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E138

BANGLADESH

"Gas infrastructure development Project"

**GAS INFRASTRUCTURE DEVELOPMENT PROJECT
ENVIRONMENT AND SAFETY
ASSESSMENT REPORT: SUMMARY**

PREPARED FOR:

PETROBANGLA

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PROJECT SUMMARY

The Gas Infrastructure Development Project (GIDP) is a continuation of the IDA assistance to Bangladesh for the development of the natural gas sector. Economic alternatives for natural gas do not exist in Bangladesh at this time. Reduction of the oil import burden will also depend on the development and production of natural gas liquids, especially LPG which can substitute for imported kerosene and local fuelwood used for cooking in households. **Natural gas is the most environmentally acceptable option for Bangladesh.**

The proposed GIDP represents the development of a new mainline 59 km pipeline right-of-way through flat agricultural land, development drilling in an existing producing field, and implementation of control and management systems. The project areas are shown in Figure A. The GIDP will support the following main components:

- Development of three production wells in the Rashidpur field and construction of associated silica gel gas dehydration surface facilities. The location of the wells and facility are shown in Figure B;
- Construction of the 59 km Ashuganj - Bakhrabad (A-B) gas transmission line and associated facilities to connect it with the Kailashtilla-Ashuganj pipeline (N-S pipeline) and Bakhrabad gas transmission system, and provision of SCADA system for the N-S and A-B pipeline and the associated pipeline system. A pipeline schematic is detailed in Figure C;
- Technical Assistance (TA) and training comprising consulting services for:
 - i) Project supervision for drilling, surface facilities, A-B pipeline, SCADA/Telecom;
 - ii) SCADA planning study;
 - iii) Institutional support for the Gas Transmission Company (GTC);
 - iv) Review of safety, environment, and gas production, transmission and distribution regulations, preparation of an environment and safety management system and institutional support to the Environment and Safety Division of Petrobangla; and,
 - v) Implementation of a Management System Improvement Program (MSIP) for the Petrobangla group;

- Training of the staff in skills related to the above-mentioned TA program in drilling engineering, surface facilities design, construction and management, SCADA design, installation, and operations, pipeline design, construction, and operations, would also be provided.

The project schedule is: (a) Rashidpur development drilling 1995-1996; (b) dehydration plant construction 1995-97; (c) Ashuganj-Bakhrabad pipeline construction 1995-1996; (e) SCADA system 1995-1996; (f) environment and safety management system 1994-1997; and (g) technical assistance and training throughout the project period.

POLICY, LEGAL AND ADMINISTRATIVE FRAMEWORK

In 1991 the GOB developed an environment policy which defines the overall environmental framework and assigns responsibility for regulatory development, administration and enforcement. The Department of Environment is within the Ministry of Environment. A National Environment Council, with the head of the government as chairperson, provides overall policy direction.

Petrobangla remains the sole entity responsible for the development of oil and gas resources. Bangladesh environmental regulations do not apply to oil and gas construction and operation except for the requirement in the Environmental Policy to conduct Environmental Impact Assessments (EIA) for new industrial projects. EIA guidelines have not been adopted except for specific project needs.

Using the 1986 - 1988 Thailand Environment Quality Standards and Laws and Standards on Pollution Control, the Bangladesh Department of Environment has developed Environmental Quality Standards (EQS) for Bangladesh. The GOB retains the right to apply the standards as required to individual projects or industries under project specific permits. The Department of Environment has obtained technical assistance to develop and apply industrial guidelines and standards. The GOB has instructed Petrobangla to undertake and complete an Environment and Safety Assessment of the Gas Infrastructure Development Project (GIDP). Petrobangla has followed the World Bank directive OD 4.01 and OD 4.30 in developing this assessment. The assessment recognizes data gaps and mitigation needs and commits the GOB and Petrobangla to a program which will be implemented and monitored to assure all impacts are adequately understood and mitigated.

Petrobangla has committed to the implementation of an environmental policy and development of an adequately staffed and operational Environment and Safety Division (ESD). The ESD was formed and staffed in November 1994. ESD staff members have been involved in the Safety Audit Program and Environmental Data Acquisition program. The development of the ESD ensures that Petrobangla has dedicated resources and assigned responsibilities for mitigation planning and monitoring of GIDP and future Petrobangla activities.

ENVIRONMENT AND SAFETY DATA

Data was gathered by local consultants from available literature, from Petrobangla staff, and through field investigations. Baseline environmental conditions were ascertained and data gaps noted. Baseline data acquisition was completed for priority areas to meet proposed development schedules. Although initial data was considered adequate for design and planning, subsequent data is being acquired for specific site planning and as part of the Petrobangla Environment and Safety Division development and training program. A report on data acquisition will be available by July 1994. This report will provide the detail necessary to complete site specific mitigation planning objectives.

Population and Land Use

Population densities in the project area vary from a high of 1313 persons / km² along the A-B pipeline route to a low of 591 persons / km² in the Habiganj / Rashidpur Gas Fields. Land use is predominantly cereal and vegetable crop agriculture with limited agro-forestry and tea plantations. The land and its agricultural products form a very important resource for the Bangladeshi people. The population density and subsistence agricultural lifestyle make the population susceptible to any changes in land use or degradation of agrarian production.

Natural Hazards

The natural hazard of significance is yearly flooding. Acidic subsoils increase pipeline corrosion potential.

Climate

Two distinct seasons occur. April to November is a period of cyclonic typhoons with heavy rains and flooding. December to March is dry and cooler. High temperatures reached in May and June are 39°C. Lows of 8°C are reached in December and January.

Air Quality and Noise

Air quality in the project areas is good although data exists. Fuel wood, kerosene and animal dung are used as fuels. Air quality data is not available for the Rashidpur facility area. The Department of Environment has set noise guidelines at 75 dBa daytime and 70 dBa nighttime for industry.

Hydrology and Water Quality

The surface and groundwater in Bangladesh comprise resources of equal importance to the agricultural soils of the country. Surface water provides for irrigation, fisheries, soil deposition, and transportation. Groundwater provides potable water and irrigation supply.

The A-B Pipeline will cross the Titas/Pagla river at Ashuganj and the Buri and Gumti Rivers at Bakhrabad. Crossing will be at low flow period. Formation and process waters discharged from the Rashidpur gas processing facilities contain less than 4000 ppm total dissolved solids and less than 100 ppm dissolved hydrocarbons. Increased sediment load or hydrocarbon contamination of the rivers could adversely affect downstream water users and fisheries potential depending on volume, periodicity and timing. The main area of concern are the tributaries to Hail Hoar originating in the Rashidpur area.

Groundwater is a critical resource which is contained in an extensive aquifer at a very shallow depth in the A-B Pipeline project area and at depths of 40-50 meters in the Rashidpur area. It is exploited extensively through installation of handwells and deep tubewells. Contamination of groundwater resources in areas where all potable and irrigation water is sourced from wells would have long term effects. Water use in the pipeline project areas is combined surface and groundwater. Domestic water use in the Rashidpur area is limited to transient surface water users and localized water wells; the area use being substantially forestry, agro-forestry, and tea

plantations. Water at the Rashidpur wellsites and facility will be provided by groundwater resources.

Fisheries

Fishing is an important industry in Bangladesh involving approximately 73 percent of rural households. Small fish pond production along the pipeline route is an important protein source for village families. A combination of over-fishing, pollution, deforestation and hydraulic structures have led to a continual decline in natural fisheries reserves. Review of the existing Petrobangla projects indicates little impact from gas development to natural fisheries. In isolated cases artificial fish ponds have been affected.

