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EFFICIENT and INNOVATIVE Designs and Technologies for PUBLIC INFRASTRUCTURE Investments in Romania



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Efficient and Innovative Designs and Technologies for Public Infrastructure Investments in Romania

- Final Report -

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Romania
Regional Development Program 2

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This report was prepared by a core team comprised of Radoslaw Czapski, Antonio Nunez, Marcel Ionescu-Heroiu, Sebastian Burduja, Alina Burlacu, Marius Cristea, Florian Gaman, Oana Luca, Andrei Stănescu, Alina Armașu, and Cristian Postolache. The report benefited from thoughtful comments by peer reviewers: Thierry Davy, Antti Talvitie, Megan Schlotjes, Rakesh Tripathi, and Carmen Racanel.

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The findings, interpretations, and conclusions expressed in this report do not necessarily reflect the views and position of the Executive Directors of the World Bank, the European Union, or the Government of Romania.



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List of Acronyms

ANRSC	National Authority for Regulating Public Utility Community Services
CESTRIN	Center for Technical Road Studies and Informatics
CNADNR	National Highways and National Roads Company
DALI	Approval Documentation of Intervention Works
DG RDI	Directorate General for Regional Development and Infrastructure
DJ	County Road
EBRD	European Bank for Reconstruction and Development
EC	European Commission
EIB	European Investment Bank
EPA	The US Environmental Protection Agency
ESAL	Equivalent Amount of Standard Axle-Load
EU	European Union
FWD	Falling Weight Deflector
GOR	Government of Romania
GPR	Ground Penetrating Radar
HDM4	Highway Development and Management Software
ISO	International Organization for Standardization
MRDPA	Ministry of Regional Development and Public Administration
OP	Operational Programme
PBMC	Performance Based Maintenance Contracts
PNDI	National Program for Infrastructure Development
PNDL	National Program for Local Development
PNDR	National Rural Development Programme
PV	Photovoltaic
ROP	Regional Operational Programme
RSA	Road Safety Audit
RSI	Road Safety Inspection
TAU	Territorial Administrative Unit
UN	United Nations
VOC	Vehicle Operating Costs
VTTS	Value of Travel Time Savings
WWTP	Wastewater Treatment Plant



Executive Summary

- 1. This report aims at providing key recommendations toward the use of innovative designs in small infrastructure in Romania.** The overall aim is to compare Romanian and international practices in design, construction, and maintenance of roads, water and wastewater infrastructure, and social infrastructure. The objective is to assess how innovative designs and technologies can contribute to better quality, cost efficient, and sustainable infrastructure projects.
- 2. In this endeavor, this Report includes a complete assessment of the current designs and technologies deployed for a set of public infrastructure investments in Romania.** In addition, it presents a set of global best practices potentially recommended for the Romanian context.
- 3. This Report also includes an assessment of non-technical issues with direct impact on design, construction, and maintenance practices.** While innovative and efficient design contribute to the delivery of better infrastructure, it is not sufficient. All the aspects related to planning, project preparation, procurement, construction and post-implementation need to ensure that the overall project delivery environment supports efficiency and cost-effectiveness through the entire project lifecycle. Findings and recommendations are aligned with the report on “Improved Prioritization Criteria for PNDL Projects,” submitted in December 2014 as part of the same Bank technical assistance for the Ministry of Regional Development and Public Administration (MRDPA). At the same time, this report informs the thinking on selection criteria for instruments like the National Local Development Program (PNDL), with the hope that selection procedures will facilitate the adoption of improved designs and technologies.
- 4. This Report provides a complete overview of the current key issues related to project design in Romania.** It also serves as basis for further fieldwork in the final phase of the current assignment; this will help disseminate best practices and collect further feedback from beneficiaries, designers, and decision makers on how to make Romanian infrastructure more efficient and cost-effective.

Cross-cutting aspects

- 5. Infrastructure strategies and projects should be correlated in space and time.** The local strategies should take into consideration the strategic projects identified by the higher-level development strategies (national, regional, and county). Investment projects should be territorially integrated at local level in order to maximize their effects and reduce inefficiencies. This report, along with the dedicated Component 1 report on “Coordination of Strategies and Programs for EU and State-Funded Investments in Romania’s Infrastructure,” makes specific recommendations on aligning infrastructure strategies and projects.
- 6. Stronger planning, improved implementation, and enhanced administrative capacity are needed to ensure the best use of the available resources.** In Romania, there is a clear capacity gap across sectors and levels (from national to county and local levels), which affects the quality of projects.



7. **In the planning process, stakeholders should look for modern, efficient, and sustainable infrastructure to be reliable, green, safe, and smart.** This report considers that these are the main pillars (families of characteristics) desired and researched in the design of new infrastructure, which respond to current requirements and concerns:

- **Reliable** infrastructure is available and durable, i.e. demonstrates high quality and low maintenance of the infrastructure components. The concept is closely related to lifetime engineering and involves the project optimization, with particular attention to maintenance, upgrades, and refurbishments.
- **Green** infrastructure features energy efficient and environmentally friendly designs. The concept can be applied to the design, building, and operation, including materials, techniques, and management for all the inputs, processes and outputs.
- **Safe** infrastructure minimizes accident risks for users and operators/workers. It also implies that, in case of an accident, the infrastructure is designed to minimize consequential effects.
- **Smart** infrastructure communicates with users, operators, and with other infrastructure. Modern infrastructure is more and more connected with the real and virtual world through direct information sent to users about its real time conditions, to operators about maintenance status, energy consumption, etc., and adapt itself to the conditions of use.

8. **When possible, award criteria should move from the current focus on the “lowest bid” to the “most economically advantageous tender” (MEAT) criterion.** This way the competition between enterprises will focus on technical aspects, not only financial considerations, leading to an improvement in technical quality and reducing the risk of designers/contractors/other service providers cutting corners to stay within a very limited budget. In addition, this measure will force enterprises to do their own research for design and building technologies that are more effective and possibly cheaper.

9. **To improve efficiency and transparency, it is recommended that Romania adopts and implements international standard FIDIC contracts – adapted to the current legislation.** It is also recommended that alternative procurement forms such as design and build, and/or build and maintenance be explored.

10. **It is mandatory to align technical standards in force with European standards, respecting climate change, traffic modifications, and other new concepts like environmentally friendly.** This alignment legally exists, but the issue is the emphasis in implementation, and lack of attention to environmental dimensions, which lead to old standards with outdated content, but also to conflictual existing standards or even specific fields which have no current standards in force.

11. **Specialists certified as technical verifiers, different and independent from the specialists who design the projects, should verify project designs, as required by current law.** The beneficiaries should be the ones contracting technical verifiers and hold them accountable directly. One way to do this is by requiring professional insurance in the bidding documents. As such, designers who make mistakes can face actual penalties (as opposed to the current system whereby they are not accountable for the quality of their work).



12. **The warranty period is mentioned in the bidding technical specifications, usually for a minimum of two years for most of the construction works.** This should be regulated and established in national regulations by taking into consideration the road technical class, traffic loads, type of road structure, type of water distribution system, characteristics of wastewater plant, and other factors. By adopting such a measure, the constructor will have a higher responsibility in building correctly and according to the standards in force. Of course, authorities then need to ensure that the road is properly used and, for instance, weight limits are strictly followed. Interview data suggest that this is not the case currently, which leads to significant repairs needed during the warranty period.

Road infrastructure

13. **Road classification in Romania should switch to a functional basis.** The technical classes and the maintenance classes should relate to the functional classification via design speed and traffic volume. Functional classes provide for continuity of the road design features and help both the road administrations and the road users structure the network.

14. **More efficient road maintenance is needed.** Road maintenance standards in Romania are time-interval, quantity- and equipment-based (e.g., paving every 7 years; specific equipment for snow clearance; etc.), not road-condition based. Standards are not only outdated, but also very costly and not life cycle cost-effective.

15. **Maintenance through performance-based contracts should be considered.** Under such framework, the Road Administration specifies the maintenance standards and the contractor has the freedom to choose the methods and means to bring the road to that standard and to maintain it at the required level. The contractor is required to have a quality assurance system to monitor the quality of its works and to report on it regularly. The Client verifies these quality reports with spot checks and pays the contractor a monthly lump sum. If the required service level is not met, sanctions are imposed if the shortfalls are not corrected within specified deadlines.

16. **Road safety standards have evolved considerably in recent years and should be continuously improved.** In Romania, while national roads and expressways do follow European standards in this respect, county and communal roads have only recently been required to include safety consideration in their designs. Starting with January 1, 2015, the Road Safety Audit is mandatory on all types of roads, in order to increase the safety of the road infrastructure.

17. **New solutions should be analyzed to improve road construction.** At present, the international focus is on improving mechanization in road superstructure works and on introducing new and advanced technologies with greater economic efficiency, in order to ensure rational use of resources. Increasing traffic volumes, increased axle load, and increased tire pressure on the European road network have led to the need for stronger and more durable infrastructure, while also ensuring reduced downtime due to traffic maintenance and rehabilitation. For this, at the European level the following trends may be observed:



- Large scale use of polymer modified bitumen and additives;
- Recycling both asphalt mixtures and cement concrete road. Recycling makes its presence felt increasingly in the construction and rehabilitation of roads, helping optimize the use of natural resources, the introduction into the market of unsuitable materials called “waste,” and contributing to the development of performant materials with high durability;
- In terms of cement concrete road, the new worldwide trend is the use of precast cement concrete pavements, continuous armed pavements, and cement concrete road rehabilitation for roads with asphalt mixtures as wearing layer;
- Recently, cold recycling raised high interest for construction and maintenance using various technologies such as foamed bitumen, bitumen emulsion or cement, with beneficial effects in terms of reducing emissions and energy consumption.
- Technologies that reduce the temperature of mixing and placing asphalt mixtures - the concept of low-temperature asphalt ("warm mix" or “cold mix”);
- The road network occupies a large area with a high potential for energy production. Thus, currently, new technologies for the use of this energy through various systems are developed – e.g., piezoelectric, sewer pipe networks that absorb heat during the summer, which will be returned to fight icing during winter.
- Use of photo-catalytic pavement blocks, especially in urban areas. They are made of materials designed to minimize air pollution. Laboratory testing showed higher effectiveness in reducing the NOx concentration in air, these pavement blocks being increasingly used in Belgium, United Kingdom, Italy, Japan and France.

18. **In case of local roads, such as currently unpaved communal or rural roads, the existing gravel can be used provided it has the appropriate features of a subbase layer, or can be otherwise treated to become a sub-layer capable to withstand traffic and environments loads.** This requires the use of additional materials such as hydraulic binders (both cement and hydraulic road binders), bitumen emulsions, foamed bitumen or environmentally-friendly enzymes, all of them with the role of securing a layer capable to withstand higher vertical loads than the current gravel layer. These new, innovative methods can yield thinner road structures which are able to withstand similar loads as regular road structures.

19. **Traffic and environmental impact studies should be required when starting a design project, just as geotechnical and topographic studies are required currently.** This way, the solutions of new construction, modernization, or rehabilitation will have better technical support.

20. **In terms of regional specificities, data on the percentage of unpaved roads in each county show that the South, West, and Center of Romania are particularly in need of investments.** On average, in 2012, 34,000 km of county and communal roads were made of dirt or gravel and required modernization, at a cost of around EUR 8.1 billion. An additional 21,000 km of county and communal roads only had surface treatment and required rehabilitation. This makes the choice of designs and technologies even more important, in line with needs, opportunities, and capacity in each locality/county/region. The project selection criteria proposed under Component 2 of this technical assistance



take into account investment needs, the current quality of road segments proposed for modernization, the number of beneficiaries, traffic levels, etc.

Water and wastewater infrastructure

21. **Romania still has one of the least developed water and wastewater infrastructure systems in Europe.** As pointed out in the Component 2 report on “Improved Prioritization Criteria for PNDL Projects,” data from the National Institute of Statistics show that some regions are especially deficient in this respect – namely, the East and South of the country, which also include some of the poorest counties in Romania. This also implies that people have limited resources to dedicate to paying for water and wastewater services that had not previously used or paid for (i.e., particularly in poor rural areas, the average willingness to pay for drinking water and sanitation services is very low). Similarly, the resources of subnational governments in these regions to subsidize costs are low or often nonexistent. It follows that the choice of designs and technologies is vital with respect to minimizing post-implementation costs such that consumers can actually afford to connect to the newly offered services and generate sufficient revenues to cover operations and maintenance (O&M) expenses.

22. **The following recommendations take into account the facts presented above, promoting the use of improved and cost-effective design solutions.** For one, the efficiency of pumps must be improved. There is room for roughly 30% increase in energy efficiency of water and wastewater pumping systems. At the same time, the use of a system of pumping stations with separation of the solids should be generalized, which may lead to additional energy savings of about 20%.

23. **The use of Supervisory Control and Data Acquisition (SCADA) should be generalized.** In order to increase energy efficiency of water and wastewater systems and improve their maintenance, the use of SCADA provides the ability to reduce the operating costs significantly. Since systems have a considerable range in terms of size and scope and their implementation costs may be high, system size and functionalities must be designed to ensure cost efficiency.

24. **Water quality must be monitored on a continuous basis, because problems will only be detected with regular sampling.** Sampling and analyses should be undertaken at the well, at the intake, where water exits the waterworks, and throughout the distribution system. At the same time, the location of the monitoring points must ensure a certain representativeness (distance to WWTP, flows, hydro-morphological characteristics).

25. **Each consumer should have a water meter.** All potable water systems have a certain quantity of water that is not paid for. A well-run utility will keep the level in the low teens and the meter readings form the basis for payment for water.

26. **High-quality products in water distribution systems are required, since the equipment is installed underground, beneath the overlying pavement.** Many water utilities have learned the hard way that substandard equipment might save money when purchased, but is much more expensive in the long term.

27. **The necessity to develop decentralized treatment for wastewater is very high.** These systems are often very cost effective and not only for rural areas. Inside of an



agglomeration, decentralized systems are relevant when the density of population is not very high and/or when the pollution is not sufficiently concentrated.

28. **Sludge disposal is a key concern.** While Romania is still considering the use of wastewater sludge in agriculture, other Western European countries are moving towards incineration as a prime disposal process. The disposal of sludge to agricultural land requires sludge (without so-called “Red-List substances”), which is prohibited in certain nitrate sensitive regions and requires considerable storage areas because there is only a narrow window of time when soil and crop conditions are amenable to receive sludge. In order to improve environmental impacts of the treatment plants, the use of sludge incinerators that provide smaller amounts of sludge up to 60% is recommended.

29. **Non-conventional waters as supply side solutions should be considered.** In a context of climate change, safe water reuse is an important aspect for industry (cooling towers), artificial recharge of aquifers, in agriculture, and in the rehabilitation of natural ecosystems.

Social infrastructure

30. **The provision of adequate social infrastructure is fundamental to ensuring people are safe, healthy, and productive in their community.** All public buildings, such as those that are part of social infrastructure, must comply in order to be accessible and easily to be used by disabled people.

31. **There is room for enhancing energy efficiency for social infrastructure.** While the law stipulates that by 2020 the national indicative target of reducing energy consumption is 19%, few initiatives to ensure more energy efficient design, construction, and operation of social infrastructure have been implemented. Efficient heating systems, efficient isolation, new sources of energy including solar panels, etc. need incentives, both monetary and legal, to become standard practice.

32. **There are many building materials typically considered ‘green’; these should be adopted and used on a much wider scale than today.** These include lumber from forests that have been certified to a third-party forest standard, rapidly renewable plant materials like bamboo and straw, dimension stone, recycled stone, recycled metal, and other products that are non-toxic, reusable, renewable, and/or recyclable.

33. **The structural rehabilitation solution will be established based on the state of degradation of the building (seismic risk category), the structural system (frames, walls, mixed), the building materials used (reinforced concrete, steel, masonry, wood, etc.) and the Importance-exposure class.** The report sets out several technical solutions for the rehabilitation of social infrastructure buildings.



1 Introduction

34. **The Government of Romania (GOR) has requested the World Bank to support its efforts to harmonize public investments financed by the European Union and from the state budget.** The objectives of this work are to encourage synergies, deliver stronger impact, and promote Romania's sustainable and inclusive development. This engagement is a follow-up to the World Bank's Regional Development Program in Romania, implemented between November 2012 and March 2014, and continues to be based on the January 2012 Memorandum of Understanding on Partnership and Support in the Implementation of EU Structural and Cohesion Funds in Romania and Modernization of Public Administration. This work includes the following four sub-activities:

- (1) **Component 1** – Assistance with the coordination of strategies and plans for EU and state-funded investments in infrastructure;
 1. Inception Report;
 2. Intermediate and Final Report on Harmonization of Strategies and Plans for Local Infrastructure Development;
 3. Intermediate and Final Report on Prioritization Strategy and Selection Criteria.
- (2) **Component 2** – Advisory services related to the existing portfolio of investment projects in the MRDPA, including their optimal prioritization and preparation of potential EU-funded investments for the 2014-2020 programming period;
 1. Inception Report;
 2. Intermediate and Final Report on Prioritization Criteria;
 3. Intermediate and Final Report on the Portfolio of Projects under the MRDPA.
- (3) **Component 3** – *Assistance with improving the use of efficient designs and technologies in investments overseen by the MRDPA;*
 1. Inception Report;
 2. Intermediate and Final Report on Technologies and Standards for MRDPA Investments.
- (4) **Component 4** – Assistance with the design of a Housing and Infrastructure Development Strategy.
 1. Intermediate Report on Inputs to Romania's Housing Strategy;
 2. Intermediate Report on housing and social infrastructure;
 3. Final Report on Romania's Housing Strategy;
 4. Intermediate and Final Report on State/EU-Funds Complementarities;
 5. Intermediate and Final Report on a Prioritization Mechanism for the Housing Sector.



35. **This Final Report corresponds to the third component mentioned above (*in italics*) – i.e., support for the implementation of innovative designs in order to deliver more cost-effective projects.** The overall aim is to compare Romanian and international practices in design, construction, and maintenance of roads, water and wastewater infrastructure, and social infrastructure. The aim is to assess how innovative designs and technologies can contribute to better quality, cost efficient, and sustainable infrastructure projects.

36. **In this endeavor, this Final Report includes a complete assessment of the current designs and technologies deployed for a set of public infrastructure investments in Romania.** In addition, it presents a set of global best practices potentially recommended for the Romanian context.

37. **This Final Report also includes an assessment of non-technical issues with direct impact on design, construction, and maintenance practices.** Indeed, issues related to standard costs, procurement processes, and the planning capacity of public authorities influence many design outcomes in Romania.

38. **This Final Report provides a complete overview of the current key issues related to project design in Romania.** It also serves as basis for further fieldwork in the final phase of the current assignment; this will help disseminate best practices and collect further feedback from beneficiaries, designers, and decision makers on how to make Romanian infrastructure more efficient and cost-effective. The report is organized as follows:

- **Chapter 1 presents an introduction on the report, with the main components of the work done by World Bank.** It gives an overview of the entire material.
- **Chapter 2 provides an overview of infrastructure planning, describes the policy context in which projects identified and implemented in Romania, and covers strategy formulation processes.** Both statutory and non-statutory plans are considered.
- **Chapter 3 presents an overview of the legal framework for the preparatory stages of infrastructure design, but also the funding opportunities for different types of infrastructure works.** The section presents different types of stages specified in Romanian law, along with an ideal framework for the preparatory phases.
- **Chapter 4 reviews the main technical regulations in Romania and their correlation with EU regulations, but also gives an overview of the key technical elements considered in the design of road, water and wastewater, and social infrastructure.** It presents the state of practice in Romania and its evolution over time, and draws some comparisons with international best practices. It also features a series of effective and innovative technical solutions, which have been successfully used at international level and proposed for implementation in our country.



- **Chapter 5 presents general aspects of the public procurement process.** It covers the legal framework, the main problems at the national level, but also recommendations on contract type in light of international best practices.
- **Chapter 6 presents the actors involved in the infrastructure construction process, along with their responsibilities.** It also covers the preparatory steps, materials, constructions techniques and safety, personnel and equipment, and verification and control for the infrastructure building process. Moreover, it describes a series of technologies used internationally, with potential good impacts on the investments in Romania.
- **Chapter 7 presents key aspects on infrastructure maintenance.** It briefly describes the Romanian system for quality assurance in construction, the post-implementation policies, and asset management for different types of infrastructure works. It also presents new technologies for improved maintenance of public investments in the country.
- **Chapter 8 summarizes the main aspects raised and described under the report.** It features proposed improvements for the specific strategies and actions for investments in Romania, together with a series of technical solutions and effective and innovative established international technologies which are suited for implementation in Romania as well.



2 Well-planned infrastructure

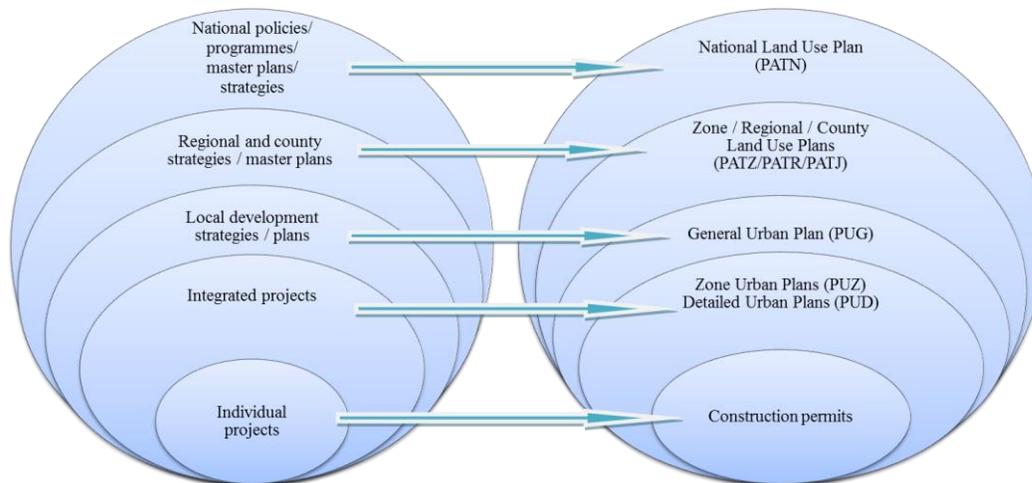
2.1 General aspects

39. **The planning system in Romania contains statutory plans and non-statutory ones.** Both types define sectoral investment priorities: transport, social, economic, environment, etc. The quality, complexity, and relevance of these documents vary greatly, as explained in what follows.

40. **There are multiple types of statutory plans, depending on the applicable territorial level.** The statutory plan for the local administration units' level is the General Urban Plan (PUG), a development plan type combined with zoning regulation, which is valid for 10 years. For their part, counties have the County Land Use Plan (PATJ) with its specific sections: transport, water and wastewater, land use, etc. Both plans have a methodological framework and an approval procedure established by MRDPA through Law no. 350/2001 on spatial and urban planning.

41. **Localities and counties also have non-statutory plans, development strategies or plans, usually designed for an EU programming period (7 years).** They cover different sectors to support community development (economy, transport and environmental infrastructure, social services, good governance, etc.). From the content point of view, the strategies encompass chapters like the analysis of the existing situation, SWOT assessment, vision and strategic development objectives, policies, programs and the list of priority projects that respond to identified problems.

Figure 1. Planning levels in Romania



42. **There is no legal methodological framework for strategy formulation.** However, different guidelines are available, especially the ones elaborated at the EU level. Examples include: the Reference Framework for Sustainable Cities (<http://app.rfsc.eu/>); good



practices and guides on Local Action Plans on the URBACT platform (<http://urbact.eu/urbact-local-groups>); the guides and methodologies elaborated under the project Platform for sustainable and integrated urban development by the Romanian MRDPA (<http://www.dezvoltareurbanaintegrata.ro/ghiduri-si-metodologii>). The local and county councils, following Law no. 215/2001 on local public authorities, approve these plans. These authorities usually subcontract most statutory and non-statutory plans to private or public organizations, such as consulting firms, universities, and research entities. Because of the current gaps in the methodological framework, the quality of the strategies depends on the terms of references and the expertise of the contractor.

43. The planning activity has become more important for local administrations after 2007, since most EU programmes required (or gave priority to) projects to be included in a local or sectorial strategy to be eligible for financing. For example, it was mandatory for water and wastewater infrastructure projects financed through the 2007-2013 Environment Operational Programme (POS MEDIU) to be part of a regional master plan for water and wastewater. Moreover, cities applying for urban development financing under Axis 1 of the ROP were required to include proposed projects into an Integrated Urban Development Plan (PIDU), aimed at promoting functional and territorial integration into a defined area of intervention. At the same time, some county and local development strategies received EU funding in the drafting process through the 2007-2013 Administrative Capacity Development OP (PO DCA). Currently, approximately 42% of the territorial-administrative units in Romania have outdated General Urban Plans. The same situation occurs in the case of County Land Use Plans, with some of them over 15 years old. In this context, the Romanian Government has issued a decision in 2012 to prolong the validity of these Plans until December 2015.

44. The General Transport Master Plan is the reference document for the national-level transport strategy. It will establish investment priorities for the 2014-2030 timeframe, thereby covering at least the next two programming periods, with a focus on central and comprehensive TEN-T road, rail, water and air transportation axis. Furthermore, each of the eight development regions have drafted Regional Development Plans for 2014-2020 programming period, coordinated by the respective Regional Development Agencies (RDAs). These include a list of investment priorities for county roads' rehabilitation and modernization, as approved by the Regional Development Councils (representatives of the component county councils and of municipalities/towns/communes). These priorities have been established in a participatory fashion, with the consultation of all counties in each region, under the supervision of MRDPA, and according to two main criteria:

- The road is to ensure the connection of regional centers and of a critical mass of citizens to the TEN-T network, as defined in the General Transport Master Plan;
- The road should promote inter-county mobility and be implemented based on a partnership among stakeholders involved.

45. While priority strategic projects included in the General Transport Master Plan are going mainly to be financed through the 2014-2020 Large Infrastructure OP, those identified by the Regional Development Plans will receive ROP funding. Finally, we



should mention that both the General Transport Master Plan and the Regional Development Plans still need to be approved (as of end of May 2015) and are under consultation with the different categories of stakeholders.

46. **There are also counties that have elaborated their own transport master plans or strategies for county and local roads, such as Iași or Timiș.** However, local investment priorities for road development are generally identified by local integrated development strategy.

2.2 Main problems related to the preparation and implementation of strategies in Romania

47. **Most county and local strategies do not fully reflect community needs and are instead designed to fit the requirements of various funding programs and shaped to justify the selection of a list of projects previously agreed.** At the same time, planning documents at different levels are not integrated. The investment priorities established at national or regional level do not correspond with the one emphasized by the local strategies.

48. **There is poor correlation between strategic planning documents and spatial/land-use documents.** Some of the investment priorities cannot be implemented because they are inconsistent with urban regulations or with environmental requirements. However, some of the strategies have to undertake an environmental assessment, according to GD 1076/2004, in order to ensure consistency with environmental requirements, especially if they have a project portfolio that could influence the environment. In practice, not all strategies go through this process (e.g., regional development plans).

49. **Ownership and engagement over the programming documents is weak.** This is the result of a superficial participative approach in the elaboration of strategies and of a lack of stakeholder consensus on investment priorities.

50. **The influence of political cycles over the programming process and strategy implementation is strong.** In general, each elected legal representative has the tendency to impose an agenda and to abandon the previously established priorities for the community, affecting the credibility of the planning process in general and potentially contributing to the problem of the ever-growing portfolio of projects that are started and left unfinished.

51. **The lack of implementation and monitoring tools is also problematic.** Once elaborated, the implementation of the strategies is not assessed by local authorities or by other stakeholders. In fact, such documents often lack a set of objective monitoring and evaluation indicators.



52. **The lack of investment prioritization can also be observed.** As noted above and in other components related to this broader technical assistance,¹ this has led to extensive lists of priority projects that overcome the existing and future financial resources that the community can access for their preparation and implementation. To make matters worse, most local authorities do not have the necessary financial and human resources to prepare and implement the projects.

53. **Multi-annual financing and the correlation between investment priorities and budgets are needed.** Although the county or local councils approve strategies, these documents do not typically contain a financing need assessment for the entire programming period or the potential financing sources for each of the proposed projects, and/or there is no specific allocation in the local budget for the priority projects identified in the strategy.

54. **A stronger “partnership culture” among stakeholders in general is needed.** So far, most PPP alternatives for the implementation of strategic projects are completely ignored, while the only focus is on EU-funded programmes, with limited resources made available to innovative schemes.

55. **Not all planning documents are properly elaborated.** The lack of standard framework or terms-of-references for the contractors, together with limited financial resources for the elaboration of local strategies and the lack of experience at the level of beneficiary, lead to low quality and potentially useless planning documents.

56. **In recent years, Romania went through major changes with respect to the structures in charge of the coordination of structural funds.** The funding rules, guidelines, and procurement legislation have suffered numerous modifications. This lack of predictability translates into poorly designed projects, delays in the assessment of projects, and long periods for processing the reimbursements applications.²

2.3 Organization of Local Authorities

2.3.1 Administration of County Roads

57. **Modern administration and management of roads should be organized around four actors: owner, administrator, manager, and supplier(s).** The functions of these actors are defined as follows:

- The **Owner** is responsible for funding, policy, and the legal and regulatory frameworks (e.g., the design and maintenance standards). For the county roads, the owner is the Romanian State represented by Ministry of Regional Development and Public Administration.

¹ See World Bank reports on the National Local Development Program (PNDL) (2015), developed as part of the same technical assistance with the MRDPA

² For an extensive assessment of such issues and others, see the two reports under “ROP 2.0: MA-IB Collaboration and Support for Beneficiaries of the Regional Operational Programme 2014-2020” (World Bank, 2013)



- The **Administrator** is the agent of the road owner responsible to ensure that performance of the transport system meets the aims of the owner. For the county roads, the administrator is the County Council.
- The **Manager** specifies the activities chosen by the Administrator to be carried out, and supervises and monitors their execution. In most counties in Romania, the manager is the Technical Department of the County; there is a trend toward contracting management with an outside firm.
- The **Suppliers** deliver services and works, selected and supervised by the **Manager**. Desirably, the supplier is a private contractor procured competitively. Currently, in most counties in Romania, the county's own construction company performs such functions without competition. Annex 1 shows the roadworks contractors owned by County Councils.

58. **In Romania, these actors and their responsibilities are not defined clearly, which results in high transaction costs and inefficiency.** Incidences of micromanagement and non-transparent political interference in project selection and priorities are common. Deficient public consultation and ad-hoc planning activities make the decision-making process non-transparent.

59. **Another key factor causing inefficiencies and slowing down decision-making is the lack of indemnity insurance for professional staff.** Staff is reluctant to make decisions for fear of errors - which are very common (e.g., data errors, design errors due to poor quality of data or design, etc.) - when they are personally liable for such errors, and, in spite of the fact that they could insure for professional liability, they hardly ever do this. One could also mention in this context the low motivation of public servants resulting from: low salaries, poor work conditions, unattractive personal development packages, frequent management changes, lack of internal performance assessment procedures and monitoring, etc.

60. **The organization of maintenance at the local level was assessed through interviews.** These took place at the level of several counties with the entities in charge of the infrastructure maintenance and at the commune level with the mayor and/or other local administration officials.

61. **The organization and the functions of the entity in charge of the maintenance of the county roads may be different from one county to another.** In some places, the Direction of the Public Domain (DAD) is in charge; in other places, this responsibility for maintaining county roads belongs to the former technical Department of the County Roads and Bridges. In some cases, the DAD has no technical means, thus it subcontracts the maintenance works. In other counties, the entity in charge owns and operates different technical means and equipment, and is working through a multiannual contract for the maintenance of the County Roads. Competences of such entities differ considerably. In most counties, such entities are only in charge with the maintenance of the county roads, but sometimes their mandate also includes the communal roads (DC). At least in some counties, the entity in charge (at the county level) provides technical



assistance to the commune with respect to maintaining the road network that is under the responsibility of the commune.

62. **At the county level, the technical direction is usually in charge of:**

- gathering information and preparing annual and monthly jobs (investment, repairs, maintenance), according to the list approved by the Ministry of Transport;
- organizing the bidding procedures for the execution of the road works program included in the County Council's Program;
- providing site supervision and being responsible for all road works financed by the County Council and supporting local councils in this respect, for their work of supervising progress and checking the volume, quality, and value of works executed by builders as reported in construction documents necessary to put roads into operation;
- organizing and participating in partial and final acceptance of the work, providing the secretariat of the committee, and pursuing measures agreed during the reception stage;
- ensuring checks and managing projects for roads, bridges, and artwork by ensuring that they meet customer requirements and ensuring proper execution of works;
- permanent liaison between the customer (County Council), designers, builders, and the State Construction Inspectorate in order to carry out contracts;
- working with Local Councils to administer local roads efficiently;
- evaluating bids for road works and preparing the necessary documents for negotiations between the County Council and contractors/designers;
- updating technical-economic documentation based on normative acts in force and preparing the necessary documents for approval by the County Council;
- verifying technologies, quality of work performed and materials, and making proposals to stop work when necessary, requesting, if necessary, quality assurance department collaboration;
- participating as members of the tender committees for the selection of roads and bridges construction or design companies;
- preparing and organizing the reception of road infrastructure works at the request of local councils;
- providing technical assistance and supervision of works approved by Rural Development Programs for road infrastructure at the request of local councils;
- preparing and submitting to the Ministry of Transport reports on the state of the road pavement works;
- carrying out specific responsibilities for quality management;
- fulfilling other duties assigned by the County Council, the President, the Vice President, and the Technical Directorate leadership.

63. **The organization of road maintenance at the communal level is very similar around the country.** One of the Deputy Mayors is usually in charge of maintenance of



roads. For this purpose, under the responsibility of the commune, the Deputy Mayor can ask for assistance from persons who receive 'social help' based on the respective provisions of the law. The commune can employ inhabitants with no income and pay them for all working time (the compensation for one month is equivalent to 72 hours of unskilled work). Unskilled persons are therefore employed for cleaning the ditches, culverts and pipes, cutting grass along the roads, and other simple road maintenance works such as filling potholes, earthworks, etc.

64. **Several communes have own quarries that provide materials (stones, ballast, and/or sand).** Most of the time the quality of aggregates is standard and they are used for typical structural works on streets and communal roads. In some cases, when basic materials are not of good quality, the commune may order other materials through a concession agreement and, in return for the exploitation of the gravel quarry, a Contractor may allow the commune to use some equipment for maintenance purpose.

65. **The communes also sometimes mobilize individual residents, either with their equipment or as workers.** Such mobilization is mostly used for winter maintenance, important repairs, annual campaigns of road repairing, or for clearing off the snow from the communal roads or village streets during winter.

2.3.2 Administration of water and wastewater system

66. **After a period of more than four decades of centralized management, Romania has decided to return to the principle of local autonomy through decentralization, transferring some responsibilities to local public administrations.** The regionalization process for the water and wastewater system started in 2001. This process was shaped by four main constraints:

- European integration issues and the need to comply with environmental standards;
- economic reasons – consisting of scale economies resulting from an operating system with a large number of consumers;
- solidarity – while big cities are self-sustainable, small communities cannot afford to prepare, implement, and sustain investment projects;
- viability – cost-benefit analysis do not justify investments in small communities, some without the necessary experience or with historical debts.

In this context, regionalization is the key element for improving the quality and cost efficiency of the water and wastewater system, with the fulfillment of environmental requirements.

