SENES Consultants Limited

Specialists in Energy, Nuclear and Environmental Sciences

NOISE ASSESSMENT REPORT

FARO MINE COMPLEX CLOSURE PLAN

Prepared for:

Yukon Energy, Mines and Resources
Assessment and Abandoned Mines
Room 210 - 419 Range Road
P.O. Box 2703
Whitehorse, Yukon, Y1A 2C6

Prepared by:

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March 2009

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Prepared By: Date: 31-March-09

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Date: 31-March-09

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Reviewed By: Date: 31-March-09

John Peters, Principal

March 2009

TABLE OF CONTENTS

Page No.

APPENDICES

LIST OF FIGURES

LIST OF TABLES

1.0 INTRODUCTION

SENES Consultants Limited (SENES) was retained by Yukon Energy, Mines and Resources – Assessment and Abandoned Mines to undertake a Noise Assessment of the Faro Mine Complex located in Faro, Yukon. This assessment was completed in support of a Project Proposal under the Yukon Environmental and Socio-economic Assessment Act.

1.1 BACKGROUND

Mining at the Faro complex began in 1969 and continued for nearly 30 years. The most recent owner, the Anvil Range Mining Corporation, was placed into receivership and all mining operations stopped in 1998. Since 1998, the Government of Canada has been responsible for the care and maintenance of site. In January 2003, the Government of Canada and the Territorial government acknowledged that the Faro Mine complex would not reopen and that a permanent, long-term closure plan would be needed for the site. A joint agreement with the Ross River Dena Council and Selkirk First Nation was reached and the Faro Mine Oversight Committee was established. This committee was created to provide overall strategic direction on the closure planning process. The Government of Canada, Yukon government, Selkirk First Nation and Ross River Dena Council took a collaborative approach to developing the closure objectives for the Faro Mine complex.

Since 2003, over 100 technical studies and assessments, numerous technical workshops and consultations were completed in an effort characterise site conditions and evaluate different approaches to site closure. In 2005, results of the technical studies and workshops were summarized in a series of twelve (12) closure alternatives, which represented the technically feasible options that were available to address the environmental issues at the site.

These alternatives were reviewed by an Independent Peer Review Panel in 2006 and included an extensive period of feedback and discussion with all stakeholders. Based on the recommendations of this Panel, and the outputs of community/government consultation, the twelve (12) closure alternatives were refined into five (5) final closure options that were further evaluated by community members, consultants and governments. As a result of this evaluation, a consensus on a preferred option and recommend a closure plan for the Faro Mine Complex was reached.

Before the preferred closure plan can be implemented, it must be assessed under the Yukon Environmental and Socio-economic Assessment Act (YESAA) for environmental, social and economic impacts, receive approval for land and water licences and permits, and secure federal government approval for funding. Under the YESAA the Faro Mine Closure Project is required to submit a "Project Proposal." Key elements of the Project Proposal include:

- Project purpose;
- Project description;
- Description of existing environmental and socio-economic conditions; and,
- Identification of potential environmental and socio-economic effects and proposed mitigation measures.

A draft project description was published in January 2009, which formed the basis of the assessment of environmental impact. The final Project Description, expected by the end of April 2009, will be incorporated into the final Project Proposal. The final Project Proposal is scheduled to be published by the end of July 2009. This preliminary Noise Assessment report has been prepared to support the development of the Project Proposal.

1.2 OVERVIEW OF REPORT

In addition to this introductory chapter, the noise assessment report includes the following six (6) chapters as outlined in Table 1. Chapter 2 provides an overview of the site and its key operating areas. Chapter 3 describes the general noise assessment methodology, including: the project description; project-environment interactions; spatial and temporal boundaries; analytical methods; and, the assessment criteria. Chapter 4 discusses the existing noise environment and Chapter 5 describes the effects assessment scenarios, noise modelling results and mitigative considerations. The key conclusions of the noise assessment are outlined in Chapter 6.

A list of acronyms and units used in this report is provided in Appendix A.

Table 1 - Report Format

Chapter	Description
2.0	SITE DESCRIPTION
3.0	ASSESSMENT METHODOLOGY
4.0	EXISTING CONDITIONS ASSESSMENT
5.0	EFFECTS ASSESSMENT
6.0	CONCLUSIONS

2.0 SITE DESCRIPTION

The Faro Mine Complex consists of three main areas: the Faro Mine area, the Tailings area, and the Vangorda/Grum Mine area. The Faro Mine area, located approximately 15 km north of the Town of Faro, includes the Faro Pit, waste rock dumps and the former ore processing facilities. The adjacent Tailings area includes a series of dams and impoundments located below the mine in the Rose Creek valley. The Vangorda/Grum Mine area, located approximately 9 km northeast of the Town of Faro, includes the Vangorda and Grum Pits and waste rock dumps, as well as water treatment facilities. The Faro and Vangorda/Grum Mine areas are connected by a 13 km heavy haul road. This road was used to transport ore from the Vangorda and Grum pits to the Faro mill for processing.

3.0 ASSESSMENT METHODOLOGY

3.1 BASIS FOR THE ASSESSMENT

A full description of the "Project" that is the subject of the Environmental Assessment (EA) is provided in the *Project Description – Faro Complex Draft (SRK, 2009a)*. The *Project Description* presented a list of closure activities areas (grouped into three main areas: the Faro Mine (Activity Code 100), Rose Creek Tailings (Activity Code 200) and the Vangorda/Grum (Activity Code 300)) (See Figure 1). These activities were each assigned a number of activity subcodes, which were referenced to a specific location within each of the above areas. A summary of the specific activities that collectively comprise the Project (i.e., Basis for the EA) are included in Appendix B (Table B-1).

3.2 PROJECT-ENVIRONMENT INTERACTIONS

On the basis of the *Project Description – Faro Complex Draft (SRK, 2009a)* and *Equipment and Activity Matrix* (Appendix B –Table B.1) the potential project-environment interactions, related to noise, were identified and are summarized in Table 2. This Table also provides the rationale for the identification of each project-environment interaction. These interactions are analyzed in subsequent sections to determine whether they are likely to result in a measurable change in the environment, and if so, to describe the relevant environmental effect.

Table 2 – Potential Project-Environment Interactions for Noise

Environmental Component	Effects Measurement Indicator	Project Interaction	Environmental Parameter	Rationale
Noise	Changes in ambient noise levels	Closest sensitive point of reception (POR), which include residences and/or sensitive land uses	Noise as a potential pathway for nuisance effects to humans.	Elevated sound levels in off-site areas present potential nuisance effects to humans.
		Wildlife corridors, breeding and foraging areas and other sensitive habitats (see discussion below)	Noise as a potential pathway for effects on wildlife (the Terrestrial Environment).	Potential effect on Terrestrial components

The discussion herein focuses primarily on noise impacts on humans, as noise criteria used are generally based on the protection of human health.

The results of the noise assessment were also provided to the Wildlife Team for its consideration. The assessment of impacts on wildlife is presented in the *Wildlife Assessment Report* (AECOM, 2009).

3.3 SPATIAL AND TEMPORAL BOUNDARIES FOR THE ASSESSMENT

The site study area is defined by a 10 kilometre radius from the center of the Faro Mine complex. This large area was selected to account for any potential wildlife migration pathways, breeding and foraging habitats as well as the Town of Faro. Closure activities will be primarily ground based sources, with the exception of some specific activities completed by helicopters (i.e., re-vegetation operations). All activities will occur within the Site Study Area.

Noise effects arising from the Project will be predominantly due to equipment operation during the various closure activities. Based on experience from past projects, the associated effects are likely to be limited to a few kilometres of these activities and will decrease with increasing distance from the activity.

The temporal boundaries for this assessment are described in the *Project Description – Faro Complex Draft (SRK, 2009a)*. For assessment purposes, the Project activities were assumed to occur for 10 hours per day over the course of the twelve (12) year Project Schedule. The Faro Mine Complex and the Site Study area are illustrated in Figure 1 and Figure 2.

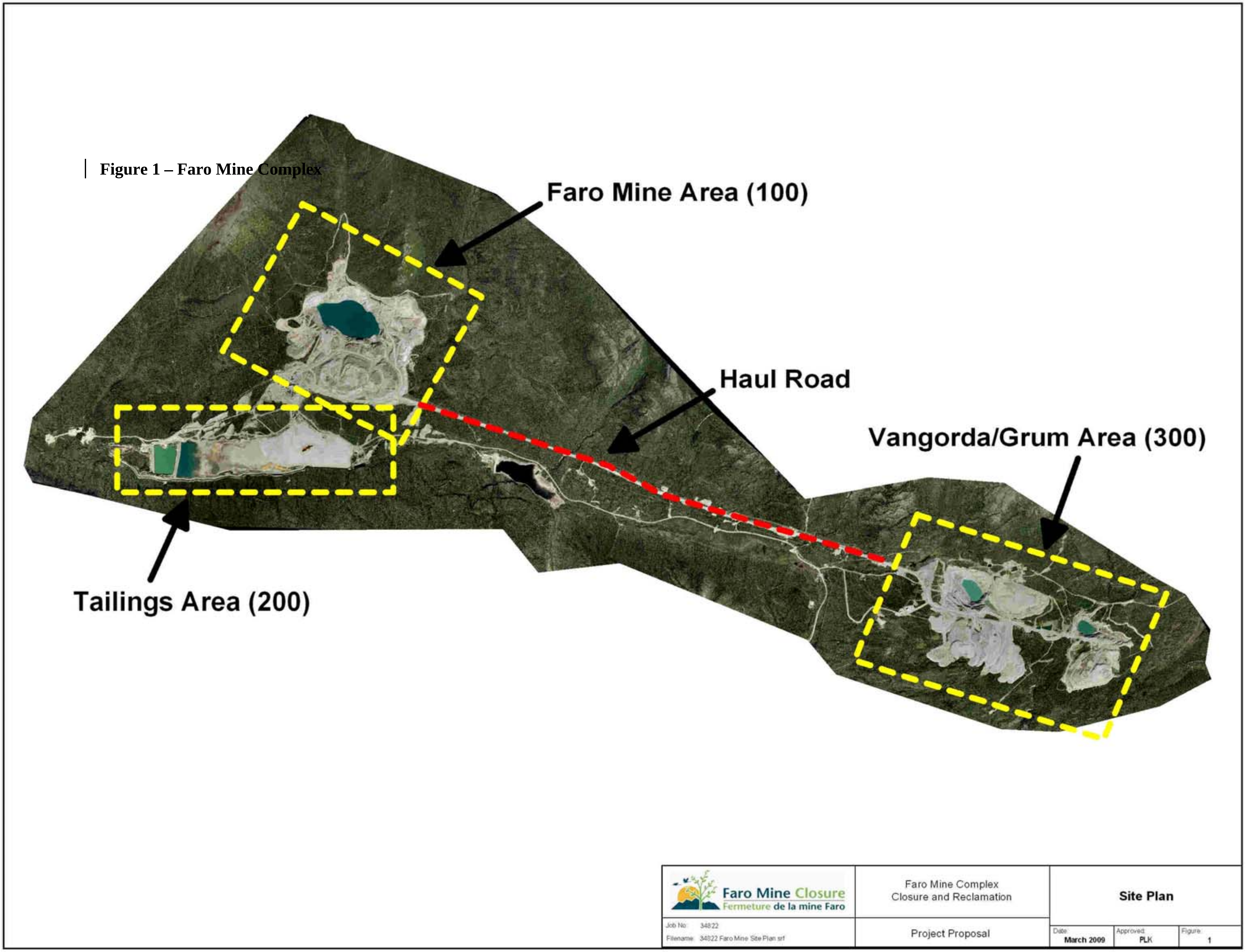
3.4 ANALYTICAL METHODS FOR THE ASSESSMENT

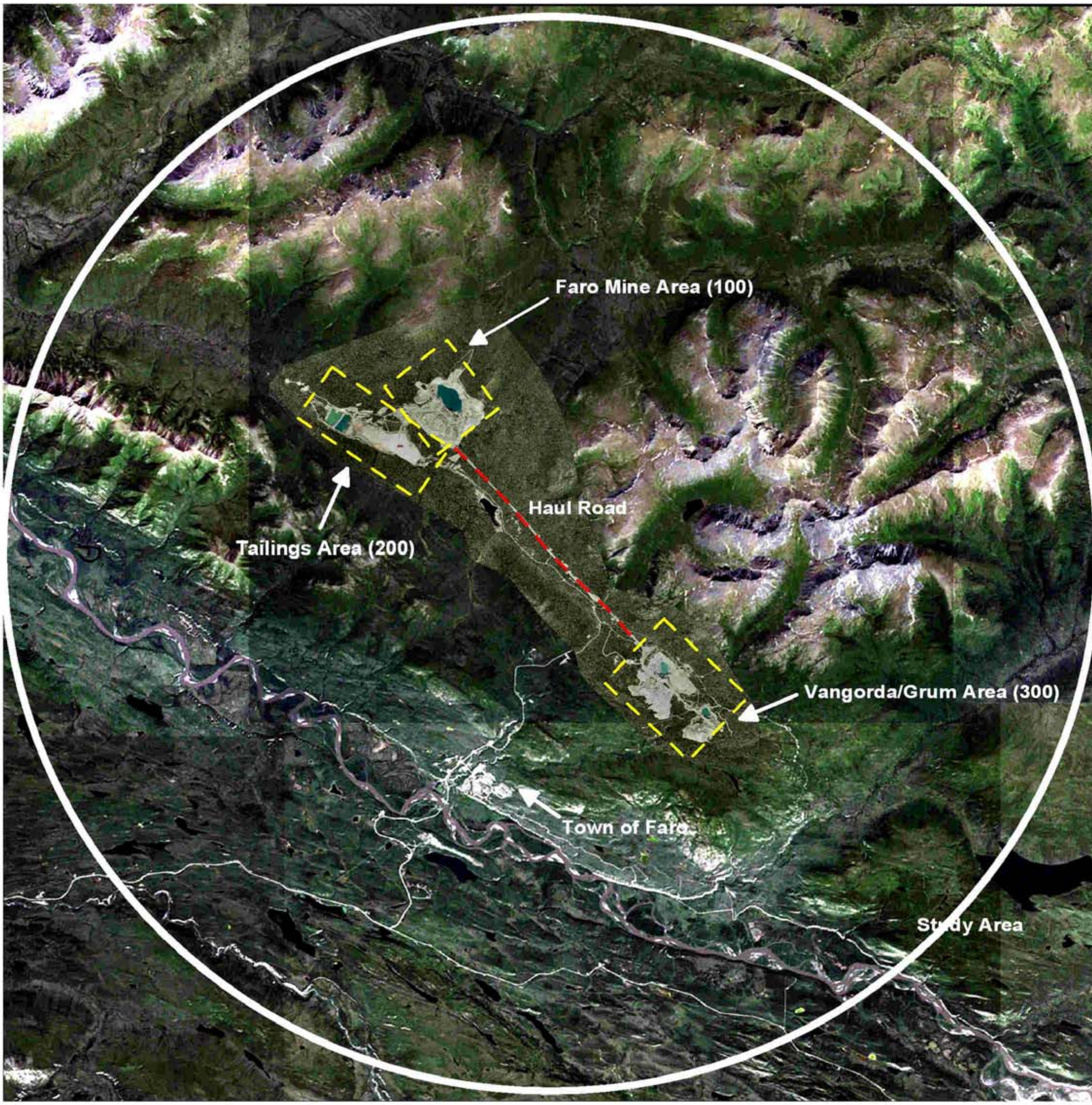
Environmental noise assessment requires the use of a variety of different analytical methods (e.g., computer models, manual calculations, professional judgement). The specific methods employed in this assessment are briefly described below:

- The Cadna-A predictive noise model was used to assess noise impacts from closure activities. The Cadna-A model is based upon ISO standard 9613: Attenuation of sound during propagation outdoors; Part 2: General Method of Calculation (ISO, 1996). The Cadna-A visual interface allows the user to create a three-dimensional representation of the project site and surrounding area, and place a variety of source types at locations representing those where the associated work is expected to be undertaken. Calculated sound level data are applied to each source as appropriate, and the model calculates the sound level due to the distance between the source(s) and user-specified points of reception and accounts for any intervening obstructions to noise propagation. The model is also able to account for atmospheric absorption and absorptive qualities of the intervening ground surface. Obstructions to noise propagation that may be incorporated into the modelling include buildings, acoustic barriers, earthen berms and natural changes in ground elevation. Cadna-A calculates the individual impact of each noise source at each defined point of reception. A sound level grid also may be created on a user-specified node spacing in order to provide a visual representation of the noise propagation in the form of isopleths.

- A combination of measured sound level data contained in SENES' noise database, standard noise calculation techniques and professional judgement were used to establish sound levels emanating from sources of noise associated with the Project.

Figure 1 – Faro Mine Complex





Scale
5,000 m

Faro Mine Closure
Fermeture de la mine Faro

Faro Mine Complex
Closure and Reclamation

Site Study Area

Job No: 34822
Filename: 34822 Faro Mine Site Study Area.srf

Project Proposal

Date: **March 2009**	Approved: PLK	Figure: 2

3.5 REVIEW OF POTENTIAL NOISE CRITERIA

A review of relevant territorial, federal and international noise impact assessment criteria is provided below.

3.5.1 Yukon Noise Guidelines

No specific environmental noise guidelines or criteria have been established in the Yukon. As such, Federal and/or International criteria will be applied.

3.5.2 Federal Noise Guidelines

The National Guidelines for Environmental Noise Control (Health Canada, 1989) provides techniques for noise measurement and outlines the roles of each level of government in environmental noise control. It also outlines the concepts and procedures for developing a noise control program and includes information on land-use planning, examples of noise control legislation and technical reference material including instrument specifications, and measurement, as well as prediction and noise reduction techniques.

The Guideline provides recommended general sound level limits for application at a point of reception (Table 3) and a process for the assessment of the magnitude of effects and application of noise control measures (Table 4).