Soils and Agriculture

Most agricultural plots in Bangladesh are less than one acre and are cropped one to three times per year. The main crops grown are cereals (primarily rice) with some vegetables and fruits. Precise data on agricultural production is being developed with the land compensation program.

The soil associations are complex. Soil surveys exist for the project areas; however, some conflicting information exists on soil types. Flat floodplains predominate in the majority of the study area, with some hills and terraces in the Rashidpur area. Due to the reliance on soils for food production and lack of accurate data, a soil survey has been performed along the A-B Pipeline route. A review of past Petrobangla activities indicated localized soil compaction, erosion, loss of fertility and contamination due to construction and operations. A soil survey for the Rashidpur sites is being conducted.

Vegetation, Forests and Wetlands

Native vegetation is important for food, timber, export, medicinal purposes and worship. Natural forest stands are being depleted for fuelwood, illegal logging, gas exploration and agriculture, most significantly in the Rashidpur area. Reforestation has taken the form of plantations, changing habitat for indigenous species. The project crosses through some forest tracts in the Rashidpur area. Detailed forest cover information is being acquired for the areas affected in the Rashidpur field.

Wetlands support hundreds of plant and animal species. The haor and bil wetlands of the northeast are important habitats for large numbers of species. Drainage, irrigation and flood control are drying up wetlands.

Wildlife

Bangladesh has been home to hundreds of recorded species. Important sources of biodiversity are the forests and wetlands. However, given pressures of illegal hunting, trapping and loss of habitat, many species have become extinct, rare or extirpated. In the future, the hill areas in the northeast may become part of a protected area, making gas extraction more difficult. Information describing the distribution of wildlife in Rashidpur area is being acquired.

Historical and Archaeological Resources

Bangladesh has a long and very rich and diverse history. The only identified sites in the project area are two grave areas located approximately 0.5 km of the A-B Pipeline route.

Resettlement, Land Acquisition and Compensation

Given the high density of settlements, any incremental loss of land which affects food production, available living space, forest resources and wildlife habitat is significant to Bangladesh. The proposed project involves resettlement of only 8-10 families along the A-B Pipeline alignment. Relocation is not anticipated for the Rashidpur well locations. Traditionally, land acquisition has been associated with delayed compensation payments. Obligations on public land do not require a reinstatement plan, therefore land degradation is often significant. The lack of a public participation process may have contributed to resentment of earlier pipeline projects.

Waste Management

Bangladesh currently has no guidelines specific to the oil and gas industry or for solid waste disposal. Therefore, the onus is on industry to minimize and safely dispose of all wastes produced. The Environment and Safety Division is developing a waste management plan. The development and operations of dry gas field produces limited volumes of waste material. The main project wastes will be camp domestic garbage, drilling cuttings and 0.5 m³/day of process

water at the Rashidpur facility.

Safety Assessment

The GOB has taken steps for regulating the safety of the natural gas industry and setting standards and policy for environmental protection. It will take several years for there to be a comprehensive system of controls. Meanwhile, Petrobangla and Bangladesh Petroleum Corporation (BPC) will be responsible for running their businesses safely with minimal environmental impact. The system is physically linked and the safety performance will be highly dependent on the effectiveness of the coordination of the entire natural gas organization.

The safety aspect of gas transmission, distribution and storage is regulated by Bangladesh's existing law, namely, the 1991 Natural Gas Safety Rules. However, the lack of adequate formal, uniform standards and technical procedures within the Petrobangla group tends to inhibit the effectiveness of the above legislation. As part of the environment and safety assessment, a team of safety engineering experts from British Gas was engaged in August 1993 to carry out a safety audit of the group's entire operations. The audit concludes that all operating companies are generally operating an adequate system and provides recommendations for safety program development.

DATA REQUIREMENTS

The information on the following pages outlines supplemental data being acquired by Petrobangla for implementation of the Environment and Safety Assessment monitoring and mitigation plan. In order for environmental and social impacts to be fully understood, properly planned for and mitigated, baseline data are being collected prior to commencement of construction and/or operations. Table A provides a schedule and summary of the data acquisition program. The data acquisition is focused on those areas where environmental impacts could arise. The staff of the Petrobangla ESD is involved in the acquisition, collation and interpretation of the data. The data will serve both the GIDP and ongoing Petrobangla operations.

Population/Settlement Survey; Nov. 1993 - July 1994

The effect of acquisition and requisition on each parcel of land affected by the right-of-way, wellsites or by flow lines has been shown and assessed on the A-B Pipeline alignment sheets and field maps. All efforts including realignment have been attempted to avoid the need for resettlement. Data on land parcels and ownership will be used by the third party consultant in monitoring the land management program.

Surveys of Wildlife, Forests, and Wetlands Nov. 1993 - July 1994

All forests, wetlands, and areas of native vegetation in the project areas are being surveyed at 1:20,000 scale and confirmed. The local use and protection status of these resources are being mapped. Using a combination of field work and LANDSAT data, areas have been defined according to location, size, and species composition. Flow patterns and productivity of wetlands will also be determined.

A combination of wildlife surveys in the field, meetings with NGO's and discussions with local administrators has been completed to determine distribution and movement patterns of native wildlife. This data is being used to finalize road and flow line alignments in the Rashidpur field once final wellsite locations are determined.

Surveys of Fisheries Production Areas; Nov. 1993 - July 1994

Fisheries production requirements and locations (including streams, rivers, wetlands, bils and fish farms) are being determined through field surveys and studies. Critical periods and ecological parameters for fisheries production maintenance will be determined. Preliminary data indicates that significant areas are not being affected by the project.

Soil Survey and Erosion Hazards; Aug. 1993 - July 1994

An agricultural soil survey of the A-B Pipeline right-of-way has provided necessary information for final A-B Pipeline construction planning, minimizing potential soil degradation. A soil survey for Rashidpur is being conducted to ensure that a reclamation program matches the soil types. In Rashidpur erosion potential is being determined for river crossings and slopes. The rights-of-

way for tie-in pipelines will be relocated and/or protection measures implemented as required depending on final well locations.

Groundwater and Surface Water Assessment; Jan. 1994 - July 1994

In conjunction with the settlement survey, tubewells are being located and use and condition assessed. The potential for loss or contamination is being documented. At Rashidpur, the major local streams that could be affected by discharge are being tested for general parameters, inorganics and hydrocarbons. A monitoring program will be initiated by the Petrobangla ESD to ascertain if Petrobangla operations are affecting water quality. Well waters around the facilities are being sampled for background. Surface water quality is being documented in the major rivers along the A-B Pipeline Route. Water quality upstream and downstream of river crossings will be acquired during construction of A-B Pipeline.

Location of Areas of Historical and Religious Import; Jan. 1994 - July 1994

Through an archaeological and historical site review, and discussions with mouza administration and landowners, historical, archaeological or religious sites which may require protection, avoidance, or excavation are being identified. Data acquired will be provided to contractors to make them aware of potential conflict sites.

Waste Guidelines; Jan. 1994 - July 1994

Waste guidelines are being developed for all aspects of GIDP including handling, transportation and disposal. Waste streams include drilling fluids, hydrostatic test fluids, and gas dehydration process water will be reviewed. International guidelines are being reviewed by Petrobangla ESD to adopt appropriate methods for project conditions.

Routing of Tie-In Lines; Mar. 1994 - July 1994

The Rashidpur gas field area is being assessed to determine optimal routing of tie-in lines based on environmental and engineering considerations. The data will be used once final wellsite locations are determined.

