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Jingyao Su
Environmental resources and sustainability undergraduate student
University of Waterloo, Canada

Simon Courtenay [Instructor]
University of Waterloo, Canada

THE ASSESSMENT OF TECK'S CASTLE PROJECT BASED 
ON FIVE VALUED ECOSYSTEM COMPONENTS

Abstract. Teck's Castle Project is the largest coal mine project to be mined in Canada. This article is an environmental assessment of Teck's Castle Project based on five valued ecosystem components (VECs) including: Surface Water Quality, Fish and Fish habitat, Vegetation, Local Employment, and Land Use. I proposed to use a surface water quality model to detect the degree of pollution of the water quality of the surrounding rivers and use an economic multiplier to measure the impact on local economic employment. Through research, I found that the water treatment facilities used by Teck Coal Limited can effectively alleviate the impact of the project on the water quality of the surrounding rivers, and I recommended that Teck Coal Limited wear protective equipment to protect their health when working.

Keywords: Valued Ecosystem Components, Teck's Castle Project, Environmental

1. Introduction

Teck's Castle Project is to mine the largest coal mine in BC and Canada. Teck Coal Limited is the company implementing this project (EPIC, 2020). They propose expanding the infrastructure of the open-pit metallurgical (for steelmaking) coal mine at Fording River Operations in south-eastern British Columbia (BC) from 2023 and start producing coal mines in 2026 (Teck Coal Limited, 2020). Mining is the backbone of the Elk Valley economy and, through its five steelmaking coal
operations, Teck is the major employer in the area (Teck, 2020). The expansion of the Castle project and its impact on the environment and indigenous peoples necessitate a federal Evaluation (Cruickshank, 2020).

This article will introduce the five valued ecosystem components (VECs) that might be selected by the stakeholders and rightsholders who involved in and affected by Teck’s Castle project, and then analyze the impacts of project activities on the 5 VECs and express their degree of impact. The two VECs determine the magnitude of project activity's impact on water quality and local employment and describe the significant impacts of these two valued components (VCs) by using the magnitude. Finally, suggest and describe possible mitigation measures for the two VCs, water quality, and local employment.

2. Five VECs Selected

2.1. Surface Water Quality (Teck, 2020)

The Castle project will operate next to the Elk River in Teck. The noise and exhaust emissions from Teck mining activities include the Elk River (Teck, 2020). The Elk River catches approximately 4,450 square kilometres, and then merges into the Columbia River and finally into the Pacific Ocean (Wikipedia, 2020). The Elk River flows through an extremely wide area, and the water quality affects the area extremely, which will cause pollution without borders. Therefore, the monitoring and management of pollutants in the elk river's water quality are particularly important. The Elk Valley River now has a high selenium content. This is a longstanding problem. The waste rock produced by Tektronix’s existing mines has polluted the water quality of the Elk River (Fischer, 2020). In addition, the closer you are to the mine, the more serious the water quality is. Drinking selenium-contaminated water will also pose a threat to human health (Williams, 2019). The Castle project is to expand more mines than the existing ones, and produce more waste rock. A large amount of rubble will be exposed to water and air as the project progresses. Crushed stone rubble is also the source of a large amount of selenium in the water (Williams, 2019). Therefore, the impact of the River Management Castle project on the water quality of the Elk River should be monitored.
2.2. Fish and Fish habitat: Cutthroat Trout (Teck, 2020)

Elk River lives in large numbers of salmon and trout. They lay their eggs on the pebbles in the basin and need clear and high-quality river water (Applied Aquatic Research Ltd., 2007). The addition of pollutants in the river and the explosion during project activities will affect fish habitat and lives. The excessive selenium content in the elk river mentioned above has severely affected the cutthroat trout in the watershed (Wikipedia, 2020). In the past few years, pictures of abnormal fish catches have appeared frequently, and scientists have found a lot of evidence that the cutthroat trout of these shortened gill plates and have snubbed noses was caused by the influence of selenium leached from coal mines in the Elk River Valley (Williams, 2019). The excessively high levels of selenium in river water have exceeded the levels known to cause fish reproductive failure (Williams, 2019). It is estimated that selenium in rivers “is killing nearly half of juvenile fish-more than 180,000 fish every year” (Williams, 2019). Not to mention, the trout population in the lower waters of the Fording River has collapsed (Fischer, 2020). Therefore, in order to protect the safety of fish in the Elk River, it is necessary to strictly limit selenium pollution, and it should be lower than the current limit (Cruickshank, 2020).