Table 3 - Health Canada Recommended Point of Reception Sound Level Limits

Location	Time Period	Sound Level Limit at Point of Reception (Leq, dBA)
Suburban Outdoor Recreational Area	07:00 – 23:00 (16-hr)	55
Suburban Outdoor Area[1]	23:00 – 07:00 (8-hr)	50

[1] often applied at the plane of second storey bedroom window for night-time hours

Table 4 – Health Canada Criteria for Assessing the Magnitude of Noise Effects

Excess Above Recommended Sound Level Limits (dBA)	Change in Subjective Loudness	Magnitude of the Noise Problem	Noise Control Measures (or action to be taken)
No Excess	-	No expected noise problem	None
1 to 5 dB inclusive	Noticeably louder	Slight noise problem	Optional
6 to 10 dB inclusive	Almost twice as loud	Definite noise problem	Recommended
11 to 15 dB inclusive	Almost three times louder	Serious noise problem	Strongly recommended
16 dB and over	Almost four times louder	Very serious noise problem	Strongly recommended (may be mandatory)

3.5.3 World Health Organization Guidelines

The *WHO Guidelines for Community Noise* outline a set of noise exposure guidelines that are based on the lowest levels of noise that affect human health (critical health effects). An adverse health effect of noise refers to any temporary or long-term deterioration in physical, psychological or social functioning that is associated with noise exposure (WHO, 1999). The guideline values represent the sound pressure levels that affect the most exposed receiver in the listed environment. The WHO guideline values are presented in Table 5.

Table 5 - Guideline Values for Community Noise in Specific Environments

Specific environment	Critical health effect(s)	LAeq [dB]	Time base [hrs]
Outdoor living area	Serious annoyance, daytime and evening	55	16
	Moderate annoyance, daytime and evening	50	16
Outside bedrooms (night-time)	Sleep disturbance, window open (outdoor values)	45	8

3.6 DETERMINATION OF LIKELY ENVIRONMENTAL EFFECTS

The project-environment interactions were evaluated to determine if a "measurable" change to the environment would occur. For purposes of this report, a measurable change to the environment is defined as a change that is real, observable or detectable compared with existing conditions. A predicted change that is trivial, negligible or indistinguishable from background conditions is not considered to be measurable.

In the event that a project-environment interaction was likely to result in a measurable change to the environment a further review of the magnitude of the effect and the potential mitigative requirements was undertaken. Where the likely effect was determined to be beneficial (i.e. noise levels reduced by the Project), no further assessment was conducted. If the likely effect was determined to be adverse, but clearly not of concern, no further assessment was conducted. Rationale was provided in each case where further assessment was not considered to be warranted. All other likely adverse environmental effects were carried forward for consideration of mitigative opportunities.

For each likely adverse effect, an assessment of technically and economically achievable mitigative options was completed. As appropriate, each likely adverse effect was re-evaluated with the identified mitigation measures in place to determine the residual effect that would remain after mitigation.

3.7 PROJECT ASSESSMENT CRITERIA

All Project-induced changes in the environment will not necessarily result in an associated environmental effect of meaningful proportions. To be meaningful as an effect, the change must exceed an appropriate measurement threshold. The potential magnitude of the effect on the existing environment can be assessed through a comparison of existing conditions to the predicted noise levels due to the Project as well as through comparison to federal and international guidelines, standards and criteria.

To determine the potential magnitude of the incremental noise levels the information Table 4 was modified slightly to reflect an incremental sound level that would not be measurable. Cowan (1994) states that the human ear cannot perceive increases up to 3 dB (Cowan, 1994), and changes in sound level from 3 dB to 5 dB may be perceived but are generally not intrusive. Based on the information presented in the preceding Sections, the project noise assessment criteria are presented in Table 6.

The specific assessment criteria for determining effects of noise on wildlife are discussed in the *Wildlife Assessment Report* (AECOM, 2009).

Table 6 – Noise Assessment Criteria

Environmental Component	Effects Measurement Indicator	Health Effects Assessment Criteria		Criteria for Assessment of Measurable Change	
		Guideline/ Criteria	Reference	Negligible	Potentially Meaningful
Noise	Ambient noise levels (human health)	Day-time 16hr Leq – 50 dBA[1] Night-time 8hr – 45 dBA[1]	WHO Guidelines for Community Noise	<3 dBA change in ambient noise levels[2] at closest POR	Any increase >3 dBA above criteria at closest POR[2,3]

dBA – A-weighted decibels

POR – Point of Reception (Residential)

[1] WHO, 1999

[2] Cowan, 1994

[3] Health Canada, 1989

4.0 EXISTING CONDITIONS ASSESSMENT

4.1 AMBIENT NOISE

The surrounding noise levels are expected to be characterized by sounds of nature with occasional noise from equipment activities related to care and maintenance at the Faro Mine complex. The care and maintenance program includes: the ongoing collection and treatment of contaminated water; management of uncontaminated runoff; inspection and maintenance of dams and diversion channels; water quality monitoring; general maintenance; and, site security.

Since no noise monitoring was completed in the baseline characterization program and no specific data were available to characterize equipment operations during care and maintenance a conservative approach to establishing background ambient noise levels was applied.

A sound level of thirty-five (35) dBA was considered to represent day-time and night-time ambient sound levels. This value was extracted from the Alberta EUB Directive 038: Noise Control (AEUB, 2007) and is based on research conducted by the Environment Council of Alberta for rural environments in Alberta. This value was used as the background value for assessing the relevance of potential changes in noise levels at sensitive receptor locations, as defined in Table 6.

5.0 EFFECTS ASSESSMENT

5.1 DEVELOPMENT OF ASSESSMENT SCENARIOS

The *Project Description Faro Mine Complex Draft* (SRK, 2009a) presented a list of closure activities grouped into three main areas: the Faro Mine, Rose Creek Tailings and the Vangorda/Grum areas (See Figure 1). These activities were each assigned a number of activity codes, which were referenced to a specific location within each of the above areas. The specific types of equipment and the number of pieces of equipment were assigned to each activity code and summarized in an *Equipment Summary Per Activity* spreadsheet (SRK, 2009b). Using this information a series of worst case operating scenarios was developed. The approach to developing worst-case scenarios is discussed in Section 5.1.1, with a summary of worst-case scenarios presented in Section 5.1.2.

5.1.1 Development of Worst-Case Scenarios

The maximum noise impact of the Project was estimated based on operating scenarios during which noise from Project activities would be expected to be at a maximum. This typically occurs during the period where work activities are scheduled that require the greatest number of pieces of equipment to be operated simultaneously. Consideration was also given to the fact that work activities may occur in up to three (3) primary areas (Faro Pit, Vangorda/Grum Pit and the Tailings Area), each with its own maximum equipment usage requirements. As each of these activity areas has a different orientation to potential receptors, a separate maximum scenario was assessed for each of the primary activity areas. For each of the maximum operating scenarios, simultaneous operations in the other activity areas (as appropriate) were also included in the noise assessment.

Preliminary worst-case scenarios for predicting noise impacts were developed based on the *Example Project Schedule* appearing in the most recent version of the *Project Description Faro Mine Complex Draft* (SRK, 2009a) that was available at the time of the preparation of this report, as well as a list of equipment (SRK, 2009b) associated with each of the various Activity Codes. The schedule and equipment list were compared and a matrix table (Appendix B-Table B.1) was developed to link the equipment totals with the activities occurring in each quarter throughout the duration of the Project.

The periods with the highest equipment demands were identified for each of the major activity areas using this matrix table. The quarters with the highest totals for each activity area were extracted, and the schedule was further consulted to determine whether any of the identified activities within the quarter would not occur simultaneously (and if so, whether this would exclude them from consideration as the maximum for the given area). The periods identified in Table 7 were selected as the focus of the noise impact assessment, and are further described in Section 5.1.2.

Table 7 - Summary of Worst-Case Assessment Scenarios

Scenario	Year / Quarter	Rationale
Scenario 1	Year 12, Quarter 2	Overall Project Maximum Total Equipment Usage Maximum for Activity Code 300
Scenario 2	Year 1, Quarter 3	Maximum for Activity Code 100
Scenario 3	Year 5, Quarter 4	Maximum for Activity Code 200

5.1.2 Description of Worst-Case Scenarios

Scenario 1: Year 12, Quarter 2 (Maximum Closure Activities for Vangorda/Grum Pit)

This scenario was assessed first as it not only involves the highest simultaneous use of equipment in the Vangorda/Grum Pit area (Activity Code 300), but also the highest total simultaneous use of equipment overall. The activities that may occur simultaneously include:

- Activity 107.4: North Fork Rose Creek Collection System
- Activity 107.6: Allowance: Guardhouse Creek Groundwater Collection System
- Activity 204.1: Cross-Valley Dam Cut-off Wall
- Activity 204.2: Cross-Valley Dam Interception Ditch
- Activity 204.3: Collect Groundwater at Interception Ditch
- Activity 204.4: Seepage Collection System above Intermediate Dam
- Activity 309.1: Grum Dump Groundwater Collection to Holding Pond
- Activity 309.2: Grum Dump Groundwater Holding Pond
- Activity 309.3: Grum Dump Groundwater Collection from Holding Pond to
  - Vangorda Pit
- Activity 309.4: Vangorda WR Dump Seepage Collection to Pit
- Activity 309.5: Allowance: Grum Dump Cut-off Wall

Scenario 2: Year 01, Quarter 3 (Maximum Closure Activities for Faro Pit)

This scenario was assessed as it involves the highest simultaneous use of equipment in the Faro Pit area (Activity Code 100). The activities that may occur simultaneously during this period include:

- Activity 102.1: Construct East Interceptor
- Activity 102.2: Extension Across West of Faro Valley
- Activity 104.1: Consolidate Oxide Fines
- Activity 104.2: Medium-Grade Stockpile
- Activity 104.3: Low Grade Stockpile “A”
- Activity 104.4: Low Grade Stockpile “C”
- Activity 108.5: Borrow Sources

The use of a helicopter is identified in the equipment list for two of the above activities (Activity 104.2-104.4 and Activity 108.5). It has been assumed that there will be only one helicopter in use at any given time. As such, two separate runs were completed for this scenario. Scenario 2a assumes that the helicopter is active as part of Activity 108.5. This scenario therefore includes all equipment associated with each of the above activities, with the exception of the helicopter associated with Activity 104.2-104.4.

Scenario 2b assumes that the helicopter is active as part of Activity 104 (and therefore not active in Activity 108.5). The helicopter is presumably used for the re-vegetation of the stockpiles and would likely be required towards the end of the Activity. It is therefore assumed that the other equipment associated with Activity 104 is no longer operating on the piles when the helicopter is required. As such, this scenario assumes that all ground-based equipment associated with Activities 102.1, 102.2 and 108.5 are active and only the helicopter is active as part of Activity 104.

It should also be noted that while Activity Code 106.1 is scheduled to occur during this quarter, its commencement is reliant on the completion of Activity 104 and as such does not occur simultaneously with the above activities, which have a higher combined equipment demand.

Scenario 3: Year 05, Quarter 4 (Maximum Closure Activities for Tailings Area)

This scenario was assessed as it involves the highest simultaneous use of equipment in the Tailings Area (Activity Code 200). The activities that may occur simultaneously during this period include:

- Activity 106.3: Waste Rock Cover
- Activity 106.4: Steep Runoff Channels
- Activity 106.5: Re-vegetate
- Activity 201.1: Cross-Valley Dam
- Activity 202.1: Intermediate Tailings
- Activity 203.1: Upgrade Upstream Portion to PMF
- Activity 203.6: Allowance: Reconstruction of Rose Creek

The use of a helicopter is identified in the equipment list for three of the above activities (Activity 106.5, Activity 201.1 and Activity 202.1). As noted above, it has been assumed that there will be only one helicopter in use at any given time. As such, three separate runs were completed for this scenario. Scenario 3a assumes that the helicopter is active as part of Activity 106.5. This scenario therefore includes all equipment associated with each of the above activities, with the exception of the helicopter associated with Activity 201.1 and 202.1.

Scenario 3b assumes that the helicopter is active as part of Activity 202.1 (and not active in Activity 106.5 or Activity 202.1). Similarly, Scenario 3c assumes that the helicopter is active as part of Activity 202.1 (and not active in Activity 106.5 or Activity 201.1). The helicopter is presumably used for re-vegetation in the area of Activity 202.1, and its use would likely be required towards the end of the activity. It is therefore assumed that the ground-based equipment associated with Activity 202.1 is no longer operating at such a time when the helicopter is required.

It should be noted that while the schedule indicates that Activity 201.1 and Activity 202.1 do not occur simultaneously with Activity 203.1, their respective close-out and start-up dates are likely overlapping, and as these activities are not denoted as being reliant upon one another (i.e., one does not need to be completed before the next one begins) they were assumed to occur simultaneously.

5.2 NOISE IMPACT ASSESSMENT

5.2.1 Calculation of Noise Data

The sound power levels for the sources included in the assessment were derived from SENES' noise database for similar noise sources or through calculation using equipment operating parameters provided in *Project Description Faro Mine Complex Draft* (SRK, 2009a) and the *Equipment Per Activity* (SRK, 2009b) spreadsheet. Detailed calculations and a summary of equipment sound levels used in the assessment are provided in Appendix C.

5.2.2 Modelling Parameters

The scenarios described in Section 5.1 were assessed through predictive computer modelling using the Cadna-A noise propagation model (DataKustik GmbH, 2005). The modelling software, whether calculated at specific points of reception or as contour plots are presented as *A-weighted Energy Equivalent Sound Levels (LAeq)*. An A-weighted sound level represents a sound level that has been adjusted to account for the response of a human ear, which is more sensitive to sounds at higher frequencies. An equivalent sound level is the sound level which if constant over a specified period would contain the same sound energy as sound of varying levels over that same period of time (Cowan, 1994).

The Cadna-A model was configured to estimate equivalent sound levels over various time periods. The time period for which modelling was performed included:

- Maximum 1-hr;
- Maximum 16-hr (representing daytime operations between 7:00 am and 11:00 pm); and
- Maximum 24-hr.

A maximum 8-hr night-time scenario was not considered as this assessment is based on the work being performed during a 10-hr workday, which was assumed to occur during the daytime hours defined above. The maximum 1-hr scenario results in the highest sound levels as it assumes that all sources associated with each activity are operated simultaneously during the maximum hour. The 16-hr and 24-hr runs are progressively less noisy as they account for periods in which equipment is not operating, which serve to reduce the energy equivalent sound levels[1].

The following general assumptions were used in modelling:

Terrain

Terrain contours obtained from the Federal Topographic Maps for the Study Area were used in the model to account for major changes in elevation. Site specific terrain contours, including berms, pits and similar features, were not considered in the assessment to allow for a worst case assessment of noise propagation.

Ground Absorption

Reflective ground absorption was applied to all activity areas, while vegetated areas immediately surrounding the Site were set to absorptive.

Source Operating Times

For modelling runs completed for the 1-hr averaging period, it was assumed that all sources were operational for the entire 1-hr period. In the 16-hr runs, all ground-based equipment was assumed to be operational for the entire 10-hr work day. This is a conservative assumption as equipment use would likely not be continuous over the entire work day. The helicopter sources were assumed to be operational for 5-hours out of the 10-hour work day.

The helicopter operation does not account for travel to and from the Town of Faro, as well as time for re-fuelling. In Activity 201.1 in which the helicopter is presumably being used to manoeuvre large pieces of material into the dam structure, helicopter use was assumed to occur for a period of 2-hours per day.

[1] 10-hr modelling runs were not completed but would follow the same rule.

Roads

No vehicle traffic information was available for the haul roads. In order to account for noise sources that are present and active during each of the above scenarios several assumptions were made. For each scenario, the equipment total was assumed to be equal to the number of people present on-site. It was assumed that all of these people travel to the site each day from the Town of Faro at the beginning and end of the 10 hour work day. In event that there is activity at both the Faro Pit and the Vangorda/Grum Pit (i.e., Scenario 1) the volume of traffic was assumed to split equally at the point where the main road forks. In the event that activity is only occurring at the east or west side of the site, it was assumed that all traffic goes directly to the predominant site.

No truck traffic data were available for the haul roads. In order to characterize noise from the haul roads it was assumed that two (2) heavy trucks per hour would travel between the sites.

Helicopter Usage Characteristics

As specific information on helicopter usage (i.e., travel speed, height of operation) was not available at the time of the preparation of this report, several assumptions were made based on general practices for the applications in which the helicopter will be required. The helicopter will often be involved in seeding operations. It was estimated that the helicopter will operate at approximately 30 m above the ground, and cruise at a speed of approximately 40 km/hr. It should be noted that helicopter noise was only included in applications where it would be operating at low altitude. Travel between the Town of Faro, the airport and the Site was not included in the assessment of maximum noise impacts.

Ancillary Equipment and Operations

Groundwater well pumps, water treatment equipment and other associated equipment were not included in this preliminary assessment. No specific data was available to characterize sound levels from this equipment (with the exception of mud pumps).

Care and maintenance activities were not included as the equipment requirement is relatively small in comparison to the other activities occurring at the site. It is expected that the operation of equipment used in care and maintenance amidst all of the other activities occurring simultaneously will not significantly affect sound level predictions.

5.2.3 Determination of Sensitive Points of Reception

The criteria presented in Table 6 for the assessment of noise impacts on human health were applied at sensitive points of reception (POR). Aerial photographs were reviewed to establish the approximate location of the nearest POR. As noted in Table 8, the nearest potential POR was slightly west of the main road leading to the Faro complex, approximately 2 km north-east of the Town of Faro and approximately 4.5 km to the west of the Vangorda/Grum mine . Residences in the Town of Faro are south-west of this receptor location and would be less exposed to noise from the closure activities.

Table 8 - Residential Receptor Summary

Receptor ID	Description	Location	Direction from Site
R1	Residential Receptor	West of main road leading to the Faro Mine complex – 2 km north-east of Town of Faro	South west

It should be noted that seasonal or rental residences and campgrounds may be present within the Study Area that are closer to the site than the receptors identified above. No information was available at the time of preparation of this report to confirm the presence/absence of any seasonal or rental residences and campgrounds.

