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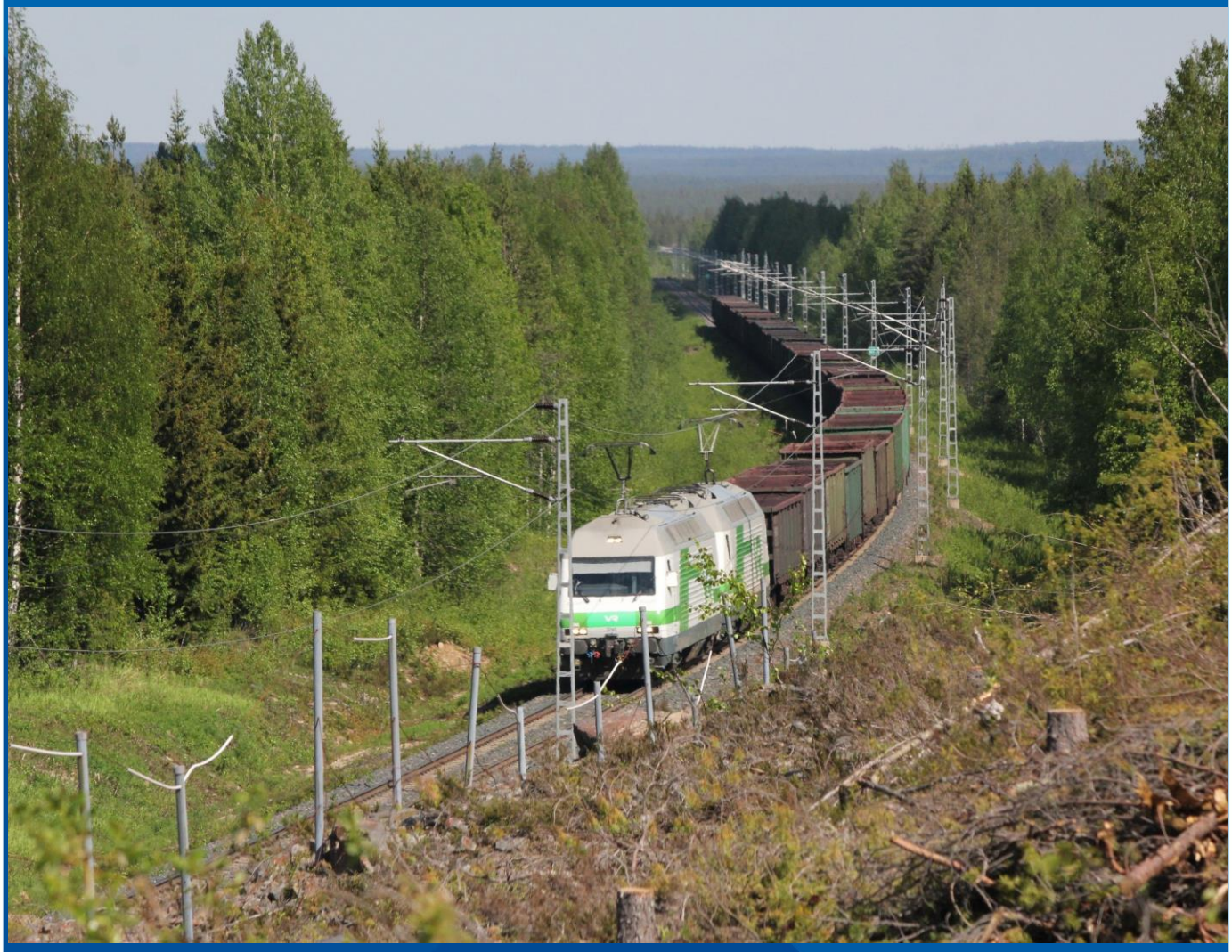
Northern Axis – Barents Link project

Report on the railway passenger transport passing through the Vartius/Kivijärvi border crossing point, Report on the needs for improvement on the Oulu–Kontiomäki line



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Abstract

This report contains two closely related studies from the Northern Axis – Barents Link project. The project as a whole charts and develops the east-west transport connections between northern Scandinavia and the northern regions of Russia.

The first study examines the possibilities of opening the Vartius/Kivijärvi border crossing point for rail passenger transport. The study defines two scenarios for transport operations, compiles the required measures and conditions for opening rail traffic and assesses the feasibility of the scenarios through the identified passenger potential and the scope of the measures.

The second study deals with the improvement needs of the Oulu–Kontiomäki line section. It reviews the current status of the line section and its role as part of the railway network. The study compiles areas for improvement regarding the line section, based on the challenges posed by the current situation and the needs posed by future traffic forecasts on the basis of expert assessments by various rail traffic stakeholders. A smooth response to changes in traffic needs both now and in the future is considered important. To ensure this, preliminary proposals for action and recommendations for further review are issued in the report.

Foreword

This report is part of the Northern Axis – Barents Link project package which includes two separate studies: Impact of the potential and the start-up of rail passenger transport passing through the Vartius/Kivijärvi border crossing point on the studied area and the need for improvements on the Oulu–Kontiomäki line section. The aim of these studies is to survey the development measures of the transport infrastructure in the reviewed area (Oulu–Kontiomäki–Vartius) and the potential of the transport corridor.

The studies in this report have been commissioned by the Finnish Transport Infrastructure Agency, a partner in the NABL project. From the Finnish Transport Infrastructure Agency, Irina Laurila has acted as the project manager in the project, with Jyri Mustonen and Esa Suoyrjö as project members in the project group.

Proxion Plan Oy has been responsible for conducting the study, with Katriina Pietilä as the project manager. Aapo Halminen, Kaisa-Liisa Tikka, Tuomas Toivio and Ville Ranta have also participated in the work. Key stakeholders have been interviewed during preparation of the report.

In Helsinki, December 2021

Finnish Transport Infrastructure Agency
Department of Infrastructure Access

Contents

1 Background and objectives of the project

The Northern Axis – Barents Link project (NABL) aims to develop east-west transport connections in the area of the Kolarctic EU-Russian Cross Border Cooperation Programme (CBC). The area includes the province of Lapland in Finland, the province of Norrbotten in Sweden, the counties of Finnmark, Troms and Nordland in Norway, and the Murmansk region, the Arkhangelsk region and the Nenets autonomous district in Russia (Kolarctic CBC 2021). Figure 1 shows the programme areas. The NABL project will be implemented in two years, with the support of the Kolarctic CBC 2014–2022 Cross Border Cooperation Programme.

Figure 1. The areas of the Kolarctic CBC Programme. The core area is in darker green. (Kolarctic CBC 2021)

The aim of the project is to identify the potential of the Northern Axis and Barents Link transport corridors and the main transport infrastructures in the studied areas. The project is expected to identify the bottlenecks of the transport corridors as well as further harmonizing the development in the area. In addition, the aim is to increase understanding between the regions and to define the impact of the various initiatives on the east-west transport corridors and networks throughout the project area. (Regional Council of Kainuu 2021a)

The project consists of ten different work packages, which are presented in more detail in Figure 2. The Finnish Transport Infrastructure Agency is a partner in the project and is involved in work packages 5 and 6, for which the following studies are compiled in this report:

- WP5b: Impact of rail passenger transport passing through the Vartius/Kivijärvi border crossing point
- WP6d: Improvement needs of the Oulu–Kontiomäki line section.

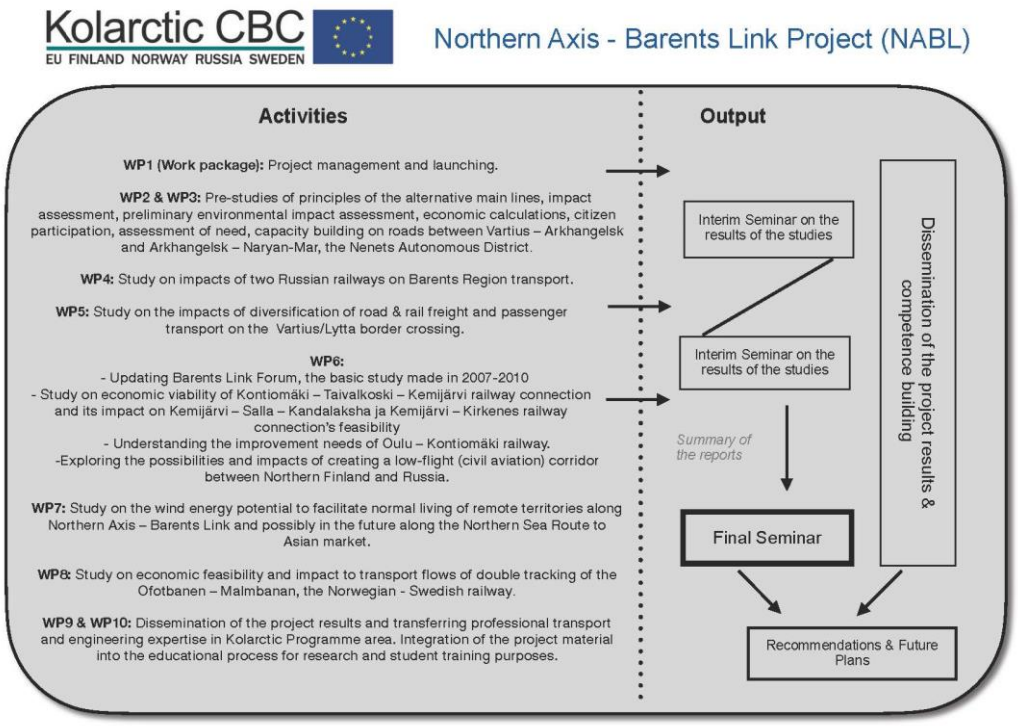

Figure 2. NABL project work packages. (Regional Council of Kainuu 2021a)

A summary of the studies completed on the project's work packages will be compiled with the aim of highlighting the opportunities and challenges of the most remote regions. The results of the studies and explorations carried out in the project will be integrated into educational processes in order to transfer expertise to students in the field.

The NABL project serves as one of the tools to achieve better transport connections to the Barents region. The NABL project partners are:

- Regional Council of Kainuu, Finland
- Futurum AS, Norway
- Northern (Arctic) Federal University, Russia
- The Local Federation of East Lapland, Finland
- North-West Strategic Partnership, Russia
- Luleå University of Technology, Sweden
- Arkhangelsk Regional Road Administration, Russia
- JSC Nenets Oil Company, Russia
- Finnish Transport Infrastructure Agency, Finland
- UiT, The Arctic University of Norway, Norway

1.1 Previous and other ongoing surveys in the area

Studies in the NABL project area have been prepared by various parties in the past, and there are several other studies and projects ongoing at the time of writing this report. The Finnish Transport Infrastructure Agency has previously commissioned the following studies for the Barents region, which will be used as supporting material for this report:

- Overview of the railway network capacity, 2020
- Cross-border rail transport in the Bothnian Bay region, 2020
- The developmental status of railway yards and their role in the railway network, 2019
- Development of the Oulu–Kontiomäki line section, 2019
- Development of the Ylivieska–Kontiomäki railway connection: Update of project appraisal of development options, 2021

A joint Euregio Karelia co-operation strategy for 2021–2027 has also been prepared for the region. Euregio Karelia is a border and co-operation area on the Finnish-Russian border between Kainuu, North Karelia, North Ostrobothnia and the Republic of Karelia. The activities are based on the common desire of the regions to improve the living conditions of their populations through cross-border co-operation. The main goal of the co-operation strategy is to make border traffic and border crossing smoother. (Euregio Karelia 2021)

The Barents Region Transport and Logistics (BRTL) project (2018–2021), funded by Kolarctic CBC, is currently ongoing. To date, the transport and logistics decisions made in the Barents region have often been based solely on national plans. The purpose of the BRTL project is to promote development in which the strategies and plans of neighbouring countries and regions are also taken into account in the decision-making and investments in the Barents region. The process of drawing up a strategy-level Joint Barents Transport Plan (JBTP) at national level for the entire Barents region began as early as 2012. The BRTL project aims to provide a platform for regional co-operation authorities to agree on the practical implementation of the JBTP in the co-operation areas. (Regional Council of Kainuu 2021b) One of the goals of the transport plan is to support the impact on climate change, and the Barents region wants to be competitive in this transition. The second goal is to facilitate the transport system in the Barents region and create new opportunities for the key industries in Finland, Norway, Sweden and Russia. (Joint Barents Transport Plan 2019)

In addition to the studies in this report, the effects of rail passenger transport passing through the Vartius/Kivijärvi border crossing point and the need to improve the Oulu–Kontiomäki line section, the following studies are underway in the NABL project:

- A study related to the diversification of Vartius' freight traffic, commissioned by the Regional Council of Kainuu
- Ofotbanen–Malmban railway study, commissioned by Futurum AS (Norway)

- Kontiomäki–Kemijärvi (route alignment options), Salla–Kantalahti study, commissioned by the Local Federation of East Lapland
- Vartius/Lyttä–Arkhangelsk Road study commissioned by the Regional Council of Kainuu

In the autumn of 2021, an impact assessment of Russian railway projects in the Barents region will be launched on behalf of the Regional Council of Kainuu. The Regional Council of Kainuu has also drawn up its own transport system plan in 2018, the most important topics of which are the upgrading of the Savo line to a national line project and the development of the Vartius–Kontiomäki–Ylivieska connection line via Oulu and Iisalmi. (Regional Council of Kainuu 2018b)

1.2 Area of the study

The entire area of the Northern Axis – Barents Link project is located in the Barents area, as shown in Figure 1. In this report and in the comprehensive scope of the two studies, the study area is located in the area of the Oulu–Kontiomäki–Vartius track connection, which is presented in Figure 3.

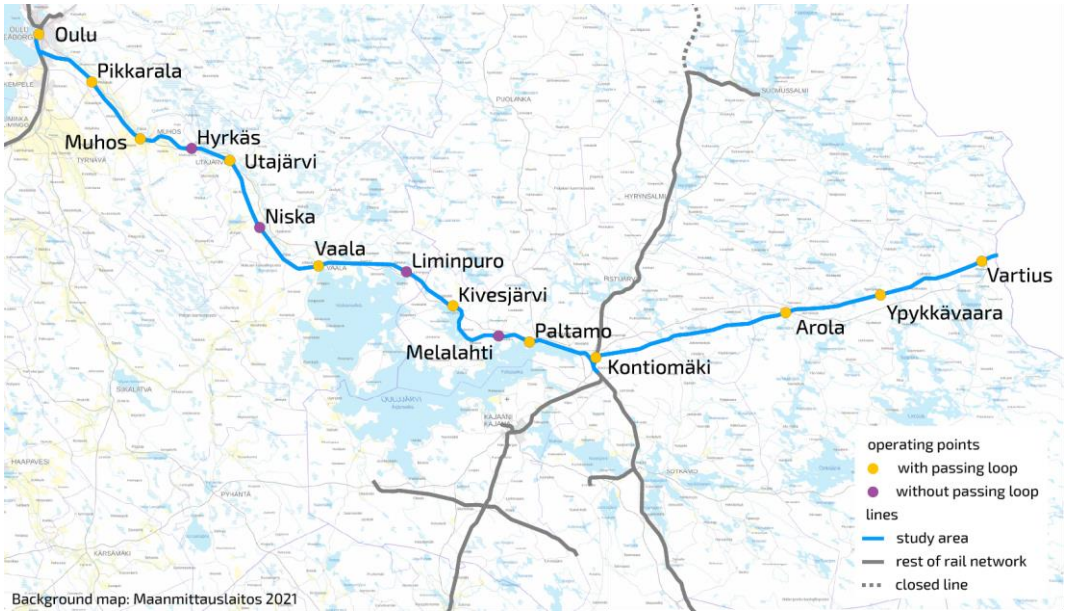

Figure 3. Review area of the Oulu–Kontiomäki–Vartius line section.

Several other line sections and areas are indirectly linked to the study area, and their impact on traffic and capacity in the areas of this study are also taken into consideration in this report from the viewpoint of, among other things, passenger potential and transit connections. The connection lines linked to this report that should be taken into account are:

- Oulu–Tornio,
- Tornio-Haparanda,
- Oulu–Rovaniemi,
- Oulu–Tampere,
- Kontiomäki–Kajaani–Iisalmi–Kuopio–Helsinki and
- Kontiomäki–Oulu–Kemijärvi

1.3 Co-operation with stakeholders

In both studies, one important part of the study has been the stakeholder co-operation, in which expert organisations in the study area have been interviewed in order to determine comprehensive background information and regional views. The interviews were conducted during the spring and summer of 2021 using remote connections and e-mail. The purpose of the stakeholder co-operation has been to identify the main development needs and challenges of rail traffic and infrastructure in the study area, as well as to survey the conditions, opportunities and potential for the opening of possible cross-border passenger transport.

