UNIVERSITY OF GOTHENBURG
SCHOOL OF BUSINESS, ECONOMICS AND LAW

Managing Risk during Rapid-Completion Projects

A case study in remediation of a Svalbard settlement

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AF GRUPPEN

STORE NORSKE

POLE POSITION LOGISTICS

Abstract

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Title/Research Question: What tools should a project manager have when planning and implementing rapid-completion projects to reduce risks associated with the environmental impact, costs, and time it takes to complete the operation?

Background and Problem statement: In the High Arctic on the Norwegian island of Svalbard, it was decided in 2016 to shut down the mining settlement called Svea, since coal prices had dropped, and it was no longer profitable to keep the settlement running. In order to discontinue operations there, the company that runs and owns the settlement, Store Norske Kullkompani Spitsbergen (SNSK), was required to comply with the Svalbard Environmental Protection Act (NO 79. of 2001). This entails the removal of all surface installations, waste, as well as roads, machinery, and other infrastructure, thereby restoring nature to its original state. Given its remote location, and the demanding circumstances surrounding the clean-up project in Svea, the project needed to be completed quickly, since that would also help limit the negative environmental consequences. However, remediating such a large and complicated project inevitably involves various risks, which is why extensive planning has been required to make sure that the project is executed in a safe manner.

Purpose: The purpose of this thesis is to explore various tools and theories that can be useful for project managers in situations where the project must be completed as quickly as possible, while minimizing both the environmental impact and costs of cleanup.

Methodology: The scholarly perspective of the thesis is a combination of positivism and hermeneutics resulting in an abductive perspective. A case study was conducted in Svea where one of the interviews was held in person with Gudmund Løvli, Project Manager of Svea Environmental Project at SNSK. The second interview was held over video call with Kenneth Eikrem, Project Manager at AF Decom AS. The data collection methods consisted of interviews, as well as primary and secondary sources.

Results and Conclusion: The results gathered from literature review and interviews showed that the risks associated with environmental impact, costs, and the time required for completing the project can successfully be minimized with the use of competent and experienced staff who in turn use the standard portfolio of tools and methods provided in the literature.
However, the standard portfolio does not take the effect of human factors on project performance into account. Adding tools that help address these factors has been identified as an area where further improvements can be made in this and future projects.

Keywords: Project Management, Remediation, Risk Management, Environmental Conservation, Svalbard, Coal Mine.

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Trond Strugstad, Project Manager for Logistics for SNSK/Pole Position Logistics, who arranged for Kaisa to go to Svea to both visit and tour the site. We would also like to thank Rune Seljevold, the Health, Environment and Safety officer and coordinator for taking the time to arrange a detailed tour of Svea and giving insight into how SNSK's risk management efforts are carried out in practice. Per Ivar Velve, construction manager at SNSK, was also an enormous help in providing us with various documents detailing the various tasks and operations at Svea.

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Kaisa Nordlund

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Elliot Moran

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1. Introduction

1.1 Background

In the High Arctic, between North Cape in Norway and the North, lies the world's northernmost archipelago, Svalbard. Known for its raw beauty, sharp mountains with bright blue glaciers and exciting wildlife, Svalbard has, over hundreds of years, attracted settlers, entrepreneurs, explorers, and in not least, coal miners (Valen, & Evjen, n.d.).

The first settlers came to Svalbard in the early 1900's, hoping to gain economic advantages by claiming parts of the land and extracting coal from the mountains (Valen & Ejven, n.d.). In 1906, the American John Monroe Longyear came to Svalbard and started the Arctic Coal Company in what today is known as Longyearbyen, the main town of Svalbard. This mine was later acquired by the Norwegian state-owned company Store Norske Spitsbergen Kullkompani (hereafter referred to as SNSK) in 1916. About 60 km south-east of Longyearbyen lies the mining settlement called Sveagruva (Svea mine), more commonly referred to as Svea. The settlement and mine were established in 1917 by the Swedish company Aktiebolaget Spetsbergens Svenska Kolfält (Lien, H., n.d.). The mine was then purchased by SNSK in 1934 and has been Norwegian ever since (SNSK, 2020). In 2001, a new part of Svea mine was opened, called Svea Nord (Lien, H., n.d).

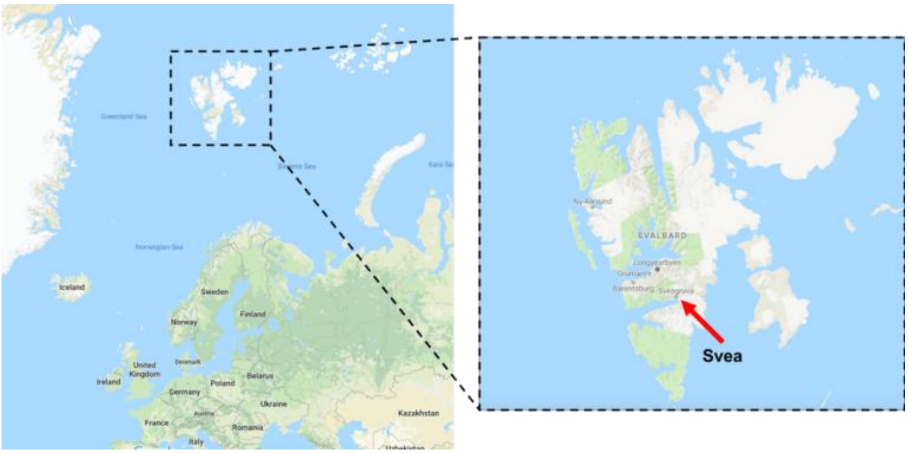

Figure 1: Map of Svalbard and Svea (Short, 2018)

Since the 1920's, coal mining has been Svalbard's main source of income. The mines in Svea account for most of the coal production, surpassing NOK 3 billion in revenue in 2008. With the success that Svea enjoyed, SNSK applied in 2010 to open another mine a few kilometers northeast of Svea in Lunckefjell. The application was approved by the Ministry of Climate and Environment at the end of 2011, and the first coal was extracted from Lunckefjell in 2013 (SNSK, 2020). According to Statistics Norway, 1.1 million tons of coal were extracted by SNSK in 2015, and around 70-80% was exported to Europe for industrial use (SSB, 2016).

However, in 2015, coal prices dropped and SNSK faced an economic crisis. In April of 2016, it was decided to close the mine in Lunckefjell after just 2.5 years of production. It was also decided to shut down and terminate all operations in the entire Svea settlement, which at this point had been running for nearly 100 years (SNSK, 2020). Because of SNSK's decision to discontinue operations in Svea, the company was required to comply with §64 (Clean-up Operations) of the Svalbard Environmental Protection Act (NO.79 of 2001), which stipulates the following:

"When an activity or parts thereof are discontinued, the head of undertaking shall at his own expense remove from the area all surface installations, all waste and other remains that are not protected structures and sites under Chapter V. The area shall as far as possible be restored to its original condition… Abandoned vehicles, vessels, aircraft, etc., shall be removed by the owner."

Additionally, §64 states that "*If an activity is closed down or discontinued, the head of undertaking shall take the necessary steps to prevent environmental damage*" (Chapter VII, §64).

The clean-up operation that SNSK must conduct to restore Svea back to nature is one of the biggest and most ambitious environmental projects in Norway and is classified as a high-risk remediation project. Over NOK 2.5 billion has been allocated from the Norwegian state budget to finance the operation (SNSK, n.d.). The clean-up operation has been divided into 2 main phases which are as follows (see Appendix 1 for an overview and picture):

Phase 1: Remediation of the mine in Lunckefjell and the surrounding area

- Start: Autumn 2018,
- Completed: Autumn 2020

Phase 2: Restoration of Svea – this has been divided into two parts:

2A: Closing and restoring the Svea Nord mine and removing all infrastructure around it, as well as the road from the stacker in Svea to the entrance of the mine Svea Nord in the Høganes glacier.

- Start: Spring 2018
- Completed: Autumn 2020

2B: Restoring the rest of Svea back to its natural state. This includes the area from the stacker at the entrance to Svea Nord mine, the Coal Preparation Plant (CPP), Svea town, roads and finally the port.

Figure 2: Stacker in Svea. Photo: Kaisa Nordlund (2021)

SNSK is currently in Phase 2B, which started in the first quarter of 2021. It is estimated that the entire operation will be completed during 2023, with final touches in 2024. (SNSK, n.d.).

Remediation of Svea needs to be carried out as quickly as possible, since it costs more than NOK 100 million per year to keep the settlement running (Ylvisåker, 2021, 31 March), which in turn has environmental implications. Thus, expediting all operations in the clean-up process is a central aspect of phase 2B to minimize the environmental cost and comply with §64 of the Svalbard Environmental Protection Act.

1.2 Problem statement

Carrying out rapid-completion projects under demanding conditions (budget and environmental restrictions) will inevitably involve certain risks. Extensive planning is therefore required to make sure that all risks are accounted for, and that the goals and demands of the project are met.

