THAILAND

Second Gas Transmission Project

Environmental Impact Assessment

SAR Report No. : 12700-TH

July 1993
SUMMARY ENVIRONMENTAL IMPACT ASSESSMENT
FOR
SECOND ERAWAN GAS TRANSMISSION PROJECT

A. INTRODUCTION

1. The Petroleum Authority of Thailand (PTT) completed the construction of a natural gas transmission pipeline and associated facilities from UNOCAL's offshore Erawan gas field in the Gulf of Thailand to consumption centers onshore in 1981. In 1985, PTT commissioned another pipeline connecting UNOCAL's Platong platform to its main transmission system and also installed an onshore compression station at Rayong. In 1992, PTT constructed additional offshore transmission pipelines from the Bongkot gas field to Erawan complex and extending the pipeline to Khanom onshore. PTT now proposes to construct Second Erawan Gas Pipeline Project (the Project) and has engaged Bechtel International to provide consultancy services and preparation of the EIA. TEAM Consulting Engineers assisted in the preparation of the EIA. The proposed Project is directly related to PTT's previous activities.

2. The scope of the EIA covers the following aspects:

(i) characteristics and quality of the environmental resources and values of the study area;

(ii) physical, biological, human use and human quality aspects that would be affected by the proposed Project;

(iii) short-term and long-term impacts of the proposed Project upon the environmental resources and values, including significance and magnitude of predicted impacts;

(iv) major changes in the environment expected as result of proposed Project development;

(v) short-term and long-term measures to prevent or mitigate the adverse effects of the proposed Project on the environment; and

(vi) appropriate environmental monitoring programs for the proposed Project based on the results of the investigation.

B. THE PROJECT

3. The proposed Project consists of supply and construction of an offshore and onshore gas transmission system including related ancillary facilities. The combined system will transport natural gas from the Erawan complex to Map Ta Phut in Rayong and from there to Bang Pakong in Chachoengsao Province. The major components of the Project are summarized below:

(i) An offshore pipeline 36-inch in diameter and 425 kilometers (km) in length to be laid in water depths ranging from 64 meters to sea level. This section will link the existing Erawan Riser Platform (ERP) with the Rayong gas receiving terminal. The new pipeline will be parallel to the existing 34-inch diameter gas pipeline.
(ii) An onshore pipeline 28-inch in diameter and 110 km in length from the Rayong gas receiving terminal to PTT's gas metering facilities near Bang Pakong.

(iii) Gas/liquids handling facilities at the Rayong gas receiving facility.

(iv) Modifications and augmentation to PTT's existing supervisory control and data acquisition (SCADA) facilities at the Erawan platform, ERP, Rayong gas separation plants, and the operations center in Chonburi.

4. The schedule for completion of the proposed Project is April 1996. The Project is needed for development of Thailand's offshore gas resources and its transportation to gas consumers. The service life of the pipeline and related facilities is expected to be about 40 years. The proposed route of the pipelines is shown in Appendix 1.

5. The offshore pipeline route runs North from the ERP to a land fall point near Rayong, parallel to the existing 34-inch diameter pipeline, approximately at a distance of 3 kms. Water depths along the corridor are expected to be 60 meters at the Erawan Riser Platform, increasing to about 66 meters at km 165, then shoaling gradually towards the landing. Bottom surface sediments along 60 per cent of the route consist of very soft to soft clay. The remaining 40 per cent of the route substrate consists of firm clay. The seabed material coarsens gradually to sand towards the landing point.

6. The onshore pipeline route starts at Rayong along PTT's right-of-way (ROW) for the existing 34-inch diameter pipeline up to the Rayong Gas Separation Plant. From the Gas Separation Plant, the pipeline route traverses West through public land up to the ROW for Rayong 115 kV power transmission line, thereafter Northwest parallel to the existing 230 kV power transmission line crossing highways number 36, 331 and the new 36. The pipeline route then runs cross country and meets the 230 kV power transmission line at the crossing of highway number 36, thereafter traverses North parallel to the 230 kV power transmission line up to the existing Block Valve #6 near Bang Pakong Power Plant. The pipeline terrain is mostly flat, sandy and sandy day soil with the exception of a few kilometers of hilly terrain along the northern end of Bang Phli-Ao Phai 230 kV line. The pipeline route consists of approximately 5 km of private land to be acquired by PTT, the remainder lies within the ROW for Electricity Generating Authority (EGAT) power transmission lines. To confirm the suitability of these routes, offshore and onshore surveys will be carried out including vibrocores, bore holes, and trial pits. Soil resistivity survey will be conducted to analyze soil conditions.

