Chapter 6: Project Alternatives

During the process of developing the Sakhalin 2 Project, many options and alternatives on all levels were identified. In this chapter, the alternatives of relevance to western gray whales are presented. The selection criteria for the identification of alternatives are described in Section 6.1. In Section 6.2, the identified technology options during the process are described and assessed. In Section 6.3, alternatives to the main facilities are discussed. The "no-project" alternative is described in Section 6.4.

6.1 Selection Criteria

SEIC used the following criteria for the assessment and selection of feasible options:

- Environment: Minimising environmental impacts during all phases of the project, including the decommissioning phase;
- Safety: Adequate protection for local residents, workers, and property from all kinds of negative impacts and emergencies, including environmental damage;
- Technology: Use of proven, environmentally-safe technology and equipment;
- Production: Assured reliability and environmental safety of production;
- Recovery: Maximisation of hydrocarbon recovery from the reservoir;
- Finance: Ability to be financed;
- Feasibility: Commercial viability.
- Social and political reasons

The options covered range from complete scenarios of oil field development to facility siting and specification of construction methods. During the process, options related to the following areas are assessed:

- complete oil field development scenarios and phasing;
- major assets inclusion or exclusion;
- major assets siting;
- pipeline routing;
- technological process selection;
- performance criteria selection;
- equipment selection; and
- construction method selection.

Environmental and socio-economic risks were considered at every level of decision making. At later stages, social and environmental protection aspects and the concept of sustainable development were also included.

The primary rationale for developing the project is economic. Various scenarios were evaluated to determine the optimal economic development case. The outcome is briefly summarised below:

- The most economically viable component of the project is a phased, two-train Lunskoye LNG project including a gas and liquid export system.
- The development of a gas and liquid export system for Lunskoye LNG enables year-round production from Astokhskoye and, therefore, economic development of the PA-B area.
- A stand-alone, year round Piltun-Astokhskoye (PA-A and PA-B) oil development is not an economically viable option.

6.2 Technological Options during the Development Process

The identification and selection of technological options has been built into the implementation of all phases of the Sakhalin II development process. In summary, the major phases are

- Oil Fields Development Feasibility Study (1992);
- conceptual engineering (1997 to 2000);
- definition engineering and design (2000 – 2001); and
- detailed final design – pending.

Those phases are outlined below.

6.2.1 Oil Fields Development Feasibility Study (1992)

In 1992, a study team lead by SMNG evaluated alternative options and components for development, and assessed the potential environmental impacts of siting project facilities at alternative locations. The team described the recommended project development scheme and alternative options and components for development. They also prepared an overview of the environmental protection programme that identified the measures that were incorporated into the project design, and the measures to avoid or mitigate the potential environmental impacts of all components and their alternatives. The alternative development scenarios studied were premised on the technical, economic, and environmental viability of the Piltun-Astokhskoye and Lunskoye fields.

Technological and siting options considered at this stage included

- piled monopod platforms;
- either one or two platforms at Lunskoye;
- between one and seven platforms at PA;

In 1993, the base case was approved by Russian authorities, and the environmental expertise was carried out.

6.2.2 Conceptual Phase 2 Engineering Design (1997-2000)

Conceptual Phase 2 engineering design for the upstream facilities commenced in late 1997 and continued into 2000. Over 100 alternatives were evaluated within the framework of the facilities selected in 1992 in the course of feasibility study. The alternatives related to the following areas of field development:

- gas pipeline to Japan;

- floating LNG;
- full subsea development;
- gas to liquids plant;
- oil to DeKastri;
- offshore pipelines (full and partial);
- well-head platforms and jack-up drilling;
- 100% offshore processing at Lunskoye; and
- year round oil export from the Piltun platform.

All of the above options were screened. They were not pursued because of economic, environmental, schedule, operational, and/or LNG marketing reasons.

6.3 Main Alternatives Considered

SEIC identified alternatives for the main elements of the project. They included the following of relevance to western gray whales:

- number, location, and design of platforms;
- location of LNG Plant/ Oil Export Terminal (OET);
- routing of pipelines;
- offshore waste management; and
- infrastructure sharing.

6.3.1 Platforms and Drilling Methods

The number of platforms, their specific locations, and their design (ranging from monopods to artificial islands) has varied over the ten-year period, but the general locations have remained the same – the Piltun-Astokhskoye field and the Lunskoye field.

