Message for the ROW team on the Yamuna River

It is about 23 years ago when I first got alerted by reading an article by James Gustave Speth, World Resources Institute, about the death of 1700 people and sufferance of several hundred thousands who drank the water from the Yamuna River in August 1987. This is when I thought about doing something to help improve the quality of water in the Yamuna River. I started to look at low cost treatment options to clean the drains discharging polluted water to the Yamuna River in greater Delhi area. That was a small step.

I believe strongly that "a journey of a thousand miles begins with the first step". We have begun our journey, our quest in helping to make clean water available to others.

Through our efforts we have cast the first stone in the river causing a ripple which before it reaches the shore of our endeavors will cause thousands of ripples as each and every one joins this good cause. I am a firm believer that the dreams we dare to dream really do come true; together we can make this dream a reality not only for ourselves but for the lives of many.

A site (Gau Ghat) on the Yamuna River near Agra, which got partially restored due to our active persuasion, monitoring, and observation of serious pollution due to petroleum products is a good example (see picture) of how your simple steps and actions can help the Yamuna River. In December 2000 while looking at the Yamuna River in Gau Ghat area, I was crossing the river by a boat. At the center of the river, I noticed some bubbles rising up from the bottom and they seemed to have some oily stains with slight rainbow color. I asked to stop the boat and collected two samples of the water. I had my flight scheduled that night back to Baltimore, Maryland that night. After arriving in Maryland, I arranged to provide the samples to STL laboratory in Baltimore, Maryland next morning. The results indicated total petroleum hydrocarbon at around 19,000 ppb. An image copy of the test result summary as conveyed to Agra in 2001 is shown in the figure below. This caused a serious alert and I started to look at the possible reason for such petroleum products in the river. Studying the local geology I observed that there is a sandstone layer that outcrops about 4 miles west of the river and sits at the river bed, at about 40' depth at the center of the Yamuna River at that location. There is a clay layer, 10-15' thick above the sandstone layer in the local area that prevents contaminants from the local area from percolating down below. Our volunteers looked into that fact and identified the Mathura Refinery at about 5 Kms west of the River and alerted the authorities, but their appeal was not heard at that time. 5 years later there was a massive fish kill at that location involving over 10,000 fish floating up. Our volunteers contacted me again at that time when I mentioned that they must ensure that no liquids and wastes from the refinery are dumped in open pits at the refinery. To that end they were successful in getting an injunction from the judge banning the refinery from discharging any waste liquids into a pit. All of their wastes had to be placed in tanks.

About 9 months later in November 2007, when I visited the Gau Ghat area of Yamuna, I saw the return of a vibrant ecology there.

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DATE: April 3, 2001 (6:06pm)

TO: Mr. Brij Khandelwal FAX# 562-364-164
Agra Ph: 562-369-176

FROM: Subijoy Dutta, P.E.

Total -5 Pages

RE: **Yamuna Water Analysis Report**

The Yamuna water sample from the Agra (Gau Ghat) area was analyzed by the EPA certified laboratory, STL Baltimore using the EPA method 418.1. The analysis report is over 25 pages and includes a complete QA/QC (Quality Assurance/Quality Control) and many other information. Because of the impromptu (unplanned) sampling, the quantity and the containers were not the best that could be used for the parameter, Total Petroleum Hydrocarbon (TPH), which was analyzed by the EPA certified Laboratory. The result showed TPH at less than 19,000 ppb or 19 mg/l. According to the Lab Manager the TPH content could be many times higher, if we had one litre of sample, instead of 50 CC. So, easily a factor of 20 could be added here, plus the oil sheen on the inside of the plastic bottle was visible to me and the laboratory, but could not be rinsed with Freon, because plastic would melt with Freon. In standard procedure, a glass sampling jar is used, and the inside wall is rinsed with Freon to recover the hydrocarbon film . So, the conclusion that could be drawn from this sampling event, supported by analysis, visual records, and pictures, is that the petroleum hydrocarbon is getting into the Yamuna river somewhere between the Sur Sarobar (where the water did not have any floating globules) and Gau Ghat. It could possibly be leaching into the river bed through perched groundwater, since the globules were predominant only on the central flow area of the river and not along the bank.

As a Registered Professional Engineer in the State of Maryland, USA, I, Subijoy Dutta, hereby certify the above findings to be true to the best of my knowledge.

