

**CONSERVATION AND MANAGEMENT PLAN FOR LAKE:
A CASE STUDY OF DAL-NAGIN LAKE IN SRINAGAR**

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CONSERVATION AND MANAGEMENT OF LAKES**
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CONSERVATION AND MANAGEMENT PLAN FOR LAKE: A CASE STUDY OF DAL-NAGIN LAKE IN SRINAGAR

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DAL LAKE

- Greatest tourist attraction
- Living floating houses
- Floating gardens
- Livelihood for large population
- Landmark identification for Kashmir
- Evolved Kashmiri civilization around

DPR – AHEC- IIT ROORKEE

- October 1999: MoEF engaged Alternate Hydro Energy centre (AHEC) of IIT Roorkee for preparation of Detailed Project Report.
- December, 2002: DPR cleared by State Cabinet and submitted to Government of India.
- September, 2005: Sanctioned by GOI for Rs.298.76 Cr
- Project Period: Sept. 2005 to 2010 extended to 2013.

OBJECTIVES

To prepare, a Detailed Project Report of a Conservation and Management Plan which:

- Improves Lake and Its Ecology
- Is Sustainable
- Is Environment Friendly
- Is Cost Effective
- Involves minimum
 - *Interventions*
 - *Displacement.*

FACTORS AFFECTING LAKE

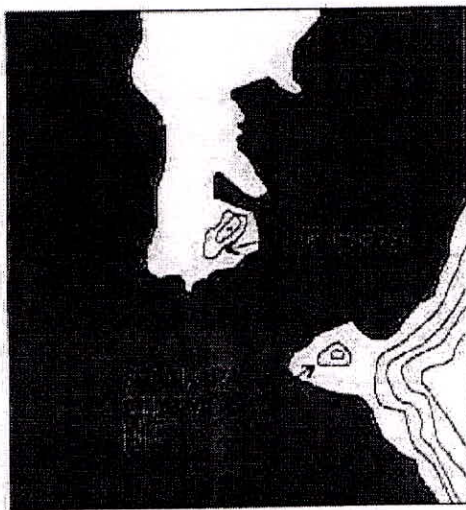
Lake is affected by its:

Watershed

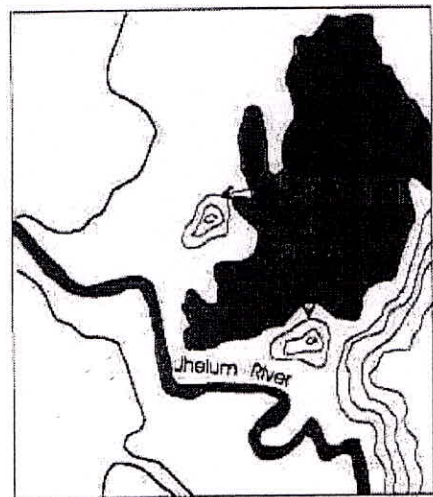
- Climate - rain and snow fall
- topography,
- hydrology,
- geology,
- manner of use of land, water and other natural resources

Manner in which the lake is Used & Activities in

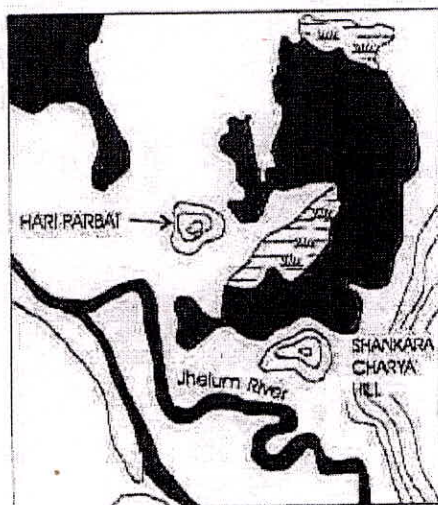
- Immediate vicinity
- Inside The Lake



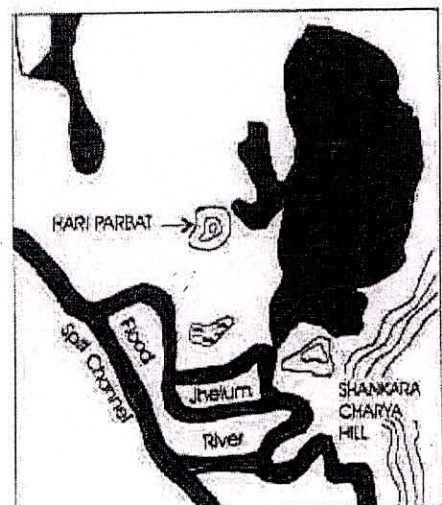
6th Century



15th Century



19th Century



1971

Fig. 1: Status of Lake since 1200 AD

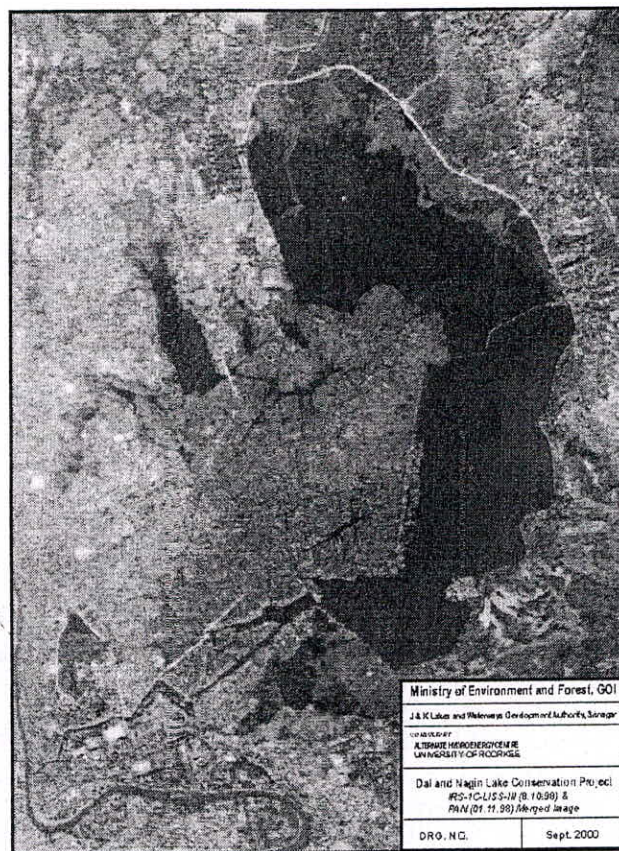


Fig. 2: Satellite Image of Lake, 1999
(5.8 m single channel and 22 m multispectral resolution)



