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Evaluation of the Embedded Environmental Impacts of the Sanitary Sewer System Using Life Cycle Assessment

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Introduction

This study identifies the overall impact that the installation and construction phase of sanitary sewer systems have on the environment. Construction data on sanitary sewer systems from small Nebraska communities was collected and compared to the operating phase of the sanitary sewer. The operating phase is the energy required for the lift station. Analyzing sanitary sewers during their entire life cycle involved the raw materials, infrastructure construction, installation, operation of the system, and maintenance.

Wastewater treatment systems are meant to reduce the negative impact that humans have on the environment. The purpose of the system is to treat and disinfect the toxic wastewater before returning it back to the environment. Few studies have been published on the embedded environmental impacts of the installation and construction phase of sanitary sewers. Most studies evaluated only the operational phase. Better planning and designing can be performed for sanitary infrastructure if the embedded environmental impacts are understood.

Research Questions

1. What percentage of the overall impact does the installation and construction of the sanitary sewers account for?
2. How does this impact compare to the municipal wastewater treatment systems?
3. How much of an impact will be seen from switching to more sustainable materials?
4. What can small municipalities do to reduce their environmental footprint from their sanitary sewers?

Methods

Study Population

- The construction and operational phase of the wastewater collection and treatment system were analyzed for three small Nebraska communities.
- The community threshold was <2,000 people and systems treating less than 0.6 million gallons per day (MGD).

Table 1. Three case studies' information

	Town 1	Town 2	Town 3
Population	223	409	1702
Town Footprint (m ²)	569,797	1,243,321	1,735,428
Flowrate (m ³ /year)	125,814	736,157	762,293
Population Density (people/m ²)	3.914E-4	3.290E-4	9.808E-4

Data Collection

- Data was obtained from the municipalities, records retained by the Nebraska Department of Environmental Quality, engineer design documents.
- Energy data for the lift stations was collected directly from the municipalities

Data analysis

- The functional unit for analysis was per m² of town area in order to normalize the data.
- Analyzed the environmental life cycle impact using SimaPro and using background process data from EcoInvent v1.7 database to evaluate relative impact of operating and construction phases.
- Compared the life cycle impact of the sewer collection system to impacts from the centralized treatment system.
- Concrete was evaluated as an alternative to clay brick for manholes.

Results

Construction vs. Operation

- Construction and installation contribute 8%-59% of the collection systems overall impacts depending on the category.
- Construction and installation of the collection system, when compared to the entire collection and water treatment system, contribute 9%-12% of the overall impact.

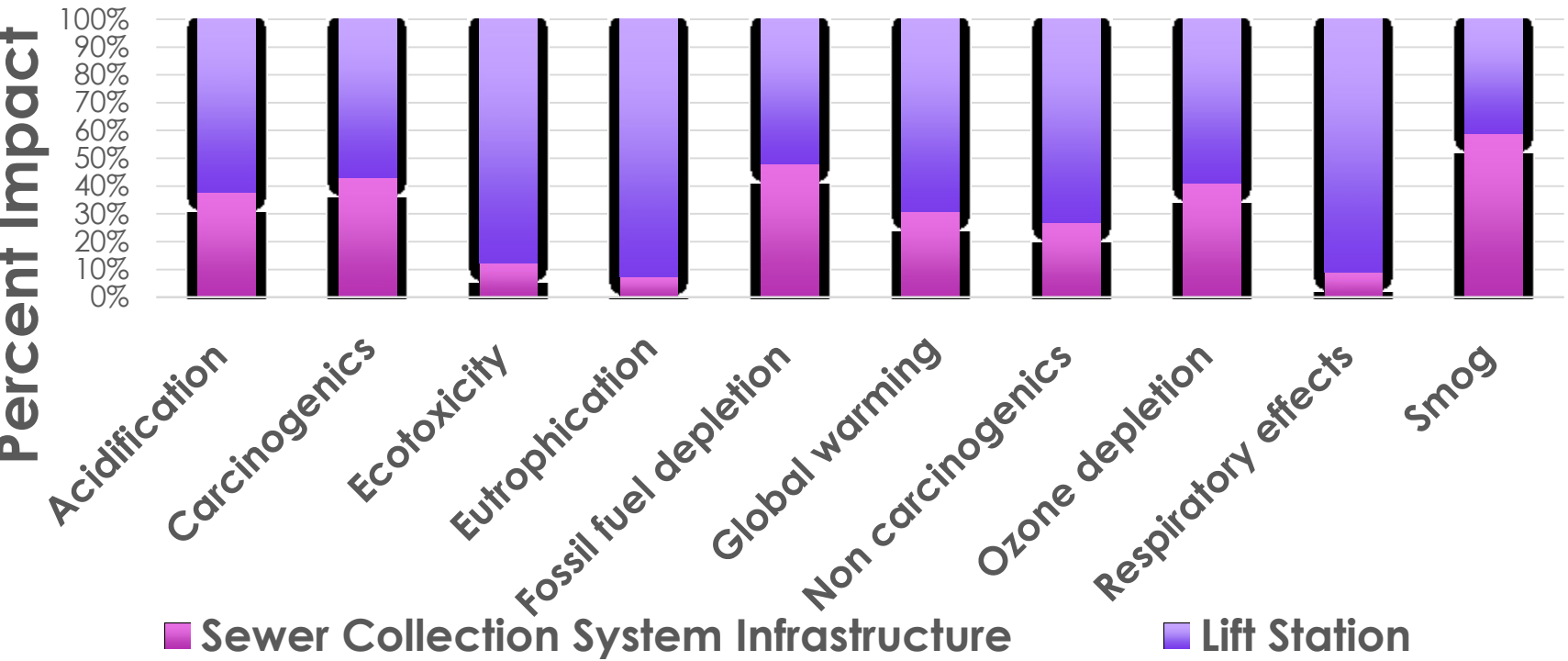


Figure 1. Relative impacts of construction phase vs. operational phase (3 town average).