In an interview with High North News (2021), the Project Manager of the Environmental Project at Svea, Gudmund Løvli, was asked if the high pace of the project involved any challenges. He responded:

"*There are different decision makers and budgets in this project. If we had waited, it would give huge benefits for society as a whole*" (Ylvisåker, 2021, 31 March).

The question remains as to whether more environmental benefits could have been obtained if the project managers would have had more time to plan the clean-up. According to Løvli, it is a cost-benefit issue, but he believes that if they had had more time to plan, it would have been *more* costly for the environment (because of the energy required to keep the settlement running) and that the highest priority is remediating Svea as quickly as possible (Ylvisåker, 2021, 31 March).

1.3 Research Question

In order to have a successful outcome for the Svea remediation project, it is essential that project managers establish a solid plan and strategy for carrying out the project as quickly as possible, while minimizing both costs and environmental impact, as well as accounting for the risks associated with a more rapid implementation. Thus, the research underlying this thesis explores the following question:

What tools should a project manager have when planning and implementing rapid-completion projects to reduce risks associated with the environmental impact, costs, and time it takes to complete the operation?

1.4 Purpose

The purpose of this thesis is to explore different tools that can be useful for project managers in situations where the project duration needs to be minimal, while also reducing the impact on the environment during the cleanup and minimizing the costs of cleanup. Tools could include processes, templates, checklists, etc. that are either manual or implemented in software. Common for all the tools are that they are intended to help the project managers make analyzes, draw conclusions, manage effectively, and monitor progress. Risks entail possible, but unlikely events or conditions, both internal and external that may have a negative effect on the outcome of the project. Risks may for example cause increased costs, delays or danger to the environment, property, or employees.

A field study of the Svea remediation project will be conducted as well as interviews to investigate how the project managers involved work with these tools or if they use other strategies. Based on information and theory gathered from academic literature and data collected from the field study, the thesis will then analyze what tools and methods work best. Having done that, we can then specify a portfolio of the most important tools/strategies that project managers should use when working with rapid-completion projects in high-risk environments.

2. Methodology

The following chapter explains the methodological approaches used when conducting the research to address the research question. For this research question, a case study was conducted on the Svea project where one of the authors traveled to the settlement to document and gather data and information. The data collection methods as well as the interview methods are also explained in further detail.

2.1 Scholarly perspectives

2.1.1 Positivism

The principles of *positivism* are inspired by physics and based on the idea that empirical data should be translatable into quantitative information. A main theme of *positivism* is the concept of reductionism: a problem can be broken down, or reduced, in order to be understood on an elementary level, thereby identifying the root of the problem. The approach deems people’s personal perception of reality as unreliable and instead focuses on an objective reality that can be explained with objective methods. Statements and reflections are to be regarded as hypotheses and tried as such, i.e., proven empirically before being regarded as reliable (Patel & Davidson, 2011).

2.1.2 Hermeneutics

Hermeneutics is a method used to interpret all texts and is based on the thought that there is no objective reality, only different perceptions of it. People perceive and, in a sense, create their own reality. The importance of this method lies in understanding and interpreting how human existence is expressed through action, text, and speech. The hermeneutic scholar approaches research with preconceived opinions and thoughts which are seen as assets in the pursuit of understanding a research object (Patel & Davidson, 2011).

2.1.3 A Combination of Perspectives

The scholarly perspective of this thesis is neither purely *positivistic* nor *hermeneutic*, instead it lies somewhere in-between. When exploring the necessary tools that this thesis aims to examine, the perspective will be more *positivistic* when analyzing the formation of, and calculation within, these tools. This is because this process is binary and needs to be analyzed objectively with objective methods. However, when analyzing everyday usage, the perspective will move towards *hermeneutics* as this involves people's personal perceptions and how they choose to apply and interpret these tools.

2.2 Methodological Approaches

2.2.1 Deductive Reasoning

The empirical observations made when using *deductive* reasoning has its foundations based on existing theories. The theory signifies what data to collect and how to interpret it. With this approach, the objectivity of the results increases as the observations and perceptions are based on theories and research, and not on the scholar's own ideas. A risk of using *deductive* reasoning is that the theory used may be biased, which affects the outcome of the results if it directs the research in a particular direction. This makes it harder for the reader to discover new areas of interest that may be relevant for the study (Patel & Davidson, 2011).

2.2.2 Inductive Reasoning

An *inductive* research approach begins with a case study being conducted without an established theoretical foundation. The idea being that a theoretical framework ought to be based in, and formed from, empirical data and not vice-versa. A subject being studied without a theory confining the frame of reference may lead to new areas of interest that likely would not be discovered. It also allows the scholar's own ideas and perceptions to influence formulation of theory (Patel & Davidson, 2011).

2.2.3 Abductive Reasoning

An *abductive* research approach is the combination of both a *deductive* and an *inductive* approach as it is based on both knowledge and observations to form hypotheses to explain the observations (Hwang, Hong, Ye, Wu, Tai & Kiu, 2019). The first step is to formulate a hypothetical model to explain a specific case, which is common for *inductive* reasoning. An example could be a first draft of a theoretical deep structure. The theoretical structure is then tested and applied on new cases, making the approach more *deductive*. By retesting the theory several times, the researcher can achieve their goal of further expanding the proposed hypothesis or theory, thus broadening the scope, and making the theory more applicable rather than keeping it specific (Patel & Davidson, 2011).

2.2.4 Approach of this thesis

Before a case study is initiated, a theoretical deep structure is established, which gives the authors a scope to work within, without limiting the possibility of discovering new areas of interest: an *inductive* approach. While executing a case study, the scope narrows as theory becomes more specific to the study in question. The theoretical information can then be used to compare how well theory and reality coincide: a *deductive* approach. As these two approaches are combined the methodological approach of this thesis becomes an *abductive* one.

2.3 Case Study

In order to obtain the best possible results for the thesis, and acquire an in-depth understanding of the problem, a case study was conducted in Svea. According to authors Crowe, Cresswell, Robertsson, Huby, Avery and Sheikh (2011), the central idea of a case study is that the event or phenomenon is explored in its natural context. The methodology behind the case study approach was further developed by Stake in 1995 as he identified and characterized three main types within the approach, namely *intrinsic*, *instrumental,* and *collective.* When studying and learning about a unique phenomenon and how it distinguishes from other cases, the case study is said to be *intrinsic*. An *instrumental* case study is applied to a particular case with the purpose of gaining a broader understanding of the phenomenon. When the study involves multiple cases simultaneously or sequentially, a *collective* case study is conducted with the purpose of getting a broader understanding of a particular issue (Stake, 1995) (Crowe et al., 2011).

For this thesis, an *instrumental* case study was conducted as research was carried out on-site on a pre-selected location (Svea) to get a broader understanding of how the project was conducted and increase the validity of the results. The research was qualitative in nature through interviews and conversations with project managers and other workers, as well as tours of the site to observe first-hand how operations within the project were carried out.

2.4 Data collection methods

2.4.1 Primary & Secondary Sources

Primary sources entail gathering first-hand information, for example by witnessing or conducting interviews and documenting the results (Patel & Davidson, 2011). For this thesis, the primary sources of data were documents compiled by SNSK describing the project, along with qualitative interviews with the project managers involved to gain a deeper understanding of their work. The secondary sources used in this thesis are mainly scholarly journal articles and books, as well as news articles relevant to this subject.

2.4.2 Interviews

As part of the case study in Svea, interviews were conducted with different project managers involved in order to get a broader understanding on how the work was carried out.

Conducting the interviews and choosing respondents

The interviews were conducted both in-person and over video calls. The respondents for the interviews were selected based on their position and involvement in the project. The respondents were:

- Gudmund Løvli, Project Manager for Svea at SNSK.
- Kenneth Eikrem, Project Manager of Decom AS - the contractor hired to demolish infrastructure in Svea.

Prior to conducting the interviews, an interview guide was prepared with a list of questions for each respondent. The interview guide was structured and divided into three main categories which follow the scope of this thesis, with specific questions for each category. The categories were as follows:

- Risks associated with environmental impact,
- Risks associated with project delays,
- Risks associated with costs.

The questions were sent to the respondents a few days before the interviews took place so that they could prepare their answers and share suitable presentations or other documents.

The interviews had qualitative characteristics and were semi-structured as most of the questions were predetermined and in a certain order. However, as the interviews took place, some questions were rearranged or rephrased based on the respondent's answers. In order to encourage the respondents to answer in their own words, the structural level of the interviews was kept low (Patel & Davidson, 2011). Questions were exploratory and specific, with follow-up questions when needed. The answers from the exploratory questions will be used as a basis for analysis while the follow-up questions were used to get further detail and expertise from the respondents. The results from the interviews are summarized in the empirical chapter, and the interview guide is translated to English, and available in Appendix 6.