67. **Nowadays, the management delegation of the water and wastewater services is the operational and institutional basis of the system.** They ensure a balanced relationship between public authorities and regional operators, focusing on implementing the investment plans and improving the efficiency of the system to ensure an efficient and sustainable management, especially in what concerns the tariff policy, the reporting and control processes, and the financial and asset management.



68. The institutional architecture of the regionalization process in the water and wastewater sector comprises two main actors:

- Intercommunity Development Associations (ADI) – with the status of a non-profit association, consist of urban and rural administrative units in a county (no private party participation is allowed). This structure allows local authorities to have ownership in the water and wastewater regional operator, and to monitor and supervise investments into the network extension and rehabilitation. The ADI takes over most of the competences that local authorities have in the field of public services and it represents the interest of all members. The association provides services exclusively to its members (territorial administrative units that have agreed to join a particular ADI).
- Regional Operator –has to be 100% publicly owned, licensed by the National Regulatory Authority of Public Community Services (ANRSC), and has to demonstrate it has the capacity to operate in a sustainable way by having a sufficient initial capital. If necessary, the Regional Operator can delegate part of its competences to other operators. The entire profit has to be reinvested in the network.

69. A public service delegation contract has to be signed between the ADI and the Regional Operator. The ADI has to elaborate a common strategy for the development of water and wastewater infrastructure in its area, together with an investment plan and a tariff policy targeting long-term price alignment. In the end, the ADI is expected to be the entity responsible for the implementation of the County Master Plan for Water and Wastewater. These documents are the basis for accessing EU funding from 2014-2020 Large Infrastructure OP (LI OP); they are similar to the ones used for the programming period 2007-2014 (for the Environment OP).

70. The administrative units that are not part of a county/regional ADI can establish their own operators for water and wastewater services, use the existing ones, or delegate the service to a private company. In any case, these operators also have to be authorized by ANRSC. Considering they are not part of an ADI, these administrative units cannot request LI OP for their investment projects, but they would be able to apply for funding from PNDR and PNDL. Annex 2 shows the ADI and Regional Operators by County.

71. The Romanian water and wastewater system is confronting a series of problems and constraints affecting the quality of services delivered to citizens. Some of these include:

- an inadequate institutional system;
- the unclear role and competences of different authorities involved in managing community public services;
- the inefficient management of operational, personnel, and maintenance costs;
- the lack of experienced personnel for the preparation and implementation of major infrastructure projects;



- the huge investment needs for the extension and rehabilitation of the network in the rural areas;
- in some areas, there is a reduced level of household connection to the network, but also a large volume of unpaid water consumption, caused by network losses and low fare collection (in the context of a tough shift in mentality regarding the need to pay for water/sanitation services); the cost recovery is an important aspect, first of all as this is a requirement of the WFD, and second as it has an impact on the sustainability of the investments;
- inadequate operating and maintenance systems, etc.

2.3.3 Administration of social infrastructure

72. **According to Law no. 196/2006 on decentralization, local public administration authorities have exclusive competencies over a wide range of social infrastructure assets.** They cover:

- the administration of the public and private domain of the commune or city;
- the administration of the cultural institutions of local interest;
- the administration of public medical units of local interest;
- primary social assistance services for the protection of children and for the elderly; and
- primary and specialized social assistance services for the victims of family violence.

73. **Local public authorities from communes and cities share competencies with the public authorities from the central level in areas related to social infrastructure that require both a national and local approach.** These areas include building social housing and housing for young people; public pre-university education (except for the education of students with special needs); medical and social assistance services for individuals with social problems; and primary social assistance services for persons with disabilities.

74. **County-level public administration authorities also share competencies with central public authorities in the area of social infrastructure.** These include: state education for students with special needs; medical and social assistance services for individuals with social problems; primary and specialized social assistance services for the protection of children; and specialized social assistance services for persons with disabilities.

75. **For education infrastructure, Law no. 1/2011 (The National Education Law) is the main document that establishes the roles and administration of such assets.** The land and buildings of early education units and of the preparatory, primary, and secondary education units (including any other units by levels of education, as established by the state) belong to the local public domain and are administered by the local councils. The other components that constitute the material basis of the units are in their ownership



and are administered by the executive boards, as required by law.³ Concerning the state schools for students with special needs and educational assistance county centers, the land and buildings in which they operate are part of the county public domain (Bucharest municipality included) and are administered by the county council through the administration councils of the respective education units. The other components from the material basis of these units are their property and are managed by their respective administration councils. As for the palaces for children, clubs for students, and sports clubs, they are part of the public domain and are managed by the Ministry of Education through county school inspectorates and through the executive boards of these units. Such facilities (including land and buildings) can be transferred from the public domain of the state to the public domain of the territorial-administrative units where they operate, at the request of the county/local council and by Government decision.

76. **The pre-school education system is facing a major deficit in terms of infrastructure.** According to the Partnership Agreement signed by Romania with EU for 2014-2020, the percentage of kindergartens coverage in the rural areas is only 7.44% of the number registered at the national level in the school year 2012-2013. PNDR mentions that from 295 nursery units in 2011 only 1% were placed in rural areas, but 45.5% of children aged 0 to 4 years were registered in rural areas. There is still limited availability, inconsistent quality and affordability of early preschool education due to the very low investments in both infrastructure and institutional development. In 2013, a new legal framework was adopted for the organization and the functions of nurseries, which requires new investments in institutional development.

77. **Similarly, there is limited availability of informal alternative education such as School-after-school or Second-Chance for students at risk of early leaving.** Because of chronic under-funding and the lack of incentives, there are limited opportunities for early leavers to re-enter the educational system. This is particularly an issue among the Roma communities, where only 6% of women and 12% of men graduate from high school.

78. **Since 2009 there could be seen a progressive closing of school of arts and trades, based on the restructuring of the Initial Vocational Education and Training (IVET) due to low enrolment and poor infrastructure.** This has happened especially in agricultural high schools, where there has been a decrease by over 80% in the last 15 years. The remaining IVET schools are considered unattractive due to the inadequate quality of facilities, equipment and staff.

79. **Much of the education infrastructure continues to be outdated and unattractive and constrains the effectiveness of existing policies.** Of particular concern are the rural schools and isolated schools in disadvantaged areas. These have poor sanitary conditions (a third of rural schools do not meet the requirements of sanitary authorities). They also lack a proper water supply (almost half of rural primary schools), are not connected to sewerage with consequent risks to health (a fifth of rural schools), and are inadequately heated (more than half of the schools in rural areas, and more than one third in urban areas, with the most serious situation recorded in primary schools). The availability of

³ See Art. 112 of the Law no. 1/2011



specialized facilities and teaching equipment for disadvantaged students, including those with special educational needs, is poor.

80. **According to the National Strategy for Regional Development, the continuous changes that have taken place in the process of restructuring the education system in Romania, together with the Education Law of 2011, led to the reorganization of the education units network.** The main change was done at the level of pre-school education (kindergartens). They have been assigned to the accredited/authorized schools with legal personality. This has led to a vertical organization of the education system, with a single management and a higher number of preschoolers and students per school unit. There has been an important decrease in the number of schools in rural areas due to the merging of the education units, based on the drop in the number of students. In what concerns professional schools, they faced a decrease in number, due to the Education Law, which imposed that the technical and professional education be done by technological high schools.

81. **Law no. 95/2006 on the health system reform sets the legal, institutional, and policy framework of the Romanian health system.** ⁴ According to this, public health units in Romania are:

- Hospitals (regional, county, local), ambulatory and emergency care services – subordinated to the Public Health Ministry, county or local councils;
- Units of medical-social assistance (dispensary/ policlinics), sanatorium, preventorium and health centers – subordinated to the local public administration.

82. **The current hospital network is formed of local/municipal, county and university hospitals, but the specification of the hospital estate is inconsistent with the delivery of a modern and efficient health service.** In general, hospital infrastructure is known to be deficient. Some services are provided in buildings more than 100 years old, which are widely dispersed and cannot accommodate standards applicable to modern hospital settings (e.g., building blocks dispersed at kilometers away from each other impeding prompt multidisciplinary diagnosis/treatment of severe urgent cases, deficient circuits within hospitals, insufficiently equipped, etc.).

⁴ Law no. 95/2006 mainly regulates the following aspects: public health assistance principles, the authorities of the public health system, public health control, medical assistance, pharmaceutical assistance, implementation and financing of national health programs, family medicine, primary medical assistance, first aid and emergency medical assistance, county ambulance services, mobile emergency, resuscitation and extrication services, community medical assistance, human organs, tissues and cells donations and transplants, organization, functioning and financing of hospitals, health insurances, medical services covered from the National Fund for health insurances, the organization of health insurances houses, medical services suppliers, voluntary health insurances companies, profession of physician, dentist, pharmacist, the Romanian Colleges of Physicians, Dentists, Pharmacists, medicines (fabrication, import, labeling, prospectus, classification, distribution, publicity, public information).



83. **One of the challenges regarding health infrastructure, underlined in the Partnership Agreement, is the underdeveloped and often outdated infrastructure and equipment.** There is a high concentration of resources within urban areas, with weak capacity to reach poor and isolated rural communities. Historical under-investments in health in the post-communist period, but also external factors (e.g., roads infrastructure) have resulted in a limited capacity to support equitable access to quality health services these days.

84. **The public hospitals that are attached to the local administration may receive funds from the state budget and from the Ministry of Health's own revenues for different purposes.** These include the following: finalizing investments (new projects or in progress); medical equipment endowment; capital repairs; modernizing, transforming, and extending existent constructions, as well as expertise, technical design, and consolidation of buildings. The local public authorities may also participate in the funding of administration and operation expenditures, respectively staff-related costs, goods and services, investments, capital repairs, consolidation, extension, and modernization, endowment with medical equipment, etc.

85. **The Ministry of Health centralizes the investment objectives/projects and other capital expenditures that are eligible to be covered under various investments program (including technical and economic documentations, approval documents, etc.).** The draft of the investments program is elaborated along with the budget proposal of the Ministry of Health. It has to take into account the following: the limits of budgetary expenditures established by the Ministry of Public Finance and the strategy of the Ministry of Health with regard to the investment policy in the health sector and the solicitations from the public units attached to the Ministry of Health and/or from its specialized structures.

86. **According to the Social Care Law from 2011, the public suppliers of social services can be:**

- specialized structures from/subordinated to the local public administration and the executive authorities of the territorial administrative units organized at commune, city, municipality level;
- authorities of the central public administration or other institutions subordinated or coordinated by them;
- health units, education units, and other public institutions that develop, at community level, integrated social services.

87. **Social services are classified, taking into consideration the beneficiary, into the following categories:** aimed at children and/or family, people with disabilities, elderly people, victims of family violence, homeless people, addicted people, victims of the human traffic, people imprisoned, people with mental illnesses, people from isolated communities, long term unemployed, and their caregivers. The social services can be offered at home, in day care centers, in residential centers, in community, protected homes and units, multifunctional or services complexes, social canteen, mobile services for food distribution etc. One of the major reforms assumed by the social assistance



system after 1989 has been the closing down of big institutions and developing small scale and community based services.

88. **Social services offered and managed by the authorities of local public administration are founded through local councils' decision.** They could be organized as structures with own legal status (as social care institutions managed by a director, supported by a consulting council formed by representatives of the beneficiaries and of the social partners in the area) or without own legal status (as social care units inside the specialty apparatus of the city/commune hall or inside the public service of social care subordinated to the county or local councils).

89. **As mentioned in the Partnership Agreement social infrastructure is insufficiently developed to meet current demands.** In 2011, there were 524 adult care units, out of which 27% were functional residential services for elderly people while the number of elderly people in the rural areas is increasing. A similar situation also applies to nurseries (as mentioned above): there were 295 units in 2011 at the national level out of which only 2 units in rural areas, while the number of children between 0 and 4 years was 1,054,946 in 2012, out of which 45.5% were children registered in the rural areas.

90. **According to GD 90/2010, the Ministry of Culture is a specialized structure of the central public administration, which develops and ensures the implementation of strategies and policies in the cultural sector.** The Ministry has to ensure the efficient administration of its institutional system, including subordinate institutions and deconcentrated public services. The Ministry has to support, in collaboration with the local public administration authorities, the proper functioning and activity of cultural institutions and settlements that are subordinated to local and county authorities. Furthermore, the Ministry has the attribution to propose and promote partnerships with the local public administration authorities and with civil society actors in view of diversifying, upgrading, and optimizing the public services offered by cultural institutions and settlements.

91. **The public cultural units are: libraries, museums, cinemas, institutions and companies for art performing or concerts (culture centers or houses) and are subordinated to the Ministry of Culture, county or local administration.** In recent years there has been a decrease in the number of libraries and an increase in the number of museums and art or concert performing institutions.

92. **Annex 2 of GD 90/2010 lists the units that operate as subordinated to the Ministry of Culture and are financed entirely from the state budget.** They are the following: county departments for culture and national patrimony, the National Preservation and Promotion Center of Traditional Culture, and the State Secretariat for Cults. The Romanian Copyright Office is a specialized body under the coordination of the Minister of Culture and is financed from the state budget. The county departments for culture and national patrimony represent the deconcentrated public services of the Ministry of Culture and their directors are appointed by the Minister of Culture. The patrimony of these departments includes rights and obligations over movable and



immovable goods that are in the public or private property of the state and that are administered by these departments.

93. **There are as well central-level specialized bodies and national interest cultural institutions that are financed both from their own revenues and through subsidies from the state budget.** They are the following: the national museums, the national theatres, the national operas, philharmonic, and choir, national art centers, the National Patrimony Institute, the National Institute for Cultural Research and Training, the National Cultural Fund Administration, Bucharest Cinema Creation Studio, “Video” publishing house, etc. There are also some cultural institutions that are financed from their own income/extra-budgetary revenues – this is the case of Artexim. Finally, there are units that operate under the authority of the Ministry of Culture: the National Printing Company “Coresi” S.A., the Autonomous Distribution and Exploitation Administration “RomaniaFilm”, Cinema Studios “Rofilm”, “Sahia”, “Animafilm”, etc.

94. **The cultural heritage including cultural infrastructure has an important role in preserving the local identity, the specificity of the areas and maintaining the traditions for the next generation.** According to the Strategy for Culture and Patrimony 2014-2020, 75% of the historical monuments are endangered and 35% of the monuments have a high degree of degradation.

95. **GD 11/2013 on the organization and functioning of the Ministry of Youth and Sports establishes the roles and responsibilities of this specialized body of the central public administration.**⁵ Among other responsibilities, the Ministry has the competence to establish youth centers by accommodating unused spaces and buildings from the public domain of the state or spaces that are administered by the institutions that are under its subordination, and has the task to develop and implement the plan for the rehabilitation and expansion of leisure centers and students’ cultural houses. It also has to ensure their organization and functioning.

96. **Annex 2 to the Government Decision 11/2013 includes the units subordinated to the Ministry of Youth and Sports and mentions their sources of funding: own income and subsidies from the state budget.** County departments for sports and youth function as deconcentrated public services of the Ministry.⁶ The sports clubs also belong to the Ministry of Youth and Sports.

97. **According to the Partnership Agreement, the transfer of competencies from the central to local government (education, health, population registry, basic public services) was done without a proper assessment of the administrative and financial capacity of the local authorities.** The transfer of responsibilities has been often incomplete or unclear/diffuse and decentralized public services delivered by local governments are, in many cases, underfunded.

⁵ The organizational structure of the Ministry of Youth and Sports is included in Annex 1 to the GD no. 11/2013, as modified by the GD no. 30/2013.

⁶ The activity of the county departments for sports and youth is regulated by GD no. 776/2010 regarding the organization and functioning of county departments for sports and youth.



2.4 Conclusions

98. **In order to improve the quality and the use of the planning instruments for the next EU programming cycle, several measures can be devised.** First, all infrastructure strategies, as well as the actual related projects, should be correlated in space and time. One relevant example would be the road and utilities infrastructure, with many newly rehabilitated roads being affected by the water, wastewater or gas construction work. The report on coordination (also developed as part of this technical assistance) covers this topic in great depth.⁷

99. **Local strategies should take into consideration strategic projects identified by the higher-level (national, regional or county) development strategies.** For example, if the General Transport Master Plan foresees the rehabilitation of a certain national road or the development of a new highway, local authorities should invest with priority in the county and local roads ensuring the connection to that specific road.

100. **Investment projects should be territorially integrated at local level in order to maximize their effects.** For example, if a certain urban or rural area is targeted for road extension or rehabilitation, the investment in utilities or social infrastructure for that particular zone should be also considered with priority. A good example in this sense is the PIDU approach for urban areas or the integrated rural renewal projects under 2007-2013 PNDR.

101. **A sound prioritization process of the investment projects, correlated with the real financial and human resources of the communities, should be conducted.** In this sense, this report argues for the use of prioritization criteria for each investment project proposed (road, water and wastewater, social infrastructure). A full list of potential criteria (to be applied to the state-funded National Local Development Program) has been delivered by the World Bank under the Component 2 of this Technical Advisory Service.⁸ Particularly important are the criteria related to the beneficiary's capacity of co-financing the projects.

102. **The periodic evaluation of strategy implementation, based on a set of objective indicators, should be carried out at least every 2-3 years, while monitoring should be continuous.** This way, the ongoing revision of the strategy will be allowed or the corrective measures will be undertaken.

103. **Alternative sources of finance should be explored.** Although EU funding will continue to be the main financing source for most investment project in the 2014-2020 programming period, development strategies should consider all potential financial

⁷ See "Coordination of Strategies and Programs for EU and State-Funded Investments in Romania's Infrastructure," World Bank, 2015

⁸ See "Improved Prioritization Criteria for PNDR Projects," World Bank, 2015



sources (a financing mix), including own budgets (if available), PPPs, and PNDL funds or credits.

104. **Authorities should consider the establishment of an inter-department steering group at the beneficiary level (in case of municipalities and counties) led by one department/project implementation unit to help the process and ensure ownership of the development strategy.** Law no. 215/2001 should be revised in order to clearly state that the local / county authorities should elaborate and adopt a decision on both strategies and lists of priority projects, with clear provisions related to financing sources (reflected also in the multi-annual budget of that particular authority).

105. **The strategy should demonstrate/provide information regarding the involvement of the community and interested stakeholders in the formulation process.** Public and online consultations for the strategies, including the list of priority projects, should be carried out and the input of the stakeholders should be clearly specified in a dedicated chapter of the document and integrated in the content of the planning document. In order to ensure the sound involvement and accountability of each stakeholder in the implementation stage, partners and local authorities should elaborate and sign a partnership contract. This contract should contain both benefits and penalties for the parties that assumed clear responsibilities in implementing priority projects. Another report (under Component 1 of the current technical assistance), to be finalized in late August 2015, explores the potential use of territorial contracts, drawing on best practices and experiences from other EU member states (e.g., Poland, the UK, etc.).

106. **Priority projects should be better promoted especially to private stakeholders.** This way they could better plan and connect their own investments to those envisaged by public stakeholders/administration (multiplying effect).



3 Well-prepared infrastructure

3.1 Legal framework

107. **A number of studies can be prepared for the preparatory phase of a project, from basic concept to detailed design.** Each study tries to answer whether and how to undertake a deeper analysis, in order to have the best results in the execution phase.

108. **In Romania, for a new construction or for rehabilitation/modernization works, Governmental Decision (GD) 28/2008 is the base document, along with other relevant regulations in force.** This document presents the framework for technical and economic studies related to public investments, and the structure and methodology for elaborating the cost estimates for investment objectives and intervention works.

109. **According to GD 28/2008, the main phases for infrastructure design, including roads, water and wastewater systems, and social infrastructure, are:**

- For new investments, including extensions:
 - Feasibility study (FS);
 - Technical design (TD);
 - Execution details (ED);
- For interventions at existing constructions, including existing installations:
 - Technical expertise, and in some cases, energetic audit;
 - Documentation for the authorization of intervention works (DALI);
 - Technical design (TD);
 - Execution details (ED).

When elaborating documentations for new constructions or extensions, which need the approval of the Government, another phase is required before the feasibility study, called a prefeasibility study. As noted later, in practice prefeasibility studies are rarely used and often lack proper quality.

3.2 Preparatory studies

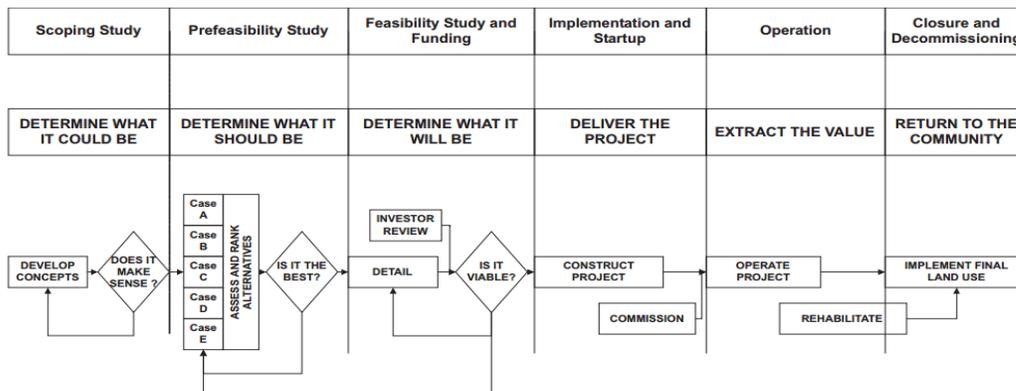
110. **Depending on the size and scope of a project, there are different phases it must undergo, starting with an idea, or concept, and ending with the actual construction (execution of works).** The timeline varies in each phase depending on the complexity of the project.

111. **For Infrastructure Planning and Facilities, every construction project begins with an idea – whether it is a sidewalk repair, a new bridge, rehabilitation of a road sector, new water and wastewater system, or modernization of social infrastructure.** First, someone identifies a probable need. From there, the idea is either studied to determine if there is truly a need, or it is given to an estimator for a calculation on the cost of the idea. If approved, the idea is then sent to the planning stage.



112. An ideal project development framework is presented in the figure below:

Figure 2. Project development framework



Source: "The use and abuse of feasibility studies"⁹

113. The framework specifically incorporates the overlap of the following activities across project phases:

- the funding or financial closure activities commence before the completion of the feasibility study, but continue after the feasibility study is completed;
- the commissioning activities overlap with the construction and operation phases; and
- the rehabilitation activities overlap with the operation and the closure phases.

3.2.1 Scoping study

114. Scoping studies provide a future Work Plan, up to the point of commitment to a prefeasibility study, and includes a description of the following:

- Scope and objectives – Define the scope and objectives for a project prefeasibility study (PFS), including:
 - declare the base and alternative cases to be considered,
 - declare technical issues requiring further investigation, and
 - identify test work to be undertaken.
- Approach – Declare the execution strategy for the PFS, including:
 - minimum standards for the PFS Report,
 - resources required and organization structure,
 - key personnel, and
 - key performance indicators for the PFS.

⁹ The use and abuse of feasibility studies, W.Mackenzie, N.Cusworth, Project Evaluation Conference, Melbourne, 2007



- Cost and schedule – Provide an estimate of cost and schedule to undertake the PFS, including:
 - budget based on scope statement breakdown,
 - schedule (Level 2), and
 - key milestones.

115. **The decision of undertaking scoping studies is usually analyzed during project generation or exploration.** Unfortunately, they are not very common in Romania.

3.2.2 Prefeasibility study

116. **In the current practice of developed countries, the pre-feasibility study or "concept design" is a fundamental document in the implementation of the project; it is sometimes more important than the other design / engineering documents.** In the case of projects involving advanced technological solutions or cleverly solving local community problems, the pre-feasibility study is the document that analyzes various constructive solutions for various sites, as well as the impact of each proposal on the overall investment budget and on the budget assigned for that operating period. It also supports policymaking.

117. **The prefeasibility study includes the technical-economic documentation that substantiates the necessity and opportunity of the investment based on technical and economic data.** The prefeasibility studies or background notes corresponding to the projects are assessed in order to analyze their suitability. If the proposal passes this preliminary evaluation, the authorities responsible for the implementation of the project can move to the feasibility study. In practice, pre-feasibility studies are rarely used in Romania, while background notes tend to be superficial and poorly argued (there are no standard forms and they usually justify why the feasibility study is needed, rather than the investment itself).

118. **The prefeasibility study, conducted during the identification phase, ensures that all problems are identified and alternative solutions are appraised, and selects a preferred alternative based on Quality Factors.** The study should provide the Funding Authority and partner government with sufficient information to justify acceptance, modification or rejection of the proposed project for further appraisal.

119. **Prefeasibility studies are typically structured to:**

- assess the likely technical and economic viability of the opportunity;
- consider different process, location, and project configuration cases;
- consider different capacities for the project;
- determine and recommend the preferred optimal case to be examined during the feasibility study;
- outline the features of the recommended project;



- determine key business drivers for the opportunity and examine any potential fatal flaws;
- determine the risk profile of the opportunity;
- determine the nature and extent of the further geological, environmental, marketing, or other work needed to be undertaken during the feasibility study;
- determine the costs and time to undertake this work and prepare a feasibility study, including an estimate of the costs and time to develop the project following completion of the feasibility study;
- identify the resources, personnel and services required to undertake further work on the opportunity; and
- provide a comprehensive report with supporting appendices that includes a recommendation to proceed or otherwise.

3.2.3 Feasibility study / Documentation for the authorization of intervention works

120. **In essence, an investment is a dynamic process that undergoes changes and adaptations at various times.** A feasibility study (FS) (for development of new assets) / Documentation for the authorization of intervention works (DALI) (for work on existing assets) provides a comparison basis for any subsequent changes/adjustments and ensures the initiator of the project that its purpose is fulfilled.

121. **The feasibility study / DALI represents establishes the main technical and economic indicators corresponding to the investment's objective based on its necessity and opportunity.** It contains functional, technological, building, and economic solutions. This study can be used by evaluators in order to verify the project's contribution to the achievement of the financing program's objectives and the quality, maturity, and sustainability of the project. Exact procedures vary across different financing sources, and particularly across EU and state-budget-funded instruments.

122. **In principle, the feasibility study / DALI is the responsibility of a designer appointed by the local government following a public procurement procedure.** The designer prepares the technical and economic content based on: information provided by the beneficiary, preliminary studies, and solutions indicated in the approvals and agreements (if applicable), and is liable for the technical solutions proposed.

123. **A feasibility study / DALI, conducted during the Formulation phase, verifies whether the proposed project is well founded and whether it is likely to meet the needs of its intended target groups/ beneficiaries.** The study should design the project in full operational detail, taking account of all policy, technical, economic, financial, institutional, management, environmental, socio-cultural, and gender-related aspects. The study will provide the Funding Authority and partner government with sufficient information to justify acceptance, modification, or rejection of the proposed project for financing.

124. **The feasibility study / DALI should be seen not as a standalone document, but as a phase of the project process.** This is because these studies will be accompanied by



preliminary surveys (topographical, geotechnical, hydraulic surveys, technical inspection reports, etc.), by approvals and permits, by plans, calculations of the amounts required for executing the construction, and by financial, risk, and sensitivity analyses.

125. **A feasibility study / DALI must be genuine and conducted in depth.** It underpins the investment decision of the local authorities and presents arguments in favor of funding to the management authorities of the funding programs. It is not a simple bureaucratic document and it has long-term implications.

126. **During the study process, alternative project configurations can be studied and decisions can be made on whether or not to proceed with project development and, if the decision is to go forward, what the optimum configuration is.** However, once a decision to proceed is made, and design, procurement, and construction efforts commence, there is little opportunity to influence the project outcome significantly.

127. **In order to be effective, a feasibility study / DALI should address the following issues:**

- The purpose of the project: The issue or the need that the investment project is to satisfy must be clearly defined. In this respect, clear data must be presented concerning the need of the project / target group. In addition, all project stakeholders must be defined, as well as their potential influence on its successful implementation.
- The current analysis / current situation: The FS / DALI must provide concrete data about the current situation of the infrastructure and must present the limits for the analysis of such data. The more complex the projects, the longer, more costly and more complex the research of data and technical situation are. The quality of the proposed solution and – ultimately – the efficiency of the project directly depend on the quality of the input data.
- The proposed solution: Potential solutions can be indicated as early as the pre-feasibility study phase, so that they can be defined in more technical details in the feasibility study. The Romanian law (GD no. 28/2008) on feasibility studies requires explaining whether the solution chosen is the result of a pre-feasibility study. The technical solution proposed must be chosen based on a multi-criteria analysis highlighting the benefits of the proposal. Once the best technical solution has been established, it requires a very detailed description both in terms of technical elements and in terms of its effectiveness. The following questions should be answered: does the solution meet the requirements / purpose of the project and is it a viable and effective solution?
- The assessment of the economic efficiency of the project: Once the solution has been defined, it must be quantified in money and the costs thus calculated should be compared to the benefits of the project. If projects are small or their impact is low, it is sometimes sufficient that the project costs be estimated and the benefits obtained be listed; as the investment grows, it requires a cost-benefit analysis and a risk analysis.



128. **In addition to the above elements, the feasibility study / DALI should also:**
- Ensure that the budget is sufficient for the investment. The FS / DALI identifies the risks of exceeding the costs and proposes risk mitigation measures.
 - Identify potential impediments from the stakeholders and enables them to get involved in the project from its initial phases. For example, environmental authorities or the utility suppliers can contribute to designing the solutions.
 - Draft an implementation plan and define the critical phases and moments.
 - Provide a basis for defining the Terms of Reference for the participants in other phases of the project (design, implementation).
129. **Some of the problems found with Feasibility Studies/DALI in Romania currently include the following:**
- Insufficient alternative analysis for FS: Instead of presenting different technical solutions, it contains one or two variations of the same solution;
 - Lack of support studies (field studies) or inconsistencies between the FS / DALI and the support studies;
 - There are not enough explanations regarding the context of the project throughout the FS / DALI: correlation with regional/national strategies or programs is not sufficiently presented;
 - While the technical solution is not fully developed and described, cost estimates are required to be as accurate as possible. The value of basic investment calculated at FS / DALI level is the base for the financing contract. Any deviation from that value is seen as a deviation from the contract. Most of the financing programs in Romania do not approve any overrun of costs or switching between cost types. But these modifications of basic costs appear all over during the implementation period: at the detailed design phase, at procurement phase, and during the investment period.
 - In some cases, the estimated cost does not contain all types of expenditure necessary to implement a project (e.g., publicity, costs related to Project Implementation Unit activity, etc.).
130. **The objective of FS / DALI is to transform a project idea into a specific plan, identifying and comparing alternatives with a view to developing different approaches, satisfying a need, and implementing the original idea.** The creation of an information set enables the competent government authorities to take well-founded, justified decisions in allocating resources for public investments. Such studies also enable the early identification of obstacles to the implementation of investment programmes and thereby accelerate the subsequent design and implementation process.
131. **As mentioned before, the main difference between FS and DALIs is their use – the first are dedicated to new constructions, and the latter to existing ones.** Also, another difference between the two types of documentation is the fact that in feasibility studies the designer analyses two solutions and proposes one of them, unlike the DALI phase, which is based on solutions from the expertise made by a technical expert,



authorized by MRDPA. Usually, a technical expertise evaluates existing constructions and proposes recommendations for their improvement.

132. **Another difference between the FS and DALI concerns the financial review.** According to GD 28/2008, it is mandatory for feasibility studies to also contain a cost-benefit analysis in order to sustain the chosen solution, unlike DALI, which does not contain such an analysis. Usually, the cost benefit analysis is required for PNDL projects for both types of studies (this happens mostly because of the lack of knowledge of the beneficiaries, who tend to confuse FS with DALI).

133. **The broad purpose of the cost-benefit analysis is to help decision-making and to make it more rational.** More specifically, the objective is to have more efficient allocation of stakeholders' resources. Cost-benefit analysis was initially used in the U.S. in the 1930's, but now cost-benefit analysis is used in many different contexts for many different purposes.

134. **The standard cost-benefit analysis is conducted while a project or policy is under consideration, independent of its type, before it is started or implemented.** The cost-benefit analysis assists in the decision about whether resources should be allocated by government or the company to a specific project or policy, or not. In situations in which analysts care only about efficiency, cost-benefit analysis provides a method for making direct comparisons among alternative policies.

135. **Given the fact that a feasibility study/DALI is also about the delivery of a business plan, not just construction of a road, process plant and infrastructure project, construction cost is but one measure of business success.** Construction schedule, ramp-up time, product quality, product output, operating cost, safety and environmental outcomes are all key measures of business success for a resource development project, and published information on these measures of project success is also virtually non-existent.

3.2.4 Detailed design

136. **Excellence in project execution is required just to maintain the value opportunity created from a good feasibility study, and excellence in project operation is required to deliver the value.** A poorly defined project will not deliver the same outcome as a well-defined project no matter how well executed and operated. Little scope exists to add or create value during project execution.

137. **The phase of detailed technical design has to follow Order 863/2008 of the Ministry of Development, Public Works and Housing.** This presents all stages to follow in order to obtain a complete documentation. More aspects of detailed technical design are presented in the following chapter.



3.3 Financing opportunities

138. **There are many financing programs available to support different infrastructure projects.** Most of them require that a Feasibility Study (FS) / Documentation for the authorization of intervention works (DALI) should be prepared according to GD 28/2008. The legislation presents the structure of the document and the structure of the General Cost Estimate. It is important to mention that in comparison to other countries, the Romanian FS stands between preliminary design or concept design and detailed technical design. It describes the status of the infrastructure, analyses several technical solutions and presents the proposed solutions from the technical point of view as well from the socio-economic impact point of view. The General Cost Estimate should include cost estimates for basic investment, taxes, engineering and consultancy, land acquisitions, and utilities.

139. **Since Romania wanted to access pre-accession EU funds, the country has started to implement a clearer legislation in this field.** The first funding programs available for the local public authorities included PHARE, ISPA and SAPARD. Whereas ISPA and PHARE were available for higher value projects, a number of smaller rural projects were funded under SAPARD.

140. **Each of these programs defined its own requirements for drafting the preliminary studies, especially the Feasibility Study.** The difference between the feasibility studies normally prepared by public authorities and those prepared for accessing European funds is that, in the latter case, the initiators had to prove the efficient management of money spent. Thus, there was an emphasis on the existing demand, on alternative solutions and on the economic efficiency of the projects.

141. **With the emergence of post-accession funding programs during the financial period 2007-2014, the requirements and structure of the preliminary studies were more clearly defined.** GD no. 28/2008 has been used as a basis for most of the feasibility studies prepared by the public authorities.

142. **Programs such as ROP, SOP Environment, or SOP Transport defined assessment criteria for funding applications, which also included the technical elements for assessing both the technical documentation and the solutions proposed.** Thus, a number of shortcomings of GD no. 28/2008 were addressed and the quality of the documents drafted under those programs is higher.

143. **The projects for road building or modernization were financially supported under the ROP (county roads, urban local network), SOP Transport (national roads and highways) and EAFRD (roads of local interest – in the communes).** In addition to the structure requested by GD no. 28/2008, the following elements were also requested or considered a plus:

- Traffic studies: Any proposed rehabilitation of county / national roads had to be done depending on traffic needs. In the case of SOP-T, traffic studies had to be drafted starting from the count done at FS level and not from the nationally



available data [The Center for Road Technical Studies and Informatics (CESTRIN), every 5 years];

- Alternative technical solutions: The studies had to describe at least two road structures or different locations;
- A rigorous assessment of costs, including bills of quantities (ROP);
- Clear maintenance plans, emphasizing maintenance costs. HDM4 (developed by the World Bank) was used for a while, but it is no longer used because of the different calibration of the data modules;
- Rigorous CBA, emphasizing VOC and VTTS: In recent years, on the basis of the transport master plan, the projects provided unified data at national level regarding the economic unit costs;
- A higher score was obtained for the existence of approvals and for overcoming potential challenges – such as environmental issues;
- The integration of the project in the national / regional strategy and its correlation with other projects.

