



TRAFIKVERKET
SWEDISH TRANSPORT ADMINISTRATION

Environmental Product Declaration for railway bridges on the Bothnia Line



Title: Environmental Product Declaration for railway bridges on the Bothnia Line
Publication number: 2016:049
Date of publication: November 2014
Registration number: S-P-00199, UN CPC 53212
Publisher: The Swedish Transport Administration
Production cover: Grafisk form, the Swedish Transport Administration
Printed by: Ineko
Distributor: The Swedish Transport Administration



En EPD® (Environmental Product Declaration; miljövarudeklaration) är ett oberoende verifierat och registrerat dokument som ger transparent och jämförbar information om produkters miljöpåverkan i ett livscykelperspektiv.

Introduction

This Environmental Product Declaration (EPD), describes, from a lifecycle perspective, the total environmental impact of railway bridges on the Bothnia Line. The EPD covers bridge “substructure” only. Track, power, signalling and telecom systems in the bridges are not included.

Within the International EPD system based on ISO standard 14025, this EPD was drawn up on accordance with Product Category Rules (PCR) 2013:19 for Railways (see www.environdec.com for further information about the EPD-system).

The aim of this EPD is that it should provide experts and scientists (in the construction and infrastructure sectors) with objective and reliable information on the environmental impact of constructing, operating and maintaining railway bridges.

This EPD was developed by Trafikverket (the Swedish Transport Administration). It has been certified by Bureau Veritas Certification AB and the certification is valid for three years (after which it can be prolonged).

Botniabanan AB has been responsible for the financing, detailed planning and building of the Bothnia Line. After completion, ownership of the infrastructure has been transferred to Trafikverket. Trafikverket has an implemented management system in accordance with the Swedish government’s regulation (SFS 2009:907) on environmental management in state agencies. One focus area for Trafikverket’s environmental work is to reduce climate gas emissions from construction, operation and maintenance of infrastructure and Trafikverket has therefore developed a tool for carbon footprint calculations for infrastructure projects (*Klimatkalkyl*, available at www.trafikverket.se). Inventory data for this EPD has been included in *Klimatkalkyl*, and the results for Global Warming and Energy Resources in this EPD is comparable to results in *Klimatkalkyl* for corresponding infrastructure parts.

This EPD describes the environmental performance of railways tunnels on the Bothnia Line. The following EPDs are also available for other Bothnia Line systems:

- EPD for railway infrastructure on the Bothnia Line.
- EPD for railway tunnels on the Bothnia Line.
- EPD for railway track foundations on the Bothnia Line.
- EPD for railway track of the Bothnia Line.
- EPD for power, signalling and telecom systems of the Bothnia Line.

As this EPD is based on data relating to Bothnia Line infrastructure, the results might not be representative of other railway bridges. In order to decide if the result can be

representative for other railway bridges, the most important areas that should be checked to be comparable with the Bothnia Line are:

- Railway functionality (single or double track, axle load etc.).
- Topography (impact on, for example, the length of bridge piers).
- Type of bridge (e.g. concrete or steel beam)
- Origin of materials (mainly steel and concrete).

Comparison towards previous EPD

This EPD is an updated version of the original EPD from 2010. The reason for the update is that the PCR has been revised. In the revision, the declared unit was changed:

Old declared unit: *1 km railway (main line) over a calculation period of 60 years*

New declared unit: *1 km railway (main line) and year*

Inventory data for LCA-calculations have not been changed, but the change of declared unit gives results in other units compared to previous EPD. The declared environmental performance in this EPD is therefore not comparable to previous EPD since it is presented in other units.

Facts about the infrastructure of the Bothnia Line

The Bothnia Line is a new Swedish railway running from Nyland (north of Kramfors) to Umeå. It is routed via Örnsköldsvik and comprises 190 km of new single-track railway with 22 sidings (each 1 km long) and 7 travel centers/stations. The latter have good connections for pedestrians, cyclists, local and regional bus traffic and private vehicles. There is one large freight terminal in Umeå and a smaller container terminal in Örnsköldsvik.