6.3.1.1 Number of Platforms

The objective of platform optimisation studies related to a need to reduce capital costs. Over the 1990s, major advances in extended reach and non-vertical drilling has allowed for a single platform to extend its lateral reach up to 6km. That has reduced the number of platforms needed for full field development from nine to three, which resulted in a smaller “footprint”, i.e. lower overall offshore environmental impact.

Reducing the number of platforms reduced disruption and loss of bottom habitat that is potential western gray whale feeding habitat. Fewer platforms also means reduced solid waste, air emissions, and effluents. Most important to western gray whales, the reduction in the number of platforms reduced potential disturbance effects on western gray whales resulting from

- installation of platforms and pipelines among platforms;
- physical presence of platforms;
- drilling noise and other noise generated on platforms;

- helicopter flights and vessel traffic to resupply platforms, rotate crews, and otherwise support platform operations; and
- maintenance of platforms and pipelines among platforms.

6.3.1.2 Drilling from Shore-based Locations

SEIC has examined the feasibility of drilling from shore-based locations. That is currently not a technically- or economically-feasible option for the development of either the Piltun-Astokhskoye or the Lunskoye field, because

- The distance between the shore and the two fields is beyond the current economic feasibility for extended-reach drilling operations in the area, lying as they do between 10 and 15 km from shore at a depth of 1,700-2,200 m. The Lunskoye field is 8 km wide, and for effective drainage, wells would have to extend to the far side of the field from shore, a distance of over 20 km.
- The distance between the planned Piltun-Astokhskoye platform (PA-B) and the existing *Astokhskoye* platform (PA-A) is >30 km, hence the PA-A platform could not be used to drill the Piltun field.
- The distance between the Piltun-Astokhskoye and the Lunskoye fields is much larger, hence the Lunskoye field is totally unreachable from Piltun/Astokh.

6.3.1.3 Location of Platforms

The proposed Lunskoye-A platform location is an alternative to the original choice of location. It was chosen to avoid an area of shallow gas at seabed level. Shallow gas hazards represent a significant safety issue.

The proposed location of the PA-B platform, also an alternative to the original choice of location, was chosen for a variety of technical, safety, and economic considerations:

- avoidance of shallow gas hazards;
- avoidance of shallow faults, which also represent a significant safety issue;
- avoidance of a clay-filled channel, which does not form a suitable foundation for the gravity based structure; and
- minimising the risk of soil liquefaction and hence, the amount of Quaternary cover to be removed.

Safety must be the foremost consideration. Ensuring platform stability also avoids potential impacts on western gray whales of oil spills and the disruption of bottom habitat and noise and disturbance that would result from having to repair or replace a platform.

6.3.1.4 Platform Base Design

At the preliminary design stage, a number of alternative types of platform base design were considered, *viz.*

- caisson gravity platform (Molikpaq type);
- single-support gravity bed-plate platform;
- three-support gravity bed-plate platform;

- four-support gravity bed-plate platform;
- single-support gravity bottom-piled platform; and
- three-support gravity bottom-piled platform.

Engineering, economic, and environmental criteria were used to select the preferred alternative. The four-support gravity type structure with a foundation plate ranked higher than any other alternative on the economic and environmental scales, and higher than all but the three-support gravity bed-plate platform (both ranked 10 of 10) on the engineering scale.

6.3.2 LNG Plant/Oil Export Terminal (OET)

The PA-B oil development and conversion of the Astokhskoye PA-A platform to year-round production is dependent upon the Lunskoye LNG project proceeding. The selection of the optimal location for exporting the LNG and oil products is, therefore, vital for the project. Alternatives relevant to the protection of western gray whales are discussed below.

Prigorodnoye (in Aniva Bay) has been approved as the preferred location for the LNG plant and the Oil Export Terminal. That is because of the requirement of LNG buyers and project lenders for a safe and secure, year-round LNG supply. Aniva Bay is a relatively ice-free, deepwater port suitable for year-round tanker operations with minimal environmental risks. Furthermore, western gray whales have not been reported to occur in Aniva Bay.

