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Barents Low Volume Road Management -project
Проект «Управление дорогами с низкой интенсивностью движения в Баренц регионе»

Analytical Report
concerning Arkhangelsk road manager training course results

Venue	Arkhangelsk Road Administration "Arkhangelskavtodor" premises Address: 38/1, Komsomolskaya str., Arkhangelsk, 163001
Date	July, 6-8, 2011 (Wednesday-Friday)
Training course topics:	1. Road drainage, its impact on road bearing capacity, and road drainage provision within the road maintenance contracts 2. Road structure deterioration mechanism and managing axle loads on gravel/forest roads 3. Modern low volume road condition monitoring techniques 4. Field observations of a pilot problem Severodvinsk-Onega road section, identifying the reasons of the problems and ways to eliminate them
Lecturer, Course Manager	Timo Saarenketo, Ph.D., key expert of all ROADEX projects, Managing Director of Roadscanners Oy, Finland
Moderators	Elena Svatkova – Lead Partner of the BLVRM project, Director of ADC Ltd. Maria Shabasheva – BLVRM Project Manager
Trainees	A group of road and timber sectors from the Arkhangelsk, the Murmansk regions and the Republic of Karelia. The list of trainees is represented in the **Annex A.** The training course evaluation by trainees is presented in the **Annex B.**
Training course reporting documents	1. **Photo report on training course results -** photos 1-4 2. **Conclusions of the theoretical part of the training course** are listed in the **Table 1**. The above mentioned is accompanied with the Lecture course (in a form of presentations), available as Annexes (see references in the Table 1) 3. **The results of the Practical part of the course – identification of road problem reasons in the pilot Severodvinsk-Onega road section, as well as proposals on how to eliminate them, which are presented in the Table 2**.

1.Photo report on road manager training course in Arkhangelsk

Training course participants in the premises of Arkhangelskavtodor **Photos 1-2**	 **(1)**	 **(2)**
Practical training course participants on filed observations on the pilot Severodvinsk-Onega road section, km 47 **Photos 3-4**	 **(3)**	 **(4)**

2. Conclusions of the theoretical part of the training course

Training course objective: Transfer knowledge obtained by the Northern Europe countries within the ROADEX long-term project to the Russian training course participants.

Table 1 The topics of the theoretical course and conclusions to adapt the foreign experience to the Russian situation

The topics of the theoretical course in accordance with the seminar programme, the Reporter's name and position	**Annex**	**Conclusions to adapt the foreign experience to the Russian situation**
1. **Training course opening and forecasted results of the project** Mr. Sergey Popov, Director of Arkhangelskavtodor; Mr. Eugeny Lobanov, Deputy Director of Arkhangelskavtodor	n/a	Road needs funding has never been sufficient. Therefore foreign experience on road maintenance within limited resources is critically important for the Russian road sector. Low volume gravel roads are essential for local economies and its share in total Northern area road network length is significant. Any contribution to improvement of these roads is contribution to competitiveness of local producers through **reduced transport costs of road users.** Nowadays additionally to industrial and social sector support, a new national task is set for the road sector – development of agricultural roads. The need in such roads and funding for its development is significant. This means the increased need in **efficient road construction and maintenance technologies.** This is the task for the newly formed national group to find these efficient technologies and develop technical standards for agricultural roads, and Mr. Sergey Popov, Arkhangelskavtodor Director, is a member of this group. The Kolarctic ENPI CBC BLVRM-project is anticipated to give concrete results – the technologies, which despite higher financial restrictions, will assist in improvement of: • Public roads in the Northern Periphery territories • Sectoral and technological roads (forest, mining, agricultural roads) • Both Kolarctic project territorial roads and roads of other Russian territories.
2. Brief presentation of the 1st training course for Russian road managers	Annex 1 Presentation Annex1 KO 243 RU	The starting point to select topics for Russian road managers' training within the Kolarctic project was an inquiry of road specialists in the Arkhangelsk and Murmansk regions and the Republic of Karelia on low volume road problems and their rating.