The line has 90 railway bridges (total length of 11 km) and 16 tunnels (25 km main railway tunnels and 16 km service and access tunnels). Designed for combined passenger and heavy freight traffic the Bothnia Line offers maximum speeds of 250 km/h for passenger trains and 120 km/h for freight trains with a maximum axle load of 25 tonnes. The groundbreaking for the project took place on 14 August 1999, and the railway is operational since autumn 2010.

There are three different types of railway bridges on the Bothnia Line; steel beam (3,5 km), concrete beam (5,4 km) and portal frame bridges (2 km). Steel beam bridges are large bridges with several concrete piers. On top of these, the superstructure is made of steel beams with a concrete overlay. Concrete beam bridges are also large bridges with several concrete piers. The superstructure is entirely concrete. Portal frame bridges are small bridges with an abutment (concrete wall with wings) at each end and a concrete overlay. The total number of bridge piers is approximately 400 with an average length of 8 m.

Technical Data Infrastructure:

- Minimum radius of curvature: 3200 m
- Maximum gradient: 10 ‰
- Track gauge: 1435 mm
- Power-supply voltage: 15 kV, 16 2/3 Hz, AT-system
- Track: ballasted concrete sleepers, UIC 60 rail (continuous welded)
- Signalling system: ERTMS level 2
- Maximum axle load: 25 tonnes (30 ton on bridges)