STATE OF MARYLAND
SUBIJOY DUTTA
No. 19127
REGISTERED PROFESSIONAL ENGINEER

I would like to share a part of my talk from a recent Dance program “Mother of Tears” in Rockville, Maryland, where I said“….**whenever you look at a stream or River, think of it as your own River, treat it like your own glass of water. As you would not throw trash or waste oil in your glass of water, please treat the River or the stream the same way.** I would like each of you to take one simple step towards preventing pollution from going into the River. We should stop throwing one piece of trash in open area today, two pieces tomorrow, and three pieces the next day. At the end of the year we will find ourselves throwing trash only in the trash bins. We must start that now, and teach one person at a time. Your determined actions will one day turn your river clean and blue.!

Let’s spread the word and watch it grow step by step.

Subijoy Dutta, P.E., Founding Director
Rivers Of the World Foundation http://rowfoundation.org

The short paper below will provide a concise history of our Yamuna River cleanup effort.

Yamuna River Cleanup Effort and Related Installation of a Low-cost Wastewater Treatment System in Hyderabad

Subijoy Dutta, P.E.[1]

http://rowfoundation.org

INTRODUCTION

This voluntary project involves an actual cleanup effort, on a demonstration scale in Phase I, to remedy the massive pollution created by the overland flow of sewer system effluent from the greater Delhi and Agra area to the Yamuna River in Northern India. A map showing Cities and Towns in the Yamuna River watershed is shown on Figure 1.

WHY CLEANUP YAMUNA RIVER?

Figure 1. Cities & Towns Along the Yamuna River

An estimated 70 percent of India's total surface waters are polluted. Out of India's 3,119 towns and cities, only 217 have even partial sewage treatment facilities. The direct discharge of the untreated sewage in the surface water course is one of the major causes of high biochemical oxygen demand (BOD) in most streams and rivers of India. A 48-kilometer stretch of the Yamuna River, which flows through New Delhi, contains 7,500 coliform bacteria per 100 cc of water before entering the capital. This ill-fated and transformed Yamuna receives an estimated 225 million gallons of untreated sewage every day from the greater Delhi area and leaves New Delhi carrying an inconceivable 24 million coliform organisms per 100 cc or 240,000 coliform bacteria per cc. That same stretch of Yamuna River picks up 5 million gallons of industrial effluents, including about 125,000 gallons of DDT wastes every day. The upstream towns have no impact on water quality at Delhi - the Nazirabad Barrage blocks the Yamuna River in the northeastern part of Delhi and the water is diverted for irrigation. The Najafgarh Nala (drain) becomes the 'Yamuna' flowing down on the East Side of New Delhi. The four-year drought in India, which reached crisis proportions in 1987, forced larger portions of the population to consume unsafe water, and as of late 1987, more than 1700 people had died and 684,000 were ill from severe diarrhea and other water borne diseases (Data from an article by Mr. James Gustave Speth, President, World Resources Institute, 1709 New York Ave., NW, Suite 700, Washington, D.C. 20006).

The short and long term goals of the project are provided below:

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SHORT TERM

To begin with a demonstration of various cost-effective treatment systems in the greater Yamuna river watershed, for treatment and removal of biochemical oxygen demand (BOD) and coliform bacteria. The proposed systems are expected to bring the BOD to a level of about 5-10% of the current levels.

LONG TERM

To conduct mass-scale remediation of the greater Yamuna River watershed using these low-cost treatment systems along the Yamuna and many similar sites in India and other developing countries.

CHRONOLOGY OF THE YAMUNA RIVER CLEANUP EFFORT:

- 1992 (Sep) – After reading the above cited article by Gus Speth (World Resources Institute) about serious pollution in the Yamuna River, Subijoy Dutta, an environmental engineer who grew up in India and designed a few low-cost wastewater treatment systems in Oklahoma thought about rendering assistance by providing low-cost treatment technologies and started collecting data on the validation of wetland treatment system for presenting to the Delhi Authorities. Mr. Dutta visited Delhi, walked all along the Yamuna river in the greater Delhi area and collected water samples and data from various points of the river as it flows southwards beginning from the Wazirabad barrage in Delhi to Agra area.