The first interview was in-person with Gudmund Løvli, Project Manager for SNSK, and held on-site in Svea on 27 April 2021. The initial plan was to interview Mr. Løvli alone, but throughout the interview he called on his other colleagues who shared the office space to join the interview and add their insights. Mr. Løvli, who oversees all operations in Svea, is not involved in the details. Thus, adding colleagues helped with additional perspective and knowledge on details. The additional persons participating in the interview included the following:

- Rune Seljevold, health and safety coordinator for SNSK
- Per Ivar Velve, construction manager for SNSK
- Trond Strugstad, project manager for logistics for SNSK/Pole Position Logistics

The second interview was conducted over video call with Kenneth Eikrem, Project Manager of AF Decom AS (hereafter referred to as Decom) on 29 April 2021. Decom is the contractor hired by SNSK to demolish the infrastructure in Svea for phase 2B. This interview was conducted with Mr. Eikrem alone.

Interview Caution

While there are many advantages associated with conducting interviews, the authors of this thesis are aware of the disadvantages and will take every measure possible to ensure that the results from the interviews are of the highest quality and reliability. One of the main issues with conducting interviews is that uncertainties and errors may arise if there is only one respondent, and the answers may be biased. For this reason, several respondents were interviewed to obtain a broader perspective.

2.5 Ethics

This thesis involves the study and participation of human subject which raises some ethical issues that needed to be addressed as part of this work. Therefore, several ethical criteria have been applied in the thesis work (Lærd, 2012):

1. minimizing the risk of harm;
2. obtaining informed consent;
3. protecting anonymity and confidentiality.

These have been addressed in the following way:

1. An analysis of potential risk of causing “harm” (e.g., conflicts) has been performed. The largest risk for such consequences resides in the way respondents address the questions and how this can be interpreted. All answers have been checked to ensure that this risk is minimized.
2. Prior to each interview, the respondents were informed via email-correspondence regarding the purpose and scope of the essay. Once they agreed to participate, the interviews took place.

3. The participants were given the option of remaining anonymous, but all gave their consent to have their names used in this thesis, as well as being recorded for the interviews. Regarding the interview with Mr. Løvli where other employees were called upon to join the interview, they also gave their consent to be recorded and have their names used. Several pictures were taken of the sites in Svea, and of various documents that hung on the walls in the office space. Permission to take these photos was always asked to ensure that nothing confidential or sensitive was captured, or that any person or persons that did not want to be photographed could remain off-camera. The documents that were provided from the employees at Svea were sent willingly, and consent was given to use and publish any information in the documents for this thesis.

3. Literature Review

The following chapter presents relevant theories (secondary sources) that may be useful strategies for project managers working with rapid-completion projects. The chapter is split into two parts: scheduling & risk management strategies, and conservation strategies.

3.1 Scheduling & Risk Strategies

When planning rapid-completion projects, various scheduling strategies can be extremely helpful for ensuring that the project is completed as quickly as possible. As explained by the authors Atin and Lubis (2019), project scheduling is used to determine the time frame in which activities must be completed, as well as what raw materials, time and manpower is needed for each activity. By using project scheduling, project managers can also determine which activities must be completed before the next can be started, while also ensuring that the activities are carried out at the lowest possible economic cost (Atin & Lubis, 2019)**.**

3.1.1 Critical Path Method (CPM)

Based on the research conducted by Atin and Lubis (2019), *CPM* is a useful tool for project managers in terms of economic and time efficiency, and especially useful in construction work as the critical path results in a schedule based on observations and experience by those with prior knowledge.

When calculating the critical path using *CPM*, you start by determining the duration of the activities in a project, where the path that has the longest duration is identified as the critical path. The critical path indicates the overall time in which it takes to complete the entire project, which means that activities in this path may not be delayed (Atin & Lubis, 2019**)**. The paths and activities that are not integrated in the critical path have slack, which means that they can be delayed, or expedited, as they have no overall effect on the timing of the project's completion.

When an activity has slack, it means that the time between the earliest start, and latest possible time of completion for an activity, is longer than the activity's duration.

In his book, *Operativ Verksamhetsstyrning* (Operations management), Lantz (2015) explains how to calculate critical paths using *CPM*. First, it is necessary to identify the following variables:

- Di: (expected) Duration of the activity.
- ES: Earliest Start of the activity, which also accounts for the previous activities in that path being completed.
- LF: Latest Finish time in which the activity can be completed, ensuring that the project will not be delayed.
- EF: Earliest finish time in which the activity can be completed, given that the previous activities in the path have been completed. In other words, EF=ES+D.

Thus, the following can be calculated:

- Total time available for the activity: LF-ES
- Slack: LF-EF

By establishing these variables, and calculating the slack for each activity, the critical path will be identified as the activities that *do not* have slack (LF-EF=0), and it is critical that these are started and completed on time to avoid the project from being delayed.

3.1.2 Project Evaluation and Review Technique (PERT)

Project Evaluation and Review Technique, or *PERT*, as Soroush (1994) explains a common tool used when "*planning, managing and controlling projects in areas such as research and development, production, construction, maintenance and others."* It is important in the planning process that the uncertainties are accounted for when calculating the time it takes to complete each activity (Lantz, 2015). The uncertainties are taken into account in *PERT* by using three estimates as time intervals, which are explained below (Habibi, Taghipour Birgani, Koppelaar, & Radenović, 2018):

- **Optimistic Estimate (O)** – the shortest time it takes to complete a project under the best possible circumstances.
- **Most Likely Duration (M)** – the time it takes to complete the project under normal and probable circumstances.

- **Pessimistic Duration (P)** – the time it takes to complete in the worst-case scenario where everything that can, goes wrong (delays occur, lack of resources, problematic weather, etc.).

By gathering these estimates, it is possible to calculate the probability that a project or activity is completed within a certain time frame or its cost. This is done by calculating the weighted mean of each duration. The estimates O and P are assumed to be equal in terms of probability or occurrence,

$$D_i = \frac{O_i + 4M_i + P_i}{6}$$

Equation 1: Calculation of activity's duration (Lantz, 2015)

while M is four times as much. Thus, the time or cost expected from an activity is as follows:

The standard deviation is calculated by using the equation below:

Once these values have been calculated for each activity, the total expected time or cost of the project is calculated, which is the total duration. Similar to *CPM*, forward and backward calculations for each activity are done in order to determine which activities are on the critical path (Habibi et al, 2018).

$$\sigma_i = \frac{P_i - O_i}{6}$$

Equation 2: Calculation of activity's standard deviation (Lantz, 2015)

3.1.3. Gantt Chart

A useful tool to illustrate the activities' chronological order is graphical representation using *Gantt* charts. In the early 20th century, Henry L. Gantt developed a bar-chart and the concept of incentive pay, which, according to Darmody (2007), "*are some of the most essential tools in project management."* One of the benefits of graphically illustrating the order of the activities, is that it becomes clearer what happens at a certain time point, and it is easier to interpret (Lantz, 2015). The *Gantt* chart consists of different bars of varying lengths which represent the duration of the activity, and these in turn can be displayed next to other bars (meaning that activities take place at the same time), to show the overall timeline of the project, and where there potentially is slack. *Gantt* charts are also beneficial to project managers, since they point out where potential bottlenecks may occur.

3.1.4 Toyota Production Systems (TPS)

TPS is a system of management philosophies developed by Toyota. This is the foundation for concepts known today as "Just in time", "lean manufacturing" and a flurry of other ideas. The main objective of TPS is to minimize overburden (*Muri*) and inconsistency (*Mura*), and to eliminate waste (*Muda*) (Ohno, 1988).

Muri represents unreasonableness in production. These are tasks that are beyond one's power to reasonably execute. Reasons for this could be a lack of tools, insufficient specifications, or over-complicated processes. *Muri* is managed through simplifying and standardizing workflow with repeatable process steps (Dennis, 2007).

Mura represents the variation and irregularity in production stemming from insufficient planning. For example, there might be certain production tasks that are more difficult than others, requiring them to be assembled separately. Because of that, there can be an uneven load and burden on employees. A way of managing this would be to allocate the workload burden/difficulty evenly over the day to ensure that none of the employees become overburdened, thereby reducing the risk of inefficiency. (Dennis, 2007).

Muda represents waste, i.e. work that is non-value adding. One example of this is unused capacity in the organization in the form of in-house knowledge and creativity not being identified and used effectively. Leaders are prone to underestimate the possibilities and expertise that may already exist within the organization (Dennis, 2007).

3.1.5 Failure Mode, Effects and Criticality Analysis (FMECA)

FMECA is a design tool used to identify and analyze points of failure in any given system. The tool consists of two sub-analyzes, the first being *failure modes and effects analysis* (FMEA), and the second being *criticality analysis* (CA). The *FMEA* pinpoints possible system failure modes and in turn the resulting effect on operations. These are ranked in order of criticality to the system and probability of occurrence using *criticality analysis* (CA). This is an effective method for evaluating effects of proposed changes to procedure (NASA, 1990).

It is of utmost importance that a *FMECA* be performed during system design to be effective. A *FMECA* would be of little value if it were to be performed after a system is created. The usefulness of a *FMECA* is dependent on identifying points of failure early in the design process in order to eliminate, or at least, mitigate them. A properly implemented *FMECA* provides a documented method for selecting a system design with a high probability of safe and successful operation (NASA, 1990).