5.2.4 Noise Modelling Results

It was determined through modelling of each of the individual activities that the approximate separation distance between any given activity to the point at which sound levels return to the estimated background sound level for the area (i.e., 35 dBA) is approximately 2 km. The closest residential receptor is approximately 4.5 km from the nearest activity. The sound level contour plots in Appendix D illustrate the noise impact from the conservative worst-case activity scenarios for each averaging period evaluated (1-hr, 16-hr and 24-hr). The 35 dBA contour line shown on these figures represents the boundary outside of which sound levels are considered as background.

The results of noise modelling for the scenarios outlined in Section 5.1.2 is summarized in Table 9 and Table 10. The results revealed that there is no measureable noise impact at the nearest POR.

Table 9 – Predicted Sound Levels at Residential Receptors

Receptor ID	Receptor SPL (dBA)		Receptor Height (m)		Coordinates		
	Daytime	Night-time	Daytime	Night-time	UTM–X (m)	UTM–Y (m)	Z (m)
R1	<35	NA	1.5	NA	587700	6902207	1036

NA – not applicable (no night-time operations)

Table 10 – Noise Impact Summary

Receptor ID	Sound Level at Receptor Day-time (L_{eq} – dBA)	Assessment Criteria Day-time (L_{eq} - dBA)		Measurable Change (Yes/No)
		Existing Ambient Noise	Performance Limit	
R1	<35	35	45	No

The noise impact on wildlife is discussed in the *Wildlife Assessment Report* (AECOM, 2009).

5.2.5 Summary of Measurable Effects and Mitigation

The predictive noise modelling indicates that the operation of equipment associated with closure activities at the Faro Mine complex are not expected to have a measurable effect on the ambient sound levels at the closest POR. Therefore, no measures are proposed to mitigate any human health related noise issues.

An assessment of noise effects on wildlife are described in the *Wildlife Assessment Report* (AECOM, 2009).

6.0 CONCLUSIONS

Nuisance noise from the Faro Mine Complex closure activities will not be noticeable at the closest human POR. The predictive modelling indicated that the worst-case daytime sound levels associated with the Project would not be discernible from background at the closest residential receptor locations. No adverse residual human health effects are anticipated.

An assessment of terrestrial noise impacts was not completed as part of this evaluation. This assessment is presented in the *Wildlife Assessment Report* (AECOM, 2009).

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APPENDIX A

LIST OF ACRONYMS AND UNITS

LIST OF ACRONYMS AND UNITS

Acronym	Descriptive Term
dB	decibels
dBA	"A-weighted measurement scale" used to duplicate the human response to the audible frequency range of noise
EA	Environmental Assessment
Leq	The energy equivalent continuous sound level
LAeq	The A-Weighted energy equivalent continuous sound level
POR	Point of reception (residence)
PWL	Sound power level
SPL	Sound pressure level
WHO	World Health Organization
YESAA	Yukon Environmental and Socio-economic Assessment Act

APPENDIX B

PROJECT DESCRIPTION, EQUIPMENT AND ACTIVITY MATRIX

Table B-1 – Equipment and Activity Matrix

		Year -3				Year -2				Year -1				Year 1				Year 2			
		Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Faro																					
Water Treatment	101.1																				
Safety Berm	101.2																				
Construct East Interceptor	102.1													14	**14**	14	14				
Extension across west of Faro Valley	102.2													18	**18**	18	18				
Upgrade North Wall Interceptor	102.3																		10		
Water Management	103.1																				
Consolidate oxide fines	104.1														**8**	8					
Medium-Grade Stockpile	104.2														**21**	21					
Low Grade Stockpile "A"	104.3														**21**	21					
Low Grade Stockpile "C"	104.4														**22**	22					
Haul Tailings to Rose Creek Tailings Deposit	105.1									11											
Groundwater Collection System (to Plant)	105.2									17											
Reslope Waste Rock	106.1															10	10	10	10	10	
Sulphide Cell	106.2																10	10	10	10	10
Waste Rock Cover	106.3																		10	10	10
Steep Runoff Channels	106.4																		10	10	10
Revegetate	106.5																		2	2	2
Upgrade North Fork Rose Creek	107.1																				
Outwash material	107.2																		7		
North Fork Rose Creek Detention Pond	107.3																				
North Fork Rose Creek Collection System (to Plant)	107.4																				
S-Cluster Collection System (to Plant)	107.5		21	21																	
Allowance: Guardhouse Creek Groundwater Collection System	107.6																				
Roads	108.1																				
Buildings	108.2																				
Contaminated soils	108.3																				
Landfarm	108.4																				
Borrow Sources	108.5															13					
Faro Area Totals		0	21	21	0	0	0	0	0	28	0	0	0	33	**105**	127	53	20	59	42	32
Tailings Area																					
Cross Valley Dam	201.1																				
Intermediate Dam Raise	201.2																				
Intermediate Dam Spillway	201.3																				
Secondary Dam	201.4																				
Intermediate Tailings	202.1																				
Secondary & Original Impoundment Tailings	202.2																				
Upgrade upstream portion to PMF (670m3/s)	203.1																				
Erosion Dissipation Structure	203.2																				
North Fork Rock Drain	203.3																				
Fuse Plug	203.4																				
Fish By-Pass	203.5																				
Allowance: Reconstruction of Rose Creek	203.6																				
Cross-Valley Dam Cut-off Wall	204.1																				
Cross-Valley Dam Interception Trench	204.2																				
Collect groundwater at interception trench	204.3																				
Seepage Collection System above Intermediate Dam	204.4																				
Reclaim unnecessary roads	205.1																				
Tailings Area Totals		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

		Year 3				Year 4				Year 5				Year 6				Year 7			
		Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Faro																					
Water Treatment	101.1																				
Safety Berm	101.2																				
Construct East Interceptor	102.1																				
Extension across west of Faro Valley	102.2																				
Upgrade North Wall Interceptor	102.3																				
Water Management	103.1																				
Consolidate oxide fines	104.1																				
Medium-Grade Stockpile	104.2																				
Low Grade Stockpile "A"	104.3																				
Low Grade Stockpile "C"	104.4																				
Haul Tailings to Rose Creek Tailings Deposit	105.1																				
Groundwater Collection System (to Plant)	105.2																				
Reslope Waste Rock	106.1																				
Sulphide Cell	106.2																				
Waste Rock Cover	106.3	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10		
Steep Runoff Channels	106.4	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10		
Revegetate	106.5	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2		
Upgrade North Fork Rose Creek	107.1																			14	
Outwash material	107.2																				
North Fork Rose Creek Detention Pond	107.3																			10	
North Fork Rose Creek Collection System (to Plant)	107.4																				
S-Cluster Collection System (to Plant)	107.5																				
Allowance: Guardhouse Creek Groundwater Collection System	107.6																				
Roads	108.1																				
Buildings	108.2																				
Contaminated soils	108.3																				
Landfarm	108.4																				
Borrow Sources	108.5																				
Faro Area Totals		22	22	22	22	22	22	22	22	22	22	22	22	22	22	22	22	22	22	24	0
Tailings Area																					
Cross Valley Dam	201.1										22	22	**22**								
Intermediate Dam Raise	201.2																				
Intermediate Dam Spillway	201.3														16	16	16	16			
Secondary Dam	201.4											9.8									
Intermediate Tailings	202.1										19	19	**19**							19	19
Secondary & Original Impoundment Tailings	202.2																				
Upgrade upstream portion to PMF (670m3/s)	203.1												**21**	21	21	21					
Erosion Dissipation Structure	203.2																10				
North Fork Rock Drain	203.3																		19	19	
Fuse Plug	203.4															12					
Fish By-Pass	203.5																				
Allowance: Reconstruction of Rose Creek	203.6												**3**								
Cross-Valley Dam Cut-off Wall	204.1																				
Cross-Valley Dam Interception Trench	204.2																				
Collect groundwater at interception trench	204.3																				
Seepage Collection System above Intermediate Dam	204.4																				
Reclaim unnecessary roads	205.1																				
Tailings Area Totals		0	0	0	0	0	0	0	0	0	41	51	**65**	21	37	49	26	16	19	38	19

		Year 8				Year 9				Year 10				Year 11				Year 12			
		Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Faro																					
Water Treatment	101.1					14	14	14	14												
Safety Berm	101.2																14				
Construct East Interceptor	102.1																				
Extension across west of Faro Valley	102.2																				
Upgrade North Wall Interceptor	102.3																				
Water Management	103.1									15											
Consolidate oxide fines	104.1																				
Medium-Grade Stockpile	104.2																				
Low Grade Stockpile "A"	104.3																				
Low Grade Stockpile "C"	104.4																				
Haul Tailings to Rose Creek Tailings Deposit	105.1																				
Groundwater Collection System (to Plant)	105.2																				
Reslope Waste Rock	106.1																				
Sulphide Cell	106.2																				
Waste Rock Cover	106.3																				
Steep Runoff Channels	106.4																				
Revegetate	106.5																				
Upgrade North Fork Rose Creek	107.1																				
Outwash material	107.2																				
North Fork Rose Creek Detention Pond	107.3																				
North Fork Rose Creek Collection System (to Plant)	107.4																		16		
S-Cluster Collection System (to Plant)	107.5																				
Allowance: Guardhouse Creek Groundwater Collection System	107.6																		18		
Roads	108.1									7	7	7	7	7	7	7					
Buildings	108.2									3.8	3.8	3.8	3.8	3.8	3.8	3.8					
Contaminated soils	108.3																7				
Landfarm	108.4																7				
Borrow Sources	108.5																				
Faro Area Totals		0	0	0	0	14	14	14	14	25	11	11	11	11	11	11	28	0	33	0	0
Tailings Area																					
Cross Valley Dam	201.1											22									
Intermediate Dam Raise	201.2												13	13							
Intermediate Dam Spillway	201.3																				
Secondary Dam	201.4																				
Intermediate Tailings	202.1	19	19	19	19	19	19	19													
Secondary & Original Impoundment Tailings	202.2	19	19	19	19	19	19	19	19												
Upgrade upstream portion to PMF (670m3/s)	203.1																				
Erosion Dissipation Structure	203.2																				
North Fork Rock Drain	203.3																				
Fuse Plug	203.4																				
Fish By-Pass	203.5																	3			
Allowance: Reconstruction of Rose Creek	203.6																				
Cross-Valley Dam Cut-off Wall	204.1												9	9	9	9	9	9	9	9	
Cross-Valley Dam Interception Trench	204.2												11	11	11	11	11	11	11	11	
Collect groundwater at interception trench	204.3												16	16	16	16	16	16	16	16	
Seepage Collection System above Intermediate Dam	204.4												14	14	14	14	14	14	14	14	
Reclaim unnecessary roads	205.1																				
Tailings Area Totals		38	38	38	38	38	38	38	19	0	0	22	62	62	49	49	49	52	49	49	0

		Year -3				Year -2				Year -1				Year 1				Year 2			
		Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Grum/Vangorda																					
Water Treatment	301.1																				
Safety Berm	301.2																				
Vangorda Pit Waste Rock Piles	301.3																				
Reslope Dump	302.1																				
Waste Rock Cover	302.2																				
Rock Drains	302.3																				
Sediment Control Ditches	302.4																				
Revegetate	302.5																				
Relocate North of Pit	303.1					13	13														
Plunge Pool	303.2					13	13														
Diversion to Dixon Creek	303.3													4							
Water Management	304.1																				
Safety Berm	304.2																				
Route into Grum Pit	305.1																				
Algae Filter	305.2																				
Route out of Pit via slot cut	305.3																				
Reslope Dump	306.1																				
Sulphide Cell	306.2								10												
Waste Rock Cover	306.3																				
Steep Runoff channels	306.4																				
Sediment Basins	306.5																				
Revegetate	306.6																				
Reslope Dump	307.1																				
Revegetate	307.2																				
Relocate to Grum Sulphide Cell	308.1							9													
Reslope Pad for drainage	308.2							1													
Waste Rock Cover	308.3							8													
Sediment Control Ditches	308.4							4													
Revegetate	308.5							2													
Grum Dump Groundwater Collection to Holding Pond	309.1																				
Grum Dump Groundwater Holding Pond	309.2																				
Grum Dump: Groundwater Collection from Holding Pond to Vangorda Pit	309.3																				
Vangorda WR Dump Seepage Collection to Pit	309.4																				
Allowance: Grum Dump Cut-off Wall	309.5																				
Remove Culverts	310.1																				
Reclaim Haul Road	310.2																				
Haul Spur Road to Tailings Area	310.3																				
Buildings	311.1																				
Sludge Pond	311.2																				
Existing Bioremediation Cell	311.3																				
Dams	311.4																				
WTP Settling Pond	311.5													4							
Contaminated soils	311.6																				
Bioremediation Cell	311.7																				
Roads	311.8																				
Borrow Sources	311.9													13							
Care and Maintenance	311.10													7	7	7	7	7	7	7	7
Grum Vangorda Totals		0	0	0	0	26	26	24	10	0	0	0	0	28	7	7	7	7	7	7	7
Total of All Equipment		0	21	21	0	26	26	24	10	28	0	0	0	60	112	134	60	27	66	49	39

		Year 3				Year 4				Year 5				Year 6				Year 7			
		Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Grum/Vangorda																					
Water Treatment	301.1																				
Safety Berm	301.2																				
Vangorda Pit Waste Rock Piles	301.3						10	10	10												
Reslope Dump	302.1						1	1	1												
Waste Rock Cover	302.2							10	10												
Rock Drains	302.3							11	11												
Sediment Control Ditches	302.4							4	4												
Revegetate	302.5							2	2												
Relocate North of Pit	303.1																				
Plunge Pool	303.2																				
Diversion to Dixon Creek	303.3																		4		
Water Management	304.1																				
Safety Berm	304.2																				
Route into Grum Pit	305.1																	16			
Algae Filter	305.2																	9			
Route out of Pit via slot cut	305.3																	15			
Reslope Dump	306.1	11	11	11	11																
Sulphide Cell	306.2																				
Waste Rock Cover	306.3			10	10	10	10														
Steep Runoff channels	306.4			12	12	12	12														
Sediment Basins	306.5			12	12	12	12														
Revegetate	306.6			2	2	2	2														
Reslope Dump	307.1																				
Revegetate	307.2																				
Relocate to Grum Sulphide Cell	308.1																				
Reslope Pad for drainage	308.2																				
Waste Rock Cover	308.3																				
Sediment Control Ditches	308.4																				
Revegetate	308.5																				
Grum Dump Groundwater Collection to Holding Pond	309.1																				
Grum Dump Groundwater Holding Pond	309.2																				
Grum Dump: Groundwater Collection from Holding Pond to Vangorda Pit	309.3																				
Vangorda WR Dump Seepage Collection to Pit	309.4																				
Allowance: Grum Dump Cut-off Wall	309.5																				
Remove Culverts	310.1																				
Reclaim Haul Road	310.2																				
Haul Spur Road to Tailings Area	310.3																	4.8			
Buildings	311.1																				
Sludge Pond	311.2																				
Existing Bioremediation Cell	311.3																				
Dams	311.4																				
WTP Settling Pond	311.5																				
Contaminated soils	311.6																7				
Bioremediation Cell	311.7																3				
Roads	311.8																				
Borrow Sources	311.9																				
Care and Maintenance	311.10	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7
Grum Vangorda Totals		18	18	54	54	43	54	45	45	7	7	7	7	7	7	7	17	52	11	7	7
Total of All Equipment		40	40	76	76	65	76	67	67	29	70	80	94	50	66	78	65	90	52	69	26

		Year 8				Year 9				Year 10				Year 11				Year 12			
		Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Grum/Vangorda																					
Water Treatment	301.1									12	12	12	12								
Safety Berm	301.2																	16			
Vangorda Pit Waste Rock Piles	301.3																				
Reslope Dump	302.1																				
Waste Rock Cover	302.2																				
Rock Drains	302.3																				
Sediment Control Ditches	302.4																				
Revegetate	302.5																				
Relocate North of Pit	303.1																				
Plunge Pool	303.2																				
Diversion to Dixon Creek	303.3																				
Water Management	304.1																				
Safety Berm	304.2																	12			
Route into Grum Pit	305.1																				
Algae Filter	305.2																				
Route out of Pit via slot cut	305.3																				
Reslope Dump	306.1																				
Sulphide Cell	306.2																				
Waste Rock Cover	306.3																				
Steep Runoff channels	306.4																				
Sediment Basins	306.5																				
Revegetate	306.6																				
Reslope Dump	307.1								1												
Revegetate	307.2								2												
Relocate to Grum Sulphide Cell	308.1																				
Reslope Pad for drainage	308.2																				
Waste Rock Cover	308.3																				
Sediment Control Ditches	308.4																				
Revegetate	308.5																				
Grum Dump Groundwater Collection to Holding Pond	309.1																		15	15	
Grum Dump Groundwater Holding Pond	309.2																		14	14	
Grum Dump: Groundwater Collection from Holding Pond to Vangorda Pit	309.3																		9.5	9.5	
Vangorda WR Dump Seepage Collection to Pit	309.4																		9.5		
Allowance: Grum Dump Cut-off Wall	309.5																		17	17	
Remove Culverts	310.1										4										
Reclaim Haul Road	310.2										4										
Haul Spur Road to Tailings Area	310.3																				
Buildings	311.1												3.8	3.8							
Sludge Pond	311.2																				
Existing Bioremediation Cell	311.3																				
Dams	311.4																				
WTP Settling Pond	311.5																				
Contaminated soils	311.6																				
Bioremediation Cell	311.7																				
Roads	311.8																			7	
Borrow Sources	311.9																				
Care and Maintenance	311.10	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7
Grum Vangorda Totals		7	7	7	7	7	7	7	10	19	27	19	22	11	7	7	7	36	72	69	7
Total of All Equipment		45	45	45	45	58	58	58	42	44	37	52	95	83	66	66	84	87	153	118	7

APPENDIX C
SUPPORTING CALCULATIONS

C. Introduction

The sound power levels for the sources included in the assessment were derived using information contained in the *Project Description (Phase 2) – Faro Mine Complex* (SRK, 2009), *Equipment Per Activity* spreadsheet (SRK, 2009b) and supplementary information supplied by the Project Team. Sources of sound power level data included standard methods of noise emission calculation and SENES' database of measured sound levels (SENES, 2009).