The stakeholders interviewed in the study included:

- Regional Council of Kainuu
- Regional Council of Lapland
- Finnish Transport Infrastructure Agency
- VR Group Ltd (passenger transport and VR Transpoint)
- Fenniarail Oy
- Operail Finland Oy
- Fintraffic Railway
- Welado Oy (rail management, Northern Finland)
- The Finnish Border Guard
- Customs
- Finnish Lapland Tourist Board ry (LME)
- Municipality of Vaala
- Municipality of Utajärvi
- Municipality of Muhos
- Municipality of Paltamo
- City of Kuhmo
- Roszheldor, Federal Agency for Railway Transport, Russia

2 Rail passenger transport operating through the Vartius/Kivijärvi border crossing (WP5b)

The Vartius operating point is one of the border crossing points for international rail traffic in the transport between Finland and Russia. At the same time, it is the northernmost rail connection between Russia and the rest of Europe. The Kontiomäki–Kostomuksha railway connection passes through Vartius, and the Vartius railway station acts as a handover and receiving station for international rail links in freight traffic between Finland and Russia. The border station on the Russian side is called Kivijärvi. Currently, only freight traffic passes through Vartius.

The aim of this study is to examine the potential of passenger transport passing through the Vartius border station, the conditions for starting traffic and the impact on the adequacy of railway capacity, travel chains, transit connections and other railway directions linked to the Oulu–Kontiomäki area. The aim is to form a comprehensive picture of the conditions under which traffic operation could be implemented, where the potential of passenger transport from the Russian side would come from and what kind of rolling stock the traffic could possibly be carried out on. The aim of the study is also to identify measures related to the implementation of potential passenger transport and to survey any issues to be investigated further.

The length of the Vartius–Kontiomäki line section is 95 km and the section was completed in its entirety in 1980. The line section is single-track, blocking protected and remotely controlled. The maximum permissible speed on the line section is 80 km/h. The line section was electrified in 2006 and in the same year, the capacity of the line section was improved by introducing traffic control equipment at the Ypykkävaara operating point. The operating points and their intervals on the line section are illustrated in figures 4 and 5.

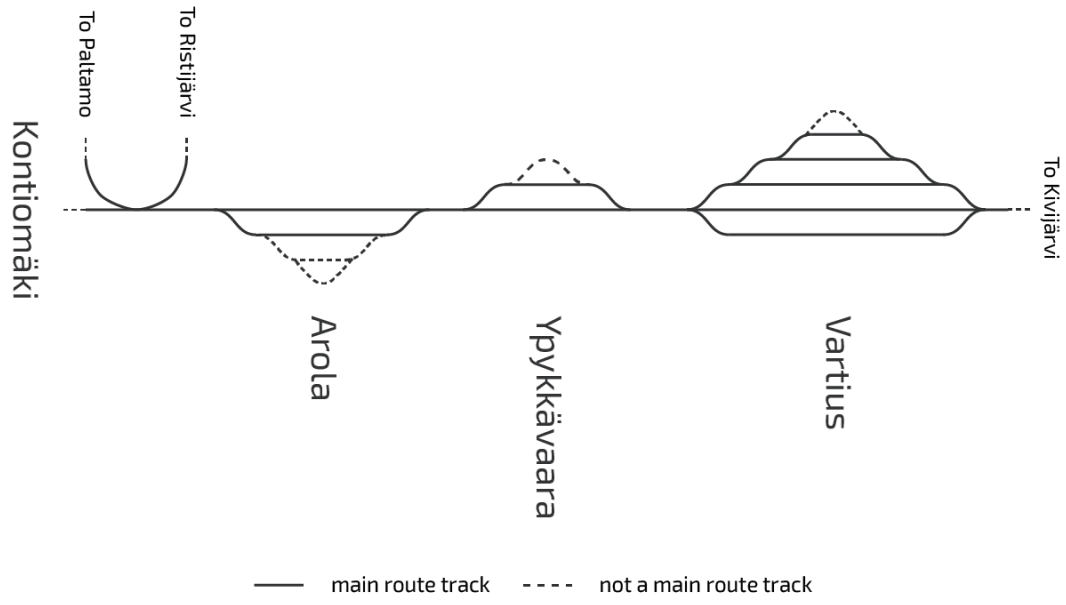

Figure 4. Kontiomäki–Vartius line section.

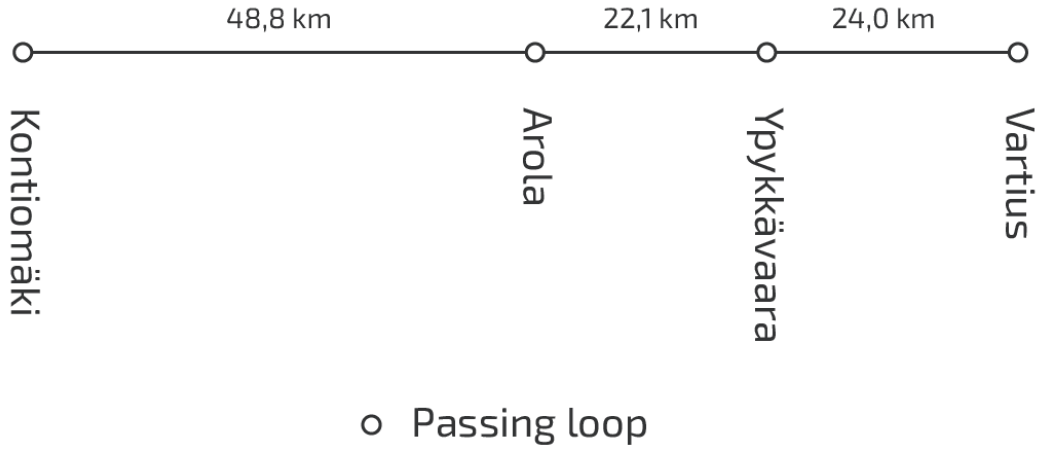

Figure 5. Lengths of operating point intervals on the Kontiomäki–Vartius line section.

The small number of passing loops, the demanding uphills of the line section and the long blocking intervals pose challenges for heavy freight traffic and the co-ordination of traffic flows from opposite directions. Between Kontiomäki and Vartius, the longest passing loop and blocking protected area is between Kontiomäki and Arola, with a length of 48.4 km. As traffic in the direction of Oulu is run in Kontiomäki mainly through a triangle, Kontiomäki does not have a possibility for trains running in opposite directions to pass each other, and the next passing loop on the Kontiomäki–Oulu line is in Paltamo.

The study will continue with an examination of the current state of passenger transport in the surrounding areas and an analysis of the passenger potential of cross-border traffic, taking into account in particular the tourism development prospects in the regional impact areas. This is followed by a more technical analysis of the conditions for opening up cross-border passenger train traffic and an assessment of potential rolling stock solutions. These sections are used to form two review scenarios (neutral and optimistic) for opening passenger transport services, and to assess their feasibility through the development perspectives for passenger transport in the region. Finally, summaries are provided of the issues and implementation potential required for the opening of the Vartius cross-border passenger train service for the transport structures of both scenarios, and a list is generated of the views on the further measures required to advance the matter in the future.

2.1 Current passenger transport in the area under review

There is no passenger transport on the Kontiomäki–Vartius line section, but the traffic consists purely of freight traffic. The closest passenger transport station to the Vartius border is Kontiomäki, with 3 + 3 daily train services operating between Oulu and Kontiomäki. The exception is Friday, when there are 4 train services in each direction. Kontiomäki, Paltamo, Vaala, Utajärvi, Muhos and Oulu serve as stops for passenger transport between Kontiomäki and Oulu.

The change in passenger numbers caused by the COVID-19 pandemic has been significant in 2020. As a result of the change, several years of upward trends in travel volumes began to decline significantly (Table 1). In 2019, the number of long-distance traffic journeys on the Kontiomäki–Oulu line section was approximately 130,000, while in 2020 the number of long-distance journeys on the line section was approximately 95,000 journeys.

Table 1. Long-distance traffic passenger numbers on the Oulu–Kontiomäki line section (Finnish Transport Infrastructure Agency 2021g).

year	number of passengers	change from previous year
2017	100,000	-
2018	110,000	+ 10.0%
2019	135,000	+ 22.7%
2020	95,000	- 29.6%

The busiest passenger transport station on the Oulu–Kontiomäki line section is Oulu. In 2019, a total of 505,000 journeys were started from Oulu and Oulu served as a destination for 507,000 journeys. In 2019, a total of 148,000 transit passengers changed to a connecting train in Oulu. (Finnish Transport Infrastructure Agency 2021a) The number of passengers and journeys also includes journeys through line sections outside the line section under review. At other passenger stops (Muhos, Vaala, Kontiomäki, Utajärvi and Paltamo), passenger numbers are considerably lower.

On the Russian side, the closest passenger train station to the Vartius border is Kostomuksha. From Kostomuksha, the line continues to Lietmajärvi. From Lietmajärvi, a line section branches in the direction of Suojärvi and Kotškoma. The Lietmajärvi–Kotškoma line section serves the needs of freight traffic. There is no passenger transport on this section of the track. The line section connects from the Kotškoma operating point to the Murman Railway, or the Kirov Railway. The Kirov Railway is an electrified line section between Murmansk and Olhava, connecting the coasts of St. Petersburg and Murmansk. There is a lot of freight, long-distance and commuter traffic on the line section.

Passenger transport is operated from Kostomuksha to Petrozavodsk and St. Petersburg. Train timetables are shown in tables 2–5. Figure 6 on page 17 shows the above-mentioned operating points.

Table 2. Passenger train timetables Kostomuksha–Petrozavodsk. Travel day Tuesday. (RZD 2021)

station	time	distance
Kostomuksha	19:05	-
Lietmajärvi	21:01	89 km
	21:06	89 km
Suojärvi	03:14	363 km
	03:59	363 km
Petrozavodsk	06:55 *	505 km

* Arrival the next day

Table 3. Passenger train timetables Petrozavodsk–Kostomuksha. Travel day Monday. (RZD 2021)

station	time	distance
Petrozavodsk	19:39	-
Suojärvi	22:47	142 km
	23:32	142 km
Lietmajärvi	05:54	414 km
	05:59	414 km
Kostomuksha	07:39 *	505 km

* Arrival the next day

Table 4. Passenger train timetables: Kostomuksha–St. Petersburg. Travel days Thursday and Sunday. (RZD 2021)

station	time	distance
Kostomuksha	20:16	-
Lietmajärvi	22:03	89 km
	22:08	89 km
Suojärvi	04:23	363 km
	04:53	363 km
St. Petersburg	13:09 *	767 km

* Arrival the next day

Table 5. Passenger train timetables: St. Petersburg–Kostomuksha. Travel days Friday and Monday. (RZD 2021)

station	time	distance
St. Petersburg	15:20	-
Suojärvi	00:08	404 km
	00:58	404 km
Lietmajärvi	07:16	676 km
	07:19	676 km
Kostomuksha	09:00 *	767 km

* Arrival the next day

Passenger transport runs through Lake Lietmajärvi to Suojärvi, continuing from Suojärvi to St. Petersburg or in the direction of Petrozavodsk as a night train. To St. Petersburg, the train route goes around the western side of Lake Ladoga via Sortavala.

2.2 Passenger potential and flows

At present, passenger train traffic between Russia and Finland only passes through the Vainikkala border station as day train service between Helsinki and St. Petersburg (Allegro) and as night train service between Helsinki and Moscow (Tolstoy). The number of Allegro service trains before the COVID-19 pandemic was approximately half a million journeys per year and the growth rate was approximately 15% per year (VR Group, 2020). Helsinki, St. Petersburg and Moscow are large cities with growing populations, which attract not only commuters but also leisure tourists to their areas. The surroundings and position of the Vartius border crossing point as a transit route is quite different compared to Vainikkala. Considering larger cities (with 200,000–300,000 inhabitants), the closest city on the Russian side along the line is Petrozavodsk at a distance of about 500 km and Oulu on the Finnish side at about 250 km from Vartius. Smaller city centres closer to the border with 30,000–40,000 inhabitants are Kostomuksha in Russia and Kajaani in Finland. Otherwise, the trackside areas consist of sparsely populated municipalities and districts. The tourism or business network between these different city centres could benefit from cross-border passenger train traffic. The volumes are naturally much lower than on the established Helsinki–St. Petersburg route. There has been heavy investment on the Helsinki–St. Petersburg route in the 2000s, which is why the most flexible connections from St. Petersburg or further from Russia to northern Finland are most efficient via Vainikkala compared to what passenger train traffic crossing over the border at Vartius could achieve, considering the current speed and traffic levels on the railway connections. Therefore, the potential for Vartius passenger train traffic should be generated at a more local level.

The Finnish Transport Infrastructure Agency has also investigated the possibility of cross-border passenger transport via Tornio to Haparanda, Sweden. The study identified only a small potential for traffic on the Oulu–Tornio–Haparanda route: a total of approximately 250 new train journeys per day, of which only less than 100 people would travel between Tornio and Haparanda. Traffic would have a significant deficit of 0.8–3.8 million euros with the above journey volumes, depending on the rolling stock options. There are a lot of uncertainties associated with the journey volume forecast and, among others, the estimates of the development of tourism and, for example, the university co-operation in the Bothnian Arch are fluctuating. The use of the region's airports, in Oulu, Kemi–Tornio and Luleå, is also challenging to predict due to supply fluctuations, but passenger train traffic has been mentioned as one potential connection to the airports. (Finnish Transport Infrastructure Agency 2020a)

The nearest airports at the Vartius border station are in Kajaani and Oulu, Finland. In Russia, the nearest airport is in Petrozavodsk. In the stakeholder interviews, it was mentioned that there will be some passengers from Russia to Kajaani, from where the journey will continue by plane. However, the number of flights in Kajaani is quite low, there are considerably more flights from Oulu. There are no direct flights from Petrozavodsk to Oulu or Kajaani. Based on the supply of the nearest airports, cross-border passenger train traffic could be directed to Oulu, from where it would be possible to continue by train to Kemi, Rovaniemi or Kolari, for example, and by plane or train to Helsinki or elsewhere in Europe. Figure 6 presents the rail network and the most significant cities in the area under review.

Figure 6. The railway network and most significant sites in the immediate vicinity of the area under review.

Should visa exemption between the EU and Russia be implemented, Russian border traffic is expected to increase significantly. The growing popularity of nature and wellbeing services (the increased importance of nature values as a priority also when reviewing methods of travel) and sustainable tourism create a good opportunity to shift tourism flows to more climate-sustainable rail transport instead of private cars. (Euregio Karelia 2020) However, the poor transport connections in the Republic of Karelia slow down the development of the region, and the flight traffic connections between Helsinki and Petrozavodsk and between Kostomuksha and Petrozavodsk are poor (Regional Council of Kainuu 2014).

The potential of cross-border passenger transport at Vartius was surveyed, among other things, through stakeholder interviews and by reviewing the population of municipalities and districts, numbers of border crossings and overnight stays by Russians in the Kainuu and Northern Ostrobothnia areas. There are numerous tourist destinations in the Kainuu and Northern Ostrobothnia areas, such as national parks, nature reserves and ski resorts. The number of overnight stays by Russians was declining after 2013, but has remained fairly stable during 2014–2019 (Figure 7). By far the most significant month for overnight stays is January. In Kainuu, January is even multifold with regard to Russian overnight stays compared to, for example, June. In Northern Ostrobothnia, in addition to January, December is also significantly more popular than other months based on the number of overnight stays.

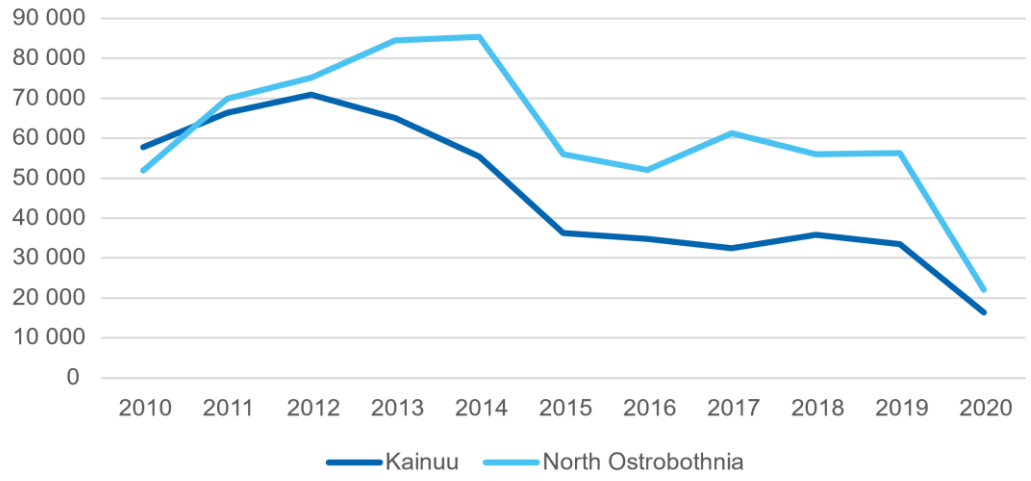

Figure 7. Overnight stays by Russians in Kainuu and Northern Ostrobothnia in 2010–2020 (Statistics Finland 2021a).