3.2 Environmental Conservation Methods

Although the purpose of a remediation project is to remove contamination and improve the environment, the operation itself usually entails a certain level of contamination/pollution over the project duration. A report from the Swedish Environmental Protection Agency (NVV) points out that one of the main obstacles for conducting effective remediation work is the lack of knowledge regarding the risks associated with contaminated areas and how these risks should be handled (Naturvårdsverket, 2008).
NVV provides decision-making guidelines for evaluating the environmental and societal consequences associated with different methods for remediating contaminated soil. These guidelines are specifically meant to be used when determining what method would be most suitable for when the project commences.

To make this applicable to the Svea project, we have slightly modified the original evaluation criteria from NVV which were: 1) Risk, 2) Environmental performance, and 3) Socio-economic impact. Instead, we use: 1) Risk, 2) Environmental Performance and 3) Project impact (cost and time). Potential options (inspired by the NVV report) for treating the waste materials resulting from the remediation include:

- *On-site* treatment and landfill
- *Off-site* treatment and landfill
- *In-situ* treatment.

On-site treatment and landfill
Includes excavation/demolition, separation into fractions depending on contamination and material types, treatment of the different fractions and placing the resulting material on a local landfill.

This approach would not be possible for the Svea project, since it negates the purpose of the project – which was to restore the area back to its original state.

Off-site treatment and landfill
Starts with excavation/demolition. Separation into fractions can be done locally on Svalbard, alternatively all material can be shipped while mixed to the off-site location (mainland Norway) and be separated there. After separation and arrival in the off-site location, the different fractions are treated, and the resulting material placed on local landfill(s).

This approach would be possible for the Svea project.

In-situ treatment
This is a method for treating contaminated soil where the contamination is treated in the ground. This can be done by chemical treatment, aeration, or freezing the ground to stabilize the contamination.

The advantages of this method include are that no material is moved, and nature is disturbed as little as possible. However, at Svea this is not possible because the ground is already frozen, and most of the material needing to be removed is already lying on top of the ground.

Discussion
In NVV's report they fail to include regulatory and ambient conditions as part of the decision criteria. In Svea's case, the *on-site* option does not comply with the regulations, and *in-situ* treatment cannot be implemented due to ambient climate. Furthermore, it is likely to be non-compliant with the regulations.
Thus, the only viable option is *off-site* treatment and landfill. A key question for the project planners is to decide whether to do separation of different fractions *before* or *after* transporting the masses to the mainland (*off-site* location).

4. Data collection / Empirical Data

4.1 Results from Svea

The results from the interviews, as well as the conversations with the above mentioned are summarized below, and split into four sections - planning preparations, risk management, environmental consideration, and concluding reflections.

4.1.1 Planning preparations

In the interview with Mr. Løvli, he explained that prior to starting the remediation project in Svea, he and his colleagues at SNSK gathered a group of experts to start planning the project and mapped out the entire area. The Norwegian government also gave them access to the best resources available, to ensure that the project would be carried out with minimal impact on the environment and risks to those working in Svea. These were experts on pollution and remediation, cultural monuments, budgeting and even archaeologists. Once they had defined the areas and estimated how long each phase would take, they commenced operations in Lunckefjell, since this area had the least amount of contamination while still planning for phase 2B. They gained a lot of time by dividing the project into different phases such that they could begin remediation on certain areas which required less planning and resources. At the same time, they could spend more time planning and allocating resources for the areas that were more complicated. The scope of the project is visualized through maps and *Gantt* charts such that all parties involved can easily see what is being done and when, and what areas are more sensitive. These maps/schedules are depicted in Appendix 2, 3 and 4.

Due to the financial demands and time constraints of the project, it was decided that the best way to dismantle Svea was to demolish the selected buildings, dig up the contaminated soil and ship all the waste to mainland Norway. In order for these operations to be carried out in a safe manner, the employees of the Governor of Svalbard[1] were heavily involved in the planning process to ensure minimal damage to the environment. Mr. Løvli and the others at SNSK established a professional relationship with the Governor, which was very helpful in the planning process. Because the project is classified as a high-risk environmental project, every part of the plan needed to be approved by the Governor or Norwegian authorities. With the good professional relationship and communication between SNSK and the Governor, SNSK received continuous feedback and help. That way, when they sent in plans for review, they knew that they would receive approval and not have to waste time on further adjustments.

SNSK hired the Norwegian company AF Decom AS to carry out the demolition and remediation of the buildings and soil in phase 2B. In the interview with Mr. Eikrem, he emphasized that the extensive planning and mapping out of the entire area by SNSK saved huge amounts of time for them. It was very easy to get an overview of every single task that needed to be carried out, and what was expected of them. Given the detail of the descriptions, Decom could more accurately plan their part of the project and present a suitable plan to SNSK when bidding for the project. Additionally, given the detail of SNSK's survey of Svea, Decom were not met with any surprises which saved them a lot of time and expenses.

[1] The Governor of Svalbard has a wide range of duties on the island. It mainly acts as the chief of police and county governor. It administratively falls under the Norwegian Ministry of Justice and Public Security, and also carries out tasks for several other ministries (Governor of Svalbard, n.d.)

Figure 3: Demolition carried out by Decom. Photo: Kaisa Nordlund (2021)

For Decom's planning process, Mr. Eikrem, like SNSK, gathered an experienced team (that had worked on similar projects on the mainland) to calculate the expected duration and analyze the risks. With the knowledge and background provided by SNSK, Decom used a calculating tool to establish the earliest and latest start and finish times for the different tasks in phase 2B. That way, they could identify what areas would have slack, and how to work around these areas with different approaches. The critical path results that Decom produced have been very useful tools both in terms of saving time and costs. According to Mr. Eikrem, this project is uncomplicated in the every-day tasks, which is why they do not use *Gantt* charts. These tasks are visualized on computer screens and as checklists to make operations clear and simple to follow.

Both Mr. Eikrem and Mr. Løvli expressed in their separate interviews that the planning preparations made by the experts and tools they used to map/plan the project were an essential part of achieving the goal of having the remediation proceed as quickly as possible. In fact, it has enabled the project to progress even faster than anticipated. Originally, the project was estimated to be completed in 2025, but now they expect it to be completed in 2023.

4.1.2 Risk Management

From the interview with Mr. Løvli, he explained that the biggest risks associated with this project are that the demolition would leave behind permanent damage to the ground and nature, as well as air pollution from vehicles. He emphasized that the aim is to restore Svea to its natural state, with no lasting damage. To manage these risks, Mr. Løvli and SNSK use a tool called PUS, *Praktisk Usikkerhetsstyrin*g (approximately "practical risk management"), for managing practical uncertainties and risk. In essence, it is an advanced excel document used to visualize and identify the risks such that they can establish strategies for each risk and minimize them. SNSK also regularly runs safety courses for the workers (held by either SNSK or the Governor of Svalbard) to make them aware of the risks and how to manage them. Additionally, SNSK uses checklists for all components of the project to ensure that all risks are accounted for and managed correctly. According to Mr. Løvli, the checklists are also an effective way of standardizing the work conducted in higher risk zones, thereby minimizing the risks.

From the planning and guidelines established by SNSK, the zones with more risks were identified, which made it easier for Mr. Eikrem and Decom to find ways of remediating Svea with minimal risks. The parts of the project that pose the greatest risks are the buildings that shall remain as cultural monuments and conserving them in a correct manner, weather conditions, and of course the health and safety of the workers.

To manage these risks and get an overview, Decom gathered employees with previous knowledge and experience from similar projects to create a document that analyzes all the tasks to be carried out, along with the risks associated with each one. The tasks are ranked on a scale of 1-10 indicating the probability of the risk occurring, which is described as a danger or an unwanted event. Additionally, the document describes the consequences of the risk occurring. Mr. Eikrem explained that each task/risk is first ranked initially and based on the outcome they evaluate based on the physical and organizational barriers. Then they re-evaluate the risk, and if the number still is too high, they continue to work with it and come up with solutions until the outcome is acceptable, allowing the operation to commence (as the risk no longer poses any danger). *"We do not have a database with correct answers on how to handle each risk, we simply do the best that we can with the experience we have",* Mr. Eikrem said.