C.1 SENES Noise Database

The SENES noise database was referenced to obtain sound power level data associated crushing equipment. The database consists of full spectrum noise data from various noise-emitting equipment/processes at various site operations. The measurements were collected with a precision integrating sound level meter, equipped with real time 1/1 and 1/3-octave band analyzers. As many of the entries in the sound level database were collected in Ontario, and used in assessments requiring approval by the Provincial Government, the source-specific spot measurements were carried out in accordance with the Ontario Ministry of the Environment (MOE) Noise Pollution Control Publication 103 (Ontario MOE, undated).

The noise database 1/3 octave band sound pressure level (SPL) data collected were converted into 1/1 octave band sound power levels (PWL), using the following methodology.

C.1.1 Conversion of 1/3 Octave Band SPL to 1/1 Octave Band PWL

The desired frequency range of octave bands for use in the assessment is 31.5 Hz, 63 Hz, 125 Hz, 250 Hz, 500 Hz, 1000 Hz, 2000 Hz, 4000 Hz, and 8000 Hz. In order to convert the measured 1/3 octave band SPL data to the above 1/1 octave band, the frequencies above are considered 'centre frequencies' on the 1/3 scale, and the corresponding sound levels are added logarithmically to the sound levels at the frequencies on either side, according to the following equation:

$$L_P = 10\log\left[10^{\frac{L_{P1}}{10}} + 10^{\frac{L_{P2}}{10}} + \ldots + 10^{\frac{L_N}{10}}\right] \qquad [1]$$

For example (sample only):

1/3 Octave Band Data:

SPL @ 25 Hz = 72.9 dB
SPL @ 31.5 Hz = 85.9 dB
SPL @ 40 Hz = 77.4 dB

1/3 Octave Band to 1/1 Octave Band Calculation:

$$\text{SPL @ 31.5 Hz} = 10 * \log\left[10^{\frac{72.9}{10}} + 10^{\frac{85.9}{10}} + 10^{\frac{77.4}{10}}\right] = 86.7 \text{ dB}$$

Conversion of SPL to PWL:

Upon conversion to 1/1 octave band, the SPL data was used to calculate the sound power levels using the following equation for point sources from the (ASHRAE 1997):

$$PWL = SPL - 10\log\left[\frac{Q}{4\pi r^2}\right] - 10.5 \qquad [2]$$

where:

Q = directivity coefficient:
Q = 1 – Spherical radiation;
Q = 2 – Hemispherical radiation;
Q = 4 – Quarter-spherical radiation; or
Q = 8 – One-eighth spherical radiation.

r = distance at which measurement was taken (ft)

Hemispherical radiation was assumed for all sources operating at ground level. After the PWL was calculated for all frequencies, the overall power level in dBA was determined using the logarithmic addition Equation [1].

C.2 Calculated Noise Data

Sound levels for much of the on-site equipment were derived from published equations (Beranek and Ver, 2006). The sources for which sound levels were derived using these equations are noted in Table C.3-1 and its footnotes. The details of these calculations including all assumptions are outlined in the following sections.

C.2.1 Diesel-Powered Equipment

Sound power levels from all diesel-powered equipment were derived using the following equation (Beranek and Ver, 2006):

$$\text{Overall PWL (dB)} = 99 + 10\log(kW) \quad [3]$$

where:

kW = rated power of the diesel engine in *kilowatts*

The maximum power rating of each piece of diesel-powered equipment was derived from technical specifications of the equipment that is expected to be in use during the site preparation and construction phases of the Project. Equation [3] results in overall sound power levels in dB. The reference provides correction factors to be subtracted from this overall sound power level for each frequency in the 1/1 octave band in order to calculate full spectrum sound power levels for use in modelling. A further correction factor was applied to each frequency in the 1/1 octave band in order to convert the calculated sound levels from dB to dBA. The correction factors are summarized in Table C.2-1.

Table C.2-1 – Octave Band and A-Weighted Correction Factors for Diesel-Powered Equipment

	Octave Band Centre Frequency (Hz)								
	31.5	**63**	**125**	**250**	**500**	**1000**	**2000**	**4000**	**8000**
Octave Band Correction	-	-11	-6	-3	-8	-10	-13	-19	-25
A-weighting Correction	-	-26.2	-16.1	-8.6	-3.2	0	1.2	1	-1.1

Equation [3] assumes that the equipment is operating at the rated power, while the construction equipment is more likely to operate at partial power. Reduction factors ranging between 5 dB and 7 dB have been applied to the various types of equipment in order to simulate more ‘typical’ operations (Beranek, 2006). Reduction factors were applied as appropriate, depending on the equipment type.

The equipment power ratings used in the calculating the sound power levels from diesel equipment are provided in Table C.2-2.

Table C.2-2 – Rated Power of Diesel-Powered Equipment

Diesel Equipment Make/Model	Diesel Equipment Description	Power Rating (kW)	Power Rating (hp)
CAT 777	Off-Highway Hauler	355	476
CAT D350	Articulated Truck	190	255
Peterbilt 367	Truck	447	600
Peterbilt 340	Truck	246	330
Peterbilt 335	Truck	246	330
Peterbilt 335	Truck w Aerial Platform	246	330
CAT 350	Hydraulic Excavator	213	286
CAT 330CL	Hydraulic Excavator	166	222
CAT 446B	Backhoe Loader	76	102
CAT 992D	Wheel Loader	529	710
CAT 966F	Wheel Loader	175	235
CAT D11	Bulldozer	634	850
CAT D10	Bulldozer	433	580
CAT D8	Bulldozer	231	310
CAT CP563	Roller/Compactor	108	145
Vibrating Roller	Roller	75	100
CAT 14G	Grader	160	215
Atlas Copco ROC D3	Air Rotary	116	156
Atlas Copco ROC L8	Air Track Rig	373	500
Grove RT530E-2	Hydraulic Crane	119	160
CAT 3512B	Diesel Generator	1491	2000

C.2.2 Helicopter

The sound power level of the helicopter was estimated based on technical literature specific (Bell Helicopter, 2003) to the make and model of helicopter planned for use during the Project, as well as the U.S. Federal Aviation Regulations (FAR) Part 36, Appendix J (U.S. Federal Aviation Authority, 2004). According to technical specifications, the Bell 407 helicopter will achieve a ground level sound exposure level of 85.1 dBA. According to FAR Part 36, Appendix J this sound level is established through measurement with the helicopter flying overhead at a height of 492 ft (150 m) ± 50 ft. The sound power level of the source was calculated using Equation [1], assuming a distance of 542 ft and a directivity factor of 1 (full spherical radiation). The distance of 542 ft was used as this results in the most conservative (i.e., highest) sound level for the source (i.e. sound pressure level at furthest distance)

C.2.3 Mud Pump

The sound level for the mud pump was estimated using technical specifications from the manufacturer of the pump projected for use in the project, in conjunction with an estimation technique for pump sound levels. The following equation was used to estimate the sound levels (Miller, 1981):

$$\text{Overall SPL (dB)} = 81 + 3\log(hp) \quad [4]$$

In the above equation the term *SPL* refers to the sound pressure level at a reference distance of 3 ft, and the term *hp* refers to the rated power of the pump motor in *horsepower*. The reference provides correction factors to be subtracted from this overall sound pressure level for each frequency in the 1/1 octave band in order to calculate full spectrum sound pressure levels. The sound levels were then converted to sound power levels using Equation [1], and a correction factor was applied to each frequency in the 1/1 octave band in order to convert the calculated sound power levels from dB to dBA. The correction factors are summarized in Table C.2-3.

Table C.2-3 – Octave Band and A-Weighted Correction Factors for Mud Pump

	Octave Band Centre Frequency (Hz)								
	31.5	**63**	**125**	**250**	**500**	**1000**	**2000**	**4000**	**8000**
Octave Band Correction	-13	-12	-11	-9	-9	-6	-9	-13	-19
A-weighting Correction	-39.4	-26.2	-16.1	-8.6	-3.2	0	1.2	1	-1.1

C.2.4 Automobile Traffic

Motor vehicle noise was assessed as workers arrive at and leave the site. The sound level generated by motor vehicles was estimated using published estimation techniques (Miller, 1981). The following equation was used to estimate the sound pressure level:

$$\text{Peak Pass-By Sound Pressure Level (dBA)} = 38.1*\log(S) + 5.5 \quad [5]$$

The above equation results in a peak sound pressure level at a reference distance of 50 ft. In the above equation, the term *S* refers to the vehicle speed in *miles per hour (mph)*. For the purposes of this assessment, the speed of the vehicles was set to 31 mph (50 km/hr). The reference document provides correction factors to be subtracted from this overall sound pressure level for each frequency in the 1/1 octave band in order to calculate full spectrum sound pressure levels. The sound levels were then converted to sound power levels using Equation [1]. The correction factors are summarized in Table C.2-4.

Table C.2-3 – Octave Band Correction Factors for Automobile Traffic

	Octave Band Centre Frequency (Hz)								
	31.5	**63**	**125**	**250**	**500**	**1000**	**2000**	**4000**	**8000**
Octave Band Correction	-11	-7	-6	-9	-10	-10	-15	-24	-31

C.3 Summary of Sound Power Level Data

Table C.3-1 summarizes the final sound power level data used for each source in the noise modelling.

Table C.3-1 – Sound Power Level Summary Table

Equipment Make/Model	Equipment Description	Sound Power Level, dBA									Overall dBA
		31.5 Hz	63 Hz	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz	8000 Hz	
CAT 777[1]	Off-Highway Hauler	-	87.3	102.4	112.9	113.3	114.5	112.7	106.5	98.4	119.8
CAT D350[1]	Articulated Truck	-	84.6	99.7	110.2	110.6	111.8	110.0	103.8	95.7	117.0
Peterbilt 367[1]	Truck	-	88.3	103.4	113.9	114.3	115.5	113.7	107.5	99.4	120.8
Peterbilt 340[1]	Truck	-	85.7	100.8	111.3	111.7	112.9	111.1	104.9	96.8	118.2
Peterbilt 335[1]	Truck	-	85.7	100.8	111.3	111.7	112.9	111.1	104.9	96.8	118.2
Peterbilt 335[1]	Truck w Aerial Platform	-	85.7	100.8	111.3	111.7	112.9	111.1	104.9	96.8	118.2
CAT 350[1]	Hydraulic Excavator	-	85.1	100.2	110.7	111.1	112.3	110.5	104.3	96.2	117.5
CAT 330CL[1]	Hydraulic Excavator	-	84.0	99.1	109.6	110.0	111.2	109.4	103.2	95.1	116.4
CAT 446B[1]	Backhoe Loader	-	80.6	95.7	106.2	106.6	107.8	106.0	99.8	91.7	113.1
CAT 992D[1]	Wheel Loader	-	89.0	104.1	114.6	115.0	116.2	114.4	108.2	100.1	121.5
CAT 966F[1]	Wheel Loader	-	84.2	99.3	109.8	110.2	111.4	109.6	103.4	95.3	116.7
CAT D11[1]	Bulldozer	-	89.8	104.9	115.4	115.8	117.0	115.2	109.0	100.9	122.3
CAT D10[1]	Bulldozer	-	88.2	103.3	113.8	114.2	115.4	113.6	107.4	99.3	120.6
CAT D8[1]	Bulldozer	-	85.4	100.5	111.0	111.4	112.6	110.8	104.6	96.5	117.9
CAT CP563[1]	Roller/Compactor	-	82.1	97.2	107.7	108.1	109.3	107.5	101.3	93.2	114.6
Vibrating Roller[1]	Roller	-	80.5	95.6	106.1	106.5	107.7	105.9	99.7	91.6	113.0
CAT 14G[1]	Grader	-	83.8	98.9	109.4	109.8	111.0	109.2	103.0	94.9	116.3
Atlas Copco ROC D3[1]	Air Rotary	-	82.5	97.6	108.1	108.5	109.7	107.9	101.7	93.6	114.9
Atlas Copco ROC L8[1]	Air Track Rig	-	87.5	102.6	113.1	113.5	114.7	112.9	106.7	98.6	120.0
Grove RT530E-2[1]	Hydraulic Crane	-	82.6	97.7	108.2	108.6	109.8	108.0	101.8	93.7	115.0
CAT 3512B[1]	Diesel Generator	-	93.5	108.6	119.1	119.5	120.7	118.9	112.7	104.6	126.0
Lippman 2248LP[2]	Crusher	75.9	90.2	100.4	102.2	111.7	114.3	114.9	110.8	101.1	119.5
Bell 407[3]	Helicopter	-	-	-	-	-	-	-	-	-	140.3
Triplex F-1600 HL[4]	Mud Pump	45.3	59.5	70.6	80.1	85.5	91.7	89.9	85.7	77.6	95.3
Automobile Traffic[5]	Automobile Traffic	89.8	93.8	94.8	91.8	90.8	90.8	85.8	76.8	69.8	100.3

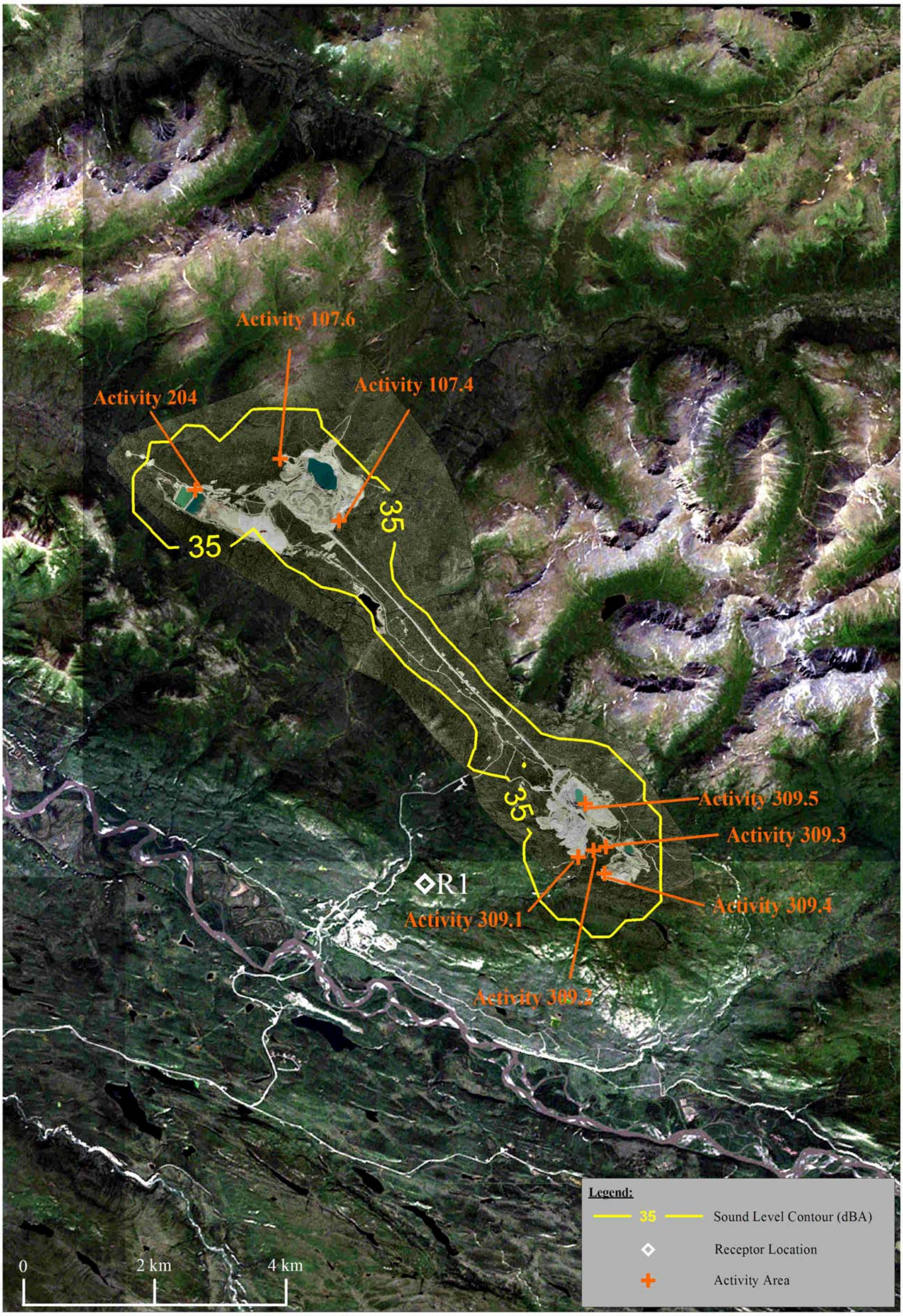
NOTES:
- Not available
1 – Sound level estimated from diesel engine noise equation based on rated power, and adjusted for typical operations per reference (Berenek, 2006; Ch. 16.6)
2 – Sound level from SENES noise database for a similar source
3 – Sound level estimated from manufacturer sound level data and United States Federal Aviation Regulations – Part 36, Appendix J (FAR, 2004)
4 – Sound level estimated from pump noise equation (Miller, 1981; Ch. 7-12)
5 – Sound level estimated from automobile noise equation (Miller, 1981; Ch. 8-1)