The northeast Sakhalin shelf was considered as an export location. Direct export from the PA area would minimise the need for infrastructure such as the pipeline and some onshore facilities. However, the extreme ice conditions and extensive field trials that would be required for tanker ice management discount that option because of serious environmental concerns and technical difficulties. The decision not to use the northeast Sakhalin shelf for the location of the oil export facility will also benefit western gray whales, which concentrate there to feed in summer, in several ways:

- reduced chance of an oil spill near their preferred feeding grounds;
- considerably reduced vessel traffic during the operations phase of the project, and the concomitant disturbance and possibility of collisions between vessels and western gray whales; and
- reduced disturbance during construction of the additional infrastructure that would be required on the northeast Sakhalin Shelf

6.3.3 Pipeline Routing

In 2000, two optional routings for the pipeline were evaluated: (1) predominantly onshore except for PA-B to PA-A to shore and from LUN-A to shore (Case 326, very similar to the current approved case – case 361, see Fig. 6-1), and (2) predominantly offshore, with pipelines from PA-B to PA-A to LUN-A to shore (Case 336, see Fig. 6-2). A Quantitative Risk Assessment (QRA) was carried out of the pipeline routing options and their associated risks related to personnel safety, business interruption, and environmental impact. The results indicated that the annual risk cost associated with the offshore

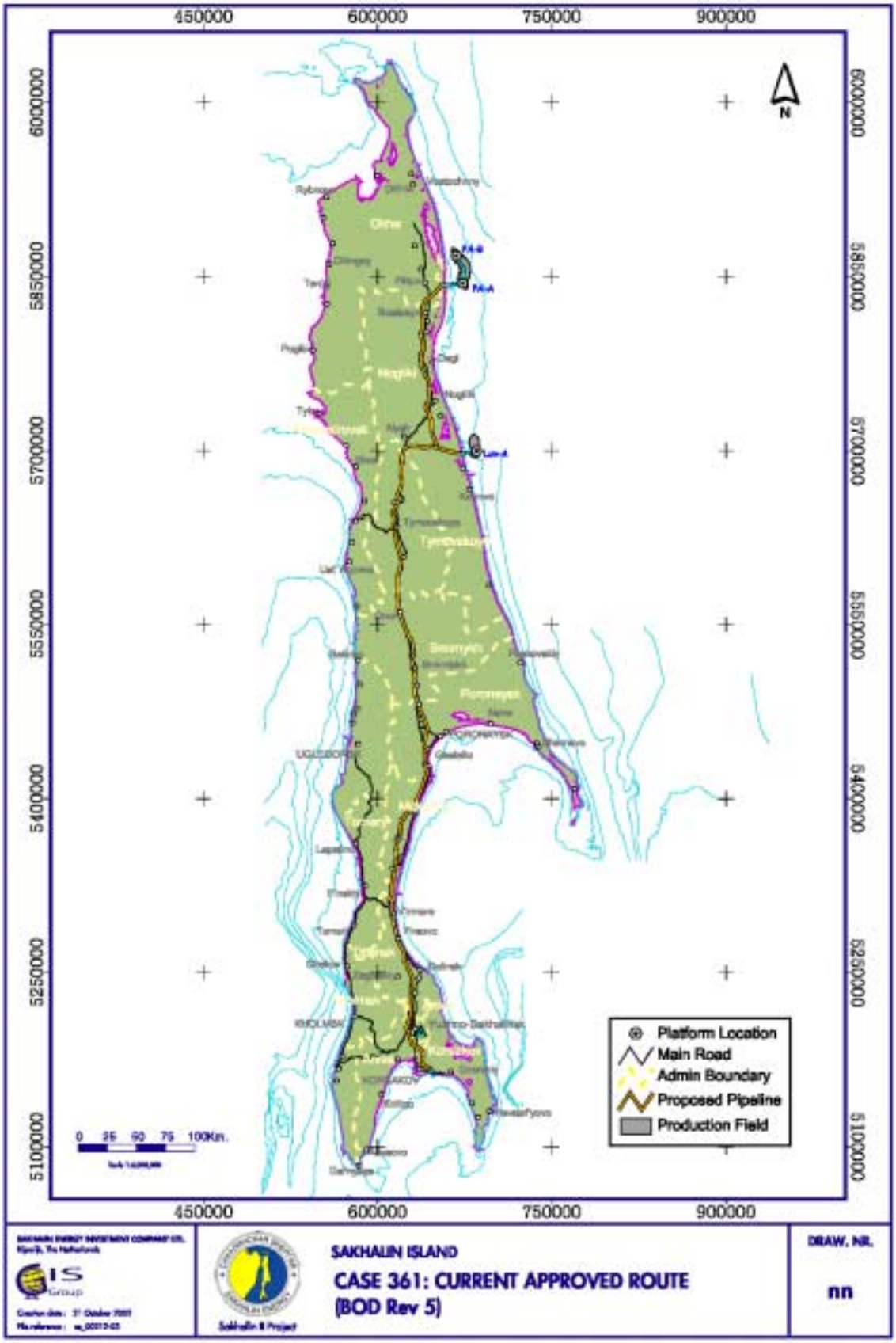

FIGURE 6-1. Onshore alternate pipeline routing for the Sakhalin II project.