Location of the Bothnia Line

Environmental performance

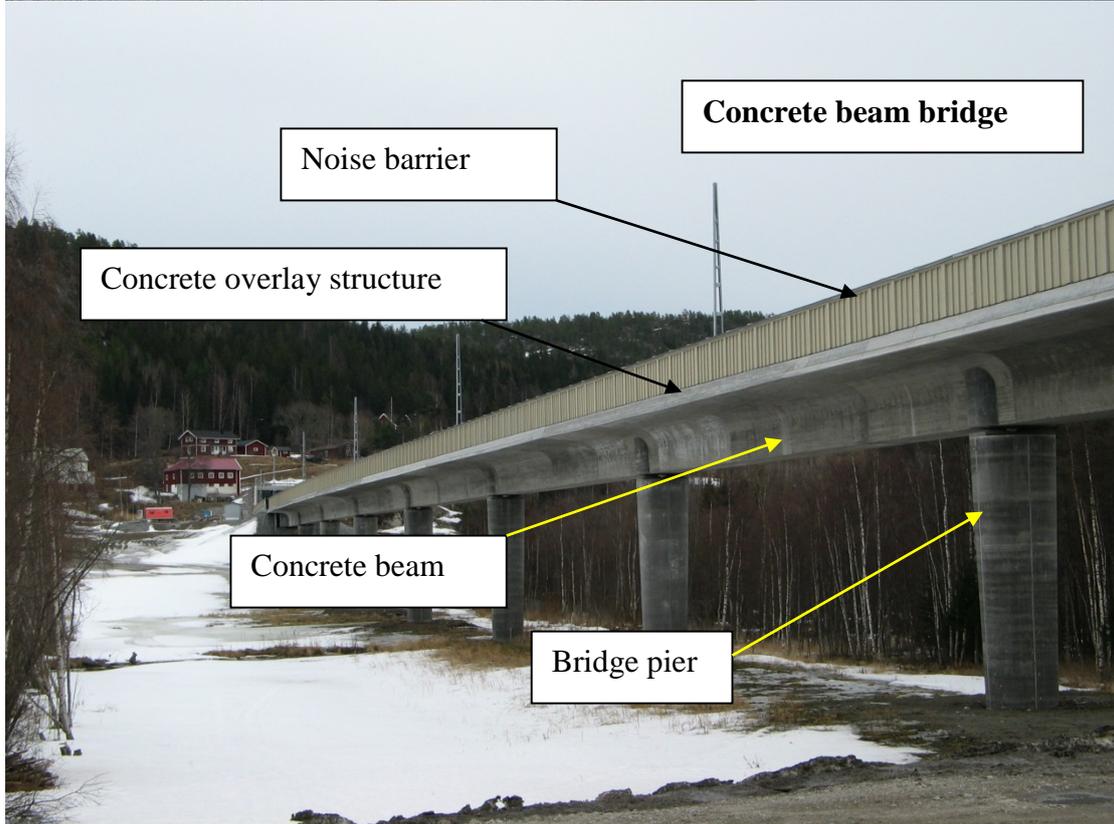
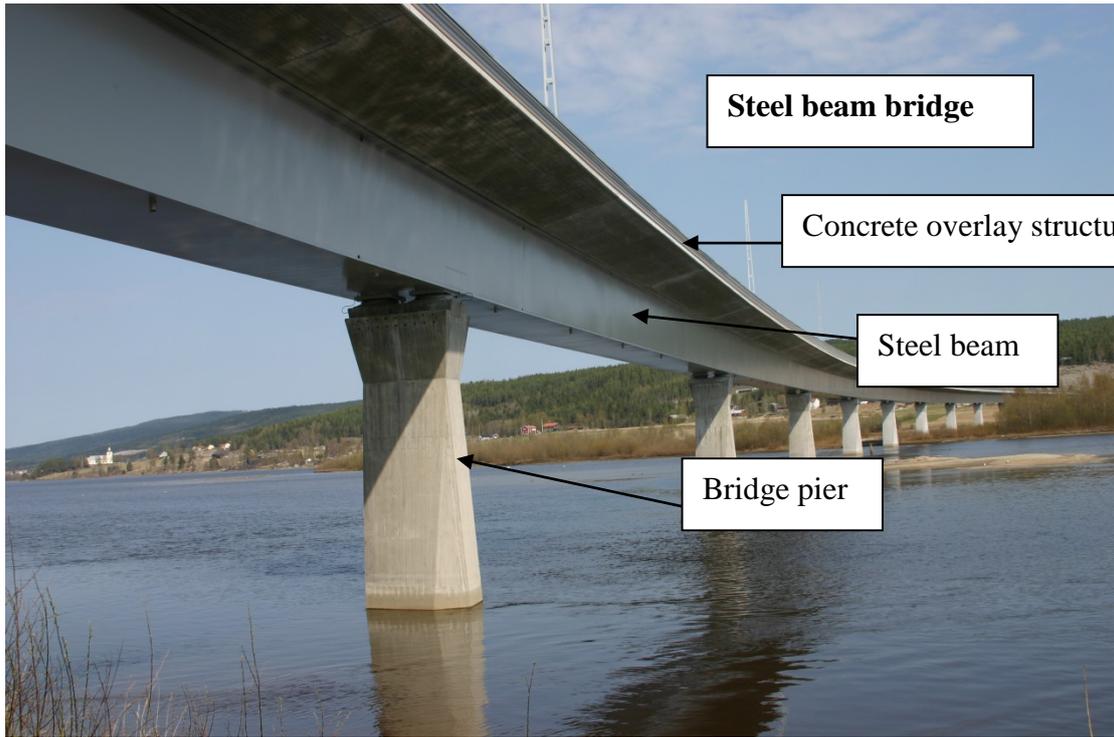
Resource use and emissions

