- Assistant Collector or Tahsildar or B.D.O. as the Chairman
- Local Police station In-Charge or the Village Police Patil
- Gram Sevak
- Chairman of the village Farmer's Co-operative Society
- Head Master of the village school

This committee should be in operation from 1st July to October or till such time a danger is apprehended to the dam.

APPENDIX –IV

Action likely to be taken by concerned officers

Tahsildar:

i) Appointment of village level Flood Committees.

ii) To fix the safe places in consultation with the villagers.

iii) Preparation of list of hundred able bodied persons from nearby villages.

iv) After receiving “Alert” Signal from Irrigation Department, Tahsildar will go to site and camp there till “De Alert Signal” is given.

v) Tahsildar will suitably instruct the village flood committee.

Collector:

i) Supervise the situation from district head quarters and will exercise over all supervision till receipt of further signal.

ii) He will also inform the State Transport authorities to be in readiness to render assistance if required.

iii) On receipt of “Action” signal Collector, Beed will take full control of evacuation and relief operations and direct and supervise them.

Commissioner:

I) The Commissioner will write to Direct Police

II) Wireless M.S. Beed in connection with installation of wireless.

III) He will make arrangements for Military assistance if required by Collector.

Superintendent of Police:

To inform the District and Taluka Home Guard Commandants, simultaneously and instruct them to be in readiness for undertaking evacuation operations when they become necessary. He will also instruct the S.D.O. Police to keep in touch with the Prant Officer and remain in readiness for undertaking evacuation operations when necessary.

Chief Executive Officer Zilla Parishad:

i) He will instruct the Block Development Officer of Panchayat Samiti to spare jeeps as and when required for evacuation.

ii) He will also instruct to the staff to render all assistance when called upon by the Tahsildar or Prant Officer.

Superintending Engineer (Irrigation Department):

After receipt of “Alert Signal” Superintending Engineer will rush to the dam site with Executive Engineer and direct for the repair operations. The Superintending Engineer, will spare jeep for Prant Officer if available.

Executive Engineer:

i) The Executive Engineer will supply copies of map showing flood zone with list of villages likely to be affected, list of special installation, list of public property such as Railway, Road Bridges, inspection Bungalow, Roads liable to submerged under flood water.

ii) After receipt of “Alert signal” Executive Engineer will rush to dam site and direct the repair operations.

Sub divisional Engineer:

i) The Sub divisional Engineer or his Section Engineer/Asst. Engineer (II) and staff will transmit “Alert Signal” to the Executive Engineer.

ii) After Transmitting the “Alert Signal” inform the police party to alert the people.

iii) He will mobilize labour according to plan and deploy for efficient and expeditions execution of repair work.

iv) He will give hourly messages of precise factual conditions of dam, until “De Alert” signal or “Action” Warning is given to the wireless operator.

v) If as a result of repairs the danger is averted Sub Divisional Engineer will give “De Alert” signal to the officers.

vi) If the Sub Divisional Engineer is of the opinion that the situation has worsened and breach is apprehended he should give “Action” signal to the officers.

vii) The Sub Divisional Engineer will give further intimation in the same manner of the breach and the anticipated timing of the flood reaching each of the localities