within the Kolarctic ENPI CBC BLVRM-Project **Ms. Elena Svatkova,** Director of ADC Ltd., Project Lead Partner		The inquiry revealed **the needs and set the priorities:** 1. **the need in technologies**, first of all related to road drainage, which has definite impact on road bearing capacity and its performances within specific Northern conditions (temperatures, geology, soils, available road construction materials); 2. the need in explanations **to make** road managers and politicians **aware of critical role of roads and responsibility for decisions**, which affect road network condition and thus competitiveness of local economies, quality of social services, road accident rates, road user health and the environment; 3. the need in **environmentally friendly and user-safe road technologies**. The training course programme for Russian specialists within the Kolarctic project is formed taking into account all the above needs and up-to-date theoretical and practical knowledge compiled by the sectoral ROADEX partnership. As Northern Russian road engineers have an opportunity to adopt experience of colleagues from EU countries within the cross-border programme, they are responsible not only for adoption but also for dissemination of this useful experience to the Russian conditions by transferring it to other Russian colleagues who have no such an opportunity to participate in international programmes.
3.**Current status of long-term ROADEX project and conclusions of the last studies of the stage IV** The issues: • Road drainage and permanent deformations • Dependence between road operational condition and road user health **PhD. Timor Saarenketo,** ROADEX expert	Annex 2 Presentation Annex2 ROADEX IV Status Arkh	The main challenge of road engineers on all the Northern Periphery area is improving roads despite stable tendency for funding reduction. The starting point: look at the mirror, see an engineer and take the 21 century challenge – increase productivity, enhance technological potential in order to move forward – develop the road network and improve its performances. The resources that could compensate lack of funding are: • **Technological innovations** based on better understanding of mechanisms that affect road structure functionality; • **Cooperation and dialogue with road users** to explain the need to use roads as a valuable community asset, because road users own competitiveness strongly depend on roads. • **Client-oriented nature of road sector**, facilitation of business activization, which replenishes the budget, from which in its turn the road needs are financed. The requirements to roads will be increased concurrently with improved understanding of impact mechanisms:

		• Impact of road performances on road users' health. This means that healthcare sector can become a team-mate of the road sector if importance of better road condition is explained; • Impact of climate change on road structures functioning and the need to adapt road design, construction and maintenance standards to this changes. This means that R&D shall be an inevitable part of day-to-day practice.
Drainage on Low Volume Roads. Part I. The issues: • Road drainage role • Drainage components • Drainage condition classification • Survey techniques **Ph.Dr. Timo Saarenketo,** ROADEX expert	Presentation Annex3 Drainage 1 ru	Know-how exchange within the ROADEX partnership allowed to reveal and exclude **erroneous practices**, which are inefficient from the standpoint of benefit/cost ratio. Examples: • **Concentrating all resources on pavement rehabilitation and maintenance while no good road drainage.** Poor road drainage will reduce lifetime of road pavement and whole road structure and therefore will impede getting return of resources spent for pavement rehabilitation. • **Shoulder strengthening with grassing** worsens road outflow from road surface and decreases road bearing capacity and road structure life time. • **Constructing of a gravel pavement less than 15cm thick** is inefficient by ratio of pavement construction costs and pavement strength and durability to permanent deformations and therefore high costs for maintenance. • **Putting steel reinforcements on the depth of less than 20-30cm** will not give an expected result – better distribution of loads and reduction of deteriorating effect from heavy transport. • **Applying the same approach to the whole road** while conditions may vary a lot within the road length (topography, geology, soil types, etc.). Application of one and single approach increases road construction and maintenance costs. Refusal from above erroneous practices allows to reduce costs and releases resources for technology improvement. The practice shows that **road bearing capacity, pavement lifetime and lifecycle of the road critically depends on functionality of road drainage.** The starting point for road drainage (and thus road condition) improvement is an inventory of road drainage quality on the road network. The inventory is made based on visual evaluation (classification) of road drainage condition. The classification is developed within the ROADEX project. Road drainage inventory reveals direct relationship: the most problematic road sections are those on which road drainage is poor.