Activity	Danger	Subject			cause	Risk			Risk Reduction		Risk Remaining			Follow up	
Work Operation	**Source of Danger/Critical Steps/Unwanted events**	**Health**	**External Environment**	**Safety**	**Cause of Unwanted events**	**Consequence**	**Probability**	**Risk**	**Physical Barriers**	**Organizational barriers**	**Consequence**	**Probability**	**risk remaining**	**Deadline**	**Responsible**
Mobilization															
Transport in/ out of Svea	Personal injury when driving a snowmobile or other transport to / from Svea over land			X	The snowmobile ends up in a glacier crack or meltwater channel when driving outside marked trail. Snowmobile tips causing snowmobile accident.	4	2	50	The route is only used when it has been inspected and approved for use (Hæhre performs inspection).	Field course / information for personnel, no driving outside marked trail. Training in the use of snowmobiles	3	2	30		Everyone
				X	Avalanche/Landsl	4	2	50	Continuous assessment of avalanche danger along the route using local expertise (including UNIS, NGI, NVE) and SNSK/NGIs tools for assessing avalanche danger	Planning of work progress so that work in the area is avoided during periods when the risk of landslides is considered to be too high, possibly slack in the progress between subsequent work activities.	3	2	30		AFD
Special Conditions															
Work carried out where there are polar bears	Injury due to polarbear attack			X	Attacks without warning	5	3	150	Bring weapon and enough equipment for flare gun to scare the bear	Procedures for polar bear safety. Safety course in handling polar bears	4	2	50		AFD, SNSG

Figure 4: Extract from Decom's task analysis which has been translated into English. The original is available in Norwegian in Appendix 5

When calculating the risks, and establishing a reasonable budget, Decom uses its own separate calculation software used by its employees. Here they collect all relevant prices from subcontractors, and then their accounting function tests and monitors those calculations. The accounting function consists of employees with different backgrounds, qualifications, and experiences. It sometimes happens that the group gets contradictory results, which is why they have many meetings and continuous communication to ensure that the plan, risks, and financial aspects are correct before they start the project. It is structured in a similar way to the task analysis document pictured above, but in this software, they rank the tasks based on "best case and worst case" to get an average outcome that is realistic. For instance, a task could in a best-case scenario cost NOK 400 000 less than planned, or in a worst-case scenario, cost NOK 400 000 more.

4.1.3 Demolition and Environmental impact

Mr. Løvli said that the biggest challenge when it comes to demolishing Svea in phase 2B is consideration for the buildings that will remain as cultural monuments. There will only be 4 buildings left standing, as well as some equipment used from the 1940's. These buildings are very sensitive and must be handled with utmost care to avoid any damage. Together with archaeologists, SNSK have produced detailed documents of every building and what to take into consideration, such that when Decom demolishes Svea, they are aware of what risks are included in each building and how to manage them. These documents are shared between SNSK and Decom on an online collaboration software called Interaxo, which is a well-known collaboration software used in many construction projects in the Nordic region.

From an economic perspective and based on the time-constraints of the project, Mr. Løvli explained that most of the buildings, equipment and soil will be demolished, dug up on-site and sorted before being shipped off to the mainland. It is not possible to compost on Svalbard because of the permafrost. Unfortunately, it was not economically feasible save and resell old equipment, so most of it needed to be destroyed. Materials such as metal and wood have been sorted and will be sold to be reused, while contaminated soil is dug up and shipped to the mainland to be treated. In order to avoid

Figure 5: Waste is sorted and stored before loaded on ships and transported to mainland Kaisa Nordlund (2021)

any damage to the soil at the Svea site, Mr. Eikrem said that Decom adjusts their plans based on the seasons and expected weather conditions. For example, the tasks which require heavy machinery can be carried out when there is snow on the ground so that the tires do not leave any marks. For the tasks that are deemed to be of higher risk, such as restoring the buildings intended to remain as cultural monuments, Mr. Eikrem said that SNSK provided archaeologists to supervise the demolition such that no damage is done to buildings or soil. He explained that it is not unusual in demolition/sanitation projects that other materials/waste appears - this poses a risk in terms of further costs and delays. Whenever deviations occur in tasks, they are reported and documented in Interaxo such that all involved parties are up to date and aware of the situation.

4.1.4 Concluding Reflections

At the end of the interviews, each respondent was asked what they would have done differently if they could re-do the project today based on what they have experienced so far, as well as if they were met with any surprises.

The main thing Mr. Løvli and his colleague Mr. Velve would have done differently was to set up their camp on Kapp Amsterdam right away and have all the buildings and employees on the same site. *"We should have just closed Svea right away - it was not optimal to spend two years living in Svea center. It was a waste to keep the different buildings warm, especially because it is so expensive to do so… To complete the Svea project, we cannot live in the same place that we are tearing down. It was not until 2020 that we moved to Kapp Amsterdam, and at that point we had spent 2 years living in Svea, with a very expensive diesel consumption and keeping the power plant running".* Mr. Velve also mentioned that the infrastructure in Svea is of low quality, which meant that they constantly had to repair and replace equipment such as heating cables to keep the settlement running. Additionally, the project could have started at an earlier time if they had established a more efficient way of going through all the memorabilia in Svea. The majority of the workers in Svea project were the same people who used to live and work in the mines there. Understandably it was emotional for them to say goodbye and demolish their homes.

Mr. Eikrem said he was pleasantly surprised at how well the project had gone. Thanks to the extensive planning work conducted by SNSK, and the amount of detail they provided to Decom for every task, they knew exactly what to expect which made it easy for them to follow the set plans. He was especially pleased with the level of communication between SNSK and Decom, and the fact that they have established a very good relationship. He explained that it is common in other projects for communication between the owner (SNSK) and contractor (Decom) to be sparse. Furthermore, it is rare that such extensive evaluation work is conducted of the site prior to remediation. Typically, when that happens, they may end up finding more contamination than expected, which in turn entails increased costs and delays in the project. This has not been the case at all with Svea, which is why Decom and SNSK have had such great success with the project thus far.

However, Mr. Eikrem did express that he would have liked to have more say in *when* they (Decom) could have started the project. "*If I could have decided, we would have started the project while we transported equipment to Svea with a ship. It would have simplified the logistics significantly, as well as our bidding offer (economically)"*. When Decom received the offer, they had to start on 1 March 2021, and they signed the contract at the end of January 2021, during which time was not possible to ship equipment to Svea because the fjord is frozen. This meant that Decom incurred higher costs because they had to ship equipment to Longyearbyen instead, and then transport everything through the terrain using snowcats and sleds. This made the project more challenging and expensive, along with it having a more significant environmental impact.

5. Analysis & Discussion

5.1 Scheduling/Risk Management Tools

From the interview results gathered from the project managers in Svea regarding how they calculate and measure the duration of each task, the *Critical Path Method (CPM)* has proven to be a useful tool. Through the extensive preparatory work carried out by SNSK, *CPM* has been a vital tool in determining the duration of each activity. As mentioned by Atin and Lubis (2019), *CPM* is particularly useful in terms of economic time and efficiency and is based on observation and experience by those with prior knowledge. While planning for the remediation of Svea, both SNSK and Decom used experts with extensive prior knowledge to help estimate, calculate and forecast the duration of the various components of the project. Furthermore, the cooperation between SNSK and Decom further facilitated a successful outcome from applying *CPM*. With SNSK's detailed plan, Decom was able to accurately calculate the duration of the activities, identify tasks with slack and find creative ways of speeding things up at the lowest possible cost. By using *CPM* strategies and experience, project managers have managed to minimize both costs and the duration of the project.

According to Darmody (2007) the *Gantt* chart is one of the most essential tools in project management. The tool graphically illustrates the order of activities, making it easy to interpret what happens and when. SNSK's case mirrors this functionality by using *Gantt* charts to visualize the scope of the project and enable all of the parties involved to easily get an overview of all ongoing and planned activities. Decom on the other hand, expressed that *Gantt* charts were not necessary for demolition planning as these activities were not advanced enough to merit the use of this tool in day-to-day operations. Thus, *Gantt* charts are more useful to depict projects on a broader scope to get an overview and prioritize, rather than in the minute details.

FMECA is a design tool used to identify points of failure in a given system. It is used to pinpoint failure modes and rank these in order of criticality to a given system. This is an effective way of managing and mitigating risk (NASA, 1990). Both SNSK and Decom have developed tools based on the principles of *FMECA*. Decom created a document analyzing each task required to be carried out coupled with the associated risks. Much like *FMECA,* these are ranked on a scale indicating the probability of the risk scenario occurring. The tasks are then re-evaluated based on physical and organizational barriers until the risk is deemed acceptable enough to commence operations. SNSK uses a tool called PUS, essentially an advanced excel document used to identify and establish strategies for risk. The idea behind all these iterations of the same tool is simple, risk becomes less threatening and manageable when identified. When strategies are in place before disaster hits, the effects will be mitigated and thus not be disastrous for the project.

PERT is a useful tool when calculating the cost and duration of tasks within a project. To account for uncertainty in calculations, *PERT* uses three estimate intervals: *Optimistic Estimate*, *Most Likely Duration* and *Pessimistic Duration.* By gathering these estimates, it is possible to calculate the probability that a project or activity is completed within a certain estimated interval (Lantz, 2015) (Habibi et. al, 2018). Much like the *FMECA* iterations created, a *PERT* iteration was created using software to calculate costs and duration of activities. The software is used to rank tasks based on "best case and worst case" in order to present an average, realistic outcome. When accounting for uncertainty, variations in cost and duration will not come as a surprise and can be managed accordingly.