APPENDIX D

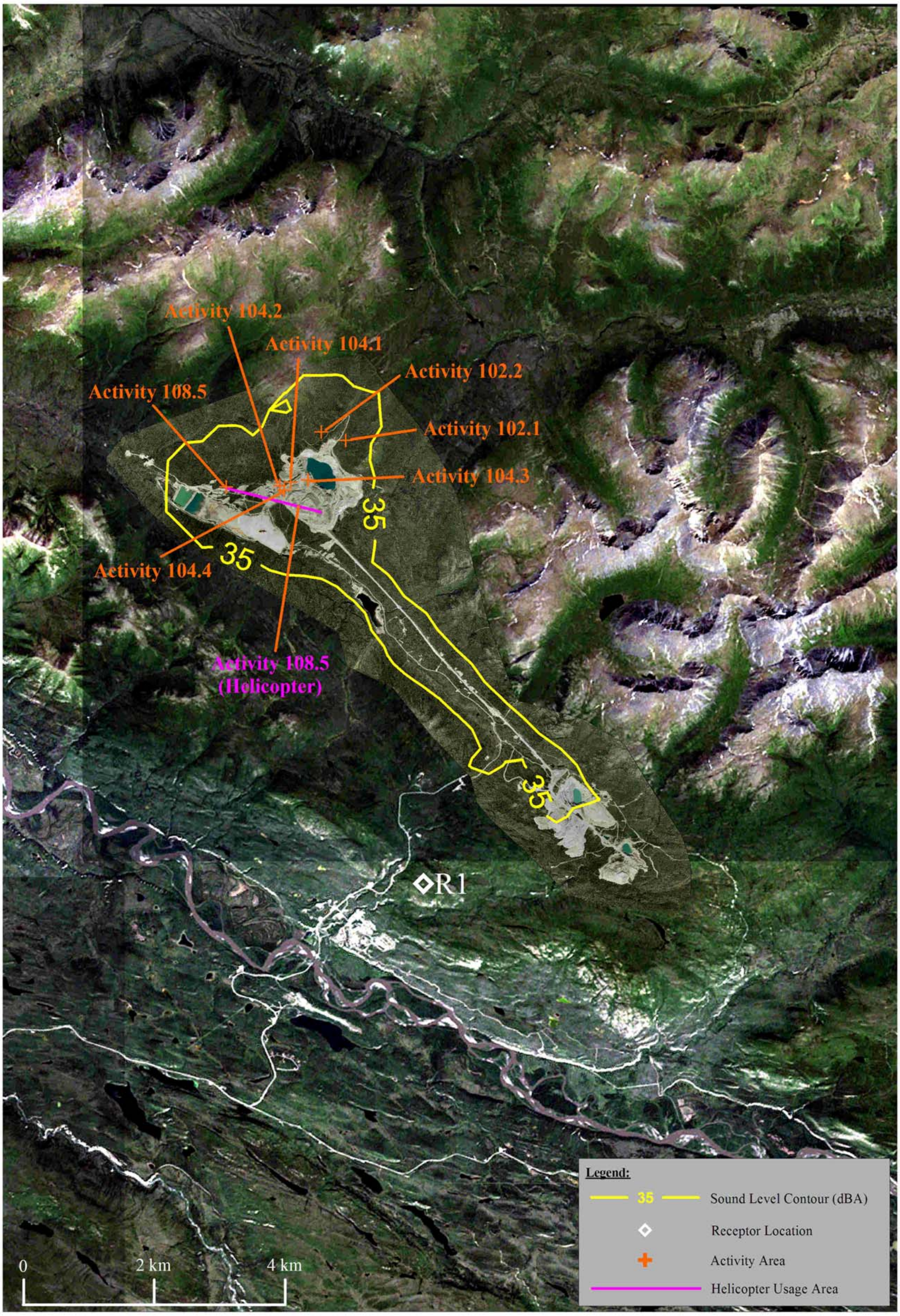
NOISE CONTOUR PLOTS

APPENDIX D.1

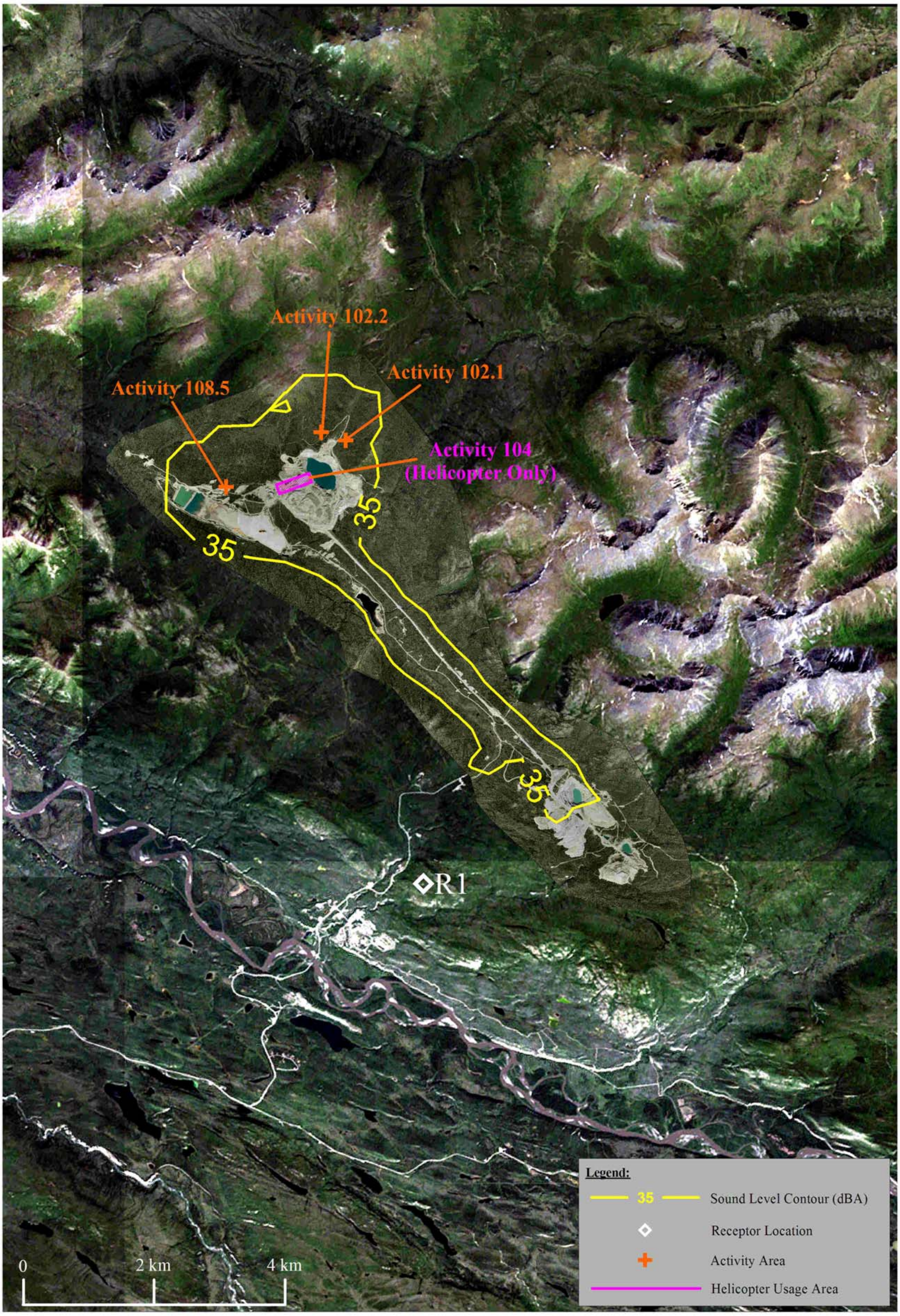
1-HR (35DBA) NOISE CONTOUR PLOTS



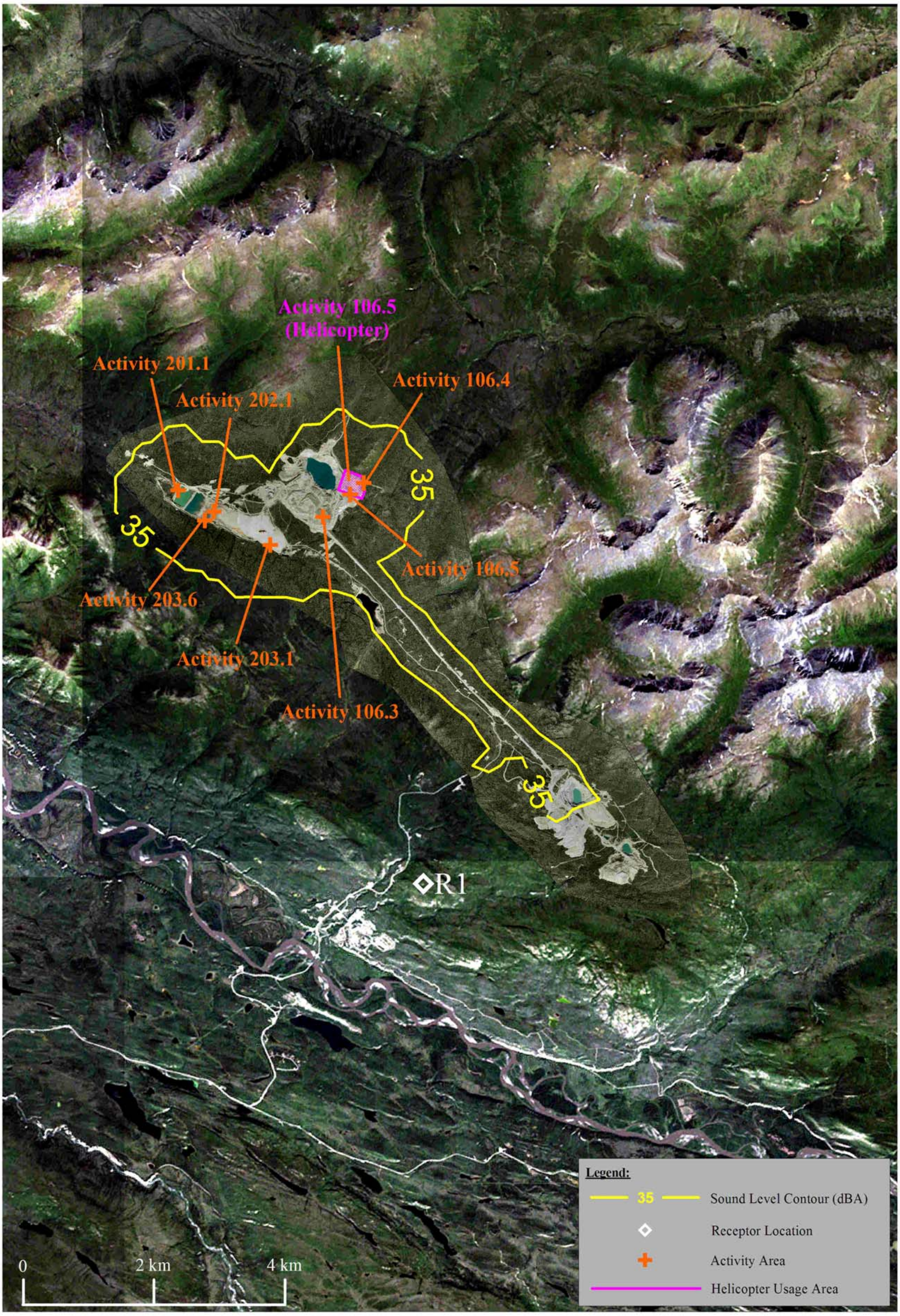
Faro Mine Closure / Fermeture de la mine Faro	Faro Mine Complex Closure and Reclamation	Sound Level Contour Plot - Maximum One-Hour Boundary At Which Noise from Project Activities Meet Background Sound Level of 35 dBA Scenario 1: Year 12, Second Quarter
Job No: 34822 Filename: 34822 - 26Mar09 - Master Plot File.srf	Project Proposal	Date: 26-Mar-09 / Approved: NZS / Figure: D-1



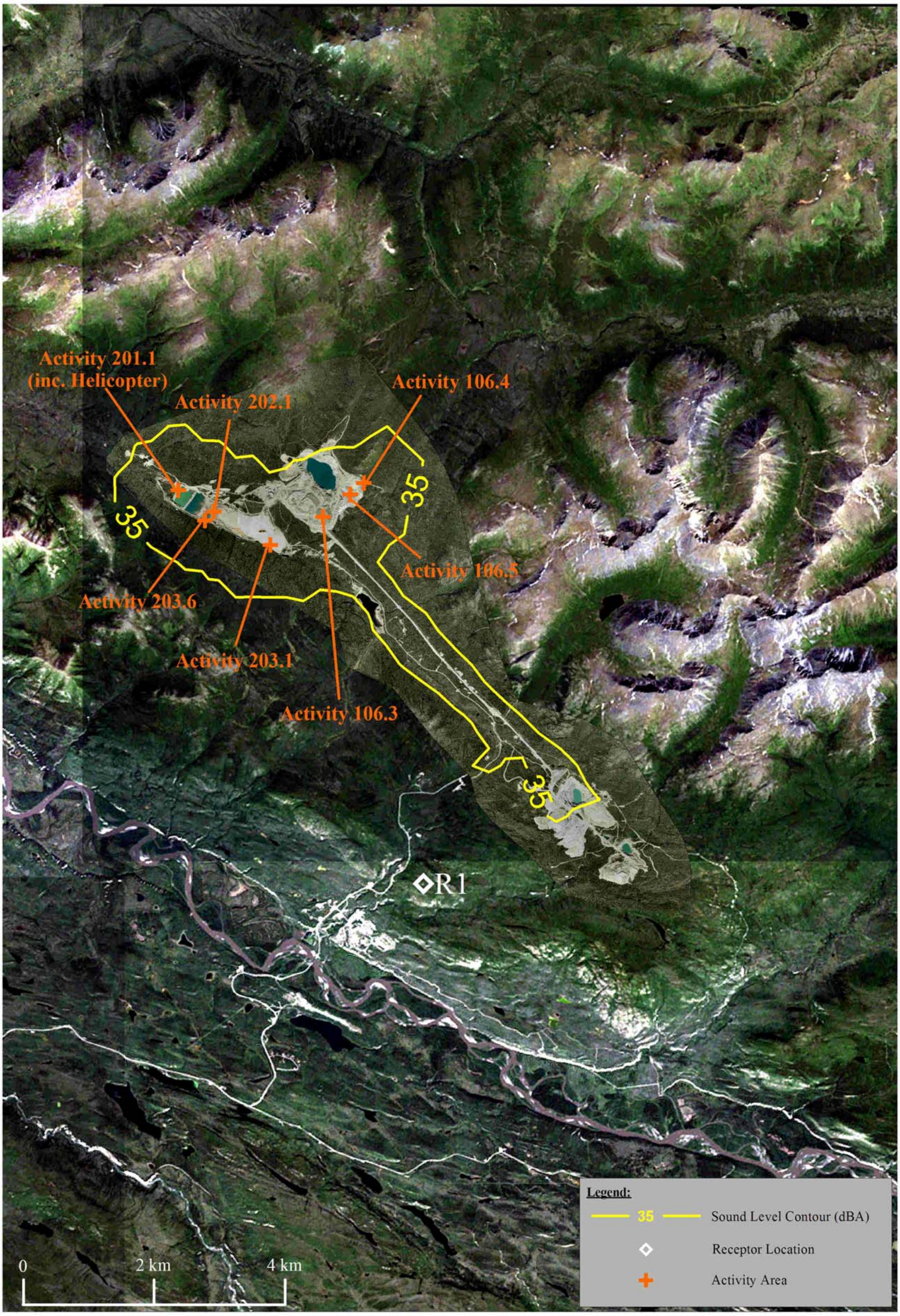
Faro Mine Closure / Fermeture de la mine Faro	Faro Mine Complex Closure and Reclamation	Sound Level Contour Plot - Maximum One-Hour Boundary At Which Noise from Project Activities Meet Background Sound Level of 35 dBA Scenario 2a: Year 1, Third Quarter
Job No: 34822 Filename: 34822 - 26Mar09 - Master Plot File.srf	Project Proposal	Date: 26-Mar-09 / Approved: NZS / Figure: D-2



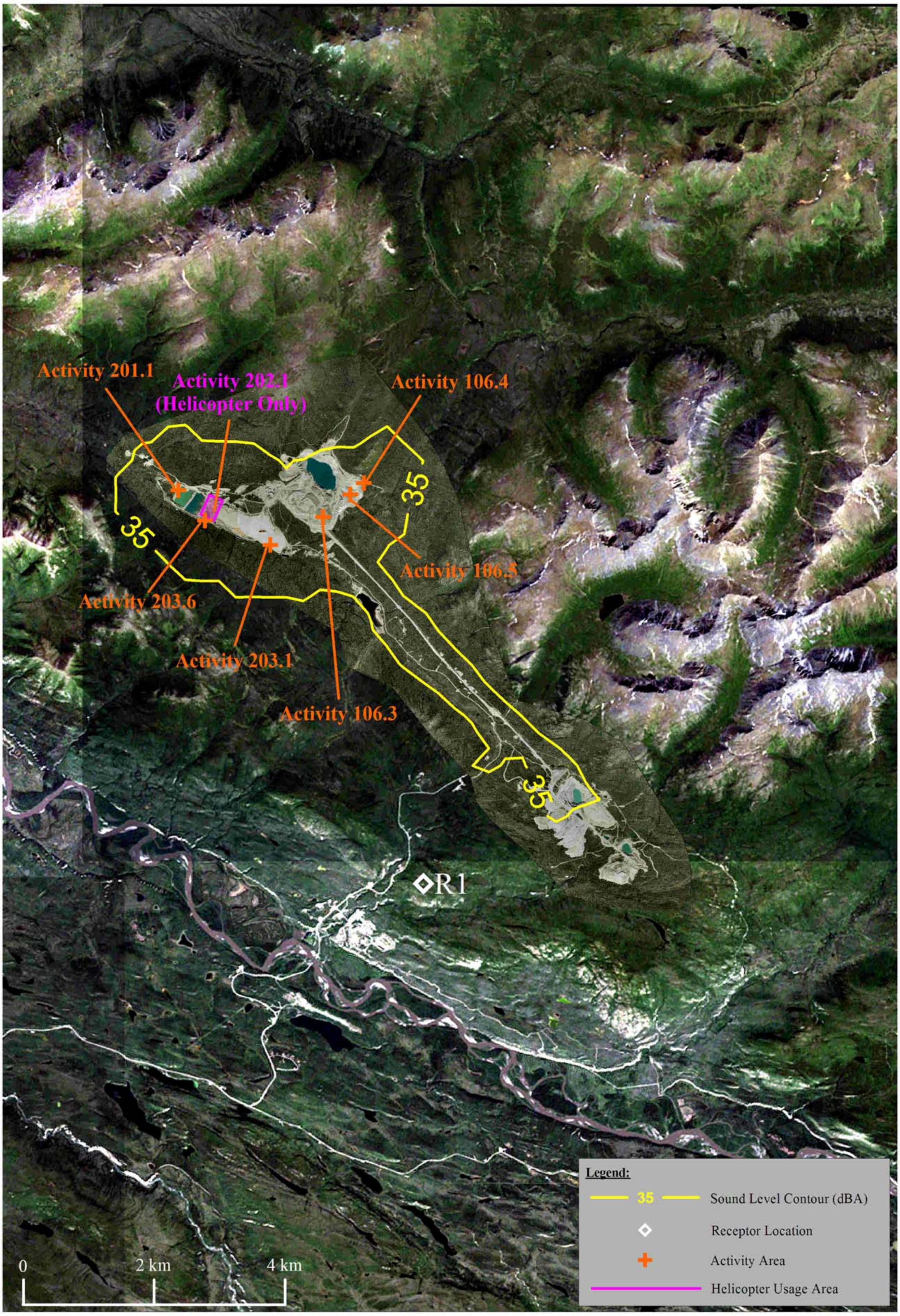
Faro Mine Closure / Fermeture de la mine Faro	Faro Mine Complex Closure and Reclamation	Sound Level Contour Plot - Maximum One-Hour Boundary At Which Noise from Project Activities Meet Background Sound Level of 35 dBA Scenario 2b: Year 1, Third Quarter		
Job No: 34822 Filename: 34822 - 26Mar09 - Master Plot File.srf	Project Proposal	Date: 26-Mar-09	Approved: NZS	Figure: D-3