Safety Audit Aug. 1993 - March 1994

A safety audit of all Petrobangla gas production operations has been completed by safety engineers from British Gas. A final report has been delivered to Petrobangla and World Bank outlining the technical needs and training for implementation under the GIDP training program.

**TABLE A
DATA UNDER ACQUISITION FOR THE
ENVIRONMENTAL ASSESSMENT OF THE GIDP**

DATA REQUIRED	ACTION PLAN	TIME FRAME
1. Requirements for all GIDP Project Areas Population/Settlement Survey <ul style="list-style-type: none"> · # of parcels < 1 - 1.5 ha · Location of dwellings 	<ul style="list-style-type: none"> · Interview small parcel owners who have been affected · Population survey of routes in all pipeline areas · Prepare alignment sheets showing acquired and requisitioned land through the row 	Nov. 1993 - July 1994
2. Vegetation/Forest Survey <ul style="list-style-type: none"> · Location, size, species composition of forests, areas of native vegetation · Expected loss of forests, native vegetation and homestead tree stands 	<ul style="list-style-type: none"> · Plot all vegetation information on alignment sheets · Survey and map all forests and areas of native vegetation · Assess current use of forests/wetlands and protection status 	
3. Fish Production Area Survey <ul style="list-style-type: none"> · Turbidity and flow requirements for fish production · Expected siltation increases · Effect of effluent on fish production · Location of all fish production areas 	<ul style="list-style-type: none"> · Survey fishing areas including streams, rivers, bils, fish farms · Determine spawning/production schedule through field surveys, local knowledge and administration · Note fisheries information on alignment sheets 	Nov. 1993 - July 1994
4. Location, Condition and Type of all Tubewells <ul style="list-style-type: none"> · Potential for disruption · Potential for contamination from incremental loss and spills 	<ul style="list-style-type: none"> · Sample if potential for contamination occurs · In conjunction with settlement survey, locate tubewells, determine status · If essential to disturb tubewells, replace and upgrade 	Jan. 1994 - July 1994
5. Location of Areas of Religious Importance <ul style="list-style-type: none"> · Location of sites, markers and celebration locations 	<ul style="list-style-type: none"> · Meet with all affected mouza administration · Avoid interference with identified sites, ceremonies 	Jan. 1994 - July 1994
6. Slope Stability, Erosion Potential at River Crossings and Hill Areas <ul style="list-style-type: none"> · Erosion hazard based on soil type, flow, bank stability · Erosion hazard based on terrain, soil type, aspect, vegetation cover. 	<ul style="list-style-type: none"> · Slope and stability survey; erosion hazard assessment · During soil survey, measure slopes of routes · Calculate erosion potential · Alter route if necessary or take steps to protect soil 	Aug. 1993 - July 1994
7. Soil Evaluation <ul style="list-style-type: none"> · soil type, depth of each horizon and characteristics, effects from desiccation 	<ul style="list-style-type: none"> · Soil survey, sampling and analysis · Establish physical, chemical and biological criteria for evaluating soils for development and revegetation 	Aug. 1993 - July 1994

<p style="text-align: center;">TABLE A DATA UNDER ACQUISITION FOR THE ENVIRONMENTAL ASSESSMENT OF THE GIDP</p>			
8.	Faunal Distribution <ul style="list-style-type: none"> • Distribution of native wildlife and location of critical habitat • Movement and migration patterns and schedules 	<ul style="list-style-type: none"> • Wildlife surveys • Wildlife habitat identification and maintenance • Endangered species sightings • Meet with interested NGO's 	Nov. 1993 - July 1994
9.	Wetland Distribution <ul style="list-style-type: none"> • Flow rate required to sustain wetlands in conjunction with fisheries • Drainage pattern of wetland system 	<ul style="list-style-type: none"> • Survey route for wetlands • Identify size, type, location and flow pattern of wetlands • Satellite image analysis 	Nov. 1993 - July 1994
10.	Location of Archaeological Resources, Historical and Sacred Monuments <ul style="list-style-type: none"> • Verify any sites and potential areas of archaeological concern 	<ul style="list-style-type: none"> • Archaeological/Historical resource survey • Identify those sites which require protection and others which require excavation • Establish excavation plan if required 	Jan. 1994 - July 1994
11.	Waste Guidelines <ul style="list-style-type: none"> • Determine exact nature of waste produced and locate possible disposal sites or determine disposal options • Determine handling requirements 	<ul style="list-style-type: none"> • Develop waste handling, transportation and disposal guidelines for pipeline construction, facility operation and well sites 	Dec. 1993 - July 1994
12.	Exact Routing of Tie-in Lines <ul style="list-style-type: none"> • Route alignments needed from Petrobangla for Rashidpur field tie-ins 	<ul style="list-style-type: none"> • Survey gas field areas and select route based on environmental and engineering considerations 	Mar. 1994 - July 1994
13.	Water Quality at Affected Sites <ul style="list-style-type: none"> • Background upstream and downstream of facility and major river crossings 	<ul style="list-style-type: none"> • Surface water sampling and analysis downstream of Rashidpur • Monitoring program • Test for general parameters, inorganics, and hydrocarbons • Review all affected streams 	Jan. 1994 - July 1994
14.	Groundwater Use and Locations <ul style="list-style-type: none"> • Locations, use and quality of groundwater along routes and at facilities 	<ul style="list-style-type: none"> • Conduct a study of groundwater users and well data 	Jan. 1994 - July 1994
15.	Safety and Hazardous Operations <ul style="list-style-type: none"> • background on safety programs in drilling, pipelines and facility operations 	<ul style="list-style-type: none"> • review all safety programs used by Petrobangla and contractors 	Aug. 1993 - March 1994 (Completed)

ENVIRONMENT AND SAFETY - IMPACTS AND MITIGATION

The impacts, mitigation, work required and monitoring to assure compliance are summarized in Table B. Mitigation and monitoring has been developed for implementation by the Petrobangla ESD with training and direction under the technical assistance programs.

Land Acquisition

The A-B Pipeline right-of-way will permanently acquire 58.5 ha. of land involving 1924 individual plots. An additional 91.12 ha. will be temporarily requisitioned from 2269 land plots. An estimated 8-10 families will be resettled along the right-of-way.

Compensation will involve an estimated 4000 families due to joint land ownership. There is a possibility of small land owners being under-compensated or becoming disenfranchised by the location of a pipeline route, facility or well site. Recognizing that compensation payments have been undervalued, GOB has increased payments to 50% above assessed value. A public consultation process involving project affected people has been developed and will be monitored to reduce previous problems associated with pipeline construction. A public awareness program will be initiated to address security and operations problems. These programs will be developed and coordinated by the Petrobangla ESD as part of the technical assistance.

Use of existing facilities is being promoted wherever possible to limit taking of land. In the Rashidpur area the main land ownership rests with GOB. Small areas of land under cultivation for tea may be impacted by road and pipeline construction. Development drilling sites will not exceed 1.5 ha. Directional drilling is intended wherever practical to minimize land acquisition through the use of developed drilling sites. Existing access roads and pipeline rights-of-way are being used wherever possible to limit road and pipeline construction. A single common drilling operations camp will be established for the drilling program. The use of closed drilling systems will be specified for Rashidpur wells, further limiting the drilling site area.

The new gas dehydration facility will utilize existing acquired land.

Natural Hazards

Detailed geotechnical investigations are completed prior to any design of facility siting. A number of river crossings will be completed using directional drilling to avoid potential problems associated with open cut crossings. Resistivity studies have been completed and corrosion protection design coordinated with specific soil properties. Soil handling and replacement methods have been developed to ensure soil resistivity characteristics are not altered substantially during construction.

