India

Lake Bhopal Conservation and Management Project

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Field Survey: November 2006 and May 2007

1. Project Profile and Japan's ODA Loan

Location of the project site

VIP Road constructed by the project

1.1 Background

Lake Bhopal[2], located in the western part of Bhopal Municipality, the state capital of Madhya Pradesh, consists of two man-made lakes, the Upper Lake and the Lower Lake (Figure 1). The Upper Lake has a surface area of 36 km^2 and catchment area[3] of 361 km^2 while the Lower Lake has a surface area of 1.29 km^2 and catchment area of 9.6 km^2. The Upper Lake was an important source of water providing more than 40% of the drinking water demand for an estimated population of 1.8 million in Bhopal City. The Lower Lake was used mainly for recreation. The environmental condition of Lake Bhopal has deteriorated over the past years because of inflow of point and non-point source pollutants such as sewage and solid waste from the urban area and silt and nutrients from the rural catchments. Encroachment on the lakeshore was also a contributing factor. Under these conditions, the need for improvement of the environmental condition and the water quality of the lake was increasing.

1.2 Objectives

The objective of the project was to promote improvement of overall environmental conditions of Bhoj Wetland and improvement of water quality of the Upper and Lower Lakes by implementing several pollution control and environmental conservation measures within the two lakes and their catchment, thereby contributing to the conservation of the lakes and improvement of overall health and sanitary conditions of the local people.

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[1] The project is jointly evaluated by Masahisa Nakamura, Victor Muhandiki and Thomas Ballatore, on behalf of International Lake Environment Committee (ILEC) Foundation.
[2] Lake Bhopal is also called Bhoj Wetland.
[3] Catchment is the area surrounding a lake from which surface water drains into the lake.

Figure 1: Drainage basin of Lake Bhopal

1.3 Borrower / Executing Agency

The President of India / Housing and Environment Department, Government of Madhya Pradesh (PHED)

1.4 Outline of Loan Agreement

Loan Amount Disbursed Amount	7,055 million yen 6,537 million yen
Exchange of Notes Loan Agreement	December, 1994 February, 1995
Terms and Conditions - Interest Rate - Repayment Period (Grace Period) - Procurement	 2.6 % p.a. 30 years (10 years) General Untied
Final Disbursement Date	June, 2004
Main Contractors	Lake Conservation Authority of Madhya Pradesh (LCA), (India)
Consulting Services	Consulting Engineering Services (India), and Kyowa Engineering Consultants Co., LTD (Japan)
Project Identification and Preparation Study, and Feasibility Study (F/S)	1994 Special Assistance for Project Formation (SAPROF)

2. Evaluation Results (Rating: B)

2.1 Relevance (Rating: a)

2.1.1. Relevance of the project plan at the time of appraisal

The 8th Five Year National Development Plan (1992 – 1997) identified regeneration and restoration of degraded ecosystems as one of the priority environmental issues. In 1987 the Government of India (GOI) initiated a Wetland Conservation Program for conservation and management of wetlands. The program identified 16 wetlands, including the Bhoj Wetland, for special conservation. An action plan for conservation and management of the Bhoj Wetland prepared by the Government of Madhya Pradesh (GOMP) received highest priority of GOI and was jointly funded by GOI and GOMP under the Wetland Conservation Program (Rs. 17.54 million from 1988 - 1993). Under this background, the project was therefore highly relevant at the time of appraisal.

2.1.2. Relevance of the project plan at the time of ex-post evaluation

The 11th Five Year National Development Plan (2007 – 2012) identifies strengthening water quality monitoring and increasing wastewater treatment capacity in urban areas as some of the priority issues. The National Environment Policy, 2006 has laid out plans for promoting integrated approaches to river basin management and water pollution abatement. The number of wetlands included in the Wetland Conservation Program has increased to 20 from 16 at the time of appraisal of the project. At the state level, a "Master Plan for Conservation and Management of Water Resources of Bhopal" was developed by the Lake Conservation Authority of Madhya Pradesh (LCA) in 2005. Lake conservation has therefore continued to attract attention at both the national and state levels.[4] The implementation of this project has provided basic infrastructure and framework for conservation of Lake Bhopal and other lakes in Madhya Pradesh and is consistent with ongoing lake conservation efforts. The project therefore remains highly relevant.

2.2 Efficiency (Rating: b)

2.2.1. Outputs

This was a multi-component project consisting of six major components (Table 1). In addition, the project had "Additional works"[5] (see Table 1) that were not originally envisioned at the time of project appraisal. Comparisons of planned and actual outputs of the project are summarized in Table 1. The results of most key outputs, such as sewerage system, link road (VIP road), deweeding, installation of floating fountains, and improvement of existing laboratory equaled or exceeded the plan. However, the results of

[4] GOT hosted the 12th World Lake Conference in Jaipur in October and November, 2007 in it aim to present its active measures for lake conservation to the international audience.

[5] "Additional works" are project components that were not originally envisioned at the time of project appraisal but which were added in the course of implementation. These components were deemed necessary to achieve the project objectives.

some key outputs such as desilting and dredging, and resettlement of dhobis[6] were less than the plan.