- 1993 - Dennis Haag, a wetland biologist and associate of Mr. Dutta visited Delhi and conducted detail site survey, site selection and looked into low-cost/biological solutions. With active enthusiasm and support of Delhi water supply and

- Wewage disposal (DWSSD) authority, a complete design drawings and plan for 600,000 GPD system at the Khyber pass drain was developed by Mr. Haag and Dutta in 1993. The effort took about 6 months and involved developing professional engineering plans and drawings.

- 1995 – Dr. Ken Brakken joined the project and visited Delhi. Met with the then Chief Minister Madan Lal Khurana. A funding ($80,000) was promised by Mr. Khurana at a meeting in Delhi.

- 1995 Dec. - Total land requirement for the proposed wetland system was about 3.0 acres and the site (behind Metcalf house) was made available, but the Delhi authorities did not begin implementation of this funded and approved project. Several requests from Mr. Dutta in Maryland and the local Lions Club in Delhi were made to start construction of the project but the Delhi authorities did not move forward.

- 1997 – Mr. Dutta and Dr. Ken Brakken went to New Delhi again, but the stalemate continued. Lions Club joined the effort with full support and people from Agra showed interest.

- 1998 - Later discussion with CPCB (Dilip Biswas) and others lead to exploring other alternatives to relieve the massive pollution load of the Yamuna by using aerators and other biological treatment systems.

- 1998 - Mr. Dutta had spent more than $35,000 (Rs. 16.5 Lacs) of personal funds by then in pursuing this cleanup effort, and thought about writing a book to generate funds to support the Yamuna cleanup.

- 1999 (Nov) – Mr. Dutta visited Delhi, Mathura, and Agra area and observed more degraded water quality.

- 2000 (July) - Formed Yamuna Foundation for Blue Water in Maryland, USA with active volunteers in New Delhi and Agra area. (http://blueyamuna.tripod.com/yamuna.htm)

- 2001 – Provided active assistance to the victims of **Gujarat Earthquake in 2001 (January).** Sent a team of volunteers with food, water, and tents for providing relief to the earthquake victims.

- 2002 - Ganga- Yamuna Remediation Options – a meeting was organized at the Jawaharlal Nehru University, in New Delhi with active assistance from Dr. Brij Gopal. Enveloped in a sizzling summer environment with water level hitting a 15-year low at the Yamuna river, the *Ganga -Yamuna Conference* drew the water hearts of this capital city and many other dedicated individuals from Agra, Kolkata, Lucknow, and Mumbai. The Lions Club of Delhi Capital, District 321 A1, outnumbered all other organizations, including the Jawaharlal Nehru University (JNU), in the total head count from one single organization at this conference. (http://blueyamuna.tripod.com/gysummary.html)

- 2002 – Went to Agra area with Dennis Haag and Dr. Maury Albertson for the Kheitam Wetland (part of the Yamuna watershed) restoration effort.

- 2002 – Completed a book "**Environmental Treatment Technologies for Hazardous and Medical Wastes: Remedial Scope and Efficacy** by Subijoy Dutta, P.E**.,** ISBN No. 0-07-043586-3, Tata McGraw Hill Publishing Co. Mar. 2002; **www.tatamacgraw-hill.com**

- 2003 – To demonstrate a low-cost wastewater treatment technology, arranged for a demonstration project in the greater Hyderabad area with help and assistance of Mr. Ram Koduri from the Chicago area. Started construction of the deep pond system at the JNTU, Hyderabad, India.

- 2004 (August) – Completed construction of the system.

- 2004 – Provided assistance to victims of a major flood in Silchar, Assam, India

- 2005 – Provided assistance to victims of the Tsunami disaster in a village (Kichengkuppam) in the Nagapattinam area of South India.

- 2004 (September) – Presented information on the Deep Pond System (installed at Hyderabad) to Mr. Regunathan, C.S. Delhi, and Rakesh Mohan, CEO, DJB (Delhi Jal Board). They seemed to have liked the system but said that they don't have any land available to install the system.

- 2004 (October) - Went to Chicago and met with Sam Pitroda along with Raj Rajaram. Both showed great support to go forward with developing the plans and proposal. Mr. Dutta went ahead and prepared a detail, 45-page proposal and sent it to DJB on Dec 4, 2004.