Surface Water Contamination

Construction of the Rashidpur dehydration facility will increase produced water volumes by 0.5 m³/day. The gas stream is very dry and process water has less than 5000 mg/L TDS, low chlorides and 100-200 mg/L dissolved hydrocarbons. A silica gel system was selected, therefore glycol will not form part of the process water stream.

Surface water contamination can occur from pipeline hydrostatic test fluids and drilling fluids. Sumpless drilling techniques will be used to limit disposal of drilling fluids. If required, containment ponds will be properly designed and managed. If fluids are to be released they will be tested and treated to meet standards prior to release into the environment. Drilling contractors will be required to utilize non-toxic polymer fluids and employ sumpless drilling equipment.

Water treatment and testing programs at facilities are being designed in order to meet EQS standards. Air strippers have been proposed by the engineering design group for dissolved hydrocarbon removal. Erosion protection measures will be followed to minimize impact to streams from siltation. Minimal erosion or soil loss is expected on the A-B Pipeline since elevation change is only 4 meters over the entire pipeline route.

Liquid waste discharge guidelines will be developed to meet EQS standards and implemented by the ESD as part of the technical assistance program.

Disturbance to Groundwater

If tubewells are not located prior to development, they could be inadvertently disturbed during drilling or construction. Potable water sources may be contaminated if operations are poorly managed or located too close to water wells. Condensate spills or leaks in the Rashidpur are not of concern due to a dry gas composition, therefore groundwater contamination potential is limited.

All tubewells within 0.5 km of pipeline routes, facilities or drilling sites are being inventoried and selected wells assessed for quality and flow rates. Compensation is provided or new wells drilled if disturbance is unavoidable or accidental. A spill and leak prevention plan will be required of by all contractors and operations personnel. Drilling and workover procedures will be undertaken using closed fluid systems to ensure that groundwater resources are protected.

Casing is cemented below the deepest aquifer to avoid aquifer contamination from drilling or production operations.

Soil Degradation and Agriculture

Exposed soils are subject to erosion, particularly on steep slopes. The impact of the proposed developments on soil quality has been fully assessed. Agricultural production will be lowered if soils are mismanaged through topsoil mixing or through erosion. Improper fertilizer applications can lead to degradation of soil fertility in the long term and may also result in surface or groundwater contamination. Fluid spills or leaks can lead to soil contamination resulting in plant toxicity, potentially affecting human health.

A construction and reinstatement plan has been developed and included in the construction tender documents for A-B Pipeline. From soil surveys, methods for soil management have been developed where they overlap with GIDP project work. These methods will be implemented on areas previously developed. Erodibility has been described and marked on alignment sheets. Design specification drawings has been referred to on the alignment sheets. Soil handling techniques and soil erosion prevention measures are specified in the construction working documents. Contractors have been required to hire a soil scientist to inspect all soil management and develop fertilizer application programs. A mitigation component will be test plots along the rights-of-way to assess effectiveness of soil management methods and to inform the rural

population of construction methods and proper fertilizer use.

All drilling fluids will be maintained in closed systems. Drilling fluids and hydrostatic test fluids will be non-toxic biodegradable to avoid long term soil degradation if spills occur.

Disturbance to Wildlife, Forests, Wetlands

In the Rashidpur area, wildlife habitat will be disturbed/dislocated where pipelines, facilities and well sites encroach in forested areas. There is minimal catalogued information on the faunal distribution in the Rashidpur project area. Access to areas increases hunting and opens foraging opportunities for native plant species. Wetlands are very important sites for plant, fish and wildlife production; contamination or alteration of flow rates could affect numerous species.

Forest cover removal occurs for right-of-way development. Increased access allows further illegal logging and fuelwood deforestation. Increased natural gas distribution will positively impact forest resources by relieving some of the current pressure on forest stands for fuelwood. To minimize forest loss, the number of site locations and size will be minimized by using directional drilling and sumless drilling techniques. Forest cover loss will be offset through replanting of forest resources. Petrobangla will maintain an inventory of all forests where gas operations affect forest cover. Methods to stop general access to newly opened areas (e.g. Rashidpur sites) will be developed. The width of roads and rights-of-way will be minimized where they encroach on forest areas in Rashidpur.

Petrobangla will minimize access to limit hunting at Petrobangla sites and will dismiss any Petrobangla employee hunting illegally.

Wetlands will be protected by minimizing disturbance to streams and reconstructing drainage channels. Pipelines will be concrete weighted to ensure floatation does not occur which would alter wetland drainage patterns.

Fisheries

Any proposed development which will alter sediment load, flow regime or composition of the stream requires careful planning to avoid consequential impacts. A reduction in fish production and survival may result from increased siltation from stream disturbance, pond level fluctuation, or contamination of sediments and surface water.

Disturbance during construction of pipeline river crossings will be minimized by using directional drilling. Construction activities which impact fishery production will be scheduled to avoid critical production periods. Any damage to fish ponds leading to production loss will be compensated. A database of all fish ponds within 200 m of the pipeline rights-of-way and wellsites is being established to assess impacts and assure fair compensation.

No waste materials from drilling, construction, or operations will be disposed to water bodies without prior sampling and compatibility testing. Department of Environment will be advised of intended discharge of materials.

Air Emissions - Gas Flaring

Local airshed air quality degradation in the vicinity of the Rashidpur gas processing facility will be minimal. The increased substitution of natural gas and LPG for present fuel sources will significantly lower total air emission levels. Flares wherever used will be operated and maintained to limit emissions. Gas vented from pipelines will be flared wherever possible. Noise increase from facility operations will increase levels by only 30-35 dBa.

Areas of Historical and Religious Importance

An initial literature search and route inspection of the A-B Pipeline and Rashidpur areas has shown no sites will be impacted. An historical/archaeological field review is being completed in the project areas. A protection and excavation plan would be developed if required, on a site-specific basis.

Production and Operation Wastes

Sludges from vessels, tanks, and drilling operations deposited to pits can cause groundwater contamination. Waste water from the Rashidpur gas plant contains low levels of chloride, dissolved solids and hydrocarbon. Accidental discharges or spills are potential sources of water and soil contamination and fire hazards.

A waste and effluent management plan, and guidelines will be developed for Petrobangla as part of the technical assistance. The plan for the limited volume of hydrocarbon sludges produced at Rashidpur is to utilize land treatment. An emergency response plan will be adopted and implemented for the overall gas production system.

Drilling sumps will utilize the mix/bury/cover method of solids management after drilling completion. Closed system drilling methods will be specified for Rashidpur wells. Solids will consist of only drill cuttings and residual drilling fluids.

ENVIRONMENTAL MONITORING PLAN

To determine the effectiveness of mitigation planning and implementation the staff of the Petrobangla ESD will undertake the following monitoring components:

- (i) Continue landowner contact program to assess landowner satisfaction or dissatisfaction with the public participation program and land compensation.
- (ii) Acquire monthly samples of waste water streams. Monitor training and initiation of all personnel in spill prevention and emergency response and contingency plans. Sample water prior to discharge of hydrostatic testing fluid. Monitor pipeline and valve stations for leaks.
- (iii) Monitor potable wells in close proximity to facilities and drilling sumps and review current cased logs and casing data.
- (iv) Monitor stream crossings and slopes to identify erosion problems and to track success of erosion control devices; monitor soil fertility and production along the right-of-way.