C. DESCRIPTION OF THE ENVIRONMENT

1. Meteorology

7. The Project area has medium to high temperatures and humidity, with rainfall and winds varying according to the monsoon season. The annual mean temperature is 28.0°C and annual mean rainfall is 1,334.5 mm. South and southwest winds are predominant from February to October, with speeds ranging from 3.0 to 9.2 knots, and extreme gusts from 40 to 50 knots.
2. **Oceanography**

8. The wave height averages about one meter at the Erawan field. The tidal currents along the east coast are weak and irregular, generally varying from 1.0 to 2.0 knots. In the vicinity of Sattahip, flooding currents set northward through the channel between Koh Khram and the shoreline and ebbing currents move southward with velocities of 2-4 knots.

3. **Geology and Seismology**

9. The topography of the eastern region comprises the northern highlands, the southern highlands, and the alluvial lowland between the highland zones. The major geological units are Precambrian, Ordovician, Cretaceous, Permian and Quaternary which consist mostly of alluvium deposits, sedimentary rocks and granite. Some metamorphism has occurred. Seismic risks along the pipeline route are considered negligible.

4. **Soils and Sediment**

10. The onshore area comprises various soil types such as poorly graded sands, silty sands, clayey sands, sandy silts, clayey silts and highly plastic clay. The subsea bottom profile of the offshore area in the Gulf of Thailand along the proposed pipeline route is composed of a soft clay overlay and rugged terrain of stiff clay formations at the Pleistocene surface.

5. **Water Quality**

11. The water quality along the proposed pipeline route ranges from normal sea water to relatively high suspended solids along the near shore area due to strong wave actions.

6. **Aquatic Ecology**

12. Abundance of plankton was measured along the proposed pipeline route and vicinity. Out of 56 planktonic species collected, 45 species comprised phytoplankton and 11 species zooplankton. Zooplankton were the dominant groups in terms of density. Benthos occupy the mud and muddy sand habitats, 28 species having been identified.

7. **Fishery**

13. The main section of the submarine pipeline will be in the central gulf up to inner gulf area where bottom trawl fish catch is relatively small. Closer to the pipeline landfall, fishing is more typical of the Thai fishery in general except for a much greater use of anchovy purse seines. About 147,000 tons of marine fish are landed annually at Rayong, this being 8.8 per cent of the overall national catch. Fish traps, comprising floating bamboo rafts moored by wire to concrete moorings, presently extend to large offshore areas. Bottom trawling for demersal fish is illegal within 3 km of the coastal line.

8. **Terrestrial Ecology**

14. Along the proposed onshore gas pipeline route, which runs parallel to the EGAT transmission line ROW, most of the affected area is currently utilized for agricultural purposes.
However, two sections of the pipeline will pass through some restricted land use area, i.e. the first section will pass the Khao Khieo national reserve forest in Amphoe Ban Bung of Chonburi Province, and the second section will pass Huai Mahad national reserve forest in Amphoe Ban Chang of Rayong Province. Part of this restricted area is categorized in watershed class II. The land use in the first section is primarily secondary growth forest while the second section is being utilized by villagers for agricultural purposes.

9. **Land Use**

15. Land use patterns within the 40 meter strip along the pipeline route of the onshore section can be classified into agricultural land (52.3 per cent) followed by idle land (32.4 per cent), forest (8.9 per cent), urban (5.7 per cent), fish pond (0.5 per cent) and golf course (0.2 per cent).

10. **Mineral Resources**

16. The information obtained from the Department of Mineral Resources indicates that no major mineral deposits are located in close vicinity of the onshore pipeline route. On the other hand, the offshore pipeline route runs along sedimentary rocks of high petroleum potential.