144. **The projects for building or modernization of water systems, sanitation networks, and treatment plants were financially supported under SOP Environment and the EAFRD.** In addition, the following elements were also requested or considered a plus:

- Willingness-to-pay surveys: Market studies were performed as a primary research on the users' willingness to tolerate increases in charges;
- Operational and maintenance plan, drafted in detail: Institutional elements were discussed and presented – who will operate the network, what are the parameters?
- Advanced hydrogeological surveys;
- A rigorous assessment of costs, including bills of quantities;
- Rigorous CBA - both financial and economic analysis;
- A higher score was obtained for the existence of approvals and for overcoming potential challenges - such as environmental issues;
- The integration of the project with the water master plans at local / regional level.

145. **The projects for building or upgrading the social infrastructure were financially supported under ROP (schools, hospitals, healthcare centers).** In addition to the structure requested by GD no. 28/2008, the following elements were also requested or considered a plus:

- Clear presentation of the needs of the target groups: A higher score was obtained for projects covering a larger target group or proposing additional solutions;
- Integration of the project in the national / regional strategy and its correlation with other projects serving the same target group;
- Clear presentation of the structure that would operate the infrastructure and of the related costs;
- Alternative technical solutions;
- A rigorous assessment of costs, including bills of quantities (ROP);
- A higher score was obtained for the existence of approvals and for overcoming potential challenges – such as those related to utility providers.



3.4 PNDL-specific issues

146. **The project preparation assumes the elaboration of the prefeasibility and feasibility / DALI studies.** These are very important in the selection process of the projects' funding, as they offer the economic justification (one of the criteria potentially used in the PNDL process of prioritizing new or existing projects). There were more solutions implemented in order to help the beneficiaries prepare the technical documentation. One of them was to finance these documents at the central level, but this solution did not impose a direct link with the local authorities and sometimes the technical experts employed did not take into consideration relevant problems, and the eligible expenditures were not clear. This then led to significant issues during implementation and to large ineligible costs.

147. **The pre-application stage is very important as it can generate delays and problems, during both the evaluation and implementation stages.** If the applicant prepares complete and correct forms, the verification process of the documentation will be easier for MRDPA. The report under Component 2 underlines the fact that this stage should involve active engagement and one-to-one exchanges with potential beneficiaries and appointment of a liaison person for the MRDPA is suggested in this respect. In addition, there is a recommendation regarding the promotion of good practices with respect to the technical solutions and technologies to be deployed and the training of potential applicants so that they can assure better project designs and accordingly a smoother implementation of the project.

148. **PNDL explicitly notes that the responsibility for preparing the initial technical documentation belongs entirely to the local authorities.** The methodological norms specify a list of non-eligible expenditures (article 8 (3)), including feasibility studies, specialty studies, technical assistance, taxes, etc.). That means that the beneficiaries directly contract technical experts (typically based on the lowest bid criterion), but even so the quality of the documentation is still unsatisfactory due to the lack of capacity and proper accountability mechanisms.

149. **Some of the problems that occurred during the last programming period (especially in small communities that lack staff and financial resources) are connected to the poor training of the designers and the insufficient time they had in order to develop technical projects.** Another factor is related to the local authorities' lack of capacity to draft stronger contracts (e.g., to cover the errors and poor-quality work of the designers and verifiers, even if discovered after the project is received by the beneficiary) and properly verify the documentation they receive.

150. **The PNDL Methodological Norms include a clear template for project proposals, which applies to both new and ongoing investments.**¹⁰ This asks for the following data: the name of the project; the name of the applicant/local authority; the location of the project; main physical characteristics; total value of the investment; total value of eligible costs to be financed from the PNDL; data regarding the design contract (contract ID

¹⁰ See Annex 2 of the PNDL Methodological Norms



number, value, etc.); and, for ongoing investments, data regarding the construction works, the percentage of the project completed to date, and the deadline for project completion.

151. Considering the three areas of intervention of PNDL – road infrastructure, water and wastewater infrastructure, and social infrastructure – the FS should address the following issues:

- Define the project application: it quantifies the network users and it identifies their needs, it presents clues about their willingness to pay, ;
- Present the detailed technical condition of the existing infrastructure and of the network operator. If the investment is (operationally) part of a regional / national network, integration requirements are also identified. In the case of new networks, it identifies who will operate the network. Topographical and geotechnical surveys provide information about the land;
- Build upon the existing data, it defines and analyzes various technical solutions. It assesses them from a monetary perspective and proposes the most efficient one. It makes sure that the designed network is regionally correlated with other initiatives and that it meets specific quality and environmental requirements;
- Present a project implementation plan. It presents risks that may affect the implementation and proposes preventive measures;
- Present methods of operation and maintenance plans and ensure that the necessary funds will be available.

152. In order to apply for funding through the PNDL, the applicant must prepare a FS/ DALI in accordance with GD no. 28/2008. The guidelines do not provide a structure for assessing FS / DALI or for scoring / prioritizing the projects. In practice, the verification process focuses on eligibility and conformity aspects.

153. A Bank team of technical experts has reviewed a sample of feasibility studies / DALIs prepared by PNDL applicants and found a range of inconsistencies:

- Old and outdated documentations;
- No FS / DALI presented in the project application – for road infrastructure, the traffic study and traffic data were missing;
- The projects did not meet the eligibility conditions for the PNDL (they were oversized or undersized).
- There was no clear correlation with the requirements of the target group and with the regional level policy / strategy.
- No technical expertise was presented for modernizing buildings.
- There were no topographical and geomorphological studies. The current condition of the infrastructure and utilities was unclear.
- Alternative technical solutions were not always presented;
- Cost assessments were flawed – the cost standards proposed in the guidelines for eligible expenses were not followed;
- There were no commitments to sustained operation. There were no maintenance plans or realistic long-term cost estimates.
- The availability of the approvals/permits was not always clear.



154. **Another common problem found in the technical feasibility studies concerns the technical standards used.** In the content of technical and economic documents reference was made to design standards that were replaced according to the Order of the Minister of Transport, Constructions, and Tourism No. 620/2005 and replaced with Eurocodes, approved as national standards and used as reference norms in the technical regulations in construction. Thus, the technical-economic documentation appears to be treated superficially and not represent a foundation of technical design in accordance with Order no. MDLPL 863/2008 for approving the "Guidelines for the implementation of certain specifications of Government Decision No. 28/2008." Specific technical solutions are delivered only at the detailed design phase, which leads to changes in solution and amounts to the FD / DALI phase. Taking certain products (for instance building materials) without complying with national and EU-level legislation may lead to changes in the execution phase solution and rejecting those products and/or work stages, generating extra costs for the beneficiary.

155. **The failure to comply with cost standards is obvious in the case of new investments, where the cost standard does not take into consideration all the requirements laid down in the specific design standards.** For example, the Standard INDEX NP01197 – STANDARD ON THE DESIGN, CONSTRUCTION AND OPERATION OF KINDERGARTEN BUILDINGS – stipulates the following functionalities that are *not* reproduced in the cost standard:

- Offices and storage areas for clean and dirty laundry, including the related endowments – according to Article T.P.2.1.: "When cooking and laundering (or either of the two activities) are performed outside the kindergarten, suitable containers will be provided for transporting food and adjacent rooms will be provided for storing and washing the dinner sets, cutlery and dishes, for heating food and / or rooms for collecting dirty linen and storing clean laundry";
- Staff office and medical office – according to T.P.2.4. Rooms for educational and care staff;
- Areas for the movement of the service and care staff, who constitute a separate functional flow; they must not be fully embedded in the multifunctional playground, so that children have no access to the areas destined exclusively for the staff, in accordance with the rules for safe operation;
- Constructions and furnishings on the premises (in the yard) of the kindergarten according to Article T.P.4.

156. **Other inconsistencies between the baseline project stipulated in the cost standard and the design standard:**

- In the baseline project, the amount of RON 11,415.00 was stipulated for machinery and technological equipment – an understated amount, considering that the boiler necessary for producing heat is alone worth approximately RON 30,000.00. This amount should be added to the other machines and technological equipment;
- In the baseline project, the amount of RON 43,340 was earmarked for endowments – an understated amount, considering that the strictly necessary endowments for the proper functioning of a full-day kindergarten (bed + mattress



- set, cabinet for the storage of blankets, table + chair sets for children, table + 4 chairs sets for children, refrigerator, stove, hood, microwave oven, dishwasher, washing machine, tumble dryer, cutlery and crockery set, bedding set, pillow and quilt set for children, waterproof bedsheet for children) exceed RON 95,000;
- Given the above, the Applicant is forced on the one hand to comply with the specific design standard and on the other hand to comply with the requirements of Order no. 1851 / 2013 of the Minister of Regional Development and Public Administration approving the Methodological norms for implementing the provisions of Government Emergency Ordinance No. 28/2013, which approved the National Program for Local Development (as subsequently amended and supplemented). In particular, Article 8 (2) stipulates that the expenses estimated in the general estimate must fall under the provisions of the cost standards in force;
 - This issue can be solved:
 - either by updating and harmonizing the unit costs laid down in the cost standards, according to GD no. 363 / 2010 on the approval of cost standards for publicly funded investment objectives (as subsequently amended and supplemented);
 - or by introducing the concepts of “eligible costs” and “ineligible costs”, which would allow the Beneficiary to comply with specific design requirements, to choose the technical solution that suits the project’s specific needs and to adequately cover cost overruns included in the chapter on basic investment in the General Estimate.

157. **The investment costs stipulated in the General Estimate are not based on the bills of quantities and related unit prices.** These requirements are laid down in the following regulatory acts:

- GD no. 28/2008 - Annex 4, Article 13 – “The cost estimate of the item, as drawn up in the design phase – feasibility study / documentation for the approval of intervention works – shall be revised taking into account the quantities of works estimated in the conceptual design phase and the unit prices following the implementation of public procurement procedures”;
- Order no. 863/2008 of the Minister of Development, Public Works, and Housing – Annex, Article 1: “The technical project must enable the drafting of execution details in accordance with the proposed materials and execution technology, in strict compliance with the provisions of the technical project, without requiring additional works and without exceeding the cost of the works determined in the feasibility study / approval documentation phase.”

158. **The requirements of GD no. 363/2010 on the approval of cost standards for publicly funded investment objectives (as subsequently amended and supplemented) leave room for interpretation.** The lack of substantiation of the investment costs in the FS / DALI phase can result in blocking the investment and in using public funds for unfinished investments if the General Estimate is understated, or in the tying-up of public funds in one investment to the detriment of others if the General Estimate is overstated.



159. **GD no. 363/2010 makes the following statement under the Notes on the unit cost:** “Such increases in the unit cost that are mainly due to the influence of the seismic and climate features of the area considered for determining the location of the investment, and / or to geomorphological features of the foundation soil that are different from the features of the baseline investment, shall be justified distinctly in the documentation for the approval of the technical and economic indicators of the investment”; however, it does not specify which concrete elements may be overrun and how much they can be exceeded. This issue could be solved if the MRDPA provided an instruction concerning the cases that allow cost standard overruns.

160. **Another aspect of the technical and economic documents submitted for the PNDL is the usefulness and the quality of the cost-benefit analysis.** According to GD no. 28/2008 and as mentioned before, cost-benefit analysis should be performed only for new investments (during the FS phase) and not for rehabilitation projects. While there is a consensus that full social and economic analysis should be prepared only for major projects, the definition of the CBA to be prepared for PNDL projects seems vague and adds little value. First, the requirements do not clear differentiate economic and financial analysis (while both can be performed as CBA) and does not specify standard parameters to be applied which would make alternative projects comparable. The definition and role of CBA for PNDL projects should be reviewed.

161. **In the case of interventions to existing buildings, it was found that the rehabilitation works were not justified, because the proposed interventions maintained an improper situation that did not comply with the standards and norms specific for the operation of the building.** For example, the rehabilitation of a secondary school is proposed; the school building also houses a kindergarten. Neither of the two functions (school/kindergarten) observes the rules on traffic flows and has the required areas stipulated in the specific design standards. Under these circumstances, it is necessary that the building be upgraded by resizing and reorganizing it in order to comply with the specific standards. This issue could be solved by introducing a phase of technical and economic assessment of the documentation, after which such non-conformities can be corrected at minimum cost.

162. **Another problem identified in the assessment of the technical and economic documents submitted under the PNDL is that the urban planning certificates issued are incomplete, i.e., they do not require the approvals imposed by the nature of the investment and the urban infrastructure in the area studied.** Most often, the approvals issued by the water and electricity operator are missing, although they are necessary since network changes and even new consumers are anticipated. There is no specific legislation or guidelines to regulate the type of approvals / agreements required for each type of investment. In the case of changes related to the utility networks, the FS is not based on a solution study; the latter is obtained after the economic and technical documentation has been drafted and, many times, it leads to a change in the technical solution.

163. **The projects covering new educational or health infrastructure objectives require staff employed by the State through the line ministries.** Such projects do not include approvals from competent institutions, because the suitability of initiating them



must be also undertaken by the Ministry of Education and the Ministry of Health, respectively, through a commitment issued by the subordinated territorial bodies concerning the availability of qualified personnel to be assigned to such future institutions.

164. **Errors were found in most of the technical and economic documents.** In the calculation of the General Estimate, they consisted of failing to comply with the unit costs and maximum limits for certain types of expenses laid down in the cost standards – GD no. 363/2010, as subsequently supplemented (e.g., the Program contribution and the own contribution were inaccurate).

165. **The result of an economic feasibility study, by definition, will be that the project is feasible and should be advanced to the design and construction phases or that it is not feasible and should therefore not move forward.** However, current practices in infrastructure projects show that the second possibility rarely considered. This can be attributed in many cases to the procedures adopted by awarding studies of economic feasibility to engineering consultants. When the owner awards a contract to an engineering consultant to perform a detailed economic feasibility study for a certain infrastructure project, this phase entails a considerable commitment of time and financial resources to perform the study. Unfortunately, once a project is advanced to this stage, the implied assumption is that the project is feasible.

3.5 Conclusions

166. **Beneficiaries of PNDL and other infrastructure funding should take into consideration multiple key issues when preparing the technical documentation in order to assure that the proposals are complete and in line with legal provisions.** These issues include the type of documentation and annexes, the content of the documentation, the local / county council decisions, and the budget. See Annex 3 (Recommendations for improving applications; technical documentation from Component 2 report).

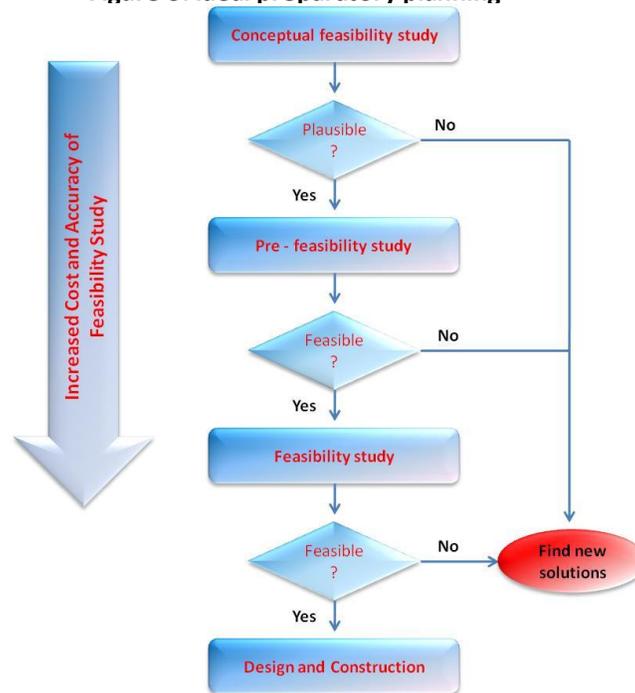
167. **GD no. 28/2008 is the main law regulating the drafting of the technical documentation for infrastructure investments in Romania.** The law is not sufficiently clear and detailed, therefore a number of errors – in form and content – occur in the document drafting process, subsequently affecting the implementation of the investment.

168. **Minimum requirements for the FS / DALI include:**

- It must comply with the structure of GD no. 28/2008
- It must be assumed by the designer
- It must clearly present the current situation
- It must present the situation of the users / application
- It must clearly present the correlation with cost standards
- It must submit plans for at least the following specialties: architecture, strength, installations.

169. The stages for preparatory planning should follow the scheme below:

Figure 3. Ideal preparatory planning



170. One solution, proposed in the Component 2 Report on the PNDL prioritization criteria, would be for the MRDPA to endorse standard contract forms as part of the public procurement documentation in order to assure that qualified, professional bidders enter the competition. Good practices that refer not only to the pre-feasibility and feasibility stages, but also to the detailed technical design, include a clear stipulation of the designer's responsibility to deliver high-quality outputs, a complete timeline for every deliverable, including payment terms, and clear requirements that all property rights over the technical documentation belong to the beneficiary.

171. The cost-benefit analysis can become more useful – for demonstrating the feasibility of the proposed investments – with clear definition and role and by including a minimal, yet standardized methodology that does not require great efforts on the part of the applicants. Consequently, all projects would be analyzed by using the same unit of measurement, thus helping with the prioritization of the funding proposals. Drafting an economic analysis, albeit a minimal one can ensure the beneficiary that the FS can be submitted for financing from multiple sources. Most European funding programs require an economic analysis, irrespective of the project value.

172. Introducing a phase of technical and economic assessment of the documentation would ensure that technical non-conformities could be corrected at minimum cost. Thus, it can be determined whether solutions adopted meet standards in force and can be implemented without additional costs.



173. **It is also recommended to consider introducing a standardized financial model to facilitate the Beneficiary's work and to prevent errors at the same time.** Errors were found in the calculation of the General Estimate: failing to comply with the unit costs and maximum limits for certain types of expenses laid down in the cost standards – GD no. 363/2010, as subsequently adjusted (e.g., the program's estimated contribution and the beneficiary's own contribution were inaccurate).

174. **New infrastructure projects may require Environment Impact Assessments.** These assessments may include hydrology studies, nature studies, etc., depending on the project. Therefore, it is possible that a given site will be inappropriate and that another site is needed. Results of the study are to be made public through a public hearing where objections to the project may be heard. Depending on the location, it is possible that significant objections will be raised by NGOs, the public in general, and/or the press. If so, the project may need to be modified and the public educated on the details of the new project.

175. **Feasibility studies for major projects should be reviewed and analyzed by experts in order to enhance their quality.** This process can be done in the following sequence:

- Asking the award winning consultant who is preparing the feasibility study to submit a draft of the study to the beneficiary before submitting the final feasibility study report for approval.
- After getting the draft study, the beneficiary needs to ask experts in this area to review the document. Peer reviewers can be selected from local and/or international consultant offices, economic experts, and academic people. They can be inside resources (e.g., City Hall staff) or outside consultants.
- Peer reviewers are required to answer the primary question: Is the study appropriately prepared? They would submit a report that includes: (a) a critical review of the draft feasibility study; (b) identification of major deficiencies and/or areas of weakness in the draft, if any; and (c) specific recommendations to improve the study.
- The award-winning consultant should include this review as an appendix in the final submitted study, and should respond and address all comments in these reviews to the satisfaction of the owner of the project.



4 Well-designed Infrastructure

4.1 The Romanian system for quality in construction

176. **The Romanian system for quality in construction is centered on Law no. 10/1995, which aims to promote the development of sustainable infrastructure works.** Primary categories covered by this law are correlated with EU Regulation no. 305/2011 of the European Parliament and of the Council from March 9, 2011, and are related to: structural engineering and stability; safety in use; fire safety measures; hygiene, health, and environmental protection; insulations and energy efficiency; and noise protection. Fulfilling the required norms under each category is the responsibility of “all stakeholders involved in the design, build, use, and reuse of constructions,” which include investors, researchers, designers, project verifiers, producers and distributors of construction materials, contractors, owners, users, technical experts, public authorities, and professional associations.¹¹ Law 10 also defines the system of quality in construction to include the following:

- a. Technical regulations for constructions;
- b. Quality of products used;
- c. Technical specifications for new products and procedures;
- d. Verification of projects, implementation of works, and ratings of buildings and constructions;
- e. Key parties responsible for ensuring quality of constructions;
- f. Laboratories for related construction tests and assessments;
- g. Measurements;
- h. Formal approval and reception of works;
- i. Evolution of constructions during use and interventions required over time;
- j. Ex-post use of buildings/materials (e.g., upon demolition);
- k. Public monitoring and control of quality in constructions.¹²

177. **Technical regulations are established by norms and procedures and address the design, calculation and composition, execution, and operation of the construction.** Minimum quality standards are established through technical regulations and are required for construction, and products and procedures used in construction. Certification of quality products used in construction is performed by manufacturers in accordance with the methodology and procedures established by the law. Technical approvals for products, processes and new equipment in construction determines, in accordance with the legislation, their suitability for use, conditions of manufacture, transportation, storage, and maintenance of their work.

178. **State quality control in construction is exercised by the State Construction Inspectorate (ISC), subordinated to the MRDPA.** The ISC is responsible for the state’s control of the unitary application of legal provisions in the field of construction quality.

¹¹ Art. 6 in Law 10/1995

¹² Art. 9 in Law 10/1995



179. **Quality technical verifications are mandatory to ensure optimum detailed design.** Specialists certified as technical verifiers must carry out technical quality verification; they must be civil engineers with a minimum of 8 years design experience, certified by the MRDPA's professional examination. Technical verifiers must be different and independent of the design specialists who elaborated the projects. In practice, however, this principle is not always followed, which creates a conflict of interest and aggravates the risk of failing to correct potential errors during the design verification phase.

180. **The quality of the construction execution is mandatory and carried out by investors through specialized site supervisors.** Site inspectors are civil engineers (the site inspectors certification procedure approved by Order no. 1496/13.05.2011 of the Ministry of Regional Development and Tourism and MRDT Order no. 277/19.03.2012 approving and supplementing the Site Inspectors Certification Procedure, as approved by Order no. 1496/13.05.2011 of the Ministry of Regional Development and Tourism) with a minimum of 3 years of experience, certified by professional examination by the ISC.

181. **For rehabilitation/modernization of existing constructions, technical expertise may be needed and for buildings an energy efficiency audit is also required.** This is a complex activity that includes, where appropriate, research, experiments or tests, studies, surveys, analyzes and assessments necessary to understand the technical condition of existing constructions or how a project meets the requirements of law, in order to fundament the intervention measures. Only certified technical experts can carry out technical expertise of the constructions or technical projects.

182. **The evaluation of the environmental impact is done according to Order 860/2002, respecting Law no. 137/1995.** Based on this, an approval needs to be given for any type of rehabilitation or construction that might have a negative impact on the environment.

183. **The owners, investors, and construction managers sign separate contracts for verification or technical review/control.** Construction companies that perform construction works ensure the level of quality corresponding to essential requirements, through their own staff and through certified supervisors responsible for execution and through their own quality control system.

184. **The authorization of laboratories for analysis and testing in construction activity represents a component of quality system established by Law no. 10/1995 regarding the quality in construction.** This way the technical competence of laboratories is officially recognized, in order for them to perform analyzes and specific tests for constructions, and their legal competence to issue valid documents to attest the quality of construction works.

185. **The final approval is a component of the quality system in construction.** It is the document through which the investor declares his acceptance regarding the construction and gives his approval to put it into use. By the act of "reception," it is certified that the contractor has fulfilled his obligations in accordance with the contract and execution



documentation. Acceptance of construction is performed both for new works and for interventions on existing construction (repairs, strengthening, changes, modernizations, extensions, etc.). The acceptance is made by the investor/owner, with the participation of involved parties (designer, constructor, site inspector and/or specialized representatives such as State Inspectorate in Constructions' inspector) and is performed in two steps:

- Acceptance at completion of the works;
- Final acceptance at the end of the defects liability / warranty period.

4.2 Analysis of current technical standards used for infrastructure projects in Romania, and their conformity with UE standards

186. **Engineers must follow the regulations and standards in force for any type of construction design related to roads, water and wastewater infrastructure, or social buildings.** According to Government Ordinance (GO) No. 39/1998 and Law no. 355/2002, the statute of standards is voluntary, unlike regulations and norms, which are mandatory.

187. **Based on the current standards and norms, the Technical Specifications (TS) are elaborated.** They represent the technical documentation that explains every step of the technological process for the realization of construction elements: resistance elements, enveloping elements, partition elements, and finishing elements. TS content is not regulated at the national level, each design company using its own more or less complete TS. Contractors then usually fail to consider the TS submitted by the designers, as they have their own execution solutions based on current practice that does not always rely on performance criteria.

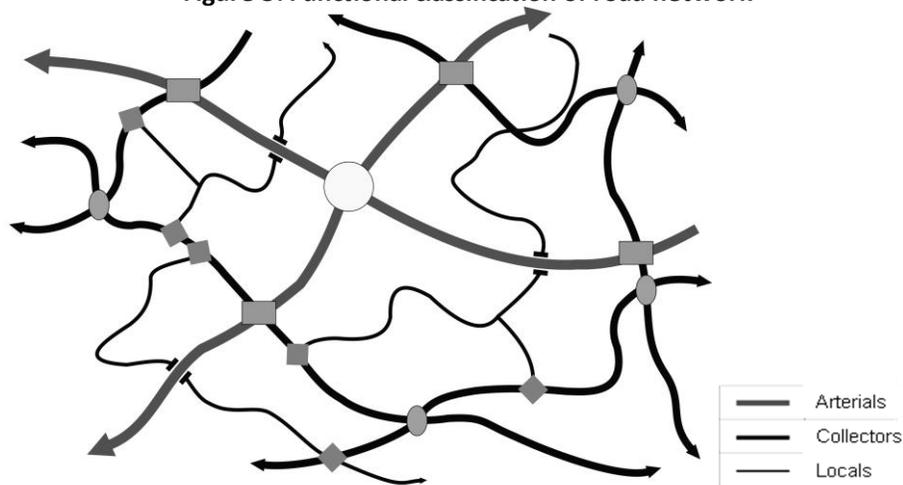
188. **Unlike other developed countries, Romania is still using technical standards that are 10-20 years old or even older.** The alignment process of Romanian standards to European ones is currently being implemented, but unfortunately, it takes time and the harmonization is done gradually. Thus, peculiar situations appear when conflictual standards coexist, or for a specific test/material, the old standard was canceled, without adopting a new one. This way, the design of Romanian roads cannot be at the same level with the roads designed in developed countries, where the standards are renewed once every 2-3 years.

4.2.1 Road sector specificities

189. **Romania's road network requires major investments.** As of June 2016, the country continues to lack a highway connecting Constanța in the East to the western border, where over 70% of Romania's exports go to. In the aggregate, in 2012, 34,000 km of county and communal roads were made of dirt or gravel and required modernization, at a cost of around EUR 8.1 billion. An additional 21,000 km of county and communal roads only had surface treatment and required rehabilitation. The Component 2 report on improved prioritization criteria for the National Local Development Program (PNDL), as well as the Component 1 report on coordination of strategies and investment programs look at regional specificities in terms of investment needs for the roads sector. The current



Figure 5. Functional classification of road network



Source: AND 600-2010¹³

192. **More complex and detailed classification systems are often used for design and funding purposes.** An example of a more detailed classification is shown below. The names of road classes used by such systems are often descriptive and specific to the countries concerned so the one provided below should be treated as an example only.

- Arterials:
 - Principal arterials (motorways and expressways)
 - Minor arterials
- Collectors:
 - Major collectors
 - Minor collectors
- Locals:
 - Public local roads
 - Private local roads

193. **Functional classification is important because it determines the range of the design speed for road sections, which in turn governs the geometric standards, pavement, and maintenance standards.** The table below shows the typical key characteristics of the three basic functional classes of roads.

¹³ AND 605, Norm for the design of junctions on public roads, 2010



Table 1. Main characteristics of the functional class system

Characteristic	Classification		
	Arterial	Collector	Local
Mobility – access ratio	Mobility takes priority	Mobility & access are equally important	Access preferred over mobility
Road purpose	Connect country administrative, industrial and cultural centers and neighboring countries	Connect county administrative and industrial locations between each other or such locations with arterial network	Connect county administrative centers to the county villages or with collector or arterial roads
Access control	Partial	Partial or limited	Limited
Flow characteristics	Uninterrupted except signalized intersection	Interrupted flow	Interrupted flow
Design speed range	80-120	70-100	40-80
Typical cross section	Multi-lane divided or 2 lanes	Usually 2 lanes	Two-lane, sometimes one lane
Typical AADT volume	>6,000	1000-6000	<1000

Source: World Bank – Component 2

194. **Romanian roads are classified technically and administratively, but not functionally.** The technical classification is supplemented by comments on the function of the road. Technical classes are, therefore, a mixture of functional and administrative classification. For example, the E-roads can be motorways (Class I), expressways (Class II), or two-lane highways (Class III). The national roads, County roads, and Communal roads are assigned functional characteristics. General observations indicate that some County roads may need to be classified as Arterial roads, while some National roads as Collector roads. It is therefore suggested to consider undertaking a thorough functional (re)classification study to improve classification and introduce a functional dimension. An improved classification system could then better guide the design parameters of roads and assure a higher level of homogeneity for the road system.

195. **The classification of the Road Network in Romania is typical for many Central and Eastern European Countries.** It is defined in the Government Ordinance No. 43/1997 from 28.08.1997 referring at Roads Domain, updated at in July 2011. In terms of location and public access, roads in Romania are divided into:

- **Public roads:** public interest roads for road and pedestrian circulation, in order to meet the general requirements of the transport economy, population, and national defense. These are public property and are maintained by public funds, as well as legally.
- **Private utility roads:** roads designed to meet the needs of road transport and pedestrians as well as economic objectives, forestry, petroleum, mining, agricultural, energy, industrial and other uses, access to premises, and those



inside them, and for organizing construction sites. These are managed by individuals or legal entities that own or manage.

196. **Based on traffic, roads are divided into:**

- roads open to public traffic, including all public roads and those roads used for private utility that provides usually non-discriminatory access for vehicles and pedestrians;
- roads closed to public traffic, including those roads for private utility serving the objectives to which the public has no access, and those public interest roads temporarily closed to public traffic.

197. **From an administrative-territorial perspective, public roads are further divided into the following categories:**

- national roads;
- county roads;
- local roads.

198. **National roads are public state property and include highways (e.g., A1, A2, etc.) and national roads (DNs) that provide connections to the capital of the country, between county capitals, other locations of national interest, and with neighboring countries.** They are classified as:

- motorways;
- express roads;
- European national roads (E);
- main national roads;
- secondary national roads.

199. **County roads (DJ) are public county property and include county roads, providing links between:**

- county capitals and municipalities, with towns, with the residences of the commune authorities, with tourist resorts and other attractive locations, with ports and airports, with the locations related to national defense or the ones of historical importance;
- towns and municipalities, and between them and commune residences;
- commune residences.

200. **Roads of local interest are public property attributed to administrative units, and can be classified as:**

- communal roads (DC) that provide connections:
 - between commune residence and component villages or with other villages;



- between town and villages to which it belongs as well as with other villages;
- between villages;
- vicinal roads (DV) - roads serving several properties that lie at distant limits;
- streets (DS) - public roads within the settlements, regardless of name: street, avenue, road, keys, embankment, roadside, alley, dead end, etc.

201. **For the design of any type of road mentioned above, there are technical standards involved, which need to be followed.** There is a general standard for roads (STAS 863), one for streets (STAS 10144), and a norm elaborated for extra urban highways (PD 162).

202. **With respect to the technical documentation for the design, construction, and maintenance of roads, some of the national standards have been harmonized with European ones and transformed in Romanian Standard (SR EN) documents (in the last 10 years).** For example, in January 2015, the Romanian Company for Motorways and National Roads (CNADNR) issued an internal normative 605/2015 regulating the conditions for roads construction, replacing STAS 7970 (Road works. Base layers of hot laid rolled bituminous mixtures. Quality technical requirements and general prescriptions for execution) and SR 174 (Road works. Hot bituminous rolled pavements).

203. **Unfortunately, the harmonization of Romanian standards with European has remained incomplete.** Thus, road engineering is still facing difficulties in working with standards that are 20-30 years old, or even older. A list with the main Romanian standards currently in force is included in the table below:



Table 2. Synthesis of Romanian standards related to road engineering

Standard indicative	Standard name	Year of application
STAS 863	Road works. Geometric elements of paths. Design prescriptions	1985
STAS 2900	Road works. Width of roads	1989
STAS 10144/1	Streets. Cross sections. Design specifications	1990
STAS 10144/2	Streets. Sidewalks, footways and bicycle tracts. Design specifications	1991
STAS 10144/3	Geometric elements of streets. Design specifications	1991
SR 10144/4	Development of intersections. Classification and design specifications	1995
STAS 10144/5	Streets traffic capacity calculus	1989
STAS 10144/6	Streets crossing traffic capacity calculus	1989
STAS 2914	Road works. Earthworks. General requirements for quality	1984
STAS 1598-1	Road works. Pavement framing for new civil engineering and road modernizing	1989
STAS 183-1	Road works. Cement concrete pavements in fixed concrete forming. Technical quality requirements	1995
STAS 6400	Road works. Road bases and sub- bases. Technical general requirements for quality	1984
STAS 10796/1	Road works. Annexed constructions for water collection and evacuation. General requirements for design	1977
STAS 10796/2	Road works. Annexed constructions for water collection and evacuation- street-gutters, ditches and side-ditches. Design and execution rules	1979
STAS 10796/3	Road works. Constructions for water collection. Drainage trenches. Design and laying- out specifications	1988
STAS 12253	Road works. Capping layers. General technical requirements for quality	1984
STAS 1242/2	Foundation ground. Geotechnical, geological and technical studies and investigations specific to the railways roads and high way layouts	1983
STAS 4032/2	Road traffic engineering. Terminology	1992
SR 1848-1	Road signalization. Road traffic signs and signalization tools Part 1: Classification, symbols and locations	2011
SR 1848-2	Road signalization. Road traffic signs and signalization tools Part 2: Technical requirements	2011
SR 1848-4	Safety of traffic. Traffic lights. Emplacement and performance	1995
STAS 1848/5	Road signs and signals. Traffic control light signals. Technical requirements for quality	1982



204. **Most of the standards used for materials and laboratory tests have been harmonized with European norms.** A good example is the series SR EN 1097 - Tests for mechanical and physical properties of aggregates, which consists of eleven parts, presenting different laboratory testing conditions for aggregates used in road construction.

205. **There are also a series of norms and regulations elaborated directly by the Transport Ministry.** They add to the technical standards presented above and complete them, having a mandatory status.

Table 3. Synthesis of Romanian norms and regulations related to road engineering

Indicative	Name	Year of application
PD 177	Normative for flexible and semi-rigid pavement dimensioning (analytical method)	2001
Ord. MT No. 50	Technical norms for the design and construction of streets in rural localities	1998
Ord. MT No. 45	Technical norms for the design, construction and modernization of roads	1998
Ord. MT No. 46	Technical norms for establishing the technical class of public roads	1998
AND 504	Norm for reviewing of public roads	2007
AND 557	Instructions regarding traffic recordings on public roads	2015
CD 155	Norm for determining the technical state of modern roads	2001
PD 162	Departmental norm on extra urban highways design	2002
DD 506	Norm for organizing and execution of traffic investigation, origin – destination. Preparation of investigation data for processing	2015
AND 554	Norm on maintenance and rehabilitation of public roads	2002
AND 603	Guide on lighting conditions on national roads and highways	2012
AND 602	Road traffic investigation methods	2012
AND 605	Warm mix asphalt. Technical conditions regarding design, preparation and implementation	

206. **The Romanian pavement design code is similar to the ones used in the European countries.** The most important distinction is between the evaluation and design of new and existing pavements, where modern practice has evolved to targeted, condition-specific interventions and explicit consideration of design life, while the Romanian system does not include such concepts. The discussion below focuses on the *existing* pavements and their rehabilitation and does not apply to new pavements.