Table 1: Summary of comparison of planned and actual outputs

Planned	Actual
1. Desilting and dredging	
1) Desilting and dredging a) Removal of silt in Upper Lake: 5.900 M m^3 b) Removal of silt in Lower Lake: 0.245 M m^3	a) 2.935 M m^3 (▼50%) b) 0.085 M m^3 (▼65%)
2) Deepening and widening of spill channel a) Removal of silt: 1.240 M m^3	a) 0.987 M m^3 (▼20%) Installation of idol immersion bay was added.
3) Restoration of Takia Island	Done as planned, with minor revisions
2. Catchment area treatment	
1) Afforestation and creation of buffer zones a) Planting of trees: 1.3 million trees in 1,500 ha	a) 1.7 million trees (□31%) in 962 ha (▼36%) In addition, 71.3 km fencing was done.
2) Check dams, silt traps and cascading a) Construction of check dams: 33 dams b) Construction of silt traps: 230 traps c) Construction of toe walls: 2,300 m d) Cascading: 48 ha	a) cancelled b) 2 traps c) 645 m d) cancelled In addition, 78 gabions and 1,400 m inverted filter were constructed.
3) Garland drains a) Construction of surface drains along lower lake: 7,000 m	a) This component was merged with the "Prevention of pollution" (sewerage scheme) component.
3. Prevention of pollution (sewerage scheme)	
1) Construction/rehabilitation of sewerage system in three zones (details not specified)	Done as per planned, with the following outputs: a) Construction of STPs[7]: 4 No. (53.99 MLD) b) Rehabilitation of STPs: 1 No. (4.54 MLD) c) Construction of SPHs: 8 No. d) Rehabilitation of SPHs: 2 No. e) Laying of sewer pipes: 85 km f) Construction of diversion systems for open drains
4. Management of shoreline and fringe area	
1) Construction of link road (VIP road) a) Construction of road: 4.9 km b) Construction of bridge: 150 m bridge	a) as planned b) 437 m (△190%)
2) Solid waste management a) Provision of trucks: 2 No.	a), b), d) and f) done as planned

[6] 'Dhobi' is generally a group of washermen in the caste system.
[7] STPs refer to sewage treatment plants.

b) Provision of refuse compactors: 4 No. c) Provision of metal containers: 100 No. d) Provision of dumper placer: 2 No. e) Provision of tippers: 1 No. f) Provision of sewer cleaner: 1 No.	c) 150 No. (△50%) e) cancelled In addition, an electronic weighing bridge was provided and awareness campaigns about solid waste management were undertaken.
3) Prevention of pollution from dhobighats a) Acquisition of land for resettlement of dhobis: 10 acres b) Construction of quarters for dhobis: 400 No. c) Construction of dhobighats: 500 No.	a) 4.5 acres (▼55%) b) 128 No. (▼68%) c) 172 No. (▼66%) In addition, an overhead water tank and a roughening filter were constructed.
5. Improvement and management of water quality	
1) Deweeding a) Removal of weeds: 1135 ha	Done almost as planned
2) Biological control of weeds (aquaculture) a) Provision of boats: 7 No. b) Provision of gill nets: 10 No. c) Improvement of nursery and hatchery d) Stocking of fingerlings: 4.30 million fingerlings	a), b) and c) were cancelled d) 3.82 million fingerlings (▼34%)
3) Monitoring of water quality a) Provision of equipment b) Improvement of existing laboratory	Done as planned
4) Installation of floating fountains a) Installation of floating fountains: 12 No. b) Installation of aeration systems: 3 No.	a) 13 No. (△8%) b) Cancelled.
6. Consulting services	
1) Engineering services: 140 M/M	1) Engineering services: 159.81 M/M (△14%)
2) Training a) Overseas: 20 M/M b) Local: 40 M/M	a) 13 M/M (▼35%) b) 12.3 M/M (▼69%)
7. Additional works	
	The following components were added: a) Establishment of a corpus fund for the establishment of Lake Conservation Authority (LCA)[8] b) Public participation and awareness campaigns c) Establishment of 1 No. Interpretation Center d) Construction of 3.2 km lake view promenade e) Demarcation of Full Tank Level (FTL) line and No Construction Zone (NCZ) and construction of 4.6 km wall f) Construction of 176 m long 4 span new bridge across Bhadbhada spill channel g) Control of seepage through earthen dam of Upper Lake h) Priority works for lake delineation and

[8] The corpus funds amounting to 723 million yen (Rs. 266 million) were to be used for a) Strengthening of existing laboratory and water quality monitoring, b) Public participation and awareness programs, c)Strengthening of the Interpretation Centre established by the project, d) Watershed management, e) Fish and fisheries management, and f) Data management.

	protection of Van Vihar National Park area (Construction of soil erosion structures, plantation, augmentation of water for animals, improvement of bird habitat within the National Park area, etc.)

There were modifications in some outputs necessitated mainly by detailed specifications and site conditions. The quantities of desilting and dredging were reduced based on detailed field surveys of desilting and dredging sites. Even though the extent of physical quantities proposed at the time of appraisal was not achieved, the desired targets of excavation levels and gradients set in the detailed plan were achieved. An idol immersion bay was also constructed at the spill way channel as an alternative site for the former idol immersion site in the Upper Lake.

In the catchment area treatment component, more trees were planted than planned. However, the total area afforested was less than planned because some of the land originally proposed for afforestation could not be acquired due to disputed ownership or encroachment and also because some of the land had to be set aside for wild life. Construction of check dams and cascading was cancelled and the number of silt traps constructed was greatly reduced. Instead, gabions and inverted filters were constructed. As to the sewerage scheme, almost all outputs in the component were as planned, and gabions and inverted filters were constructed as per specifications planned.

Under the management of shoreline and fringe area component, the length of the link road constructed and the number of equipment acquired for solid waste management were as planned. However, the length of the bridge was increased because the road was realigned to avoid existing monuments and religious structures on the shoreline. Also, the land acquired for resettlement of dhobis and the number of new houses and washing platforms constructed for dhobis in the new area were less than planned. This is because the number of dhobis was not clear at the time of planning and more than the actual number was estimated. While 128 dhobis who had valid lease rights (patta holders) were fully compensated with the new houses and washing platforms according to the type of their former residences, one hundred and twenty (120) dhobis who did not have lease rights (encroachers) were compensated with the lease rights for the new houses and washing platforms.