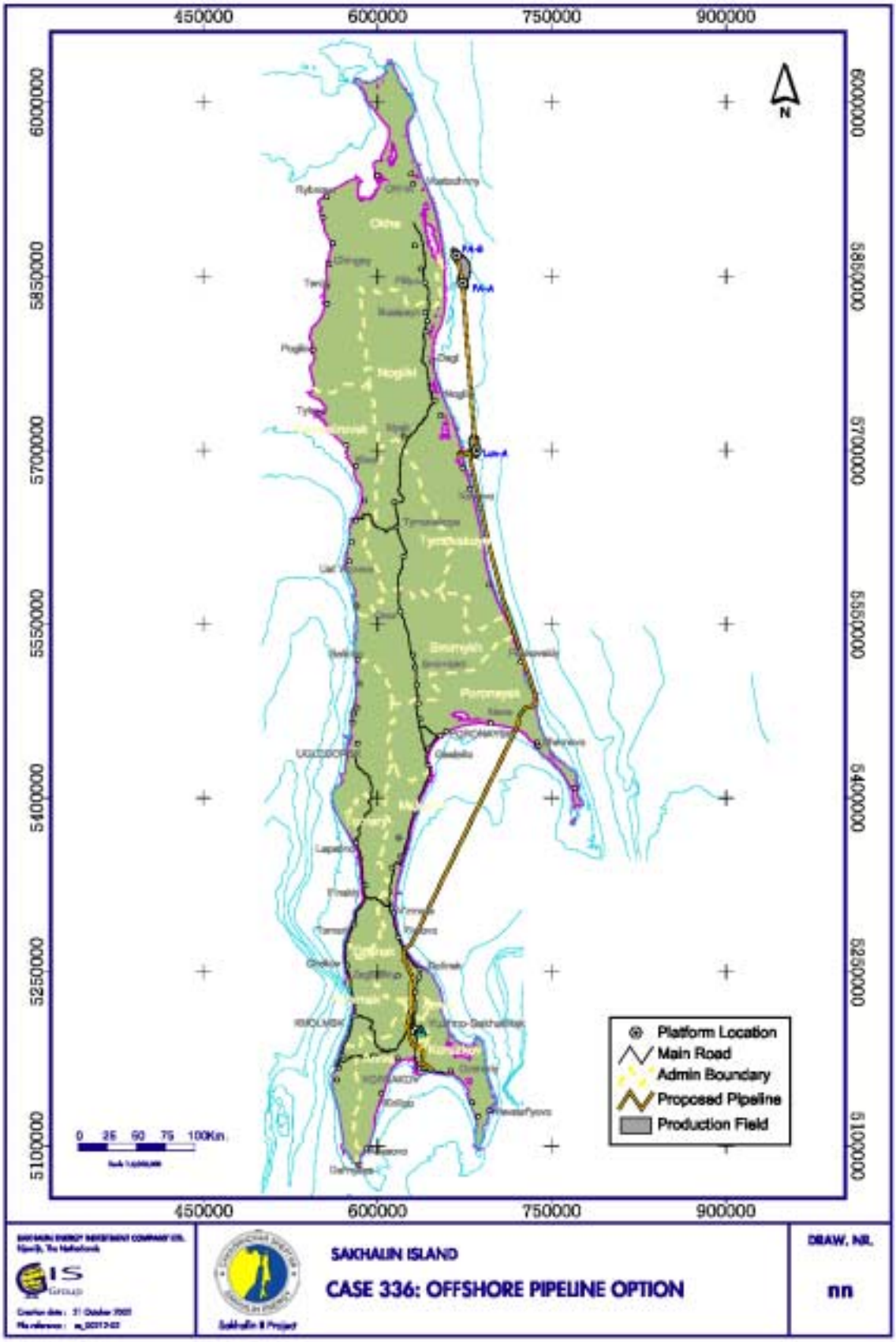

FIGURE 6-2. Offshore alternate pipeline routing for the Sakhalin II project.