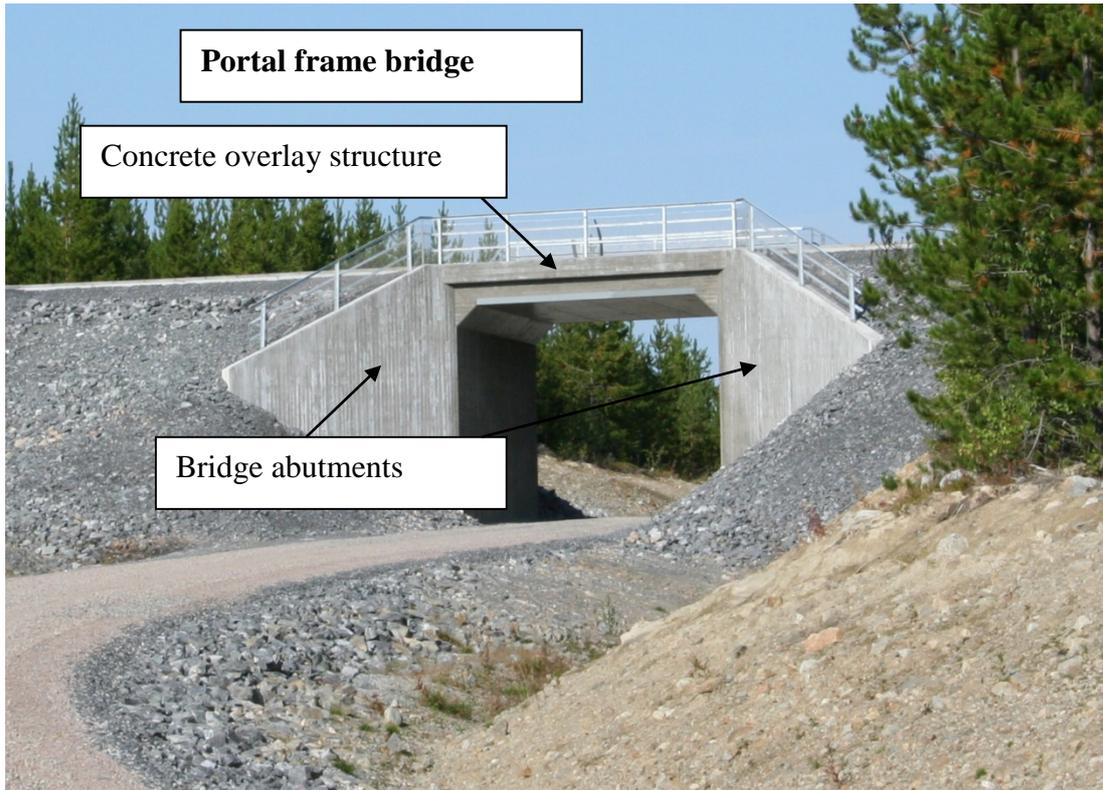
The environmental performance section of the declaration is based on a lifecycle assessment (LCA) carried out by WSP in 2014. The LCA was largely based on ecoinvent-data for materials and processes, and implemented in the software SimaPro. Inventory data was collected from the LCA for the Bothnia Line made by IVL Swedish Environmental Research Institute in 2009. An overview of system boundaries and included processes is given in the text, figures and tables below.

Extraction and production of raw materials, transport of materials and manufacturing of products were included in the LCA calculations. The data in respect of infrastructure-related processes and quantities of materials was collected from the building of the Bothnia Line. Selected generic data for material production was used according to the calculations rules in PCR 2013:19. The electricity used in construction processes and for production of materials was calculated as the average electricity mix for the countries hosting the processes.

Calculation of the environmental impact of railway bridge construction was based on data from three selected “typical” bridge contracts. As regards concrete and steel reinforcement quantities, fuel and electricity consumption, etc., specific data was collected from these contracts and used as a basis for calculating the environmental impact of all the tunnels on the Bothnia Line.

The LCA calculations are based on the technical life times of all included components and results in a yearly contribution to all impact categories. All construction, reinvestment, operation and maintenance processes are included in that. All results are presented in the declared unit per kilometre of bridge and year. As a complement, the impact from the construction phase is presented separately per kilometre of bridge.