Figure 2: Planned afforestation (shaded area on lakeshore) and desilting and dredging (shaded area in lake) areas

Figure 3. Actual afforestation (shaded area on lakeshore) and desilting and dredging (shaded area in lake) areas

As for the improvement and management of water quality component, key outputs for deweeding, monitoring of water quality and installation of floating fountains were achieved as planned. However, for the biological control of weeds sub-component, the number of fingerlings stocked was less than planned because it was not possible to supply the required numbers of fingerlings at the right time due to high mortality rates and the stocking itself was abandoned in 2001.

The number of man-months (M/M) for engineering services under consulting services for the project exceeded the planned number because of extension of the project period. The M/M for training was reduced based on re-assessment of training needs during project implementation.

2.2.2. Project period

The overall period at appraisal was 61 months from February 1995 to March 2000. The actual project period was 112 months from February 1995 to June 2004 (184% of the plan). Most project components were completed behind schedule. The main reasons for the delay were: 1) Delay in preparation of the detailed project plans (which are noted as Detailed Project Reports (DPRs)). The implementing agencies （IAs） did not have required expertise for specialized works such as deweeding, desilting and dredging, floating fountains, and sewerage scheme. The DPR for dredging and desilting, and sewerage scheme were approved in September 1999, 4.5 years behind schedule (89% delay); 2) Poor coordination among multiple IAs. The project had multiple components that were implemented by different IAs. Many of the IAs did not have prior experience in implementing a similar projects and coordination regarding important project decisions like project site and designs was difficult; 3) Inclusion of additional works. Most of the additional works were proposed and approved after March 2000, the original project completion date; 4) Litigation during project implementation such as by landowners or encroachers opposed to being relocated; 5) Protracted negotiation for resettlement of dhobis; 6) Unfavourable geological features where residents were against blasting for the construction work and geological conditions in sewerage component areas such as narrow

roads and rocky terrain.

2.2.3. Project cost

The actual project cost was 7,706 million yen compared to an estimated cost of 8,300 million yen (93% of the planned amount). The reason for having been able to keep the actual project cost down was due to revisions in project designs, the lower actual expenditure in yen due to decline in the value of Rupee beyond the rate of inflation, and the lower disbursement costs thanks to introduction of competitive bidding.

2.2.4. Summary

Considering outputs, project period and project cost, efficiency is evaluated as moderate.

Figure 4: Map of project site

2.3 Effectiveness (Rating: a)

The project aims to promote improvement of overall environmental conditions and the water quality of Lake Bhopal. Effectiveness of the project should therefore examine the degree to which the implemented measures have led to improvements in the environmental status of the lake and its basin. However, because of long retention times and complex response dynamics of lakes, it generally takes many years to detect any noticeable improvements in lake environments resulting from management interventions. Therefore, this evaluation will use indirect indicators to assess the improvement in the environmental status of the lake (see "Thematic Evaluation Report" for application of a

framework that considers special characteristics of lakes in the evaluation of lake basin management projects).

2.3.1. Improvement and management of water quality

(1) Reduction of pollutants in the lakes by desilting and dredging

Significant amounts of pollutants were removed by desilting and dredging. An estimated 592 tons of nitrate and 1,177 tons of total phosphorus were removed, corresponding to about 26 times and 12 times, respectively, of estimated annual nitrate and phosphorus input loads to the Upper Lake from untreated sewage.

(2) Improvement in water quality of the Upper Lake due to relocation of idol immersion sites

Figure 5: New idol immersion site created outside the Upper Lake

Improvement in water quality at Shetal Das Ki Bagiya (a traditional idol immersion site previously located very near to portable water intakes in the Upper Lake) was noted after relocation of the immersion site in 1999. For example, phosphate concentration decreased from 2.98 mg/L to 0.37 mg/L at the former idol immersion site. However, the phosphate concentration increased from 0.81 mg/L to 3.21 mg/L at the new idol immersion site located downstream. As a result the measure mentioned above has not led to a total solution to the problem. However, the measure to relocate the site of traditional ritual from the lake to a manmade pond for the environmental protection itself is noticeable for its uniqueness among the various examples of measures in the world.

(3) Achievement of water quality targets

Table 2 shows observed trends in surface water quality of Lake Bhopal. There have been no major changes in lake water quality and the water quality targets have not been achieved. However, the water quality data show improving trends. Significant improvement in water quality is expected to take long. It is likely that the situation would have been worse without the project. In this sense, the effectiveness of this project is judged to be high.

Table 2: Trends in surface water quality at offshore deeper parts of the lakes

Item	Observed Data			Indian Standard		
	1998	2003	2006	A	C	D
Upper Lake						
pH	8.1 – 9.0		6.9 – 8.7			6.5-8.5
DO (mg/L)	5 - 11		6 - 27	6	4	4
Turbidity (FAU)	68	56	17			
Total Alkalinity (mg/L)	228	210	110			
BOD (mg/L)	36.4	32.2	12	2	3	
COD (mg/L)	270	144	138			
Chloride (mg/L)	50.6	48.0	37.0	200	600	
Total hardness (mg/L)	200	212	104	300		
Phosphate (mg/L)	2.98	3.37	2.64			
Nitrate (mg/L)	8.76	9.98	6.42	20	50	
Lower Lake						
pH	> 8.7		> 8.5			6.5-8.5
DO (mg/L)	1.6 – 18.7		1.2 – 20.0	6	4	4
Turbidity (FAU)	168	178	56			
Total Alkalinity (mg/L)	268	216	182			
BOD (mg/L)	68	58	46	2	3	
COD (mg/L)	286	244	182			
Chloride (mg/L)	78.9	56.6	42.9	200	600	
Total hardness (mg/L)	212	186	176	300		
Phosphate (mg/L)	7.89	6.28	4.72			
Nitrate (mg/L)	12.23	10.72	7.32	20	50	

Data Source: ERL(Environmental Research laboratory), LCA
Note) Ultimate targets were set as Class A for the Upper Lake and Class D for the Lower Lake. Standards at the time of appraisal were IS 2290. Current standards are BIS 10500.