pipeline option was US$ 68.4 MM lower than the offshore option. However, the onshore option was selected for several reasons:

- Delivering gas to communities, utilities, and industry on Sakhalin Island, and the concomitant upgrades to the island transport infrastructure, would be a positive socio-economic impact of the project;
- Some form of boosting would be required for the offshore pipeline option. Onshore booster stations are more straightforward than offshore, thus the pipeline would need to come onshore at least once for boosting; and
- Changing the development concept on which the license is based needs approval and co-operation of all parties. The Oblast was not in favour because of environmental concerns about an offshore oil pipeline in an earthquake-prone area with ice covering the sea for about six months.

In 2001, a third option was evaluated, using offshore pipelines to bypass the onshore section through swamp between Piltun-Astokhkoye and Lunskoye and the Makarov mountain crossing (Case 409, see Fig. 6-3). An evaluation was made of the merits of the two bypasses, and although they were technically feasible, no clear cost savings could be demonstrated because of uncertainty in IUP scope reduction and the sensitivity of any savings to the rates for offshore lay barges. In addition, the reasons mentioned above for the choice of the onshore option (Russian content, approval process, environmental considerations) apply here as well, as follows:

- The indigenous population favoured the onshore routing because of increased employment opportunities, domestic gas supply, and infrastructure upgrades.
- The onshore routing offers the greatest opportunity for maximising Russian content, both in terms of materials and supply of construction manpower and equipment. No offshore laybarge capability exists in Russia, whereas there are a number of experienced onshore pipeline contractors.

Offshore pipelines have potentially major negative impacts on western gray whales. Noise associated with installation of the pipelines and possible oil spills resulting from pipeline rupture could impede or even block their migration to preferred feeding grounds, or interrupt feeding for much of the time available to them to feed. Because the population is so small, interrupted feeding of only a few individuals could have negative impacts at the population level.

The currently-approved onshore pipeline routing (Fig. 6-1) involves the least amount of offshore pipeline, however the nearshore portions of the pipelines from both the PA-A and LUN-A platforms cross the route that western gray whales use to migrate to their feeding grounds. The Lunskoye area is not a known feeding area, but the nearshore portion of the pipeline from the PA-A platform crosses the southern end of the best-known western gray whale feeding area, located in waters < 20 m deep off Piltun Bay (Fig 4-2).