Faro Mine Closure / Fermeture de la mine Faro	Faro Mine Complex Closure and Reclamation	Sound Level Contour Plot - Maximum One-Hour Boundary At Which Noise from Project Activities Meet Background Sound Level of 35 dBA Scenario 3a: Year 5, Fourth Quarter
Job No: 34822 Filename: 34822 - 26Mar09 - Master Plot File.srf	Project Proposal	Date: 26-Mar-09 / Approved: NZS / Figure: D-4



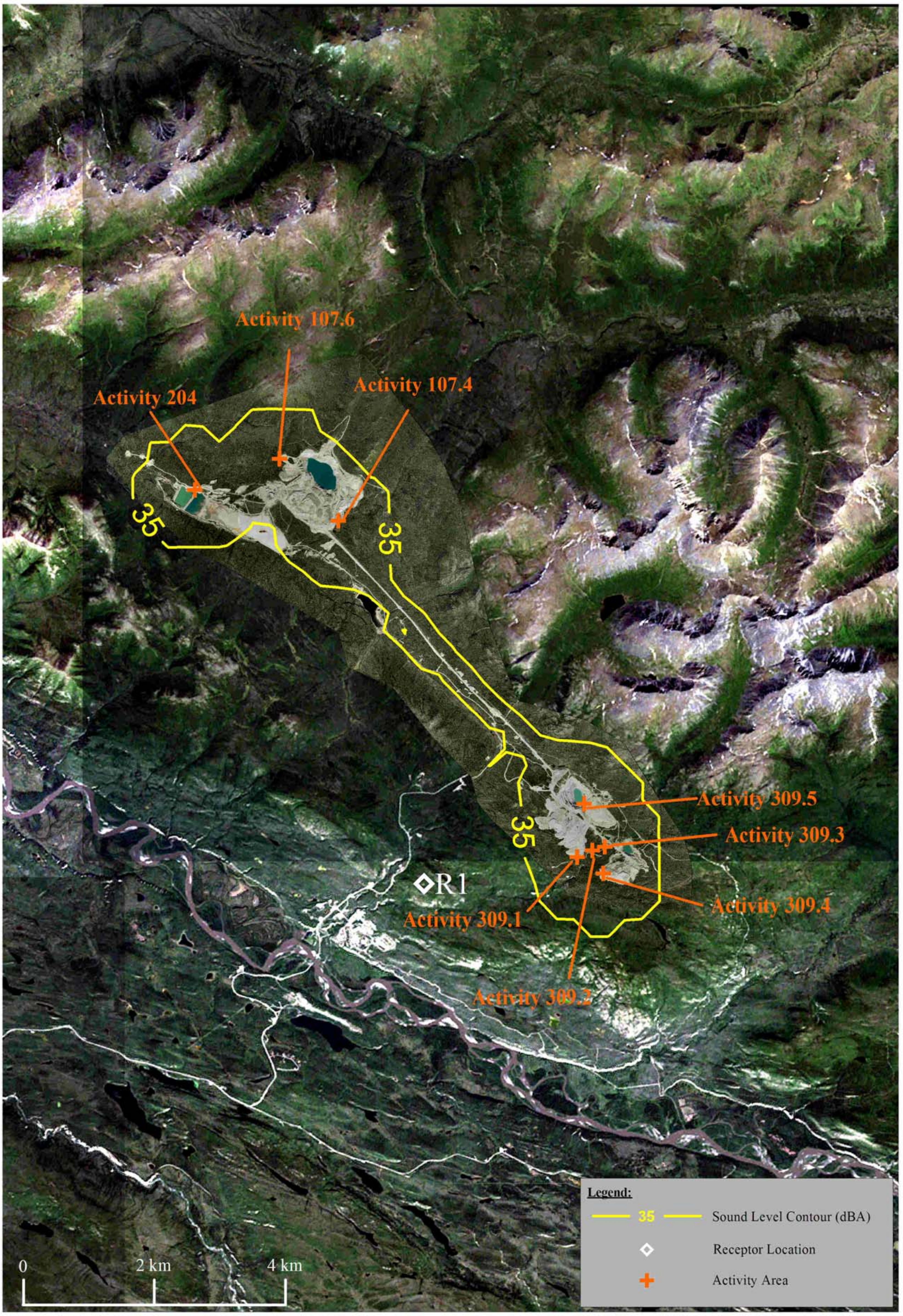
Faro Mine Closure / Fermeture de la mine Faro	Faro Mine Complex Closure and Reclamation	Sound Level Contour Plot - Maximum One-Hour Boundary At Which Noise from Project Activities Meet Background Sound Level of 35 dBA Scenario 3b: Year 5, Fourth Quarter		
Job No: 34822 Filename: 34822 - 26Mar09 - Master Plot File.srf	Project Proposal	Date: 26-Mar-09	Approved: NZS	Figure: D-5



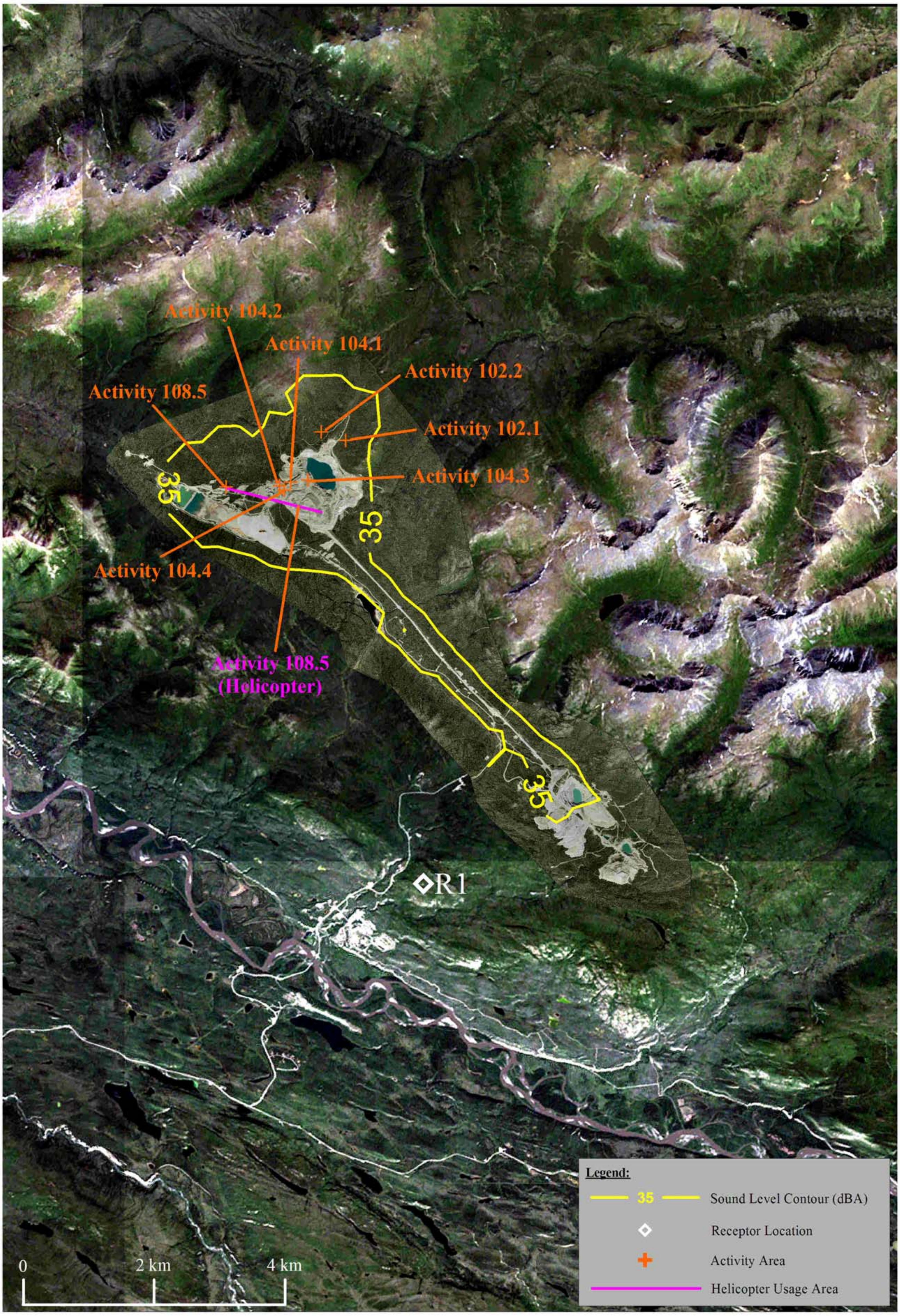
Faro Mine Closure / Fermeture de la mine Faro	Faro Mine Complex Closure and Reclamation	Sound Level Contour Plot - Maximum One-Hour Boundary At Which Noise from Project Activities Meet Background Sound Level of 35 dBA Scenario 3c: Year 5, Fourth Quarter		
Job No: 34822 Filename: 34822 - 26Mar09 - Master Plot File.srf	Project Proposal	Date: 26-Mar-09	Approved: NZS	Figure: D-6

APPENDIX D.2

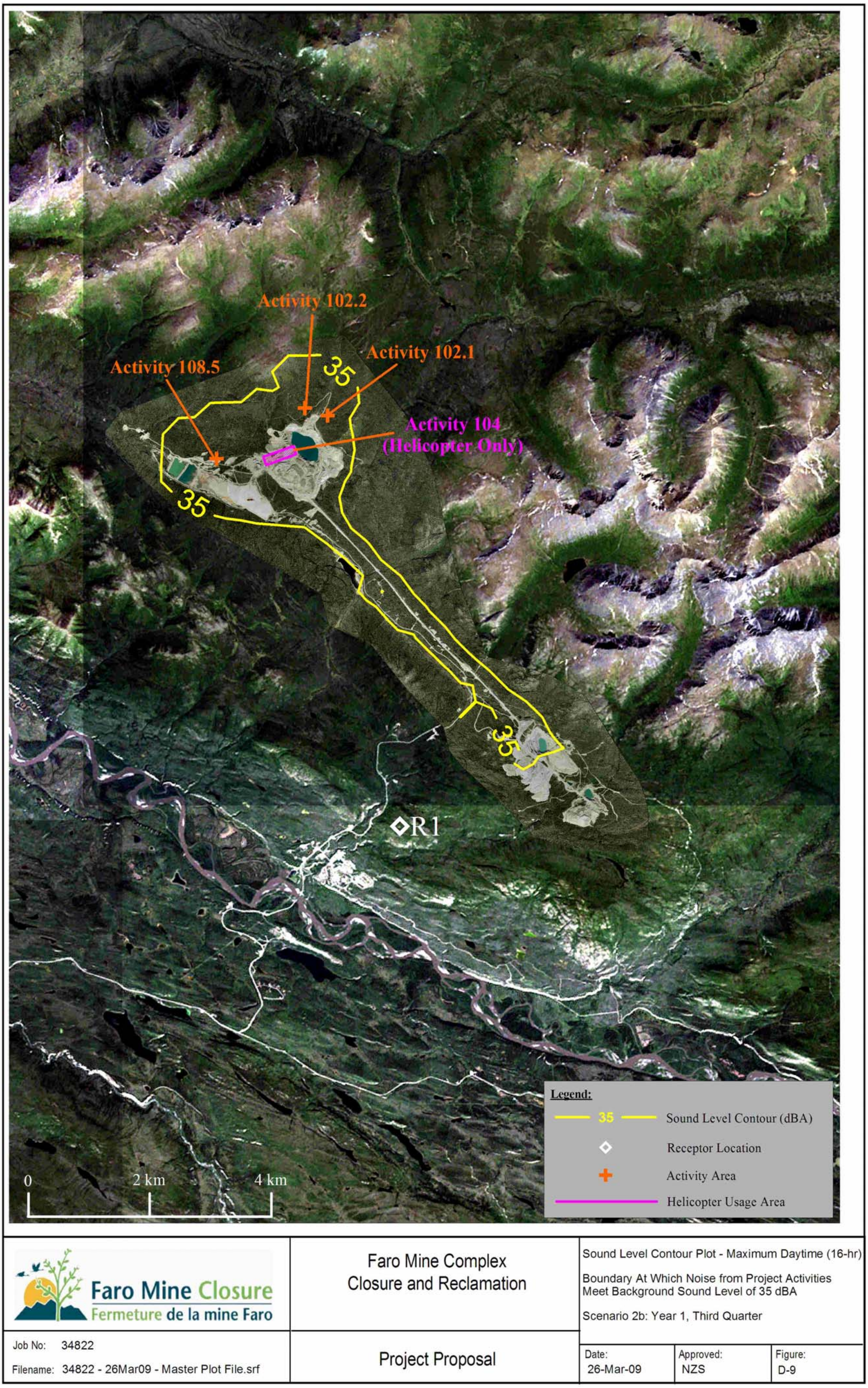
16-HR (35DBA) NOISE CONTOUR PLOTS

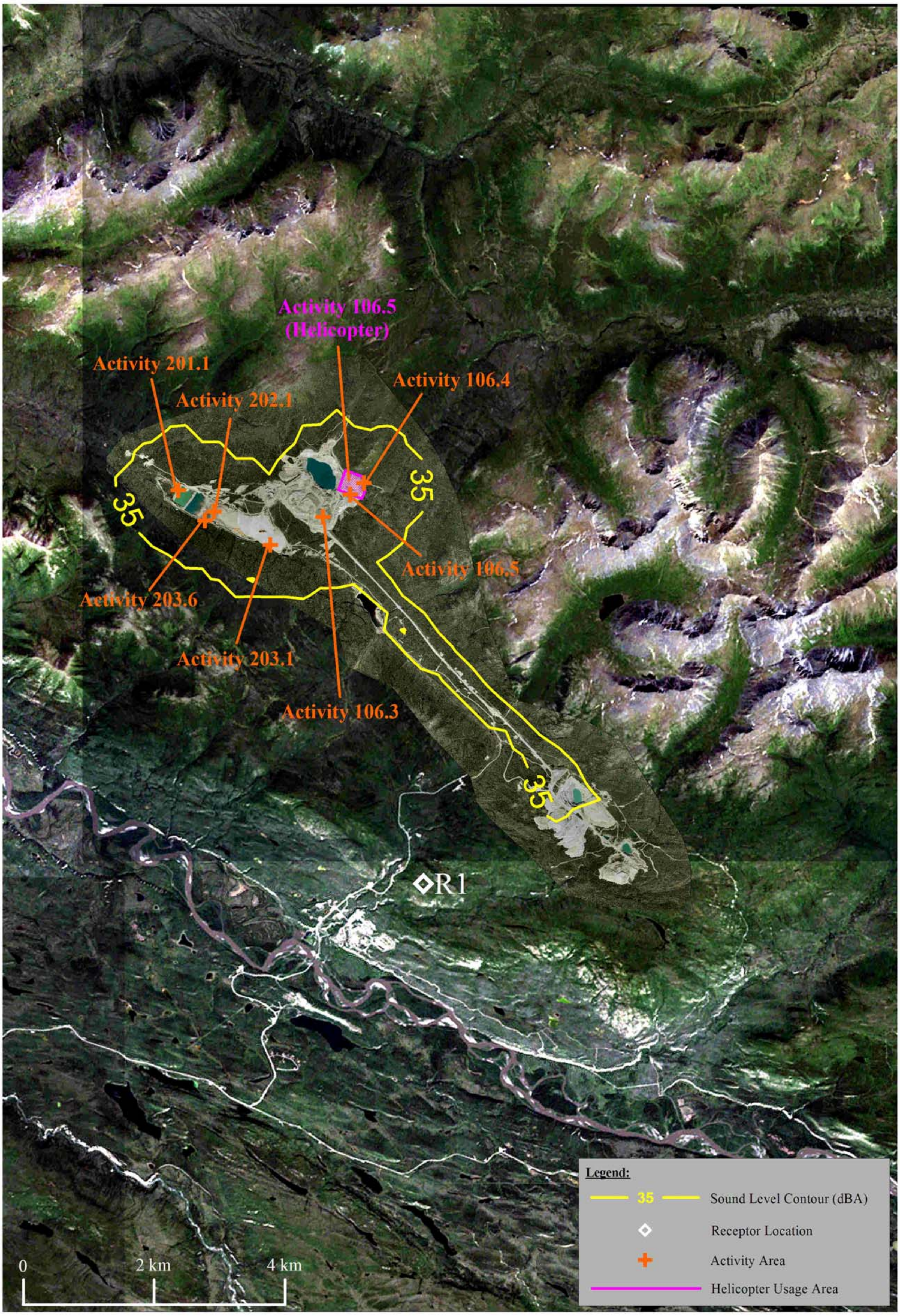


Faro Mine Closure / Fermeture de la mine Faro	Faro Mine Complex Closure and Reclamation	Sound Level Contour Plot - Maximum Daytime (16-hr) Boundary At Which Noise from Project Activities Meet Background Sound Level of 35 dBA Scenario 1: Year 12, Second Quarter		
Job No: 34822 Filename: 34822 - 26Mar09 - Master Plot File.srf	Project Proposal	Date: 26-Mar-09	Approved: NZS	Figure: D-7