Fig. 3: IKNOS satellite imagery Dec 30, 2000 with 1 m resolution



Fig. 4: Different Views of Dal-Nagin Lake

WATER TRANSPARENCY OF DAL LAKE

	Nagin	Hazratbal	Boddal	Gagribal
Depth of max Visibility (m)	4.8(3.8)	1.3	1.0	2.9(2.9)
Depth of min. Visibility (m)	2.5(2.0)	0.64	0.94	2.1(1.0)
Mean	3.6(2.9)	0.97	0.97	2.5(1.9)

ISSUES

- Reduction in Water Area - Encroachments by Hamlets and Floating Gardens
- Reduction in Volume - Silting Caused Mainly By Catchment Area Degradation
- Present area at various levels

Level	Area
1582.3 m	14.5 sq.kms.
1583.5 m	17.1 sq.km.

- Increased Pollution by - Lake Dwellers, Floating Gardens, Entry of Untreated Sewage, Solid Waste and Agricultural Return Flow
- Reduction in water channels within the lake - Decrease in Circulation
 - Reduction of fresh water inflow into the lake.
 - Nutrient enrichment of the lake resulting in excessive weed growth and changes in the bio-diversity

CONSTRAINTS

Large number of people living inside the lake, Agriculture in floating gardens, Shortage of land for disposing off dredged material and Power Shortage

METHODOLOGY

Undertook Site Assessment,
 Held extensive consultations with stake holders
 Obtained data from various sources ,
 Reviewed the existing data and reports,
 Identified Gaps in the data,
 Filled in the gaps through

- field surveys and
- remote sensing data (Indian & US)

 Analysed the data to develop plan strategy

Following studies were undertaken:

Bathymetry and topographic details of lake

Hydrologic Studies - Design Flood and Water Balance
Remote Sensing Studies (upto 1 m resolution)
Socio-economic Surveys
Soil Strata and Infiltration Indices
Studies of the Catchment thru's RS
Solid Waste Classification
Sedimentation Studies
Assessment of present limnological studies