11. **Transportation/Navigation**

17. The gas transmission line will intersect the following highways in the vicinity of Chonburi and Rayong provinces: 3191, 3376, 331, 3241, 344 and 315. The pipeline will also intersect the railway line linking Sattahip and Map Ta Phut which is currently under construction and is scheduled to be completed by 1995. Thailand’s main ports are located in Bangkok and along the eastern seaboard. About 38 per cent of the domestic coastal traffic will cross the pipeline route.

12. **Infrastructure and Public Facilities**

18. Eight waterworks, under the management of the Public Works Department, are located along the proposed pipeline route. Most of the raw water is obtained from Bang Phra, Chang Nam, Map Prachan, Nong Kho and Nong Kiang Dong reservoirs. Electric power for the eastern region is mainly supplied from EGAT’s combined cycle power plants at Bang Pakong and Rayong. The ROW for two high-tension transmission lines linking Rayong power plant and Bang Pakong power plant will serve as the route for the proposed/onshore gas transmission pipeline. Most submarine cables in the Gulf of Thailand lie along the west coast and will not be crossed by the proposed pipeline route. There is one submarine communication cable linking the Sattahip Base in Thailand and Van Tan in Vietnam but it is currently inoperative.

13. **Socio-Economic Data**

19. Results of the interviews with the community residing along the existing onshore gas pipeline showed that most of the people are indifferent about the operation of the existing gas pipeline. Interviews with the community along the proposed route showed that most people did not know about the Project, some expressed concerns about possible disruptions during construction.
14. **Archaeology/Historical Values**

20. There are no reports or evidence of archaeological or historical values located in the vicinity of the proposed pipeline route.

15. **Aesthetic/Tourism**

21. There are several tourist places located between Map Ta Phut and Bang Pakong. These attractions, however, are at a significant distance from the pipeline route.

**D. ANTICIPATED ENVIRONMENTAL IMPACTS AND MITIGATION MEASURES**

1. **Trenching of Seabed**

22. The offshore pipeline seabed will be trenched approximately 4 meters deep for the first 4 km from the shore and back filled after the pipeline is laid. These activities will increase the concentration of suspended solids in water column. The decreased transparency and light penetration along the pipeline route will temporarily affect the growth of the phytoplankton. In addition, the benthic organisms along the trenched seabed will be directly disturbed along the 4 km trench. However, the findings from the monitoring program during construction of the Bongkot Gas Transmission Project established that the abundance of phytoplankton and zooplankton in coastal sea water were not affected outside of the immediate pipeline route area by the construction activities. Change in species composition were observed but may not be directly associated with construction activities. It was also observed that there were algae growing on the sediment surface when benthic was sampled approximately 100 meters from the pipeline, which indicated relatively minor disturbances on the aquatic habitat and that an adequate amount of sunlight must have reached the seabed for algal growth. The integrated finding on planktonic and benthic communities confirm that the actual impact on aquatic life is limited to the immediate area of the pipeline route and the effects on the other nearby areas are relatively minor.

2. **Disposal of Solid Waste and Waste Water**

23. Solid wastes will be generated mainly during the construction period from onshore pipeline excavation and refuse from construction camps and pipe laying barge. The spoil from the onshore trenching will be temporarily stored along the sides of the trench and used as back filling material upon completion of the pipe laying activity. The solid refuse from the construction camps as well as the pipe laying barge will be stored in the designated containers and disposed of onshore. The pipe laying barge will be equipped with an effluent treatment system which will treat the waste water to conform with Thai Standards prior to discharge to the sea. For the on land construction camps, sanitary latrines will be adequately provided to minimize any contamination of the water resources. The process waste water from the pipeline operation will be collected at the Rayong gas terminal and will be sent to the effluent treatment facilities to reduce oil/grease content to 15 ppm. before disposal according to Thai regulations.

3. **Obstruction of Transportation/Navigation**

24. The onshore pipeline will cross 8 highways and one railway line. In general, highways and railway lines can be crossed without disruption of traffic. To accomplish this, a larger diameter steel
casing pipe will be bored and jacked under the highway/railway crossing using specially designed equipment and the pipeline will be slipped through the casing pipe. During construction of the offshore pipeline, the use of a pipe laying barge that will have the pipeline suspended behind the barge, will pose a hazard to navigation. With proper warning buoys to mark the construction area and with frequent patrolling by speed boats to warn ships in the area prior to the pipe laying process, this impact will be relatively minor. The near shore pipe laying operation near the IEAT Map Phut Port is expected to take a maximum of five days. Some interference with the navigation to the port may be encountered during this period. The IEAT industrial port access channel is utilized only by about 11 vessels each day. Consequently, the offshore pipeline construction activities should not pose any significant impact on the navigation channel. During operation stage, the onshore pipeline will not affect transportation network as the pipeline will be buried underground and the route itself is not on the normal public transport network. For the offshore route, anchorage will be prohibited along the pipeline to prevent any possible pipe damages.