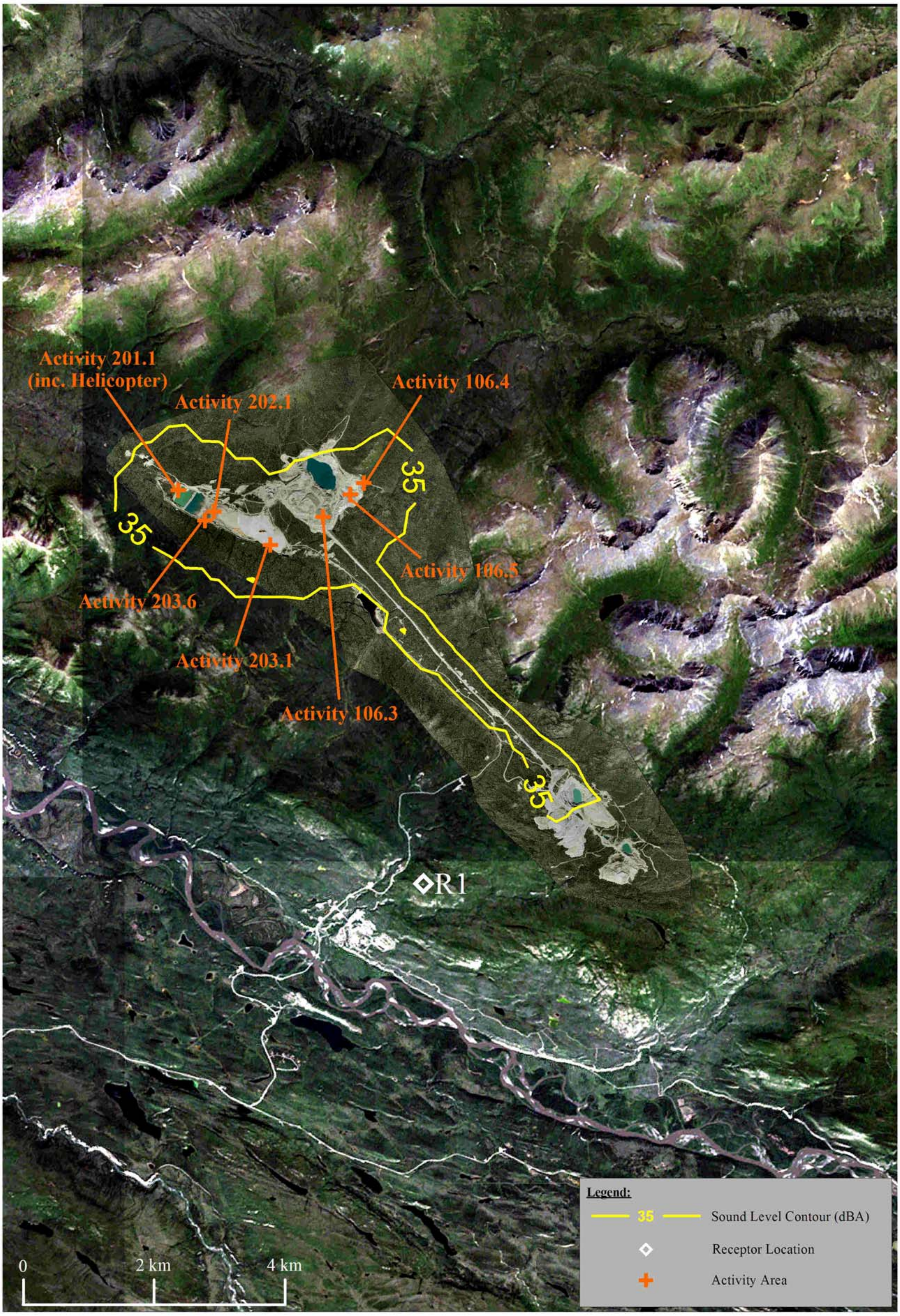


Faro Mine Closure / Fermeture de la mine Faro	Faro Mine Complex Closure and Reclamation	Sound Level Contour Plot - Maximum Daytime (16-hr) Boundary At Which Noise from Project Activities Meet Background Sound Level of 35 dBA Scenario 2a: Year 1, Third Quarter
Job No: 34822 Filename: 34822 - 26Mar09 - Master Plot File.srf	Project Proposal	Date: 26-Mar-09 / Approved: NZS / Figure: D-8


Activity 102.2
Activity 102.1
Activity 108.5
Activity 104
(Helicopter Only)
35
35
35
35
R1
0
2 km
4 km
Legend:
35 Sound Level Contour (dBA)
Receptor Location
Activity Area
Helicopter Usage Area
Faro Mine Closure
Fermeture de la mine Faro
Faro Mine Complex
Closure and Reclamation
Sound Level Contour Plot - Maximum Daytime (16-hr)
Boundary At Which Noise from Project Activities
Meet Background Sound Level of 35 dBA
Scenario 2b: Year 1, Third Quarter
Job No: 34822
Filename: 34822 - 26Mar09 - Master Plot File.srf
Project Proposal
Date: 26-Mar-09
Approved: NZS
Figure: D-9



Faro Mine Closure / Fermeture de la mine Faro	Faro Mine Complex Closure and Reclamation	Sound Level Contour Plot - Maximum Daytime (16-hr) Boundary At Which Noise from Project Activities Meet Background Sound Level of 35 dBA Scenario 3a: Year 5, Fourth Quarter
Job No: 34822 Filename: 34822 - 26Mar09 - Master Plot File.srf	Project Proposal	Date: 26-Mar-09 / Approved: NZS / Figure: D-10



Faro Mine Closure
Fermeture de la mine Faro

Faro Mine Complex
Closure and Reclamation

Sound Level Contour Plot - Maximum Daytime (16-hr)

Boundary At Which Noise from Project Activities Meet Background Sound Level of 35 dBA

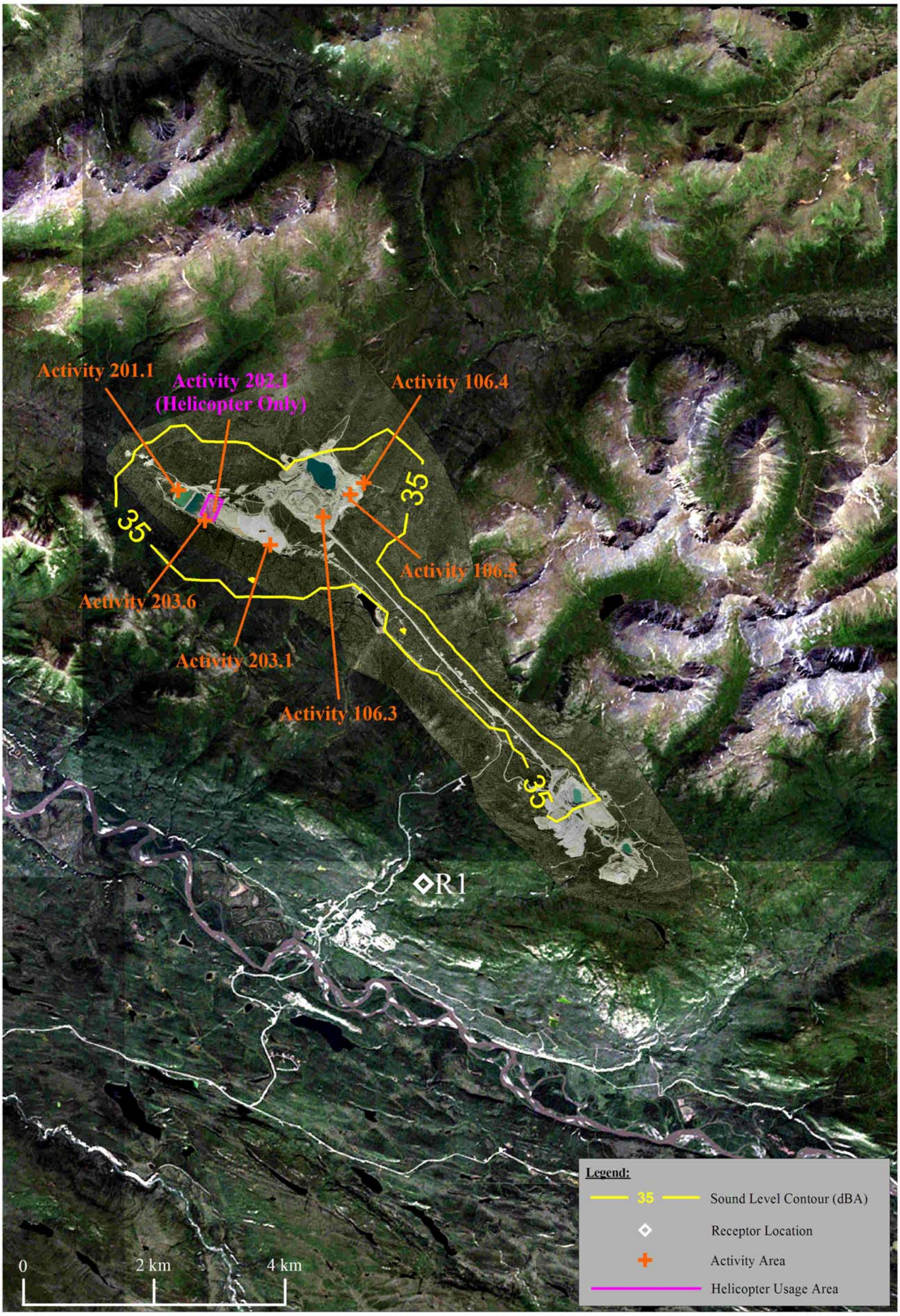
Scenario 3b: Year 5, Fourth Quarter

Job No: 34822

Filename: 34822 - 26Mar09 - Master Plot File.srf

Project Proposal

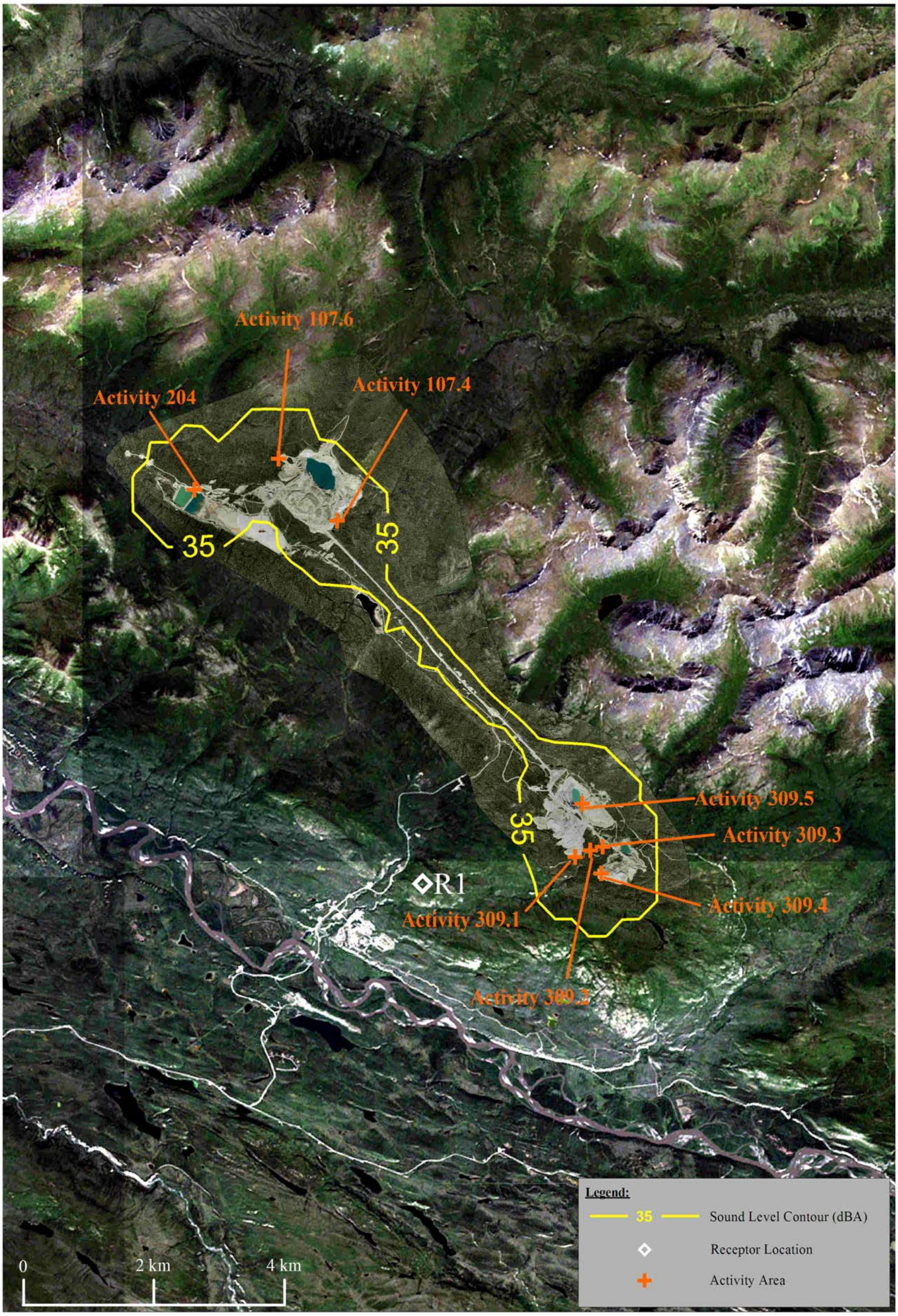
Date:	Approved:	Figure:
26-Mar-09	NZS	D-11



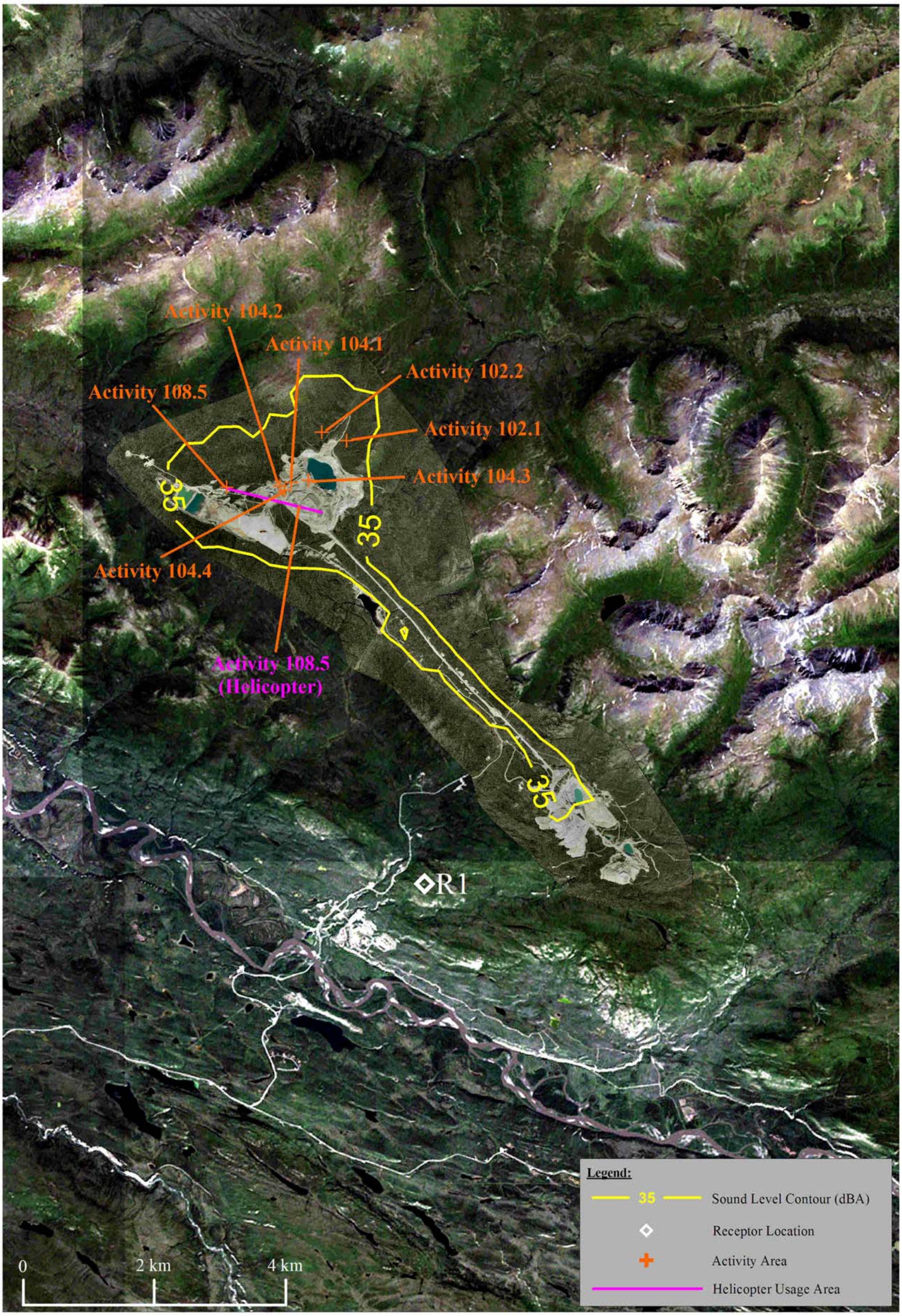
Faro Mine Closure / Fermeture de la mine Faro	Faro Mine Complex Closure and Reclamation	Sound Level Contour Plot - Maximum Daytime (16-hr) Boundary At Which Noise from Project Activities Meet Background Sound Level of 35 dBA Scenario 3c: Year 5, Fourth Quarter		
Job No: 34822 Filename: 34822 - 26Mar09 - Master Plot File.srf	Project Proposal	Date: 26-Mar-09	Approved: NZS	Figure: D-12