The volume of cross-border passenger transport at Vartius has been declining since 2016 (Figure 8). The COVID-19 pandemic during 2020 had a significant impact on border crossings. No seasonal variation such as overnight stays was observed in the number of border crossings, but the summer season is a slightly busier compared to the turn of the year. The significance of the Vartius border crossing point for seasonal tourism from Russia to Finland thus seems to be only minor at present.

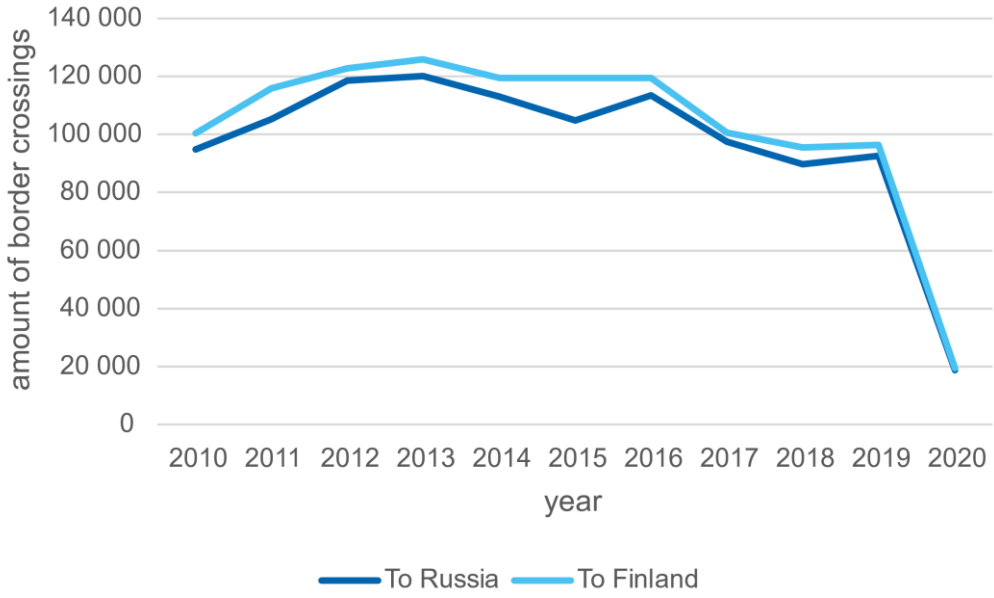

Figure 8. Vartius border crossings with cars and vans in 2010–2020 (Finnish Transport Infrastructure Agency 2021b).

The population of Kainuu (Figure 9) has decreased by approximately 9% from the 2010 numbers to 2020. The population of Northern Ostrobothnia, on the other hand, has grown by approximately 4%, mainly due to growth in the Oulu region. When reviewing just the population of the trackside municipalities along the Vartius–Kontiomäki–Oulu line (figures 10–11), the only positive change has been in Oulu and Muhos, whereas the population of other trackside municipalities has decreased by 13–19% between 2010 and 2020. The trackside municipalities are also quite small in terms of population and with regard to the Vartius passenger transport potential, the station areas in the trackside municipalities along the Vartius–Kontiomäki line are located far from the centre of the area: for example, Kuhmo station is approximately 50 km from the centre of the town.

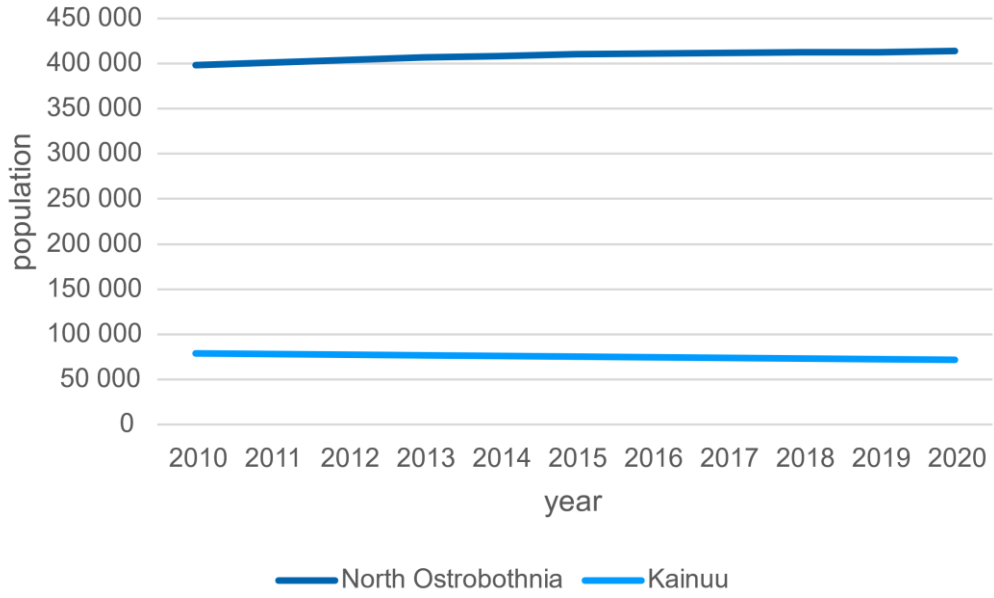

Figure 9. Population of Kainuu and Northern Ostrobothnia in 2010–2020 (Statistics Finland 2021b).

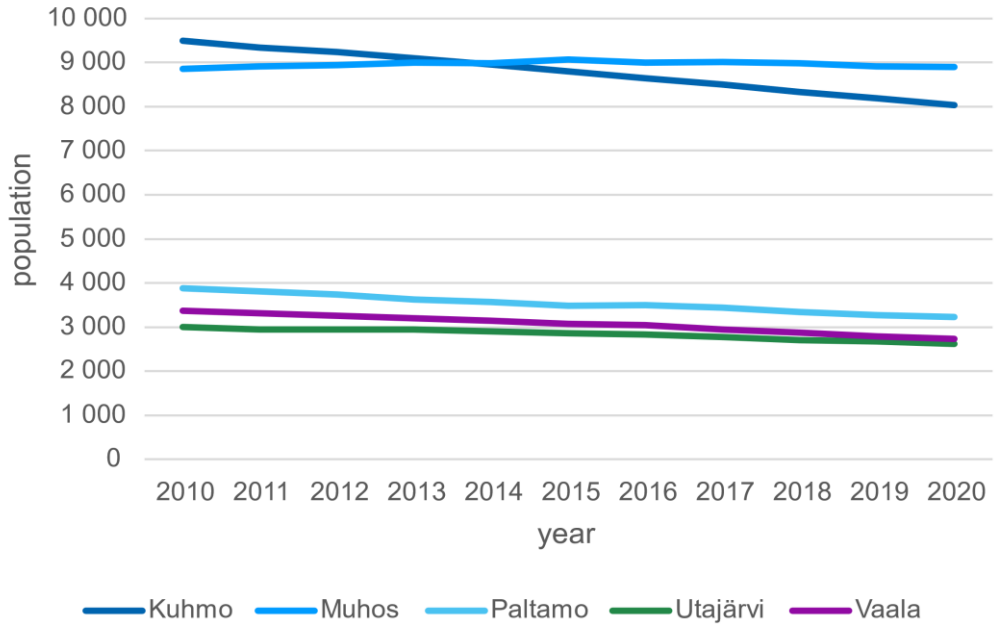

Figure 10. Population of Vartius–Kontiomäki–Oulu trackside municipalities in 2010–2020 (Statistics Finland 2021b).

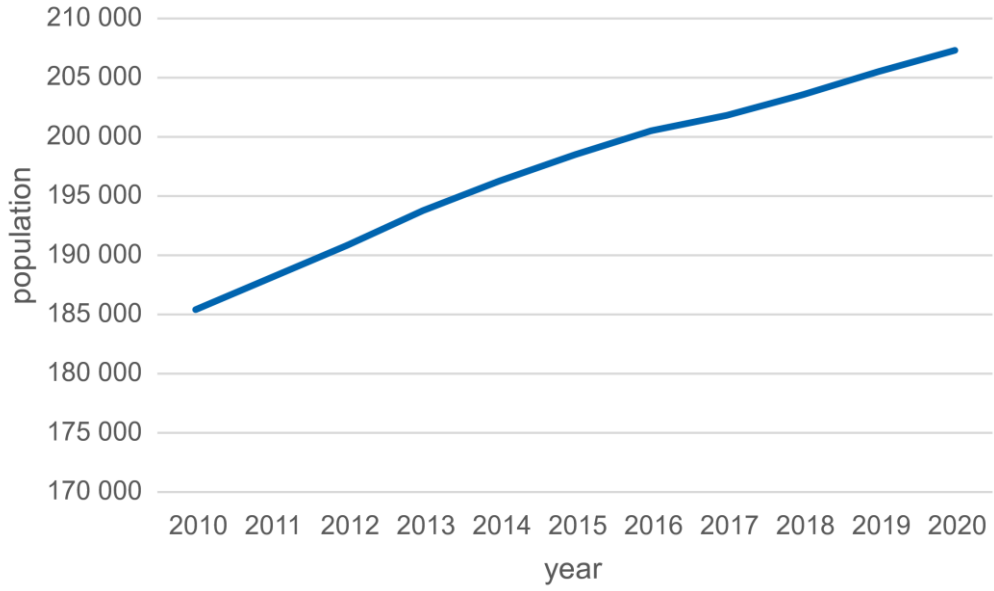

Figure 11. Population of Oulu in 2010–2020 (Statistics Finland 2021b).

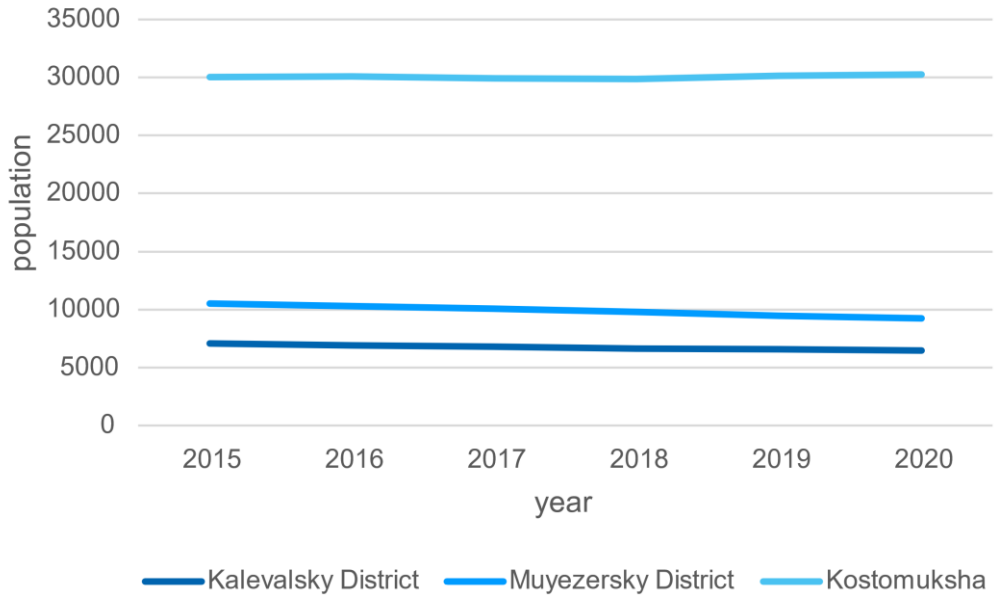

Figure 12. Population of cities and districts on the Russian side near the Vartius border in 2015–2020 (Rosstat 2021).

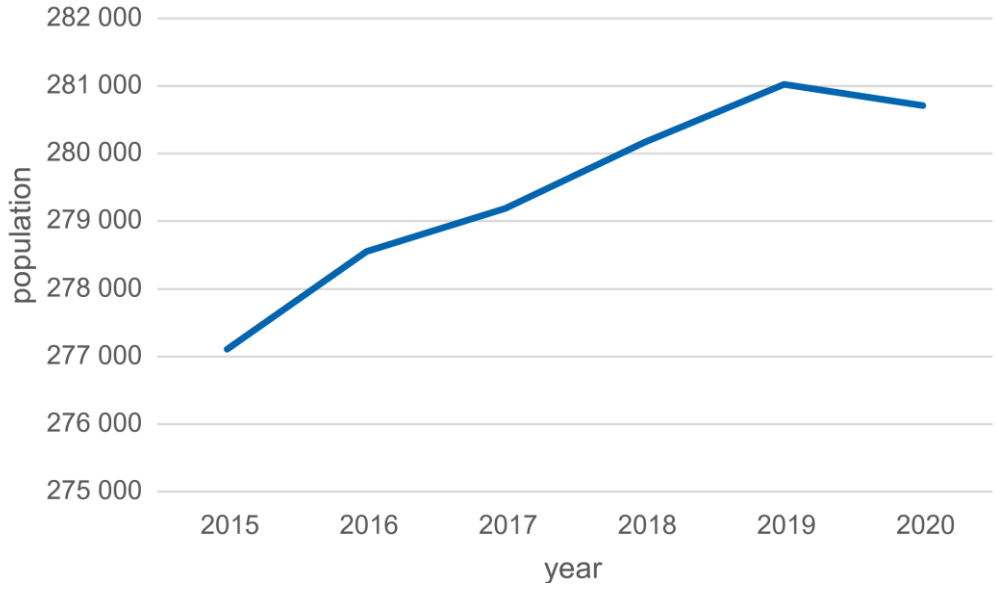

Figure 13. Population of Petrozavodsk in 2015–2020 (Rosstat 2021).

In Russia, the population of the Republic of Karelia (the area shown in Figure 6 on page 17) in 2020 was 609,071 inhabitants, which is 6% less than in 2010. In 2020, the population of Kostomuksha, the nearest larger city on the Vartius border, was 30,273. Another significant city in the Republic of Karelia is Petrozavodsk, which had 280,711 inhabitants in 2020. (Rosstat 2021) The population of both Kostomuksha and Petrozavodsk has grown by 3–4.5% from 2012 to 2019, but in 2020, the population of Petrozavodsk began to decline slightly. The population in the close vicinity of the Kostomuksha area, the Kalevala and Mujejärvi districts, totalled 15,730 in 2020, and the population of both districts has decreased by about 16–18% since 2012. (Euregio Karelia 2020, Rosstat 2021)

2.3 Tourist destinations and regional development activities

The tourist destinations and goals set for tourism in Kainuu and Northern Ostrobothnia were surveyed, among other things, through stakeholder interviews. The Regional Council of Kainuu, the trackside municipalities and, outside the area, also the Regional Council of Lapland and the Finnish Lapland Tourist Board ry (LME) were interviewed for the study.

Kainuu and Northern Ostrobothnia

Kainuu and Northern Ostrobothnia are so-called international zones, whose tasks include developing the province's reputation and being open to other cultures and nationalities. The Regional Council of Kainuu co-operates with domestic and foreign actors to create an international co-operation network. Various projects and development activities are carried out, for example, through co-operation between Barents, Kainuu and Russia, as well as several international networks. (Regional Council of Kainuu 2021c) Similar measures are being taken in Northern Ostrobothnia, where the aim is to promote international competitiveness by, among other things, promoting the TEN-T core network and, thus, accessibility (Council of Oulu Region 2021a).

Kainuu's most significant tourist destinations include Vuokatti, Ukkohalla ski and sport resort, Paljakka Strict Nature Reserve and Paljakka Ski Center. Hossa National Park is in the northern parts of Kainuu, continuing to the side of Northern Ostrobothnia. Other important tourist attractions in Northern Ostrobothnia include Rokua Geopark, Ruka Ski Center and Oulanka National Park. The aim is to increase the international visibility of Finland's tourist areas, for example, with the tourism road map between Northern Finland and the Republic of Karelia, which has been prepared for 2021–2023. (Euregio Karelia 2020)

In addition to Northern Ostrobothnia, Lapland is also a potential tourist area for passenger transport from Vartius, as Lapland can be reached by train from Kontiomäki and Oulu. According to a stakeholder interview of the Finnish Lapland Tourist Board ry (LME), there were 3.1 million overnight stays in Lapland in 2019, and more than half of the overnight stays were by foreign tourists. The number of foreign tourists is also growing faster than that of domestic tourists. International tourists are increasingly coming from Asia, the United Kingdom and Central Europe, among others, but Russian tourism has remained moderate since 2015.

The COVID-19 pandemic during 2020 has had a significant impact on the overnight stays and border traffic of foreigners, but the tourism strategy of the Regional Council of Kainuu, for example, aims to increase the number of foreign tourists, including Russians, by 5% from 2019 by 2025 (Regional Council of Kainuu 2018a). The goal of Northern Ostrobothnia is also to make the area a year-round destination accessible to international and domestic tourists. The aim is to reach 2019 tourism volumes as soon as possible after the COVID-19 pandemic. (Council of Oulu Region 2021b)

Russia, Republic of Karelia

To the east of Finland, in the Republic of Karelia, a significant part of passenger flows travels by road, due to the short distance between the Finnish border and St. Petersburg. The area of the republic includes significant monuments, such as the UNESCO World Heritage Site of Kizhi, the Ruskeala Mountain Park and the Valamo Monastery Island in Lake Ladoga. There are also quality hotels and restaurants in the area. There is a ski and outdoor sports centre near Petrozavodsk and another one is planned in the Sortavala area. The Republic of Karelia also has ongoing projects promoting tourism, which aim to attract one million tourists to the region per year by 2025. (Euregio Karelia 2020)

2.4 Conditions for starting passenger transport services

No passenger transport has passed by rail through the Vartius border crossing point. For this reason, starting passenger transport across the Vartius border is not simple, but requires consideration of numerous matters and plenty of planning. For example, the track infrastructure and the border crossing process involve technical and operational conditions and regulations that must be met. In addition, cross-border co-operation and resources between operators and authorities need to be taken into account.