2.3.2. Improvement of overall environment conditions of Bhoj Wetland

(1) Improvement and conservation of the physical environment

The storage capacity of Upper Lake was increased by 3.97 M m^3 (4%) and that of Lower Lake increased by 0.085 M m^3 (1%) due to desilting and dredging, against set targets of 6% and 3% for the Upper Lake and for Lower Lake, respectively. In overall, about 66% of the planned targets were achieved. In addition, restoration of earthen dam at Kamla Park has reduced discharge from the tunnel from 28-30 m^3/s to 0.2 m^3/s (99% reduction). Increased storage capacity of the lakes has led to increased protection against floods. This is evident from the fact that floods were significantly reduced in 2006 when one of the heaviest rainfall seasons recorded in recent years occurred.

Erosion of the banks of Takia Island, a small island of religious importance, has been prevented by the constructed retaining wall and tree plantations. Regarding afforestation, high survival rates of plants were achieved, at 90% for non-submerged plants and 80% for submerged plants. The afforested areas and constructed physical barriers like the link road, parks, etc. prevent encroachment or settlement on the lake fringe.

Regarding soil erosion in the catchment area and control of silt inflow, afforestation and catchment area treatment structures achieved expected outcomes. However, most of

the catchment area treatment structures are not properly maintained. In one region, silt accumulated in gabions and blocked water flow which caused flooding in farmland. As a result farmers destroyed the gabions.

(2) Mitigation measures for water quality deterioration

Table 3 shows the outline of the sewerage system before and after the project. The sewerage system in the project area has been improved and its capacity greatly increased. The constructed sewerage system, which includes interception of sewage flowing in open channels from un-sewered areas and its diversion to the sewerage system, has reduced inflow of raw sewage to the lakes. Pollution load to the lakes has decreased because of the construction of the sewerage system.[10] Of the four sewage treatment plants (STPs) constructed under the project, two were operating normally. However, the other two STPs were not fully operational at the time of this survey.[11] Construction of an effluent discharge channel at one of the STPs was delayed because of dispute with neighboring farms over location of the channel. As for the other, the inflow to the plant is low which is causing a trouble in the sewage process.

Table 3: Outline of sewerage system in project area

Item	Before Project (1994)	After Project (2005)
Estimated population in project area[1)]	233,000	360,000
Estimated population served in project area (%)	10	90[2)]
Estimated amount of sewage treated at STPs (MLD)	4	15
Installed treatment capacity (MLD)	4	58.53
Rate of STP facility utilization in project area (%)	100	25

Data Source: Estimates by PHED (Public Health Engineering Department)
Note 1) Project area covers about 18% of the Bhopal Municipality area
Note 2) About 15 – 20% are house connections, the rest being by diversion from open drains

In addition, relocation of washing activities from Lower Lake to downstream of the lake has contributed to reducing input of pollutant load to the lake. The project increased capacity for solid waste management. The weighing bridge installed at the solid waste dumping site is convenient for monitoring amount of solid waste. However, with only about 60% of the generated waste being collected, the current state of solid waste management is still poor, with litter evident in many parts of the city. There is still lack of primary collection and storage facilities especially in low income residential areas.

(3) Improvement of lakeshore scenery

[10] The number of individual house connections to the piped sewerage system after the project is still low. In a new project (Urban Water Supply and Environmental Improvement in Madhya Pradesh, UWSEIMP) funded by the Asian Development Bank (ADB) that is under implementation, house connections are proposed to be provided free of charge in the JBIC project area.

[11] While STPs of Kotra and Badwai were operating normally, the other two STPs, namely, Maholi STP (the largest STP with 25 MLD capacity) and Gondarmau STP were not fully operational at the time of this survey.

Aesthetic appearance of the lakeshore has been improved by afforestation, development of parks and gardens, and restoration of Takia Island. The link road and floating fountains have also improved the scenery. According to the results of a beneficiary questionnaire survey[12], in overall, 57 – 73% of the 728 respondents in the eight target groups surveyed noted that there has been improvement in aesthetic appearance.

(4) Improvement of ecological habitat

The ecological habitat has been improved by the construction of a buffer zone of plantations on the lakeshore and in the rural catchment of the Upper Lake. The number and species of migratory birds on the lakefront have increased. Demarcation of a Full Tank Level (FTL) and declaration and enforcement of a buffer zone from the FTL of the lakes as a No Construction Zone (NCZ) has also contributed to this ecological improvement. However, physical structures on the lakeshore such as concrete walls may negatively affect the ecology of the literal zone.

Figure 6: Park developed at former dhobi area on shoreline of Lower Lake

(5) Overall improvement in environmental condition of Lake Bhopal

Sixty five percent (65%) of beneficiaries surveyed in the beneficiary questionnaire survey reported overall improvement in environmental condition of the lake. However, the percentages of dhobis and fishermen who reported improvement were relatively low at 12% and 37%, respectively, possibly because expectations of these two target groups were not met (lack of maintenance of the roughening water filter and discontinuation of fingerlings stocking program).

2.4 Impact

2.4.1. Effect on residents

(1) Improvement in health and sanitary condition

The sanitary and hygienic conditions in the project area have improved especially in those areas covered by the sewerage component of the project due to installation of the sewerage system including diversion of open drains to the sewerage system, and creation of parks in some areas surrounding the open drains. Among the 149 households targeted in the questionnaire survey in the sewerage project service area,[13] 71% noted improvement in health and hygiene conditions because of the project.