		ROADEX recommendations and principles to increase output of resources spent on road drainage improvement: • Technological solution shall be adapted to the conditions of concrete section and terrain. The principle is as follows: One should refuse from one and single approach to the whole road as this is unreasonably wasteful for sectoral resources. • Adaptation to concrete conditions requires information on road and drainage condition, section by section. The principle is as follows: the more accurate is information, the better addressed and specified (and thus more efficient) will be the measures proposed to increase drainage quality. The practice shows: • Road drainage condition improvement from class 3 to class 1 increases road lifetime by 2.2 times and releases significant money to solve other road maintenance tasks. The principle is as follows: invest money to better road drainage today and reduce operational costs of road users and postpone the need in road rehabilitation in future. Every Euro invested into improvement of road drainage gives 6-7 Euros of economic benefits for the community. • To form a bad opinion of road users about the road (and this of the road sector) the total length of problematic sections shall be 10% of total road length. Therefore one must focus limited resources on problematic sections improvement. The principle is as follows: Focused investments give maximum economic output. • For roads built on peat and other watersusceptible soils with poor bearing capacity output of resources spent on road drainage improvement is even higher than 1:7. For some sections road drainage improvement my require only elimination of grass verges to provide surface water outflow to the ditches. The principle is as follows: The tougher are financial limitations the more focused shall be the investments to implementation of measures that ensure quick payback. **Conclusion 1:** The **maximum economic output is ensured though improvement of road drainage.** The economic benefit depends on integrity of the technological chain: inventory and drainage problem analysis – setting requirements to road drainage improvement – Defining amount of needed investments – Managing road maintenance contracts (including road drainage maintenance). The result: extending service life (period between rehabilitation) and releasing resources for other road network needs.

Drainage on Low Volume Roads. Part II. The issues: • Experience on road drainage improvement within the road maintenance contracts • The problems and possible solutions • The risks and conditions for introduction of a new policy **Ph.Dr. Timo Saarenketo,** ROADEX expert	Presentation Annex4 Drainage II ru	For a man who managed to get rid of extra weigh the most complicated task is to keep this level for long time. The same is fair for the road administration: after improving road drainage to the required level one should keep it functional permanently. This means that the **complex task to ensure quality road drainage on the road network** will include three actions by the road administration: 1. learn how to diagnose road drainage problems 2. learn how to solve road drainage problems 3. learn how to keep good road drainage condition on the whole road network **The position of the Client** is critical for the success of this complex task. Despite road drainage maintenance is a component of road maintenance, the focused attention to drainage by the Client shall be impact of "road drainage component" on: 1. the need in other road maintenance works and total financial need to keep required performances of the road network; 2. inflexibility of load limitations and duration of these limitations during the periods of spring and autumn weakening; 3. transport and operational costs of road users and competitiveness of local economies; 4. road sector image among road users (tax-payers). Therefore the right Client's position is not fully relying upon a contractor concerning road drainage issues but managing the situation with means of: 1. clear formed requirements to road drainage condition; 2. fixing the above requirements in Terms of References (technical specifications) within the tender documentation; 3. reflecting in the contract all obligations of the Contractor to follow the requirements concerning road drainage condition and "rules of play", including mauls (sanctions) and bonus for compliance/incompliance with the contract requirements. Modern equipment for instrumental survey of road drainage condition seems to be expensive ex facte. The cost of the survey may cost 25-40 thousand Euro for the network. However, taking into account road network length, the costs will be about 20 Euro/km (800 RUR). The need of technological equipping of road drainage surveys is evident if one remembers about quick and accurate data collection (which is critical for right conclusions and precise solutions). The visual inspection and evaluation by road maintenance contractor is very subject. Therefore clear evaluation with means of instrumental