The current treaty on border traffic between Finland and Russia defines the Vartius/Kivijärvi border crossing point as being suitable also for rail passenger transport. However, as there has been no transport so far, its launch will require consultation and agreement between the countries' ministries responsible for transport. (Statute Book of Finland 2016)

Vartius passenger transport infrastructure

In order to enable passenger transport, the passenger transport infrastructure currently lacking at the station should be constructed at the Vartius operating point. With regard to regular passenger transport service, this would mean at least the following additions to the passenger transport infrastructure at the operating point:

- traffic platform
- platform equipment
- passenger information equipment
- platform lighting
- small parking area

If the traffic were only occasional, for example of the charter type, the passenger service level requirements could potentially be lower. The implementation of the platform solution could be implemented with a temporary platform model, which would be a more economically sensible solution for non-scheduled service and would provide better conditions for starting passenger transport.

Border and customs operations and passenger services

It is possible to carry out the customs clearance of passengers on a moving or stationary train. For more specific personal customs controls, separate facilities are required at or near the railway station. At present, Vartius does not have the facilities required for cross-border passenger transport, such as the facilities required for arriving and departing passengers for border and customs formalities.

According to a notification by the Customs authorities, it is possible to implement individual train services with special arrangements if necessary, but for more regular passenger transport, there should be appropriate premises for the needs of both Customs and the Finnish Border Guard. The natural location for these facilities is at Vartius, but depending on the traffic method of the trains, another station may also be considered (European Parliament and Council 2016). Based on an interview with the Finnish Border Guard, the duration of the customs and border inspection is approximately 3–5 minutes per passenger. At the start of regular passenger transport service at the Vartius operating point, at least the expansion of the station area and new facilities would be required not only for passenger services but also for official functions, taking into account, for example, the systems required by the Schengen provisions.

Alternatively, Vartius can also act as an operating point that does not provide passenger services, in which case it is not possible to get on or off the train at Vartius. However, border and customs formalities must be arranged at one operating point along the train route.

The most viable option for passenger services at the Vartius operating point is track 666 (Figure 15). With regard to passenger transport, this track would be the best option for passengers to board and leave the train. The track is located next to the current station building, thus, it would also smoothly serve the border and customs functions.

The Vartius border crossing point is open from 7 a.m. to 9 p.m., as are the services of Customs and the Border Guard at the border crossing point. With regard to Customs, the opening hours for rail traffic have been extended until 10 p.m., if necessary. The additional time has been reserved for trains returning to Russia.

Rail capacity

There is quite a lot of capacity on the Vartius–Kontiomäki line. The importance of timetable planning is emphasized on the line section with regard to the co-ordination of traffic. The maximum speed of the line section (80 km/h) as well as the blocking protection between operating points combined with long operating point intervals (Figure 14) and the low number of passing loop options make traffic co-ordination and the planning of additional traffic demanding.

Lengths of operating point intervals:
- Vartius–Ypykkävaara: 24 km
- Ypykkävaara–Arola: 22.1 km
- Arola–Kontiomäki: 48.8 km

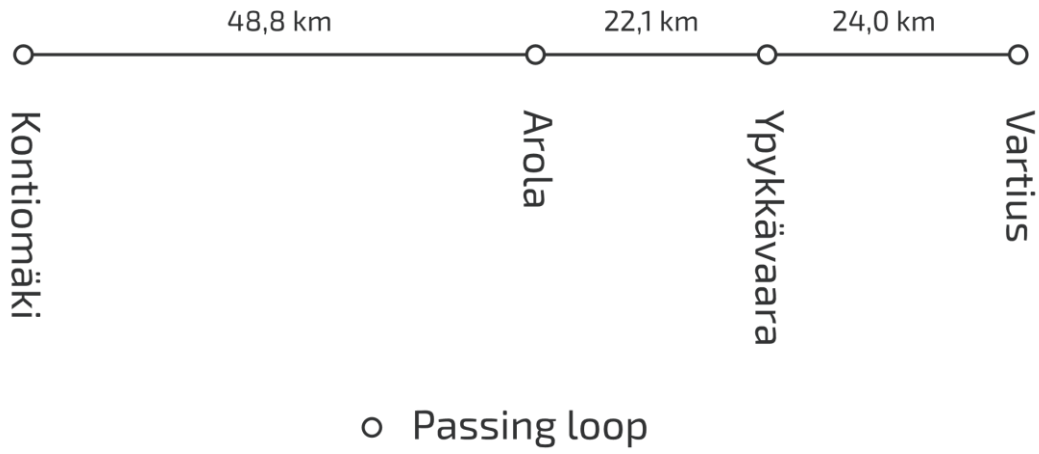

Figure 14. Operating point intervals between Kontiomäki and Vartius.

The stakeholder interviews highlighted a particularly challenging situation in co-ordinating the traffic of two line sections. Between Paltamo and Arola, the distance between passing loops is more than 60 km, as it is not possible to organise an encounter between trains in opposite directions on the Kontiomäki triangle. It is possible for trains to pass each other in Kontiomäki, if at least one of the trains runs through the Kontiomäki railway yard. In this case, the direction of travel of the train passing through the railway yard needs to be changed, which generally means stopping and moving the locomotive to the other end of the train and testing the brakes.

The challenge posed by the possibility of trains encountering is directly reflected in the capacity of the Vartius–Kontiomäki line section and makes it difficult to co-ordinate traffic flows on the two line sections. An additional challenge is to find capacity at a suitable time also on the Kontiomäki–Oulu/Iisalmi line sections as an extension of the arrival in Kontiomäki.

The traffic structure on the line section is currently (review period June 2021) established in a form where in the morning, the freight traffic runs in the Kontiomäki–Vartius direction and in the afternoon and evening, in the Vartius–Kontiomäki direction. During the night, train traffic is limited due to the opening hours of the Vartius Customs and Border Guard services.

There are five main route tracks at the Vartius operating point. The non-electrified track 665 is used for track maintenance purposes. Vartius track lines are illustrated in figure 15.

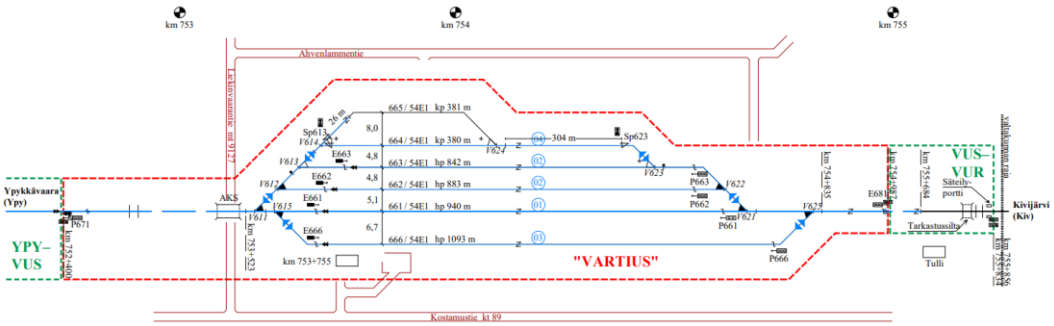

Figure 15. Track line diagram of Vartius operating point.

The railway yard capacity of the Vartius operating point is fully utilised during peak hours (e.g. from 10 a.m. to 12 noon). In addition to the departing and arriving trains, the moving of locomotives between trainsets requires one pass-through track. Shunting at the Vartius operating point is performed with local permits, which in practice prevents other train operation during shunting.

2.5 Rolling stock options

The implementation of transport would be possible with several different rolling stock solutions. The key factors are the type of rolling stock and the ownership of the rolling stock, which can be influenced independent of one another. The type can be, for example, night train stock (cf. Lapland night train traffic, Tolstoy), conventional locomotive-driven long-distance traffic (cf. IC trains), high-speed electric motor train (cf. Allegro) or regional train traffic. The rolling stock can be owned by a Finnish operator (cf. IC trains, former Sibelius train), October railway (cf. Tolstoy) or the rolling stock may be jointly owned by the operators (cf. Allegro). Figure 16 shows the rolling stock options and table 6 presents the pros and cons of the different options.

Figure 16. Examples of types of rolling stock: top left, Finnish locomotive-driven long-distance rolling stock (photo: Aarne Alameri), top centre, Russian locomotive-driven long-distance rolling stock (Xenotron/Wikimedia Commons, CC BY-SA 4.0), top right, Finnish night train rolling stock (Smiley.toerist / Wikimedia Commons, CC BY-SA 4.0), centre left, Russian regional train traffic multiple unit train (Xenotron/Wikimedia Commons, CC BY-SA 4.0), centre, Finnish regional train traffic multiple unit train (Phil Richards/Wikimedia Commons, CC BY-SA 2.0), centre right, Russian sleeper car rolling stock in Finland (Fabien Perissinotto/ Wikimedia Commons, CC BY-SA 4.0), bottom left, co-owned high-speed multiple unit train rolling stock (Ralf Roletschek/Wikimedia Commons, Free Art License), bottom centre, Finnish high-speed multiple unit train rolling stock (Phil Richards/ Wikimedia Commons, CC BY-SA 2.0), bottom right, Russian high-speed multiple unit train rolling stock (Sergey Korovkin/Wikimedia Commons, CC BY-SA 3.0).

Table 6. The pros and cons of different rolling stock options.

		ownership		
		domestic operator	**joint ownership**	**October railway**
rolling stock type	**night train rolling stock**	+ It could be possible to use the trainsets of the Kolari traffic service. + Locomotive interchangeable in Vartius. + Well suited for long journeys.	+ It is possible to define the technical characteristics of rolling stock according to traffic. - Requires rolling stock purchases; high investment costs. + Locomotive interchangeable in Vartius. + Well suited for long journeys.	+ There may be rolling stock available. + Locomotive interchangeable in Vartius. + Well suited for long journeys.
	locomotive-driven long-distance traffic	+ Locomotive interchangeable in Vartius. - There is limited rolling stock. - Distances are long for day train service.	+ It is possible to define the technical characteristics of rolling stock according to traffic. - Requires rolling stock purchases; high investment costs. + Locomotive interchangeable in Vartius. - Distances are long for day train service.	+ There may be rolling stock available. + Locomotive interchangeable in Vartius. - Distances are long for day train service.
	fast multiple unit train	- No rolling stock. - Would require the possibility to use diesel locomotives, or electrification in Russia. - The area's railway network does not allow full utilisation of rolling stock.	+ It is possible to define the technical characteristics of rolling stock according to traffic. - Requires rolling stock purchases; high investment costs. - The rolling stock would need to be procured as diesel or hybrid stock. - The area's railway network does not allow full utilisation of rolling stock.	- The availability of rolling stock is probably poor. - Only diesel locomotives could be used. - The area's railway network does not allow full utilisation of rolling stock.
	regional rail transport with multiple unit trains	- No rolling stock. - Would only operate as feeder traffic between Kontiomäki and Kostomuksha. - Only diesel locomotives could be used.	+ It is possible to define the technical characteristics of rolling stock according to traffic. - Requires rolling stock purchases; high investment costs. - The rolling stock would need to be procured as diesel or hybrid stock.	+ Diesel rolling stock is most likely available. - Would only operate as feeder traffic between Kontiomäki and Kostomuksha.

From the point of view of passenger services, the traffic estimated to be the most potential is the night train traffic with the rolling stock of either October railway or a domestic operator. Night train traffic has more potential than other types of traffic, because the distances in the area are quite long, especially on the Russian side. From the point of view of starting a train service, it would be more advantageous if existing rolling stock could be utilised, so the use of wagons owned by another service operator would be the simplest solution. At the border, the

locomotive would be replaced, as is already the case with Tolstoy trains and freight traffic.

In practice, however, the opening hours of the border limit the benefits of using night trains, as the border cannot be crossed at night. The second most potential service is estimated to be locomotive-driven long-distance traffic with day train rolling stock, on the basis of which a capacity analysis has also been performed in this study. During the same day, it would be possible for one rolling stock unit to travel from Kostomuksha to Oulu and back to Kostomuksha.

In addition to these, regional train traffic with multiple unit trains could be an option. An Allegro-type high-speed multiple unit train is the least likely of the alternatives, as it would have considerable start-up costs.

2.6 Development of cross-border passenger transport

The potential for cross-border passenger transport at Vartius has been examined using two different scenarios, a neutral and an optimistic scenario. The neutral scenario takes into account the uncertainties of tourism in the coming years due to, among other things, the COVID-19 pandemic and the current number of border crossings and overnight stays. The scenario aims to enable cross-border traffic at the Vartius border without significant investment needs, for example, in the border station facilities or rolling stock: it would be possible to try out the transport operation by using individual train services. The optimistic scenario looks further into the future at a situation where the potential of cross-border passenger train traffic at Vartius has been established as a sensible investment target and a more regular traffic service can be started. Given the number of tourists and the size of the cities and municipalities near the Vartius border, the optimistic scenario is not a realistic option in the current situation.

Neutral; the potential scenario for the near future

The importance of tourism for the vitality of both Kainuu and Northern Ostrobothnia was emphasised in the stakeholder interviews. The regions have numerous tourist destinations, the attractiveness and accessibility of which are being improved through various means, including co-operation with Euregio Karelia (see Chapter 2.3). The passenger-transport crossings of the Vartius border and the overnight stays by Russians on the Finnish side, however, have remained at fairly the same level since 2015.

Due to the stability of the number of border crossings and Russian overnight stays, as well as the smaller and decreasing population in the area, the implementation of cross-border passenger train transport at the Vartius border is not viable as a regular, weekly service. However, there could be a demand for individual, on-demand-type chartered service flights, but the realisation of traffic requires activeness from both the Russian and Finnish actors, such as representatives of the tourism industry and municipalities and regional councils. Seasonal variations in the tourist destinations of Kainuu and Northern Ostrobothnia could be better taken into account with the help of charter train services, and it would be possible to run the services more frequently, for example, in December and January, when overnight stays by Russians are at their highest in the region.

The potential departure and destination station of the train in Russia is Kostomuksha, as the city has, among other things, night train connections from elsewhere in Russia, and the city is thus accessible by transit connections. Travel time from Kostomuksha to the Vartius border is also moderate, approximately 40 minutes, and the line section is only about 40 kilometres long. From Kostomuksha, the train would continue across the Vartius border to Kontiomäki, after which the train would stop at the existing passenger stations in Paltamo, Vaala, Utajärvi, Muhos and Oulu, that are also used in domestic traffic. It is necessary to continue the train route to Oulu, as, of the operating points along the Vartius–Oulu line, Oulu has the best opportunities for storage and maintenance of rolling stock. There are well-functioning transit connections from Oulu to northern Finland and, for example, via Tornio to Sweden. The same connection line would also work in the opposite direction, i.e. from Oulu via Kontiomäki and Vartius border to Kostomuksha, where passengers can be directed to other parts of Russia via transit connections. From Kontiomäki it is also possible to change trains to Kouvola and Helsinki, for example.

Implementing individual train services would be a low-cost option for testing the potential of the cross-border passenger train traffic at Vartius. Border formalities would be possible to implement without significant investments in the Vartius station and the rolling stock could potentially be available without new acquisitions. However, the implementation requirements need to be re-examined in more detail, if conditions for traffic are seen viable.

Optimistic; the long-term scenario

If the long-term potential of cross-border traffic in Vartius increases from the current level, it is possible to plan more regular passenger train traffic, for example once or twice a week, between Kostomuksha and Oulu. The launch of such transport may be necessary in the future, for example, due to climate objectives. In Sweden, for example, several cross-border passenger train connections across country borders have been successfully implemented, including the service on the routes Stockholm–Oslo, Luleå–Narvik and Malmö–Copenhagen routes (Järnväg.net 2021). However, the start of regular traffic would require investments in, among other things, the Vartius border station, and would require a clear increase in the travel between Russia and Finland. In addition, the limited capacity of the Oulu–Kontiomäki line section and the Vartius railway yard pose a challenge.

The long-term scenario also involves the wider development of passenger transport service provision in the region. The future possibilities of passenger transport between Joensuu and Kontiomäki have also been studied (Regional Council of North Karelia 2016). The challenges regarding the passenger potential are similar to those identified in this study for the Vartius passenger transport. These train connections would complement each other in terms of the service level of train and public transport, and, in part, the growth of the potential requires similar changes in the mobility in the area.

2.7 Impact of the launch of passenger transport

Chapter 2.2 states that the passenger potential of passenger transport across the Vartius border is very small, so the impacts of starting passenger transport are also assumed to be isolated or require more definite certainty about the implementation of passenger transport and the number of journeys. The impacts of the start-up of passenger train traffic were examined from the perspectives of the adequacy of rail capacity, travel chains, transit connections and other directions of railway traffic linked to the Oulu–Kontiomäki area, also taking into account the possible effects on tourism.