207. **The actual stage of road design should include phases related to the elaboration of the traffic study, Environmental Impact Study, Road Safety Audit, Road Safety Inspection, topographic studies, geotechnical studies, geometric design, pavement design, drainage design, and art works design.** Noise protection of urban areas, in the



vicinity of the roads where noise arising from vehicles exceeds certain thresholds, is less documented.

208. **The Geotechnical study shall be drafted in accordance with the Standard on geotechnical documents for constructions (Index NP 074-2014).** A project auditor certified for the "A^F" quality standard in constructions must verify it: "Strength and stability of foundation grounds and ground massifs".

209. **According to Order no. 700 / 09 July 2014 of the General Manager of the National Agency for Cadaster and Land Registration (ANCPI) approving the Rules for the approval, acceptance and registration in the Cadaster and Land Registry records,** the topographical plans related to the feasibility studies must be accepted / approved by the Office of Cadaster and Land Registration.

210. **Road Safety Audits (RSAs) and Road Safety Inspections (RSIs) are mandatory for all types of roads, starting from January 1, 2015.** According to the law currently in force (Law no. 265/2008) in Romania, every road project needs to be verified for all its stages (feasibility study, detailed technical project, after construction) by accredited road safety auditors, in order for it to comply with predefined checklists. Road safety auditors or inspectors must be different and independent of the design specialists who elaborated the projects.

211. **Even though stipulated by current legislation, RSAs and RSIs are still not implemented on all road projects as it is stipulated by Directive 2008/96/EC of the European Parliament and of the Council.** This happens due to multiple reasons: lack of trained professionals (auditors/inspectors) – only 12 in the entire country; lack of clear regulations regarding the main authority that is supposed to supervise the audits/inspections; and also the very high prices established by the Romanian Road Authority (ARR) (e.g., EUR 50,000 per km for new highways, EUR 15,000 per km for national road rehabilitations, etc.).¹⁴ Currently, instead of being independent, auditors are contracted by the designer/constructor, even though this is against the law. Thus, present road projects still lack road safety.

212. **The main problem of the current road infrastructure in Romania is its focus on vehicles.** Usually when funds are allocated for infrastructure, they are all directed to roads, without taking into consideration the other road users, such as pedestrians and cyclists. It can be noticed that the standards for sidewalks, footways, and bicycle lanes are more than 20 years old, and from a technical point of view they do not correspond to the current traffic needs and are not harmonized with European strategies.

213. **Infrastructure safety is the first aspect typically compromised when a road project is started in Romania.** Due to the shortage of financial funds, beneficiaries and project managers tend to cut technical solutions that are related to the safety of road users, starting with road signs and markings. The principle used is to build or rehabilitate as many kilometers as possible, most of the time without considering their safety.

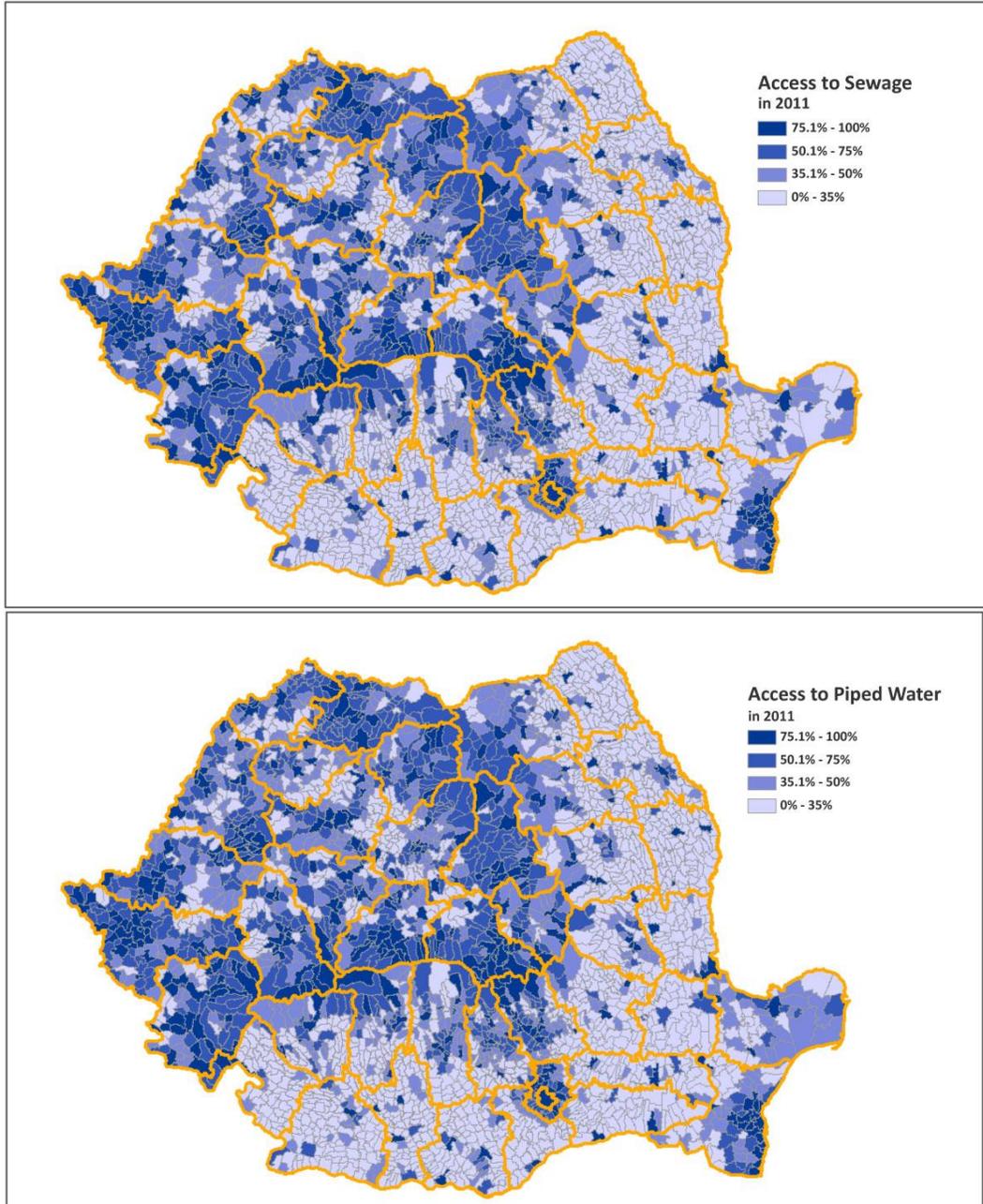
¹⁴ Annex 2 of Transport and Infrastructure Ministry Order no. 480/2011



4.2.2 Water and wastewater specificities

214. Romania still has one of the least developed water and wastewater infrastructure systems in Europe. As pointed out in the Component 2 report on “Improved Prioritization Criteria for PNDL Projects,” data from the National Institute of Statistics show that some regions are especially deficient in this respect – namely, the East and South of the country, which also include some of the poorest counties in Romania.

Figure 6. Access to sewage (up) and water (down) services



Data Source: National Institute of Statistics (2011)



This also implies that people have limited resources to dedicate to paying for water and wastewater services that had not previously used or paid for (i.e., particularly in poor rural areas, the average willingness to pay for drinking water and sanitation services is very low). Similarly, the resources of subnational governments in these regions to subsidize costs are low or often nonexistent. It follows that the choice of designs and technologies is vital with respect to minimizing post-implementation costs such that consumers can actually afford to connect to the newly offered services and generate sufficient revenues to cover operations and maintenance (O&M) expenses.

215. The main principles of water management in Romania, which represent the basis of the present regulations, in line with the EU framework, are the following:

- water is a finite and vulnerable resource;
- water management is organized at the river basin level;
- integrate management for quality and quantity;
- river basin solidarity (hydrosolidarity);
- polluter pays;
- user pays.

216. The water and wastewater sector is governed by a set of laws. The Ministry of Regional Development and Public Administration has published a list of Romanian standards in construction developed as a national version of European standards (SR-EN), which contains 1377 regulations of which 44 refer to water and wastewater infrastructure.

217. Generally, the Romanian law is compatible with EU directives. Nevertheless, legislative dysfunctions are related to the fact that Romanian Law 10/95 does not address the efficacy of a treatment process such as the treatment of water, wastewater, and sludge. It only covers the quality of the components used for construction of WWTP installations.

218. The most important European standards in the field of water and wastewater are the following:

- The Council Directive 91/271/EEC concerning urban wastewater treatment concerning the protection of the environment from the adverse effects of urban wastewater discharges and discharges from certain industrial sectors, but also the collection, treatment, and discharge of domestic wastewater, mixture of wastewater, and wastewater from certain industrial sectors.
- The Drinking Water Directive (Council Directive 98/83/EC of November 3, 1998 on the quality of water intended for human consumption) concerning the quality of water intended for human consumption.
- The Water Framework Directive 2000/60/EC concerning water resources management, which aims to protect and restore aquatic ecosystems, and to guarantee long-term, sustainable water usage for individuals, businesses, and the natural world.
- Directive 91/676/EEC concerning the protection of waters against pollution caused by nitrates from agricultural sources.



- Directive 76/464/EEC and “daughters” directives on pollution caused by certain dangerous substances discharged into the aquatic environment of the Community.
- Directive 2006/7/EC of the European Parliament and of the Council of 15 February 2006 concerning the management of bathing water quality and repealing Directive 76/160/EEC.

219. **Unfortunately, just like the case of road engineering, there are also standards in force that are 20-30 years old or even older.** Some of them can be found in the table below:

Table 4. Synthesis of Romanian standards related to water and wastewater engineering

Standard indicative	Standard name	Year of application
SR 8591	Buried urban pipes. Requirements for layout	1991
STAS 9312	Underpasses for railways and highways with pipelines. Design specifications	1987
STAS 7656	Line- welded steel tubes for installations	1990
STAS 2448	Sewerages. Manholes. Design rules	1982
STAS 3051	Sewerage systems. Channels of external sewerage networks. Basic design rules	1991
SR EN 124	Gully tops and manhole tops for vehicular and pedestrian areas. Designs requirements, type testing, marking, quality control	1996
STAS 1478	Sanitary installations. After supply for civil and industrial buildings. Main design specifications	1990
SR 4163	Water supplies. Distribution networks. Design specification	1995
STAS 4165	Water supplies. Reinforced and prestressed concrete tanks. General specifications	1988
STAS 9470	Hydrotechnics. Maximum rainfall. Intensities, durations, frequencies	1973
STAS 12594	Sewerages. Injection stations. General rules for designing	1987

220. **In Romania, water must be treated to the standards set down in the drinking water directive, as modified by Romanian Law no. 458/08.07.2002.** The old technical solution (before 1950) involves only mechanical treatment and chlorination before distribution. After 1970, the water treatment is improved by manganese and ferric removal. The new technical solutions applied after 1990 involve the ozonization of the water, which insures better quality and better hygiene control. The chlorination is not made any more with lime but with gaseous chlorine that can be better controlled.

221. **Water suppliers use a variety of treatment processes to remove contaminants from drinking water.** These individual processes may be arranged in a “treatment train/chain” (a series of processes applied in sequence). The most commonly used processes include flocculation and sedimentation, filtration and disinfection for surface water. Some treatment trains also include ion exchange and absorption to cope with



problems with residual tastes and odors or to deal with trace quantities of pesticides. Treatment trains used for underground water are different from treatment trains used for surface water and include ferric and manganese removal using active coal. Water utilities select a combination of treatment processes most appropriate to treat the contaminants found in the raw water used by the system.

222. Existing, older water distribution networks are frequently inefficient and wasteful of water. They have grown to serve expanding towns and frequently the core part of a network is under-sized. Pipes and their joints may be worn out. Various techniques allow identification of the water losses using water meters, acoustic devices, electromagnetic and chemical detection.

223. In Romania, wastewater treatment technical solutions have evolved considerably. The old technical solution (before 1960) of construction of wastewater treatment plant involved only mechanical treatment, which eliminated only solid materials, floating materials and sand. Starting with 1980 the technical solution was based on mechanical and biological treatment of wastewater. This technical solution involved, however, very high power consumption and did not resolve the issue of sludge disposal. The equipment used was of very poor quality in terms of power consumption and reliability. After 1990, the new technologies were applied. Nowadays, the technical solution is mechanical, biological nutrient removal tertiary stage. This solution uses less power and reduces the quantity of sludge. The equipment is reliable and cost efficient and the sludge could be used in agriculture, power generation, cement, and construction industries. Acquisition of incineration industrial equipment has started. It is intended to use big units at county level in order to minimize costs for energy and chemicals.

224. In the water and wastewater sector, the main power consumption sources are the pumping stations. They have the technological function of carrying water between system components and from these components through the distribution network, ensuring service pressures required by end consumers. First stage of power consumption reduction was achieved in Romania in 1990 by replacing the existing water supply pumps with efficiency of 60 – 70% with new pumps with efficiency of 80 – 90%. At this moment all water supply pumps have been replaced, which has led to a power consumption reduction of approximately 20%. The second stage of reduction of power consumption was achieved in 2000 by replacing the existing wastewater pumps with efficiency of 20 – 30% with new pumps with efficiency of 50 – 60%. At this moment nearly 70% of wastewater pumps have been replaced, which translates into a power consumption reduction of approximately 30%. The actual state of the art for lowering the power consumption and improving the pumping system is the introduction, starting with 2010, of the solid separation pumping system for waste water, which induces a pumping efficiency of around 70%.

4.2.3 Social infrastructure specificities

225. Social infrastructure buildings are included in the civil buildings legislation and are covered by the general approach of Eurocodes. A series of European standards (EN



1990 - EN 1999) provide a mandatory and common approach for the design of buildings, civil engineering works, and construction projects. They are intended to:

- Prove the compliance of building and civil engineering works with the basic requirements of the Construction Products Regulations;
- Determine the performance of structural components, and parts / assemblies;
- Define the technical specifications in public contracts according to the Public Procurement Directive;
- Set the parameters of best practices.

226. **For the design and construction of buildings and civil engineering works, the EN Eurocodes are intended to be used in conjunction with standards for materials, products, and test standards.** The set of standards covers all aspects of construction, namely design rules, the properties of materials, the execution of structures and special works, specifications for construction products, as well as quality control.

227. **The main aim is to ensure a more extensive use of European standardization in policy and legislation and to improve the efficiency, coherence, and visibility of European standardization.** In terms of design in the construction field, main European regulations are the Eurocodes with subsequent additions:

EUROCODE 1	Calculation of actions on structures
EUROCODE 2	Calculation of concrete structures
EUROCODE 3	Calculation of steel structures
EUROCODE 4	Calculation of composite structures steel-concrete
EUROCODE 5	Calculation of wood structures
EUROCODE 6	Calculation of masonry structures
EUROCODE 7	Geotechnical calculation
EUROCODE 8	Provisions for calculating the resistance of structures to seismic action
EUROCODE 9	Calculation of aluminum structures

228. **In Romania, technical regulations in construction are treated in a uniform manner in the MRDPA under the supervision of the General Technical Directorate.** Specialized technical committees were set up, which, according to Law no. 10/1995 regarding quality in construction and related regulations, have to meet three requirements:

- development of technical regulations for components of construction quality system;
- technical approval for products, processes and equipment;
- certification of conformity of quality for products used in construction.

229. **To ensure quality parameters in order to fulfill all these performance requirements, there were provided standards or codes, regulations, methodologies, manuals, etc.** Romanian Standards (SR) and Romanian codes (CR) are technical documents with general character and rigorously studied. Their application is mandatory for all the buildings. Design regulations (NP), guidelines, methodologies, manuals include additional explanations, practical methods and models that support the effective implementation of the standards.



230. **The technical regulations in Romania aim the design, execution, reception, and operation of constructions and related equipment.** In November 1997, the Ministry of Public Works and Regional Planning launched the program of Romanian Codes - CR for "technical regulations for civil and industrial engineering structures for the period 1997-2000 and harmonization with the European Union technical regulations ". CR program elements have been defined in accordance with Eurocodes 1-9, in the attempt to become National Application Documents (DAN), i.e., to fully take the content of ENV Eurocodes into Romanian version. Special features and appropriate adaptation for the situation in our country were supposed to be found in the National Annex NA.

231. **Nevertheless, this program has suffered numerous interruptions and did not correlate fully with the Eurocode.** However, the technical prescriptions issued after year 2000 integrate in their content related provisions of the Eurocodes. Recently, the Ministry of Regional Development and Public Administration published (September 2014) a list of Romanian standards in the field of construction, developed as a national version of European standards (SR-EN), which contains 1377 regulations.

232. **According to the law in force, Romanian engineers have to take into consideration and calculate the Energy Performance of buildings.** The Law no. 372/2005, which is the main normative act in the field of energy performance of buildings, entered into force in January 1, 2007. Currently it is subject to a legislative proposal modification in order to comply with the new provisions of the Energy Performance of Buildings Directive.

233. **The main requirements for the energy efficiency of buildings introduced by this law were the following:**

- Starting with January 1, 2007 all new buildings and public buildings need to be evaluated and have an energy performance certificate;
- The same provision is applicable for all types of buildings (existing construction) starting with January 1, 2011;
- New buildings with a surface of more than 1000sqm need to analyze the possibility of using alternative sources of energy; the analysis should consist in a feasibility study that is required by the local public authority;
- The existing buildings with surfaces larger than 1000sqm that are undergoing renovation processes should seek to improve the energy efficiency of the building, wherever it is possible, from technical, economic and functional point of view;
- The public buildings with a surface larger than 1000sqm should publicly display the energy performance certificate.

234. **Design regulations apply for schools and kindergartens.** Schools and high schools are designed according to "Regulations regarding design, construction and operation of buildings for schools and high-schools" - NP 010 – 1997. Kindergartens are designed according to Regulation NP011-97. According to the kindergartens standard the recommended number of stores for kindergartens with 6-10 groups is one ground and one floor. For 1-5 groups the number of stores is ground floor. For schools with more than 8 classrooms the recommended number of stores is ground floor and 2 floors. For schools with less than 8 classrooms the recommended number of stores is ground floor or ground



floor and one floor. Buildings for schools and kindergartens designed and built with supporting walls of brick, stone, reinforced concrete panels with concrete or steel structure and concrete slabs have 100 years' service lifetime. Nurseries are regulated by the "Regulations regarding design of nurseries and special nurseries" - NP 022-1997.

235. **Design regulations also apply to health facilities.** Hospitals, dispensaries, and other health facilities are designed according to general Romanian codes for building design. They are accompanied by specific regulations, depending on their functional particularities: "Regulations for design and verifying of hospital buildings and their installations"- NP015-97, "Regulations for design of dispensaries and other health facilities" - NP 021-1997 and "Regulations for design of homes of elderly and disabled people"- NP 023-1997.

236. **Design regulations exist for cultural and administrative infrastructure as well.** Cultural objectives of local interest such as libraries, museums, and cultural multi-functional centers are designed in terms of requirements for strength, stability and durability under Romanian general design codes for buildings, accompanied by specific regulations depending on the functionality of these buildings: "Regulations for cultural networks - "P 25-1985, "Regulations for design of cultural community centers" - P 87-1986 and "Regulations for design of public audition rooms" - NP 002/0-1996.

237. **The social infrastructure design for small communities does not have a proper technical base.** Regulations related to education, health, cultural, and administrative infrastructure mentioned above have taken into account the socio- economic conditions of the centralized state, corresponding to the '80s-90s. Nevertheless, decentralization is imposing technical solutions for inter-connecting, multi-functional facilities, adapted for small communities. These issues require technical and functional review of the technical regulations mentioned above.

238. **Earthquake engineering is the scientific field concerned with protecting society, the natural and the man-made environment from earthquakes, by limiting the seismic risk to socio-economically acceptable levels.** Traditionally, it has been defined as the study of the behavior of structures and geo-structures subject to seismic loading, this considered as a subset of both structural and geotechnical engineering. However, the tremendous costs experienced in recent earthquakes have led to an expansion of its scope to encompass disciplines from the wider field of civil engineering and from the social sciences, especially sociology, political science, economics and finance. The main objectives of earthquake engineering are to:

- Foresee the potential consequences of strong earthquakes on urban areas and civil infrastructure;
- Design, construct, and maintain structures to perform at earthquake exposure up to the expectations and in compliance with building codes.

239. **All the social infrastructure types of buildings in Romania are exposed to the risk of earthquakes.** In terms of designing new buildings in Romania, the reference standard is P 100-1-2013 vol. I code - the seismic design of new structures, as result of a long history of earthquakes registrations and research.



240. **Before the 1940 earthquake, in Romania most buildings were built taking into account only the gravitational loads.** The earthquake of 1940 was the first major earthquake affecting the structures of tall buildings constructed after 1920 in Bucharest. Consequently, in 1941 the authorities adopted the first Romanian standard aiming to secure the buildings to seismic action, following German and Italian experience. In 1963 and 1970 new versions were developed, based on the American experience (Californian earthquakes). The earthquake of 1977 was the first major earthquake registered by technical instruments (seismographs) in Romania. Based on these registrations, first version of Regulation P100 was adopted in 1978 and improved in 1981, as technical documentation that describes the particularities of Romanian earthquakes and provides calculation methodology for securing the buildings at seismic action. Two other important earthquakes have shaken Romania in 1986 and 1990 and have improved the statistical approach taken into consideration for the future three editions of this regulation. Starting with P100-1/2004 the correlation with the European practice (Eurocode 8) was applied.

Table 5. Synthesis of Romanian regulations and standards related to earthquake protection

Date of the earthquake	Romanian regulations and standards	Year of application
November 10, 1940		
	First Romanian standard related to secure the buildings to seismic action.	1941
	P13-63	1963
	P13-70	1970
March 4, 1977		
	P100-78	1978
	P100-81	1981
August 30, 1986		
May 30, 1990		
	P100-92	1992
	P100-1/2004 based on the format of EC8 (SR EN 1998-1:2004)bb b	2006
	P100-3/2005 for existing buildings expertise	2008
	P100-1/2013	2014

241. **P100/2013 is accompanied by other important regulations:**

- CR 0-2012 Basics of designing building structures (loads group);
- CR 1-1-3 - 2012 Evaluation of snow on construction;
- CR 1-1-4 - 2012 Evaluation of wind action on construction;
- and specific normative for structures made of masonry, wood, concrete or steel.

242. **A properly engineered structure does not necessarily have to be extremely strong or expensive.** It has to be properly designed to withstand the seismic effects while sustaining an acceptable level of damage, but without risk of collapse and remaining safe for users / occupiers.



4.3 Current state of research, development and innovation in Romania

243. **Innovation and research in construction are poorly developed by research institutions.** The main organizations involved in the research process are the following: the National Institute for Research in Constructions (INCERC) for civil buildings; the Institute for Research in Transportation (INCERTRANS); the Technical Roads Studies and Information Center (CESTRIN) for roads and bridges; and SC PROED SA, SC AQUAPROIECT SA, National Institute for Hydrology and Water Management (INHGA), Institute for Hydro-energetic Studies and Design (ISPH) for water supply, wastewater, hydrographic, hydro-technic and hydrologic works. In the field of design of civil buildings, the emphasis on research moved to universities. The relationship between research and implementation at the level of design / execution companies is not found in an organized framework at the level of professional associations or ministries (MRDPA, Ministry of Transport, and Ministry of Environment, Waters and Forestry).

244. **Laboratories of private construction companies apply programs of verification and testing under Romanian and European legislation, aiming to contribute to the harmonization of test methods.** Unfortunately, practical experience of laboratories fails to be disseminated due to interruption of exchange programs organized. The State Inspectorate in Constructions (ISC) organizes an annual symposium for exchange of experience, which involves the heads of laboratories and certified road inspectors. At the same time, it organizes a Road Specialists Congress that allows exchanges of ideas, views, and information in a professional network.

245. **Nowadays any new material proposed on the Romanian market (imported or invented) must be approved based on laboratory testing procedures.** Approvals procedures for companies that can issue quality certificates for materials and the low efficiency of the quality verification system have led to the proliferation on the market of materials with higher quality certificates than real parameters found. Due to low prices, this market of “acceptable” materials discourages producers who respect the quality provided in certificates in the production line. Some European countries are maintaining centralized quality checking for materials by national laboratories, e.g., France - Centre Scientifique et Technique du Batiment (CSTB). A similar structure existed in Romania, the National Research Institute in Constructions (INCERC), whose monopoly was abolished.

246. **The legislative harmonization process is delayed due to the low degree of absorption of new SR EN by design companies, due to lack of promotion/dissemination.** The Romanian Association for Standardization does not benefit from adequate funds in order to organize regular presentations of newly adopted harmonized regulations.

247. **Before 1990, the centralized state ensured a forced implementation of research and innovation in current practice.** After 25 years, the Romanian society failed to enable, in the free market, new links between the few R&I centers (institutes or universities) and the remaining companies operating on the construction market. Various professional associations, several congresses, national conferences, and workshops organized by the



Ministry or other State institutions did not have continuity in order to become home of constant promotion of new ideas between construction actors in Romania.

4.4 Analysis of best practice technical solutions proposed to improve cost effectiveness of infrastructure projects in Romania

Cross-sectoral aspects

4.4.1 Compliance monitoring

248. **Compliance monitoring is a fundamental activity within environmental protection and is one of the ways by which adherence to limits and laws can be assessed for regulatory purposes.** It may include a range of inspections and reporting activities undertaken to determine compliance with regulatory requirements. The achievement of best practice in compliance monitoring requires careful consideration of key stages:

- Reasons for monitoring;
- Responsibility for monitoring (by whom);
- How to set limits and parameters which can be monitored;
- Principles of practical monitoring;
- How to judge compliance;
- Response to compliance failings;
- Summary and communication of findings and conclusions.

249. **Formal requirements for compliance monitoring include:**

- Laws;
- Regulations;
- Permits;
- Directives;
- Prohibitions;
- General binding rules;
- Enforcement orders;
- Operator obligations and commitments;
- Monitoring and improvement programs.

4.4.2 Data and Document Management systems (DMS)

250. **A document management system (DMS) is a computerized method of storage, management hosting and distribution of project documentation.** It is an essential tool to store, track and distribute documentation and data to users groups who may be correlated or distantly located. It provides a component of enterprise content management relative to digital asset management, document imaging, workflow systems and records management.

251. **ISO has created a set of standards regarding technical documentation.** Typically, a DMS acts as a central database / depository for all project documentation, ranging from drawings, reports, emails, letters, etc. and ensures that all participants and stakeholders



have a full record of the project history but also always the latest status of information as well as the history to date. The document control facility ensures that all necessary actions are tracked relative to the appropriate time scales and warnings issued of potential delays. Access to sensitive and /or exclusive information may be restricted to designated users.

4.4.3 Energy efficient and environment friendly infrastructure

252. **Green infrastructure uses vegetation, soils, and natural processes to manage water and to create healthier environments.** It seeks to provide a better resolution and integration of man-made heavy polluting and high energy consumer environment, by building with nature. Green infrastructure can refer to rainwater harvesting, rain gardens, planter boxes, flood protection, green streets and alleys, permeable pavements, green roofs and others. This type of solutions can enhance or even replace a functionality that is traditionally provided by man-made structures.

Figure 7. Green infrastructure examples



Source: <http://thegirg.org>¹⁵

253. **A low energy infrastructure in a life cycle concerns the amounts of energy spent in its embodied energy, energy needed for operation and demolition.** The European Union is aiming for a 20% reduction in annual primary energy consumption by the year

¹⁵ Website of “The Green Infrastructure Research Group”, at the University of Melbourne

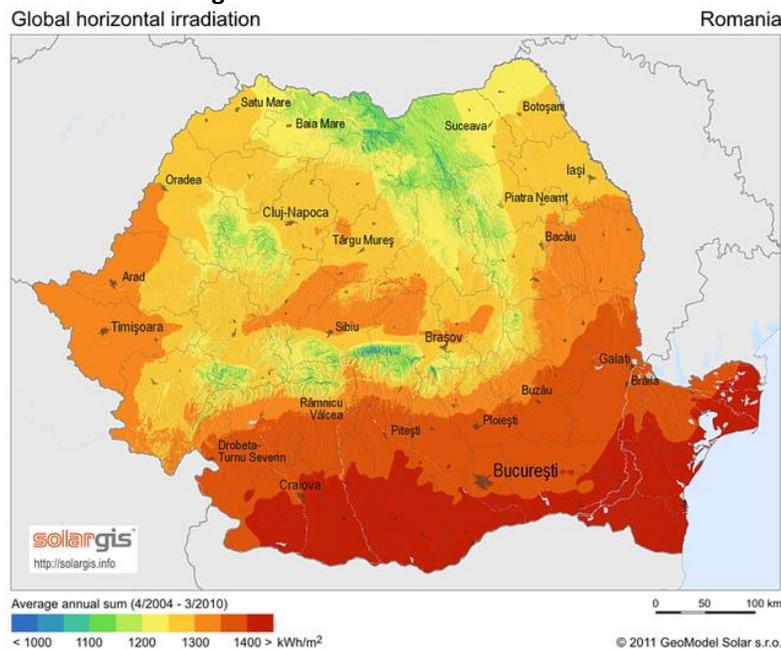


2020. The commission has proposed measures to increase efficiency in all stages in the energy chain – generation, transformation, distribution and consumption.

254. **Energy efficiency standards of infrastructure are not formalized.** At this moment, the Romanian legislation has targeted the energy efficiency based on the art. 4(1) of Directive 2006/32/EC of the European Parliament. This article stipulates that until 2017 Romania, like other EU countries, has to reduce the total energy consumption by at least 9% compared to 2008 values. In addition, article 1(3) of the Energy efficiency Law no. 121, published in august 2014, stipulates that by 2020 the national indicative target of reducing energy consumption is 19%. This has not yet been approved. For Romania, however, it is a challenge that must be taken up and delivered successfully in the future infrastructure and social housing projects planned for Romania.

255. **Romania has a good potential of solar radiation, which can be used in photovoltaic applications as an alternative energy source.** According to statistical data for Romania, annual solar radiation on a horizontal surface varies between 1500 kWh/sqm (in Dobrogea - South/East of Romania) and 1300 kWh/sqm (Transylvanian Plateau) so that autonomous photovoltaic systems may cover a large territory, especially in isolated areas with low demand for electricity.¹⁶ This type of photovoltaic applications can be applied in new technologies for roads, water, wastewater, and social infrastructure, such as facades or rooftops for buildings, solar powered road signs, traffic lights, power stations, rural electrification, solar lamps, water pumps, parking meters, and many others.

Figure 8. Solar radiation in Romania



Source: 2011 GeoModel Solar s.r.o.¹⁷

¹⁶ Romania National Report, Harghita Energy Management Public Service & UEM CARDT, Wide the SEE,

¹⁷ Solar Radiation Map: Global Horizontal Irradiation Map of Romania, SolarGIS 2011



4.4.4 Smart Infrastructure

256. **Information availability and exchange is a key characteristic of our society and it does not exclude infrastructure.** Modern infrastructures communicate with users, operators and between themselves. A smart infrastructure responds intelligently to changes in its environment, including user demands and other infrastructure, in order to achieve improved performance.

257. **Intelligent transportation systems (ITS) are advanced applications that aim to provide innovative services relating to different modes of transport and traffic management and enable various users to be better informed and make safer, more coordinated, and 'smarter' use of transport networks.** Although ITS may refer to all modes of transport, EU Directive 2010/40/EU (7 July 2010) defines ITS as a system in which information and communication technologies are applied in the field of road transport, including infrastructure, vehicles and users, and in traffic management and mobility management, as well as for interfaces with other modes of transport.

258. **A variable-message sign, often abbreviated VMS, CMS, or DMS, and in the UK known as a matrix sign, is an electronic traffic sign often used on roadways to give travelers information about special events.** Such signs warn of traffic congestion, accidents, incidents, roadwork zones, or speed limits on a specific highway segment. In urban areas, VMS are used for parking guidance and information systems to guide drivers to available car parking spaces. They may also ask vehicles to take alternative routes, limit travel speed, warn of duration and location of the incidents, or just inform of evolving traffic conditions.

Figure 9. Variable speed signs in Denmark



Source: Lene Herrstedt "Self explaining and forgiving roads – speed management in rural areas", Denmark

259. **While Romania already uses e-vignette, satellite-based tolling systems could also be considered.** Following the successful German experience, many countries have adopted or are considering adopting advanced tolling technologies which are distance-based and can be applied to specific categories of vehicles (only heavy trucks, all trucks, all vehicles) and to specific parts of the network (only motorways, motorways and national roads, etc.).



260. **Smart water systems are important in delivering more integrated and resilient water, wastewater and flood protection infrastructure in order to meet the current and emerging global sustainability and climate change challenges.** New strategies currently being implemented or considered around the world include smart closed-loop wastewater systems with energy recovery, both small and large scale (UK); water resource and flood information and management response systems (Netherlands, China); holistic catchment management integrated with water supply and wastewater management (US)¹⁸.

261. **Building automation is the automatic centralized control of a building's heating, ventilation and air conditioning, lighting and other systems through a Building Management System or Building Automation System (BAS).** The objectives of smart buildings are improved occupant comfort, efficient operation of building systems, and reduction in energy consumption and operating costs.

Roads

4.4.5 Comfortable and Safe Road Infrastructure

262. **The main purpose of road infrastructure is to satisfy the need for the safe, economic, and comfortable transport of people and goods.** To fulfill these requirements and services for the users, infrastructure must meet certain quality standards such as skid resistance, evenness, and noise emission. These properties must be created and maintained throughout the whole lifetime of a road.

263. **Safety aspects are gradually included in all phases of the infrastructure lifecycle, from worksite preparation to operation and maintenance.** Road safety is a key concern worldwide and Romania still falls behind the European road average on fatality and injury rates.

264. **The road safety audit has the greatest potential for improving safety and is most cost-effective when it is applied to a road or traffic design before the project is built.** It can be conducted on any design proposal that involves changes to the ways road users will interact, either with each other or with the physical road environment. It is a formal process using a defined procedure. To be effective it must be conducted by people who have appropriate experience and training, and who are independent.

265. **The road safety audit needs to be a routine practice, in the same way that independent structural checking or benchmarking has become a common practice.** Road safety audits are commonly used in the United Kingdom and Australia, and are coming into wider use in the United States.

4.4.6 Self-explaining roads

¹⁸ Smart Infrastructure: the future. The Royal Academy of Engineering. January 2012



266. **A self-explaining road can be defined as a road designed and constructed to elicit correct assessments from road users on appropriate driving behavior matched to the road environment, thereby reducing the likelihood of driver errors and enhancing driving comfort.** A self-explaining road environment can be facilitated by properly categorizing the road scene according to existing schemes, i.e., through a set of standardized “signals” in each road category, easily recognized and acted upon by road users. Drivers have to cope with increasingly complex traffic environments, including different types of road layout and all kinds of signposting, many of which are supported by telematics. In some cases, this may lead to an excessive workload imposed on the driver. This workload may include striving to read a VMS (variable message sign), while seeking the correct route in an unfamiliar environment (often in a foreign language and even with unfamiliar signs). It may also include attempts to detect the required, relevant piece of information from an abundance of information sources (including in-car navigation system, traffic management and information center or radio announcements, VMS signs, road signs, ADAS [advanced driver assistance systems] messages, etc.).¹⁹

Figure 10. Examples of self-explaining road design



Source: “The influence of road characteristics on road safety”²⁰

267. **The most important quality of a self-explaining road is its ability to communicate to the road users what behavior they should adopt in certain traffic conditions.** For example, it is imperious for a road environment to suggest a low speed for a driver in a resident area, with many vulnerable road users, by using traffic calming measures.