		monitoring is crucial for quality management of road maintenance contracts and is a good case-based reasoning for fair payments for the contractor's work. Adequate **pricing of road drainage maintenance works** – is an important issue for road condition improvement, especially on the first stage when the needs in road drainage improvement are defined and work volumes are significant. In this case one is recommended to apply **subsidies to cover contractor's costs** related to elimination of under-rehabilitation of road drainage (or its wrong construction) and restoring its right initial functional condition (1 class). Additionally to reaching the required drainage condition level these works will result in **calculation of adequate unit costs for further application in road maintenance contracts** (including quality road drainage maintenance taking into account local conditions and climate) **Conclusion 2:** Justified requirements of the Client facilitate self-development of contractors, promote them to search solutions related to technological and organizational improvements, prevent costly engineer mistakes that will result in road deterioration (e.g. constructing T-junctions without taking into account drainage or wrong installation of culverts).
Structural condition diagnostics and design principles for gravel/forest roads The issues: • Damage mechanism • Basic diagnostics of deformations (rutting) • Solutions to eliminate road deterioration reasons using new technologies • Road condition monitoring **Ph.Dr. Timo Saarenketo,**	Presentation Annex5 Gravel roads damage ru	Gravel roads can recover after passages of heavy vehicles within the range of their resistance to deformations. Therefore one should stay within this range. However, in reality this task is complicated with some factors. The factors that define stability of roads during its operation are as follows: • Seasonal conditions (thawing, flooding, heavy raining) • Heavy traffic loading (axle loads) • Traffic volumes • Vehicle speeds • Road factors (road drainage condition, pavement structure, materials, soils, steel reinforcements, etc.). Permanent deformations mean that road stability has failed because of some of the factors (one or more). Road bearing capacity is a too general criteria to evaluate road condition, which allows not to clearly diagnose **critical factor or combination of factors** as a reason for the road problem. It is known that to eliminate the problem one shall eliminate the reason of this problem.

ROADEX expert		The new system of gravel road diagnostics applied in the world practice is diagnostics of permanent deformations **by rutting modes.** Complemented with methods to evaluate functionality of road drainage, geotechnics, frost heave and design mistakes, the **new system of diagnostics** is capable to reveal up to 99% reasons of gravel road problems and therefore choose focused (efficient) solutions to **eliminate them.** E.g. the reason of permanent deformations may be heavy traffic during spring thaw when road structure is water-saturated and its capability to recover is reduced. Closing roads or axle load limitation on roads during spring thaw is a traditional practice aimed at preventing roads from quick and early deterioration during this critical period. Sometimes the period of limitations is quite long and has negative impact on local businesses (forestry, mining, construction, etc.). This impedes filling up of the budgets and financial welfare of road sector. No one has calculated externalities of the Russian community resulted from such a policy. The problem is only emotionally discussed by stakeholders from the position of sectoral interests. E.g.: 1) The most crucial impact on the roads is related not to loaded but to empty trucks moving on the weakened spring road with high speed and high tyre pressure. This movements increase road wear, vehicle wear and have negative impact on driver's health (musculoskeletal and cardiovascular systems sensitive to vibrations). The solution of this problem is an **intersectoral dialogue**, which shall result in heavy traffic moving at a lower tyre pressure mode, reduced speed and with interval between trucks, which gives: • Better preservation of roads and savings of road sector resources needed for some other road tasks, • Reduced business externalities because of road closing/axle load limitations and disturbance of normal production logistics, • Reduced vehicle operational costs and reduced road accident risks, • Better competitiveness of local business with favorable economic and social consequences. To ensure such a dialogue **the road sector shall make the first step** as it is a normal Client-orientation of the services produces for its consumer – the road user. Other countries' practice shows that this is followed by the adequate reaction of road users. 2) In Finland timber industry enterprises are shifting to timber transportations by 30.5m long and 90t weigh articulated lorries. However, distribution of this weigh by axles reduces these axle loads from 11.5 to 8 t. The transport costs when using such lorries are 30% less than with traditional 60t timber trucks. This results in higher competitiveness of Finish timber industry on the world market. The task of the