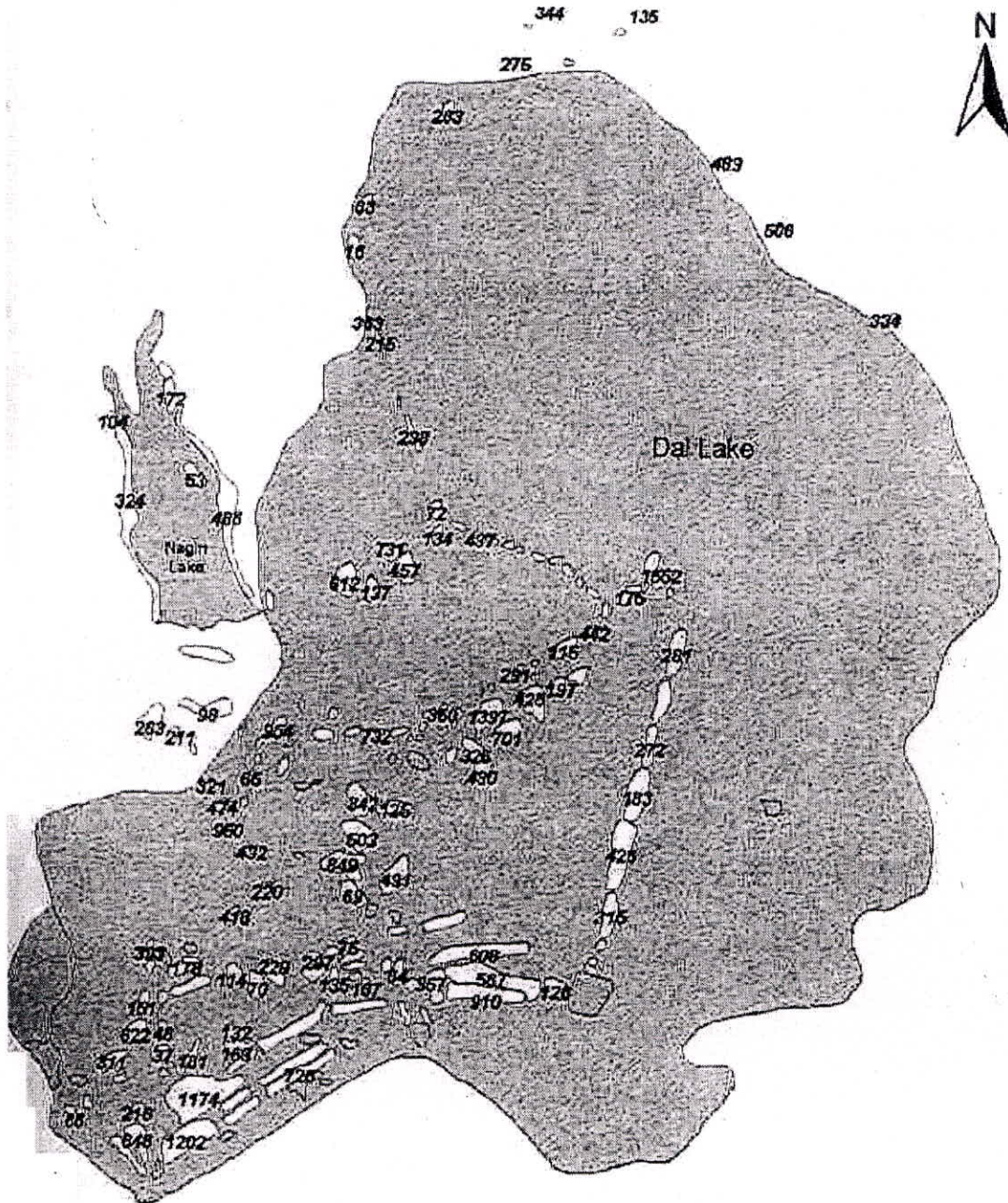


Fig. 5: Habitation (Mohalla) Map

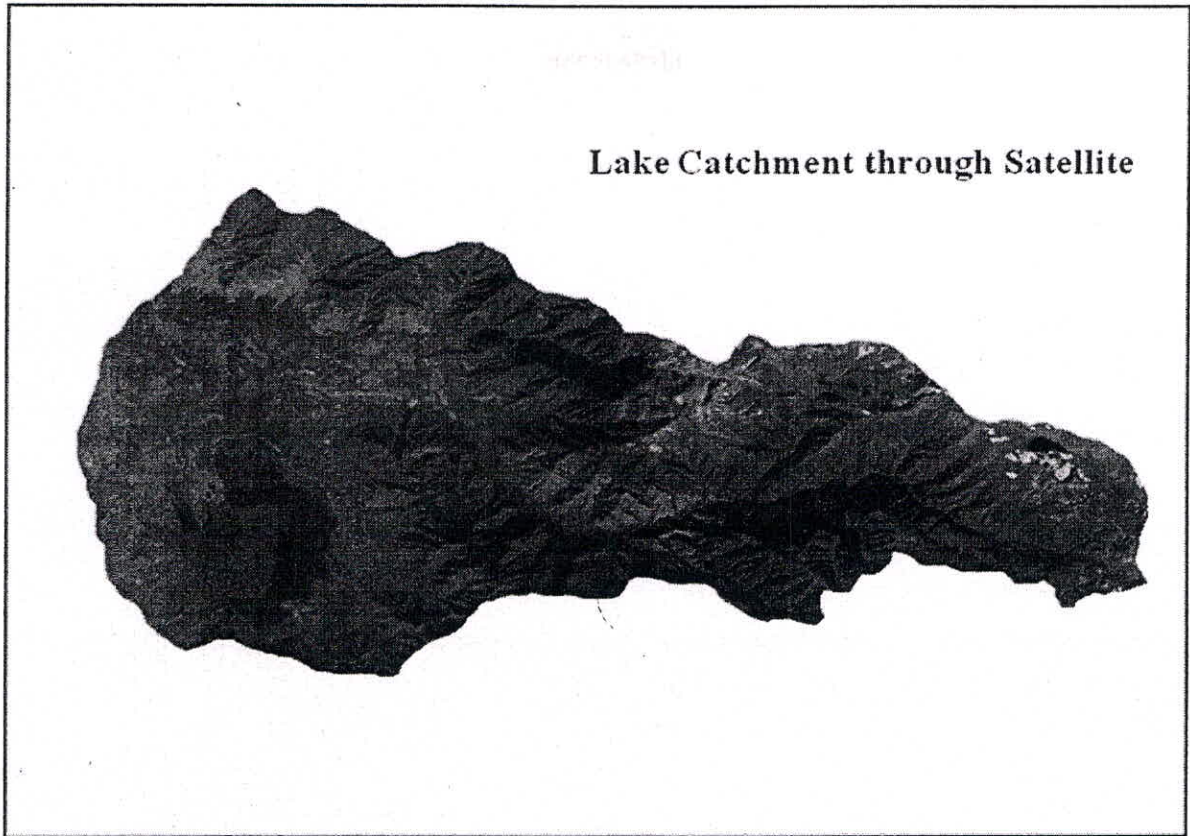


Fig. 6: Map of Lake catchment

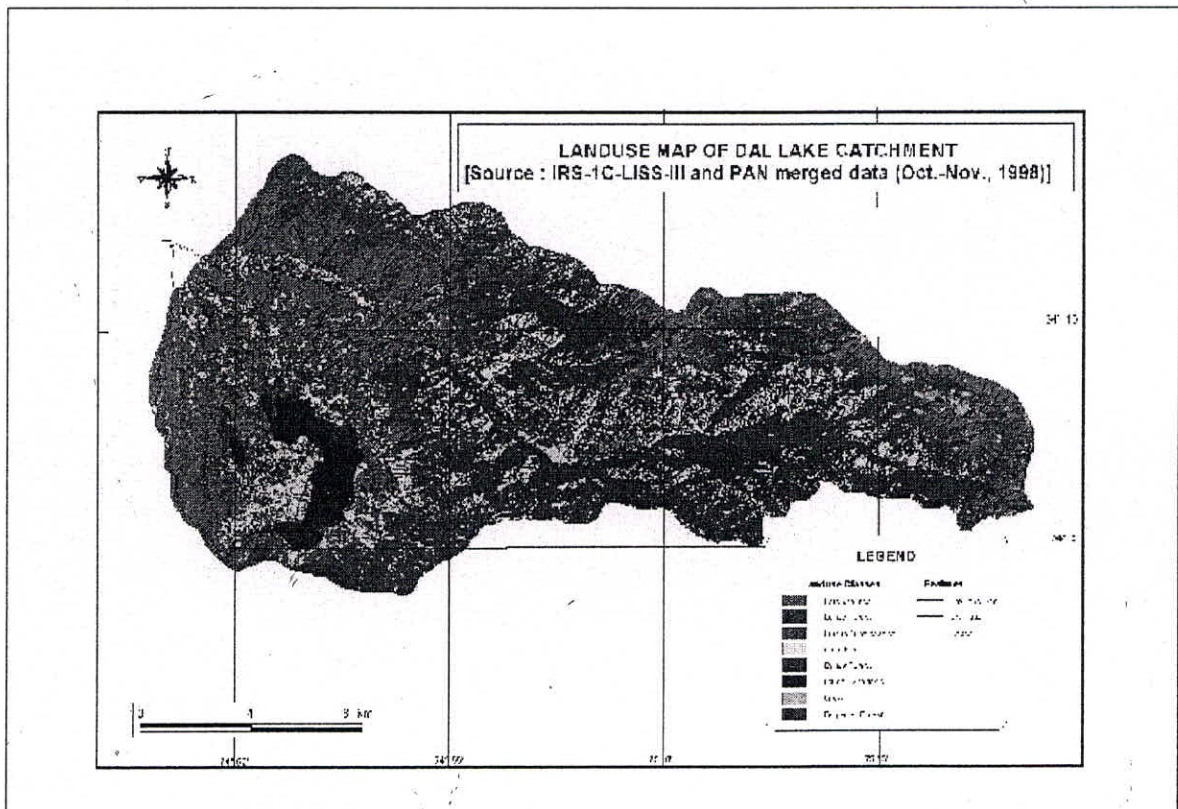


Fig. 7: Land-use map of the catchment

APPROACH PLAN

The approach plan should be:

Comprehensive – considering all elements which affect the lake. Sustainable and Optimal Interventions should be :

- Minimal to achieve the desired objectives
- Consistent with the ecology
- Should not be at the cost of biodiversity

Aspects Covered

- Catchment & its treatment
- Inflows and Outflows from the lake
- Point & non-point sources of pollution
- Activities in the vicinity of the lake
- Activities within the lake
- Sanitation in & around the lake
- Solid Waste Management
- Power Availability
- Operation & Maintenance Issues
- Problems of Lake Dwellers & other state holders
- Sustainability
- Institutional Arrangement
- Implementation Mechanism
- Resettlement & Rehabilitation Issues
- Circulation Modelling

Interventions

Catchment Management Plan:

- Sewerage and Sewage Treatment
- Solid Waste Management
- Sanitation
- Hydraulic Structures : Head works, Settling Basin, Nallah Amir Khan
- remodeling and Barari Nambal Cut

Restoration and Development :

- Additional Water from Sindh Nallah
- Separation of spring water from Sewage
- Dredging
- Deweeding

Impact Assessment : Circulation and contaminant models

Modelling

Mathematical Models:

- Circulation Model

- Contaminant Transport Model

- Used for

- * Assessing Impact of Interventions

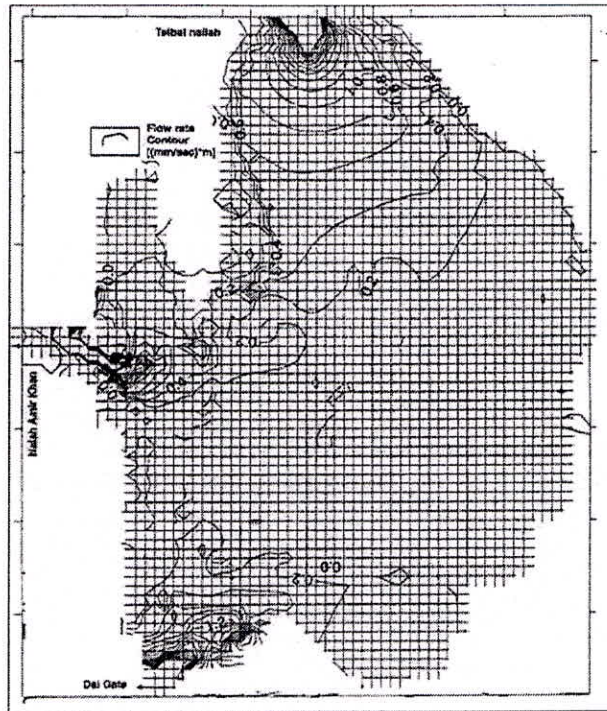


Fig. 8: Simulated Pre-intervention Circulation

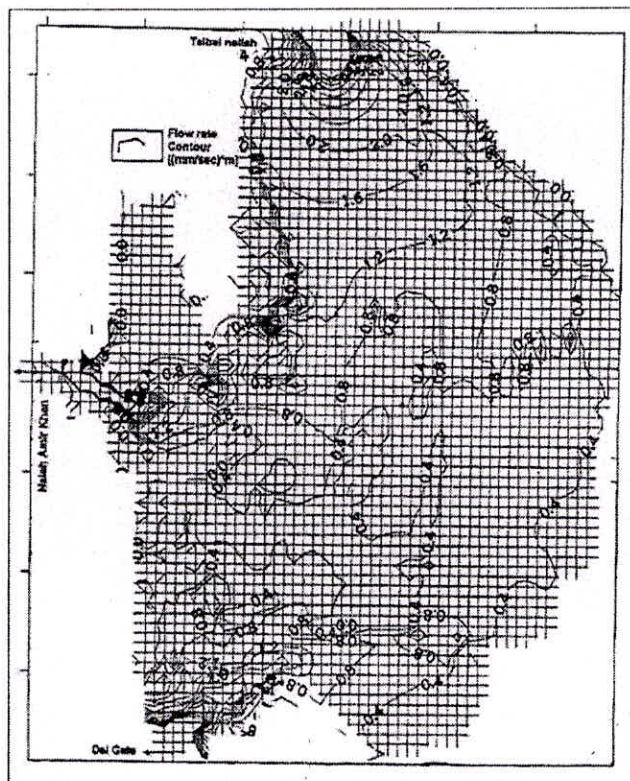


Fig. 9: Simulated Post-intervention Circulation

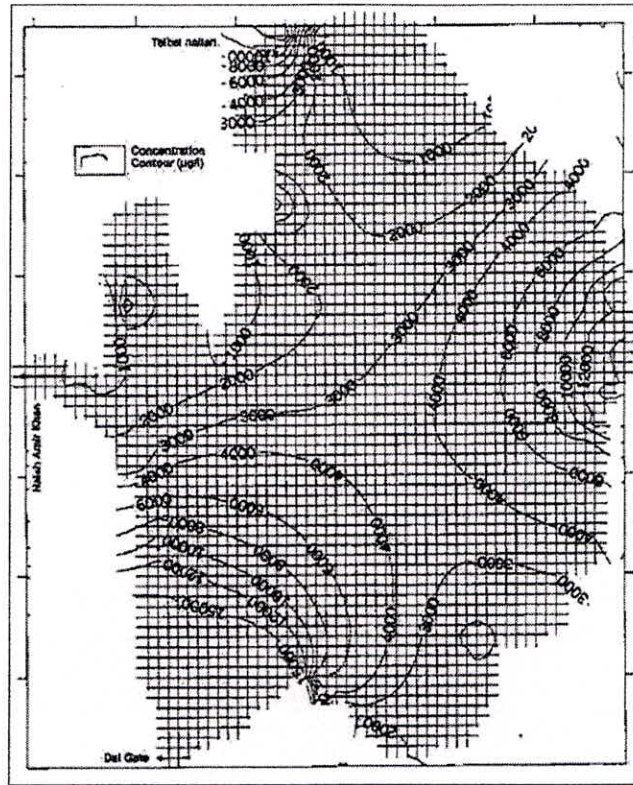


Fig. 10: Simulated Pre-intervention BOD Distribution