- (v) Select indicator species in rivers and in forest areas, to determine the effect of the development on fisheries and wildlife. Monitor use of the right-of-way and access points to determine increased use.
- (vi) Monitor fish production following pipeline crossings.
- (vii) Ensure that an archaeological expert is available on call to identify and plan for significant sites, if uncovered.
- (viii) Track the treatment, testing and disposal of all wastes through accurate record keeping.
- (ix) Ensure that the Environment and Safety Division of Petrobangla conducts at least one formal Environment and Safety Quality Audit on all Contractor's performance during construction and testing.
- (x) Monitor environment and safety training programs.
- (xi) Establish a record keeping procedure, central filing system and reporting system for all of the above plans, to be managed by the Environment and Safety Division.
- (xii) Prepare quarterly progress reports on all monitoring programs as part of the overall Management Information System.

TABLE B				
SUMMARY OF IMPACT, MITIGATION AND MONITORING				
POTENTIAL IMPACT	MITIGATION	PROGRAM WORK REQUIRED	MONITORING REQUIRED	TIME FRAME
1. Local Involvement and Compensation <ul style="list-style-type: none"> • Compensation Payments • Disenfranchised landowners • No opportunity for public participation • Long-term loss of land • Employment of local manpower • Damage to property 	<ul style="list-style-type: none"> • Develop public participation process model • Base compensation on actual land values and properties • Inform landowners of safety limits • Begin work on changes to land policy to introduce surface rights procedures 	<ul style="list-style-type: none"> • Establish public consultation process involving Thana administration • Negotiate a system of fair compensation payment with the G.O.B. • Work with government to change rules for land requisition 	<ul style="list-style-type: none"> • Investigate replacing the system of acquirement to one of easement • Maintain a public relations/contact program throughout project lifetime • Ensure compensation payments are prompt and fair 	Nov. 1993 - July 1994
2. Discharge of Waste Water to River <ul style="list-style-type: none"> • Rashidpur Facility • Pipeline Hydrostatic Testing Fluids • Drilling and Workover Fluids • Pipeline Pigging 	<ul style="list-style-type: none"> • Review installation of treatment mechanisms to bring water quality up to Quality Standards • Determine what fluids could be substituted for drilling and workover, hydrostatic testing, and facilities chemicals • Conduct a surface and groundwater sampling program 	<ul style="list-style-type: none"> • Review workover fluid and material requirements • Test waste water stream to determine discharge levels after commissioning of facility • Review spill handling at facilities and level of discharge to area surface waters from incidental spills • Determine spill response equipment needs • Determine concentration and type of hydrostatic test fluid used and methods for treating its discharged fluids • Sample surface waters 	<ul style="list-style-type: none"> • Complete monthly samples of waste water stream during facility operations • Continue downstream sampling programs • Assure adequate treatment is available to treat incremental and large hydrocarbon spills • Test waters during discharge of hydrostatic testing • Assess toxicity of workover fluids 	Jan. 1994 - June 1996
3. Disturbance to Groundwater <ul style="list-style-type: none"> • Impairment of water quality • Change to water well production 	<ul style="list-style-type: none"> • Locate all wells within 1.0 km of facilities, wellsites, and pipelines (according to topography) • Develop a groundwater protection plan to avoid short or long-term impact 	<ul style="list-style-type: none"> • Inventory all wells in affected areas • Determine flow rates and quality in specific wells • Determine effects from a spill of drilling, workover fluids, condensate or waste water • Determine drilling and workover procedures for groundwater protection 	<ul style="list-style-type: none"> • Monitor wells in close proximity to facilities • Review current cased logs and casing data • Monitor wells in close proximity to drilling sumps 	Jan. 1994 - June 1996

TABLE B
SUMMARY OF IMPACT, MITIGATION AND MONITORING

POTENTIAL IMPACT	MITIGATION	PROGRAM WORK REQUIRED	MONITORING REQUIRED	TIME FRAME
<p>4. Soil Erosion and Fertility</p> <ul style="list-style-type: none"> • Hill areas are highly erodible • Soils with acid subsoil are toxic if uncovered and desiccated • Soil contaminated with wastes are toxic and sources for groundwater contamination 	<ul style="list-style-type: none"> • Route design should limit cuts into steep slopes • Develop soils data of all project areas • Develop all drawings necessary for inclusion in construction bid documents • Develop handling techniques for soil specific to each project area • Develop planting and reinstatement procedures to maximize soil protection 	<ul style="list-style-type: none"> • Finalize area route alignments for Rashidpur • Soil surveys for project areas and along pipelines • Include soil handling specs, and drawings in the engineering specs • Develop a soil reclamation and planting program for each area • Implement erosion mitigation techniques on areas already completed during SGDP 	<ul style="list-style-type: none"> • Assess soil survey program • Review N-S and Brahmaputra Basin Pipeline ROW for fertility problems • Assess effectiveness of reclamation and erosion control along N-S Pipeline ROW 	<p>1 Jan 1994 - July 1994 - surveys</p> <p>2 Jun 1994 - July 1994 - programs</p>
<p>5. River Crossings</p> <ul style="list-style-type: none"> • Lower fish production and survival by increased sediment load • Alter stream substrates or change channel regime • Pipeline ruptures • Spills from construction operations 	<ul style="list-style-type: none"> • Schedule to avoid critical periods for fish production • Minimize time for crossing • Install silt curtains if required • Install valve stations to protect rivers in event of leak 	<ul style="list-style-type: none"> • Employ crossing technique which minimize disturbance of river bed • Determine periods critical to fish production and avoid or mitigate appropriately 	<ul style="list-style-type: none"> • Check river crossing monthly for one year; • Employ erosion prevention structures if necessary • Monitor sediment loading during construction, • Assure spills are not allowed to enter surface water 	<p>Jan. 1994 - June 1996</p>
<p>6. Fisheries</p> <ul style="list-style-type: none"> • Toxic effects • Reduced production and survival, reduced prey base 	<ul style="list-style-type: none"> • Install silt curtain if necessary • Schedule to minimize impact • Avoid spawning beds 	<ul style="list-style-type: none"> • Locate natural fishing areas and fish farms • Survey for species distribution, survival and critical areas 	<ul style="list-style-type: none"> • Fish monitoring program in Suma River • Monitoring at selected sites in project areas 	<p>Jan. 1994 - June 1996</p>
<p>7. Forest, Native Vegetation and Wetland Loss</p> <ul style="list-style-type: none"> • Loss of biodiversity, resources and areas of wildlife and fisheries production, through incremental development • Increased logging through new access routes 	<ul style="list-style-type: none"> • Minimize disturbance through forests • If disturbance is unavoidable, replace in other areas • Use native species to revegetate right-of-ways where possible 	<ul style="list-style-type: none"> • Locate all forests, areas of native vegetation, and wetlands and assess predicted impact • Survey for species composition, size, access points, and rare species 	<ul style="list-style-type: none"> • Monitor use of forests through new access points • Monitor reforestation and planting programs effectiveness 	<p>Jan. 1994 - Dec 1996</p>
<p>8. Loss of Wildlife</p> <ul style="list-style-type: none"> • Loss of wildlife habitat • Increase hunting pressure 	<ul style="list-style-type: none"> • Avoid areas of critical habitat • Schedule to avoid critical periods (e.g. waterfowl nesting) 	<ul style="list-style-type: none"> • Wildlife surveys to determine distribution, abundance, status and requirements of wildlife • Determine migration and movement schedules 	<ul style="list-style-type: none"> • Ensure hunting pressure does not rise • Monitor effects of habitat loss 	<p>Jan 1994 - Dec. 1994</p>