		Finnish road sector is to find technological and organizational solutions and serve new lorries thus contributing to competitiveness of local economy. As a prospect solutions the following are considered: • Defining the interval necessary for the road to recover after each passage by truck, • Improving quality of road construction materials used • Adapting road geometry to the new lorries (curves, rest sites and parkings). **Conclusion 3:** Shifting from narrow departmental positions to the process of common searching of **User/Road optimum** creates benefits for the community in general and improves the image of the road sector among taxpayers.
Gravel road survey and design techniques The issues: • Modern techniques • Alternative ways to measure deformations • Design principles • Principles of comparative economic effect evaluation for different options **Ph.Dr. Timo Saarenketo,** ROADEX expert	Presentation Annex6 Gravel roads survey&design ru	The starting point and the critical stage of gravel road improvement process is collection of initial data on road condition. The full tool-kit includes traditional methods and modern equipment (GPS, video, GPR), which allows to operatively collect accurate data on initial road condition, interprete the data and choose precise and efficient solutions to eliminate the reasons of deformations. In Finland modern technologies has been first applied in the timber industry where equipment was purchased by private companies in order to improve condition of technological roads and reduce logistic externalities of business. Equipment application allowed to improve road network quality and reduce further maintenance costs. Equipment costs were paid back many times. The road sector followed the business's way and achieved the same positive results for the sector, road network quality and taxpayers. The cost reduction is achieved through more accurate data, which allow to apply more precise calculations to differentiate road pavement structures taking into account bearing capacity of underlying soils. Such a road structure is less costly for construction and further maintenance than that calculated based on general data, which allow only common and coarse, less economic solution for road design (expensive solution may be applied on sections where it is not needed, e.g. if road pavement is constructed on bedrock). Additionally to this simplified methods of deformation surveys and measurements (e.g. E2 modulus calculation method) are very approximate and therefore one can manipulate the results and overrate work volumes). Instrumental survey allows analyzing not only pavement condition but also hidden road structure. **This clarifies diagnostics of road problem reasons** similar to the situation when roentgenogram improves diagnosis of a doctor. The more accurate is the diagnosis, the better is treatment and thus the higher is

		quality and accuracy of engineer solutions applied with higher output from resources through: • Placing the resources on solving real problem due to natural reasons (frost heave) and operational reasons (traffic loads). • Identifying the problems on the earlier stage when small measures are enough to prevent worsening of road performances. Additional benefit from instrumental diagnostics and precise treatment measures is **increased warranty period** provided by the contractor – from 5 to 15 years when the road will keep resistant to permanent deformations. **Conclusion 4:** Shifting from general and costly approach (applying of one and single technical maintenance standard to the whole road) to a differentiated and efficient approach (applying addressed and precise solutions based on quality initial data concerning reasons of deformation on concrete sections) releases resources and allows to spend them for real needs of road network.
Low volume road condition monitoring techniques The issues: • The objects of monitoring • The methods of monitoring • The initial data needed for quality design • New monitoring techniques, examples **Ph.Dr. Timo Saarenketo,** ROADEX expert	Presentation Annex 7 Monitoring ru	Regular monitoring allows to reveal **the risks of conditions favorable for problem development** and undertake measures to prevent the problems before the problem: • will turn from potential to the real one • produce costs for the road user • require significant efforts and costs to eliminate it. The typical sections of roads with conditions favorable for poor longitudinal road drainage with subsequent permanent deformations are junctions. Therefore one can identify problems on the earliest stage through field observations before the situation goes like it goes and the problem will result in road deterioration and costs to road users and owners. Importance of regular monitoring is most evident for the railway engineers as more strict requirements are applied to railways (all-year-round, smooth and timely traffic, safety). Therefore such a monitoring is an inevitable part of railway operation. The trend of road network monitoring techniques development is an instrumental monitoring with 3D visualization to allow road engineers make early diagnostics of problems and eliminate them with

		minimum resources. **Conclusion 5:** Shifting from reactive management (reacting on the existing problems) to proactive management (preventing the problems) – is an advanced skill of road engineering and the basic resource not only to improve existing road networks but also its prospect development within limited resources and unfavorable climate change. The road sector has no any alternative in this case.

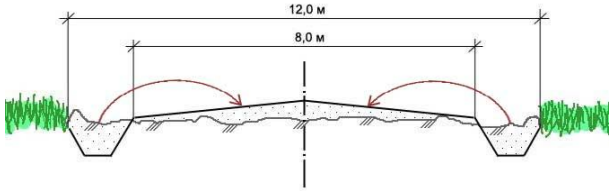
3.The practical training course part results – identifying road problem reasons on the pilot section and proposals to eliminate them

The objective of field observations: transferring to the training course participants practical skills based on theoretical ROADEX knowledge. The pilot section Severodvinsk-Onega, km 47, near the Verkhovka river bridge (Primorsky District, the Arkhangelsk Region).