4. **Obstruction of Fishery Activities During Construction**

25. The suspended pipeline during construction could affect near shore fishing during construction because the fishing nets for trawler fishing could get fouled on the pipeline. However, these problems can be alleviated by using proper warning devices and prohibition of trawling in the vicinity of the pipe laying barge.

5. **Interference with the Existing Socio-Economic Conditions**

26. During construction period, temporary increase of the population due to the pipe laying activities can be expected, which may create social problems. The problems can also extend to nearby communities. In addition, workers will require additional water supply, health services and other infrastructure facilities. These requirements can be accommodated by adequate provision of such facilities and services during the construction period. Additional transportation/navigation generated by construction activities including transportation of construction workers and materials may increase incidence of accidents both onshore and offshore. However, measures to conduct safe operations will be enforced. The benefits which can be derived by the local people include commercial services, food, medical, and household necessities.

6. **Hazardous Conditions and Disruptions**

27. Tropical cyclones and typhoons normally occur from September to December. The severe weather will have a significant impact on the pipe laying activities. The construction activities have to be stopped during these storms. The mobility of the pipe laying barge can prevent damage to the pipeline including the vessel and crew during rough sea conditions. In order to enhance the occupational health and worker safety during the construction period, construction equipment will be kept in good order. Good working conditions will be established at the sites. Adequate safety measures will be taken and safety related equipment as well as fire fighting equipment will be provided in order to reduce the potential for accidents. In addition, stringent safety regulations will be set and safety awareness increased by training and education of construction workers. Proper records of accidents, their causes and the damage will be maintained.

28. Hazardous operating conditions can result from over-pressure, leaking equipment, fire or inadequate maintenance. Hazard analysis was conducted for onshore and offshore pipelines.
Hazard assessment was conducted for the fire damage caused by onshore pipe leak including instantaneous release with immediate ignition. Pipeline leakage may cause flash fire within a range of 8 km from the release source. This distance can be minimized with the appropriate design, and by establishing and adhering to proper operating and maintenance procedures as well as personnel training. Specifically, over-pressure protection of the pipeline is ensured as the pipeline design pressure is significantly higher than the operating pressures. In addition, over-pressuring of the platform facilities as well as the onshore pipeline terminal facilities are prevented by various types of safety equipment, including pressure regulators, high pressure alarm, shutdown valves, emergency shut-down system, blow-down connections and pressure safety valves. For the subsea pipeline, the hazard of gas leakage was assessed as being at a low level.

E. ALTERNATIVES

29. Alternative offshore routes do not present any significantly different environmental conditions than the chosen route. The proposed onshore route has less impact on the environment than the next alternative, which would be parallel to the existing pipeline, and be located adjacent to the highway for a considerable portion of the route. The proposed Project is part of an investment program that is designed to increase the natural gas output from the offshore Bongkot and other gas field in the Gulf of Thailand. The supply of gas from the offshore field to onshore markets for power generation and other industries will help alleviate energy supply shortages and save foreign exchange. Natural gas made available through the transmission facilities constructed under the proposed Project will replace imported fuel oil used in power generation and will also be used as a feedstock for the petrochemical industry, as new gas markets emerge in the longer term. In the absence of the infrastructure for supply of natural gas to be made available through investment in the proposed Project, the alternative fuel used for power generation would be imported fuel oil, or possibly domestic lignite. The gas-fired power plants will lead to improved environmental quality, as natural gas is a cleaner fuel source compared with alternative energy sources. Improvements in the environment will be particularly important in terms of air quality made possible through reduced emissions of carbon dioxide and sulfur dioxide.