Construction, Installation, & Alternatives

- Concrete showed to have a higher impact than clay brick by 11%.
- Cast iron (manhole covers) showed a 72%-77% impact on Carcinogens over the three towns.
- Vitrified clay pipe (VCP) showed a 43%-47% impact on Fossil Fuel Depletion and a 44%-49% impact on Global Warming.

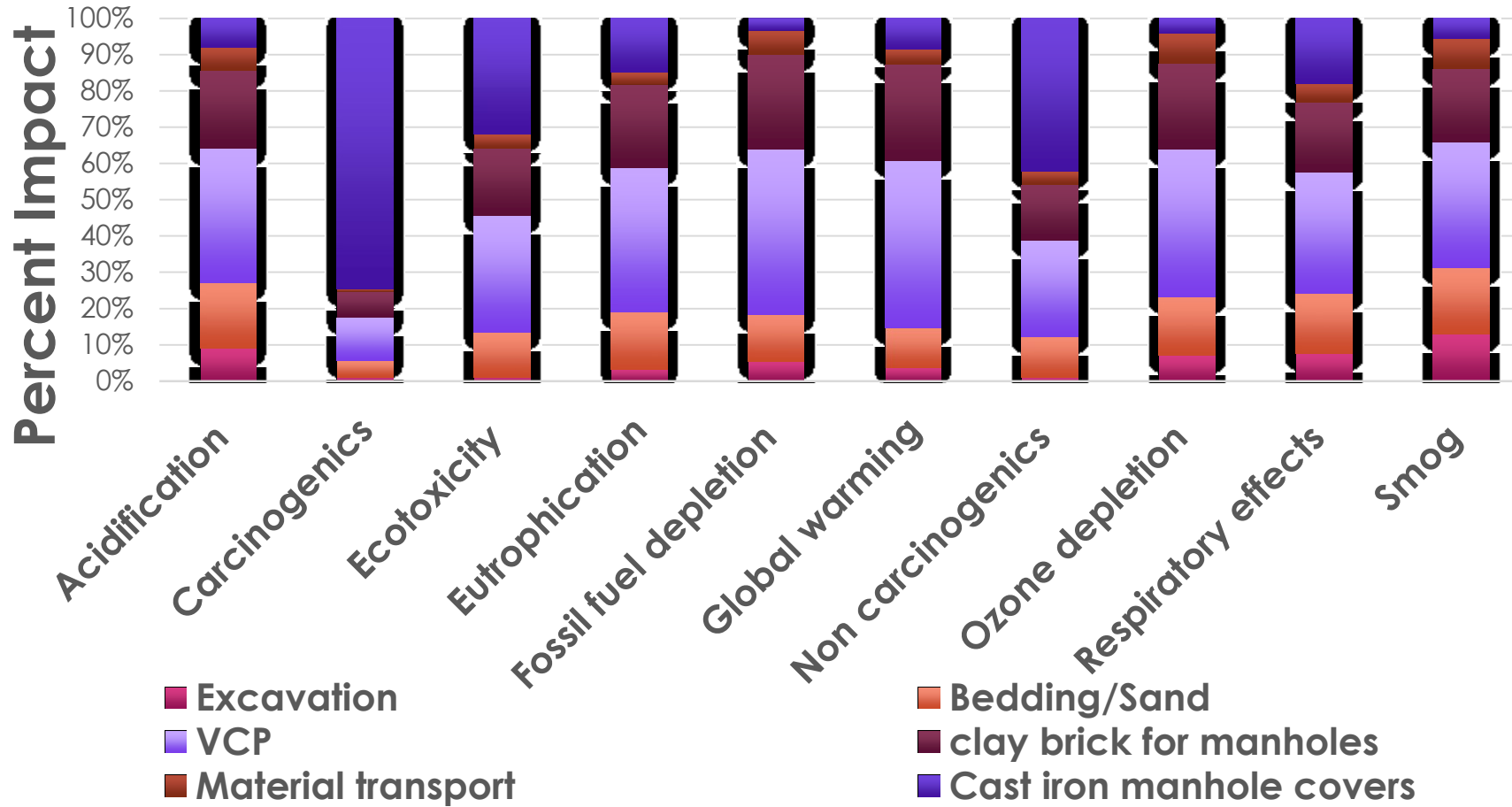


Figure 2. Relative impacts of materials in construction and installation phase (3 town average).

Conclusions

- The construction and installation phase is a large contributor to the sanitary sewer system impacts.
- The construction and installation impacts are small when compared to the wastewater treatment system impacts.
- Lowering the use of VCP and Cast Iron will reduce the construction and installation phases net impact.
- Many small towns in Nebraska have a lower overall impact by using clay brick instead of concrete in their manholes.
- Regularly scheduled maintenance can extend the systems lifespan reducing net environmental impact.

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