[12] A beneficiary questionnaire survey was carried out among eight target groups. The total number of samples was 745. The eight target groups and the corresponding number of samples (in parenthesis) were: 1) Households in sewerage component, HH (159); 2) Common people and ordinary citizens of Bhopal, CT (100); 3) Visitors to the Interpretation Center, IC (90); 4) Visitors to the Lakeview Promenade, PR (87); 5) Dhobis, DB (86); 6) Farmers, FM (66); 7) Fishermen, FS (66); and 8) School children, SC (91). The questionnaire survey was implemented in April – May 2007.

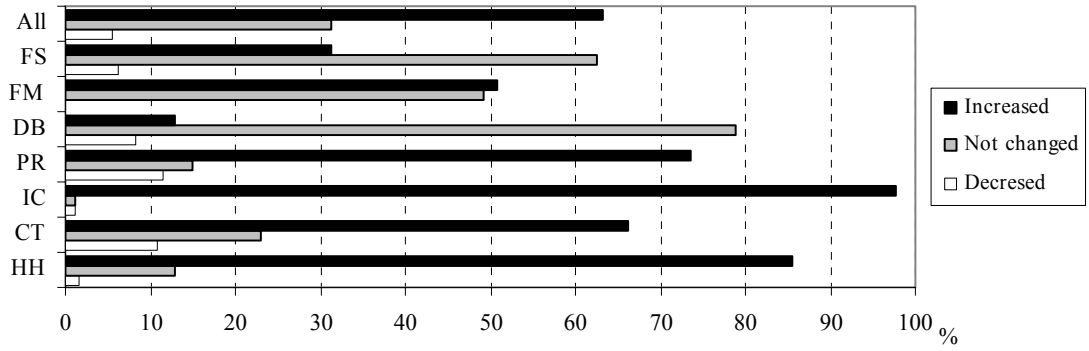
[13] They are four areas: Kotra, Badwai, Maholi and Gondarmau.

(2) Improvement in quality of life

The quality of life in the project area has improved due to improvement in sanitary facilities, provision of recreation facilities such as parks. Results of beneficiary questionnaire survey on overall change in quality of life as a result of the project for 581 are shown in Figure 7. Sixty three percent (63%) of all the respondents reported improvement in the quality of life. However, the percentages of dhobis, farmers and fishermen who noted improvement were relatively low at 13%, 51% and 31%, respectively. This could be attributed to the same reasons discussed above.

Figure 7: Overall change in quality of life in Bhopal because of the Project (beneficiary survey results)

(Unit: % of respondents)



HH: Households in sewerage component areas; CT: Common people and ordinary citizens of Bhopal; IC: Visitors to Interpretation Center; PR: Visitors to Lakeview Promenade; DB: Dhobis; FM: Farmers; FS: Fishermen; All: All groups

(3) Increased convenience

Accessibility has been improved in many project areas due to construction of access roads, pathways and pavements. Residents have increased access to the lakeshore for recreation along the lake view promenade and surrounding areas. Traffic congestion in the city has been relieved by construction of the VIP road and bridge across spill channel. The overall increased convenience has lead to the value of the land and properties and contributed to the development of the city.

2.4.2. Social effect

(1) Employment creation

Some employment opportunities have also been created for post-project maintenance activities such as grass and weed cutting, plant pruning, and nursery maintenance in afforestation areas. Women participated at different levels of the project especially in public awareness and afforestation programs. They continue to participate in these activities, though at a reduced level due to shortage of funds, even after project completion.

(2) Relocation of dhobis

Dhobis were resettled after public consultations and negotiations and all resettled dhobis who had lease rights at the former settlement were compensated. The resettled dhobis have better housing facilities than before. However, most dhobis seem to be dissatisfied with the project because there have been no follow-up activities since the project was completed. The roughening filter that was intended to provide better quality water for washing is not functional because it is not being maintained by the responsible agency (Bhopal Municipal Corporation: BMC). Also, the expectations of some of the dhobis for as the provision of drying sheds have not been realized. The sanitary infrastructure at the new settlement site is also not properly being maintained, with many manholes/drainages blocked.

2.4.3. Increased public awareness and participation

Environmental awareness among local residents has increased. Results of beneficiary questionnaire survey showed that 61% of all the 582 respondents reported increased interest in environment. Among the seven target groups surveyed, dhobis, fishermen and farmers showed the lowest percentage increases at 15%, 25% and 44%, respectively. Possible contributing factors could be discontent among these groups because of lack of maintenance of relevant project facilities and follow-up as mentioned above. Ninety percent (90%) of the respondents noted that idol immersion contributed to the pollution of the lake. Also, more than 80% of the respondents agreed that discouragement of idol immersion from the Upper Lake (a source of drinking water) was appropriate, and that idol immersion in the Lower Lake (not a source of drinking water) should be discouraged too. These results indicate that citizens are highly conscious about the negative effects of idol immersion. While these results do not directly indicate that the high conscience is due to the project, it is likely that the project has greatly contributed to raising the consciousness since relocation of idol immersion from the Upper Lakes was one of the most sensitive issues that the project successfully accomplished through public awareness campaigns.

2.4.4. International recognition

Achievements of the project have been recognized not only within India but also globally. The experiences of the project have provided useful lessons for Indian and other world lakes. The Bhoj Wetland was designated as a Ramsar site in 2002. The project has also received several international awards including the technical prize awarded by the Lake Conservation Institute in USA in 2001 in recognition of its achievements.

2.5 Sustainability （Rating: b ）

2.5.1. Executing Agency

The project was implemented under a complex arrangement involving multiple state government departments and agencies as implementing agencies, with the Housing and

Environment Department (MPHED) as the executing agency and Environmental Planning and Coordination Organization (EPCO) as the coordinating agency. Other relevant departments and agencies for operation and maintenance were Public Health Engineering Department (PHED), Capital Project Administration (CPA) Forest Division, Van Vihar National Park (VVNP), Bhopal Municipal Corporation (BMC), and Lake Conservation Authority of Madhya Pradesh (LCA). The respective roles of the agencies are shown in Figure 8.