APPENDIX D.3

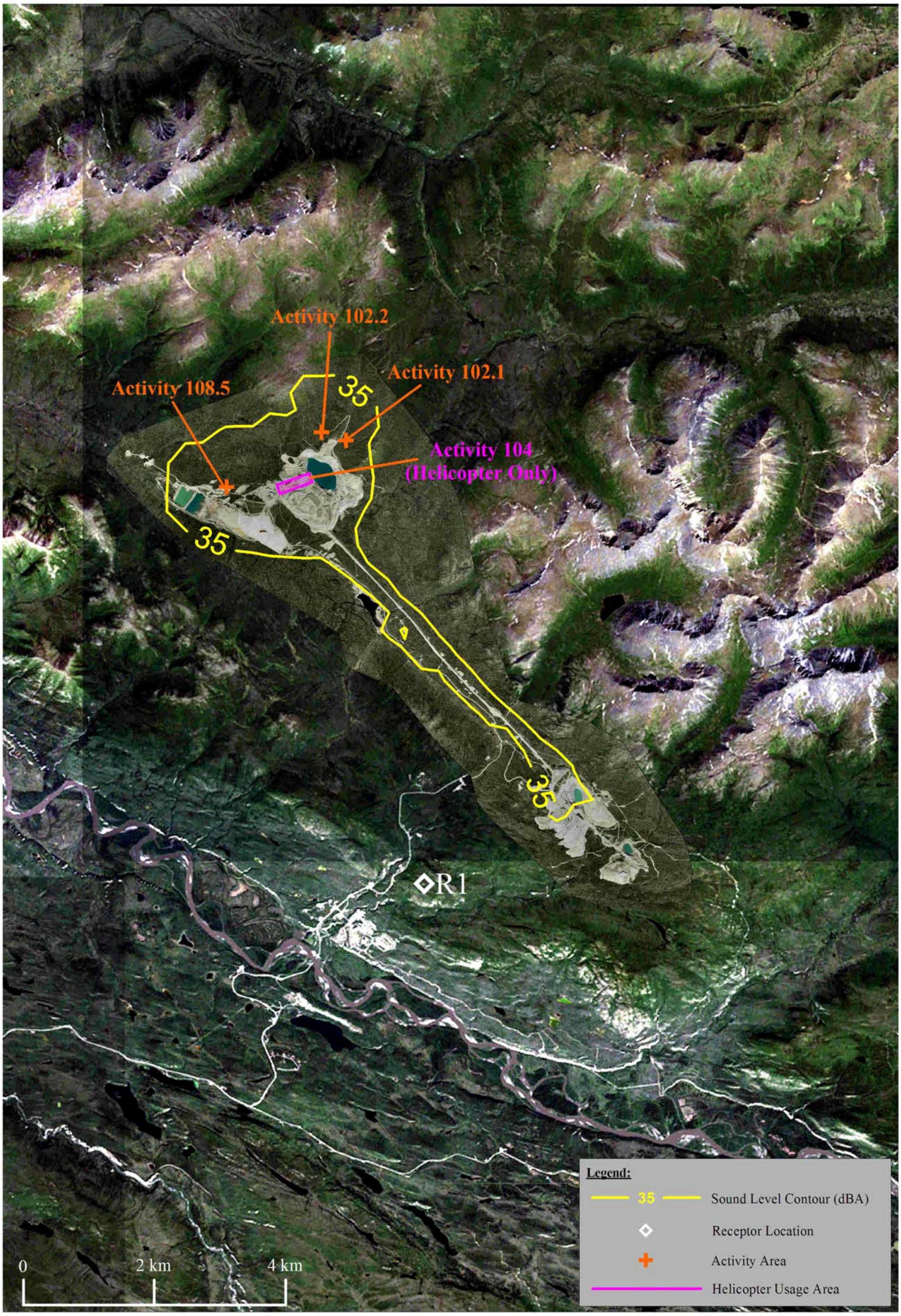
24-HR (35DBA) NOISE CONTOUR PLOTS



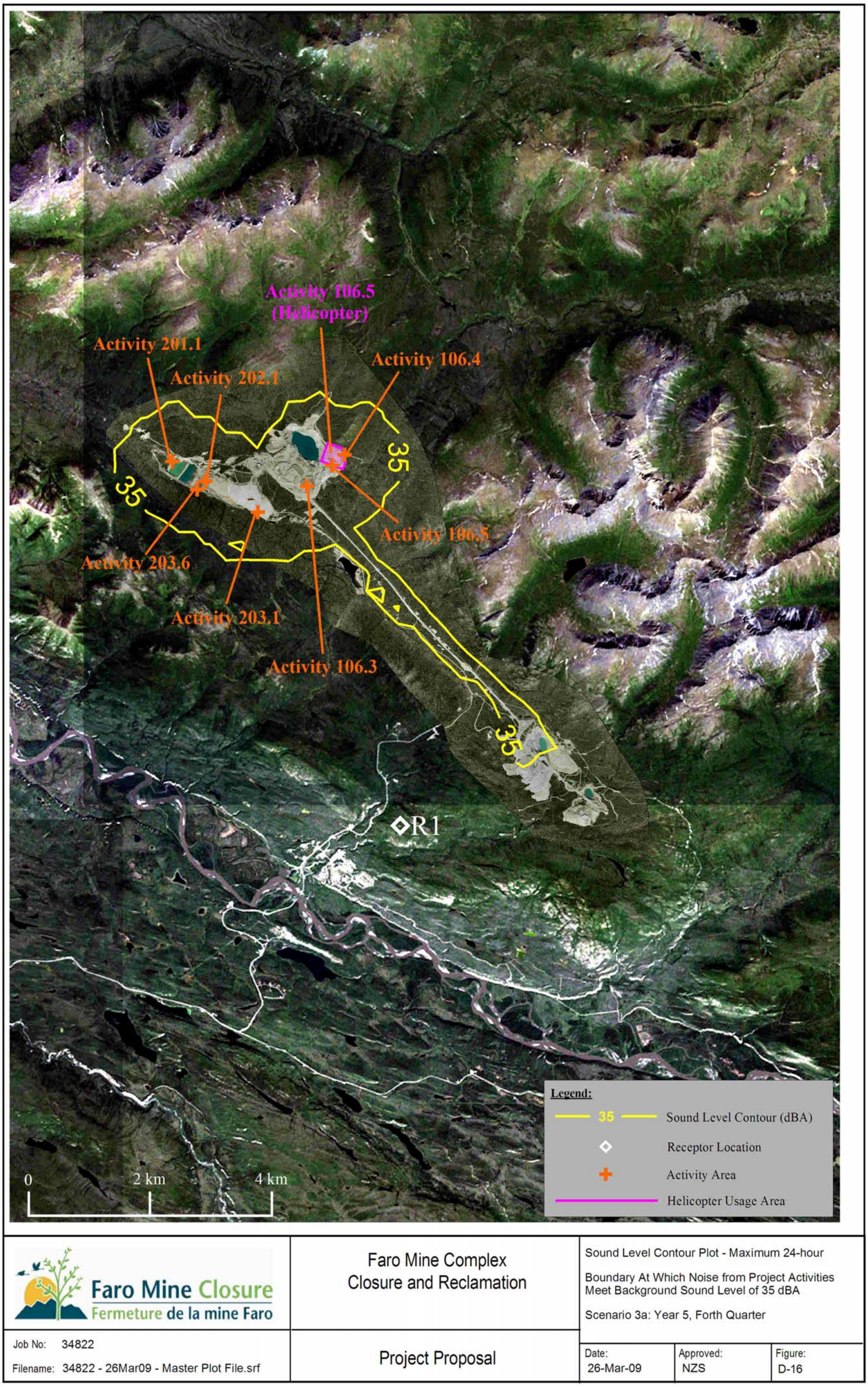
Faro Mine Closure / Fermeture de la mine Faro	Faro Mine Complex Closure and Reclamation	Sound Level Contour Plot - Maximum 24-hour Boundary At Which Noise from Project Activities Meet Background Sound Level of 35 dBA Scenario 1: Year 12, Second Quarter
Job No: 34822 Filename: 34822 - 26Mar09 - Master Plot File.srf	Project Proposal	Date: 26-Mar-09 / Approved: NZS / Figure: D-13

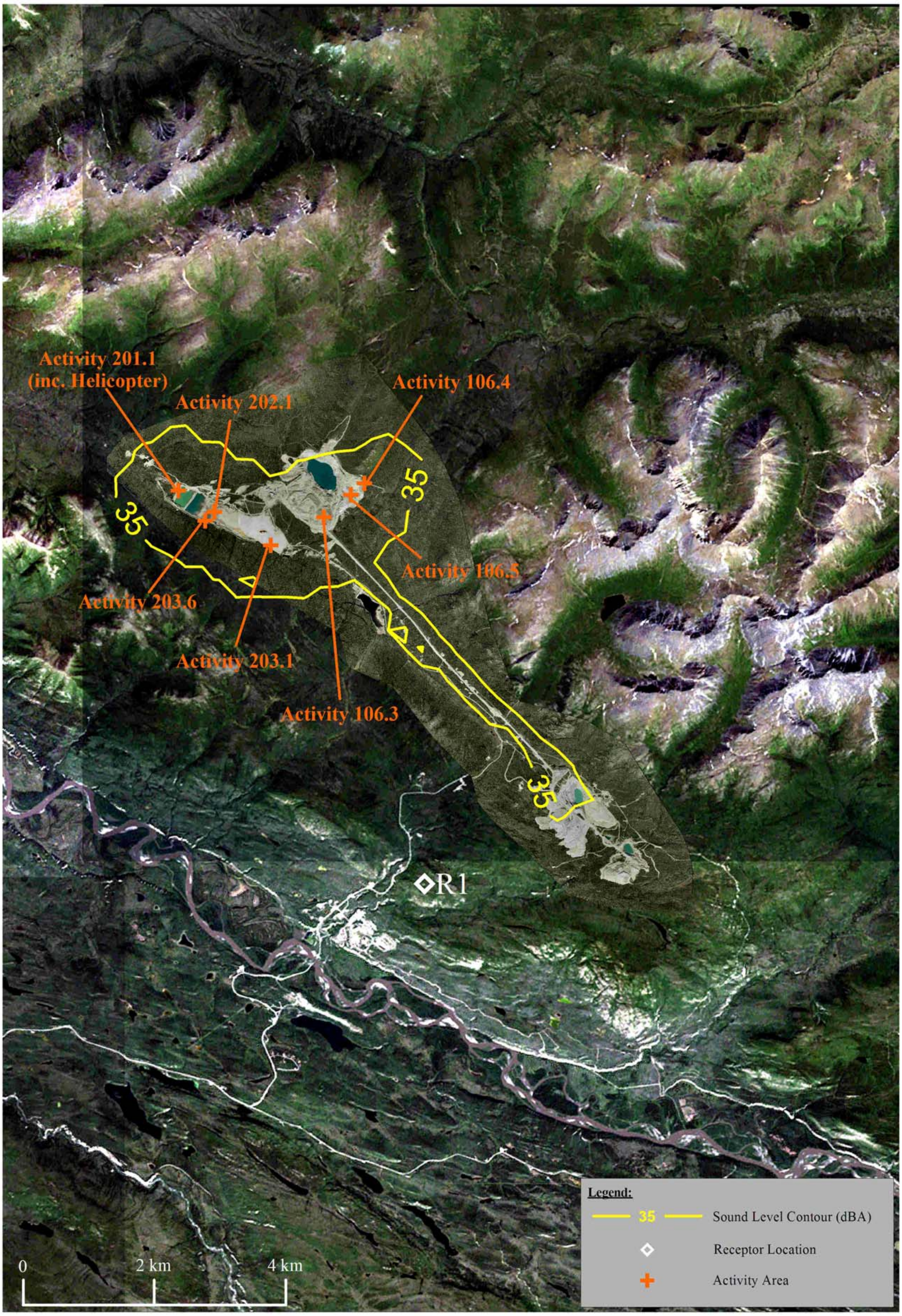


Faro Mine Closure / Fermeture de la mine Faro	Faro Mine Complex Closure and Reclamation	Sound Level Contour Plot - Maximum 24-hour Boundary At Which Noise from Project Activities Meet Background Sound Level of 35 dBA Scenario 2a: Year 1, Third Quarter		
Job No: 34822 Filename: 34822 - 26Mar09 - Master Plot File.srf	Project Proposal	Date: 26-Mar-09	Approved: NZS	Figure: D-14



Faro Mine Closure / Fermeture de la mine Faro	Faro Mine Complex Closure and Reclamation	Sound Level Contour Plot - Maximum 24-hour Boundary At Which Noise from Project Activities Meet Background Sound Level of 35 dBA Scenario 2b: Year 1, Third Quarter		
Job No: 34822 Filename: 34822 - 26Mar09 - Master Plot File.srf	Project Proposal	Date: 26-Mar-09	Approved: NZS	Figure: D-15


Activity 106.5
(Helicopter)
Activity 201.1
Activity 202.1
Activity 106.4
35
35
Activity 106.5
Activity 203.6
Activity 203.1
Activity 106.3
35
R1
Legend:
35 Sound Level Contour (dBA)
Receptor Location
Activity Area
Helicopter Usage Area
0
2 km
4 km
Faro Mine Closure
Fermeture de la mine Faro
Faro Mine Complex
Closure and Reclamation
Sound Level Contour Plot - Maximum 24-hour
Boundary At Which Noise from Project Activities Meet Background Sound Level of 35 dBA
Scenario 3a: Year 5, Forth Quarter
Job No: 34822
Filename: 34822 - 26Mar09 - Master Plot File.srf
Project Proposal
Date: 26-Mar-09
Approved: NZS
Figure: D-16



Faro Mine Closure
Fermeture de la mine Faro

Faro Mine Complex
Closure and Reclamation

Sound Level Contour Plot - Maximum 24-hour

Boundary At Which Noise from Project Activities Meet Background Sound Level of 35 dBA

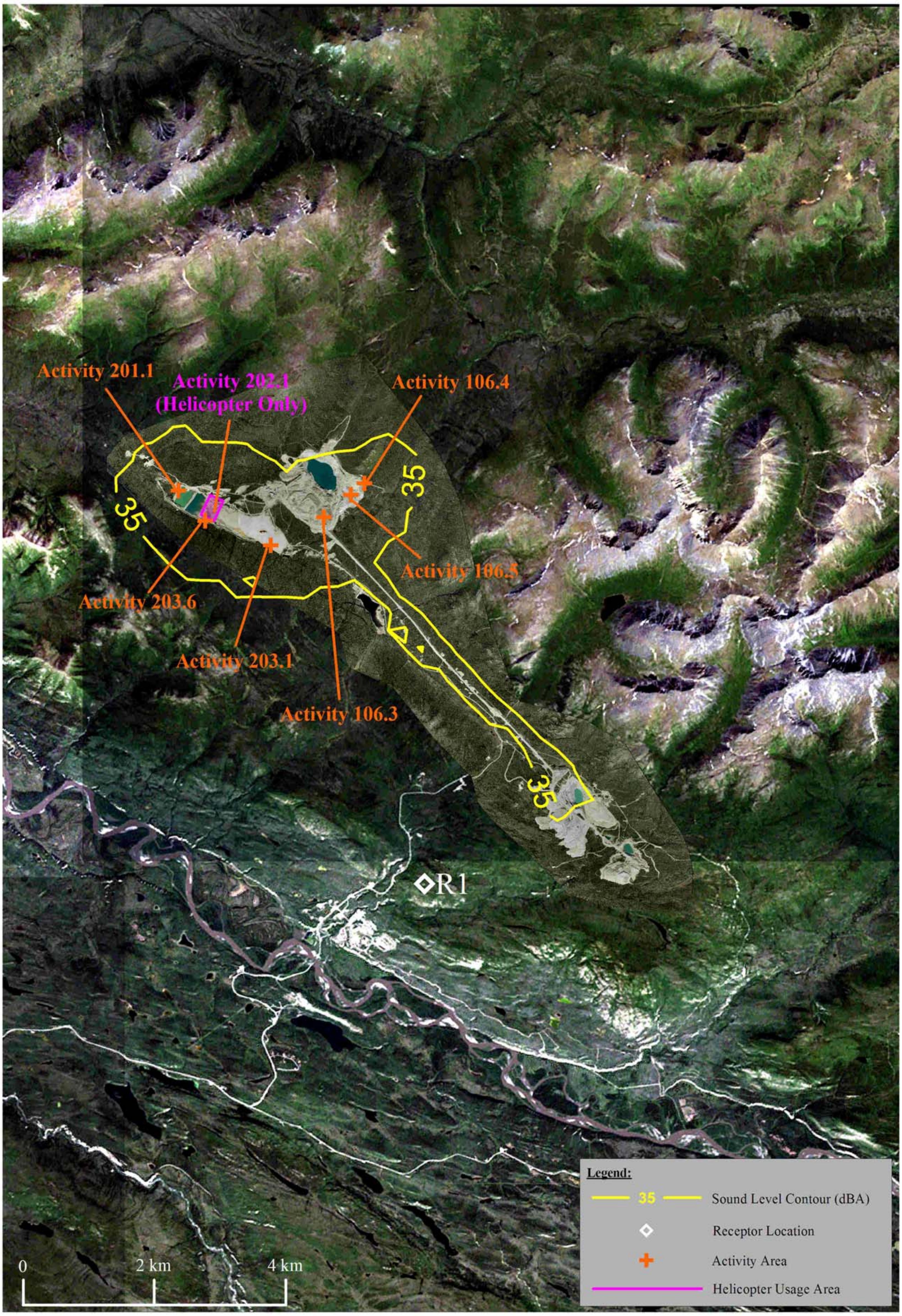
Scenario 3b: Year 5, Forth Quarter

Job No: 34822

Filename: 34822 - 26Mar09 - Master Plot File.srf

Project Proposal

Date:	Approved:	Figure:
26-Mar-09	NZS	D-17



Faro Mine Closure / Fermeture de la mine Faro	Faro Mine Complex Closure and Reclamation	Sound Level Contour Plot - Maximum 24-hour Boundary At Which Noise from Project Activities Meet Background Sound Level of 35 dBA Scenario 3c: Year 5, Forth Quarter
Job No: 34822 Filename: 34822 - 26Mar09 - Master Plot File.srf	Project Proposal	Date: 26-Mar-09 · Approved: NZS · Figure: D-18