Impacts on rail capacity and transit connections

The adequacy of rail capacity on the Vartius–Kontiomäki–Oulu line section is challenging. This line section is sensitive to interference and it is only possible to operate passenger transport services that are sensible in terms of travel time at times when transit connections do not function in an optimal way. A train connection from Kostomuksha to the Finnish side would enable a transfer connection from the night train coming from Petrozavodsk, but in the return direction from Kostomuksha there will be no further connections to the rest of Russia on the same day. The transfer connections are indicated in more detail in Figure 17 and the timetables of charter-type passenger train services are presented in the graphic timetable in Appendix 1.

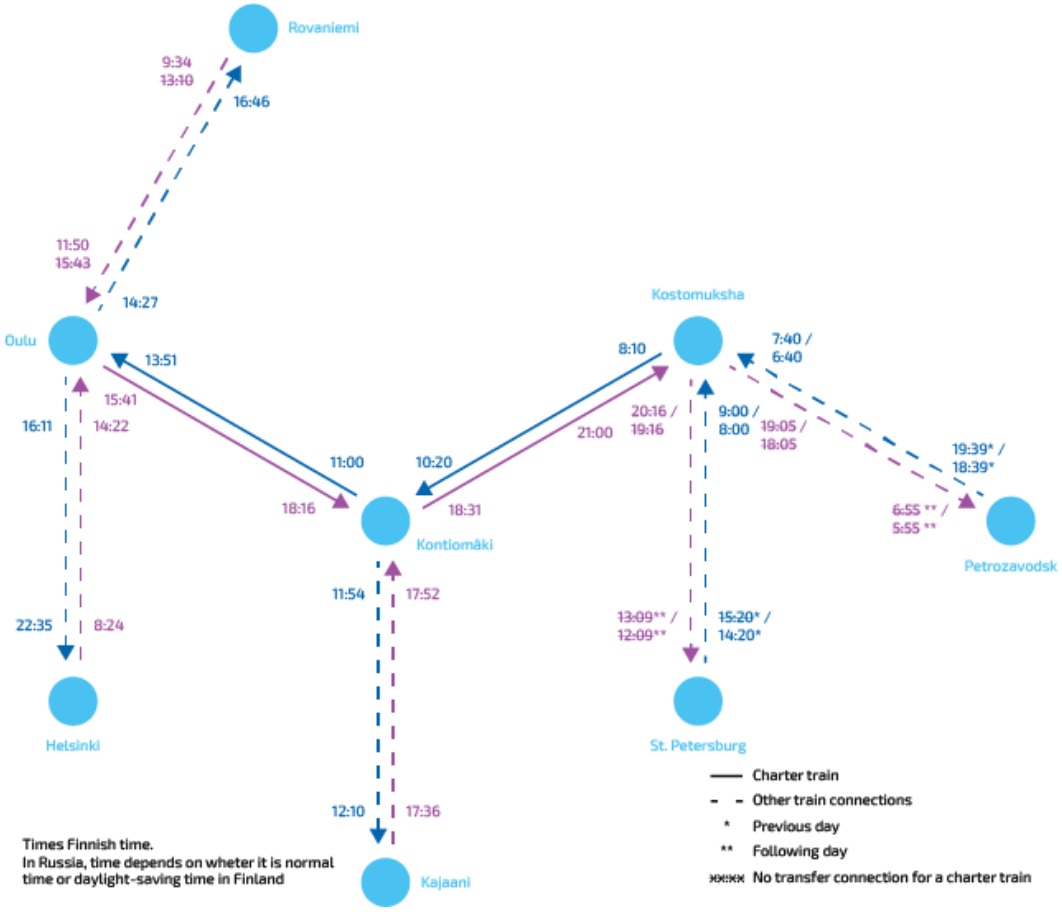

Figure 17. Transfer connection options for a charter train.

Impacts on other line sections and travel chains

Due to the above-mentioned challenges related to transit connections caused by the rail capacity, the impacts of cross-border passenger transport at Vartius on other than the Kontiomäki–Oulu route are small. The impacts of traffic between Kontiomäki and Oulu are discussed in more detail in connection with Chapter 3 and in Appendix 1. The possibility of utilizing Tornio and Haparanda in tourism mentioned in the stakeholder interviews would require not only traffic through Vartius but also better connections from Tornio to Haparanda.

Stakeholder interviews also highlighted the importance of smooth travel chains. The perception was that there are many shortcomings in travel chains in the current situation, as train and other public transport timetables in the Kainuu and Northern Ostrobothnia regions are often insufficiently co-ordinated. This was also seen as a major challenge for the implementation and functioning of cross-border passenger train services in Vartius, as the impacts on tourism in general and tourism in smaller localities, among others, could be very minor if other public transport options besides the train connection are not smooth.

The possibilities of opening the Joensuu – Kontiomäki line for passenger transport along its entire length have also been examined in 2016, when the continuation of the Joensuu–Nurmes connection was uncertain (Regional Council of North Karelia 2016). The study also evaluated aspects related to the organisation of traffic on the line in question, especially with regard to tourism. The existence of this connection would increase the number of potential transit connections for trains crossing the Vartius border and thus add Vuokatti, for example, to the list of tourist destinations directly accessible by train. According to the study, in terms of trafficability, the Joensuu–Kontiomäki route faces the same challenges in terms of passenger potential as the traffic crossing the Vartius border. On the other hand, smooth passenger transport on the track in general would require substantial investment in infrastructure. The study also came up with a seasonal model of transport experimentation that would support tourism in particular. However, the traffic analysis of the study focused on northbound traffic. From the point of view of available regional traffic and its accessibility, the direction of Kontiomäki should also be given more focus.

2.8 Conclusions and further measures

The current passenger potential for cross-border passenger transport in Vartius has been found to be small in this study. It is due to, among other things, the small size of the cities in the region and the declining development of overnight stays and border crossings by Russians. In addition, Vartius has not been currently identified as a significant border crossing point for tourism, so without further research on the reasons behind border crossings, it is difficult to assess the transition potential of existing border crossers to train users. The route via Vartius cannot be considered a competitive route for international trains passing through Vainikkala, as this route with its comprehensive transit connections on the Finnish side is efficient and competitive.

In order to be able to carry out passenger train traffic across the Vartius border, it requires commitment and close co-operation between the tourism operators and regional councils in the Republic of Karelia, Kainuu, Northern Ostrobothnia and Lapland, among others, as well as a strong determination to start traffic services. In practice, a new user base for train traffic should be found through active marketing efforts directed at the target groups. Enabling cross-border passenger train traffic also requires an agreement between the State of Finland and the ministries responsible for traffic in the Russian Federation. Naturally, both countries must be prepared to allocate the resources to border formalities required by transport operations.

In the current situation, where there is not enough passenger potential ready for train services, the most viable option for opening traffic is charter-type transport, which would be the responsibility of regional tourism operators and/or entrepreneurs. Charter trains do not require as much infrastructure development measures as more regular traffic services would need, which makes it easier to start traffic services even on a pilot basis. The Vartius operating point would not necessarily require any development measures, if it is not in passenger use. In that case, border formalities would be handled, for example, in Kontiomäki.

Regular traffic would place significantly more demands. In the current situation, in addition to the support of regional actors, a very strong political commitment at national level to open up transport would be needed. In practice, transport should be arranged as state-sponsored purchased traffic service, as market-based potential is not in sight in the current environment. There should also be a permanent increase in resources for border formality processes compared to the current situation at the Vartius border crossing point. Permanent facilities would have to be allocated to passenger services. At this stage, the simplest operating model is most likely the development of the Vartius operating location. Adequate premises should be built at the Vartius border crossing station for both the border and customs operations as well as passenger services. A passenger platform would also be needed in Vartius. When planning the rotation of the rolling stock needed for the traffic service, the storage possibilities of the rolling stock at, for example, the Oulu depot and the activities related to the locomotive change in Vartius should also be taken into account. The capacity of the Vartius operating point should also be re-evaluated, and the construction of an additional track for passenger trains may well be necessary.

Preliminary timetables (Appendix 1) have been drawn out for charter-type passenger transport from Kostomuksha via Kontiomäki to Oulu, taking into account the current train traffic timetables. In addition, the situation in the near future has been examined, in which, among other things, after the completion of the Kemi bioproduct mill, the transportation of raw timber may increase from the current level and increase the number of freight trains, especially between Oulu and Kontiomäki. It is challenging to make timetables reasonable in terms of travel time and functional with regard to their transit connections. In Chapter 3.7 , the needs for infrastructure-related measures along the entire Kontiomäki–Oulu line section are examined in more detail, also taking into account the potential passenger train traffic crossing the border at Vartius.

Further measures

The operating costs of train service in cross-border passenger transportation has not been reviewed in more detail in this study, as the costs vary greatly depending on, among other things, the type of rolling stock selected for the service (night train/day train/number of wagons), number of staff and wage differences between Finland and Russia, duration and method of border formalities, travel time, effects of the non-electrified line section on the Russian side on the selection of locomotive, track access charges and fuel price fluctuations. Determining the costs of traffic services is one of the measures on the agenda next, if planning of cross-border traffic at Vartius is to start in more detail. This is significantly affected by the type of traffic (charter trains or regular train service). The profitability of train transportation must then be assessed in relation to the desired target group of users. There is a need to complete a separate comparative analysis of transport modes and costs, if a decision is made to promote starting transport operations at all.

The current data suggests that the potential for regular cross-border passenger transport at Vartius is not sufficient to justify the larger development measures it would require with regard to the track and passenger services. It is clear that a regular transport service would require its own project appraisal and a more in-depth understanding of passenger flows and their future development across the border. If the establishment of train services is to be supported politically or if structural changes leading to passenger flows can be predicted, such a broader study may be relevant at such a time.

If the border regions, municipalities and businesses have a shared determination and commitment to invest in cross-border passenger transport, based on the reviews of this study, charter train transport would then be the model that could be used in trying to open the Vartius border crossing for passenger train traffic without making any excessive investments. In this case, the next step that is necessary is to draw up a project map, in co-operation between the business operators and municipalities on both sides of the border, on which operators would benefit from charter trains, what is the target group of the train services, how they can be reached and how will the financial responsibility for chartered traffic be shared.

Based on this study, the Vartius border does not currently have sufficient passenger potential to open up passenger transport services and the route has not been found to be very competitive to attract new passenger flows. Without a strong regional and unified determination and systematic surveying and active promotion by regional operators of the passenger potential generated by the train connection, there is no need for further measures to start passenger train services in Vartius.

The development of Vartius and the Kontiomäki–Vartius line may also be necessary for freight traffic in the future, as there is currently a significant freight flow through the track and the route is seen as having potential for growth in freight demand. In the future, the conditions for opening or expanding passenger transport should be assessed in the same context as other development measures are planned in the region.

3 Improvement needs of the Oulu–Kontiomäki line section (WP6d)

The aim of this study is to survey the current traffic status and traffic capacity of the Oulu–Kontiomäki line section, identify the section's development targets taking into account future traffic needs (including attention to the passenger transport potential studied in Chapter 2), and to use these as a basis to present the improvement measures for the line section to be taken next as well as any potential topics for further studies.

Several studies directly concerning the Oulu–Kontiomäki line section (Figure 18) have been completed during the last decade. The route is minor in terms of passenger transport, but busy in terms of both the number of trains and the freight tonnage. Studies have been carried out on the development of freight traffic routes (Iikkanen & Lapp 2016, Iikkanen & Lapp 2021) and on new operating points (Iikkanen & Lapp 2019, Finnish Transport Agency 2017). Over the last 10 years, major overhaul and other individual development measures have also been carried out in the area under review, but the rail capacity of the line section remains challenging with regard to the traffic.

The current climate targets call for a strong increase in the share of rail transport in both passenger and freight transport. As demand grows, it is important that the railway system is able to adapt to changes with the least possible disruption as quickly as possible. If demand cannot be met, a transport market will emerge for other less environmentally friendly modes of transport, and these structures may develop and become more efficient, thus forming a higher threshold for switching to rail in the future. For this reason, it is important to anticipate the level of operating conditions for transport and to enable their development and maintenance, and it is worth investing in the development of the railway system in general. The importance of this point is emphasised on congested line sections such as the Oulu–Kontiomäki section.

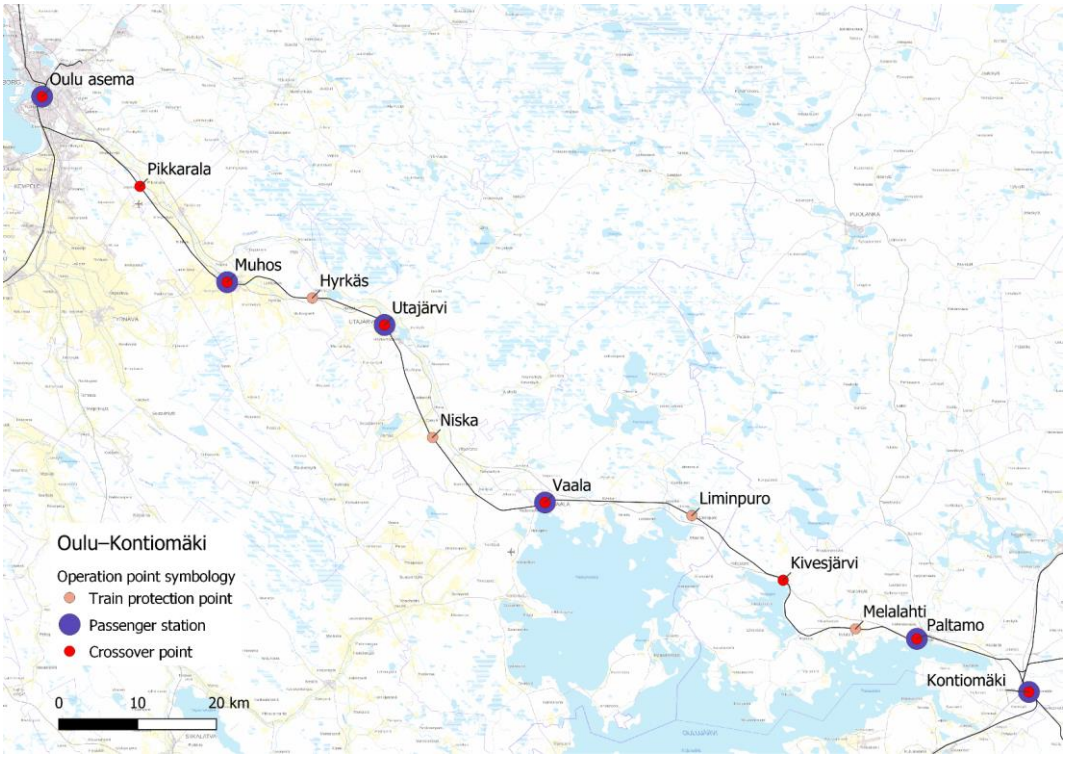

Figure 18. Oulu–Kontiomäki general chart.

The sources of information for this study include the previous studies in the area under review as well as the expert interviews. Chapter 1.3 includes all the stakeholders interviewed throughout the study. For this chapter, the interviews with experts from the railway environment have primarily been used. The study also analyses the adequacy of rail capacity at a general level, based on traffic scenarios generated using data sources and identified as the most potential in the near future. Based on the results of the stakeholder interviews and the capacity review, the most appropriate and necessary measures to improve the train service on the line section will be identified. Attention is also paid to the conditions for cross-border passenger traffic at Vartius examined in Chapter 2 for the Oulu–Kontiomäki route.

This chapter continues with a description of the line section's current status, traffic and rail capacity. An overview is then generated of the planned and ongoing rail projects in the region, as well as nearby projects affecting traffic in the area. This is followed by a presentation of the capacity and timetable review methodology, and the development needs identified based on its results and the interviews. Finally, proposals are provided for measures to develop the performance of the line section, and a summary of this chapter is also included.

3.1 Current status of the line section

The Oulu–Kontiomäki line section (line section number 531) is the central connection of the Finnish railway network in northern Finland between the Oulu region and Kainuu. From the point of view of the transport network, it continues the Savo line, connecting it to the main route in Oulu and is thus part of the most direct railway route from the Bay of Bothnia and Lapland to Eastern Finland. The southern terminus of the track, Kontiomäki, transmits passenger transport from

the direction of the Savo line toward Oulu and it is a major junction station for freight traffic, around which connections from Suomussalmi, Vartius and Joensuu also cross.

The line section is 166 km long and was completed in its entirety in 1930. The section is single-track, blocking protected and remotely controlled line and it was electrified in 2006. Measures to improve the traffic capacity of the line section have been reviewed in recent years and partly also implemented. Some of the decided improvement measures are awaiting the start of construction. There is some regular passenger transport on the track, 3–4 pairs of trains a day. In addition to Oulu and Kontiomäki, the section has five stations serving passenger transport. In 2019, 135,000 journeys were made on the line section, and in 2020, the number was 95,000 journeys. Passenger transport consists entirely of purchased traffic of the Ministry of Transport and Communications.