2.3. Vegetation: Whitebark Pine & High Elevation Grasslands (Teck, 2020)

The mining of coal mines will inevitably clear the vegetation on the surface, and its own open-pit mining will damage the vegetation, and the vegetation that provides the storage area for waste rock will also be destroyed (Nicholls, Drewitt, Fraser, & Carey, 2019). Open-pit mining is the main method of mining ore by Teck, so the vegetation damage to the project area is extremely massive (Teck, 2020). The vegetation in this area includes spruce and fir trees, grassland, and whitebark pine. Abundant herbs provide wild animals. A good living environment (Teck, 2020). In addition, the Castle project is bound to affect BC’s high-altitude grassland, and high-altitude grassland is an important ecosystem in BC, so stakeholders and rightsholders will choose vegetation as one of them VECs (Teck, 2020).

2.4. Local Employment (Teck Coal Limited, 2020)

The Castle project was established in a traditionally populated area. Tektronix
actively cooperates with local indigenous people and other partners in project implementation, providing a large number of jobs for Elk Valley, and promoting economic growth (Teck, 2020). For example, ore mining workers, transportation workers, and workers dealing with long-term selenium management and other substances released by mining activities (Teck, 2020). But long-term participation in mining work will also cause negative health to local workers Impact. Research has shown that “long-term exposure to high concentrations of selenium can cause nausea, fatigue, skin damage and neurological diseases” (Williams, 2019). Therefore, it is necessary to evaluate in detail the possible economic benefits of the Castle project and the impact on the health of employees.

2.5. Land Use (Teck Coal Limited, 2020)

The Castle project will inevitably destroy the land and mountains. Stakeholders and rightsholders need to communicate with local aboriginals, whether the project activities will affect the lives of the aboriginals. For example, whether land occupation will damage Kainai’s ability to harvest plants for food, medicinal, and ceremonial (Cruickshank, 2020). Will it affect Kainai’s hunting rights, and traditional activities, such as hunting practices of elk, mule deer, and bear (Cruickshank, 2020). In addition, the damage to the mountains in the project may cause a large amount of river water to rush downstream, cutting off the travel routes of wild animals and plants and local aboriginals (KleanIndustries, 2020).

3. Simple Interaction Matrix

Table 1

| Valued Ecosystem Component (VEC) | Project Activities | Total Impact Score |
|---------------------------------|--------------------|--------------------|
|                                 | Rock storage       | Waste treatment    | Site cleaning (passage, mine pit) | Coal transportation | Use of explosives | infrastructure |                   |
| Water quality                   | -3                 | -1                 | -2                            | -2                 | +2                | -6               |
| Fish and fish habitat           | -4                 |                    | -1                            | -1                 | +2                | -4               |
| Vegetation                      | -2                 | -1                 | -3                            | -1                 | -3                | -10              |
| Local employment                | -2                 |                    | +3                            | -2                 | +2                | +1               |
### Table continuation 1

| Valued Ecosystem Component (VEC) | Project Activities | Total Impact Score |
|----------------------------------|--------------------|--------------------|
|                                  | Rock storage       | -3                 |
|                                  | Waste treatment    | -1                 |
|                                  | Site cleaning      | -4                 |
|                                  | Coal transportation|                    |
|                                  | Use of explosives  |                    |
|                                  | infrastructure     |                    |
| Land use                         |                    | -8                 |
| + = positive impact              |                    |                    |
| +/- negative impact              |                    |                    |
| no impact                        | no impact          | 0                  |
| negligible impact                | negligible impact  | 1                  |
| minor impact (short term)        | minor impact       | 2                  |
| major impact (medium term)       | major impact       | 3                  |
| severe impact (permanent)        | severe impact      | 5                  |

The Secretary of the U.S. Environmental Protection Agency wrote to "The direct and cumulative effects of coal mining in Elk Valley have led to impacts on the water quality, fish and fish habitats of Lake Koocanusa and Kootenai River." (Cruickshank, 2020). Open-pit mining is the main method of obtaining coal reserves in North America. The process involves removing vegetation, soil, and rocks. Therefore, the impact of site cleaning and explosive use on vegetation is -3 (Nicholls, Drewitt, Fraser, & Carey, 2019). Since Teck Coal Limited planned to cover waste rock by vegetation, the impact of waste rock treatment on vegetation is -2 (Teck, 2020). More than half of Teck Castle's greenhouse gas emissions are caused by burning fossil fuels during truck transportation. A large number of greenhouse gases will affect nearby rivers and plants, and acid gases have a particularly obvious impact on water quality (Fischer, 2020). Therefore, the impact of coal transportation on water quality is -2, and the impact on plants, fish, and fish habitat is -1 (Fischer, 2020). However, at the same time, coal transportation provides many jobs for local residents, so the impact on local employment is +3.