- 2005 (February) - Tthe DJB tried to contact our (Yamuna Foundation) Calcutta Office and asked for clarifications. Mr. Dutta called them right away and told them that he would come down to Delhi in March and provide clarification.

- 2005 (March) – Mr. Dutta visited Delhi and gave a presentation to the DJB on March 30th and clarified their questions and issues. Mr. Ram Koduri was also present with me during that presentation.

The DJB engineers then suggested that we should revise the proposal for a smaller drain with lower flow rate. Mr. Dutta went again to 3 different sites next day morning with an engineer from DJB and picked the Kotlah Drain as a second feasible site and collected various field data.

- After returning to MD Mr. Dutta took help from Dr. Bill Roper (GMU) to make significant revisions to the proposal and resent that at the end of September, 2005 along with Dr. Raj Rajaram to the DJB.
- Nothing has been heard from the DJB since then. In Oct 2005 Mr. Dutta met with: Mr. Rajiv Lal, Ashok Kumar Jain, Engineer and Rakesh Mohan, Chairman, DJB, but no communications from them have been received yet concerning the proposal.
- On May 5, 2007 the Yamuna Summit was arranged in Oak Brook, Illinois. The **Yamuna Summit 2007** was practically an invigorating meeting where a number of dedicated individuals gathered to pour their great ideas into one massive "Kolsi" (Clay Pot) to create paths and filters to bring life back to the Yamuna River. It was organized to develop the plans and programs (paths and Filters) for restoration of the Yamuna River near New Delhi, India.
- A 10-point plan for the path forward was generated at this Summit

INSTALLATION OF A LOW-COST WASTEWATER TREATMENT SYSTEM IN HYDERABAD

Often the cost of wastewater treatment is prohibitive for the cities and municipalities in urban and suburban India. To address this issue, use of low-cost biological treatment systems have been studied by Subijoy Dutta for the past several years (Dutta, 2003). To cater to this growing need of people in India, a low-cost wastewater treatment system was developed in 2003 by a group of scientists and engineers affiliated with S & M Engineering Services in Crofton, Maryland.

This project involved implementing a low-cost wastewater treatment system on a demonstration basis in Andhra Pradesh, India. Part of the design drawings and specifications were developed by S & M Engineering Services, Crofton, Maryland with the expertise of Dr. Maury Albertson and Subijoy Dutta. Assistance in project coordination and implementation was provided by Mr. Ram Koduri of Delta Business Services, Environmental Division, Naperville, IL, who was visiting Andhra Pradesh, India. The Jawaharlal Nehru Technological University, and the Sreenidhi Institute of Science and Technology, both in greater Hyderabad, India had expressed strong interest in participating by providing land, wastewater and other infrastructure support for the demonstration project.

PARTNERS – ROLES AND RESPONSIBILITIES

1. The State of Maryland - Maryland Technology Development Corporation (TEDCO) participated in the project administration; reviewing project modifications, monitoring progress, and helping establish the administrative procedures.

2. S & M Engineering Services – The design drawings and specifications were developed by S & M Engineering Services, Crofton, Maryland with the expertise of Dr. Maury Albertson and Subijoy Dutta. During the initial site selection process S & M Engineering provided support in evaluating

the potential sites and communicating with other Project partners on a daily basis. After selection of a potentially suitable site at the Jawaharlal Nehru Technological University (JNTU) in Kukatpally, a north-western suburb of Hyderabad, Andhra Pradesh, the process of getting a formal approval from the Vice Chancellor of the university was quite elaborate and a lot of supporting information on the design and expected performance of the system had to be additionally prepared by S & M Engineering and sent to the site owners. All monthly reports and deliverables were prepared by S & M Engineering (SNM). Mr. Subijoy Dutta of S & M Engineering visited the site and conducted inspection, final adjustments, and initial startup of the system on August 30, 2004. S & M Engineering has been providing the complete analyses of all site data, including water quality monitoring reports. There is a high potential for implementation of similar projects in many other parts of India and other countries and SNM is exploring these possibilities by visiting with potential clientele in different parts of India.