Freight traffic on the line section has been increasing over the last ten years. In 2018, transport volume was 6.4 million tons. Most of the current freight traffic is iron-pellet and raw timber transports. Growth expectations for cross-border traffic are uncertain, but timber transport is forecast to increase by 0.55 million tonnes per year as a result of forest industry projects (Iikkanen & Lapp 2021).

Operating points

In addition to the end points of the line section in Oulu and Kontiomäki, the section currently has a total of 10 operating points. Five of these provide passenger services. In addition to passenger transport points, two of the operating points offer passing loops, i.e. the possibility for trains to meet. Four fairly new operating points currently only serve in shortening the interval of train protection points, but some of them are planned to be expanded to include passing loops in the near future. In addition, a reservation has been made for yet two new passing loop operating points in the future. The operating points on the line section are very different from a traffic management perspective. Table 7 presents basic information on all the current operating points. The location of operating points as well as the distances between them are indicated in figures 19 and 20.

Table 7. Operating point information.

operating point	platform tracks	passing loop (yes/no)	through-transit tracks	maximum useful length (m)	distance from Oulu (km)
Oulu	3	Y	*	*	0
Pikkarala	–	Y	2	759	19
Muhos	1	Y	2	986	36
Hyrkäs	–	N	–	–	48
Utajärvi	2	Y	3	807	58
Niska	–	N	–	–	73
Vaala	2	Y	3	1,067	92
Liminpuro	–	N	–	–	111
Kivesjärvi	–	Y	2	1,100	125
Melalahti	–	N	–	–	141
Paltamo	1	Y	3	764	149
Kontiomäki	3	Y	*	1,029	166

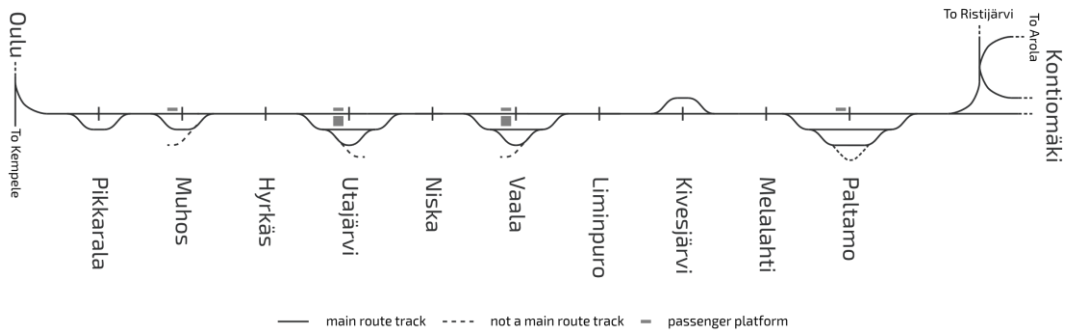

Figure 19. Operating point diagram Oulu–Kontiomäki.

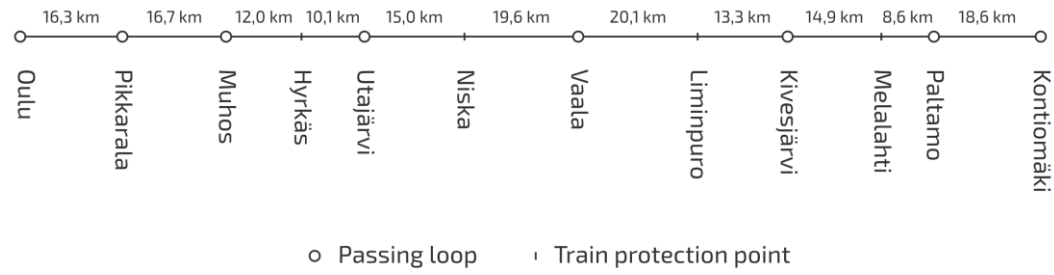

Figure 20. Operating point interval on the Oulu–Kontiomäki line.

Track speed level and condition

The previous major overhaul of the Oulu–Kontiomäki line was completed in 2014–2017. The superstructure class of the track is D and the permitted axle weight is 22.5 tons. Following the major overhaul, the track is largely in good or very good condition. However, along the entire line section there are a few individual line sections classified as being in poor condition. Figure 22 shows the line section's areas classified as being in poor condition on the basis of the condition map of the rail network (Finnish Transport Infrastructure Agency 2020b).

The general maximum speed level of the track is 140 km/h. In practice, this upper limit is mainly set by the track geometry and the numerous level crossings on the line section. However, the section has several local speed restrictions. Figure 21 shows the speed level of the line section in a diagram form.

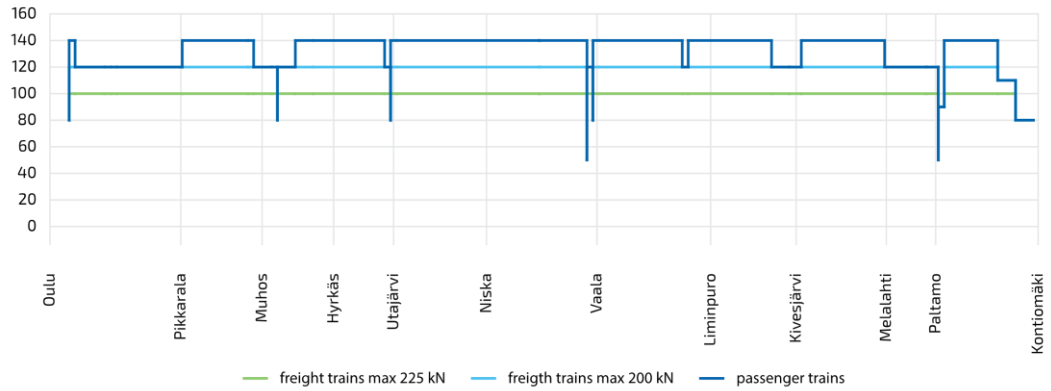

Figure 21. Speed level on the Oulu–Kontiomäki line section.

Some of the restrictions only apply to a short distance, due to the condition of the local elements or structures on the track. For example, at the Pikkarala operating point, the condition of the points causes a temporary speed restriction of 80 km/h that is valid for the time being. Due to the vibration, heavy freight trains (more than 3,000 tonnes, or more than 2,500 tonnes with eastern transit operation wagons) have a speed restriction of 50 km/h in the vicinity of the Muhos population centre, and 45 km/h in Oulu in the Heikkilänkangas area. (Finnish Transport Infrastructure Agency 2020d)

Based on condition data and the interviews, three railway bridges have been identified as problematic locations, and there are also local speed restrictions on the track in the immediate vicinity of the bridges. These railway bridges are the Muhosjoki bridge east of Muhos (track kilometre 791 + 165), the Vaalansalmi bridge (track kilometre 843 + 637) on the west side of the Vaala operating point and the Kiehimäjoki bridge (track kilometre 902 + 658) in Paltamo. They have all been under special monitoring and have undergone a special inspection during the past decade. These bridges are also marked in Figure 22.

Figure 22. Track condition information. Unclassified line sections are in good condition. (Condition classification: Finnish Transport Infrastructure Agency 2020b)

There is a short distance equipped with a speed restriction of 80 km/h at the Muhosjoki bridge. The bridge is not in a particularly poor condition, but there is a depression on the track. The speed restriction of 80 km/h at Utajärvi is due to a platform path. Since passenger trains stop at the operating point, there is no interference to traffic caused by the speed restriction due to the platform path. Vaala also has a speed restriction determined due to a platform path, but there is no interference to traffic caused by this speed restriction.

There is a speed restriction of 50 km/h at the Vaalansalmi bridge. The bridge needs repairs, and a major overhaul is provisionally planned for 2023. In Paltamo, the Kiehimäjoki bridge is prone to strong transverse oscillation due to the damaged sections. There is also a speed restriction of 50 km/h at the bridge, despite the fact that maintenance repairs were conducted on the bridge in 2020.

According to those who carried out the maintenance repairs, the sidings of the operating points are largely in good condition and usable. Renewal of points will become topical for all operating points in the 2030s as part of basic track maintenance. The estimate is that there will be a need to renew the sleepers in the Paltamo passing loop and the Vaala single-ended siding already before 2025, and in Kivesjärvi already in 2022, to ensure safe traffic operation. With regard to the passing loop rails, it is also advisable to change the rails to type 60E1. (Finnish Transport Infrastructure Agency 2020d)

There is plenty of remaining service life for safety equipment, and their renewal will not become relevant until the 2050s. However, the power supply system is aging and would require measures to improve its serviceability, which is also a nationwide problem. (Finnish Transport Infrastructure Agency 2020d)

Level crossings

There are 51 level crossings between Oulu and Kontiomäki. They are located along the entire length of the line. Removal of two of these in the municipality of Paltamo is currently being planned. In addition, there are other improvements planned for two other level crossings. These repairs are part of the Finnish Transport Infrastructure Agency's level-crossing programme for 2018–2022. According to rail management, the half-barrier boom level crossing at the Utajärvi operating point is problematic. With certain route selections, the booms are down when the train is at a standstill at the station. This has resulted in cars driving around the booms to speed up the crossing of the railway. Figure 23 displays all the level crossings of the line section on the map.

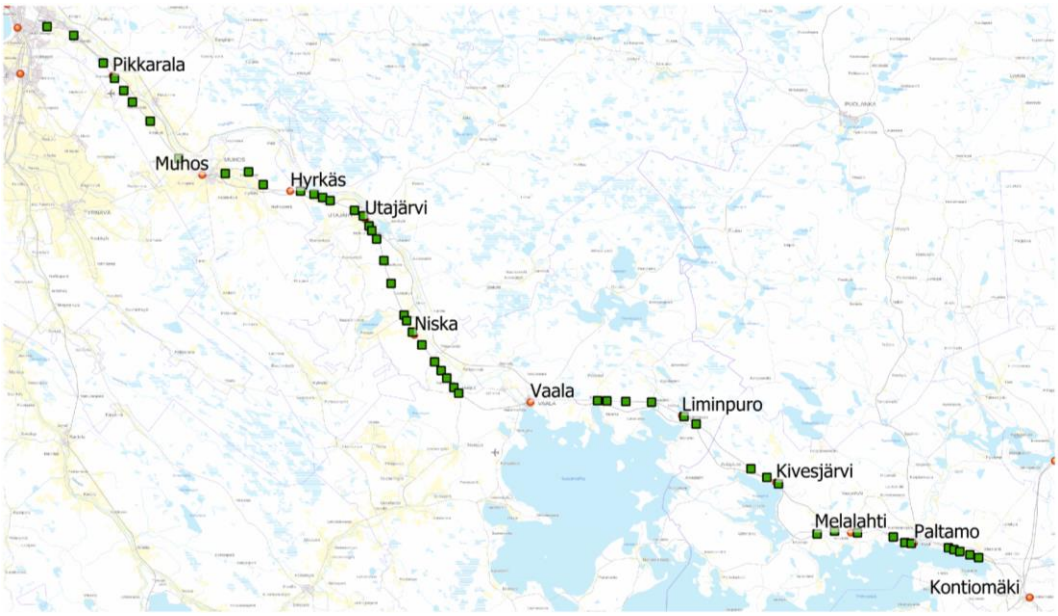

Figure 23. Level crossings between Oulu and Kontiomäki marked with green squares.

Platform paths lead to the intermediate platforms of the Vaala and Utajärvi stations, and the paths automatically result in a local speed restriction of 80 km/h. On the other hand, all passenger trains stop at these stations, so this is not a significant slowdown in train passage.

3.2 Current traffic in the area under review

The traffic in the area under review focuses on freight traffic, which mainly consists of the transport of iron pellets and raw timber. The line section also has a few daily passenger transport services.

Passenger transport

In May 2021, three passenger trains ran between Oulu and Kontiomäki in both directions on all other weekdays, except on Fridays, when there were four scheduled trains. On weekends, there were 2–4 train services, depending on the direction. One train pair a day was run on Sm3 rolling stock, between Helsinki and Oulu. Other scheduled services were run with IC rolling stock on the connection

lines Helsinki–Oulu, Kuopio–Oulu or Kuopio–Rovaniemi. The coronavirus pandemic that began in the spring of 2020 has at times had a strong impact on the train service supply in Finland. In the timetable period in force at the beginning of the epidemic and in the preceding period, four daily train services ran in both directions on weekdays and 3–4 on weekends, which has long been a typical schedule between Oulu and Kontiomäki. The route has, on average, had a relatively free schedule to arrange services, and the route is not currently part of any special seasonal tourism: on the basis of Finnish Transport Infrastructure Agency's statistics, the average number of passengers each year in recent years has been 40–50 passengers per train. Based on composition data, there have been more than 200 passenger seats on all scheduled trains on the connection line in May 2021 (Fintraffic 2021). Based on the capacity offered and the number of journeys, the utilisation rate of passenger trains on this connection line is clearly lower than the national average. All current passenger transport between Kajaani and Oulu is purchased traffic of the Ministry of Transport and Communications.

Based on the current journey volumes on the route, there is no pressure to increase the offered service capacity. On the other hand, current train timetables do not support daily business travel in the vicinity very well. For example, it is difficult to utilise train services in the direction of Oulu for commuting during the typical office hours.

Table 8. Passenger train timetable from Kontiomäki to Oulu.

station	IC 711	IC 713	IC 65	S 67
Kontiomäki	9:35	14:49	17:54	21:28
Paltamo	9:47	15:00	18:06	21:40
	9:52	15:01	18:07	21:44
Vaala	10:23	15:31	18:39	22:15
	10:24	15:32	18:40	22:19
Utajärvi	10:45	15:51	18:59	22:38
	10:46	15:52	19:02	22:39
Muhos	10:59	16:07	19:19	22:53
	11:03	16:08	19:31	22:56
Oulu	11:36	16:39	19:56	23:21

Tables 8 and 9 present the May 2021 Friday timetable between Oulu and Kontiomäki. This timetable corresponds to a very typical daily timetable for the period before the epidemic. Train travel times vary from slightly less than two hours to slightly more than two hours. The main reason for the variations in running and halting time are the waiting times due to trains passing one another on the track. The mutual encounters of passenger trains on the route are scheduled to take place at Utajärvi where there are two platform tracks. There are also two platforms in Vaala. In addition, the aim has been to arrange, as far as possible, train encounters with freight trains so that the passenger train has a station stop at the same time at any case.

Table 9. Passenger train timetable from Oulu to Kontiomäki.

station	S 66	IC 716	IC 70	IC 710
Oulu	7:10	10:03	12:24	18:12
Muhos	7:34	10:27	12:47	18:40
	7:37	10:28	12:48	18:43
Utajärvi	7:51	10:42	13:02	18:56
	7:52	10:45	13:03	18:59
Vaala	8:12	11:05	13:22	19:17
	8:13	11:06	13:25	19:20
Paltamo	8:46	11:39	13:56	19:56
	8:47	11:40	13:57	19:59
Kontiomäki	8:59	11:52	14:11	20:12

Freight traffic

Freight traffic on the line section is round the clock and busy. In May 2021, an average of 11 freight trains were run per day, with a daily range of 9 to 15 trains (Fintraffic 2021). The largest regular transport batches are the iron pellet transports from Vartius to Kokkola and Raahe and raw timber transport from Kainuu timber loading sites to the Pietarsaari, Oulu and Kemi production mills. There is also a weekly export train pair from Kemijärvi to Kotka and a tank / mixed train pair between Joensuu and Oulu. There are also some recurring but irregular services passing through the line section every now and then, for example, between Uimaharju and Kemi.

Figure 24. An iron pellet train arriving exceptionally in Kontiomäki to be turned to run in the opposite direction. (Photo: Aarne Alameri)

Train cancellations and journeys deviating from the timetable are typical for freight traffic in the area, and especially for cross-border traffic. This causes a constant need for change planning. In the case of pellet trains, the effects of the changes are accentuated because the trains are heavy and long and can currently only stop for passing each other at a few encountering points.

3.3 Rail capacity

The rail capacity utilisation rate between Oulu and Kontiomäki has been high for a long time. Although there are not many such trains in terms of numbers, a challenge for arranging timetables has been posed by the length of blocking intervals, the scarcity of locations for trains to encounter and their partial incompatibility with current traffic needs. The projected growth in demand would not currently be able to be met effectively by organising new train services, and the tolerance for interference is being tested as it is. This undermines the competitiveness and attractiveness of rail transport on this connection line.

The previous measure to improve the track's capacity were the four new intermediate blocking protection points established in the spring of 2019. The addition of blocking protection points makes it possible to increase the frequency of train services running in the same direction. The achievable capacity gains are then limited to times when it is reasonable to plan to run several trains one after the other in the same direction over a longer distance, preferably in practice so that there are only oncoming trains at the beginning or end of the route. Otherwise, oncoming trains would have to wait longer at encountering points. This principle can be followed to some extent on the line section, as in the mornings the main direction is to Kontiomäki and in the afternoons to Oulu. However, from the point of view of passenger transport, such planning poses challenges.