Although *Toyota Production Systems* (TPS) was originally developed for manufacturing, its management principles are widely applicable. *Muri*, *Mura* and *Muda* are three key components of the TPS. *Muri* being tasks that are overly complicated with insufficient specifications. *Mura* being variation in difficulty of tasks that are not evenly dispersed over the project's timeline. *Muda* being waste; like underestimating and not utilizing expertise within the organizations (Ohno, 1988). To manage and minimize *Muri*, SNSK has created checklists that standardize the way in which, and in what order, tasks are executed. The extensive planning and detailing of each task that needed to be carried out led to accurate calculations in difficulty and duration of said tasks. This allowed for a well-planned out timeline that avoids *Mura*. Throughout the project and its planning, both SNSK and Decom have utilized their in-house expertise. The experience within the organizations is referenced repeatedly when discussing the creation of standardized practices, risk/cost analysis documents and everything in between. The practice of identifying and utilizing corporate knowledge in this way minimizes the risk of waste: *Muda*.

5.2 Environmental Considerations

From the report produced by Naturvårdsverket (2008), one of the challenges associated with remediation work is the lack of knowledge regarding the risks surrounding high-risk or contaminated areas, and how to handle these. In the Svea project, SNSK and Decom dealt with this obstacle via extensive preparatory work/planning. The detailed documents for each task and the risks connected with each task helped reduce all risks associated with environmental impact. Furthermore, by involving archaeologists to oversee the operations, SNSK further ensures that as little damage as possible is done to the environment and buildings.

Based on the knowledge and background work conducted, SNSK determined what type of remediation method to use. From the three methods inspired by Naturvårdsverket (2008), *on-site*, *off-site* and *in-situ*, it is evident that *on-site* and *in-situ* treatment are not possible in the context of Svalbard. This is because of the permafrost and strict regulations for ensuring that as there is as little damage as possible to the environment. For example, it is not possible to dig deep enough into the ground because it is frozen, and there is high risk of damaging the soil and leaving marks by using *in-situ*.

The appropriate technique for Svea is *off-site* treatment and landfill. By removing and sending all contaminated soil and infrastructure to the mainland by ship, the risks associated with environmental damage are reduced since SNSK can quickly remove the material. It also shortens the duration of the project and Svea's ultimate closure.

5.3 Human Factors – a New Perspective

The tools and strategies mentioned in Chapter 3 are well-known and used by the project managers involved. Despite Svalbard's remote location and access to limited resources, the tools and experience gathered by SNSK and Decom have been both useful and successful in the aim of reducing risks associated with environmental impacts, costs, and the time it takes to complete the project.

However, what surprised the project management is the impact of emotions and feelings of sentiment connected to the settlement. Prior to Decom arriving at Svea, the workers who were tasked with removing Svea were the same who used to live and work in Svea. They were the ones who had to clean out their homes and go through all the memorabilia, and it is understandable that they were saddened to say farewell to their homes. It seems here that managing these feelings better could have been an opportunity to reduce times somewhat, which may have reduced costs.

Finally, the importance of experience and tools to communicate should be emphasized. A major factor which allowed the Svea project to be so successful, is that the team working on it consists of people with a wide range of experience and knowledge. These expert teams have contributed significantly to minimizing risks associated with increased costs because of their ability to account for all risks, and how to tackle them. Furthermore, the excellent communication between SNSK, the Governor of

Svalbard, and Decom have facilitated higher transparency, such that no surprises have arisen. This has been a key factor for operations having gone so smoothly.

6. Conclusion

Svea is a very successful project conducted by a highly experienced and skilled team of employees. Strict environmental regulations along with Svalbard's challenging weather, terrain, and remote location, as well as the emotional connection workers have to the site have made its success all the more impressive.

Furthermore, the project has successfully utilized the tools and methods considered to be standard in the literature, including *CPA, PERT, Gantt* Charts, *FMECA, TPS* as well as using the most suitable conservation method, *off-site treatment*.

The validity of this thesis has been greatly improved and strengthened by having access to such experienced and competent staff, which has meant that the input data for the tools and methods used have been of high quality. The staff has also ensured and demonstrated that field activities have been carried out in a safe and professional manner - which has led to minimized environmental impact as well as safely preserving all historical remains.

Thus, the answer to the research question is as follows: risks associated with environmental impact, costs and time it takes to complete the operations can successfully be minimized with the use of competent and experienced staff who in turn use the standard portfolio of tools and methods provided in the literature.

However, the interviews showed further potential for improvement that is not addressed by standard methods and tools: staff motivation and emotions.

Our conclusion is that in situations where a project outcome significantly impacts the lives of those in charge of its implementation, it is essential to take into account their motivation and feelings, using tools and methods appropriate for that as well. Examples of such tools could be an on-site counselor or positive incentives to motivate the staff to see the work through.

Finally, we would like to congratulate everyone involved in the Svea project on an exemplary job of running an effective project that nurtures the Arctic environment and preserves the memories and emotions that exist in the mining history at Svea.

7. Future Research

This thesis has addressed project management tools, specifically focusing on remediation project management. The main contribution was to identify that working with staff motivation and feelings can further improve project performance beyond what the standard set of project management tools can do.

For future research it would be relevant to explore methods of handling the softer aspects, namely the emotional ties that employees or others have to the construction site. Additionally, it would be interesting to see what effects it would have on the project’s outcome if suitable methods had been used for that purpose. This is especially relevant given the fact the last mine in Longyearbyen is due to be closed and removed in a few years, which is a large part of the town’s identity and history.

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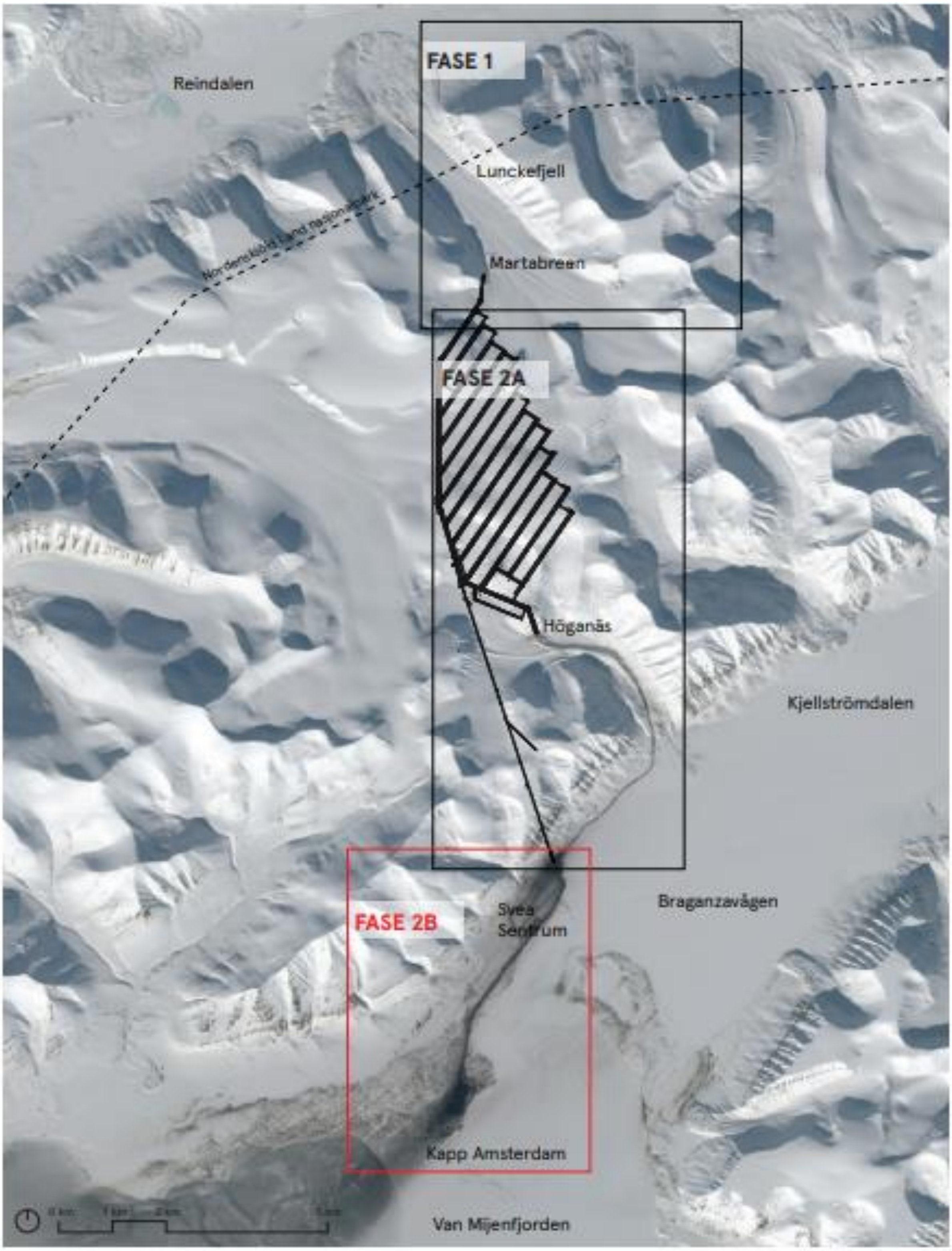
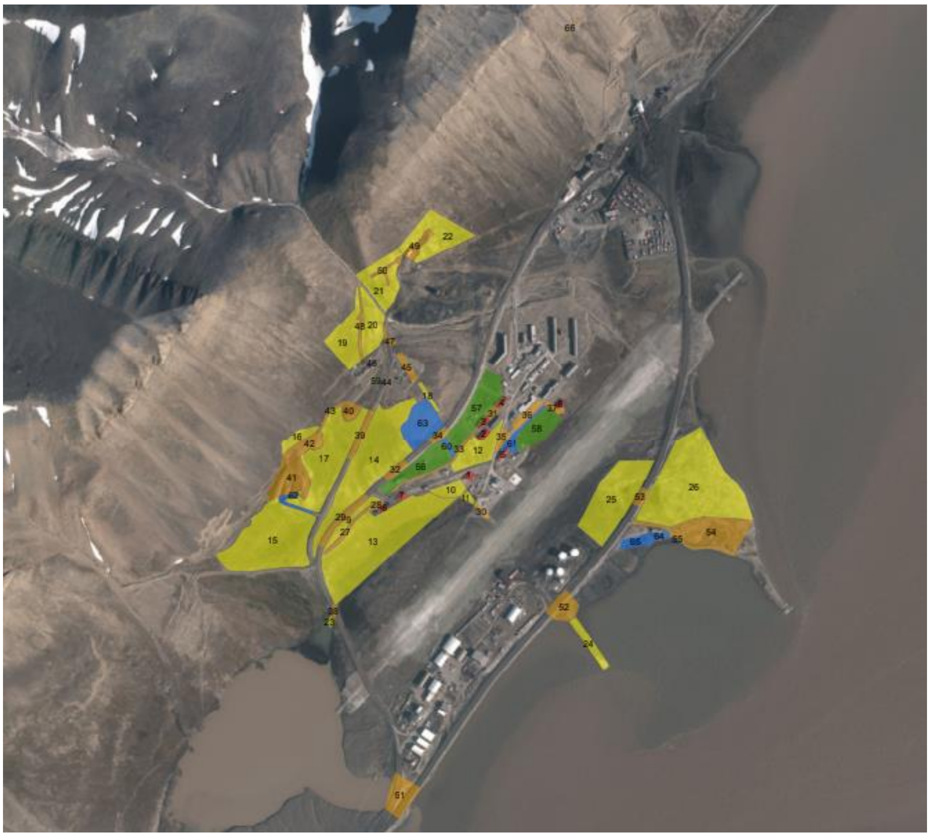
Appendix