268. **Three practical examples of self-explaining road concepts for rural roads have been identified in Europe.** These concepts introduce different speed and traffic regulations for different road categories and provide similar solutions to prevent head-on collisions. Although similar layouts can be identified, there also are some differences due to design philosophies and local conditions. The distinguish ability is mostly achieved by conspicuous markings and considerable different cross-section dimensions.

¹⁹ Implementation scenarios and further research priorities regarding forgiving and self-explaining roads. IN-SAFETY EU Project. 2005.

²⁰ Burlacu Florentina Alina, “The Influence of road characteristics on road safety,” PhD thesis, Technical University of Civil Engineering Bucharest, 2014



269. **In the Netherlands, self-explaining roads are one part of the sustainable safety concept.** Based on a reorganization of the functional categorization plan in 1997, three categories for the rural road network have been defined according to the traffic functions mobility, distribution and access. From 1997 onwards, all the measures and modifications of parts of the network are in line with this categorization plan. One of the most important modifications was a coherent marking-plan during the last 5 years to improve the acknowledgement of the function of the road.

270. **In Denmark, a system of road categorization according to speed-classes has been proposed and applied in a pilot study.** It uses eight road categories according to the traffic functions (mobility, distribution and access) and different speed levels (high, medium, low).

271. **In Germany, the forthcoming road design guidelines for rural roads propose four different road types.** They are categorized according to their function and the importance of connections, each type comprising a distinguishable and standardized road layout.

272. **In France, several projects have been started to better understand the influence of road infrastructure on driving behavior in order to improve road safety.** Among others, projects comprise the collection of experiences on national and local road networks, the analysis of determinative factors and road user behavior, the improvement of road legibility processes (guide book and technical notes do exist), field tests of new road designs such as 2 x 1 lane layout with overtaking lanes, mini-roundabouts in interurban zones, and a full scale test on a road project. Moreover in 2006, the French Ministry organized a seminar with more than 600 participants on recent developments to induce calm driving. The seminar also included presentations from Switzerland and the Netherlands.

4.4.7 Forgive roads

273. **A forgiving road²¹ is defined as a road that is designed and built in such a way as to counteract or prevent driving errors and to avoid or mitigate the negative consequences of such.** Forgive road environments can be considered a basic tool to prevent or mitigate an important percentage of road accidents related to driving errors. More specifically, statistics show that about 25%-30% of fatal accidents involve crashes with fixed roadside objects. Those accidents are mainly caused by driving errors, leading to departure from the road. The existence of a forgiving road environment would prevent accidents of this type (and generally accidents that involve driving errors) or, at least, reduce the seriousness of the consequences of an accident.

²¹ Towards Forgive and Self-Explanatory Roads. Evangelos Bekiaris and Evangelia Gaitanidou. In Infrastructure and Safety in a Collaborative World - Road Traffic Safety. Springer 2011

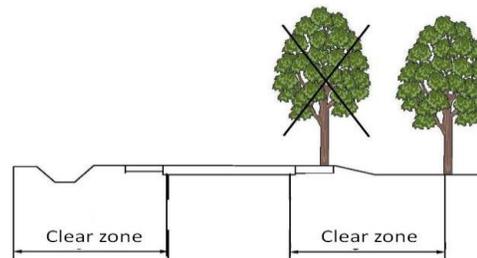
Figure 11. What not to do: An unforgiving roadside environment



Source: "The need for safer and forgiving roads"²²

274. **The clear zone is a key safety concept used in road design.** It represents the area that begins at the edge of each travelled lane and is available for emergency use by errant vehicles that run off the road. This zone includes any adjoining lane/s, road shoulders, verges and batters.

Figure 12. Roadside clear zone concept



Source: Road Safety Manual for Republic of Moldova²³

275. **Generally, the width of the required clear zone increases as the design speed increases.** Based on accident analysis in the Netherlands, the SWOV (Dutch Institute for Road Safety Research) has estimated that the minimum width of clear zones for three types of roads should be as follows²⁴: 3.5 meters for single-lane regional highways; 7 meters for single-lane federal highways; 10 meters for motorways.

276. **Drainage structures are an essential element of roads.** They are designed to collect the pluvial water but, at the same time, they are very dangerous for road users. Because of the high water volume, they are designed deep and with a high lateral slope of the walls, and in some cases they are even made of concrete. The development of new drainage systems that can cope with the expected amount of rainfall, yet do not create unsafe conditions for traffic users is not an easy task, but it is a necessary compromise. Developed countries have started to use permeable drainage systems, built from a porous

²² Burlacu Florentina Alina, Tarata-Campeanu Otilia, Dicu Mihai: "The need for safer and forgiving roads," 3rd International Conference on Road and Railway Infrastructure, Split, Croatia, April 2014

²³ Search Corporation and Universinij: Road Safety Manual for the Republic of Moldova, 2011

²⁴ SWOV: Roadside design in the Netherlands for enhancing safety, International Conference on Traffic Safety of two Continents, Lisbon, Portugal, 1997



material. These types of systems are also environmentally friendly and allow any type of infiltration to evaporate, even the ones from the road foundation.

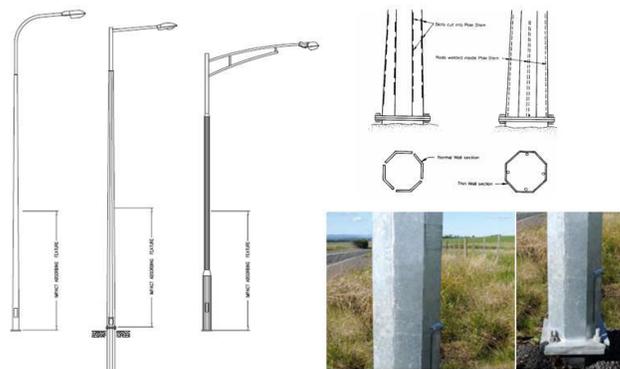
Figure 13. Unsafe drainage systems



Source: "The need for safer and forgiving roads"²⁵

277. **Where it is not feasible to eliminate roadside hazards, it is possible to make them less injurious by changing their design as long as this takes account of real world accident data and current vehicle design.** Frangible poles can be effective in reducing the severity of pole related crashes. These types of utility poles are specifically designed to collapse or break away on impact and reduce the severity of potential injuries.

Figure 14. Frangible poles



Source: Road Hazard Management Guide²⁶

A risk assessment of the potential effect of using passively safe lighting columns and signposts has been performed in the UK by combining the likelihood of occurrence of different events that can lead to passenger injuries. The risk associated with the use of "passively safe" or "forgiving" lighting columns was evaluated as almost 8 times lower than the risk associated with conventional unprotected columns. The solution of protecting the column with a safety barrier leads to a risk that is still 2 times higher than the risk associated to using "passively safe" columns. (Source: Williams, G. L., Kennedy, J. V., Carroll J. A., Beesley, R. (2008), "The use of passively safe signposts and lighting columns" Published by TRL, UK)

²⁵ Burlacu Florentina Alina, Tarata-Campeanu Otilia, Dicu Mihai: "The need for safer and forgiving roads," 3rd International Conference on Road and Railway Infrastructure, Split, Croatia, April 2014

²⁶ Department of infrastructure, Energy and Resources: Road Hazard Management Guide, Tasmania



278. **Barrier systems should be used in areas where, in case of a run-off accident, the consequences would be much worse than if it would hit the parapet.** Safety barrier ends are usually considered hazardous when the termination is not properly anchored or ramped down in the ground or when it does not flare away from the carriageway. Crashes with “unprotected” safety barrier ends can result in a penetration of the passenger compartment with severe consequences.

Figure 15. Unsafe barrier systems



Source: “The influence of road characteristics on road safety”²⁷

279. **The main role of the barrier systems is to diminish the severity of a run-off-road accident, which is accomplished when they are well designed and installed.** For this to happen, they must absorb the shock of impact and prevent bouncing a vehicle back on the road just after a collision.

Figure 16. Safe barrier systems with proper ends



Source: PIARCS²⁸

280. **The median barriers are designed to avoid front collision between vehicles travelling from opposite directions, but also they have an impact on pedestrians, as they encourage them to use safer areas to cross the road.** A distinction needs to be made between the medians used to guide directional traffic management and those used for safety reasons. The second category must have a more solid construction, since their function is to divert vehicles tending to go over the median axis and absorb as much of the kinetic energy during the collision.

281. **Shoulder rumble strips have been proven a low cost and extremely effective treatment in reducing single vehicle run-off-road crashes and their severity.** For rural

²⁷ Burlacu Florentina Alina, “The Influence of road characteristics on road safety,” PhD thesis, Technical University of Civil Engineering Bucharest, 2014

²⁸ PIARC Technical Committee on Road Safety: Catalogue of design safety problems and potential countermeasures, 2008;



freeways, the Crash Modification Factor for the use of milled rumble strips has been estimated combining different studies²⁹: 0.89 (which means potential reduction of crashes of 11%) for single vehicle run-off-road crashes, with a standard error of 0.1; 0.84 (which means potential reduction of crashes of 16%) for single vehicle run-off-road fatal and injury crashes, with a standard error of 0.1. For rural two lane roads, the Crash Modification Factor for the use of milled rumble strips has been estimated combining different studies: 0.85 (which means potential reduction of crashes of 15%) for single vehicle run-off-road crashes, with a standard error of 0.1; 0.71 (which means potential reduction of crashes of 29%) for single vehicle run-off-road fatal and injury crashes, with a standard error of 0.1. Given the very low standard errors, these results can be considered extremely reliable in estimating the potential effect of milled shoulder rumble strips on these types of roads.

Figure 17. Rumble road surfaces along center line and edge lines



Source: "The influence of road characteristics on road safety"³⁰

A specific study was conducted in Sweden to evaluate the effectiveness of milled shoulder rumble strips in rural dual carriageway freeways. Over a 200 km long segment, milled shoulder rumble strips with a typical configuration have been built between June and October 2007. Information from all single vehicle accidents occurred between January 1, 2004 and December 31, 2010 was collected from the STRADA (Swedish Traffic Accident Data Acquisition) database, allowing for the development of a before-after analysis. The results show an overall estimate of a 27.3% reduction of single vehicle crashes (CMF = 0.727). Within a 95% confidence interval the potential reduction in accidents was estimated between 8.6% and 45.7%, showing a definitely positive effect even though there is still a large variability to be explained. (Source: Fagerlind, H., Martinsson, J., Nitsche, P., Saleh, P., Goyat, Y., La Torre, F., Grossi, A. (2011). "Guide for the Assessment of Treatment Effectiveness". ENR SRO1 – ERANET Project IRDES – Deliverable N. 2)

4.4.8 Complete streets

²⁹ ERA-NET ROAD: Safety at the Heart of Road Design, Final Report of the ERA-NET programme, May 2012

³⁰ Burlacu Florentina Alina: "The Influence of road characteristics on road safety", PhD thesis, Technical University of Civil Engineering Bucharest, 2014



282. **A complete street³¹ is designed and built not only for vehicles, but for all types of road users.** It is very important to create an infrastructure with proper means of transportation for pedestrians, such as sidewalks, crosswalks - including median crossing islands and raised crosswalks, accessible pedestrian signals - including audible cues for people with low vision and pushbuttons reachable by wheelchair users, and sidewalk bulb-outs; traffic calming measures to lower driving speeds and define the edges of car travel ways; bicycle accommodations, such as dedicated bicycle lanes or wide shoulders; mass transit accommodations, such as bus pullouts.

283. **Streets that are truly “complete” provide all of us with a choice of mobility options.** They allow everyone to travel to and from work, school, and other destinations with the same level of safety and convenience, whether or not they have mobility, vision, or cognitive disabilities. Complete streets also help people who are coping with temporary disabilities as well as those pushing strollers, pulling wheeled luggage, or managing large packages.

284. **Complete streets provide children with opportunities to walk, bike and play in a safe environment.** More children are likely to walk or bike to school when sidewalks or footpaths are present, when there are safe street crossings, and when school zones enforce a reduced vehicle speed. Streets that provide dedicated space for bicycling and walking help kids get physical activity and gain independence.

285. **Complete streets are a natural complement to sustainability efforts, ensuring benefits for mobility, community, and the environment.** Many elements of street design, construction, and operation can work in favor of achieving both complete streets that work for all travelers and green streets that serve environmental sustainability.

Figure 18. Complete streets concept



Source: Complete Streets Conference, LA, 2011

³¹ <http://www.completestreets.org/>



286. **When streets are designed only for cars, they deny people the opportunity to choose more active ways to get around, such as walking and biking.** Even where sidewalks exist, large intersections and speeding traffic may make walking unpleasant or even unsafe - discouraging any non-motorized travel. Complete streets provide opportunities for increased physical activity by incorporating features that promote regular walking, cycling and transit use into just about every street.

287. **Complete streets reduce crashes through comprehensive safety improvements.** The measures that design the street with pedestrians in mind – sidewalks, raised medians, better bus stop placement, traffic-calming measures, and treatments for disabled travelers – all improve pedestrian safety. Some features, such as medians, improve safety for all users: they enable pedestrians to cross busy roads in two stages, and reduce left-turning motorist crashes to zero, a type of crash that also endangers bicyclists.

288. **Planning and designing roads to make them safer for all users and more inviting to pedestrians, bicyclists, and transit users can increase overall capacity and efficiency without a negative impact on automobile travel.** For example, improving intersections for pedestrian safety can reduce the time needed for a pedestrian crossing signal phase, keeping vehicular traffic flowing. Complete streets improve access to public transportation and assist transit vehicles in moving efficiently along the road, making it an attractive and viable option to more people. Increasingly popular are the use of bus rapid transit and bus priority signal systems, which allow buses to extend green lights and shorten red lights.

Figure 19. Before and after “complete street” concept applied



Source: New York State Department of Transportation³²

289. **As areas become more attractive and balanced, land values increase.** Some Complete Streets projects have increased adjacent land values 30-100%. Integrating sidewalks, bicycle lanes, transit amenities, and safe crossings into the initial design of a project spares the expense of retrofits later.³³

³² <https://www.dot.ny.gov/programs/completestreets/best-practices>

³³ http://en.wikipedia.org/wiki/Complete_streets



A road diet on South Olive Avenue (Complete Street and Road Diet – reduction of road width from 4 lanes to 3 lanes) in West Palm Beach, Florida reduced crashes 35 percent and increased bicycling and walking 23, and 30 percent respectively. The change also helped spur economic development and was claimed to enhance the neighborhood's sense of place, resulting in an increase in adjacent home values of \$115,000 in just one year. (Source: Ian Lockwood, P.E., 2006)

4.4.9 Sustainable roads

290. **Minimizing environmental impacts on communities and natural habitats are the main issues of this concept.** Sustainable or green infrastructure fits into its surroundings and contributes by means of design and composition to minimizing the impact of traffic (noise, air pollution and vibrations) and energy consumption of the transport system. It also optimizes the use of non-traditional materials for road building and reduces the use of natural resources. Green infrastructure stands for reducing the environmental impact of traffic and infrastructure on the sustainable society.³⁴

291. **Better integration of infrastructure in its surroundings is rather a matter of willingness to give natural habitats a chance to survive than a lack of road engineering solutions.** Proper design and modelling of the verges and the creation of barrier-free ecological areas using eco ducts are examples of ecological engineering that can already be found in some European countries. Local circumstances and demands will ultimately determine the best solutions.

A Norwegian study released on March 19, 2007 found conclusive evidence that road realignments and upgrades reduce car emissions. Taking three baseline scenarios, the emissions of CO₂ were found to be reduced by up to 38% while local pollutants dropped by a staggering 75%. The same study indicated that in a majority of cases the changes did not generate new car trips. (Source: ERF and IRF "Sustainable roads", 2007)

292. **Traffic noise is another potential tension area between individual mobility needs and legitimate societal aspirations for quieter lifestyles.** Up to 80 million Europeans suffer from unacceptable levels of noise, much of it caused by the transport sector. It is estimated that pavement properties on a well-maintained road network can reduce noise emission levels by as much as 5 dB(A). Acoustic barriers offer another on-site noise reduction solution, typically lowering noise levels by 5 to 10 dB(A) (i.e., cutting the loudness of traffic noise by as much as 50%).³⁵

³⁴ New Road Construction Concepts. Towards reliable, green, safe & smart, and human infrastructure in Europe. FEHRL. 2008

³⁵ The European Union Road Federation (ERF), the Brussels Programme Centre of the International Road Federation (IRF), "Sustainable roads," Discussion paper, 2007



A demonstration trial was undertaken for the UK Highways Agency using solar panels mounted on highway noise barriers on the M27. The trial followed an earlier feasibility study, which found that the significant infrastructure of noise barriers that already exists on UK highways provides an ideal location for solar panels. (Source: ERF and IRF "Sustainable roads", 2007)

293. **The vertical (gradient of abutments) and horizontal (curves) alignment of road design and the condition of the road surface (texture, evenness) particularly affect the rolling resistance of trucks and thus fuel consumption (and air pollution).** Rough and uneven road surfaces will increase this consumption.

294. **Green design solutions for roads have started to be implemented in developed countries.** A good example is represented by the permeable drainage systems, which are commonly used in the proximity of roads, following the idea that they will be more dry than wet, even in areas with heavy rain. If the side of the trench is porous, evaporation is faster, and not just for the water seeped through the sides of the trench in the ground, but for any other type of infiltration. This is also a sensible ecological measure and it is called "shallow green ditches." It has been discovered that most of the critical pollutions of the water from the road, such as oil and petrol will be destroyed by soil bacteria. For the case in which the water permeability of the soil is low, a subsurface piped solution is recommended.

Figure 20. Permeable drainage systems



Source: PIARC³⁶

Water and wastewater

4.4.10 Control Systems and water management technology

295. **Water distribution systems have often developed systematically over many years with no overall plan.** To achieve the best results and the highest return on investment, any physical installation or change of operation must be designed with anticipated future need for water supply in mind, not just be a repeat of the original dimension.

³⁶ PIARC Technical Committee on Road Safety: Catalogue of design safety problems and potential countermeasures, 2008



296. All potable water systems will have a certain quantity of water that is not paid.

A well run utility will keep the level in the low teens. The best utilities will achieve around 3 percent. Utilities with low quality and poorly maintained infrastructure, inadequate procedures, no leakage management systems and no meter testing programs may lose 40 percent or more of their output. Some utilities may be uncertain about the actual levels of water loss. In a country such as Romania leakages in networks can reach high levels (30% or more), which has an impact on the sustainability of the service. It is very important to take into consideration the non-revenue water. To achieve a reliable picture, precise metering equipment must be installed both at the pumping inlet and at the customer.

297. Ideally, each consumer should have a water meter.

The meter readings shall be the basis for payment for water. Romania has not yet achieved this level and water is often paid for on another basis such as pro rata – depending, for example, on the number of inhabitants. Many apartment buildings in Romania have water supplies entering in two or three locations meaning that more than one water meter may be required per property. More than 90% of the apartment buildings have about four water meters, including two for cold water and two for hot water. Since 1990, practically all buildings have been provided with individual water meters. In order to lower the reading costs, the water companies have started to use water meters with electronic distance reading. However, the installation cost may be too high for old buildings, and in any case incentives must be in place for users to comply with any meter installation policy.

298. High quality equipment for water management is required.

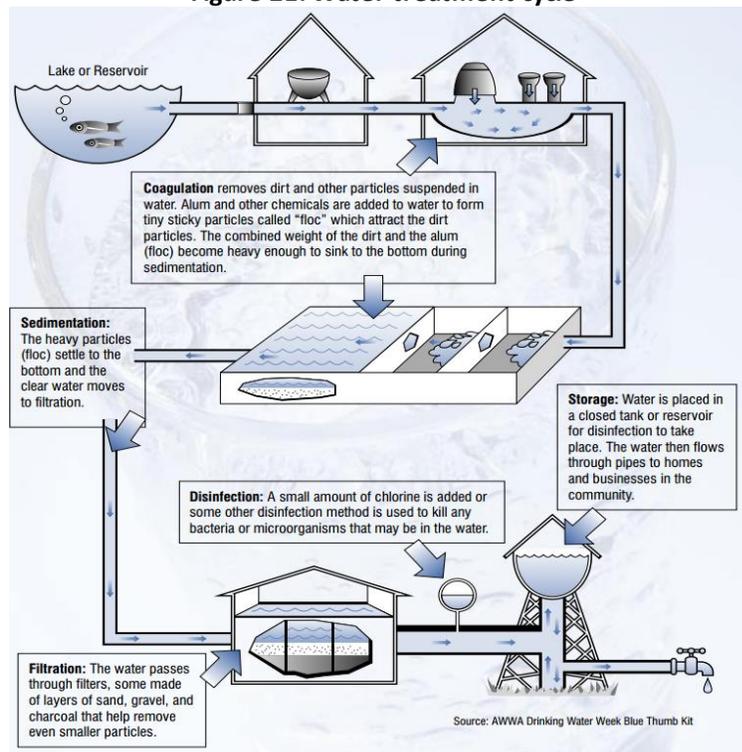
It is very important to invest in high quality products in water distribution systems as the equipment is installed underground, beneath the overlying pavement. If the equipment fails or starts leaking it might take long before it is discovered and be costly to repair or exchange; repairs may affect the overlying pavement and cause significant disruption to communities. Many water utilities have learned the hard way that substandard equipment might save money when purchased, but is much more expensive in the long term.

299. The operation of the distribution system tends to have a negative impact on the water quality.

In most places, it is necessary to add chlorine to disinfect the water before distribution to avoid bacteriological contamination of the water, but if the distribution system does not operate properly, it will result in excessively high chlorine content near the pumping station and low or zero chlorine further out in the distribution system. Both are detrimental to the water quality and to the consumer. The flow and age of the distributed water must be as uniform as possible all over the distribution system to make the chlorination efficient. If the chlorine degrades, a distribution system with a high leakage will be vulnerable to contamination resulting from vacuums developing during low-pressure situations. A properly designed, operated, and maintained distribution system will minimize the risk of contamination, and it will secure safe drinking water for the consumer.



Figure 21. Water treatment cycle



Source: EPA from the American Water Works Association

The water treatment technology used most often in Denmark to convert groundwater into drinking water is aeration and filtration for removal of iron, manganese, and ammonium. This is a chemical-free and natural process using just compressed air as the oxidation media. This treatment method is now also used in Hungary for the 12,000 inhabitants of Tolna, a city 135 km south of Budapest. The new waterworks has a good working environment with no wastewater problems and safe and easy operation, and the citizens now enjoy superior drinking water free of chemicals. (Source: Rethink Water & Danish Water Forum 2013 - Ensuring great-tasting and safe tap water 24 hours a day. Solutions for a safe, reliable and resource-efficient drinking water supply)

300. **Water quality must be monitored on a continuous basis, because problems will only be detected with regular sampling.** Sampling and analyses should be undertaken at the well, at the intake, where water exits the waterworks, and throughout the distribution system. Fortunately, various modern methods, sensors, and measurement equipment have made it quicker and less costly for utilities to monitor water quality throughout the process, thereby detecting irregularities in both treatment and supply. Sensors can be given online links to management systems that ensure alarms and data capture regarding process irregularities.



301. **The longer the water remains in the pipeline, the poorer the quality of the water reaching the customers.** Hydraulic models are used to optimize the quality of the drinking water when it reaches consumers by calculating the age of the water in the network. In order to establish a functional hydraulic distribution network model, reliable data about pipeline locations and dimensions is necessary. Further data or estimates about consumer demands around the distribution network are also required. The more accurate the information about consumption and time-dependent demand variations for each supply zone, the more advanced the model simulation of the distribution network that can be established.

302. **Ensuring constant pressure throughout the distribution network is one of the most important aspects that could benefit from advanced technology, tools, and designs.** Any pressure drop will not only affect the pressure at the tap, but also involve a huge risk that contamination will be sucked into the distribution network. This is often the case in the event of a fire, because in many cities firefighting is based on the use of fire hydrants using water taken from the distribution network. The optimum starting point to solve this is also with hydraulic models combined with GIS systems, which provide a great platform for decision-making regarding the distribution network design and rehabilitation. Real-time modeling may then provide information for daily operation and management of pressure in the drinking water network — and be even more effective when combined with pressure sensors installed in the distribution system.

4.4.11 Wastewater management

303. **Wastewater projects typically include the construction of a new treatment plant or the upgrading of existing systems, in order to clean properly the water as well as the associated distribution system that may include pipes, pumping stations, and storage of reclaimed water.** In the design of sewerage networks optimum use is made of gravitational flow and pipes are sized and installed at the minimum gradients consistent with self-cleansing (meaning continuous mobilization of solids at minimum night flows). The number of pumping stations in an agglomeration is minimized to contain capital and operational expenses. Vacuum systems are used in plain areas where intensive pumping is necessary. The action area of a vacuum station is larger than the action area of a regular pumping station, so the number of vacuum stations and the corresponding power consumption are minimized.

304. **Three main types of wastewater systems can be identified:**

- Separate sewer system that collects and transports by at least two separate networks all waters which are collected (usually one for wastewater and one for rain water);
- Mixed sewer system that collects and transports water from the locality through different systems, in part through the unitary sewer system and in part by a separate sewer system.
- Unitary sewer system that collects and carries on the same network all waters, sewage and rain water in the locality. This is the cheapest system in terms of both investment and operating costs. This system implies a mechanism of water



segregation before the treatment station to deal with overflow due to rainwater. In addition, in case of flat areas, the system allows a self-cleaning during the rains, which otherwise would need additional mechanical cleaning that induces treated water losses and higher costs.

305. Numerous processes can be used to clean up wastewaters depending on the type and extent of contamination. There are two basic approaches: to use the waste in the water as a resource (such as constructed wetlands) or strictly as pollution (such as the majority of today's treatment plants). Most wastewater is treated in industrial-scale energy intensive wastewater treatment plants (WWTPs), which include physical, chemical, and biological treatment processes. However, the use of septic tanks and other On-Site Sewage Facilities (OSSF) is widespread in rural areas, serving up to 20 percent of the homes in the U.S.³⁷

306. The most important aerobic treatment system is the activated sludge process, based on the maintenance and recirculation of a complex biomass composed by microorganisms able to absorb and adsorb the organic matter carried in wastewater. Anaerobic wastewater treatment processes (UASB, EGSB) are also widely applied in the treatment of industrial wastewaters and biological sludge. Some wastewater may be highly treated and reused as reclaimed water. Wastewaters ecological approaches using reed bed systems such as constructed wetlands are being increasingly used. Tertiary treatment is increasingly applied and most common technologies are microfiltration or synthetic membranes. After membrane filtration, the treated wastewater is indistinguishable from waters of natural origin of drinking quality (without its minerals). Nitrates can be removed from wastewater by natural processes in wetlands but also via intensive microbial denitrification, for which a small amount of methanol is typically added to provide the bacteria with a source of carbon. Ozone wastewater treatment is becoming more popular and requires the use of an ozone generator that decontaminates the water as ozone bubbles percolate through the tank. The solution is, however, energy intensive. Latest and very promising treatment technology is aerobic granulation.

307. Dewatered sludge can be dried to lower moisture contents by various processes termed sludge drying. For transportation, sludge benefits from being as dry as possible and a cost balance must always be made between transport costs and drying costs. For use of sludge as a fuel, dry solids mater must generally exceed 50%. Wastewater sludge can be mixed with the purifiable elements of domestic waste to make a so-called "compost-like" output that can be used for soil enhancement. Prior to 2008, available disposal solutions for wastewater sludge included incineration, and sludge was used as an agricultural fertilizer and disposed to landfills. However, since 2008, following amendments to the landfill, the option to dispose of sludge into landfill is no longer allowed. While Romania is still considering the use of wastewater sludge in agriculture, the other Western European countries are moving towards incineration as a prime disposal process. The disposal of sludge to agricultural land is prohibited in certain nitrate

³⁷ U.S. Environmental Protection Agency, Washington, DC, 2008. "Septic Systems Fact Sheet". EPA Publication no. 832-F-08-057



sensitive regions and requires considerable storage areas because there is only a narrow window of time when soil and crop conditions are amenable to receive sludge.

308. Another optimizing action is enhancing treatment processes with microorganisms. Specialized microorganisms can positively affect solids management and odor control in wastewater treatment operations. It is also possible to degrade specific substances with specialized microorganisms to lower substance levels in the plant effluent. In sludge and biomass treatment, adding actively growing, specialized microbial strains enhance the response of the biomass to process fluctuations or to degradation of certain components. Bio-augmentation, as it is called, offers many advantages over traditional technology platforms such as chemicals and has for years proven its effectiveness at degrading organic compounds. Other technologies can also improve effluent quality, but those technologies are often much more expensive and more difficult to handle.

309. The aeration process in biological wastewater treatment normally takes up more than half of the total energy demand of the plant and increasing the efficiency will have a high impact on total operating costs. Generally, surface-aerated basins do not achieve the same energy performance as diffused bottom aeration. Taking it one step further, supplying the exact amount of clean air required in the process with optimized aeration technology makes it possible to achieve great savings. Analyzing a plant's current set-up and an alternative configuration calculated by aeration experts will make it possible to estimate potential savings.

A treatment plant in Bloomington, Indiana, USA has achieved annual savings of around 1.8 million US dollars by upgrading the plant with new fine-bubble diffusers and single-stage centrifugal turbo compressors with dual-point control. In Catalonia, Spain a treatment plant for industrial and domestic wastewater with a capacity of 30,000 cubic meters per day saved around 30 percent of its electricity consumption by upgrading the aeration compressors and control system. (Source: Rethink Water & Danish Water Forum 2013 - In control of wastewater to protect people and ecosystems. Efficient solutions for treatment of wastewater)

310. Disposal of wastewaters from an industrial plant is a difficult and costly problem. Most petroleum refineries, chemical and petrochemical plants have on-site facilities³⁸ to treat their wastewaters so that the pollutant concentrations in the treated wastewater comply with the local and national regulations regarding disposal of wastewaters into community treatment plants or into rivers, lakes or oceans. Constructed wetlands are being used in an increasing number of cases as they provided high quality and productive on-site treatment. Other industrial processes that produce a lot of wastewaters, such as paper and pulp production, have created environmental concern,

³⁸ Tchobanoglous, G., Burton, F.L., and Stensel, H.D. (2003). Wastewater Engineering (Treatment Disposal Reuse) / Metcalf & Eddy, Inc. (4th ed.). McGraw-Hill Book Company. ISBN 0-07-041878-0.



leading to development of processes to recycle water use within plants before they have to be cleaned and disposed.

311. **Reducing the costs of wastewater handling is an issue in most places, as costs for collection and treatment of wastewater often are twice the costs for production and distribution of drinking water.** More and more wastewater treatment plants in Europe are thus upgraded with anaerobic digestion of sludge to better collect and utilize produced biogas for generating electricity or heat. Solutions depend on individual plant design and opportunities for internal use or sale of the produced electricity or heat. The limit at which the implementation of anaerobic digestion is financially viable changes with the development and application of new technologies and changes in the price structure for purchase and sale of electricity and heat.

312. **A new trend is coupled control.** Nowadays most of the developed countries' wastewater treatment plants have online measurement equipment for optimization of biological processes and plant hydraulics. Now this technology also emerges for the optimization of sewer systems to avoid massive investments in large retention basins or increase of sewer network capacity. Online monitoring instruments such as flow meters, sewage level loggers, and precipitation gauges combined with weather radar at regional and local levels in advanced storm water drainage and treatment models are now the new trend for coupled control of drainage system and wastewater treatment plants.

313. **Intelligent regulation, control, and coordination in the management of drainage systems and wastewater treatment plants may be the first defense against floods and sewer overflows for cities facing higher risks of extreme weather with heavy rainfall, saving them from new massive investments in climate adaptation.** Intelligent wastewater management is primarily a solution for cities of a certain size and with combined sewer systems that require special operational rules during heavy rainfall to avoid hydraulic overload and resulting discharge of untreated wastewater. Integrated solutions are the new trend to connect the wastewater treatment plant with a drainage model and get a coherent model for the entire wastewater system. Advanced technology such as sensors, flow meters, and intelligent software ensure that the capacities of sewer pipes are maximized. This means that rather than blindly expanding the capacity of the sewer system to cope with heavy rainfalls, the intelligent system sends the water where there is room for it.

314. **Many countries also use the decentralized treatment for wastewater that is not discharged to a municipal treatment plant.** These solutions are applied mainly in rural areas, but may also include relatively large areas, such as university campuses or industrial parks with their own treatment plants. Decentral wastewater treatment thus takes place at widely different scales from clusters within a mega-city to scattered individual households in rural areas. The rapid urban growth in many developing countries makes decentralist solutions attractive in order to maintain a manageable size of sewer networks, which can be make use of the topography for gravity drainage and avoid escalating pumping costs. The cluster approach is also attractive in cities with large differences in service levels between the urban center and surrounding shantytowns or satellite cities as a gradual upgrading of water supply and sanitation can be achieved via



local collection and decentral treatment of wastewater. Still it is important to be aware that wastewater treatment plants located within cities are difficult to manage due to risk of foul smell from the treatment basins and the heavy transport required for disposal of sludge.

315. If treated properly, wastewater can be reused as drinking water in industry (cooling towers), in artificial recharge of aquifers, in agriculture, and in the rehabilitation of natural ecosystems. There are numerous benefits to using recycled water for irrigation, including the low cost, consistency of supply (regardless of season, climatic conditions and associated water restrictions), and general consistency of quality. Irrigation of recycled wastewater is also considered as a means for plant fertilization and particularly nutrient supplementation. Furthermore, organic content can be used for energy production when concentrated in sludge. Phosphorus can be extracted from the wastewater or sludge and applied as fertilizer replacing mineral phosphorus, which rapidly is becoming an increasingly scarce resource. Energy wise, excess heat can be withdrawn for production of heat and electricity and the remaining mineral and organic content in the sludge can be used as soil conditioner or as additional fertilizer.

The Republic of Malta has implemented a new wastewater infrastructure, which aims at reusing the effluent for irrigation and for industrial purposes. Treated wastewater is today considered a useful resource in Malta and the irrigation systems ensure a significant increase in agricultural production during dry periods. The project included upgrading of one wastewater treatment plant and building of two new ones to treat sewage from most towns and settlements on the two islands of Malta (Malta and Gozo). (Source: Rethink Water & Danish Water Forum 2013 - In control of wastewater to protect people and ecosystems. Efficient solutions for treatment of wastewater)

Social infrastructure

4.4.12 Safe social infrastructure

316. The provision of adequate social infrastructure is fundamental to ensuring people are safe, healthy, and productive in the community. Increasingly sophisticated research demonstrates the critical link between economic sustainability and investment in law and order, education, healthcare, culture, recreation, housing and communications infrastructure.

317. All public buildings, such as those that are part of social infrastructure, must be accessible and easily used by disabled people. A noticeable change in some parts of the world is the installation of elevators, automatic doors, wide doors and corridors, transit lifts, wheelchair ramps, curb cuts, and the elimination of unnecessary steps where ramps and elevators are not available, allowing people in wheelchairs and with other mobility impairments to use public sidewalks and public transit more easily and more safely.