3. Delta Business Services – Project coordination and assistance was provided by Mr. Ram Koduri of Delta Business Services, Environmental Division, Naperville, IL, who was in Hyderabad, Andhra Pradesh, India all throughout the project. Delta Business Services assisted in setting up proper arrangements with their associates and a few local organizations, such as site owners, local Engineering colleges and institutes in Hyderabad area of Andhra Pradesh, India. Delta Environmental worked through a very intricate approval process of the University with patience and finally got the signature of the Vice Chancellor in late February 2004. Mr. Koduri from Delta arranged to get the site access by late March 2004 and started with the site survey work. All survey data were transmitted almost daily to SNM in Maryland and the construction plans were prepared by SNM and sent by email to Delta. Daily communications took place between the project partners, mainly Delta and SNM to ensure proper implementation and installation of the system.

4. Jawaharlal Nehru Technological University (JNTU) – One of the largest contributions in this demonstration project was made by the site owner, JNTU by providing the highly valuable land for construction of the treatment system. The wastewater discharge from the student dormitories, residential housing area, and the Cafeteria has also been suitably directed by JNTU to be tapped as intake for the treatment system. The maximum design flow of 10,000 gallons/day is expected as the total intake from the above listed facilities. JNTU has also provided verbal commitments to conduct periodic water quality monitoring of the system.

THE DEEP POND TREATMENT SYSTEM

The project consists of an anaerobic, deep pond, which uses a digestion chamber for degrading various types of sewage sludge and the solids from the influent wastewater stream. This system has the potential to generate and capture methane gas for various beneficial uses if the influent solids volumes are high. At the present time the solids volume flowing into the system are quite low and an insignificant amount of methane gas is generated at the facility. The anaerobic digestion of the solids is expected to keep the solids level at or below 3 feet from the bottom of the pond and is not expected to increase beyond the bottom 4 feet of the pond. In similar systems in the U.S. no solids/sludge removal was necessary for over twenty years of operation. The effluent is planned to be used for irrigation of orchard near the treatment facility.


Figure 2. Biological Treatment System. Pond #1 (photo: Srikant, Dec 26, 2004).

During August 2004, Subijoy Dutta visited the site and conducted the system inspection and testing prior to the initial startup of the system. Delta Business Services, and along with contractors and their field persons completed the final piping, electrical, spillways, and all other ancillary construction work to get the system ready for the startup.

Figure 2 shows the picture of the Pond #1

The influent wastewater from the student dormitories, cafeteria, and the administrative buildings enter pond #1 by gravity flow. The wastewater from the residential area to the south of the facility is pumped up from the south side to Pond #1 by a grinder pump.

Figure 3 shows a schematic of the low-cost biological treatment system.

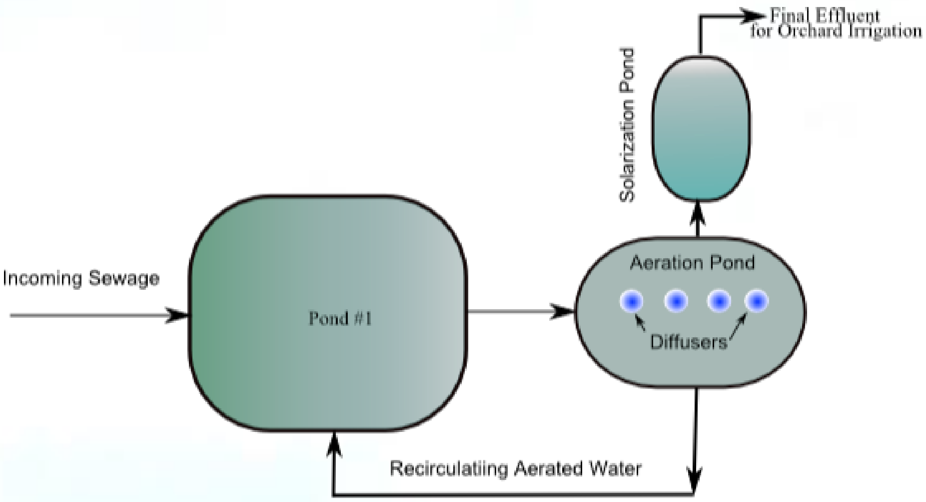

Figure 3. Schematic of the Deep Pond System

BENEFITS ACHIEVED BY THE PROJECT

The project accomplishments and achievement of each goal are elaborated below:

- This project met the objective of demonstrating a low-cost treatment alternative for wastewater by completing the system construction, adjustments, and monitoring within $82,800.00. The cost included some additional items such as fencing and high-end polishing for removal of pathogens for agricultural reuse. For a similar performance and capacity of 10,000 gallons/day in Andhra Pradesh, India, a standard wastewater treatment system would cost a minimum of about Rs. 20,790,000 (Indian Rupees, INR) or $450,000 (US Dollars). Thus the proposed project has successfully demonstrated a cost saving of more than 80% over conventional system by use of the innovative system.