All processes and elements needed to construct, operate and maintain railway bridges has been included in the LCA. However, note that track, power, signalling and telecom systems are not included. The figures above show the three different bridge types and some of the most important structural elements.

Overview of processes and elements included in the LCA for railway bridges on the Bothnia Line.

Bridge construction	Bridge operation	Bridge maintenance
Soil and rock excavation		Reinvestment determined by lifetimes of components and constructions
Ground reinforcement		
Filling with soil and crushed material		
Bridge construction		
Deforestation		
Service roads		

Ducting (cable ducts and manholes)		
Drainage and surface water piping		
Noise barriers		

As, under the rules in PCR 2013:19, waste handling processes make a negligible contribution to environmental impact categories (<1%), they were excluded from the LCA. For processes excluded by default, see PCR 2013:19.

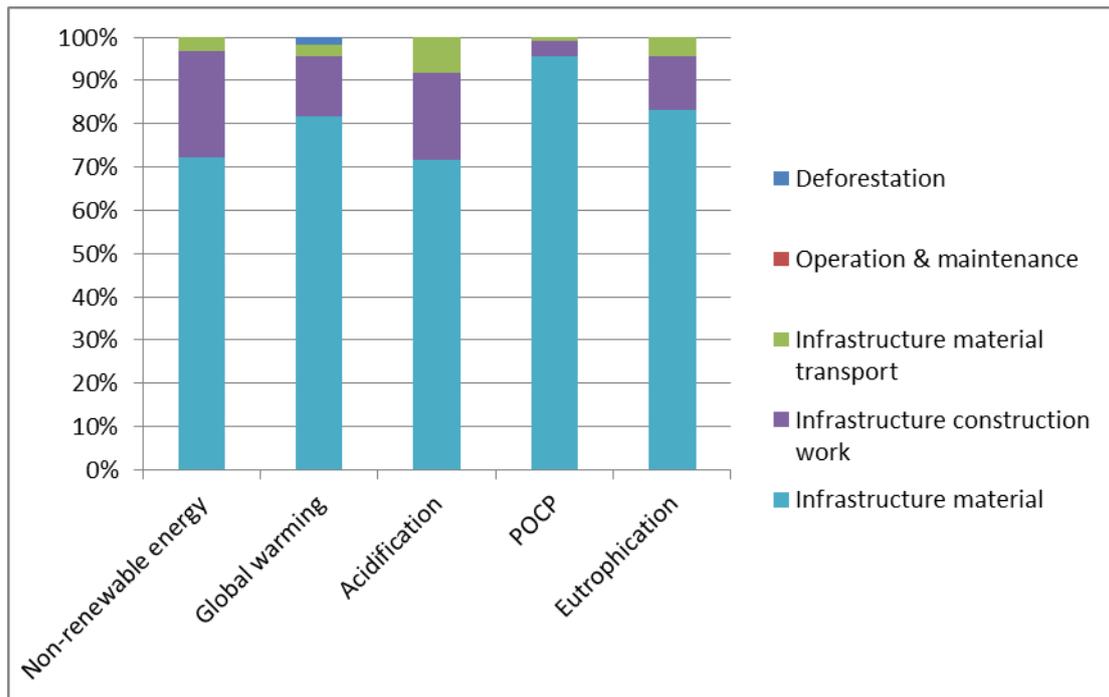
Annual environmental impact for 1 km of railway bridge on the Bothnia Line. All construction, reinvestment, operation and maintenance activities are included for the track infrastructure. Impact from construction phase is presented separately per km (not annually). Note that the track, power, signalling and telecom systems are not included.