F. INSTITUTIONAL REQUIREMENT AND ENVIRONMENTAL MONITORING PROGRAM

30. The PTT Safety and Environmental Division of the Gas Pipeline Operation Department will be the responsible unit for implementation of the proposed monitoring program. The environmental monitoring program will include water/aquatic biology samples during construction and operation phases. In addition, the monitoring of land use changes, socio-economic impacts, occupational health/safety, transportation/navigation and solid waste generations have to be conducted periodically. PTT will assign the trained transmission system and environmental personnel to monitor and maintain the suitable safety and environmental conditions during construction and operation of the proposed pipeline. Furthermore, the designated personnel will be re-trained periodically in environmental management, safety, fire control, loss control and hazardous chemical management to enhance their abilities to improve and maintain the proper environments and working conditions according to internal and international standards. PTT will submit the monitoring report every six months to the Bank throughout the construction period and the first year of operation.
G. CONCLUSIONS

31. The implementation of the proposed Project will provide a clean burning fuel supply to EGAT for a combined cycle power plant at Bang Pakong and other locations and customers, thereby reducing Thailand's dependence on foreign energy sources. To receive these benefits, certain potential environmental impacts of the proposed Project, i.e., water quality/aquatic biology, solid waste/waste water disposal, obstruction of transportation/navigation, fishery, and risks with hazardous conditions will have to be tolerated. The anticipated impacts are mostly short-term and are relatively minor. Furthermore, the mitigation measures proposed will reduce the impacts to acceptable levels. To ensure the effectiveness of the mitigation measures, monitoring programs include water quality, aquatic biology, public health and safety. PTT proposes an environmental monitoring plan that will sample water quality and aquatic biology during both construction and operation. The plan will also monitor fish landings at Rayong, solid waste generation, water supply requirements and socio-economic impacts. The results will be used to adjust the environmental management plan based on experience gained. The Safety and Environment Division of PTT's Gas Pipeline Operation Department is directly responsible for the implementation of the pipeline environmental management plan. Pipeline system personnel have been trained in loss control, safety, fire control and hazard management on a regular basis. PTT realizes its responsibility for maintaining good working conditions, operational safety and environmental protection which are comparable to international standards. In order to evaluate the effectiveness of its practices, PTT periodically has safety audits carried out by outside parties specializing in providing such services. Operational safety is paramount to PTT which will be monitored as part of the environmental management plan.
### SUMMARY OF POTENTIAL ENVIRONMENTAL IMPACTS, MITIGATION MEASURES AND MONITORING PROGRAMS