Appendix 1 - overview of Svea project. Image retrieved from SNSK



Appendix 2 - Mapped areas of Svea.

From “Kulturminnekart med arbetsbeskrivelser” received from Mr. Seljevold



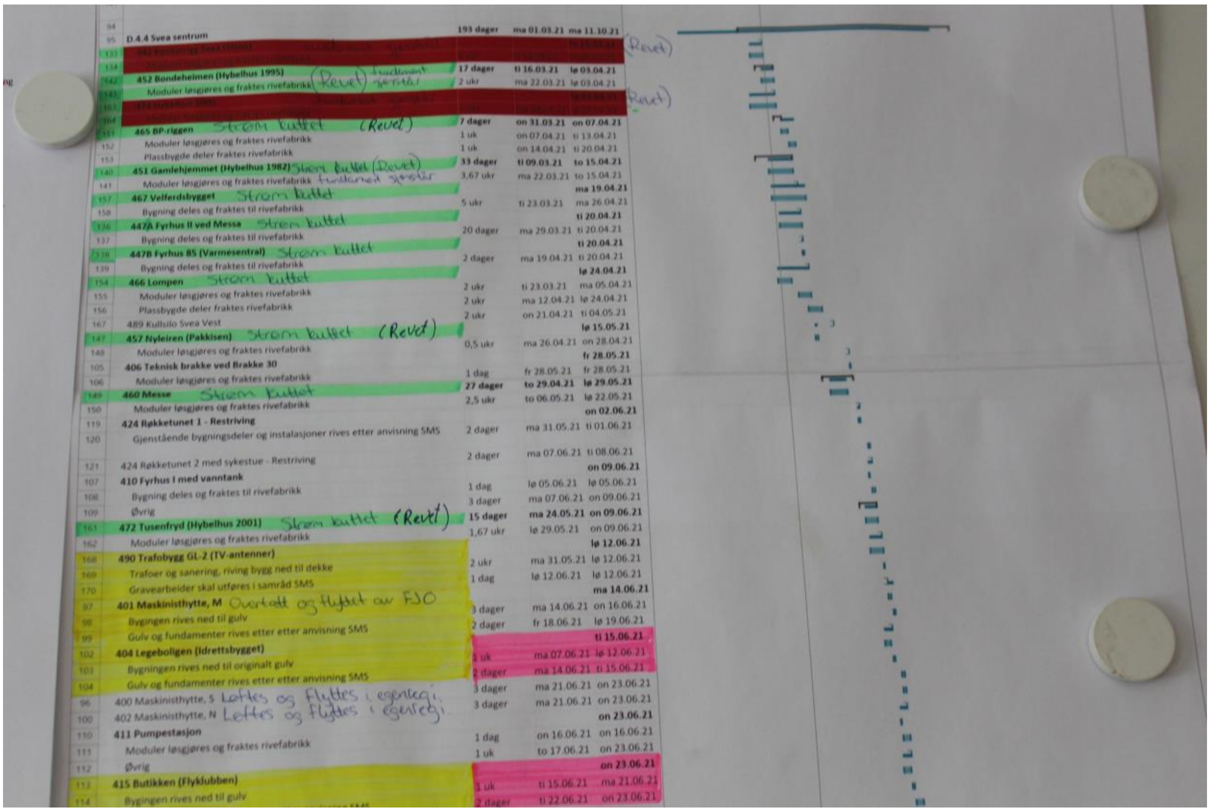
Appendix 3 Extract of description of the mapped areas

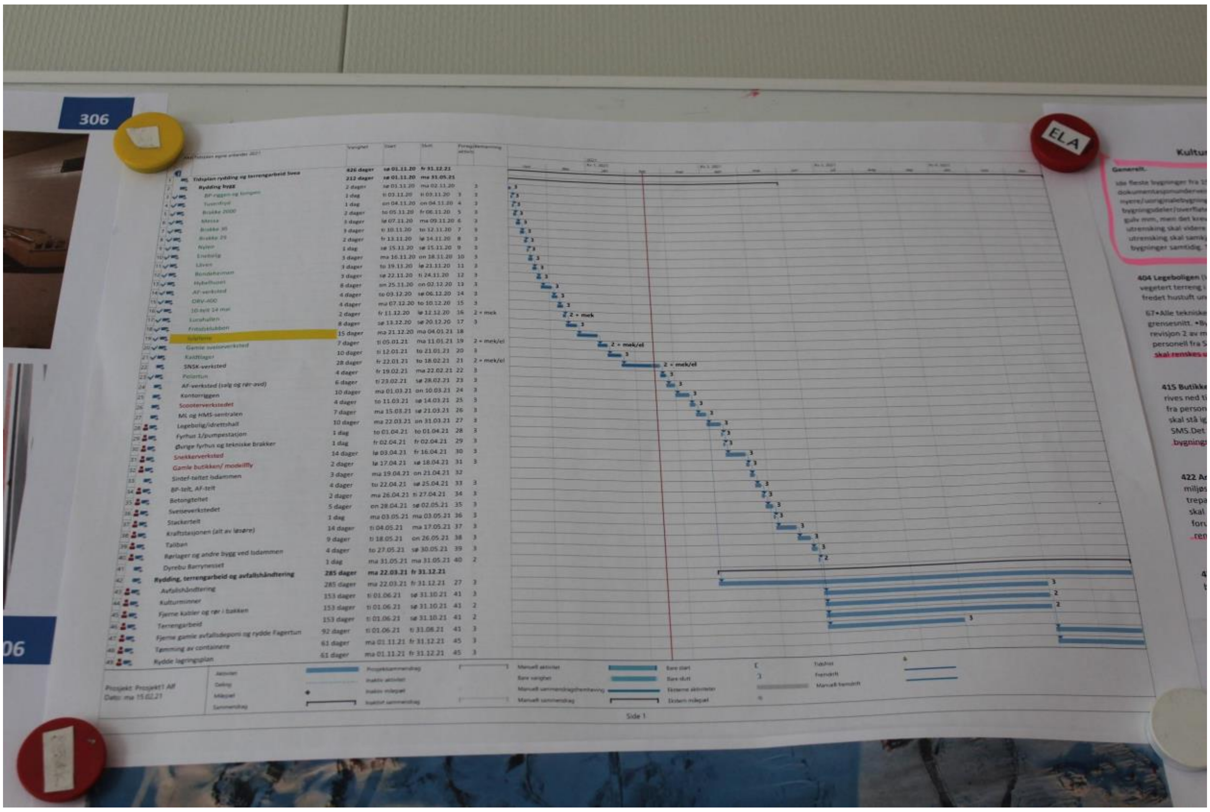
From “Strukturliste” received from Mr. Seljevold.
The numbers are connected to the zones on the map in Appendix 2.