318. **Fire safety measures include those that are intended to prevent ignition of an uncontrolled fire, and those that are used to limit the development and effects of a fire after it starts.** Fire safety measures include those that are planned during the construction of a building or implemented in structures that are already standing. The technical design documentations of a building that is part of the social infrastructure must specify the fire risk (including smoke control) and the protection systems of the rooms, spaces and departments for the whole building.

319. **Thermal comfort is primordial in modern social infrastructure.** The main role of heating systems is to ensure in the cold season the optimum temperature in the buildings for social infrastructure. Heating systems can be hot air systems, radiant heating, or heat pumps. Air conditioning systems are designed to provide thermal comfort conditions in the warm season in buildings that are part of social infrastructure. They must maintain air parameters throughout the year, regardless of the variation of meteorological factors, the occupancy of rooms, in other words, regardless of changing thermal loads (heating, cooling) and of prevailing humidity and moisture.

4.4.13 Sustainable buildings

320. **In October 2014, the EC published a report concerning the implementation of nearly zero energy buildings “NZEBS”.** Article 9(1) of the energy performance in buildings directive is to ensure that by December 2020 all new buildings are to be nearly zero energy and, after December 2018, new buildings owned and occupied by public authorities are to be nearly zero energy buildings. It is expected that the nearly zero or very low energy required should be covered by energy from renewable sources.

321. **Recycling provides the opportunity to reduce the embodied energy by using recycled materials and reusable/recyclable materials/components.** The recycling potential is between 35% and 40% of the embodied energy of a building, which represents around 45% of the total energy needed.³⁹

322. **Energy efficiency is the first step toward achieving sustainability in buildings.** Energy efficiency helps control rising energy costs, reduces environmental footprints, and increases the value and competitiveness of buildings. Mostly, energy losses in social buildings are due to inadequate state of the building envelope, including walls, floors, roofs, doors and windows. Therefore, any social building older than 20 years is poorly insulated, needs thermal rehabilitation, in order to save about 50% of energy consumption and support achieving thermal comfort in winter and in summer. The most commonly used materials for social infrastructure buildings with thermal insulation can be classified as:

- Vegetable: cork, fiber (chips) of wood, flax, straw, etc.
- Mineral: fiberglass, mineral wool, expanded clay, glass foam, etc.
- Synthetic materials: expanded polystyrene, polyurethane and phenolic foam, etc.

³⁹ Catarina Thormark. Building and Environment Volume 37, Issue 4, April 2002, Pages 429–435



323. **As an integral part of innovative and efficient design as well as to meet the future EU requirements for nearly zero energy buildings, a comprehensive approach is necessary to be taken, in order to utilize the benefits and facilities provided by building controls and management systems.** Numerous computerized systems already exist on the market but it is advisable for designers to take a comprehensive approach and to integrate fully the building envelope construction and performance with the solar energy collectors, heating methods, insulation, temperature control, building shading, ventilation, lighting, metering, water supply, drainage, and waste.

By optimizing heating, ventilation and air-conditioning systems for its customers in over 6,500 buildings around the world Siemens says it has saved them around £900,000 and reduced CO2 emissions by 2.4 million tons. (Source: Raconteur Media-CLEAN TECHNOLOGY. Turning up the power)

324. **The Energy Performance of Buildings Directive (EPBD) is considered the main piece of legislation that supports and regulates the development of energy efficient buildings.** Also known as "the EU green building legislation", EPBD started to be transposed in the national legislation of most Member States in 2006. Since it is very comprehensive, it is also difficult to implement fully and to acquire a common position at the EU level.

325. **The directive is designed to promote the energy performance of buildings in the Member States through the following measures:**

- The introduction of a framework for an integrated methodology for measuring the energy performance of buildings.
- The energy certification and advice for new and existing buildings; and the inspection and assessment of boilers and heating/cooling systems.
- Visionary companies' interest in developing capabilities to excel in the construction and related industries and generate sustained profits.

326. **Energy efficiency can be improved in different ways.** For existing social infrastructure buildings in Romania, especially for education and health facilities, thermal rehabilitation may be accomplished by replacement of heating system (from stoves to thermal plants), thermal insulation of the building (walls, roof and basement), new entrance doors, efficient new lighting system and rehabilitation of internal installations.

327. **Solar energy, in particular by direct conversion of solar energy into electricity, can be considered the most common type of renewable energy for buildings that are part of the social infrastructure.** Photovoltaic – PV - systems require light and not necessarily direct sunlight in order to generate electricity. PV systems can be installed on roofs or facades, thus contributing to reducing energy consumption in those buildings. They do not produce pollutants and can be integrated in various aesthetic solutions.



Solar thermal uses energy from the sun to create hot water for use in buildings. It is the most prolific renewable technology in the UK with approximately 90,000 installations currently fitted. Typically, panels of a 3-4 square meter total area will produce up to 70 per cent of the hot water demand of a three-person household. (Source: Raconteur Media- CLEAN TECHNOLOGY. Turning up the power)

4.4.14 Building Information Modelling (BIM)

328. **Building Information Modelling and 3D modelling involves the creation and management of digital representations of physical and functional characteristics for designed elements and forms.** BIM software is used by businesses and government agencies to plan, design, construct, operate and maintain physical infrastructure ranging from water and wastewater treatment plant, refuse disposal, electricity and gas supply services, communications utilities through to roads, bridges, housing and schools. At the beginning of a project and during the whole life cycle BIM facilitates predictability of outcome as well as options for change and modification in good time to allow the most effective decisions to be made often on a “just in time” basis.

329. **The use of BIM goes beyond the planning and design phases.** It extends through all stages and supporting processes of cost management and facilities operations. In a number of EU countries there is an objective to harmonize BIM standards to improve inter- operability and cooperation.

4.5 Conclusions

330. **There are multiple recommendations for improving the design of public infrastructure projects in Romania.** For one, it is mandatory to adapt the technical standards in force to European standards, reflecting climate change, traffic modifications, and other new concepts environment friendly. Some standards are too old and their content is not up to date compared to international best practices.

331. **There should be a switch of the current Romanian roads classification to a well-structured functional classification, including relating the technical classes and maintenance classes to a revised functional classification via design speed and traffic volumes.** Functional classes provide continuity for the road’s design features (and other road management matters). Functional classification is also important to land uses and helps both the road administrations and the road users structure the network.

332. **The implementation of the Road Safety Audit and Road Safety Inspection should be properly done.** ARR should organize technical courses for the accreditation of auditors/ inspectors, but also new and clear regulations should be established according to the law in force. Another important aspect that should be considered is related to the prices for a RSA or RSI. They should be revised and adapted to the economic situation of Romania.



333. **Traffic and environmental impact studies should be required when starting a design project, just as geotechnical and topographic studies are required currently.** This way, the solution of new construction, modernization, or rehabilitation will have better technical support.

334. **The implementation of drinking water safety management and food safety systems such as ISO 22000 is needed.** Many water utilities in Europe have chosen to be ISO 22000 certified because this ensures safe healthy water throughout the entire supply system. Romanian regional water operators should adopt similar measures.

335. **The verification of the project should be made by specialists certified as technical verifiers, different and independent of the design specialists who elaborate the projects.** The beneficiaries should be the ones to contract the technical verifiers, and not include this task into the design phase, which is in fact against the law. Put differently, practice needs to reflect what the law mandates.



5 Well contracted-out Infrastructure

5.1 Public procurement in Romania

5.1.1 Legal Framework⁴⁰

336. **Public procurement procedures constitute one of the most time consuming stages in the project cycle for infrastructure in Romania.** This is a consensus amongst stakeholders and experts. The Romanian legal framework is now entirely “harmonized” with the specific European *acquis communautaire*. The most important legal act regarding public procurement procedures in Romania is the Government Emergency Ordinance (GEO) No. 34/2006 on the awarding of public procurement contracts, works concession contracts, and services concession contracts. This ordinance, as all regulatory acts in this field, is in accordance with the Romanian constitutional principles, and with the Treaty on European Union, with the Treaty on the Functioning of the European Union, as well as with the European directives on public procurement. The GEO no. 34/2006 represents the general legal framework for the public procurement field as it provides the principle rules required for organizing and carrying out these types of procedures.

337. **The key institutions for ensuring the implementation of public procurement rules in Romania are the following:**

- National Authority for Regulating and Monitoring Public Procurement (NARMPP), which is the regulatory body;
- National Council for Solving Complaints (NCSC), which is the review body;
- Unit for Coordination and Verification Public Procurement (UCVPP) within Ministry of Finance, which is an ex-ante control body;
- National Management Centre for Informational Society (NMCIS), which is the national operator of the Electronic System for Public Procurement;
- ESPP is an information system for public procurement (accessible at www.e-licitatie.ro), providing access to the economic operators and contracting authorities in the public procurement process.

338. **GEO no. 34/2006 provides the fundamental principles of the public procurement procedures:** non-discrimination; equal treatment; transparency; mutual recognition; proportionality; and efficient use of public funds and accountability. According to the legislation, any situation for which there is no specific and explicit regulation shall be interpreted through these principles.

⁴⁰ This was covered in depth in the World Bank 2014 report on “ROP 2.0: Support for Applicants and Beneficiaries of the Regional Operational Programme 2014-2020.” Some sections are included here for background purposes.



339. The national public procurement legislation provides for four main types of contracts:

- public procurement contracts for services;
- supply of goods and provision of works;
- services concession contracts;
- public works concession contracts.

In particular, Art.3¹ from GEO no. 34/2006 (Art. 3¹ was introduced by point 4 of the sole article of Law no. 337 of 17 July 2006, as published in the Official Journal no. 625 of 20 July 2006) refers to: contracts for works; contracts for provision of goods and contracts for provision of services, and the Government Decision No. 71/2007 approving the rules and provisions referring to the awarding of the public works concession contracts and of services concession contracts.

340. GEO 34/2006 (as amended) allows for all award procedures provided for (and allowed) in the EU Directives:

- Open procedure;
- Restricted procedure (two stages: selection of the best economic operators based on qualification and selection criteria and evaluation of the technical and financial proposals based on the award criteria);
- Competitive dialogue;
- Negotiated procedure with prior publication of a contract notice;
- Negotiated procedure without publication of a contract notice;
- Design contest.

341. The general rule is stated in article 20 (1) of the GEO 34/2006, according to which the contracting authorities shall award public contracts by applying open or restricted procedures – at their own free choice. The other procedures may be applied only in specific circumstances provided for by the legislation. For low-value contracts, the request for quotations shall be used, which is an open procedure with reduced deadlines. Framework agreements are considered “special modalities” for awarding contracts. For concluding a framework agreement, the contracting authority shall apply the same rules and procedures as for the award of a contract.

342. Starting with January 1, 2013, the direct entrustment cap was raised from EUR 15,000 to EUR 30,000 for services and to EUR 100,000 for construction works, according to GEO 34, modified by Law 193/2013.⁴¹ Even though the European Union average for direct entrustment is EUR 130,000 Euro for services and EUR 5,000,000 for works, in Romania this is still considered a large amount to be entrusted without a bid. If the services/works are financed from European funds, then the beneficiary is required to post the entrustment on SEAP if the sum is larger than EUR 5,000.

⁴¹ Article 19 GEO 34, modified according to Law no. 193/2013



343. **According to most public procurement procedures, in practice, the main winning criterion is the lowest bid.** This way, enterprises are forced to cut as much as possible from different works or quantities, which eventually lead toward a poor quality of design projects and construction works. In addition, no dumping price is stipulated, so a small enterprise can bid even below 15% of the estimated initial sum of the project and win, if it justifies its offer.

5.1.2 Public procurement process

344. **Before starting the award procedure, contracting authorities must have all the tender documents prepared.** Usually, tender documents contain the following parts:

- Procurement Data Sheet;
- Standard Forms;
- Contract model;
- Tender (technical) specifications.

345. **The Procurement Data Sheet (PDS) is intended to provide information about any request, criteria, and other rules needed to insure the bidder/candidate has access to complete and explicit information regarding the manner in which the procedure will be organized, including:**

- general information regarding the contracting authority (address, telephone, fax, e-mail, contact persons, means of communication) and the contract (type, CPV code, short description of the activities, estimated value, duration, place of delivery/location of works);
- instructions which must be complied with in relation to the participation in the procedure (deadlines for submitting the bids, place for submitting the bids, guarantees, validity of the bids);
- minimal requirements for qualification, as well as documents to be presented by bidders/candidates for demonstrating the fulfilment of the qualification and selection criteria;
- information regarding the award criteria ;
- instructions regarding the manner of elaboration and presentation of the technical proposal and the financial proposal;
- instructions regarding the review procedures.

346. **The most sensitive issue during the elaboration of the PDS is the decision regarding the qualification criteria and award criteria.** During the verification of various award procedures applied in recent years for EU funded projects/contracts, the biggest number of financial correction were related to qualification criteria and award criteria. In many cases, it was considered that tender documentations had contained disproportionate qualification requirements and/or irrelevant/inappropriate award criteria.



347. **GEO 34/2006 provides for an exhaustive list of qualification criteria that may be used for verification of the suitability and choice the participants in the award procedure.** The list contains the same criteria as those provided in Art. 45 – 50 of Directive 2004/18/EC:

- situation of the legal representative of the company;
- suitability to pursue the professional activity;
- economic and financial standing;
- technical or professional ability;
- quality assurance standards;
- environmental management standards.

348. **The qualification criteria are used to reduce the number of candidates that will submit bids in the second phase.** In an open procedure, the qualification criteria are used only as a filter: pass/fail. In a restricted procedure, the qualification criteria are used both as a filter and as selection criteria. For instance, the level of turnover, the value of similar contracts, the experience of the key experts, are selection criteria generally used in a restricted procedure.

349. **Award criteria are consistent between GEO 34/2006 provisions and the EU Directives' provisions.** Both criteria – the “most economically advantageous tender” (MEAT) and the “lowest bid” – are included in GEO 34/2006 without special restrictions. However, many problems are encountered in practice when contracting authorities apply the MEAT criteria. Many contracting authorities do not have enough knowledge about how to formulate adequate award criteria in the tender documentation. The lack of knowledge, in conjunction with NARMPP intervention, has led to the widespread use of the lowest bid as an award criterion.

350. **A wide range of standard forms has been developed in recent years.** Their main use it to ease the way in which the economic operators prove the fulfilment of the qualification requirements. There are no specific issues related to this part of the tender documents for which quite rare difficulties are reported.

351. **NARMPP has developed some simplified models for supply contracts, services contracts, and works contracts (Order no. 138/2012 and Common Order no. 2266/335/2012).** These models were designed to facilitate the work of the contracting authorities and, at the same time, to ensure a general framework for such contracts. Unfortunately, the contracting authorities used those models rather mechanically. Very often, the contracts were only a copy-paste version of the model, without adapting the contractual terms.

352. **Tender (technical) specifications are by far the most sensitive issue in the development of tender documents.** Technical specifications require sufficient personnel with proper expertise in the field related to the subject matter of the contract and not necessary in public procurement. Very often, contracting authorities focus on the legal aspects of public procurement but they do not have experts for preparing the technical



specifications. In case of contracts for works, despite good technical specifications, major problems are found in practice. The feasibility studies and detailed technical designs are prepared, as a rule, by external experts, which are chosen following an award procedure in accordance with GEO 34/2006. Despite of efforts to select a good designer, the result is that many technical projects are of low quality. It is likely that such situation occurs because of frequent use of the lowest bid criterion when the designer is selected.

353. **The tender procedures start when the contracting authority sends a contract notice to be published in ESPP and in OJEU (in the case of high-value contracts).** Since 2009, the contracting authorities have to publish all the tender documents in ESPP, at the same time with the contract notice. Therefore, if the tender documents are accepted by NARMPP, the system will generate automatically the contract notice, which is sent by electronic means for publication in OJEU and it is published in ESPP as well. All those operations are performed without any supplementary intervention of the contracting authority. In case of high-value contracts, minimum deadlines provided for submitting the bids or applications are the same as provided in EU Directives. Very often, the economic operators ask for clarifications; according to the law, the contracting authority shall answer, as a general rule, in no more than 3 working days, and all the answers have to be attached in ESPP as supplementary pieces of the tender documents.

354. **An evaluation committee must be appointed by the Contracting Authority (CA).** This committee must include specialists in the field of the object of the contract to be awarded and they must be members of the public procurement department within the CA. In addition, in order to support the evaluation activities, the CA can also appoint co-opted external experts. During the award process, the members of the evaluation committee have a confidentiality obligation regarding the contents of the tenders and any other information submitted by the tenderers. In addition to the confidentiality agreement, both the evaluation committee and the co-opted experts must sign a statement of non-conflict of interest.

355. **The evaluation committee will decide on essential clarifications and additions necessary for the assessment of every tender, and the period granted for providing the information.** In case the explanations submitted by the tenderer are not conclusive, the tender shall be considered irregular. Equally important, the evaluation committee has the right to correct the arithmetic errors and the formal flaws only with the tenderer's approval. When the tenderer does not accept the correction of these errors/flaws, the tender will be considered irregular. The evaluation committee has the obligation to reject the unacceptable and irregular tenders.

356. **All the bids are opened in a public opening meeting, immediately after the expiry of the period for submission of bids, as indicated in the tender documentation.** Participation at this meeting is open to any economic operator who submitted a bid. Any decision on qualification/selection of bidders/candidates or regarding the evaluation of bids is precluded during the opening session. During the opening of the bids, no bid can be rejected, except those that fall amongst one of the following situations:

- they were submitted after the deadline or at another address than the ones stipulated in the contract notice;



- they are not accompanied by the tender security as it was requested in the tender documentation.

357. **Subsequent analysis, evaluation, and comparison of bids are conducted by members of the tender committee.** External experts may be co-opted for supporting the tender committee in evaluation of bids, particularly technical specifications. The external experts involved do not have the right to vote, but they have the obligation to elaborate a technical report, which is intended to support the decision-making process for the tender committee in establishing the successful bidder. This report must be attached to the report of the award procedure and becomes part of the public procurement file. During the analysis and verification of the documents presented by the bidders, the tender committee may, at any time, request clarifications or completions of the documents presented by the bidders in order to demonstrate the fulfilment of the minimum qualification requirements or to demonstrate the conformity of the bid with technical specifications. In practice, it can be noticed an excessive preoccupation of tender committee for the formal aspects of the bids. It is likely that more than a half of the time allocated for evaluation of bids is devoted to verification of qualification documents to the detriment of checking the technical proposal. Too much emphasis is given to the “form” and it appears that, sometimes, the ultimate goal (“substance”) of the public procurement process – to get the best value for money – is completely forgotten. In practice, there is still a clear reluctance of the tender committees to correct errors and the tendency is rather to reject those bids.

358. **Abnormally low bids are now excluded.** A clear trend for submitting very low prices has been noted since 2008. In many cases, those bidders were declared winners and they concluded the contracts at those prices. The main mechanism for covering the potential losses was contract addenda and additional revenues, which were easier to justify given the low quality of the technical projects. Trying to stop this tendency, one of the amendments introduced in the legislation in 2009 established a rule according to which a bid offering a price less than 85% of the estimated value of the contract (or, less than 85% of the arithmetic average of the bid prices submitted, in cases where more than 5 admissible bids are submitted), is considered abnormally low. However, such a bid could be rejected only after the tender committee asks for explanations from the economic operator. While the law obliges the members of tender committee to ask for detailed explanation for abnormally low prices, it is unclear whether they have proper technical skills to analyze the proposed technical solutions. It would be suitable that at least some of the members of the tender committees have expertise in assessment of technical specifications.

359. **A specific provision of the law allows any company to participate in award procedures benefitting from the support of another company, which is not participating in that procedure.** Some of the economic operators as well as contracting authorities perceive this as controversial since it leads to low capacity firms bidding with artificial or politically oriented support. For instance, if the qualification requirements are too drastic for an economic operator (e.g. the minimum level of turnover in the last three years must be EUR 20,000,000 and his turnover is only EUR 10,000,000), he may prove the fulfillment of the requirement related to the turnover by presenting a commitment from a third party



who meets the minimum level. The commitment must specify that the bidder will have access to the resources of the third party and, if he will encounter difficulties during the execution of the contract, the third party commits to provide the full accomplishment of the contractual obligations, by direct involvement.

360. **The evaluation committee has the obligation to establish the successful tender within 20 days of the opening date.** This deadline may be extended only once, in duly justified cases. The extension of the evaluation period is not limited by the law, however it is in practice limited to 45 days and any another extension is prohibited. When the evaluation of tenders is completed, the committee shall elaborate the report on the award procedure, which shall be signed by all its members. The report shall be forwarded to the head of the CA for approval.

361. **The contracting authority has the obligation to communicate the outcome of the process to all economic operators involved in the award procedure.** All the information is to be communicated in writing, as soon as possible, but not later than 3 working days of the date when the decision has been made.

5.2 Main problems with public procurement in Romania

362. **The inadequate public procurement framework features as the most important obstacle in accessing ROP funds in a survey implemented as part of a previous work.**⁴² One can certainly argue that the same results can be applied to PNDL. Over 70% of public beneficiaries rate the inadequate public procurement framework as an extremely or very important obstacle in the implementation phase.

363. **The key issue of public procurement procedures is the suboptimal, inefficient ex-ante and ex-post verification system, with a chronic lack of accountability to all stakeholders involved, with the exception of beneficiaries, who are left to bear the entire burden of potential mistakes.** For their part, beneficiaries often lack the technical capacity to avoid all pitfalls of a very complex public procurement framework (GEO 34/2006 and its many subsequent changes). The central authorities (MRDPA) cannot help much because that would create a conflict of interest with their role in evaluation, while the Court of Accounts (CoA) only has a mandate for ex-post audits. There are instead dedicated institutions that are mandated under Romanian law to oversee and regulate public procurement, particularly the National Authority for Regulating and Monitoring Public Procurement (NARMPP), the National Council for Resolving Disputes (NCRD), and the Unit for the Coordination and Verification of Public Procurement (UCVPP). Currently, none of these actors is willing to formally “endorse” a clear set of general rules or resolutions for specific cases, so beneficiaries are left to bear the entire responsibility over the process without the certainty that the other actors involved help eliminate the risk of subsequent corrections. Beneficiaries are also the only ones penalized even though past procurement procedures had passed through the NARMPP and UCVPP filters. In quite a

⁴² See the reports on the “ROP 2.0: MA-IB Collaboration and Support for Beneficiaries of the Regional Operational Programme 2014-2020” (World Bank, 2013)



few cases, corrections apply long after the sums had been reimbursed (i.e., after another ex-post set of verifications by the CoA) and even after projects have been fully finalized.

364. **A related concern is the lack of technical competencies among auditors.** Beneficiaries note that many auditors come from a finance/economics background and do not fully understand the technical reasons behind certain procedures (for example, unpredictable but required works that are not related to errors in project design). In practice, many beneficiaries do not have a clear understanding of why they are sanctioned and how the level of penalties is decided.

365. **More broadly, the overall public procurement system appears broken.** Procedures take too long and are subject to numerous legal proceedings, often times initiated by “professional challengers.” There are known firms who participate in biddings and later challenge them, even without any serious reason. If a challenge is struck down by the National Council for Resolving Disputes (NCRD), some firms will take the case to court and can generate delays of up to 1-2 years. A solution that has been suggested in 2010 is fining repeated challengers who dispute public procurement procedures without just cause. They would stand to lose a small sum of money deposited at the time of the tender, which is obviously a stick that is not big enough to discourage malevolent legal action. Currently, the Constitutional Court rejected this measure, being considered against the law.

366. **A key priority to improve the system is to allow a departure from the current focus on the lowest bid as the default selection criterion.** The NARMPP has often shown reluctance to approve documentation that was based on technical-economic standards for awarding contracts, and many beneficiaries were requested to review such documentation. A common practice has emerged of using price as the sole selection criterion, which was found by beneficiaries to be palatable to the NARMPP, whose approval is needed before publishing the public procurement procedure on the Electronic System for Public Procurements (SEAP). The consequences have been often regrettable: some companies have submitted low-ball, dumping price offers and beneficiaries were not able to disqualify them, so they ended up with contractors trying to (a) provide low-quality work and (b) increase the price through various tactics like adjusting the technical project or claiming “diverse and unforeseen expenditures.” For their part, many beneficiaries have to deal with poor-quality service providers but avoid cancelling the contract and organizing new public procurement procedures, for fear of going beyond the agreed calendar for the project’s implementation, which can also result in financial corrections. As such, they are often in a “catch-22” situation: break the contract and face the possibility of losing the PNDL financing for current year, or keep working with cheap service providers who do poor-quality work

367. **In addition to allowing the inclusion of defined indicators of technical quality as selection criteria, decision-makers should apply regulations allowing for the disqualification of dumping-price offers.** In practice, public tender commissions have had a hard time proving that particular offers were unreasonable or unfounded, despite the fact that they used their right to ask for clarifications (as mentioned above). There is a



need to involve experienced experts in these commissions to determine and explain more clearly whether a particular offer is feasible or not.

368. **In procedures for awarding contracts for works, the technical projects and the details of execution are the most important parts of the tender specifications.** The effects of poor quality of the tender specifications are felt during the performance of the contract; sometimes there is a real need to change the technical solutions or to change the bill of quantities leading to additional contracts, which mean, according to national legislation and EU Directives, application of the negotiated procedure without prior publication. The possibility to apply the negotiated procedure without prior publication has to be interpreted in a very restrictive manner and low quality of the technical specifications cannot be accepted as reason for awarding a contract (additional) without reopening the competition. It is worth to note that NARMPP is not at all involved in verification of technical specifications.

369. **Additional contracts may increase the value of the initial contract, in some cases far exceeding the estimated value.** Therefore, in these cases, execution companies are awarded the tenders for an amount less than or equal to that estimated by the contracting authority, but during the execution, the amount is increased by additional contracts. There are cases when the winner of the tender is performing the works for an amount that exceeds the offers submitted by some of the competitors.

370. **There are some cases when bids can be rigged/fake.** Bid rigging/faking involve secret agreements between bidders in order to increase prices or decrease the quality of products, services, or works to the beneficiaries. The goal is to win the bid at a better price than would normally result in competition (competitive price). Rigging/faking a tender/bid takes many forms, but essentially, the bidders agree to act together as a cartel. Among the participants in the bidding may arise secret agreements for sharing the market, agreements on winning the bids “by rotation,” agreements that establish successful tenders, the others participating just to have the minimum number of bidders (so-called dead hands), arrangements to reward the unsuccessful tenderers by subcontracting, etc. Another case of rigged/fake bids can be made by proposing peculiar conditions in the tender specifications that can only be achieved by certain enterprises. These bids are also called “dedicated bids.”

5.3 Recommendations for improving the public procurement framework

371. **Public procurement law must find a compromise between excessive regulation, meant to ensure strict compliance with governing principles, and freedom of decision, which would allow contracting authorities to select those tenders that suit best their particular needs.** The following list of recommendations offers potential solutions for addressing the issues related to the current public procurement framework and ease the burden on ROP beneficiaries implementing projects. It is important to note that some of these ideas are particularly technical, while others require a national-level resolution. That said, the hope is that these suggestions help advance the conversation on an extremely complex and sensitive topic – public procurement – and enable PNDL beneficiaries to



organize efficient and effective procedures for awarding contracts. At a minimum, some of these ideas could form the basis of upcoming changes to Romania's public procurement law (Government Emergency Ordinance 34/2006), in line with corresponding dynamics at the EU level.

372. An improved public procurement framework should aim to reduce, to a minimum, the number of contracts awarded on the basis of the "lowest bid" criterion and instead rely, in most cases, on the "most economically advantageous tender" (MEAT) criterion. This evolution, which concerns the entire public procurement field, resonates with similar concerns at the EU level. There could be a minimum share (expressed as a percentage of the total value of contract award procedures launched yearly by a contracting authority) for the contracts awarded based on the MEAT criterion. These measures involve some changes in the national legislative framework, but they align with the developments of the Community rules on public procurement. Because they are based on administrative levers, these measures possess the advantage of having an immediate effect on the change of the proportion of contracts awarded on the basis of the MEAT vs. lowest bid criterion and enable, at the same time, the unbiased, rigorous verification of their compliance (as a % of total contracts awarded).

373. Contracting authorities would benefit from recommended sets of evaluation factors, based on broad types of public contracts. These factors should be synthetic and allow for an objective assessment of the tenders, but they have to be, at the same time, relevant to the object of the contract.

374. Better support is needed to help contracting authorities prevent and avoid potential conflicts of interests. This can be achieved by providing PNDL beneficiaries with detailed checklists as a mandatory component of the tender evaluation process. These should be drawn up based on the template used by PNDL. Raising awareness on conflicts of interests by filling out such checklists will allow contracting authorities (in good faith) to avoid omissions due to negligence or to lack of training/experience of the staff. In addition to a minimum methodology for the verification of conflicts of interests (e.g., guidance notes on how to fill out the proposed detailed checklists), it is necessary that the relevant legal provisions be synthesized and clarified. The NARMPP has already begun this effort, as demonstrated through the issuance of Order no. 170/2012 concerning the interpretation of Art. 691 of the GEO 34/2006 governing the conflict of interests between economic operators participating in a procurement procedure and people who hold decision-making positions within the contracting authority.

375. The usage of professional liability insurances should be expanded. According to art. 185 (1) (a) of GEO 34/2006, the economic and financial situation of a particular agent can also be demonstrated with evidence related to the existence of professional risk insurance. With regard to this qualification criterion, NARMPP has decided, by Order 509/2011, to restrict the possibility of using this requirement only to cases expressly regulated by legal provisions (e.g., technical design services.)⁴³ In the past, some

⁴³ According to NARMPP's interpretation, as it follows from Order 509/2011, the following qualification requirement is unrestrictive: "the bidder must produce evidence regarding the professional risk insurance



contracting authorities have included the requirement concerning the professional liability insurance in the template for the contract, annexed to part of the procurement documents. Although this practice has not been expressly approved by NARMPP, the generalization of this requirement is necessary to improve the delivery of services and, as argued elsewhere in this report, to “clean up” the market by charging higher premiums of those providers who do not fulfil their obligations. In order to apply this requirement, the request for professional liability insurance must be regulated for additional types of services (following the example of design services, mentioned by NARMPP) and rules must be adopted on how to calculate the ceiling of professional liability insurance, in order to avoid situations in which this requirement would be deemed excessive or restrictive.

376. Public procurement procedures can be launched under a “suspension clause”. Taking into account the significant duration of the selection, the evaluation, and the contracting stages, the deferred launching of the award procedure, after the signing of the financing contract, can lead to failure to comply with the schedule of activities, because of possible delays in public procurement. From this point of view, a possible solution consists in the launch of award procedures under a “suspension” conditional clause (“clauză suspensivă”), the effect intervening after the designation of the successful tender, but prior to the signing of the public contract. The conclusion of the public contract is delayed/suspended until a particular condition is met (i.e., the financing request submitted by the beneficiary is approved by the PNDL). This solution requires specifying in the call for tenders and in other procurement documents that the failure to sign the financing contract will determine the annulment of the procedure, based on art. 209 (1) (c) of GEO 34/2006, because the signing of the public contract has become impossible. This will ensure an appropriate degree of transparency and protect the contracting authority against a potential liability claim made, in the case of annulment, by the successful bidder.

377. Recommended templates should be designed for contractual variation clauses. In the case of public works contracts, the actual performance of the contracts may reveal differences against the quantities estimated by the technical documents. In order to regulate such changes of the object of the contract, where they do not involve a review of the technical solution adopted or of the technical requirements laid down in the specifications agreed to by the contractor, the contracting authorities can include, in the contract template, certain variation clauses according to which the final price of the contract is to be determined as the product between the prices/quantities initially tendered and the actual costs resulted from works on the ground. Obviously, this option is valid only if the price of the contract has not been determined in its absolute value, but only provisionally, as a product between the prices per unit and the quantities of works estimated by the technical documentation. The legality of variation clauses has been confirmed also by the letter No. MARKET/C3/EP/kr (2012) 677516 of the General Directorate Internal Market and Services of the European Commission, but is subject to the cumulative fulfilment of the following requirements:

related to the contract to be awarded, only if there are legal provisions governing such a situation.” At the same time, according to the same legal act, it is deemed restrictive a requirement concerning “the submission by the economic operator of professional risk insurance.”



- the formula for calculating the final price has to be defined, objectively, and it should be communicated to all prospective bidders, by including it in the procurement documents or in the contract template; and
- variations of the quantities of work and, implicitly, of the price actually paid have to result from the mechanical application of the variation clauses.

This solution has the advantage of being suitable to both the current tendering method for public works contracts, based on detailed items, as well as to the method based on consolidated components. The adoption of the solution would be facilitated by the development of standard contractual clauses (preferably by NARMPP), as well as by defining the specific implementation mechanism, in order to avoid applying it in the case of modifications deemed as “substantial.” It is important to emphasize that, as the European Commission has also specified, by using such contractual clauses, the variations of the quantities of works and of the final price do not constitute modifications of the contract per se, but only the application of the provisions of the initial contract.

378. Support for PNDL beneficiaries in the procurement process should be provided. Establishing a new professional body of assessors for the alternative technical solutions. The assessors may be required by the beneficiaries to evaluate bids and payments from the PNDL budget and they must be MRDPA certified engineers as site inspector (*Diriginte de șantier*) of Technical Responsible with Execution (RTE).

Contribution of the new Directives in the EU public procurement framework

379. Three new directives on public procurement bring a significant reform to the Community law framework⁴⁴. In December 2011 the Commission proposed the revision of Directives 2004/17/EC (procurement in the water, energy, transport and postal services sectors) and 2004/18/EC (public works, supply and service contracts), as well as the adoption of a directive on concession contracts. The directives were voted by the European Parliament on 15 January 2014 and adopted by the Council on 11 February 2014. The Member States have until April 2016 to transpose the new rules into their national law (except with regard to e-procurement, where the deadline is September 2018).

380. Some of the new provisions are already included in various forms in the Romanian legislation on public procurement (like the right of the bidders to provide, initially, only a self-declaration as preliminary evidence that the economic operator fulfils the relevant qualification criteria), so transposition should be easy. Nonetheless, more attention should be given, at the national level, to how existing legal mechanisms and instruments can be applied in practice. The following list is not a comprehensive review of EU-level changes in public procurement, but merely highlights some issues that will interest PNDL beneficiaries.

⁴⁴ For details see http://ec.europa.eu/growth/single-market/public-procurement/modernising-rules/reform-proposals/index_en.htm



381. **The New Directive on public procurement provides for the reduction of the minimum deadlines for receipt of requests to participate and for receipt of tenders.** The New Directive on public procurement, as set in the text, compared to Directive 2004/18/EC, establishes minimum deadlines comparing with former Directive. The significant reduction of deadlines for receipt of requests to participate and for receipt of tenders will accelerate the public procurement procedures. Although the deadlines set by the Proposal for a Directive on public procurement are minimal, the Member States having the right to establish longer deadlines, in Romania's case, it is recommended to adjust the new minimum deadlines. This adjustment will also speed up the process of implementing the projects and will minimize the risk of incurring delays versus the timetable of activities, as set in the financing application. Nonetheless, contracting authorities should be made aware of the fact that the actual deadlines must be set in accordance with the complexity of the contract and/or its specific requirements. This obligation is already provided for by the Romanian legislation (art. 71 of GEO 34/2006), but it will gain even greater importance if the deadlines are reduced. In order to help contracting authorities, it would be useful to define guidelines for determining the proper deadlines for a public procurement procedure, so that these are adequate and sufficient, as required by the aforementioned legal basis.

382. **The directive requires contracting authorities to exclude from participation in a procurement procedure the economic operators that are in breach of their obligations related to the payment of taxes or social security contributions.** A direct consequence of this fact will be the obligation of contracting authorities to request from economic operators the relevant documents in order to check if the aforementioned exclusion grounds apply. Noncompliance with this may lead to serious outcomes, including awarding a contract to an economic operator that should have been excluded.