TABLE B				
SUMMARY OF IMPACT, MITIGATION AND MONITORING				
POTENTIAL IMPACT	MITIGATION	PROGRAM WORK REQUIRED	MONITORING REQUIRED	TIME FRAME
9. Contamination by Wastes <ul style="list-style-type: none"> · Contamination of soil, surface water and groundwater · Expensive to remediate · Impair human health · Toxic to plants, wildlife 	<ul style="list-style-type: none"> · Implement waste management program including: <ul style="list-style-type: none"> · Drilling waste guidelines · Hazardous waste guidelines · Waste minimization · Transportation guidelines · Handling guidelines · Disposal and storage guidelines · Contaminant minimization program · Test hydrostatic test fluid, treat or remove to containment area 	<ul style="list-style-type: none"> · Document all types and volumes of wastes produced · Develop waste management program · Assess sumps and containment areas to ensure wastes are safely contained · Develop a land treatment facility and operations guidelines 	<ul style="list-style-type: none"> · Track all wastes produced, disposed and stored · Develop an on-going training program for workers 	Juno 1994 - Dec 1995
10. Loss of Archaeological/Historical Sites <ul style="list-style-type: none"> · Loss of an Important aspect of Bangladesh History 	<ul style="list-style-type: none"> · Protection plan and excavation plan for dealing with sites which are uncovered · Archaeological/historical resources survey prior to construction 	<ul style="list-style-type: none"> · Conduct archaeological/historical resources survey · Develop a protection and excavation plan 	<ul style="list-style-type: none"> · Employ an expert to be on-call to deal with new sites which are uncovered 	Jan. 1994 - Dec. 1994
11. Safety and Hazardous Operations <ul style="list-style-type: none"> · Loss of Life · Damage to Environment · Damage to Equipment and Facilities · Loss of Gas Supply 	<ul style="list-style-type: none"> · Assess hazardous operations sites for planning needs · Develop safety manuals, procedures and practices · Develop Emergency Response Plans · Develop safety systems throughout corporation and field units 	<ul style="list-style-type: none"> · Audit all facilities and operations · Develop a safety management system · Develop all necessary plans and procedures 	<ul style="list-style-type: none"> · Train and test personnel for comprehension · Assure all manuals are in place at field · Conduct compliance assessments 	Jan 1994 - Dec. 1996
12. Equipment Damage & Loss <ul style="list-style-type: none"> · Process water quality · Soil acidity · Biological Attack · Adjacent facilities 	<ul style="list-style-type: none"> · Check equipment regularly · Clean, maintain and replace equipment as necessary 	<ul style="list-style-type: none"> · Develop equipment maintenance/ replacement program 	<ul style="list-style-type: none"> · Assure equipment is replaced and serviced as required 	Ongoing

SAFETY AND MAJOR HAZARDS

The entire project design will be in accordance with applicable international safety codes and standards. Construction of the project works will be undertaken by experienced international contractors who use high standards of safety and environmental protection.

Although the pipeline and facilities will be designed and implemented to international specifications, a lack of safety programs and maintenance will tend to degrade the safety of all systems. If major explosions occurred at the field facilities or at the Ashuganj pipeline terminus a major disaster may result in mortality and severe damage to the gas system, LPG system and potentially the Zia Fertilizer Factory.

Overall safety systems and management, and industry regulations are not being properly enforced to meet safety and hazard requirements. Therefore, development of the safety management system is essential to assure a tolerable level of risk in the operations of all aspects of the Bangladesh gas industry.

The safety audit completed by British Gas concludes that all operating companies are generally operating an adequate system. Nevertheless, several important recommendations have emerged from the audit. These relate to the need for the Petrobangla group to:

- a) adopt a common set of safety standards and codes that are comprehensive, up to date and are disseminated to managers and supervisors;
- b) carry out technical audits of existing facilities and systems to ensure their compliance with the requirements of the 1991 Gas Safety Rules;
- c) adopt common emergency response procedures;
- d) provide formal and certificated training for managers, supervisors and operatives particularly with regard to the following:

- 1) regulator design, operation and maintenance;
- 2) pipeline maintenance;
- 3) leak detection and pipeline surveillance; and
- 4) corrosion prevention.

These recommendations will be incorporated in the terms of reference for the environmental and safety management technical assistance to be implemented under the project.

A major hazards report will be developed for Rashidpur facilities as part of the ESMS training program once final design has been completed.

ENVIRONMENT AND SAFETY MANAGEMENT SYSTEM

Expansion of the gas system requires careful integration of environmental and safety considerations. The overall policy framework, legislation and institutional capabilities for dealing with emerging environmental and natural resource management issues have not yet been sufficiently developed. Specific gas sector environmental regulations have not yet been developed. With regard to safety, the Ministry of Energy and Mineral Resources issued in 1991 the Gas Safety Rules, which cover transmission, distribution and storage of natural gas, but not the upstream activities.

Petrobangla currently has no well-defined safety engineering standards and environmental regulation, nor does it have an adequate institutional framework and capability to properly administer the safety and environmental aspects of its operations. Recognizing the critical need to address this deficiency, Petrobangla has recently created an Environment and Safety Division (ESD) in the Holding Corporation which would serve as the focal point for coordinating among all operating companies:

- 1) development and dissemination of a comprehensive set of safety standards and environmental protection rules and
- 2) implementation of an environmental and safety management system.

The objectives of the system are:

- a) development of comprehensive sets of safety standards and environmental protection regulations covering exploration, production, processing, transmission, distribution, marketing and end-use;
- b) development and implementation of an adequate environmental and safety management system for each operating company which shall include procedures for conducting routine technical and safety audits and programs for environmental mitigation and monitoring;
- c) development of the human resources requirements for administering the environmental and safety aspects and assist in developing managerial and professional staff resources through a program of in-country and overseas training and new recruitment; and
- d) emplacement of a mechanism/process for ensuring adequate public consultation and for stimulating public awareness and support for enhancing environment protection and safety.

An anticipated development schedule and tasks are outlined in Table C. The ESD has been staffed with a manager and three professionals who have been involved in initial training and data acquisition functions. The timing of further ESD development will depend on the initiation of funding for GIDP. A complete ESD implementation plan will be completed as a component of project technical assistance.

**TABLE C
ENVIRONMENT AND SAFETY
MANAGEMENT SYSTEM
- DEVELOPMENT PLAN**

COMPONENT	PROGRAM WORK REQUIRED	TECHNICAL ASSISTANCE	SUPERVISORY MONITORING - WORLD BANK	TIMING
Adopt E&S Policy	Distribute policy statement to all OCs and personnel. Develop a work plan to implement GIDP E&S program items.	ESA consulting team to work with Petrobangla ESA counterparts on implementation program.	World Bank to review program.	Dec. 1992 (completed)
Supplemental data acquisition	Assign a technical representative from Petrobangla. Acquire data as outlined.	Assign appropriate expert staff to acquire data. Will require 1 foreign expert to coordinate.	World Bank to review data.	Jul. 1993 - July 1994
Assign head of Division of Env. and Safety in Petrobangla	Empowerment of E&S Division to work according to policy. This will require E&S to be adequately placed in organization structure.		Assure empowerment is adequate for E&S program.	Dec. 1993 (completed)
Assign key E&S staff for Safety and Env.	Train for audit programs. Write job descriptions. Review ESA for GIDP	Audits experts to provide written background material for review.	Assure staff meets needs of program.	July 1994
Conduct Safety Audits Begin ESD Development	Appoint 2 foreign audit experts. Adapt international standards. Conduct audits and write summary reports. Define equipment needs.	6-8 man months of foreign expert input.	Assure experts are assigned. Review inception and summary reports. Review adequacy of Safety needs.	Aug. 1993 - Jan., 1994
Phase 1 of E&S Division Development	Develop a strategic plan for the E&S group. Establish plans and procedures for the E&S operations based on audit and GIDP ESA reports. Develop staffing needs and write job descriptions for all staff including OC assigned staff. Begin equipment acquisition lists.	Assign foreign experts for 3 year programs to work with the E&S Division on policies, programs and operating procedures.	Review experts and quarterly summary reports. Conduct biannual on-site review.	June - Dec., 1994