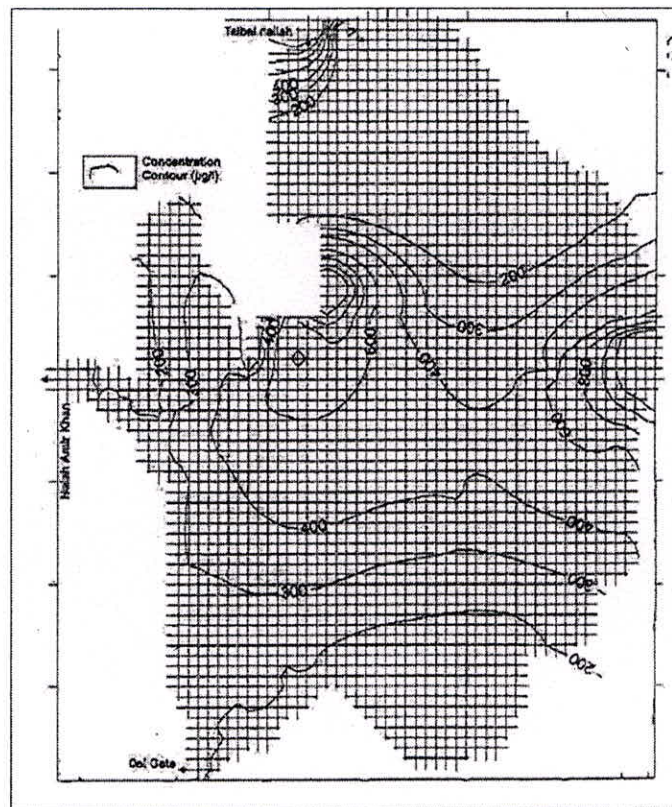


Fig. 11: Simulated Post-intervention BOD Distribution

Table: Annual Nutrients Load Before and After Treatment in mTon

Sr. No.	Location	Capacity, MLD	NH ₃ - N		T.P.	
			Before	After	Before	After
1 a	Habak	3.2	4.97	0.25	9.95	0.995
1 b	REC	7.5	16.27	0.82	8.87	0.89
1 c	Nalla Amir Khan	5.4	4.99	0.25	9.98	0.99
2	Brari Nambal	9.5	17.61	0.85	16.90	1.69
3 a	Hotel Heermal	6.6	13.71	0.65	13.43	1.34
3 b	L A M	4.5	6.036	0.15	4.89	0.48
	TOTAL in mTon	36.7	63.586	2.97	64.02	6.385

SEWERAGE AND SEWAGE TREATMENT

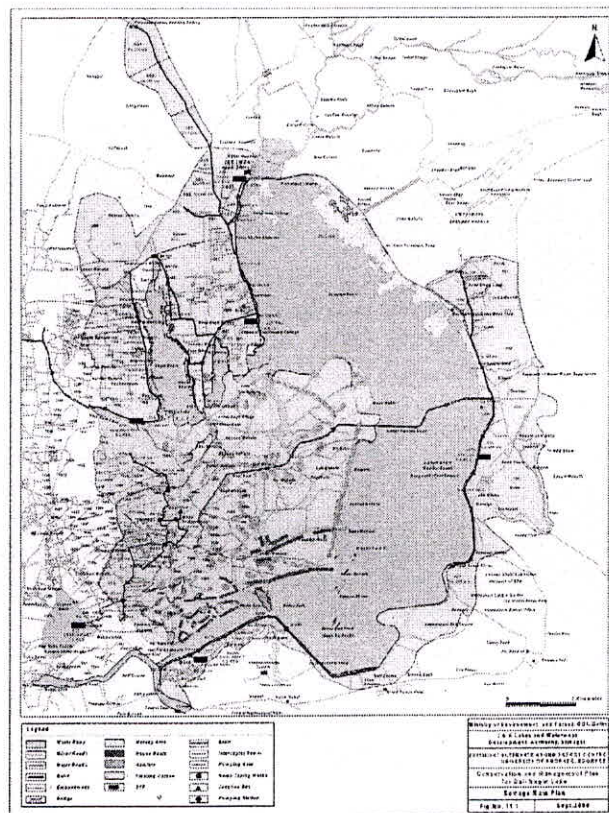


Fig. 12: Proposed Location of STPs

Reviewed

- * Proposed Ring Sewer
- * Centralised Sewage Treatment

Suggested Decentralised system with

- * 6 Nos of STPs, reduced no pumping stations
- * Corresponding sewage conveyance system
- * Cheaper and less Power Intensive as Compared to Conventional ASP with Lower O&M Costs
- * Treated Effluent From 3 STPs Discharged into the Lake, Other 3 discharged outside of Lake

Total capacity to be installed = 36.7 MLD
Plants = 5 Nos
Plants Commissioned = 3 Nos (15.2 MLD)

STP Hazratbal (7.5 MLD)

- Targeted Sewers lines = 7909 m
- Sewer lines completed = 7563 m (95.6%)
- Laterals = 11933 m (60%)
- House Connectivity = 40%
- IPS = 2 (July & September -09)

STP Habak (3.2 MLD)

- Targeted Sewers lines = 3057 m (100%)
- Laterals = 6133 m (75%)
- House Connectivity = 65%

STP Laam (4.5 MLD)

- Targeted Sewers lines = 4920 m (100%)
- Laterals = 21664 m (65%)
- House Connectivity = 79%
- IPS = 1 No. (Commissioned)