383. **A new reason for excluding economic operators from a procurement procedure includes significant or persistent deficiencies in the performance of a substantive requirement under a prior contract, which led to early termination of that prior contract, damages, or other comparable sanctions [art. 57].** This provision allows contracting authorities to sanction those economic operators that have not fulfilled, properly and according to the quality standards agreed upon, their previous contractual obligations, by excluding them from the procurement procedure.

384. **The New Directive on public procurement, as set out in the compromise text, provides for the wider use of self-declarations by economic operators, in the form of the European Single Procurement Document (art. 59).** This provision states the obligation of contracting authorities to accept that economic operators submit, instead of certificates issued by public authorities or third parties, the European Single Procurement Document consisting of an updated self-declaration as preliminary evidence for fulfilling part of the selection criteria. The main aspects of the European Single Procurement Document are already regulated in the national legislation on public procurement: art. 11 (4)-(6) of GD 925/2006 stipulate the right of economic operators to submit, initially, only a self-declaration by which they attest the fulfilment of the qualification criteria set in the tender documents.



385. **The growing Community trend of favoring „the most economically advantageous tender” (MEAT) award criterion is easily discernible.** In the New Directive art 67 it is written that, „contracting authorities shall base the award of public contracts on the most economically advantageous tender.” However, the text brings an important nuance: although it mentions only one award criterion – the „most economically advantageous tender,” the actual definition of this criterion reveals the role that the price or cost still plays. Thus, the most economically advantageous tender from the point of view of the contracting authority shall be identified on the basis of the price or cost (using a cost-effectiveness approach, such as life-cycle costing) and may include the best price-quality ratio, which shall be assessed on the basis of criteria including qualitative, environmental, and/or social aspects linked to the subject matter of the public contract. Consequently, contracting authorities have the possibility of applying the revised MEAT criterion, based solely on the cost or price offered.

386. **As for criteria used to determine the best price-quality ratio, the Proposal introduces another major change:** the possibility of using criteria like the organization, qualification, and experience of staff assigned to performing the contract. This is particularly useful in situations where the quality of the staff employed can significantly affect the level of performance of the contract, allowing contracting authorities to evaluate and score tenders based on the staff designated for performing the work.

387. **Finally, the Directive defines more cases in which contracts and framework agreements may be modified without a new procurement procedure [art. 72 (1)].** Out of these, of particular significance is the one stipulated by art. 71 (1) (a), according to which modifications may occur, irrespective of their monetary value, where they have been provided for in the initial procurement documents in clear, precise, and unequivocal review clauses (which may include price revision clauses), or options

5.4 Choice of contract type

388. **The historical conditions of the pre-1990 socialist economy meant that the contracting parties were more or less representing the same player – the state.**⁴⁵ Under this system, the work used to be performed by a general contractor (usually a large state enterprise) and the construction phase was preceded by a full design provided by a state design institute covering all design specialties. As a result, the contracts used to be rather sketchy regardless of project size, complexity, or cost. Today’s industry has inherited this situation, and is more used to a certain contractual simplicity and with a basic traditional procurement route. Regarding the formulation of contracts, post-1990 efforts were mainly concerned with the update of main legal contract provisions to respond to the new legal statutory frame. Very little has been done to prepare the managerial and executive parts of the contracts to offer better-adapted managerial tools to suit the new economic conditions. This resulted in a low degree of contractual harmonization with:

⁴⁵ Cristian Banica. Standard Forms of Construction Contracts in Romania. Urbanism. Arhitectură. Construcții, Vol. 4, Nr. 4, 2013



- the progress of procurement routes and the emergence of new types of collaboration in construction (such as design and build formulas, adopted especially by the public sector);
- the specific and technical-operational working procedures that accompany the modern management of complex construction projects.

389. **Traditionally PNDL contracts are simple and straightforward.** From a sample of contracts analyzed, the quality ranges from very good contracts quite similar to FIDIC Green type (discussed below) to simple forms establishing the obligations of each party.

390. **While in theory the beneficiary could chose the type of contract that works best for defining the work components to be executed by the contractor, in practice all PNDL contracts are for execution based on bill of quantities.** The main reasons for this choice (over a design and build contract) is the low quality of the feasibility studies and the lack of familiarity with design and build contracts. If the beneficiary designs a project and then contract out its execution, the technical designer will be mandated to develop a bill of quantities (BoQ). The BoQ is used in the tendering procedures and helps contractors price the work required, and also ensures consistency and comparability across different offers. Designers in Romania typically develop the BoQ with the help of a computerized system that has data on standard, defined items (based on a collection of construction items of work – “indicatoare de norme de deviz”).

391. **More importantly, the current method preferred by designers is to use BoQs based on detailed items instead of consolidated components (“articole comasate”), which generates difficulties during the implementation phase.** The approach based on detailed articles dates from the communist era, when the government implemented all projects and required extensive explanations for every material used, including its quantity and its price. This is not needed under a system where a beneficiary and a service provider agree on a defined list of major components to be delivered as part of a construction project, along with set indicators and aggregate costs. The essential point is that the best practice of using consolidated items should be adopted by both beneficiaries and designers.

392. **Compared to the model described above, the design-and-build contract should provide even more flexibility for contractors with respect to the quantities used, within the limits defined by the beneficiary.** In this case, there is no need to define specific quantities ex-ante if the contractor is also in charge of developing the technical project. According to a recent JASPERS report, if a bill of quantities BOQ is included by the designer, “it can [then] be difficult to agree on the cost of variations if the work defined in the BOQ is higher or lower than that shown on the tender drawings or defined in the general specifications.”⁴⁶ Ultimately, the principle enunciated above remains valid: the simpler it is for beneficiaries to define construction work components and monitor their completion, the more efficient the whole system becomes. This also translates in

⁴⁶ “Support for the Preparation of Romanian Standardized Tender Documents for the Transport Sector 2010 132 RO ROD Ref. PO42217/CC. 4195,” JASPERS

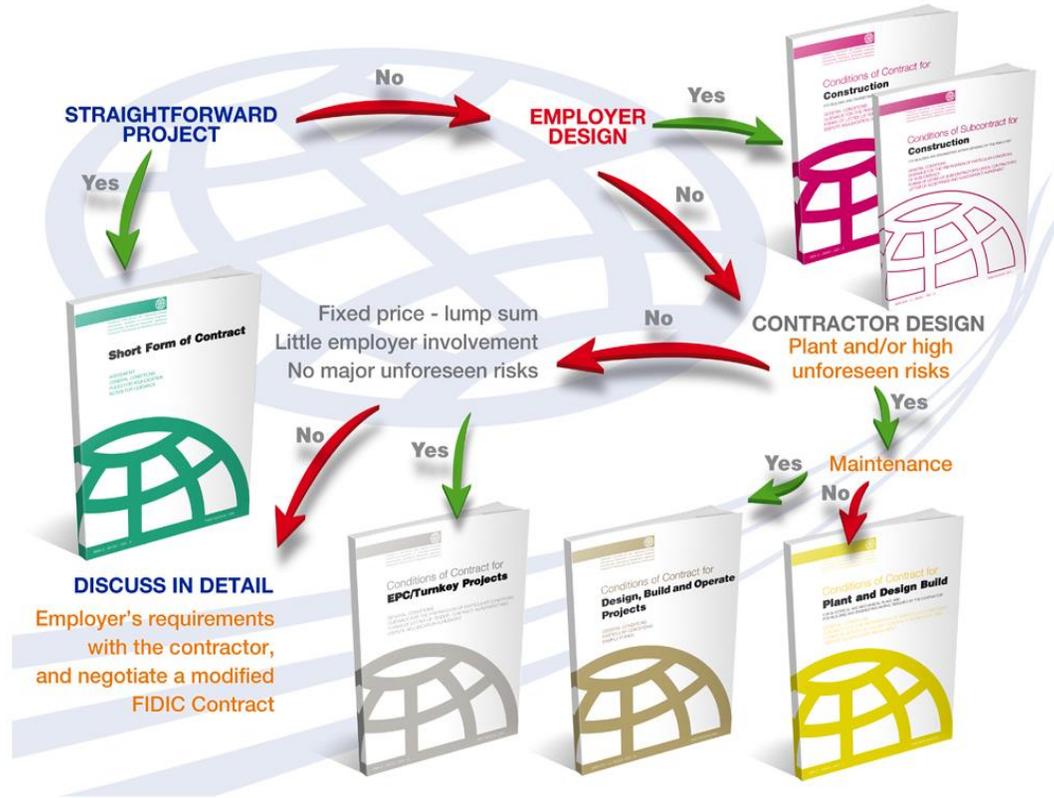


beneficiaries and the construction site supervisor having more capacity to focus on other critical items, instead of tracking every single item and material that goes into producing a certain deliverable.

393. **At the end of the day, the type of contract and BoQ used should be above all the beneficiary's choice based on which model delivers greater benefits.** A few supporters of the current preference for detailed items note that it is a method for preventing corruption and ill-intentioned cost changes. In practice, however, this does not work because contractors who would resort to such practices have easy ways of tricking the system. What is more, it should not be important whether the list of detailed items is implemented exactly as requested, but rather that the final product is according to all requested specifications. Keeping in mind the various contract forms in use, MA and IB experts should advise beneficiaries of ROP funds to rely on the system that is easiest and most efficient to implement.

394. **In particular, the FIDIC standard contract forms would help beneficiaries manage projects better, while protecting the interests of all stakeholders involved.** FIDIC, which stands for the International Federation of Consulting Engineers, is an international private organization that has developed since the 1950s various contract forms to facilitate the implementation of infrastructure and construction projects. Gradually, the superior quality of these proposed forms has translated into more and more people adopting them around the world. The main benefits of the FIDIC contracts revolve around a balanced sharing of risks between the beneficiary and the contractor and a greater degree of familiarity of international investors with the specific conditions and procedures mandated by these contracts. Indeed, the FIDIC contracts have already demonstrated their usefulness by covering a broad range of situations that may arise during the project's implementation and having clear mechanisms for resolving them in a fair and transparent manner. Since both beneficiaries and service providers benefit from adopting the FIDIC contract (compared to other formats that may expose one of the parties to greater risks), this practice has taken deep roots in the vast majority of developed countries, as well as for projects implemented by multilateral development banks.

Figure 22. Selecting the right type of contract (i.e., FIDIC color) is relatively simple



Source: <http://fidic.org/node/149>

395. In a welcomed recognition of the potential benefits involved in the adoption of red and yellow FIDIC, the Ministry of European Funds (MEF) has launched a significant effort to reintroduce these contract forms into the Romanian legislation. The first step was the May 2013 World Bank report on Improving the National Framework for Preparing and Implementing Public Investment Projects. This work built on the request expressed by consulting firms, technical designers, as well as public and private sector beneficiaries, who manifested a strong preference for FIDIC. The MEF initiated several rounds of consultations and, in August 2013, published a draft document on three types of FIDIC contracts (red, yellow, and green), noting its intention to adopt these forms through a legislative act with a higher authority than a simple Minister Directive (i.e., a Government Decision). This would prevent conflicts with the current Romanian legislation and improve the chances of beneficiaries adopting the FIDIC contracts, leveraging all the corresponding benefits described above.

396. While its approval is still pending, the new FIDIC proposal promises to solve a number of critical issues that have slowed the implementation of public investment projects (including investments with ROP co-financing). Specifically:

- *Unpredictable circumstances*: The new FIDIC General Conditions clearly define what conditions need to be fulfilled for a particular situation to be qualified as



“unpredictable,” a matter of great debate and confusion during the 2007-2013 period.

- *Role of the engineer:* The Engineer has to obtain the beneficiary’s approval in a number of instances, such as: particular technical solutions leading to increases in the contract’s price (clause 3.5); the appointment of subcontractors (4.4); the extension of the execution timeline (8.4); the suspension of works, partially or in full (8.8); and increases in the contract’s value beyond the approved budget for eligible expenditures, with the potential to minimize the number of instances when a particular needed expense is considered “ineligible” and has to be incurred by the beneficiary (clauses 13.1, 13.3., 13.5, and 13.6). Importantly, however, an issue left unresolved even under the new proposal is the amendment of Law 10/1995 that should reflect the role of the engineer, as warranted by FIDIC.
- *Professional insurance for designers:* It is recommended to add a clause (to article 18) requiring technical designers to have professional insurance. A potential formulation of this clause follows: “The contractor has to own a professional insurance policy that would cover all risks associated to professional negligence in the design of the project. The minimum level of the coverage should be equal to the total sum presented in the Annex to the offer. The contractor is required to maintain this policy up to the deadline mentioned in the same Annex.” As noted earlier in the report, this requirement would significantly boost the designer’s ownership over the quality of the product and gradually “clean” the market of those firms that are not abiding by rigorous standards.
- *Dispute Adjudication Board:* The proposal introduces for the first time the Dispute Adjudication Board (DAB), as the main body responsible for mediating between the key parties (beneficiary, contractor, engineer, etc.). The DAB is fundamental for accelerating the pace of projects’ implementation and can prevent lengthy court procedures.
- *Existing utility networks:* The new FIDIC adds a special clause to the following effect: “The contractor is required to know in advance, based on documentation submitted by the beneficiary and relevant entities, the physical location of all utilities, before the start of any works that may affect the existing networks.” While this clause is needed, this would also require that the beneficiary allow sufficient time for contractors to prepare their offers and become fully aware of the reality on the ground (i.e., under the minimum timeframe of 45 days).
- *Reception of partial works:* The new FIDIC contracts would permit beneficiaries, upon the Engineer’s recommendation, to receive partial works, as long as they are physically and functionally independent components of the larger project. This would create a win-win situation: the beneficiary could begin using certain parts of the investment sooner; the contractor would be able to cash in the warranty for proper execution; and the overall absorption rate would accelerate.

397. **More broadly, the FIDIC contracts ensure that there are balanced responsibilities between all the key parties – beneficiaries, consultants, designers, and contractors.** In addition, when finalized, the legislative proposal should be correlated with



the latest changes in this area: for example, the NARMPP recently issued Order no. 138/2012, which regulates certain provisions for FIDIC contracts applicable to road works.

398. **For major projects related to water supply and wastewater, Romania is already using Yellow and Red FIDIC contracts.** Red FIDIC contracts are usually used for execution of water supply and wastewater networks including necessary pumping stations. A common situation is to provide water supply and wastewater networks through Red FIDIC contracts and pumping stations through Yellow FIDIC contracts within the same contract (also called Yellow in Red). Yellow FIDIC contracts are usually used for execution of treatment plants, as well as for all types of works with specific execution or operation technology. In this case, the design is also provided by the constructor.

399. **Similarly, both Yellow and Red FIDIC are used for major road works.** While Red FIDIC is used for rehabilitation of national roads, Yellow FIDIC is used for new highways and motorways.

400. **Green FIDIC is adapted to PDNL projects.** Green FIDIC is suitable for projects of small value and low complexity. These are precisely the main characteristics of PNDL investments. Adoption of Green FIDIC for PNDL may represent a significant step towards improving the speed and efficiency of implementation. The proposal for Green FIDIC is provided in the annex.

5.5 Conclusions

401. **The award criteria should move from the current “lowest bid” criterion to the “most economically advantageous tender” (MEAT) criterion.** There could be a minimum share (expressed as a percentage of the total value of contract award procedures launched yearly by a contracting authority) for the contracts awarded based on the MEAT criterion. This way the competition between enterprises will focus on technical aspects, not only financial considerations. In addition, this measure will force enterprises to do their own research for design and building technologies that are more efficient and effective.

402. **Higher attention must be given to technical specifications.** Qualified technical experts, proving no conflict of interest with the bidding companies, must be systematically involved in the selection process. This will be even more relevant and needed as the use of MEAT with quality criteria becomes more prevalent.

403. **It is very important to make the technical specifications for public procurements as complete as possible.** Requiring new, green, and smart technologies for the construction of roads, water distribution systems, wastewater plants, and social infrastructure would be a first step to improve the quality of infrastructure in Romania.

404. **Public procurement procedures can be launched under a “suspension clause.”** Taking into account the significant duration of the selection, the evaluation, and the contracting stages, the deferred launching of the award procedure, after the signing of the



financing contract, can lead to failure to comply with the schedule of activities, because of possible delays in public procurement. From this point of view, a possible solution consists in the launch of award procedures under a “suspension” conditional clause (“clauză suspensivă”). The conclusion of the public contract is delayed/suspended until a particular condition is met (i.e., the financing request submitted by the beneficiary is approved by the PNDL).

405. **Green FIDIC should be adapted to PNDL projects.** Green FIDIC is suitable for projects of small value and low complexity. These are precisely the main characteristics of PNDL investments. Adoption of Green FIDIC for PNDL may represent a significant step toward improving the speed and efficiency of implementation.



6 Well-built Infrastructure

6.1 Roles and responsibilities

406. **The actors involved in the construction process are the Designer, the Certified Project Verifier, the Constructor, the Certified Technical Execution Responsible (RTE), the Site Inspector, and the Certified Technical Expert.** In compliance with Law no. 10/1995 on the quality in constructions, all the actors involved in the design and execution of works are responsible for the level of quality of the construction works for which they are contracted, according to the requirements.

407. **The execution of the construction works is the joint effort of the Beneficiary/Investor, design team, site inspector and Constructor/Contractor.** This process entails technical, financial, and legal aspects necessary to fulfill, during the entire lifetime of the construction, the essential requirements relating to: a) mechanical resistance and stability; b) fire safety; c) hygiene, health and environment; d) operating reliability; e) noise protection; f) energy saving and thermal insulation.

408. **In PNDL, beneficiaries are responsible for monitoring work progress and reporting updates to county councils and to MRDPA.** The flow of reports is similar to the one presented for financing requests: local beneficiaries send all documents corresponding to PNDL investments to county councils; every quarter, county councils send to the MRDPA a consolidated update on the progress of construction works. Upon request, beneficiaries are required to send to the MRDPA any document related to the financed project. For its part, the MRDPA is responsible for the monitoring and controlling the program's implementation. In this capacity, the Ministry can appoint representatives who, together with counterparts from the State Inspectorate for Constructions, verify the accuracy of reported data and compare it to the reality on the ground.

409. **The state control of construction works is conducted by the State Inspectorate for Constructions (ISC) throughout Romania, through its related regional inspectorates that order the measures and penalties provided by the law.** Through its regional inspectorates, ISC may order halting the construction works when it finds that the works are carried out in violation of legal provisions, of requirements related to construction quality assurance, without the basic engineering technical design or based on an illegally issued construction permit. Through its regional inspectorates, ISC informs the public administration authority on whose territory the inspection was performed about the findings and the instructed measures. In this situation, the control bodies of the County Council / Local Council have to monitor and follow up on the manner in which the ISC instructions are implemented.



410. **The Constructor must respect the main obligations as provided in Art. 23 of Law no. 10/1995 on quality in constructions.** Thereby, the Constructor must perform the following actions:

- inform the Beneficiary/Investor on the nonconformities and non-compliances found in the technical design, so that these problems can be solved;
- start the execution of works solely to the legally authorized constructions and solely on the basis and in compliance with the designs verified by the certified specialists;
- ensure the designed quality level through its own staff, which includes certified technical specialists in charge with the construction;
- invite the parties that are to take part in the inspection of works that have reached decisive stages of execution (determinant phases) and provide the necessary conditions performing works, so that work continuation approval is obtained;
- solve nonconformities, faults, and non-compliances that occur during the execution stages, only according to the solutions established by the Designer with Beneficiary's/Investor approval;
- for the construction works, only use the products and procedures that are provided in the technical design, are certified or approved, and meet the essential requirements, and manage the control samples;
- replace the products and procedures provided in the design with the ones that comply with the specified conditions, only based on the solutions proposed by the designer with the beneficiary's/Investor's approval.
- observe the technical designs and detailed engineering to achieve the quality level in compliance with the requirements;
- notify within 24 hours the State Inspectorate for Constructions (ISC) in case any technical failures occur during the construction works;
- implement the measures included in the control documents or construction works acceptance documents in a timely manner;
- remedy, at the contractor's own expense, the defects that occurred by its fault both during the construction period and during the warranty period, as stipulated by the law;
- leave the temporarily occupied areas in their initial condition, upon the completion of the works;
- establish the responsibilities of all participants in the production process – decision makers, collaborators, subcontractors – according to an own quality assurance system and based on legal provisions.

411. **The construction works' compliance with the documentation will be checked for the Constructor by the technical specialist in charge (RTE).** The beneficiary will supervise the works through the site inspector. The work site inspector's duties and responsibilities are in accordance with the provisions of Law 10/1995 on quality in constructions. The main purpose of works verification is to confirm observance of the project, specific technical regulations, and material specifications within the limits provided by the quality



indicators and admissible deviations. Depending on the time when verifications are performed, such verifications target the following:

- Determine – by measurements – the correspondence of the checked elements with the project;
- Verify the existence of documents certifying the quality of materials and equipment used in the works;
- Perform the tests and trials required by the projects and technical regulations, and prepare the documents summarizing such test and trial results as well as the Inspection Reports on buried works;
- Examine the existence and content of the documentation and inspection reports, as well as their summaries and conclusions;
- Conduct random checking (at the request of Reception Commission) and additional tests to confirm the correctness and validity of the signed documents (if these are requested).

412. **The contract performance guarantee is established by the contractor to ensure the Beneficiary that the works will be performed completely and properly during the agreed contract timeframe.** In the tender documents, the Beneficiary will provide the manner in which the performance guarantee is to be set up and its value, which will not exceed 10% of the contract price, VAT excluded.⁴⁷ Typically, the performance guarantee is set up by a guarantee instrument issued by a bank or insurance company, in accordance with the law, and it becomes an appendix to the contract. For works contracts, the contracting authority is required to issue/return the performance guarantee as follows:

- 70% of the value within 14 days of the signature of the Reception/acceptance report upon works completion, provided that no claims have been made in relation to such guarantee and that the hidden defect risk is minimal;
- the remaining 30% of the value, upon the expiry of the warranty period for the executed works, according to the final acceptance report.

413. **The designer, including specialists in architecture, strength and installations, is initially remunerated for elaboration of the technical design (level of the technical documentation for construction permit - DTAC) and obtaining the building permit.** During this period many versions, modifications, and changes are discussed and agreed between the Beneficiary and the Designer. The Beneficiary may suspend payment, respectively the design, until the construction permit is obtained. It may also happen that the Beneficiary intentionally undertakes the modification of the technical design,, which is followed by the redesign of the entire structure after the building permit is obtained. In such circumstances, the Constructor will not receive the entire project in due time and thus he will not have time to find any errors or inconsistencies.

⁴⁷ According art. 89 of Government Resolution no. 925/2006 on the approval of the rules for the implementation of the provisions concerning the award of public procurement contracts stipulated by the Government Emergency Ordinance no. 34/2006, as subsequently amended and supplemented.



414. **The work guarantee term (period) is the time between the date of acceptance at work completion and the final acceptance date, the duration of which is provided under the contract.** Within the warranty period, the constructor must remove, at its own expense, all the deficiencies that occur due to failure to comply with the contract clauses or specifications or with the applicable technical regulations.⁴⁸

6.2 Preparatory steps

415. **The management system of construction works is specific for every Romanian constructing company based on the national legislation on quality and occupational health and safety, financial/accounting, public procurement (if applicable), and legal field.** Alignment of national construction quality requirements to the international requirements took the form of Law no. 10 on quality in constructions adopted on January 18, 1995. Control quality programme for determinant phases is specific for each type of work and is elaborated by the Designer in the technical design, and is endorsed by the ISC.

416. **According to legislation in force (Law 50/1991 on authorizing the construction, republished and amended), the execution of construction works may start only for constructions authorized under the law.** Delays in the release of building permits from specialized departments in Local Councils / County Councils (mostly due to the delay of issuance of approvals by the specialized bodies) lead to delays in starting the construction process. Given that investments of this kind are financed from the PNDL budget, beneficiaries cannot afford to waste a calendar year due to bureaucracy, lack of staff, or other reasons put forward by issuing bodies and are forcing the start of the construction process without having a building permit.

417. **The execution of the construction works can be achieved solely based on technical design developed at the level of detailed engineering.** The issuing authority of the construction permit establishes a timeframe for works commencement of max. 12 months from the issuance date, during which the applicant has the obligation to start the works. The permit is valid for the entire period of works execution, according to the basic technical design. The Beneficiary is obliged to notify the construction permit issuing authority and the construction regional inspectorate about the date when the authorized works are to be commenced. These deadlines can be extended to a maximum of 12 months; after that, permit reissuance is required.

418. **Technological designs, which correlate and include all technological processes needed to achieve a certain stage of a work, tend to simplify and improve the organization of infrastructure works.** Technological projects include physical stages and flowcharts of operations, technological descriptions of processes, and all this information is needed for the development of economic documentation in order to ensure both quality and economically efficient work execution.

⁴⁸ See GD no. 273/1994 on the approval of the Regulation for the acceptance of construction works and related installations, as subsequently amended and supplemented



419. **There are also some issues arising from the design process that may affect the proper construction process.** These include: problems caused by design errors mainly due to the lack of accuracy of the feasibility studies or support studies (topographic survey and geological studies); lack of knowledge of the real on-site situation; and the changes in the on-site situation between the preparation of the technical design and detailed engineering design and the actual commencement of the execution works.

420. **If any inaccurate topographic survey is found, it should be determined whether the level difference between the geodetic levels provided in the project and the actual geodetic levels are constant throughout all networks/entire road or differ in various network areas/road sections.** If the level differences are constant, the implications on the construction works are minor and the actors involved can switch from the absolute level measuring system to the relative level measuring system. This change will not affect the quality of works, the amount of works or, ultimately, the construction costs. It should be pointed out that the post-execution drawings should present the real situation, having the measuring system expressed in absolute levels.

421. **When performing the topographical survey to set the site boundaries, some observations may arise in relation to the intersection between the designed road and private land.** This is caused by the fact that the Designer has worked based on old, outdated drawings, which were not approved by the Office for Cadaster and Land Registration (OCPI). In consequence, delays appear in the project implementation schedule due to the unclear legal status of the land. It is therefore necessary to issue immediately a work site provision/instruction for the update of the technical documentation. The fault belongs to the designer because the designer has not carried out its work based on the drawings approved by OCPI, but also to the Beneficiary, because it is the Beneficiary's responsibility to hand over to the Constructor the land unoccupied, free of charges. The solutions must include an update of the cadaster drawings and clarifying clarification of the legal status based on precise topographic survey. Afterwards, the road will be redesigned based on the plans approved by OCPI. One solution would be to keep the road structure and dimensions, if the road width cannot be reduced, and to lease additional land, or both solutions combined (redesign the road and lease additional land). The final solution will be chosen by the Beneficiary together with the designer, based on technical and economic grounds.

422. **Careful attention should be paid to the intersection between various water supply and sewerage systems and to any level differences of such systems.** If the level differences on various sections of the network are not constant, the implications on the actual execution of works are major and can lead to technical solutions that are different from those provided by the designer in the technical design and detail engineering design. These different technical solutions may lead to different works quantities and even works that are different from those provided in the initial project, which may finally affect the value of the execution contract. Such issues are solved by site provisions/instructions drawn up by the designer and implemented by the Constructor. If the value of the contract is exceeded by these site provisions/instructions, any additional value will be covered by the designer (FIDIC Red book) or by the constructor (FIDIC Yellow book). It should be underlined that the post-execution drawings must present the real situation.



423. **In case of problems caused by the designer’s lack of knowledge of the actual on-site situation, the implications on the execution could be major and could lead to technical solutions that are different from those provided by the designer in the basic engineering and detail engineering design.** These different technical solutions may lead to different works quantities and even works that are different from those provided in the initial project, which may finally affect the value of the execution contract. Such issues are solved by site provisions/instructions drawn up by the designer and implemented by the constructor. If the value of the contract is exceeded by these work site instructions, any additional value will be covered by the designer. It should be underlined that the post-execution drawings must present the real situation.

424. **For the problems caused by the changes in the real on-site situation that has occurred between the technical design and detail engineering design date, and the actual commencement of the works, the implications on the construction works could be major and could lead to technical solutions that are different from those provided by the designer in the technical design and detail engineering design.** These different technical solutions may lead to different works quantities and even works that are different from those provided in the initial project, which may finally affect the value of the execution contract. Such issues are solved by work site provisions/instructions drawn up by the designer and implemented by the constructor. If the value of the contract is exceeded by these work site instructions, any additional value will be covered from the project budget, line 5.3 on “Diverse and unforeseen expenditures.” It should be underlined that the post-execution drawings must present the real situation.

425. **Legislative changes are valid from the moment the Law is published, which may generate ad-hoc technical and economic changes in the design and execution process.** If the design process has a certain flexibility, changes in the execution process lead to additional costs and delays.

426. **Inconsistencies caused by errors in the preparation of the tender/ bid, based on which the execution contract was awarded are mainly caused by arithmetic errors when filling out the lists of quantities.** The amounts paid to the constructor will be those provided in the contract if the correct amount is higher than the amount stipulated in the contract, or the actual ones if the correct amount is lower than the amount stipulated in the contract.

6.3 Analysis of best practice regarding technologies proposed to improve cost effectiveness for infrastructure investments in Romania

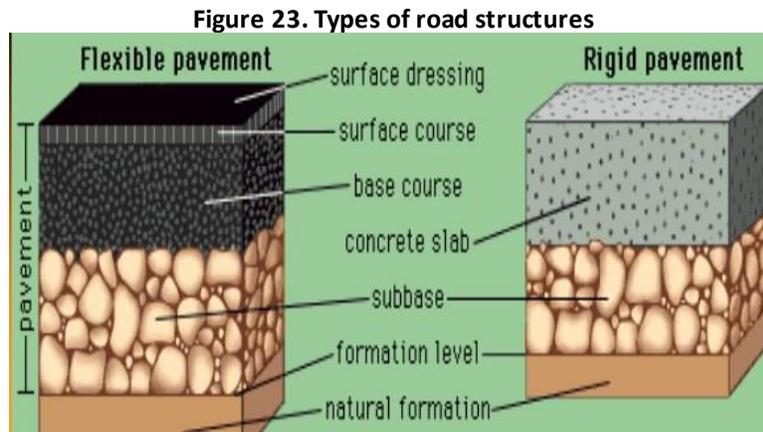
427. **The use of new and improved construction materials is an important aspect of today’s economy.** Considering the best international practices, new solutions for road infrastructure, water and wastewater systems, and social infrastructure are available regarding the materials used. This way, green and environment friendly infrastructure can be built.



ROAD INFRASTRUCTURE

428. From the perspective of the materials used, road pavements can be classified into three major groups, although they have the same function – to take over and transmit traffic loads to the foundation ground. These three categories are:

- Flexible road pavement - consists of a series of layers made of mechanically stabilized non-cohesive materials and / or hydrocarbon binders, wear and base layer made of asphalt, bituminous macadam, or ordinary macadam;
- Rigid road pavement - made up of a series of layers stabilized with binders (or not stabilized), on which there is a coating of cement concrete;
- Mix road pavement - consists of natural aggregates layers that are stabilized mechanically and with hydraulic or pozzolan binders, and also includes wear and base bituminous layers.



Source: *Pavement and foundation*⁴⁹

429. According to European standards on asphalt mixtures (SR EN 13108), there are seven types of mixtures:

- Asphalt Concrete – with a strong mineral body;
- Asphalt Concrete for very thin layers – used in wear layers of 2-3 cm;
- Soft Asphalt – has in its composition soft bitumen and are often used in Northern countries;
- Hot Rolled Asphalt – has a discontinuous and dense mineral body, with high performances;
- Stone Mastic Asphalt – high chipping content;
- Mastic Asphalt – is an asphalt mixture without voids;
- Porous Asphalt – has a high volume of voids, allowing water and air to pass through.

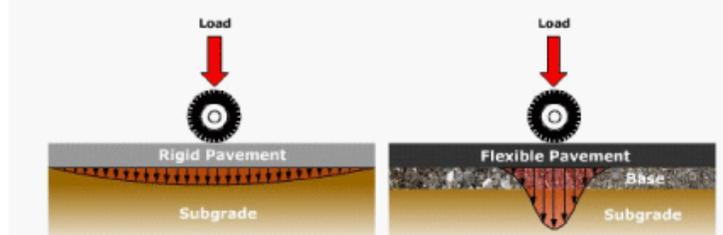
In Romania, only three of these asphalt mixtures are used: Asphalt Concrete, Stone Mastic Asphalt, and Mastic Asphalt. For the others, there are no standards implemented.

⁴⁹ <http://www.civilengineeringterms.com/pavement-and-foundation/base-course-flexible-pavement/>

430. **There are also differences in the types of cement concrete wear layers used internationally, such as:**

- Simple cement concrete;
- Reinforced cement concrete;
- Dispersely reinforced cement concrete with synthetic and metallic fibers;
- Continuously reinforced cement concrete;
- Thin layers for the rehabilitation or reinforcement of flexible pavements;
- Slightly noise cement concrete wear layers ;
- From prefabricated elements of concrete or reinforced concrete;
- Prestressed concrete;
- Composite structures.

Figure 24. Typical stress distribution under a rigid and a flexible pavement



Source: *Pavement Design Guide*⁵⁰

431. **At present, the international focus is on improving mechanization in road superstructure works and on introducing new and advanced technologies with greater economic efficiency, in order to ensure rational use of resources.** Increasing traffic volumes, increased axle load, and increased tire pressure on the European road network have led to the need for stronger and more durable infrastructure, while also ensuring reduced downtime due to traffic maintenance and rehabilitation. For this, at the European level the following trends may be observed:⁵¹

- Large scale use of polymer modified bitumen and additives;
- Recycling both asphalt mixtures and cement concrete road. Recycling makes its presence felt increasingly in the construction and rehabilitation of roads, helping optimize the use of natural resources, the introduction into the market of unsuitable materials called “waste,” and contributing to the development of performant materials with high durability;
- In terms of cement concrete road, the new worldwide trend is the use of precast cement concrete pavements, continuous armed pavements, and cement concrete road rehabilitation for roads with asphalt mixtures as wearing layer;

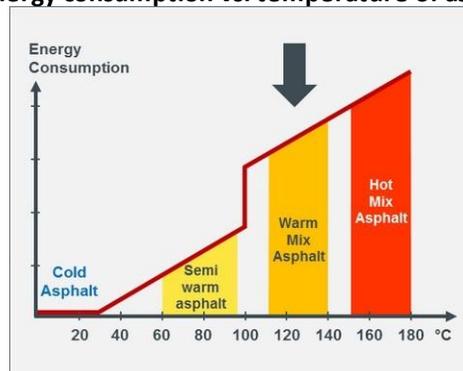
⁵⁰ Russel W. Lenz. *Pavement Design Guide*, 2011

⁵¹ Adrian Burlacu. “Road Infrastructure Technologies – Course Notes”, Bucharest, 2015



- Recently, cold recycling raised high interest for construction and maintenance using various technologies such as foamed bitumen, bitumen emulsion or cement, with beneficial effects in terms of reducing emissions and energy consumption.
- Technologies that reduce the temperature of mixing and placing asphalt mixtures - the concept of low-temperature asphalt ("warm mix" or "cold mix");
- The road network occupies a large area with a high potential for energy production. Thus, currently, new technologies for the use of this energy through various systems are developed – e.g., piezoelectric, sewer pipe networks that absorb heat during the summer, which will be returned to fight icing during winter.