Table 2 The results of field observations aimed at identification of pilot road section problem reasons and proposals for its elimination

Current road features	Road condition	Photos to illustrate the pilot section problems
The road parameters: • Regional public road with low traffic volume (less than 500 vpd) • Before the road became a public road it was used for timber haulage • The prospects: the Severodvinsk-Onega road is a part of the Northern Transport Corridor (the Northern Route) • Gravel pavement • Design road width 8m	The gravel road pavement thickness is uneven and in some places too thin – 5-7cm. Embankment is constructed of silt, therefore when rainy heavy traffic causes permanent deformations – rutting mode 2 (permanent deformation of not only pavement but embankment too. The real road width is about 12m, which is 4 m wider than the design width (additional 2 m each side).	 **Photo 5** The problem pilot section Severodvinsk-Onega, km 47, on approaches to Verkhovka river bridge

		 **Photo 6** Dusting is one of the typical problems for this gravel road section
The problem (as identified by the road owner)	**The problem generation mechanism (as stated by the Finnish experts)**	**Photos to illustrate problems and the schemes**
The problems: 1. Rutting after each rain and the need in constant grading to keep good road performance; 2. Washboarding effect 3. Dusting 4. Increased costs for road maintenance both in summer and in winter (grading).	The plastic subgrade soil is squeezed out to shoulders under passing traffic loading. The subsequent road grading to eliminate rutting and restore the road shape evens the road surface and move the material to both sides by 5-15cm annually. Excess road width results in surface water that is not able to reach the ditches (even if the road cross-fall is ok) because of long distance to pass and this water penetrates to thin gravel pavement. The ditches loose its functionality and this doesn't promote regular maintenance of ditches and shoulders (with grass verges). This result in cause-and-effect relation: • The wider is the gravel road, the less effective is surface drainage, the higher is moisture content of the subgrade, the poorer is road resistance to permanent deformations, the quicker is deterioration and more resources are needed to keep adequate operational condition. Additional negative impact is caused by high tyre pressure of heavy vehicles and results in washboarding effect. Washboarding effect causes vibration, which:	 **Photo 7** Right shoulder condition on the pilot road  **Photo 8** Left shoulder condition on the pilot road

	• Negatively affects drivers and passengers' health (especially for constant roadusers – headaches, low-back pains, cardiovascular exacerbation) • Reduces vehicle lifetime, increases needs in repair, spare parts, i.e. road user costs are increased thus increasing the prices for products and services, worsening quality of life of population and decreasing competitiveness of local enterprises. **Proposals to eliminate the reasons of pilot section problems:** 1. Provide road width within normative 8m. Excess width shall be eliminated with means of cutting clear shaped slopes and ditches. 2. Excess material from both sides of the road can be used to strengthen the pavement (See Figure 1). However, before using this material shall be: • Checked in the road laboratory for quality and grain-sizing to identify needs in additional materials to improve the existing pavement characteristics (adding extra stone materials or treating chemicals) to reduce dusting). • Prepared through elimination of organic impurities (roots, etc.). 3. In early spring the snow walls on the shoulders shall be pushed away to the ditches to prevent accumulation of melted water on the surface and provide even thawing of the road along its width.	 **Photo 9** Quality of pavement material  **Figure 1** Correction of gravel road shape using existing material
	Expected result from improvements Returning to the normative road width will help to improve drainage and is critical for: 1. road resistance to permanent deformations – mode 2 rutting, washboarding; 2. improving of road performance 3. providing roadside reserve construction material for future road maintenance needs; 4. reducing work volumes of grading when summer maintenance	 **Photo 10** Example of a width-controlled gravel road

	and decreasing the number of grader passages when snow removal in winter 5. reducing costs for road maintenance by 100%. Constructing road ditches and its functioning will increase road resistance to deformation during spring thaw. This allows to decrease axle load limitation period for heavy transport or apply smooth measures for logistics (not that big limitations by weigh in combination with tyre pressure control and observing of needed intervals between vehicles); Opportunity to moderate requirements will reduce road user costs and sectors that form local economies.	with quick water outflow to the ditches. **Note:** In similar conditions of Northern Finland (with roads serving high share of timber hauling lorries) the width of gravel roads is 6.5m at maximum, which is optimal from standpoint of: • quick surface water drainage to the ditches preventing water penetration into the road structure, rutting and road weakening; • reduced costs of summer and winter maintenance (only two passages of a grader are enough).