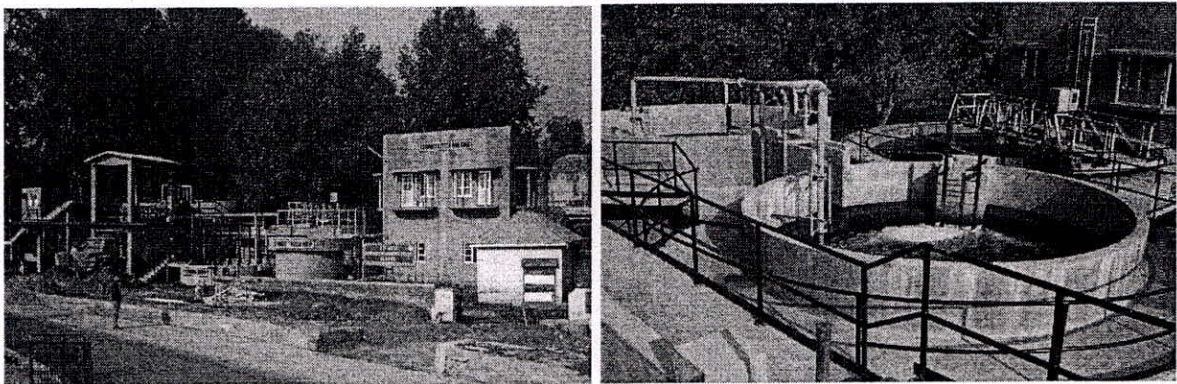


Fig. 13: Sewage Treatment Plants

Waste from Houseboats

- The houseboats in Nageen Lake on the eastern side are being provided with a sewer line.
- After completion of work on Intermediate Pumping Station at Saderbal and Nageen, the houseboats will get connected to the STP at Hazratbal.
- Laying of sewer line on Western shore of Nageen Lake is in progress, which will cater the sewage of the houseboats along this side of the Nageen Lake and ultimately connected to STP at Nallah Amir Khan.

HYDRAULIC WORKS

- i) Cut and Cover Conduit at Brari Numbal (468 m) (An alternate flushing conduit created as an alternative to Nallah Mar.
- ii) Outflow channel of Nallah Amir Khan improved to enhance its carrying capacity nine folds from 150 cusec to 1330 cusec
- iii) Settling basin at Teilbal Nallah commissioned - designed for 80,000 tons/yr
- iv) Diversion Head Works on Teilbal Nallah with escape gates, fish ladder and avigational lock channel in final stages of completion (civil works already completed).

OTHER ITEMS

- Captive Power
- Research & Development
- Institutional Development
- Public Awareness Plan

DREDGING

Restoration Goals

- Removal of nutrient rich sediments
- Deepening of silted lake areas to improve water flow
- Removal of shoals and solid land mass
- Reduction of emergent vegetation

Dredging has negative effects also as

- It removes vegetation,
- Nutrients can get released
- Algal blooms may occur
- Turbidity may result



Fig. 14: Proposed uses of Dal-Nagin Lakes and Reed Belt Formation

Selective dredging recommended:

- Only to deepen parts of the lake which obstruct free flow
- Removal of only upper 20 cm of sediment to ensure maximum nutrient removal.
- Dredging sites not to fill up the wetlands and destroy the biofilters.
- Macrophytes on silted up areas in the northern basin be dredged out and not allowed to trap silt.
- Continuous monitoring of the dredged area be undertaken by a scientific committee.

Impact of dredging

- 40% increase in water transparency in Hazratbal Basin
- 10% decrease in COD values in Hazratbal Basin.
- 295.11 tons of nitrogen and 73.74 tons of phosphorus removed from lake nutrient budget as a consequence.
- Volumetric capacity of lake increased by 2 million cum.



Fig. 15: Dredging/cleaning of Brari Numbal Lagoon

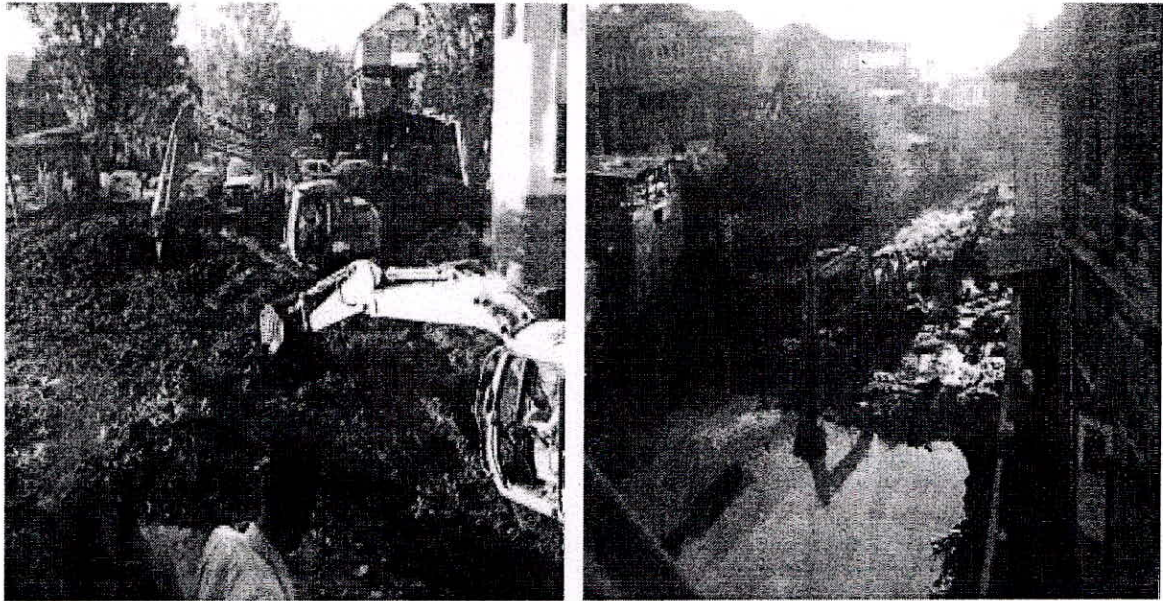


Fig. 16: Dredging of nawpora channel in progress

RECOMMENDATIONS

Harvesting should be limited to the following areas:

- Backwaters
- Areas where exotic water fern and water lily abound.
- Additional areas being brought under lotus. Gagribal and Nagin basin- parts used for swimming and other recreational activities.