<table>
<thead>
<tr>
<th>Environmental Component</th>
<th>Phase</th>
<th>Cause of Impact</th>
<th>Mitigation Measure</th>
<th>Monitoring Program</th>
</tr>
</thead>
<tbody>
<tr>
<td>Meteorology</td>
<td>Construction</td>
<td>Severe weather can affect the construction activities.</td>
<td>Properly plan construction activities, particularly in September through December for possible storm encounter.</td>
<td>None</td>
</tr>
<tr>
<td>Soil</td>
<td>Construction</td>
<td>On shore pipe laying can induce soil erosion along the pipeline.</td>
<td>Backfilling and replacement of ground cover as soon as possible after burial of pipeline.</td>
<td>None</td>
</tr>
<tr>
<td>Marine Water Quality</td>
<td>Construction</td>
<td>- Pipe laying will disturb sea bottoms, increase the suspended solid concentration turbidity in the immediate area. - Disposal of refuse and garbage from the working vessel into the sea.</td>
<td>- Select spoil areas for trenching and placing gravel at spans. - Strictly prohibit the dumping of refuse and garbage to the sea. - Provide containers for refuse on barge.</td>
<td>Monitor the marine water quality in the coastal areas close to the sensitive receptors to be affected by the transmission pipeline (every 3 months throughout the construction period and first year of operation period).</td>
</tr>
<tr>
<td>Aquatic Biology</td>
<td>Construction</td>
<td>- Habitat disturbances increase turbidity and suspended solid in water column. - Toxic contamination of hydrostatic test chemical. - Hinder fishing boat operation.</td>
<td>The same measures as those for water quality. - Select appropriate excavation for coastal pipe laying. - Limit the chemical concentration to the level that is acceptable in major fishing areas. - Same as marine water quality.</td>
<td>Monitor plankton and benthos in the coastal area (every 3 months throughout the construction period and first year of operation period).</td>
</tr>
<tr>
<td>Terrestrial Ecology</td>
<td>Construction</td>
<td>Additional clearing of trees in Khao Khieo and Huai Mahad Forests.</td>
<td>Minimize the additional clearing area.</td>
<td>None</td>
</tr>
<tr>
<td>Transportation</td>
<td>Construction</td>
<td>- Interfere the traffic flow temporarily. - Increase traffic volume from construction activities.</td>
<td>Provide proper frontage access for the construction vehicle. - Strictly limit the speed and traffic rule of all construction vehicles.</td>
<td>Regularly collect the accident records during the construction period.</td>
</tr>
<tr>
<td>Component</td>
<td>Phase</td>
<td>Cause of Impact</td>
<td>Mitigation Measure</td>
<td>Monitoring Program</td>
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<tr>
<td>Infrastructure</td>
<td>Construction</td>
<td>Increased local water consumption.</td>
<td>- Provide drinking water from other sources.</td>
<td>- Regularly collect the record on provision of water supply, personal hygiene and accidents.</td>
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<td></td>
<td></td>
<td>Intersect existing water transmission lines.</td>
<td>- Implement the suitable construction and supervision method.</td>
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<td></td>
<td>Possible accident with construction vehicles and electrical transmissions line towers.</td>
<td>- Strict enforcement of proper precaution measures and close supervision during construction.</td>
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<td></td>
<td>Possible electrical shock from induce high voltage to the pipe and other related facilities.</td>
<td>- Employ proper electrical grounding method and proper inspections.</td>
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<tr>
<td>Navigation</td>
<td>Construction</td>
<td>Increased number of ship in the Project's construction vessels in the navigation route.</td>
<td>- Provide the signalling devices during the pipeelaying period especially at the intersected shipping lines.</td>
<td>- Regularly collect the accident records during the construction period.</td>
</tr>
<tr>
<td></td>
<td>Operation</td>
<td>Ship's anchor may damage the pipeline.</td>
<td>- Set up a prohibited anchorage zone.</td>
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<tr>
<td>Socio-economic</td>
<td>Construction</td>
<td>Social problems such as different traditions, theft, quarrel and drug abuse.</td>
<td>- Regularly monitor situation and caution workers.</td>
<td>- Conduct attitude survey once a year during construction and first year of operation period.</td>
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<td></td>
<td>Increase job opportunities.</td>
<td>- Cooperate with local authorities.</td>
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<td></td>
<td>Inconvenience for the local traffic.</td>
<td>- Offer fair compensation rate.</td>
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<td></td>
<td>Temporarily decrease quality of environment in the immediate vicinity of the pipeline construction area.</td>
<td>- Provide improved facilities for community.</td>
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<td></td>
<td>Operation</td>
<td>Environmental problems of the transmission pipeline project, which can induce negative attitudes of local residents.</td>
<td>- Set up Public Relation program for the local residents.</td>
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<tr>
<td>Public Health/Safety</td>
<td>Construction</td>
<td>Health problems and accidents, Living conditions in construction camps.</td>
<td>- Provision of proper health and environmental sanitation improvement in workers' communities.</td>
<td>- Regularly collect update and assess public health problems and accident.</td>
</tr>
<tr>
<td></td>
<td>Operation</td>
<td>Public health and occupational health problems.</td>
<td>- Provide adequate safety devices and set stringent regulations.</td>
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<td></td>
<td>Hazardous events from gas leakage.</td>
<td>- Conduct comprehensive training programs, with special attention to pollution control, safety and fire prevention.</td>
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</tr>
<tr>
<td>Aesthetic/Archeology</td>
<td>Construction</td>
<td>No impact on the existing aesthetic/archaeological values.</td>
<td>- None</td>
<td></td>
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</tbody>
</table>
Appendix I

THAILAND
SECOND ERAWAN
GAS TRANSMISSION PROJECT

LEGEND:
- National Capital
- City/Town
- Road
- Railway
- River
- Regional Boundary
- International Boundary

(Boundaries not necessarily authoritative)

[Map of Thailand showing the Second Erawan Gas Transmission Project with key locations and pipeline routes.]