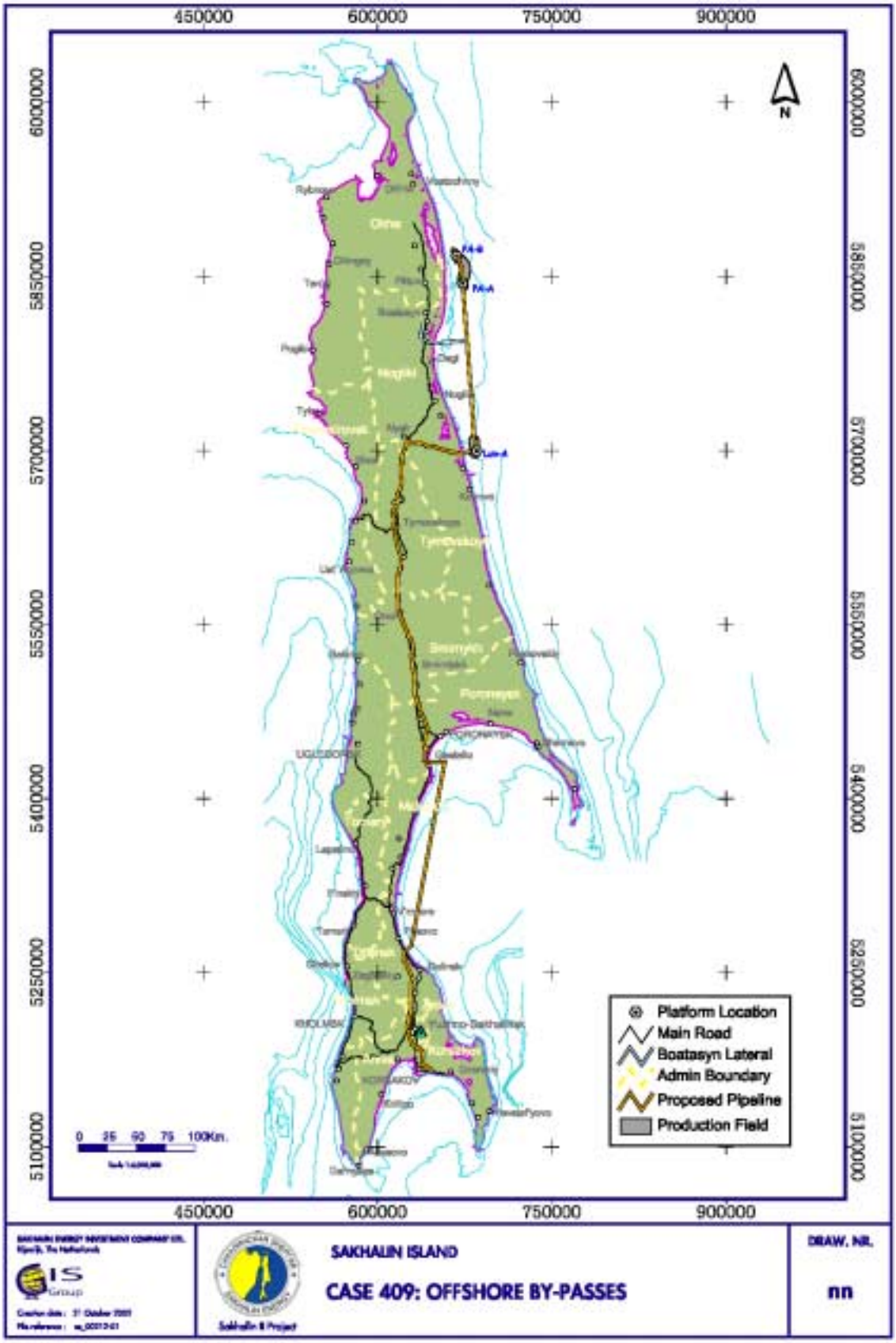

FIGURE 6-3. Onshore with offshore bypasses alternate pipeline routing for the Sakhalin II project.

The offshore pipeline routing (Fig. 6-2) involves the greatest amount of offshore pipeline. There is no pipeline from the PA-A platform, but there is a pipeline from the LUN-A platform to shore, and the pipeline is very close to shore from Lunskoye to its landfall on the Terpeniie peninsula. Installation of both of those pipeline segments has the potential to impede or block western gray whale migration. Also, the pipeline between the PA-A and LUN-A platforms crosses the second known feeding area, located in waters 35-45 m deep, from Chayvo Bay to Nyiskii Bay. Potential impacts of the portion of the pipeline that crosses Terpeniie Bay are uncertain, because there is no detailed information on their migration route there. Eastern gray whales stay close to shore while migrating, but do cross the mouths of bays. This alternate pipeline routing has the greatest potential to impact western gray whales.

The onshore pipeline routing with offshore bypasses (Fig. 6-3) has an intermediate amount of offshore pipeline. As is the case with the offshore routing, there is no pipeline from the PA-A platform, but there is a pipeline from the LUN-A platform to shore, which may interfere with migration, and the pipeline between the PA-A and LUN-A platforms crosses the feeding area off Chayvo Bay. Furthermore, there is a second pipeline to shore that would also cross the offshore feeding area and the migration route to the Piltun feeding area. As noted above, potential impacts on western gray whale migration of the Makarov bypass, which runs along the shore in Terpeniie Bay, are uncertain.

Thus, each of the three alternative pipeline routings has potentially major negative impacts on the migration and feeding of western gray whales. The offshore routing is the least preferred alternative. The predominantly onshore routing and the onshore routing with offshore bypasses have a similar potential to adversely impact western gray whales: Each has two portions of pipeline that cross the migration route, and each crosses through a known feeding area.

An alternative pipeline routing that avoided the Piltun feeding area would be preferred because it would remove the potential impacts on western gray whales feeding at their best-known feeding area, an area that is of great concern to both government and NGOs. That could be accomplished by keeping the pipeline offshore for 10-20 km before making landfall. Such a routing would retain the positive socio-economic impacts for north Sakhalin Island that are associated with the onshore routing.