DEWEEDING:

- 20,000 cum of wet weed on average is removed from Dal-Nagin lake area relieving the lake of nutrients trapped in weeds.
- Skimming of water ferns and floating weeds followed as additional measures to clean the lake.
- Removed weeds disposed off to dumping sites.
- During 2008 alone, 45000 cum of wet weed removed manually against 6444 cum during 2007, which is 7 times more than the previous year



Fig 17: Dewatering

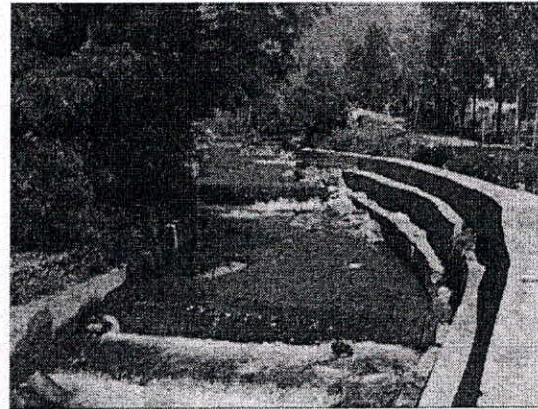
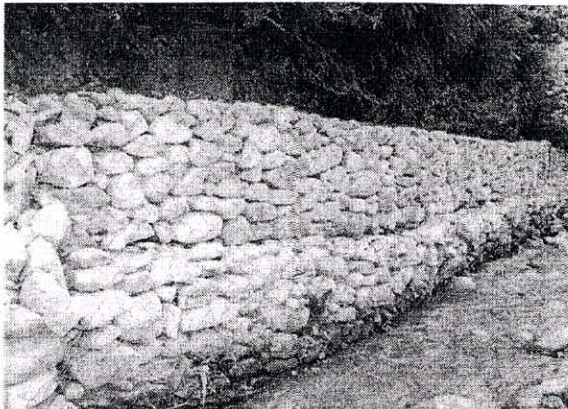
CATCHMENT MANAGEMENT

- Main contributory Catchment
(6 water sheds with 12 micro water sheds 337 Sq. Km area in Dachigam, Dara – Danihama, lake body and peripherals draining towards lake).
- Interventions & achievements
 - Gully plugging, anti-erosion, toe-crates and check dams in storm-water rivulets, trenching, pasture development, fencing, harvesting, etc to achieve:
 - a. Contour trenching : 13992 Cum
 - b. Inspection paths : 10 Kms.

- c. Gabion/Retard Check dam : 46101 Cum
- d. Afforestation : 881937Nos.
- e. Barbed wire fencing : 115845 Rft
- f. Pasture Development : 580800 Patches



(a) Before Treatment



(b) After Treatment

Fig. 18: Critical area of the project

HOUSEBOAT SANITATION – REALIGNMENT THEREOF

- The Houseboats in Nehru Park basin are proposed to be relocated and realignment to facilitate geometric pattern of laying sewer besides improving internal landscaping and aesthetics of lake.
 - 50 Houseboats realigned along Western Foreshore Road so far.
 - Three mini STPs working on different technologies identified - installed and under trial for house boats to be moored in open waters .
- *The offsets of Houseboats from Boulevard being increased from existing 65 mtrs to 100 mtrs.*
- *Activities of deepening and cleaning lake area along WFR at Kohna Khan to provide additional mooring site and increase clear water expanse.*