- This project has demonstrated the use of effluent from the polishing pond for irrigating the orchard next to the treatment system. Because of the very low volume of solids at the intake there is very little sludge digested at the bottom of the pond. The resulting methane and carbon dioxide generation is thus very minimal at the bottom of the pond. The modified design involved recirculation of aerated water from the aeration pond (pond #2) which provides a high oxygen level in the top part of the first pond. This helps in reducing/converting the methane gas to carbon dioxide and water as per the equation below:

$$CH_4 + 2O_2 = CO_2 + 2H_2O$$

- This system has thus demonstrated reduction of greenhouse gas (methane) emission which would have otherwise emitted from a standard/conventional treatment plant using other technologies and due to the sludge disposal from such plants. Compared to the existing condition of severely leaking and overflowing septic tanks at this site, installation of this treatment system has resulted in the reduction of at least 1128 ft^3 or 8,437 gallons of methane gas, which would have otherwise been emitted from this site per day.

- The system is relatively simple to install and operate. It has **only three moving parts** which makes it a very low maintenance system.

System Performance and Preliminary Results:

Water samples were collected in the 3rd week of December, 2004 and the sampling results were sent to S & M Engineering Services, Maryland.

From this water quality sampling results, the following preliminary observations of the data are furnished below:

- It seems that the system did not reach steady state by the sampling date because of the low flow volume into the system. Due to school closings and vacations, the system was receiving less than 20% of the designed flow for the weeks prior to sampling resulting in a high retention time (lack of sewage) and presence of algae in the pond.

- The results seem to indicate that the Deep Pond (Pond #1) and the aeration pond (pond #2) is working very effectively. The direct effect of aeration by the diffusers helped almost double the oxygen level (DO) of the water (from 3.3 mg/l to 6.4 mg/l) while passing through the aeration pond (Pond #2).

Potential Application of the Deep Pond System in Treating Discharges to the Yamuna River

Based upon the available information from the Central Pollution Control Board (CPCB 2000), the estimated wastewater discharge to the Yamuna River from the greater Delhi area through the major drains is 2,723 Million liters/day (MLD) or 720 Million gallons per day (MGD). There are about 17 drainage canals which carry enormous volume of wastewater including raw sewage to the ill-fated Yamuna River as she flows south from the Wazirabad Barrage to the Oklah Dam. While considering potential treatment alternatives to treat these wastewater discharges from these drainage canals the Biological treatment system seems to have great potential to remove the pollutants without incurring huge costs and in a phased manner by treating these drains progressively by fine-tuning the technology to yield the most desirable outcome as the process continues.

A proposal involving design, installation, and initial operation and maintenance of a Wastewater Reclamation System (WRS) at the Kotlah Drain site on the east central side of New Delhi has been submitted to the Delhi Jal Board. The total facility is proposed to be completed by using a new technology involving an integrated biological wastewater treatment system.

The general area of the proposed site has been visited by Mr. Subijoy Dutta on April 12, 2005.

The cost of the proposed project is estimated to be 1/10 th or 10% of the installation cost of a standard wastewater reclamation system for a similar flow volume.

CONCLUSIONS AND RECOMMENDATIONS

The growth in India's population followed by massive development in practically all major cities and towns calls for a stable water supply and sanitation system to avoid major health problems and related outbreaks. The low-cost biological treatment system installed in Hyderabad on a demonstration basis could have effective application in many other metropolitan cities and suburbs in India to meet their wastewater treatment and reuse needs.

References

1. Dutta, S. 2003, "*Use of Low-cost Wastewater Treatment Systems*", paper presentation at the Workshop on Low-Cost treatment technologies for water treatment, the George Washington University, Washington DC, May 30, 2003.

2. CPCB 2000, Water Quality Status of Yamuna River, Series: ADSORBS/32/1999-2000, April 2000.