Askeladden ID	Omr.	Beskrivelse	Strukturnummer	Gammel Id / nyregistrering
263621-58	2	Tuft	B120	Nyregistrert
263621-59	2	Taubanebukk	BT1	Nyregistrert
263621-60	2	Betongfundament	D101	Nyregistrert
263621-61	2	Betongfundament	D102	Nyregistrert
263621-62	2	Trestolpe med skoningsstein	D103	Nyregistrert
263621-63	2	Metallgjenstand	D104	Nyregistrert
263621-64	2	Lastevogn og store metallgjenstander	D105	Nyregistrert
263621-65	2	Veifar og bygningsrester	D111	Nyregistrert
263621-66	2	Trestolpe med skoningsstein	D117	Nyregistrert
263621-67	2	Tuft etter Reservekraftstasjon	H17	Nyregistrert
263621-68	2	Bygningsrester	H39	Nyregistrert
263621-69	2	Tuft 1 norsk etterkrigsperiode	NH1	Nyregistrert
263621-70	2	Tuft 2 norsk etterkrigsperiode	NH2	Nyregistrert
263621-71	2	Tuft 3 norsk etterkrigsperiode	NH3	Nyregistrert
263621-72	2	Gamle bakeriet / Vinboden (Bygg 413)	NH4	144344-1
263621-73	2	Sykehuset / Saloonen (Bygg 405)	NH5	144344-2
263621-74	2	Legebolig/gymsalen (Bygg 404)	NH6	144344-3
263621-75	2	Gamle butikken (Bygg 415)	NH7	144344-4
263621-76	2	Fjøset / Verksted – skytebane (Bygg455)	NH8	144344-5
263621-77	2	Arbeidermessa (Bygg 422)	NH9	144344-6
263621-78	2	Bygningsrester	B131	144344-7,-17
263621-79	4	Hundegården (Bygg 345)	NH12	144344-25
263621-80	2	Brakke 29 (Bygg 429)	NH10	Nyregistrert
263621-81	2	Brakke 30 (Bygg 430)	NH11	Nyregistrert
263621-82	1a	Tuft/bygningsrester	B105	Nyregistrert
263621-83	1a	Gruveåpning	B121	159020-1
263621-84	1a	Gruveåpning	B124	159020-2
263621-85	1a	Massetipp	B122	Nyregistrert
263621-86	1a	Tuft etter smørehall/verksted	B123	Nyregistrert
263621-87	1a	Tuft/bygningsrester etter Kullsilo	B126	Nyregistrert

Appendix 4 - Gantt Charts

Photo of visualization wall at the project management office at Svea (19 April 2021).
Photo by Kaisa Nordlund





Appendix 5 – Decom's Task analysis in Norwegian,

Screen shot from Excel

OPPGAVEANALYSE

A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R
ID	AKTIVITET	FARE	FAG			ÅRSAK	RISIKO			RISIKOREDUKSJON		RESTRISIKO			OPPFØLGING		
ID. Nr	Arbeidsoperasjon	Farekilder/ kritiske trinn/ uønskede hendelser	Helse	Ytre miljø	Sikkerhet	Årsaker til uønskede hendelser	Konsekvens	Sannsynlighet	Risiko	Fysiske barrierer	Organisatoriske barrierer	Konsekvens	Sannsynlighet	Risiko, rest	Frist	Ansvarlig	Signatur (Utført ok)
	Mobilisering																
	Transport inn/ ut av Svea	Personskade ved kjøring med snøskuter eller annen transport til/fra Svea over land			x	Skuter havner i bresprekk eller smeltevannskanal ved kjøring utenfor oppmerket løype. Skutervelt og skuterulykke.	4	2	50	Trase benyttes kun når denne er kontrollert og godkjent for bruk (Hæhre utfører kontroll).	Feltkurs/informasjon til personell, ingen kjøring utenfor oppmerket løype. Opplæring i bruk av snøskuter.	3	2	30		Alle	
					x	Snøskred/sørpeskred	4	2	50	Løpende vurdering av skredfare langs traseen ved hjelp av lokal kompetanse (bl.a. UNIS, NGI, NVE) og SNSK/NGIs verktøy for vurdering av skredfare.	Planlegging av arbeidsfremdrift slik at arbeider i området unngås i perioder hvor skredfaren er vurdert til å være for høy, eventuelt slakk i fremdriften mellom etterfølgende arbeidsaktiviteter.	3	2	30		AFD	
	Rigging	Utstyr fra fastlandet er forurenset med frø/uønsket biologisk materiale som ikke hører hjemme på Svalbard		x		Forsendelse av ikke rengjort utstyr	5	2	100	Spyling og rengjøring av utstyr før forsendelse	Info om denne spesielle risikoen til prosjektpersonell	5	1	50		AFD	
		Kollisjon mht trafikk, uvedkommende, tredje part, påkjørsel			x	Arbeidsområde ikke definert/inngjerdet, uoppmerksomhet	3	2	30		Det er infomert i lokale media om oppstart av anleggs-virksomhet på Svea, slik at det er allment kjent at aktivitet pågår	3	1	15		AFD	
		Fare for utslipp fra dieseltank på anlegget		x	x	Påkjørsel, inkl. skade ved brøyting	5	2	100	Bruke eksisterende tanklagring på anlegget som hovedlager Bruke doble, mobile dieseltanker for fylling av drivstoff ute i anlegget Sette tanken på en egnet plass slik at den er synlig, godt lys på anleggsplass.	Info om hvor tank skal stå der det er flere tunge kjøretøy inne på anlegget	4	1	25		AFD	
				x		Lekkasje ved fylling	3	2	30	Bruke sugeslange/pumpe	Maskinfører følger med ved fylling	3	1	15		AFD	
	.Mobilisering av personell/ ankomst personell på prosjekt	Prosjektet innebærer nye og ukjente problemstillinger som isbjørn, skredfare, snø-/isvei, kulturminner		x	x	Nytt personell kjenner ikke til de nye farene og riktig atferdsmønster på Svea	5	2	100		Prosjektpersonell får oppstartskurs ved ankomst prosjektet	5	1	50		AFD/SNSG	

Appendix 6 - Question Guide

1. Background

- Can you tell us about your role in Svea?
    - What does a “normal day” look like?
- What goals were / are there for each phase and how are these measured (metrics)?
    - Are these metrics prioritized in any way?

- We are focusing on tools that minimize risks – thus the following background information is important to know:
    - What are the risks where the project can cause environmental damage (equipment breaks down and causes emissions, accidents, etc.),
    - What are the risks that the project does not carry out the remediation correctly / properly (ie the environmental problems are not remediated)?
    - What are the main risks (in addition to the above) that cause price increase?
    - What are the main risks (in addition to the above) that cause delays?
    - Have you had any situations where risks have actually occurred?

2. Planning with a short time frame

- Can you give us an overview and tell us how you worked when you planned this project? How did you work step by step?
    - What result do you wish to achieve from the planning? How is this result used? How do you know when the planning is complete?

- How did you work with the risks we discussed?
    - What Tools did you have for this in the various stages of planning?
        - eg checklist, old plans, budget tools / processes, post-it notes, etc
        - which tools did you think work best? did you miss anything?

- What are the internal and external risk factors that affect the project's **environmental risks**?
    - How do you plan for these (tools)?
    - Have you developed your own strategies for minimizing risks based on experiences from previous projects that have been successful? If so, which?
        - How did you develop these (method + tools)?
        - What made them successful? which tools did you think work best? did you miss anything?
        - How have you possibly modified the strategy to suit Svea?

- What are the internal and external risk factors that affect the project in terms of **cost**?
    - How do you plan for these?
    - Have you developed your own strategies for minimizing risks based on experiences from previous projects that have been successful? If so, which?
        - How did you develop these (method + tools)?
        - What made them successful?
        - How have you possibly modified the strategy to suit Svea?

- What are the internal and external risk factors that affect the project in terms of **time**?

    - How do you plan for these?
    - Have you developed your own strategies for minimizing risks based on experiences from previous projects that have been successful? If so, which?
        - How do you develop these (method + tools)?
        - What made them successful?
        - How have you possibly modified the strategy to suit Svea?

- Which aspects / activities within the remediation are most sensitive / critical / time-consuming?
    - Why are they sensitive?
    - What impact do they have on the outcome of the project?
    - How did you identify them?

Do you do any retrospective work? (ie reflection / evaluation meeting at the end of the respective phase to evaluate what you have learned / pass it on to future projects. eg with the help of checklists, or for this in this project if it would be relevant)

Concluding / other questions

- If you could redo the project / planning with what you can now, what would you have done differently?
- Any tool you thought was really good, really bad, or that you missed?
- What are you most proud of in the project?