In the case of freight trains, the entire route must also be taken into account when assessing the overall significance. According to the persons interviewed by Fintraffic, the increase in intermediate blocking protection points for freight traffic in the direction of Vartius has not brought any significant benefits, as there is practically no reason to run trains one after the other to Vartius to wait for the border crossing. When crossing the border, as a rule, the set of wagons run in both directions, with one train at a time waiting in Vartius. Although several of these trains can be run from Oulu to Kontiomäki in the morning, according to the timetable, the latter have to wait longer in Kontiomäki before leaving for Vartius and thus, they will reserve more capacity in Kontiomäki.

In the 2019 traffic transmission capacity review (Pitkänen et al. 2020), it was found that the peak hour capacity utilisation rate of the line section is over 85% and the average daily capacity utilisation rate is 51%. The corresponding upper limits recommended by the International Union of Railways (UIC) are 75% for peak hours and 60% for average utilisation. Exceeding these limits makes it difficult to recover from disruptions and, due to single track, poses a particularly significant risk to the spill-over effects of traffic disruptions on other line sections. Due to the risk of extensive spill-over effects, the importance of peak hour utilisation rate should not be underestimated, although the situation is better on a daily basis.

In terms of capacity, there are operational bottlenecks with passenger trains stopping at stations. There is only one platform track in Muhos and Paltamo, in which case the stopping passenger train reserves the main track. The passing freight train will then have to run through slow points on to the siding. From the intermediate stations, Muhos and Vaala have a track length that is sufficient for stopping long freight trains (at present, iron pellet trains). Elsewhere, they cannot wait at the station, and other traffic must get to the stations first to wait in case there is an encounter of trains. This easily causes extra delay for passenger trains when encountering other trains, if freight trains do not run on schedule.

3.4 Railway projects affecting traffic

Over the past few years, several improvement projects have been underway on the Oulu–Kontiomäki line section. Since the renovation was completed in 2017, efforts have been made to increase the line section's capacity and tolerance to interference. In 2019, four new operating points were opened, and they have so far served as new intermediate protection points. At the same time, plans have been made to improve and increase the number of options for train encounters on the line section.

Between 2021 and 2022, a project is underway to implement four new passing loops, dimensioned for encounters of 925-meter trains. The previously established Niska and Liminpuro intermediate protection points will be expanded to train passing loops, and a new operating point Kuusikkoniemi will be built between Paltamo and Kontiomäki. In addition, the track system at the Utajärvi operating point will be extended. The useful length of all four operating points will be at least 925 meters (Finnish Transport Infrastructure Agency 2021c). This more than doubles the potential places to arrange encounters of long iron-pellet trains, thus greatly facilitating the planning of these encounters. The placement of the new operating points on the track and those to be improved, is shown in Figure 25.

In addition, another project plan is pending for the area, in which another new operating point, Heikkilänkangas, would be built near the Oulu operating point, enabling long trains to encounter each other, and a triangle track would be implemented south of Oulu. The triangle track would allow trains coming from the direction of Kontiomäki to run directly in the direction of Ylivieska without the need to turn the train into the opposite direction in Oulu. The timetable for the implementation of this project is still open, as the track plan is being appealed in the Administrative Court (Finnish Transport Infrastructure Agency 2021d). If implemented, the project would significantly reduce the need for shunting for trains continuing south of Oulu, thus reducing traffic costs and travel time. This would, in particular, streamline the operation of existing iron-pellet trains and enable the number of these train pairs to be increased from the current number (Iikkanen & Lapp 2019).

Other railway projects affecting the Oulu–Kontiomäki line section

Plans have also been made to improve the capacity of the Oulu–Kemi line section by adding passing loops and protection points. The increase in capacity generated by the project will also have a positive effect on the planning and flow of traffic between Oulu and Kontiomäki, if raw timber transports from Kainuu to Kemi are to increase. The track plans for the project have been approved and competitive

bidding for construction is underway. (Finnish Transport Infrastructure Agency 2021e)

A new triangle track for freight arriving from the north of Oulu is also under construction in the port of Oritkari in Oulu. Trains coming from the direction of Kontiomäki can already run to Oritkari through Nokela in Oulu. The project will therefore not directly affect the traffic on the Oulu–Kontiomäki line, but will increase the capacity of the railway yard in Nokela, which is, after all, the terminus or intermediate change point for many freight trains running in the Kontiomäki direction.

The Iisalmi–Ylivieska line section (Figure 25) is being electrified and the Iisalmi triangle track is being built. These are expected to be completed in 2023 (Finnish Transport Infrastructure Agency 2021f). These improvements provide another electrified route from Kontiomäki to the main line and the ports of the Gulf of Bothnia. This brings flexibility and increases room for maneuver in freight traffic planning and changes in the event of disturbances, also for the Oulu–Kontiomäki line section. However, for iron-pellet trains coming from Vartius at full load, the route is not practical even when electrified due to the hilly nature and the lack of long passing loops (Iikkanen & Lapp 2019).

Plans for the major overhaul of the Kontiomäki–Pesiökylä line section (Figure 25) are currently being made. In addition, a plan has been made for a new raw timber terminal in Pesiökylä. These projects are expected to be completed by 2024. The projects are based on the increase in demand and transportation of timber in the region. One of the preconditions for starting the renovation was the decision announced in early 2021 on the construction of a new forest industry production mill in Kemi. According to the experts interviewed, it is anticipated that more timber transport flows to Oulu will be coming from the area in the future with the start-up of the Kemi mill.

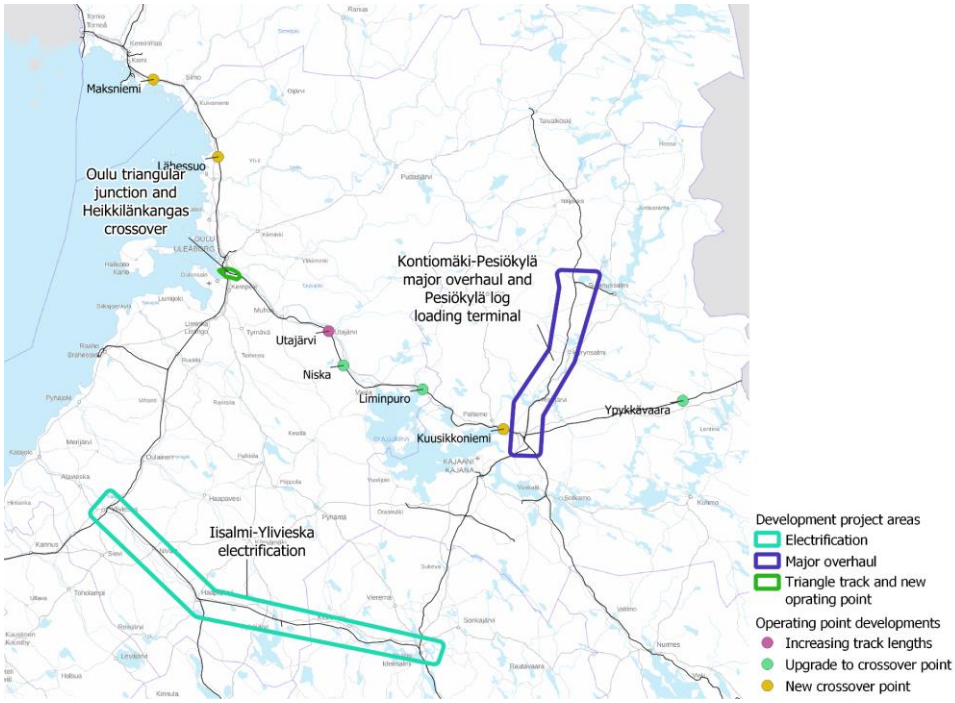

Figure 25. Projects affecting the operation of the Oulu–Kontiomäki section.

There is currently no timber loading activity between Oulu and Kontiomäki. As the demand for wood increases, the construction of new log loading terminals, for example, in the area of Vaala municipality has been discussed during the spring of 2021. In terms of traffic management, this would change the current situation, where traffic on the Oulu–Kontiomäki line is almost invariably end-to-end. The timber loaded from Vaala would very likely travel in the direction of Oulu, in which case the load on this line could rise higher than in east of Vaala.

3.5 Capacity examinations

The capacity of the Oulu–Kontiomäki line section was examined through a timetable review, which sought to match the foreseeable traffic to the line section. The review was conducted on the basis of the September 2021 timetable structure as it was at the beginning of July 2021. Timetable graphs are presented in Appendix 1. The review assumed that the infrastructure development measures already decided have been implemented. Thus, the Kuusikkoniemi operating point and the additional tracks in Liminpuro and Niska were included.

Estimates of future traffic volumes differed in volume between the traffic forecasts provided by recent surveys and the volumes estimated in the interviews. Therefore, the analysis was carried out for two different scenarios: in the first, the increase in freight traffic was as expected in the literary sources, and in the second, preparations were made for slightly higher volumes of freight transport.

Scenario 1

The traffic volumes in the scenario 1 were based on the freight transport volumes estimated in the Ylivieska–Kontiomäki rail connection development study (Iikkanen & Lapp 2021) and the current numbers of passenger trains, which were supplemented by one pair of charter passenger trains to Russia per day. Although the number of trains used is close to the current traffic volume, they allow for a significant increase in the volume of freight transported, as considerable amounts of overcapacity have now been applied for on this line section. The train numbers were as follows:

- 4 + 4 domestic passenger trains
- 3 + 3 raw timber trains
- 1 + 1 mixed freight trains (Fenniarail Patokangas traffic)
- 5 + 5 pellet trains
- 1 + 1 charter train to Russia

In the timetable review, trains from several days were combined, because not all of the above-mentioned trains were running on individual days. The review was mainly based on current timetables, but for some trains the timetables were changed as some line sections had requested capacity in conflict with other trains, however, in such a way that conflicting trains never run on the same day. What is noteworthy, is the transfer of the encounter of raw timber train 5320 with other trains, as a result of which the arrival time in Kontiomäki will change, and the complete re-scheduling of raw timber train 5322 (marked in the timetable without the train number as an timber train).

In addition, the timetable review retained the two-hour breaks for trackwork at all operating point intervals, except for the interval between Pikkarala and Oulu, where there is no two-hour trackwork break even now, only several one-hour trackwork breaks. The trackwork breaks are marked on the timetable graphics with pink boxes of two hours in width.

Arranging charter trains in the timetable structure was successful, although they required several stops to accommodate for train encounters and, as a result, they have a considerably long travel time. In addition to the options for train encounters, the train timetable possibilities were limited by both the opening hours of the Vartius border crossing point and the capacity of the Vartius railway yard. For example, between 10 and 12 o'clock in Vartius, according to the timetable, there is one trainset that has stayed overnight, one trainset arrived from Finland and two trainsets arrived from Russia at the same time, and thus there is no space for other trains to be included.

An additional passing loop track at Kivesjärvi was identified as a precondition for arranging freight trains, as the distance between Paltamo and Melalahti was found to be very challenging in terms of timetable planning. No reasonable timetables could be found for the train from Oulu to Kontiomäki in a suitable time window without this additional track. Another possibility could be a new operating point between Paltamo and Kivesjärvi, enabling train encounters.

Scenario 2

In scenario 2, preparations were made for a moderate increase in freight traffic on the line section by increasing the number of raw timber trains on the line section by 1 + 1 train per day. The aim is to prepare for the increasing quantities of raw timber, for example, due to the Kemi mill project. The train numbers in this scenario are as follows:

- 4 + 4 domestic passenger trains
- 4 + 4 raw timber trains
- 1 + 1 mixed freight trains (Fenniarail Patokangas traffic)
- 5 + 5 pellet trains
- 1 + 1 charter train to Russia

The traffic volumes in scenario 2 could be adjusted for the line section without other infrastructure needs than those proposed in scenario 1, although there will be encounter delays, especially for the raw timber train from Oulu to Kontiomäki.

As a whole, after the development measures now decided, the capacity of the line section will be more or less sufficient for the traffic that can be foreseen in the near future. However, the interval between the Paltamo and Kivesjärvi operating points is a bottleneck that complicates the planning of traffic on the rest of the line, and it is recommended that measures be considered to increase capacity between the two operating points.

A bigger problem than infrastructure on the said line section is the capacity management. Particular attention should be paid to the development of management. For example, train 5228 has been cancelled in every single scheduled day in 2019 and 2020, and in the first half of 2021 it has only been run on nine days in April. However, the capacity allocated to this train affects other traffic on the line section. Although train 5228 has been used as an example, the

capacity management problems apply to the line section more broadly. For this reason, before taking any infrastructure measures, it is strongly recommended that efforts be made to develop capacity management on the line section so that the transport services using the line can run smoothly and no additional investments are necessarily required.

3.6 Development needs on the line section

This chapter comprehensively lists the various development targets that have been identified for the line section in the framework of the interviews and material collected in this study. In order to assess the development needs, the previous sections have provided as comprehensive understanding of the current state of the line section as possible. Stakeholder interviews related to the study have been a key source in identifying the current status and development needs of the line section. In addition, through the capacity review in Chapter 3.5, an assessment has been made on the development needs of the railway infrastructure, especially in terms of the adequacy of capacity. The development measures currently being implemented have been taken into account, where applicable, during the analysis of the projects to be developed.

The main theme in the surveying of development needs has been the quality of transport operations, both in terms of the current situation and by taking into account the forecast changes and potential changes in traffic on the line section. New projects in the Finnish forest industry and the future of transit traffic will affect the demand for freight traffic on the line section. Estimates of the future prospects of traffic were sought from previous surveys and interviews. Through the interviews, traffic management perspectives and assessments of the effects and development needs of traffic changes emerged. The adequacy of the rail capacity has been assessed by completing a timetable review for two different traffic scenarios. The review has taken into account the new passing loops under construction on the line section.

Observations have also been made on the condition of the line section and more general summaries have been made on the basis of the observations. Individual condition targets emerged in the interviews, and efforts have been made to identify their significance for the quality of traffic on the line. A more detailed assessment of the condition of the structures and the planning of improvement measures are not part of the scope of this study, but are most often part of the planning of track maintenance activities. The condition targets related to improving the service level of the track have been described in more detail.

Increasing the axle load

The rail network's desired scenario for 2050 published in 2020 (Finnish Transport Infrastructure Agency 2020c) deals with, among other things, the national target for the axle loads of the railway network. A uniform axle load target of 25 tonnes has generally been proposed for transit routes, which has been or is being implemented in some parts of the country. The Oulu–Kontiomäki line has also been included in the desired state for 2050 as part of the 25-tonne load capacity network. As this is a longer-term goal, no individual action is therefore needed. However, all future track improvement measures should be taken in view of the 25-tonne bearing capacity target. The needs for measures related to the increase

in axle load are also being investigated (Finnish Transport Infrastructure Agency 2021h). Based on the results, the superstructures and substructures also need repairs, but these can be taken into account in the next major overhaul which is also scheduled for the 2050s based on the needs. In addition, the bridges in poor condition mentioned in Chapter 3.1 need to be rebuilt.

Passenger platforms

Passenger transport stations require measures for overall traffic management. All stations should have two platform tracks to bring more options for traffic management. After the Utajärvi track extension, even long freight trains can stop to wait at all other stations except Paltamo. Equipping the siding with a platform in Paltamo and Muhos would also make it possible to run passing traffic along the main track when encountering passenger trains. In the current traffic service, passenger train encounters occur at all stations, and excluding Utajärvi, they occur with freight trains. This highlights the importance of emphasising traffic flow and energy efficiency in the fact that a passing freight train does not have to slow down in order to move to the side at the points, if there is a platform for a passenger train on the siding. This is especially significant for iron-pellet trains, as their maximum speed in points is often only 20 km/h.

The passenger platforms at intermediate stations on the line section do not meet current requirements and, from the point of view of passenger services, they would need general development in areas such as height, width, shelters and passenger information.

Side tracks

The side tracks of the new passing loops in the future will be built according to the current standard for axle loads of 25 tonnes with 60E1 rails. According to the area's rail management, gradual rail changes to 60E1 rails also with old side tracks would be beneficial for maintenance, as freight traffic in the area is quite heavy. Rail type 60E1 is more resistant to dynamic forces, which are greater the heavier the axle loads run on the rails. This is also in line with the long-term 25-tonne- axle load target.

The adequacy of sidings should also be quantified when planning future improvements. The interviews revealed that, due to maintenance needs, it would be useful to have more operating points with at least three tracks, so that stopping and storing for trackwork equipment would not be such a challenging task for traffic planning. In the case of heavy traffic, it would then be more efficient to take advantage of the current scarce trackwork breaks.

Trackwork breaks for maintenance

Maintenance trackwork breaks on the line section are challenging at present. According to traffic control, the line section has special trackwork break weeks twice a year. At other times, short trackwork breaks are generally available on a daily basis, but a two-hour trackwork break for the entire line is not available within the train timetables (Pitkänen et al. 2020). Chapter 3.5 and Annex 1 provide a more detailed assessment of the scheduling of trackwork breaks in the timetables determined for future traffic scenarios.