TABLE C ENVIRONMENT AND SAFETY MANAGEMENT SYSTEM - DEVELOPMENT PLAN				
COMPONENT	PROGRAM WORK REQUIRED	TECHNICAL ASSISTANCE	SUPERVISORY MONITORING - WORLD BANK	TIMING
Phase 2 of E&S Division Development	Organize and provide for staff technical and management training. Overseas program definition and attendance. Pilot project training for specific needs. Begin equipment acquisition and deployment.	Experts to develop courses and pilot training projects. Overseas courses to be organized. Development of draft procedures and guidelines taken from existing foreign sources. Standards of operations will be developed.	Review experts and quarterly summary reports. Conduct biannual on-site review. Review adequacy of overseas courses being proposed and monitor effectiveness. Review regulation development.	Jan. - June 1995
Phase 3 of E&S Division Development	Finalize standards of operations. Begin incorporating operations standards into remedial work. Continue training and begin training of field staff and OC E&S units. Begin Technical Safety & Environment Audits.	Experts to finalize setup of computer systems and manuals for management system and field training programs.	Review experts quarterly reports. Review equipment acquisition reports and deployment programs.	July, 1995 - June, 1996
Phase 4 of E&S Division Development	Implement guidelines and procedures at field level. Continue training of field staff. Assess management and worker competence. Begin complete pilot programs for ES staff. Train staff and test equipment. Continue Technical Safety & Environment Audits.	Assure complete understanding of management systems. Assure equipment training is developed and instituted. Conduct competency tests.	Review pilot programs for ES directorate. Assess competency of program. Assess progress of regulation development.	July 1996 - June 1997

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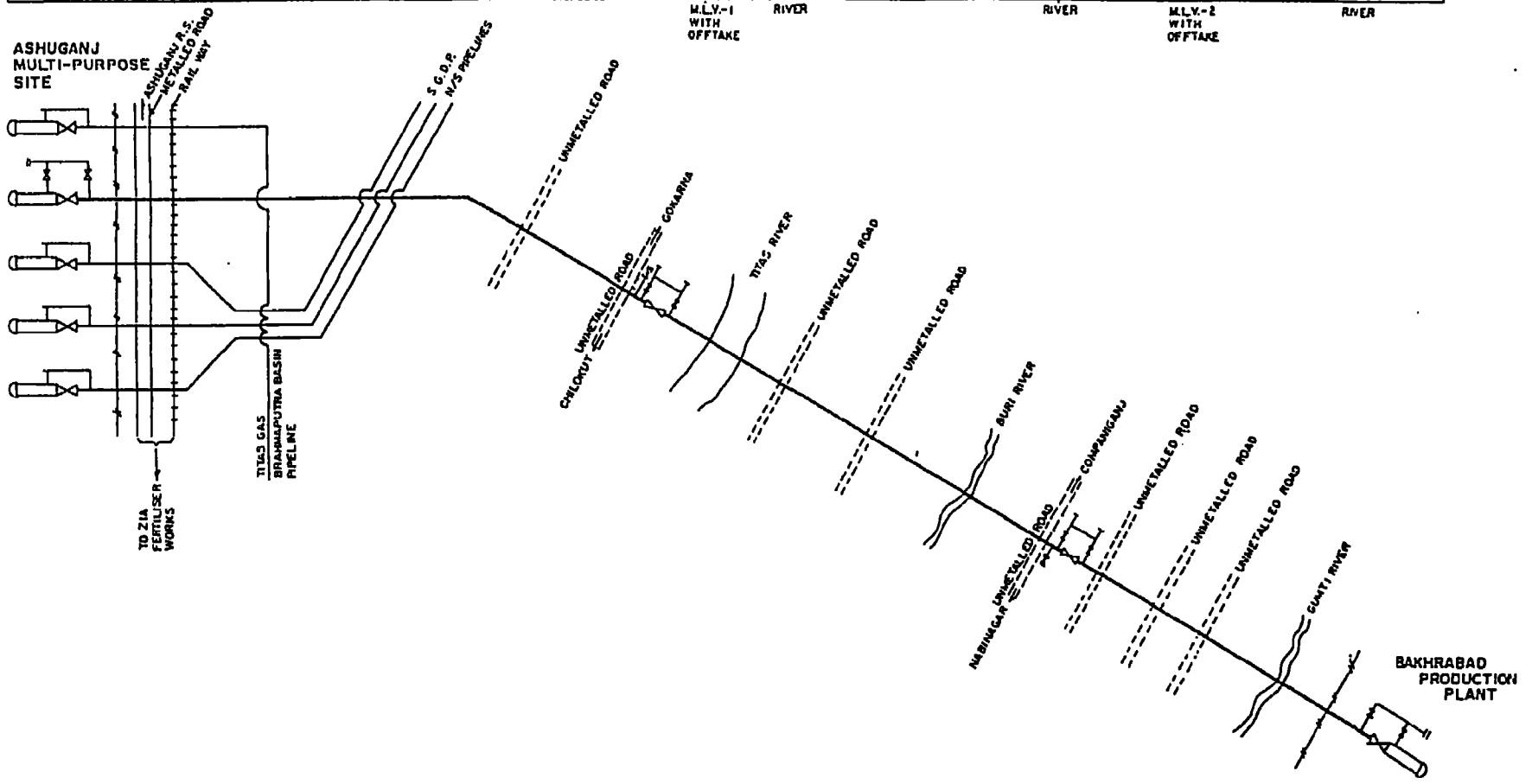
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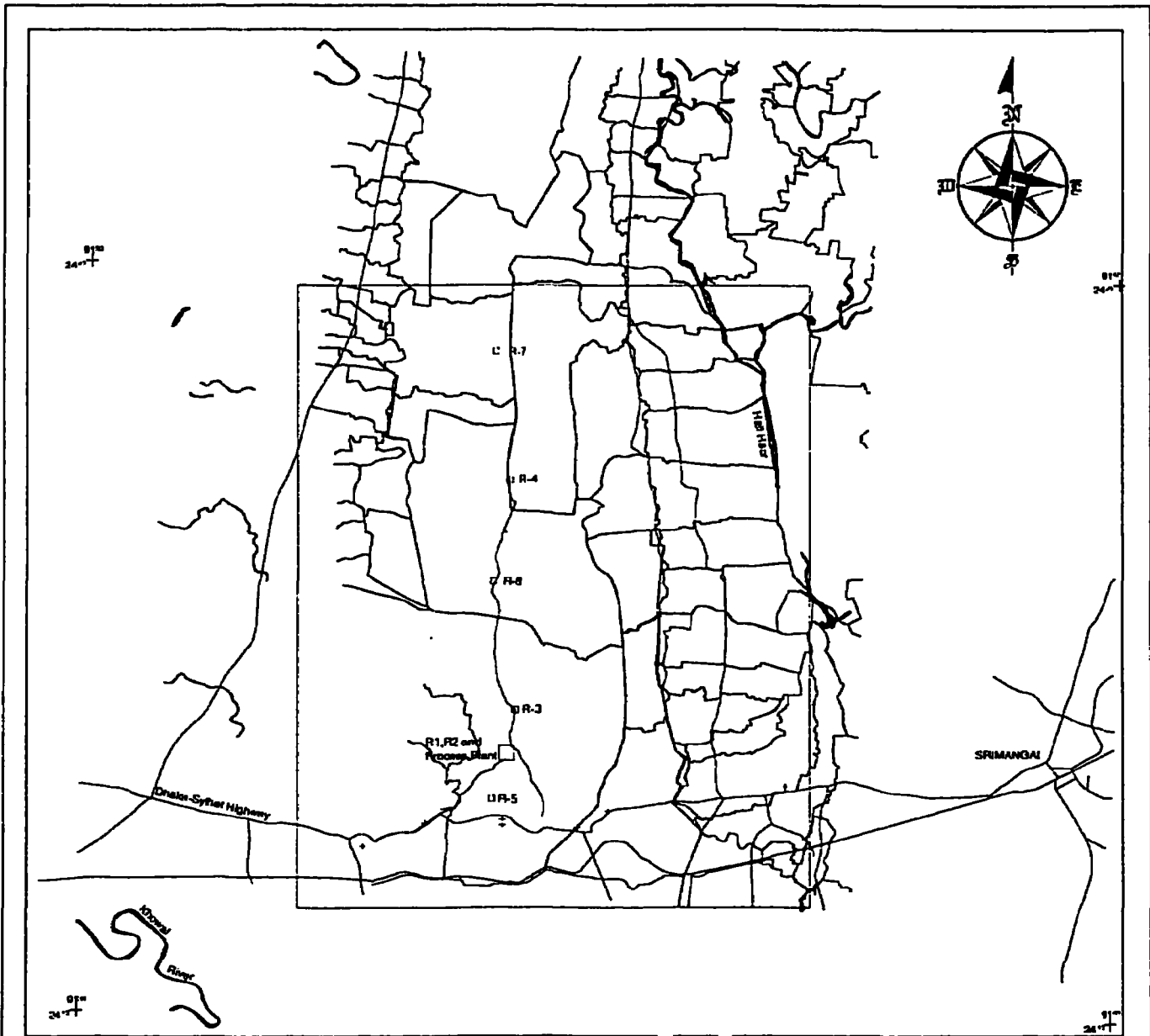
Engr. Md. Ehsanullah, GM, Petrobangla