6.3.4 Offshore pipeline construction method for landfalls

Two alternative methods of installing the pipelines at the landfalls at Piltun and Lunskoye: Trenching and horizontal directional drilling (HDD). HDD is the preferred method for environmental reasons, because it reduced the amount of suspended sediment produced, the number of vessels operating close to shore where the western gray whales migrate to their feeding grounds, and the underwater noise produced during the operation. However, the HDD method was not recommended for the Piltun and Lunskoye sites, because of the high cost (number of pipelines) and especially the technical feasibility (the shore crossings are unconsolidated sand, which is not suitable for HDD). The final choice will be made during the detailed engineering phase.

6.3.5 Offshore Waste Management

Several offshore waste streams were identified and subject to alternative studies prior to selection of the preferred option. Alternatives considered and preferred options are shown in Table 6-1.

TABLE 6-1. Selection of Alternative Solutions for Process and Domestic Waste Utilisation

Type of Waste	Alternatives considered	Preferred option
Drilling Muds and Cuttings	Overboard discharge, grinding and injecting into wells, shipment to shore for disposal at an approved site.	Maximising injection into the subsurface at the platforms
Produced water on platforms	Treat and discharge to the sea, treat and inject into the producing formation, and transport to shore with subsequent disposal in a deep well	Injection into the subsurface at the platforms
Waste water (industrial and domestic) offshore	Discharge to the sea or treatment followed by discharge or injection with the produced water	Treatment and discharge to the sea. If toxic substances can not be removed by treatment, injection into the subsurface (with produced water)
General solid waste offshore	Incinerators on each platform, transfer and disposal on land	Transfer and disposal on land

The preferred option, injection of produced water and drilling muds and cuttings into wells, and disposal on land eliminate potential impacts on western gray whales.

6.3.6 Infrastructure Sharing

During 2000, extensive joint technical studies were carried out with Exxon Neftegas Limited (ENL), the Operator of the Sakhalin I venture, to determine if there were benefits to be gained by the sharing of infrastructure between the ventures. ENL's plans for a first phase of development are to evacuate oil from the Chayvo field to the port of de Kastri on the Russian mainland from where it will be exported. That will mean ice navigation during the winter months. Gas will initially be re-injected in the field to maintain reservoir pressure.

SEIC's plans are to install gas and oil pipelines down the island to LNG plant and oil export terminal in Prigorodnoye. That option was chosen because it allows LNG and oil to be exported from a largely ice-free port, which is an important consideration for LNG buyers from the point of view of reliability of supply. It is also an important safety consideration, as it reduces environmental risks. The plan is consistent with the original

TEOI for the license, and also allows gas to be delivered for domestic uses in the southern part of the island, as outlined in the Plan of Development and agreed with the Russian Party. As Sakhalin I and II evacuation strategies are fundamentally different, there was found to be little advantage in the sharing of pipeline infrastructure, and the discussions are now closed out. However, an agreement is in place for the sharing of island upgrades, and discussions will continue on the sharing of future operations and logistics activities.

SEIC and ENL continue to pursue cost-sharing initiatives, such as Nogliki camp, Nogliki airport upgrade, roads and bridges north of Nogliki, oil spill response, and western gray whale monitoring. All of those initiatives will be of benefit to western gray whale protection either by facilitating research and monitoring, or improving the ability to respond to an oil spill.

6.4 No-Project alternative

The assessment of a no-project alternative (a zero-option alternative) has revealed the following likely significant effects:

- A zero-option alternative for Sakhalin-II development does not preclude the development of the other licenses, as oil and gas development and production offshore of Sakhalin are expected to continue;
- The probability that other developments may be influenced by the success or failure of the SEIC project, because failure may be taken as an indicator of environmental, technical, financial, or political problems hindering investments in Sakhalin oil and gas development;
- In the absence of employment, revenues and expected investments, the economic decline that was seen on Sakhalin Island in the 1990s may continue to affect both private and public sectors. The potential follow-on effects may include continuation of infrastructure deterioration and economic migration.
- In the absence of the expected land clearance, some additional forestry may be maintained. However, at present, the rate of forestry plantation and logging is limited by liquidity issues, a lack of available mature trees, and a lack of investments;
- The more inaccessible areas opened up by the pipeline right of way and facilities would remain isolated from human influence; and
- The environmental risks associated with the project, such as oil spills and soil erosion, would be removed.

In summary, a zero-option alternative would bring no anticipated economic benefits, and there would be a possibility of negative social impacts. However, the anticipated environmental impact and risks would be eliminated.