With traffic on the line section projected to increase slightly, it is even more challenging to schedule trackwork breaks, and there are no two-hour trackwork breaks available even separately for each line section separately in the determined timetables. However, the need for maintenance also increases as traffic increases, so attention must be paid to the maintenance work conditions. In order to facilitate trackwork opportunities, it would be good in the future to have more storage sidings available for maintenance equipment. In this case, even short trackwork breaks could be utilised efficiently. However, the new operating points under construction are double-track, which means that it is not advantageous with regard to traffic management to reserve tracks for storing work machines except for short periods of time.

Despite the goal, adequate views on the fluency of actual maintenance operation on the Oulu–Kontiomäki line section were not obtained from track maintenance for this study. It is important to understand the operating conditions of maintenance when planning more detailed infrastructure improvement or modification measures, and also in connection with traffic planning.

Passing loops on the Oulu–Muhos line section

After the new passing loops to be implemented, the distance between Oulu and Muhos will be the longest interval for encounters of long trains compared to the rest of the line section. When implemented, the Heikkilänkangas operating point would have a positive effect on this. According to traffic control, the extension of the tracks at the Pikkarala passing loop would also be useful for traffic management. This can be assumed to be even more significant, if the southern triangle track in Oulu is built. In that case, the importance of the Oulu railway yard as a buffer for disruptions would decrease, as several trains in the Kontiomäki direction would no longer run through it, and it is very likely that the aim would be to avoid turning trains at Nokela in Oulu, even as a back-up option, because it is a time-consuming and expensive measure. According to traffic control, trains between, for example, Vartius and Oulu are not preferably run through Kontiomäki station for the same reason.

Kontiomäki operating point

The Kontiomäki operating point is quite congested as a busy junction station. Its capacity runs out from time to time, according to traffic control. Increasing its capacity would provide some additional buffering reserve for the congested traffic in the direction of Oulu. However, as stated above, trains traveling from Vartius to Oulu are not preferably run to Kontiomäki for switching their direction of travel. After the major overhaul of the Pesiökylä line, the same basic practice is probably a sensible operating model for raw timber transport trains continuing from there to Oulu. Currently train units are driven from the direction of Ämmänsaari to Kontiomäki, or an on-call locomotive picks up wagons from Hyrynsalmi, which are then assembled as a train in Kontiomäki.

Figure 26. Kontiomäki triangle track. Along the left branch, trains from Ämmänsaari and Vartius can run without visiting Kontiomäki station. (Photo: Aarne Alameri)

In the possible pilot phase, it would be simplest to locate the functions and facilities required for cross-border passenger transport in Kontiomäki if the traffic consists of individual charter trains and if Vartius is not an actual station (European Parliament and Council 2016). There would necessarily be no need for passenger facilities at all, as it is also possible to carry out checks and inspections on a moving train. However, some kind of facilities should be allocated to the Customs and Border Guard staff. In addition, the capacity of the Kontiomäki station should be reviewed separately, if an international passenger train would need to stand at the station for a long time. However, the train timetable would also need be adapted to the needs of cross-border passenger demand. If, for example, a night train were the solution, it would probably need to stand in Kontiomäki in the early hours of the morning before the inspections were conducted, if they were not to be conducted on a moving train.

All in all, the functionality and condition of the Kontiomäki area is a broad entity, and also connected to the major overhaul work of the Pesiökylä and Vuokatti directions and the electrification of the Ylivieska–Iisalmi line section, so a more in-depth examination of the Kontiomäki operating point is not within the scope of this study.

Increasing capacity

In previous surveys, the utilisation rate of the line section has been found to be at a risk level at times. It has been difficult to schedule train encounters in practice for the traffic forecast on the basis of timetable reviews conducted for this study, despite the new passing loops already under construction. The most difficult area was the vicinity around Paltamo, as a result of which a development proposal for this area has been drawn up in Chapter 3.7 in order to ensure the smooth flow of traffic and to maintain trackwork breaks in the future.

On the other hand, the plan for the Oulu triangle track and the Heikkilänkangas operating point, if implemented, would most likely affect the train timetables and the buffer reserve for trains in Oulu that would need to be passed in the future. As a result, the nature of capacity problems may change. According to an estimate by traffic control, the line section between Oulu and Muhos may in the future become a bottleneck for the line. It is difficult to assess the capacity situation in its entirety, if this project is also to proceed, as the situation on the Ostrobothnian line would have a more solid effect on the Oulu–Kontiomäki section in the future.

Although only minor additional measures are needed for the now forecast traffic in terms of the adequacy of capacity, it is also worthwhile to prepare for a more unforeseen increase in traffic at the level of planning preparedness. The interviews highlighted more speculative flows of freight related to the interest to increase container transport to Asia and the industry's potential need to import raw timber from Russia via Vartius. These opportunities have not yet been considered separately in traffic forecasts, but their impact can be moderately thought to be considered as part of the estimated demand for mixed freight trains.

Capacity management

The study has revealed some contradictory aspects of the capacity of the line section, which suggest that the management of the capacity of the line section should be considered as a development target. The current traffic and timetable is fairly congested. However, there are several provisions in the regular timetable that are not run daily. This is due, among other things, to the irregularity and seasonal fluctuation of transit transport. Five scheduled timetable slots are reserved for trains daily, but in most cases no more than three of these trains have been run in the last couple of years.

It is interesting that, despite this, according to the interview, traffic control perceives timetables as tight and there are large-scale traffic disruptions on a monthly basis. This raises the question: what would happen if all the trains on the current timetable were run daily. However, the timetable has been designed on the basis that the trains indicated in it can be run on schedule under normal circumstances. Also on the traffic review day of 2019, according to which the capacity utilisation rate has been examined (Figure 3.3), eight scheduled trains were cancelled. Based on this, the case may be that regular timetables could be too tight in relation to the actual capacity of the track. The number of cancelled trains then gives a misleading picture of the unused or so-called free capacity for increasing train service.

3.7 Proposed development measures

To increase capacity, an additional passing loop is proposed in Kivesjärvi (Figure *27*). This would ease the bottleneck between the Kivesjärvi and Paltamo operating points. Another option would be to consider building a new operating point with a passing loop between these two operating points, but as a measure, it would be larger than the construction of an additional track in Kivesjärvi. The current tracks in Kivesjärvi have a useful length of approximately 1,100 m. For this reason, the proposal is to build the new passing loop track in equivalent length.

Figure 27. New passing loop in Kivesjärvi.

In addition, additional platforms are proposed for Muhos and Paltamo (figures 28 and 29). Currently the only passenger platform at these operating points is located on the main track, which poses challenges for the encounter of freight and passenger trains, described in more detail in Chapter 3.3. The construction of a single-track platform is proposed for track 422 in Muhos, and a new single-track platform for track 462 in Paltamo. In Paltamo, the construction of a single-track platform requires the demolition of track 463. In any case, the track in question is in poor condition. Track 464 can be retained as a dead-end track for the storage needs of track maintenance. The new platforms would streamline the encounters of passenger trains and freight trains at best with several minutes.

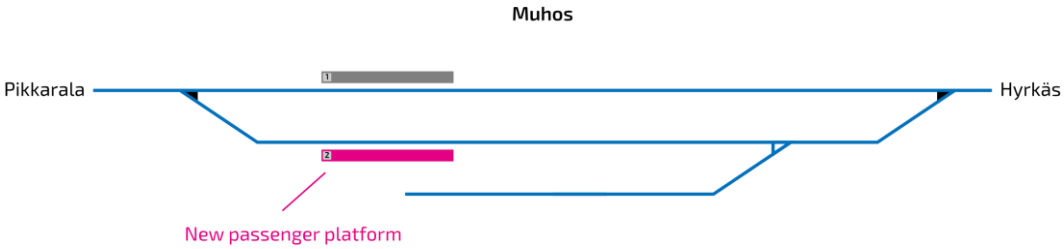

Figure 28. New passenger platform in Muhos.

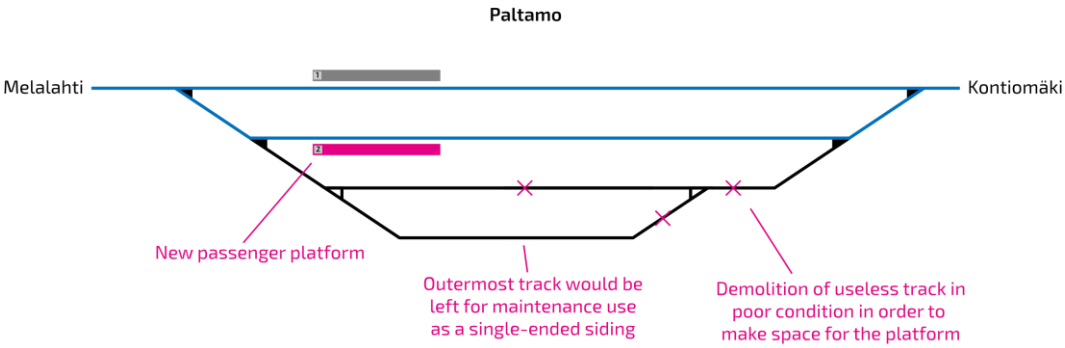

Figure 29. New passenger platform in Paltamo.

The costs of the measures have been estimated on the basis of the investment costs of standardised halts presented in the publication New Railway Halts (Finnish Transport Infrastructure Agency 2019). The costs of the Kivesjärvi additional passing loop are presented in Table 10 and the costs of the additional platforms in Muhos or Paltamo in Table 11.

Table 10. Cost estimate for the additional passing loop in Kivesjärvi (MAKU 120, 2015 = 100).

Structural part	amount (pcs / m /%)	unit cost (€/piece / €/m)	costs (€)
Electrified siding and safety equipment	1,250	1,410	1,762,520
Points	2	152,160	304,320
Client tasks	15%		310,026
Total			**2,376,866**

Table 11. Cost estimate for the additional platform in Muhos or Paltamo (MAKU 120, 2015 = 100).

Structural part	amount (pcs / m /%)	unit cost (€/piece / €/m)	costs (€)
Traffic platform	250	1,359	339,824
Level transition structures	1	1,724,480	1,724,480
Driving connections	250	202	50,720
Platform equipment	1	27,388	27,388
Platform lighting	1	71,008	71,008
Client tasks	15%		33,2013
Total			**2,545,433**

The total cost is thus EUR 2.37 million for the additional passing loop in Kivesjärvi, EUR 2.55 million for the additional platform in Muhos and EUR 2.55 million for the additional platform in Paltamo. The total for all measures is EUR 7.47 million. The costs are reported at the MAKU index (Cost index of civil engineering works) value of 120 (2015 = 100).

In addition, speed restrictions for short distances should be removed in connection with other maintenance measures. This is likely to require the repair of the previously mentioned bridges. The measures are part of normal track maintenance and therefore no cost estimate has been calculated for them.

3.8 Conclusions

The aim of this study was to widely examine and identify the improvement needs of the Oulu–Kontiomäki line section, focusing on the service level and traffic management of the line. The study took into account the situation in the near future, where new passing loops will be constructed for the line section. The analysis is based on previous studies on the area used as literary sources and on open data from Finnish Transport Infrastructure Agency and Fintraffic; information gathered through interviews on the operational activities of the area, the condition

of the track, and the future prospects for traffic volumes; capacity and timetable reviews in the light of future traffic forecasts.

A lot has been invested in the line section in the 21st century. After electrification and major overhaul, the line section will be a significant route for freight traffic and will be in good condition for the most part. It is a key connection line for raw timber and transit transports, at the top end in Finland in terms of tonnage. Maintaining the quality of the line section's usability and the competitiveness of the railway as a mode of transport in the region is therefore important. The line section is a common link from several different directions from Kainuu to the ports and industrial plants of the Gulf of Bothnia.

Managing the capacity of the line section and preparing for the increase of transport volumes is the most important identified target for development. There is a lot of speculation in the development of freight traffic in the region, but even the more analytical and moderate estimates of the increase in rail transport lead to the conclusion that the capacity and reliability of traffic are being put to the test. Therefore, it is likely that more infrastructure expansion measures will be needed in addition to the sites that have already been decided to be constructed. A preliminary proposal for action is provided in Chapter 3.7

In addition to the adequacy of capacity itself, challenges have also been identified in the management of capacity. One observation is that train services are regularly run in far fewer numbers than the capacity requested. Another observation is that the timetables for regular capacity, the 2019 capacity analysis and the actual train running data are not logically fully consistent. Thus, a relatively large amount of additional capacity has been requested for the line, but according to the actual train traffic, the capacity utilisation rate is still at risk limits. This raises questions about how well the traffic would actually run in accordance with the allocated capacity. The principles for allocating capacity should therefore be discussed in more detail with railway operators. In addition, the quality of the current regular timetable should be examined in conjunction with the actual causes of traffic disruptions in the region. Ways to improve the punctuality of freight traffic and the predictability of demand fluctuations on the line section should also be explored in order to improve operational performance on the line section.

Measures have also been proposed to improve the operational flow of traffic. The passing loops already under construction will help in the rapid traffic planning of unscheduled situations outside the timetable and in the scheduling of trackwork. In addition, the construction of additional passenger platforms at intermediate stations is proposed to streamline the encounter of various types of trains. During the course of the study, proposals were also heard for extending the Pikkarala operating point. However, this need is affected by the progress of the plans for the Oulu triangle track and the Heikkilänkangas operating point, which would create a new passing loop between Pikkarala and Oulu, but at the same time, for some of the trains this would mean that the significance of the buffering effect of Nokela in Oulu would no longer exist and exceptional situations on the track would also be more strongly connected to the traffic on the Ylivieska–Oulu line. In the context of this study, this entity could not be assessed in more detail.

The need to improve the Kontiomäki operating point has already been identified in previous studies in the area, and this study also states the importance of Kontiomäki's capacity and functionality and its ability to buffer for the traffic on this line section. Within the framework of this study, mainly the suitability of Kontiomäki for the service needs of cross-border passenger transport discussed in Chapter 2 was analysed and it was found that Kontiomäki could be utilised at least if charter train traffic were to be tested.

Taking care of the maintenance conditions of the line section was often emphasized in the steering meetings for the study and the conditions were discussed in the interviews. No comprehensive picture of operations in the area at the operative level of maintenance was able to be formed, so it has not been possible to form definite development proposals in this regard. Some notable targets with potential condition issues were identified on the line section in terms of traffic and service level, and attention should also be paid in the future to these targets when planning improvement work.

4 Summary

This report contains two separate studies from the Northern Axis – Barents Link (NABL) project, which examine the Oulu–Kontiomäki–Vartius line connection. The first of the studies concerns the potential of passenger train traffic at the Vartius/Kivijärvi border crossing point and the conditions and needs for starting such traffic operations. The second study generally focuses on surveying the improvement needs of the Oulu–Kontiomäki line section. However, the surveys have been carried out at the same time and they have interests in common between them. Oulu was selected as the most potential terminus for passenger transport across the Vartius border, so international trains would run on the Oulu–Kontiomäki line, and the improvement needs caused by traffic operations of such trains have also been examined in the framework of the second study. On the other hand, a significant amount of freight traffic on the Oulu–Kontiomäki line crosses the border in Vartius, in which case changes in the operation of this traffic will have an impact on possible passenger train traffic at the border and vice versa.

In the study on Vartius/Kivijärvi passenger train traffic, two scenarios were formed for the mode of operation of the traffic. One scenario concerned more occasional services consisting of charter trains and the other concerned regularly run train services. As a result of the analysis of passenger potential, it was clearly identified that regular service is by no means a viable option in the current situation, as the extensive measures required would need significantly more existing travel demand compared to the current state to be justified. Therefore, no detailed reviews of regular traffic service schedules were made, but the study focused on describing the requirements for launching such services and the implications for other traffic. The charter train scenario was discussed in more detail, and it was also taken into account in the Oulu–Kontiomäki–Vartius timetable reviews carried out in the study of the improvement needs of the Oulu–Kontiomäki line section.

The operating model based on charter train traffic was identified as a lighter option in terms of operational needs, and it was found to be a theoretically potential operating model if there is a desire to test passenger transport in the area. However, no existing user potential was identified for this operating model either. Therefore, operators on both sides of the border should first work together to define the target groups of train services and to identify and reach the users. A likely use of services could be seasonal tourism. The following stages would be to plan the mode and routes of transport and agree on the division of financial responsibilities.

The study of the Oulu–Kontiomäki line improvement needs examined the factors affecting the use and trafficability of the line, the decided improvement measures and forecasts for the near future on the line itself and also on other related line sections. With the support of previous studies, stakeholder interviews and a review of the timetables, improvement needs were identified that would benefit future traffic service and ensure the track's adequacy of capacity and its competitiveness, especially in freight traffic. Passenger transport in the area is insignificant.

Ensuring the future capacity of the track and improving capacity management emerged as the main areas for development. In future development activities on the track, it is worth paying attention to the maintenance conditions and ensuring the level of service on the track. Concerning capacity and traffic flow, concrete

proposals for measures were presented with cost estimates. However, as this study is a general survey rather than a precise needs assessment, several identified areas for improvement require a more detailed further analysis of the actions required.

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