2.5.1.1. Technical capacity

There is sufficient technical capacity to operate the physical facilities installed by the project since most of the facilities do not require sophisticated technical skills for operation. Where needed, it is possible to acquire technical skills through the concerned staff in the form of on-the-job training during project implementation. PHED and BMC have adequate technical capacity to operate major project facilities under their responsibility (sewerage system, link road, floating fountains, etc.).

LCA was established at the completion of the project to coordinate planning for the management of the entire Lake Bhopal Basin and other lake basins in Madhya Pradesh State. This is an enormous task that requires appropriately trained staff in various fields of lake basin management. However, during field interviews, one issue of concern that was noted was lack of job security for some key technical staff who are employed on yearly contracts. Long-term human resource development of LCA needs to be strengthened.

Additionally, the technical analytical capacity of the laboratory at LCA needs to be upgraded. For example, some old laboratory equipment that were installed more than 10 years ago need replacement or upgrading. The technical capacity for data management at LCA needs further strengthening and facilitation, both in terms of provision of appropriate data management equipment and technical staff.

2.5.1.2. Institutional setup

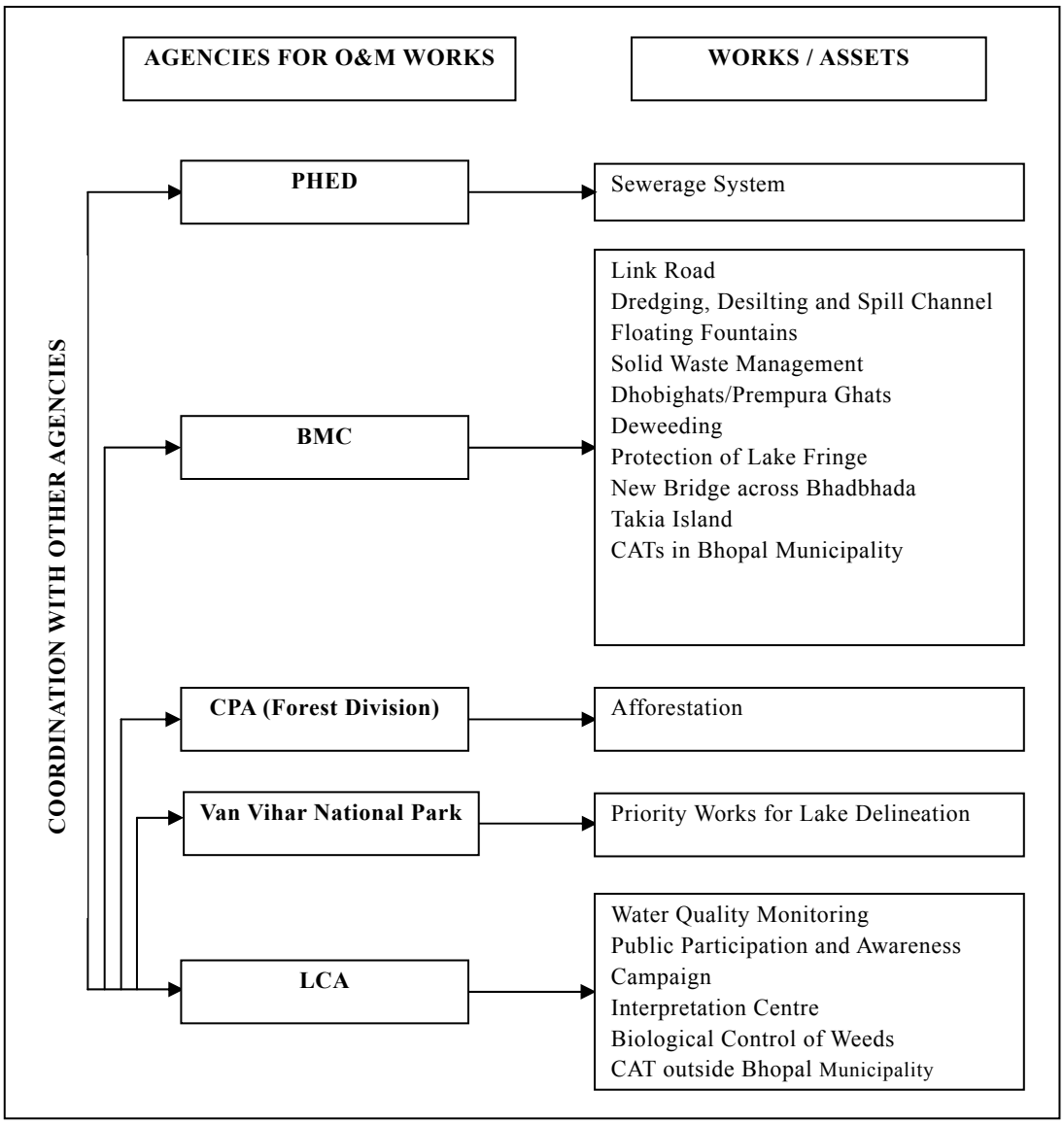
At the completion of the project, constructed facilities were transferred to relevant agencies for operation as shown in Figure 8. Apart from BMC, all the other organizations are departments of the state government. The transferred project components are within the jurisdiction of the respective agencies and therefore it is expected that the facilities will be continuously operated by the agencies.

Because lake basin management involves multiple sectors and requires planning on a basin scale, LCA was established at the completion of this project as the lead organization responsible for conservation and management of Lake Bhopal and also other lakes in the state of Madhya Pradesh . LCA is responsible for coordinating among the agencies concerned with operation of the facilities created under this project. From a lake basin management perspective, establishment of LCA is an important step for sustainable

management of Lake Bhopal.