Impact category	Unit	Declared unit per km and year			Construction per km
		Construction & reinvestment	Operation & Maintenance	Total	
Use of resources					
Non-renewable materials	kg	1 065 730	0	1 065 730	118 591 473
Renewable materials	kg	0,88	0	0,88	67
Non-renewable energy	MJ	862 964	0	862 964	91 746 363
Renewable energy	MJ	53 777	0	53 777	5 884 575
Secondary materials	kg	328 596	0	328 596	35 794 843
Secondary energy	MJ	157 376	0	157 376	18 554 743
Water, total	kg	441 530	0	441 530	48 702 358
Water, direct	kg	0	0	0	0
Land use	m2	4 264	0	4 264	265 215
Potential environmental impacts					
Global warming	kg CO ₂ -eq.	71 344	0	71 344	7 607 357
Acidification	kg SO ₂ -eq.	230	0	230	23 326
POCP (Photochemical oxidant formation)	kg C ₂ H ₄ -eq.	13	0	13	1 349
Eutrophication	kg PO ₄ ³⁻ -eq.	95	0	95	9 611
Waste and outflows					
Output of materials for recycling	kg	328 596	0	328 596	0
Waste, hazardous	kg	1,5	0	1,5	152
Waste, excess soil	kg	203 346	0	203 346	23 276 555
Waste, other	kg	11 355	0	11 355	1 159 123

Specification of resources making the largest contributions to the different resource use categories

Resource use category	%
Non-renewable materials	
Rock, gravel	53%
Soil	40%
Calcite	4%
Clay	2%
Iron	1%
Renewable materials	
Wood	100%
Non-renewable energy	
Fossil	79%
Nuclear	21%
Renewable energy	
Hydropower	87%
Biomass	10%
Wind, solar, geothermal	3%

Dominance analysis



Emission impact categories and the relative contribution (in %) made by the process groups relevant to the Bothnia Line’s railway bridges. The process groups include all activities during the lifetime of the infrastructure. For example, “Infrastructure material” covers all materials used during construction, maintenance and reinvestment.

Upstream processes

Infrastructure material = Emissions from raw material acquisition and production of materials such as steel, concrete etc.

Infrastructure material transport = Emissions from vehicles (e.g. trucks and trains) used for transporting infrastructure material (e.g. concrete and reinforcement steel) from suppliers to the construction site.

Core processes

Infrastructure construction work = Emissions from machines (excavators, trucks, drilling rigs etc) used in constructing the infrastructure. This also includes transport of excavated soil and rock.

Deforestation = Net emissions of CO₂ resulting from forest land being permanently changed to railway land.

Downstream processes

Operation & maintenance = Emissions from production of electricity used for operation of the infrastructure (e.g. tunnel illumination) and from use of fuels for maintenance work. Normally not applicable for bridges.

Additional environmental information

The impact that the building and operation of the Bothnia Line has on land use, biodiversity and environmental risk-related issues has been analysed and is described in the EPD for railway infrastructure. However, it is not possible or relevant to relate the results of the impact analyses to the individual infrastructure elements. Consequently, this EPD contains no such details.

Recycling declaration

The main infrastructure elements that are relevant as regards waste management and recycling are track, power, signalling and telecom equipment. Within Trafikverket, there is currently no general national strategy for recycling materials that are replaced during maintenance. Such materials often become the property of the contractor. Trafikverket's environmental strategy contains the following prioritised goals for the future:

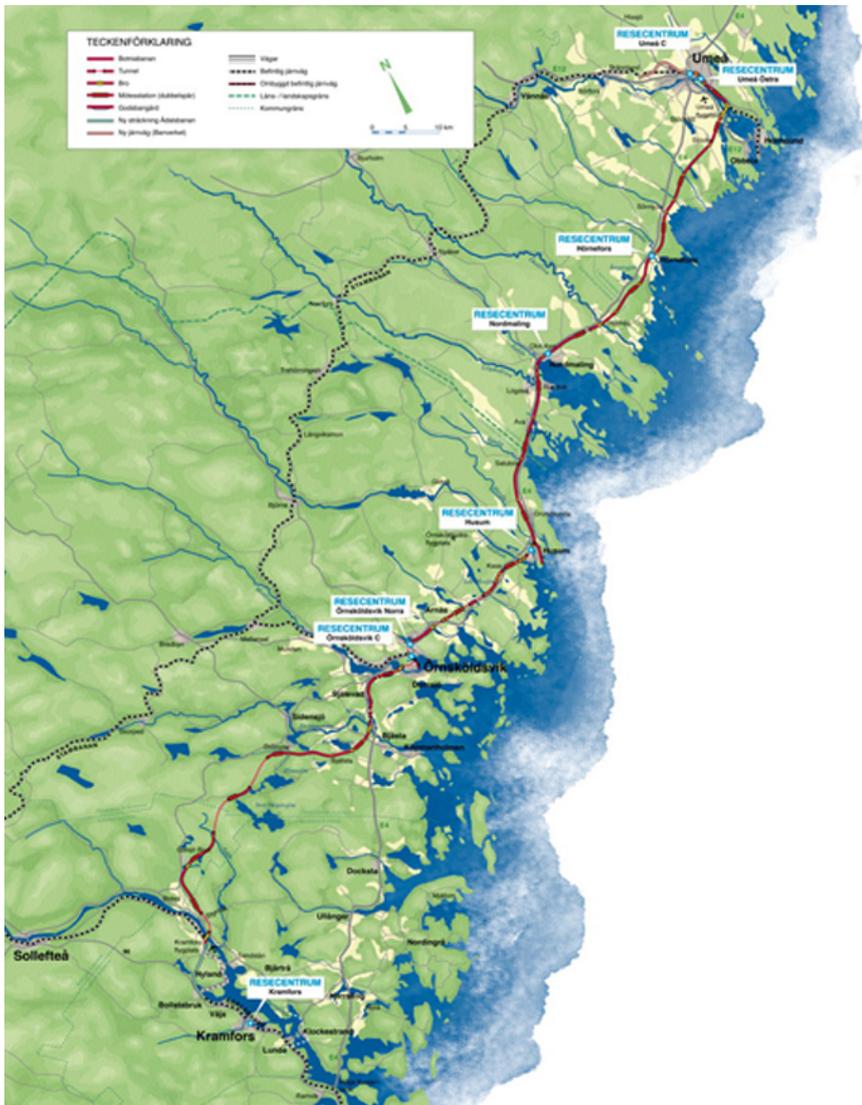
- Development, from an environmental perspective, of long-term reutilisation plans for strategic materials.
- Development of environmentally sound and effective management procedures for prioritised categories of waste.

Management of materials and substances

Throughout the construction of the Bothnia Line, all contractors have, as regards any chemical products and potentially environmental harmful materials they use, been required to obtain the approval of Trafikverket's Chemicals Board. Another requirement has been that PVCs and certain other materials (a number of specified harmful substances included therein) must not be used before the contractor has made an environmental risk assessment and Botniabanan AB has agreed with the use. If the use of any of these substances could not be avoided, the location of the components containing the substances has been documented by the contractor.

The satisfaction of these requirements has been checked in audits of all major contractors.

Hazardous waste generated in all contracts for the building of the Bothnia Line has been collected in environmental stations supplied by Botniabanan AB and managed by companies accredited for management of hazardous waste.



Route and travel centers/stations of the Bothnia Line (tunnels and bridges also shown)

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- EPDs from different programmes may not be comparable
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- See www.trafikverket.se for more information on the EPD and background material

PCR review was conducted by the Technical Committee (TC) of the International EPD Consortium (IEC).
See www.environdec.com for more information and contact for IEC.

Independent verification of the declaration and data, according to ISO 14025:

<input type="checkbox"/> Internal	<input checked="" type="checkbox"/> external
Third party verifier: Bureau Veritas Certification AB Fabriksgatan 13 SE-412 50 Göteborg SWEDEN	
<i>Accredited by: Swedac</i>	



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