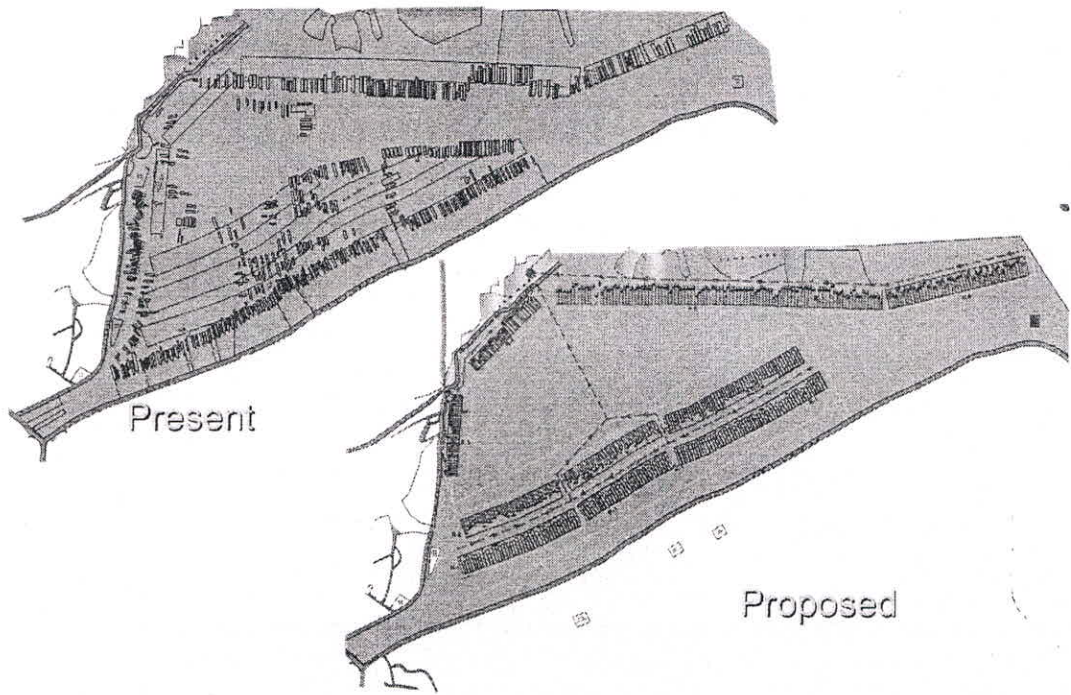


Fig. 19: Proposed Realignment Plan

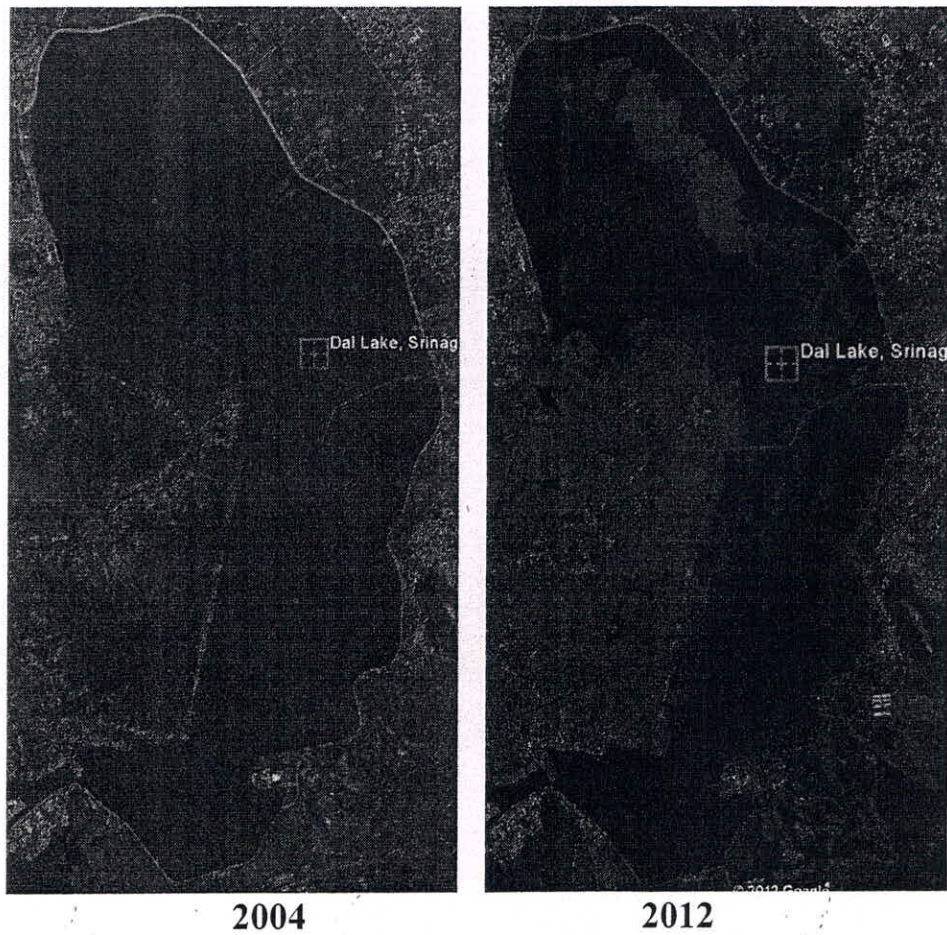


Fig. 20: Dal Lake

COST ESTIMATES

No.		DPR
1	Sewage Treatment Works	Rs. In Laacs
(i)	Sewer lines	3148.08
(ii)	Sewage Pumping Stations	1783.30
(iii)	Sewage Treatment Plants	2021.93
(iv)	Treatment of waste within the lake hamlets	1080.00
	house boats and peripheral villages	
	Sub Total	7684.49
2	Solid waste management works	55.30
3	Hydraulic Works	
(i)	Diversion works on Telbal nallah	306.46
(ii)	Remaining works for Outlet of	122.63
	Nallah Amir Khan	
(iii)	Remaining works for Outlet of	331.40
	Barari Nambal Cut	
(iv)	Construction of extended Padshahi	261.25
	Canal to lake	
	Sub Total	1021.74
(v)	Works for carrying fresh water	289.48
	streams to lake	
(vi)	Budget for Dredging & Deweeding based on	1000.00
	Monitoring Committee recommendation	
(vii)	Aerators	30.00
	Sub Total	3794.37
5	Catchment management works	2084.40
6	Infrastructure Facilities	
(i)	R&D, water quality/monitoring lab	109.08
(ii)	R&D labs for IT/MIS	134.40
(iii)	Buildings for Labs and Jammu &	325.08
	Kashmir Lake and Waterways	
	Development Authority (JKLWDA)	
(iv)	Captive Power Plant	1092.96
(v)	Bathymetric Survey Equipment/Work	30.00
	Sub Total	1691.52
7	Public Awareness	541.08
	Total (1+2+3+4+5+6+7)	17703.72
	Unforeseen, miscellaneous etc @ 3%	531.11
	Total	18234.83

R & R - IMPORTANT FACTS ABOUT LAKE DWELLERS

-	Number of hamlets.....	106
-	Number of families living in the hamlets.....	.6415
-	Population living in hamlets inside lake & its periphery	39595
-	Number of adult mails	11214
-	No. of families owning house boats.....	758
-	No. of families owning houses.....	6937
-	No. of families owning land.....	3171
-	Total area owned (cultivated 310 ; under water 466)	869 Ha
-	Number of families engaged in agriculture.....	2360
-	Number of families earning from lake.....	7355

R & R ALTERNATIVES

1. Shift entire lake population, acquire all rights on land, buildings & water.
2. Shift part population identified by SDA – aesthetic and pollution grounds.
3. Shift families (50%) not earning livelihood mainly from lake.
4. Shift all population, acquire their buildings but not agricultural rights.
5. Shift only those whose land is required for dredging to create channels.

R & R – ALTERNATIVES COSTS

Alternative		1	2	3	4	5
Nos. of PAF to shift		10,426	4,398	5,607	8,744	Only those whose land is required for create channels
Pvt land include water and garden hectares		466	148	187	292	
Structure nos.		7,791	5,428	Nil	Nil	
Cost in Cr	Govt.	445	183	79	213	
	Institutional	109	50	Nil	Nil	Nil

STATUS

➤ Land made available to the authority by the State Govt.:

- 7526 Kanal at Rakh-Arth

➤ Phase-1 (land proposed to be developed) 3000 Kanal

➤ No. of families to be Rehabilitated in P-1 4600

- Area substantially marshy. Requires earth filling and site development.
- Work on earth filling in progress. 1,60000 cum carried to site ending 3/09. Approach road completed 1Km involving an expenditure of 2.5 crore up to end 03/2009.
- Rupees 2 crore advanced to PHE deptt. for internal laying of pipe system for the colony.
- Rupees 2 crore advanced to PDD deptt. for internal electrification of the colony.

- *Providing of built up shelters under the centrally sponsored scheme Basic Services For Urban Poor, approved by GOI.*

REHABILITATION AND RESETTLEMENT

- No. of families living in 58 hamlets: 6000*
**(Socio Economic Survey of 1986)*
- Families Rehabilitated: 1299
Names of Colonies:
(Agro Bagh, Devdi Bagh, JKPCC Colony, Botakadal Bemina, Habibullah Nowsheri colony, Panchkharwari and Fishermen Colony Laberpath)
- Families to be rehabilitated at Rakh-i-Arth: 4701**
*** (Assumed to have increased to 11,000 since 1986)*