From interviews and field visits, a major problem that was noted regarding the current institutional setup was lack of coordination among the various concerned organizations. One of the reasons for this is that the LCA does not have a clear long-term plan for arrangement of human resources as it is not long since it was established, nor does it have adequate legal mandate to effectively do so. Another weakness is the current arrangement where LCA's Chief Executive Officer (CEO) is an administrative officer posted from the state government (and sometimes with other multiple responsibilities apart from LCA) usually lasting for a very short period of about 2 years. Considering LCA's mandate and the need for long-term planning in lake basin management, consideration should be given to appointment of technical persons with relevant training in lake basin management to the position of CEO and with a much longer term of office.

Figure 8: Organization for post-project maintenance of project facilities



2.5.1.3. Financial status

Budget allocation for operation and management is provided by the state government or by the respective executing agencies from their own revenue sources. Generally, allocations of funds for operation and management of project facilities are far below requirements, with most of the funds being taken up by staff salary. Limited budget allocation was mentioned by most agencies as one of the main reasons for the poor state or operation and management for most project facilities. There are therefore concerns about the financial sustainability of the project.

The financial data for PHED, BMC, CPA, and VVNP were not available. Table 4 shows LCA's income and expenditure for the 2005 financial year. LCA is mainly funded from interest earned on a "corpus fund" of 26.6 crores (Rs. 266 million) contribution from the balance of funds under the project. The current allocation of about Rs. 1 crore/year for LCA's operations is far much below the specified contract amount of about Rs. 5 crore/year (Rs. 26.66 crore over 5 years) that was intended to be allocated over a period of 5 years since 2004. However, considering long term financial sustainability, preference of the corpus fund arrangement has been acknowledged.

Table 4: LCA's income and expenditure for the year ending 31st March 2006

(Unit: Rs.)

Item	Income		Expenditure	
Interest				
GOMP Interest	9,000,000			
Interest	1,006,803	10,006,803		
Others				
Interpretation Center	195,124			
Consultancy	77,500			
Water Quality Monitoring	489,014			
Others	87,766	849,405		
Administrative and Operational				
Salary			4,147,166	
Others			2,818,896	6,966,062
LCA Project Cost				
Consultancy			1,368,750	
Interpretation Center			215,095	
Organic Farming			3,806	
Public Awareness			24,375	
Water Quality Monitoring			79,973	1,691,999
Project Cost				4,835,449
Depreciation				576,868
Total		10,856,208		14,070,378

2.5.2. Operation and maintenance status

Some project facilities are properly maintained while others are not. Table 5 summarizes the operation and maintenance status of major facilities of the project. Lack of adequate budget allocation for operation and maintenance was cited by most agencies as the main reason for the poor operational and/or physical state. Though the cost for enabling proper functioning of the sewerage system is to be partly covered by a new project funded by the Asia Development Bank, adequate budget allocation for operation and maintenance of the project facilities should be ensured by the concerned government agencies.

Figure 9: A damaged CAT structure

Table 5: Situation of operation & maintenance of project facilities
(at the time of survey in May 2007)

Responsible Agency	Project Component	Situation
LCA	Water quality monitoring	Operating as planned
	Public participation	Being continued, but at a reduced level than during project implementation
	Interpretation Centre	Operating as planned
PHED	Sewerage system	O&M activities hindered due to lack of funds.
BMC	Link road	Operating as planned
	Floating fountain	Operating as planned
	Solid waste management	Generally situation of solid waste management is not good with uncollected litter in many parts of the project area
	Dhobi ghats	The roughening filter is not functional due to lack of maintenance. Sewerage infrastructure and drainage system are not properly maintained.
	Protection of lake fringe	Facilities (promenade, parks, etc.) are in good condition and properly maintained
	New bridge across spill channel	Operating as planned
	CAT structures	Many have not been maintained since they were constructed. Some facilities are damaged.
CPA (Forest Division)	Afforestation	The plants are in good condition, though they have not been maintained for the last 3 years.
VVNP	Priority works for lake delineation	Most facilities are in good condition.

Figure 8 shows the organization structure for operation and maintenance of project facilities. The sewerage component is proposed to be ultimately transferred from PHED

to BMC. This is because BMC has responsibility for sewerage under the 74th constitutional amendment in Madhya Pradesh in 1992 that required transfer of water and sewerage assets to Municipal Corporations. However, because of lack of capacity by BMC, both BMC and PHED have continued to have dual responsibility over the functions of planning, design, construction, and operation and maintenance of sewerage facilities in Bhopal. This arrangement has associated problems such as lack of accountability and cost-effectiveness. The transfer of assets of the sewerage component of the project to BMC for operation and maintenance has been proposed but is yet to be realized.

LCA was established to oversee the conservation and management of Lake Bhopal Basin. Therefore, LCA is expected to not only continue with water quality monitoring that was part of this project, but to undertake studies on self water purification function, biodiversity improvement, and control of buffer capacity of the coastal zone in order to compile basic information needed for basin management in the long-term. Also, LCA is expected to be the core of inter-agency coordination to ensure smooth implementation of basin management policy. However, being a young institution, LCA does not seem to have sufficient institutional capacity for not only pursuing the project but also for operation and maintenance after completion of project.

For LCA to undertake its role as lead organization for lake management and conservation in Madhya Pradesh, it requires appropriately trained staff to coordinate various aspects of lake basin management. Their training to acquire technical and managerial skills requires extensive upgrading. Further, some laboratory equipment that are now old need to be renewed and properly utilized with expert assistance. Establishment of a proper data management system also requires facilitation. However, given that institutional development of lake basin management institutions takes time, it is expected that with proper facilitation by the state government and other stakeholders, LCA will evolve with time to meet the challenges it currently faces.