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CONCRETE WEIGHT COATING	33 mm	42mm	42mm	-	42mm	33mm	42mm	42mm	33 mm
PIPE WALL THICKNESS	17.48mm	14.28mm	14.28	17.48	14.28mm	17.48	14.28 mm	14.28mm	17.48mm
CLASS LOCATION	3	2	2		2		2	2	3
DISTANCE IN KILOMETRES	0.0	1.0	10.5	11.5		29.0	36.5	58.0	58.5

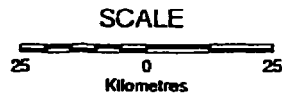


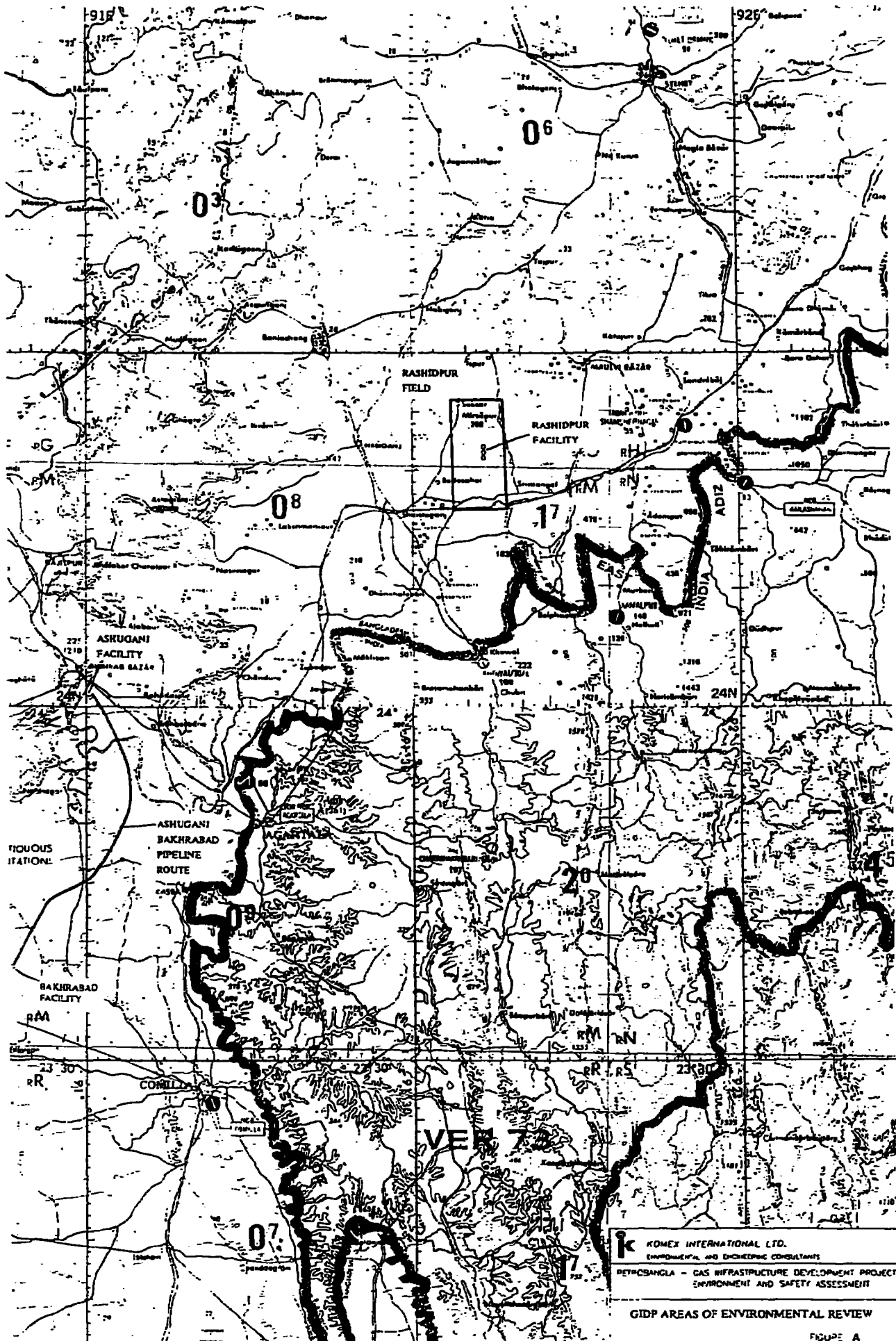
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 ENVIRONMENT AND SAFETY ASSESSMENT
 PIPELINE SCHEMATIC
 SOURCE: PENCOIL ENGINEERING CONSULTING, 1991. FIGURE C




LEGEND	
□	Process Plant
○	Well Site
+	Pipeline Crossing
—	Pipeline
—	Roadway
—	Railway
—	Mouza Boundary

FIGURE B
Surrounding Areas of Rashidpur Process Plant and Field Area






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GDP AREAS OF ENVIRONMENTAL REVIEW
 FIGURE A