### 4. Method to Magnitude the Impacts

#### 4.1. Surface Water Quality

The Castle project's activities will affect the local water quality, and the polluted water also affects the aquatic life living in it, the surrounding wildlife, and humans. The main reason for the decline in the water quality of the Elk River is that...
the selenium element in the rubble in the mining process seeps into the river water (Williams, 2019). Surface water quality models can help stakeholders and rightsholders better understand the impact of pollutants on surface water and how better to protect surface water (EPA, 2014). This model can be used to detect the pollution of the Elk River water quality and whether Teck's solutions are effective.

4.2. Local Employment

To measure the impact of local employment on the economy, needing to use economic multipliers. The Castle project can be seen as an injection of funds into the local economy, which will increase the initial currency of local funds, and then as employees’ income bids, the impact on the local economy will increase in the form of a multiplier (Noble, 2015). Through economic multipliers, it can be predicted that the Castle project can bring huge economic benefits to the local area. Besides, the increase in local employment can promote economic development and promote the healthy development of the community and improve local residents' happiness.

5. Impact Significance

5.1. Surface Water Quality

The Castle project has a long-term impact on the water quality of the Elk River. During and after the project, selenium will pollute the water quality, and selenium cannot be separated directly from the river, and finally flows into the Pacific Ocean to cause borderless pollution (Wikipedia, 2020). Although Teck has taken protective measures, its effect is not significant from the perspective of the existing mines. It still has an impact on the water quality of the Elk River and has an impact on the fish in it (Fischer, 2020; Wikipedia, 2020). Therefore, the impact of the Castle project on the water quality of the Elk River is long-term and significant.

5.2. Local Employment

As one of the top 100 employers in Canada, Teck provides a large number of jobs for Elk Valley (admin, 2019). Only now Fording River employs about 1,400 workers, and when the Castle project is launched, Teck will provide more jobs to locals, such as truck driver and miner (Jones, 2020). Coupled with Teck's investment
and construction in the local area, this Castle project has a long-term and huge impact on the local economy. However, the inevitable blasting and waste gas pollution in project activities will also adversely affect the health of employees (Williams, 2019). Even if it is known that high concentrations of selenium have a huge impact on the human body, it is difficult to predict the extent and durability of the harm to the human body during the implementation of the project (Williams, 2019).

6. Mitigation Measures

6.1. Surface Water Quality

Water treatment facilities can effectively reduce downstream water pollution problems. The first water treatment facility operated by Teck in Line Creek is currently processing up to 7.5 million liters of water, and its downstream selenium concentration has also been reduced (Cruickshank, 2020). Teck is also continuously improving the processing speed of their facilities and plans to process up to 47.5 million liters of water by 2021 (Cruickshank, 2020). Even if water treatment facilities can significantly reduce selenium and nitrate in the watershed, selenium will continue to flow out of the waste rock in the mine, so water treatment plants are not a cheap long-term solution. (Cruickshank, 2020). Reducing the output of selenium and nitrate is the key. Teck's saturated rock landfill method can almost completely remove selenium and nitrate in the waste rock, and Teck is also developing new liners to reduce nitrate explosives' contact with water (Teck, 2020). Under the new technologies and effective supervision of the Castle project can almost negligible pollution of surface water.

6.2. Local Employment

Explosions and exhaust gases during the Castle project activity may potentially affect the health of the staff. The main reason for the impact on the human body is that dust enters the respiratory tract, so employees should wear protective gear when working to avoid dust inhalation (Gasparotto & Martinello, 2020). And regularly arrange for employees to conduct physical health checks, check their physical
conditions, and change their work content according to their physical conditions, which can greatly reduce the impact of exhaust gas on employees (Howard, 2018).

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