3. Feedback

3.1 Lessons Learned

(1) Two of the reasons for the prolonged delay in completion of this project are difficult implementation arrangements for coordination among multiple implementing agencies and long time required to prepare detailed project reports (DPRs). Before implementing lake basin management projects, it is important to assess the capacity and preparedness of the implementing agencies, and the institutional arrangements in place to ensure effective coordination. The time required for relevant detailed studies and preparation of DPRs should be appropriately estimated and factored into project design.

(2) Some of the project components such as relocation of idol immersion sites, afforestation, and awareness-raising campaigns were relatively successful in this project because of active involvement of affected people. In a comprehensive lake basin

management project such as this one, active participation not only of those directly being affected but also of the citizen as a whole is essential in project design and implementation.

(3) In this project declaration of a buffer zone from the Full Tank Level (FTL) of the lakes as a "No Construction Zone" (NCZ) and its enforcement would not have been successful without active support of GOMP. The role of the state government for these types of very delicate problems such as social structures and religions is very important.

(4) Establishment of appropriate institutional arrangements for post-project follow-up is essential. Lake basin management is a continuous process that involves multiple players. It is therefore necessary to establish appropriate institutional setups for post-project operation and maintenance and follow-up works with clearly defined roles and responsibilities. Since the establishment of LCA could be proved as a role model for other similar cases elsewhere, a constant monitoring of LCA's performance over the next several years would be quite important.

3.2 Recommendations

(1) Proper maintenance of project facilities should be ensured by departments/organizations to which O&M responsibilities have been transferred. GOMP and BMC should provide the required budget allocation. As to LCA, for it to evolve with time as an institution to meet the challenges inherent in lake basin management, continued support and facilitation by the state government and other stakeholders is essential.

(2) Facilitation of transfer of operation and maintenance of sewerage component of the project from PHED to BMC is desirable. This will require provision of relevant human and financial resources.

(3) BMC should consider alternative means of generating revenue for operation and maintenance of sewerage facilities such as implementation of the proposed introduction of sewerage user fee. Efforts should be made to increase the number of house connections to the sewerage system in the project area.

(4) For LCA, long term human resource development, enhancement of technical capacity including provision of laboratory equipment, and provision of sustainable financing need to be addressed. Also, a data management system for data storage, processing and dissemination should be introduced.

(5) To assess the effects of project activities on the water quality and the lake environment one of the important requirements is collection of relevant data on inputs of pollution load to the lake from both point and non-point sources. Most of these data are not currently available for Lake Bhopal and it is recommended that the Environmental Research Laboratory of LCA should lead efforts to collect these data.

Comparison of Original and Actual Scope

Items	Planned	Actual
(1) Outputs		
1. Desilting and dredging		
a) Desilting and dredging	a) Removal of silt: 6.145 M m^3	a) 3.020 M m^3 (▼51%)
b) Deepening and widening of spill channel	b) Removal of silt: 1.240 M m^3	b) 0.987 M m^3 (▼20%)
c) Restoration of Takia Island	c) Restoration of Takia Island	c)Done as planned, with minor revisions
2. Catchment area treatment		
a) Afforestation and creation of buffer zones	a) Planting of trees: 1.3 million trees in 1,500 ha	1.7 million trees (△31%) in 962 ha (▼36%)
b) Check dams, silt traps and cascading	b) Construction of check dams: 33 dams b) Construction of silt traps: 230 traps	b) cancelled b) 2 traps
c) Garland drains	Construction of surface drains along lower lake: 7,000 m	Merged with the "Prevention of pollution"
3. Prevention of pollution (sewerage scheme)		
a) Construction / rehabilitation of sewerage system in three zones	Construction/rehabilitation of sewerage system in three zones (details not specified)	Done as per DPR specifications
4. Management of shoreline and fringe area		
a) Construction of VIP road	a) Construction of road: 4.9 km	a) as planned
b) Solid waste management	b) Provision of solid waste management equipment and machinery	b) as planned with some revisions
c) Prevention of pollution from dhobighats	c) Construction of quarters for dhobis: 400 No. c) Construction of dhobighats: 500 No.	c) 128 No. (▼68%) c) 172 No. (▼66%)
5. Improvement and management of water quality		
a) Deweeding	a) Removal of weeds: 1135 ha	a) Done almost as planned
b) Biological control of weeds (aquaculture)	b) Stocking of fingerlings: 4.30 million fingerlings	b) 3.82 million fingerlings (▼34%)
c) Monitoring of water quality	c) Provision of equipment	c)Done as planned
d) Installation of floating fountains	d) Installation of floating fountains	d) Done almost as planned

6. Consulting services a) Engineering services b) Training	 a) Engineering services: 140 M/M b) Training: 60 M/M	 a) 159.81 M/M (△14%) b) 25.3 M/M (▼58%)
7. Additional works		a) Public participation and awareness campaigns, b) Establishment of Interpretation Centre, c) Construction of lake view promenade, d) Demarcation of FTL and NCZ, e) Construction of bridge across spill channel, f) Control of seepage through earthen dam of Upper Lake, and g) Priority works for protection of VVNP
(2) Project Period Construction period	Feb. 1995 – Mar. 2000 (61 months)	Feb. 1995 – Jun. 2004 (112 months)
(3) Project Cost Foreign currency Local currency Total - ODA loan portion - Exchange rate	 785 million Yen 7,515 million Yen (2,237 million Rs.) 8,300 million Yen 7,055 million Yen 1 Rs. =3.36 Yen (as of Apr. 1994)	 547 million Yen 7,159 million Yen (2,632 million Rs.) 7,706 million Yen 6,537 million Yen 1 Rs. =2.72 Yen (Average year 1994-2004)