Figure 25. Energy consumption vs. temperature of asphalt mixture



Source: Marini-Ermot Fayat Group ⁵²

432. **The efforts toward saving natural resources must be extended to saving energy.** Handling of thousands of tons of building materials is a very energy consuming business for road construction. Nevertheless, important savings can be made by focusing more on the treatment of these materials on site and in plants. Hot asphalt mixes are the main components of pavement constructions. The development of high quality low temperature binders and mixes produces substantial savings in energy and production costs. In this context and in view of the increasing scarcity of natural oil, the development of so-called Bbo-binders (binder burn out) is a potential option.

433. **A technical solution used internationally, particularly in urban areas, is that of photo-catalytic paving slabs.** They are made of materials designed to minimize air pollution. Laboratory testing showed higher effectiveness in reducing the NOx concentration in air, these slabs being increasingly used in Belgium, United Kingdom, Italy, Japan and France.

⁵² <http://en.marini-ermont.fayat.com/TECHNOLOGY/Warm-mix>



Figure 26. Photo-catalytic paving slabs in Antwerp, Belgium



Source: NR2C⁵³

434. **Most developed countries have used in the road construction process a rigid pavement solution, with cement concrete.** This type of pavement has numerous advantages comparing to the flexible pavement, which is currently used on most roads in Romania. Some of these advantages are:

- great rigidity and consequently a good distribution of the loads on the foundation and excellent fatigue behavior;
- great resistance to wear and rutting and edges that do not erode;
- not affected by oil, organic substances, chemicals;
- bright color, skid resistance and safety in winter;
- environmentally friendly - Asphalt (bitumen) produces lots of highly polluting gases at the time of melting it for paving; also, less fuel consumption by the vehicle running on a concrete road means less pollution;
- concrete pavements last long too and require little maintenance, at least if they have been designed properly and executed professionally;
- saving of natural resources: Asphalt (bitumen) is produced from imported petroleum, the reserve of which is becoming reduced drastically; on the other hand, concrete (cement) is produced from abundantly available limestone.

Cement concrete roads have been used since the 19th century and until now more than 200.000 km were built in US, 3.000 km in Germany, and 90% of the roads in Austria were built using this technology. (Source: prof. Gheorghe Lucaci – Course on Rigid road pavements)

⁵³ NR2C. New road construction concepts, 2008



Figure 27. Cement concrete road pavement



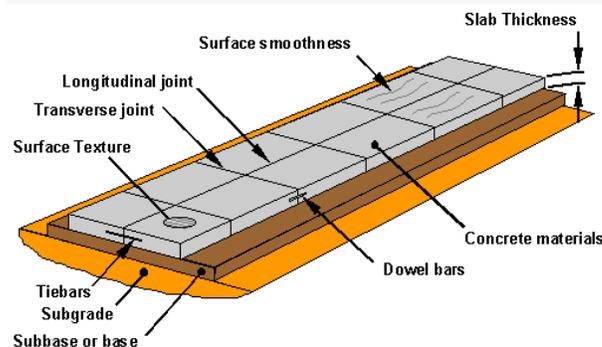
Source: Southern California Regional Rocks and Roads ⁵⁴

435. Like any road pavement, cement concrete has also its disadvantages, such as:

- High initial costs;
- Need for high standard construction methods;
- Joints required for contraction and expansion;
- Generally rough riding quality;
- High repair costs.

436. The main limitation for the use of cement concrete pavement in Romania is the building process. Cement concrete pavements imply new technologies, but also qualified personnel to implement them. Unlike flexible pavements that can be easily repaired in case of inadequate building, the cement concrete pavements have rigorous standards that must be strictly respected. In case of flaws, the repair process is very complex and expensive.

Figure 28. Basic components of a concrete pavement



Source: Construction of Cement Concrete Pavement ⁵⁵

437. In Romania, road infrastructure pavement is usually a flexible one, consisting of various layers and granular materials provided with a layer of bituminous materials on top. Their main advantages are:

⁵⁴ http://socalregion.com/highways/us_99/us99028/

⁵⁵ Ravi Gupta B.Tech(Civil Engg.) – Construction of Cement Concrete Pavement, 2014



- The economic aspect - less costly compared to concrete and a shorter period needed to build an asphalt road than a concrete road;
- Adaptability to stage construction;
- Availability of low-cost types that can be easily built;
- Ability to be easily opened and patched;
- Easy to repair frost heave and settlement;
- Resistance to the formation of ice glaze.

438. **The main disadvantages of flexible pavements are:**

- Reduced durability (heavy rain and other extreme weather conditions damage the asphalt road, and the roads need to be repaired frequently);
- Weather pollution (melting asphalt produces lots of harmful greenhouse gases, and costly petroleum is required to produce asphalt);
- Higher maintenance costs;
- Shorter life span under heavy use;
- Damage by oils and other chemicals;
- Weak edges that may require curbs or edge devices.

Figure 29. Asphalt road pavement



Source: Baumeister⁵⁶

439. **For flexible road pavements, another advantage is the ability to recycle.** Although this technology is not frequently used in Romania, it might have very good results from an economic point of view.

440. **The main aspects that may interfere in the construction process of a flexible road pavement are:**

- Segregation – the separation of big dimension aggregates from the smoother part of the mixture, due to multiple causes, such as long transport distances;

⁵⁶ <http://www.baumeister-utilaje.ro/lucrari-de-infrastructura>



- Contamination with petroleum products – they are used in cleaning the machines, and if they get in contact with the asphalt mixture, they dissolve the bitumen;
- Compaction problems – due to the high speed of the compactor, among other causes;
- Working in inappropriate weather conditions;
- Low adherence between layers – if the priming is not appropriate, the layers tend to not bond to each other.

Figure 30. Low adherence between layers

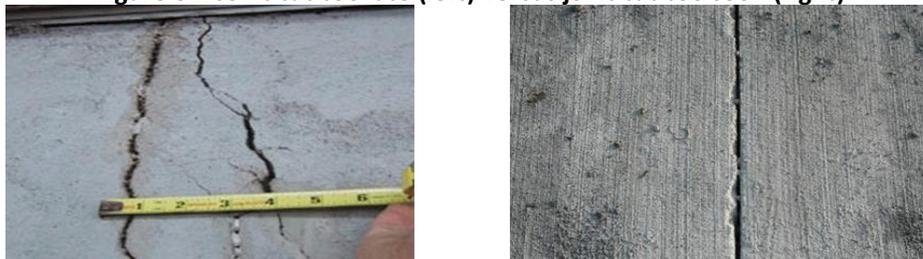


Source: *Road Infrastructure Technologies – Course Notes*⁵⁷

441. **Some of the main aspects that may interfere in the construction process of a rigid road pavement are:**

- Segregation – the separation of big dimension aggregates from the smoother part of the mixture, due to multiple causes, such as long transport distances;
- The improper vibration of the concrete during construction process;
- The incorrect execution of joints;
- Inadequate leveling of the concrete surface;
- Working in inappropriate weather conditions.

Figure 31. Joint cut too late (left) versus joint cut too soon (right)



Source: *Road Infrastructure Technologies – Course Notes*⁵⁸

442. **In case of local roads, such as current communal or rural dirt roads, the existing gravel can be used provided it has the appropriate features of a subbase layer, or can be otherwise treated to become a subbase layer capable to withstand traffic and environments loads.** This requires the use of additional materials such as hydraulic binders (both cement and hydraulic road binders), bitumen emulsions, foamed bitumen or

⁵⁷ Adrian Burlacu: “Road Infrastructure Technologies – Course Notes”, Bucharest, 2015

⁵⁸ Adrian Burlacu: “Road Infrastructure Technologies – Course Notes,” Bucharest, 2015



environmentally-friendly enzymes, all of them with the role of securing a layer capable to withstand higher vertical loads than the current gravel layer. These new, innovative methods can yield thinner road structures which are able to withstand similar loads as regular road structures.

443. Utilization as much as possible of local materials in order to minimize costs of transportation from remote areas. Thus, the initial assessment of the existing road infrastructure is of particular importance, and the existing road structure materials should be used based on reliable technical and economic studies. In case of roads with an existing structure but which are either very degraded or obsolete in terms of load-carrying capacity, the following recycling techniques may be reliably used: hot recycling in the asphalt mixing plant, in-place hot recycling, in-place cold recycling, and full recycling of the road structure.

444. As far as asphalt mixtures are concerned, there are 4 main aspects which bear on the production cost: materials, production at the plant, transportation and laying. In the case at hand, 70% of the cost of a new asphalt mixture is represented by the cost of materials and of producing the asphalt mixture. Even though an average of 20% of the old asphalt mixture is used nowadays, this percentage is on a significant increasing trend. If a new asphalt mixture costs approximately 250 lei per ton, a mixture of 100% recycled materials could cost as low as 50 lei per ton.

445. The most economical solution is to use recycled asphalt mixtures for the middle and upper layers of flexible road structures, in which the cheaper recycled bitumen may be combined with new bitumen and various regeneration additives, thus cutting production costs. The use of recycled asphalt mixtures in the hot laying technology leads to savings in excess of \$300 million in the USA alone, by cutting down materials use and removing costs. According to a study, more than 68.3 million tons of recycled asphalt mixture were reclaimed for use in new roads in the United States in 2012, with related savings in excess of \$2.2 billion.



Table 6. Recycling at international level⁵⁹

Country	Available reclaimed asphalt (tonnes)	% of available reclaimed asphalt used in				% of the new hot and warm mix production that contains reclaimed material
		hot and warm recycling	half warm recycling	cold recycling	unbound layers	
Austria	750.000	95		3	2	
Belgium	1.500.000	61	No data	No data	No data	51
Czech Republic	1.450.000	18	0	25	20	10
Denmark	790.000	83			17	58
Finland	860.000					20
France	6.900.000	64	No data	No data	No data	>65
Germany	11.500.000	90			10	No data
Greece	No data					0,03
Great Britain	4.000.000-5.000.000					
Hungary	88.000	80	0	10	10	20
Iceland	15.000					3,0
Ireland	150.000					
Italy	10.000.000	20				
Luxembourg	300.000	90	0	10	0	50
Netherlands	4.500.000	76				70
Norway	686.268	21	0	5	74	20
Romania	22.000	20	20	20	30	10
Slovakia	26.000	90	0	5	5	
Slovenia	26.000	26	0	20	54	5
Spain	205.000	85		7	8	1,3
Sweden	900.000	80	5	5	10	70
Switzerland	1.370.000	48	17	15	8	27
Turkey	1.200.000	3		1	96	1
Japan						76
U.S.A.	69.000.000	92			8	

446. **There are more than 15 million kilometers of roads and motorways in the world, of which a few hundred thousand require significant rehabilitation works on an annual basis.** Governments and local authorities everywhere earmark approximately USD 100 million each year in an attempt to maintain roads functional and safe. In spite of this, many roads are damaged due to insufficient transportation budgets and to the high costs of the traditional rehabilitation methods. For instance, approximately 90 million tons of recycled asphalt mixture are reused each year in the United States, nearly two times more than the combined quantity of recycled paper, glass, aluminum or plastic⁶⁰.

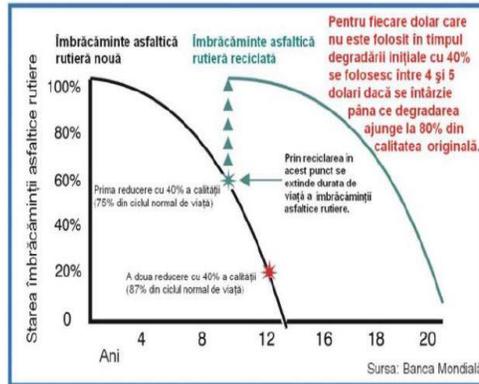
447. **The damaged road pavement is characterized by low operating quality and by physical degradation such as cracks, rutting and slippery road surface.** As shown in the figure below, the deterioration of the road pavement steps up after a few operating years; however, timely rehabilitation by applying a new coat or by recycling the asphalt can restore the quality of the road pavement and thus extend the service life of the respective road. Studies carried out by the World Bank showed that recycling the road lining is highly cost-effective, particularly when performed before the deterioration becomes very advanced.

⁵⁹ European Asphalt Pavement Association (EAPA)

⁶⁰ D. Popescu, A. Burlacu. „Considerations on the benefits of using recyclable materials for road constructions”, Conference on „Road research and management”, CAR 2015

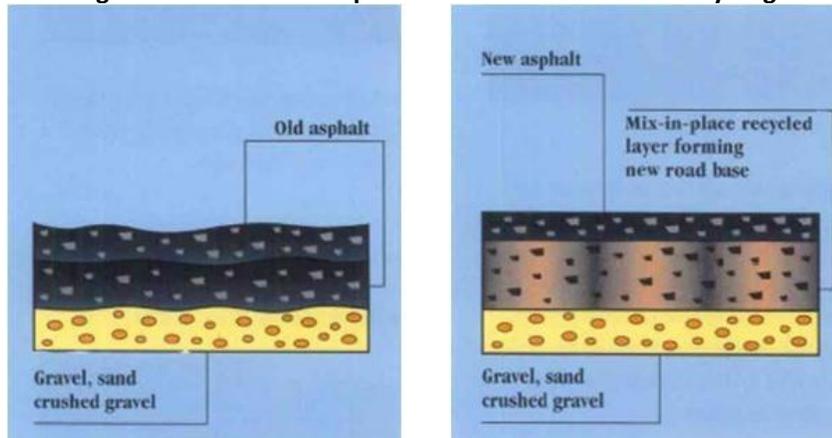


Figure 32. Best time for recycling the asphalt mixture



448. **Asphalt mixture recycling reduces the amount of virgin aggregate and liquid asphalt used, and mitigates the cost, logistics, and environmental impact of trucking the material to the place of use.** It can quickly fix deteriorating pavements, including problems in the subgrade. When recycled asphalt is used, the new road is often built better than the first one. The final wearing course can be as minimal as macadam, or as sturdy as a full layer of hot mix asphalt. Asphalt recycling can also be used to expand lane widths or shoulders.

Figure 33. Flexible road pavement before and after recycling



Source: Bomag⁶¹

449. **The hot recycling technology for bitumen road pavements may be applied in the following variants:**

- a) by cold grinding of the existing bituminous layers, followed by proper recycling by hot mixing of the milled mixture with the additives in a mobile dryer-mixer plant;
- b) by infrared heating (radiant panels) of the existing bituminous layers, followed by scarifying and mixing the hot asphalt mixture with additives, either directly on the base or in a vat or mixer above the base.

⁶¹ http://www.bomag.com/worldwide_replacement



450. **In-place hot recycling is a method for the rehabilitation of degraded road pavements.** This operation is entirely carried out in-place, by means of a machine assembly (recycling train) and begins by the application of heat to “soften” the road surface. The softened asphalt material is removed by grinding devices, and subsequently mixed with or without the addition of recycling agents. The recycled asphalt mixture is then laid along the road and compacted to complete the recycling process. Although this recycling method is 100% effective, certain remixing options such as the addition of new hot asphalt mixture or new mineral aggregates may be required for the structural correction and improvement of the geometrical features of the road.

Figure 34. Hot-in-place recycling



Source: Road infrastructure technologies – Course notes⁶²

451. **Advantages of this method:**

- Old, weathered and defective surfaces are replaced by a new layer, which eliminates both the longitudinal and the transversal damages;
- Removal of cracks and other surface flaws;
- Reuse of existing materials;
- The recycled mixture is itself recyclable;
- Minimizes road closures – works can be carried out on one lane, while the other remains open to traffic;
- Preservation of the current road geometry.

The road pavement produced out of recycled asphalt mixture is usually similar, if not better than road pavements produced out of new asphalt mixture by traditional methods.

⁶² Adrian Burlacu. “Technologies for road infrastructure – Course notes”, Bucharest, 2015



452. **The full recycling of the road structure is a cold technological process which consists in grinding the entire road structure and mixing it with in-place additive binders, a material which will serve as the base for the future road structure.** The usual additive binders are bitumen emulsion, foamed bitumen, power plant ash and lime.

453. **The in-place cold recycling of bituminous road pavements consists of the following main stages:**

- Grinding of the old, degraded asphalt pavements;
- Crushing of the ground material down to the required granularity;
- Spraying binders on the ground material (various binders);
- Mixing of the resulting mixture;
- Laying-in of the mixture;
- Compaction;
- Paving of the laid layer with asphalt, depending on the existing conditions and on the sizing requirements for the new structure: 3 asphalt layers (wearing, binding and base layer), one or two layers of bituminous pavement, bituminous treatments.

Figure 35. In-place cold recycling



Source: Road infrastructure technologies – Course notes⁶³

454. **The advantages of cold recycling are the following:**

- Environmentally-friendly process;
- Reuse of the old asphalt structure materials, with minimum addition of new material;
- It is considered the most economical method for road rehabilitation;
- Low cost, as aggregate purchasing and trucking to the laying place are no longer required;
- No NOx emissions from hot asphalt mixtures, as the recycling is cold-based.

⁶³ Adrian Burlacu: „Technologies for road infrastructure – Course notes”, Bucharest, 2015.



A specific example is the rehabilitation of Dersingham Avenue in London, where a total of approximately £80,000, 4 weeks of noise and traffic restrictions, and more than 9 tons of CO2 emissions were saved. Repairing the road by conventional methods would have incurred nearly £320,000 in taxpayers' money and would have lasted for 7 weeks. Thanks to the in-place cold recycling, the street was rehabilitated in 3 weeks, for a total cost of approximately £240,000. Thus, the in-place cold recycling technology proved faster, more economical and more environmentally friendly.

455. **Using this technology saves power, mitigates the aggregate transportation costs and construction waste and preserves natural non-renewable resources such as bitumen or new aggregates.** The recycling of asphalt mixtures creates an optimum usage cycle for the natural resources and supports the asphalt producing industry.

456. **Types of recycling-suitable materials in road construction works:**

- **Slags:** The first experiences in using slags as an aggregate in asphalt mixtures dates back to 1969, when an experimental road section was built in Toronto. For this road section, steel furnace slag was used as an aggregate in both the base course layer and the wearing layer. The asphalt mixtures reviewed showed very good results in terms of load-carrying capacity, resistance to external factors and durability.⁶⁴
- **Crumb rubber:** Crumb rubber modified bitumen is a mixture of hot bitumen and ground rubber from waste or scrap tires. It is widely used in the transportation sector in both Europe and the United States. As far as noise is concerned, the Rubber Pavements Association (RPA) declared that the addition of rubber in asphalt mixtures cuts noise levels by up to 50%.
- **Glass:** Currently, up to 10% glass can be used instead of aggregates for base course layers in the US. The maximum glass size must be 4.75 mm for safety reasons, but also since coarse-grained glass surfaces will not have the required granularity. The best results were achieved with a glass content of at least 10% of the total weight and a glass size less than 6 mm.
- **Plastic:** UK-based studies on asphalt mixtures containing recycled plastic, particularly low-density polyethylene (LDPE), which replace approximately 30% of the 2.36 - 5 mm diameter aggregates, showed benefits such as increased Mashall stability and tensile strength. The most significant advantage is that the production process does not require any alteration of the current LDPE-asphalt mixture mixing plants.⁶⁵
- **Crushed concrete:** The American Concrete Pavement Association estimates that approximately 322 kilometers of cement concrete roads are recycled each year, and that approximately 1750 tons of crushed concrete can be recovered from 1 km of cement concrete road with a 25 mm average thickness. This means that

⁶⁴ J. J. Emery. "Slag utilization in pavement construction. Extending aggregate resources", in *American Society for Testing and Materials*

⁶⁵ W.H. Chesner, R.J. Collins, M.H. Mackay: "User Guidelines for Waste and By-Product Materials in Pavement Construction", no. FHWA-RD-97-148, April 1998



2.6 million tons of concrete are recycled each year in the United States. Concrete from roads, sidewalks, buildings and other sources can be crushed for reuse. Before crushing, the concrete should be stripped of reinforcements or other enclosed materials. Concrete crushing produces hard granular aggregates made of inert minerals, such as sand, gravel or crushed stone. Due to cement plaster bonding on the concrete aggregates, the aggregates resulting from the crushing of concrete are hard textured, have an apparent low density, and their water absorption exceeds that of similar sized natural aggregates.

Water and wastewater infrastructure

457. **For water and wastewater systems, the durability of a plumbing system is dependent on the quality of its component parts and the assembly skills of those who install it.** No plumbing system, however well designed, can be expected to operate safely or hygienically if the products or materials used are unsatisfactory. The inverse is also true – if the best-quality products or materials are used but are installed incorrectly, the system will be a failure.⁶⁶

458. **Pipes, valves, taps and other fittings used for the supply of drinking water or the removal of wastewater must not contain harmful substances above the specified amount that could leach into the water.** Lead, cadmium, and arsenic are examples of many possible contaminants that could be present. The pipes, valves, taps, and other fittings must be capable of conveying water at a nominated pressure within a prescribed environment, and must be of sufficient strength to contain anticipated internal pressures. They must also be able to withstand external pressures if they are to be buried. The impact of environmental factors such as heat, cold, expansion, contraction, corrosion, pH and bacteria levels also need to be considered.

459. **A range of pipe materials is available for water distribution.** The old technical solution (before 1950) of construction of distribution systems involves cast iron and concrete pipes. Cast iron is an excellent pipe material, which is used even nowadays, but a very expensive one. This is the reason why cast iron material was completely replaced in 1960 by concrete pipes. Pipes made of concrete were very cheap but very heavy and poor quality regarding joints and roughness, which induce high power consumption for pumps and high water losses. The concrete pipes were replaced in 1970 by asbestos cement pipes, which were lighter and had a better jointing system, at a lower cost. However, asbestos cement is dangerous to health and the roughness is still high. In the 1980s, steel pipes were starting to be used for replacing the asbestos cement pipes. The steel material was better than cement or asbestos cement pipes in all matters (roughness, weight, joints), but has a very small durability because of poor protection against rust.

460. **In recent years, new materials have come into use.** Water transmission main pipes above 600mm are usually made from glass reinforced plastic and smaller pipes within distribution networks and service pipes to individual properties are made from black high or medium density polyethylene. For difficult and aggressive soil corrugate high

⁶⁶ http://www.who.int/water_sanitation_health/hygiene/plumbing10.pdf



density, polyethylene is used. New water networks and additions to existing water networks are designed using computer software and a wide range of design packages are available. Various computer software is used for hydraulic modeling of the networks that allow constant pressure and flow irrespective of geodetic levels. Designs generally allow for some form of ring structure within core networks to allow water to be delivered to any property by more than one route. Designs also allow for a number of pressure zones within town where there is variation in altitude and generally allow for sub-zones within a large network known as District Metering Areas.

461. There are two families of materials available for water pipework systems: metallic and non-metallic. Of these, the most commonly used materials for drinking-water supply piping are galvanized steel or iron, copper, polybutylene, unplasticized polyvinylchloride (PVC), chlorinated polyvinylchloride (CPVC), and polyethylene (PE). Metal alloys, which far exceed the performance specifications of their respective parent materials, are also widely used. New materials and construction technologies are continually developed for the building industry and the plumbing industry. Without some form of control at the respective levels within the plumbing and building industries, it would be easy for unscrupulous manufacturers to use inferior materials to the detriment of installers and end-users. This can ultimately damage the environment and the health of the community and lead to greater costs later when systems fail prematurely

462. Galvanized steel or iron was the traditional piping material in the plumbing industry for the conveyance of water and wastewater. The term “galvanizing” once referred to hot dipped galvanizing, in other words total immersion in molten zinc after pretreatment cleaning. This technology afforded a reasonable level of internal and external protection to the metal pipe. More recently, the use of electroplating technologies has provided a more attractive external finish, but little or no internal protection. Although still included in many codes of practice throughout the world, the popularity of galvanized piping is declining.

463. Copper tubing is extremely flexible in the hands of a competent installer and smaller in overall diameter than the equivalent galvanized steel pipes and fittings. Corrosion can be a problem, though usually to a lesser degree than with galvanized steel; care must be exercised to avoid contact with dissimilar metals. Copper tubing, due to its thinner wall section, is relatively light to handle and is available in coil form or straight lengths as required.

464. Chlorinated polyvinylchloride is widely used in water and sanitary systems for hot and cold-water distribution. It is a thermoplastic produced by polymerization of vinyl chloride, with additional chlorination. It offers much better resistance to corrosion and has a high tolerance to acids. It is fire resistant, though toxic fumes are emitted when it is burned.

465. Unplasticized polyvinylchloride PVC, when used with a solvent cement jointing system, is comparable in bulk to galvanized steel or iron for drinking-water piping, but much lighter. It does not suffer the same corrosion problems internally or externally as galvanized steel. However, it is susceptible to physical damage if exposed above ground



and it becomes brittle when exposed to ultraviolet light. The pipe is light to handle, but it is too bulky for aesthetically acceptable internal use in domestic buildings.

466. **Polyethylene (PE) pipes and fittings of numerous types and designs have been available for over forty years.** The market requirements today have been refined to three general groupings, as follows:

- High-density PE is available in a post-manufactured stress-relieved state (best practice PE), or as extruded product with no treatment; it is used mainly for drainage applications where it can withstand higher temperature discharges than PVC;
- Medium-density PE is more flexible than the high-density pipe. It has a slightly thinner wall thickness and is capable of withstanding higher internal pressure; it is the preferred material for long-distance drinking-water piping;
- Low-density PE is suitable for the irrigation industry, where operating pressures are very low and a high degree of flexibility and low cost is required; low-density PE pipe and fittings are not acceptable for use for connection to the water mains in many countries because of the low pressure rating of the material and its high leakage rate.

467. **Fiberglass pipe also referred to as Fiberglass Reinforced Plastic (FRP), Glass Reinforced Plastic (GRP), and Reinforced Thermosetting Resin Pipe (RTRP), is one of the latest trends regarding water and wastewater systems materials.** FRP Pipe resistance to corrosive chemical environments and cost effectiveness has proven its ability to replace carbon steel and stainless steel pipe at a lower overall cost. Their main qualities are Light weight, Strength to weight ratio, Dimensional Stability, Electrical properties - Standard fiberglass pipe is nonconductive.

468. **Glass reinforced resin pipe is one of the strongest piping material by weight in use today.** Most of these piping products are made by using filament winding or centrifugal casting techniques. Varying conditions of service has resulted in the use of three major FRP piping resins: epoxy, polyester, and vinyl ester. Like most plastic piping systems, FRP is durable, safe and easy to install. In addition, it is very cost competitive when compared to many metal-alloy piping systems. Most FRP piping has both internal and external chemical resistant barriers.

Social infrastructure

469. **For social infrastructure, there are many building materials typically considered 'green'.** These include lumber from forests that have been certified to a third-party forest standard, rapidly renewable plant materials like bamboo and straw, dimension stone, recycled stone, recycled metal, and other products that are non-toxic, reusable, renewable, and/or recyclable. For concrete a high performance or Roman self-healing concrete is available. The EPA (Environmental Protection Agency) also suggests using recycled industrial goods, such as coal combustion products, foundry sand, and demolition debris in construction projects.



470. Existing buildings are subject to structural assessment before deciding whether they should be demolished or rehabilitated. The seismic risk category depends primarily on the construction timeframe, as described in the Figure 36.

Figure 36. Seismic risk category of buildings according to construction timeframe

Seismic intensity (MSK)	Construction timeframe				
	Prior to 1940	1941 - 1963	1964-1977	1978- 1990	after 1990
VI					
VII					
VIII		Pre-code level: Seismic risk category 1	Low code level: Seismic risk category 2	Moderate code level: Seismic risk category 3	Moderate-high code level: Seismic risk category 3
IX					

Source: Buildings in strong earthquake-prone areas - Dan Dubina and Dan Lungu, 2003

471. The structural rehabilitation solution will be established based on the state of degradation of the building (seismic risk category), the structural system (frames, walls, mixed), the building materials used (reinforced concrete, steel, masonry, wood, etc.) and the Importance-exposure class. Some of these methods are described below.

472. The reinforced plaster shotcreting and reinforced concrete lining methods are suitable for brick and reinforced concrete buildings. They consist in the total or partial jacketing of the structural elements (pillars, girders, reinforced concrete or brickwork walls) with a layer of concrete reinforced with steel bars. This method increases the load-bearing capacity of the structural elements and improves the overall quality of the building.

Figure 37. Reinforced shotcreting of walls (left); reinforced concrete lining of girders and pillars (right)



473. The carbon fiber or glass fiber lining is similar to the above, the difference being that carbon fiber or glass fiber is used instead of reinforced concrete as lining material.



Figure 38. Carbon fiber lining of pillars in an office building (Japan)



Source: *Technical Seminar on Seismic Retrofit Construction using Continuous Carbon Fiber Reinforced Materials*

474. **The use of reinforced walls or steel bracing consists in the insertion of structural strengthening elements.** This method is suitable for reinforced concrete or steel frame buildings. Thus, the hollow frames may be fitted with reinforced concrete walls or steel bracing. This increases the overall stiffness and stability of the building.

Figure 39. Building of a reinforced concrete wall in a framework hole (left); fitting of steel bracing in framework holes – Cocor store building, Bucharest (right)



Source: *UTCB course – Methods for structural rehabilitation of existing buildings*

475. **The fitting of exterior reinforced concrete or steel frames has the advantage of being carried out mainly on the outside of the building, thus avoiding any disruption of the normal activities indoors.** The works consist in building an outside frame connected to the supporting structure of the building. It improves the overall stiffness and stability of the building.



Figure 40. Reinforced steel frames on the outside of an existing building – school in Japan (left); steel braced frames on the outside of an existing building – the Emergency Hospital of Slobozia (right)



Source: UTCB course – Methods for structural rehabilitation of existing buildings

476. In this case, buildings are earthquake-protected by the fitting of elastic neoprene dampers between the building foundation and the superstructure. Thus, the building is isolated from its substructure and the effects of potential seismic action on the building are mitigated. This method is suitable for all structural systems. It is particularly suited to highly important buildings which are critical in post-earthquake situations, such as hospitals, emergency centers, buildings that house sensitive equipment such as nuclear power plants, IT or telecommunication centers. Furthermore, it represents an ideal solution for heritage buildings, which cannot be subject to works that would alter their architectural features.

Figure 41. Diagram of an isolation system laid beneath the pillars of a building (left); elastomer dampers placed under pillars – the Bucharest City Hall (right)



Source: UTCB course – Methods for structural rehabilitation of existing buildings

6.4 Construction process and safety

477. According to the regulations in place, every construction company of any size should appoint a properly qualified person (or several) whose special and main responsibility is the promotion of safety and health. Before commencing the actual works on the site, a series of elements should be analyzed: order of the works, focusing on the analysis of dangerous/hazardous operations and processes workers' travel routes designed to protect against exposure to hazards, vehicle access routes, one-way - to the extent possible, material and equipment storage procedures, as well as on artificial lighting and procedures on the location of the construction equipment. Special care



should be given to the insulation of power supply lines, personnel handrails, fuel and explosive material storage and protection of pedestrian access routes bordering the works site. Fire safety on site mainly includes fire-fighting procedures learned by the workers, arrangement of Fire safety units provided with fire extinguishers, sand, shovels as per the drawings provided in the basic engineering design, learned by the Occupational Health and Safety Department.

478. Companies that perform construction work need to ensure the level of quality corresponding to essential requirements through their own staff, through Certified Technical Execution Responsible (RTE), and through their own quality control system.

Since the beginning of the execution process itself, after signing the report of acceptance of the site and issuing the building permit, an entire process related to time-money-quality is activated. In terms of unwanted real situations, there are delays in execution, payment delays, and lack of quality for works that could compromise the finalization of the construction.

479. During the execution process, many accidents can happen. A high rate of accidents is caused by: the high percentage of firms and laborers working on their own, the variety and relatively short lifetime of construction sites, high rotation of workers/laborers, the large number of seasonal workers (many of them not familiar with construction processes) and also the influence of climatic conditions.

480. During project implementation, various changes, errors, provisions, etc. by the Constructor may occur. These must be registered and archived in a public and transparent system for all parties involved, in order to count/measure precisely the response times. It is also recommended archiving of photos that are registering works progress (dated), laboratory tests, site provisions, reports related to critical stages of construction and weekly and monthly reports, etc.

481. Owners may ask for compensation for damage of their homes caused by traffic during the works' execution or operation period. Claims for compensation may or may not be justified, but if there is no basis of comparison between the situations before-after implementation/operation of the road, there is virtually no evidence of this. It is recommended to prepare reports and appraisals on the state of housing located near the road, clearly showing its condition at the start of construction works (Beneficiary via a licensed expert).

482. While excavation for foundations' execution is done, unforeseen situations occur. Some examples consist of buried foundations or ruins of other construction; pipelines (fuel / water / steam / electricity) that cannot be dismantled (and must be removed) or can be still functional (and must be relocated); wires or other utilities routes not specified in the approvals asked by Urbanism Certificate; accidental hydrocarbons infiltrations; buried garbage accumulations; archaeological sites; and soil layers with geotechnical characteristics lower than expected in geotechnical studies. Such situations require further studies, different technical solutions than adopted in the initial Technical Design, or even changing the Technical Design and Execution Details. This is a critical time when compromise should be found between the new technical solution recommended by



the Designer, the new cost borne by the Investor/Beneficiary, and the extra time required to incorporate amendments to be managed by the Constructor. Usually, according to GD 28/2008, an increase in the value of the works up to 10% may be considered acceptable in the project budget, in accordance with the General Breakdown, chapter 5.3 – “diverse and unforeseen expenditures.” Nevertheless, the suspension of the investment can also occur due to the large number of tracks to be relocated, technical complications (pipeline design, flows, bends, etc.), and/or the associated legal problems in relation with the land to be used.

483. **For excavation works/earthworks in cohesive soil, the Constructor prefers to reduce / waive construction works for supporting the banks / slopes / embankment to save labor force / materials.** In such circumstances, workers perform construction works without any protection, with high risk of loss of human lives, destruction of equipment or deterioration of the foundation soil.

484. **The Beneficiary should provide unoccupied land, free of charge to the constructor.** The following activities must be achieved before starting the construction process:

- detection of pipes;
- project for relocation of pipelines;
- relocation of pipes (relocation may require additional expropriations).

485. **In Romania, delays do not result in penalties for the actors involved in the project, and are generally incurred by the Beneficiary/Investor.** Delays, depending on their magnitude, have a different impact on the works execution.

Table 7. Impact of execution delays

Length of the delay	Impact on execution
2-8 hours/week	Imperceptible by establishing a work program based on performance indicators of the Constructor’s personnel.
2-3 days/month	Acceptable, delays are recoverable
2-4 weeks/year	Assumed by the Beneficiary/Investor
Less than 2 months/year	Acceptable, if amicable renegotiation of the terms of contract is performed and balanced responsibilities are assumed.
2-4 months/whole duration of execution	Depending on the contractual terms may result in termination of the contract between Beneficiary-Constructor or between Funder-Beneficiary
More than 4 months/whole duration of execution	Involves termination of the contract between Beneficiary-Constructor and indefinitely extension of the execution duration.

Source: World Bank - feedback from design and construction companies

486. **There are cases when, during the project’s implementation, or after finalization of the construction, works are found to not meet the quality standards of the project because of the unprincipled collaboration between the Constructor and the Laboratory.**



Constant monitoring of laboratory tests and sampling is required, which a site inspector performs. The Laboratory communicates the test results to the site inspector, upon request. The Constructor receives written notification from the Beneficiary (upon notification from the Site Inspector) if the results are not compliant with the technical specifications. If the Constructor disputes the results, supplementary tests are performed in order to determine the causes of errors (non-compliant materials used by the Constructor from the suppliers, works that were carried out in non-compliant circumstances, etc.)

487. **In case of unilateral termination of the contract between the Beneficiary and the Constructor, the trial in court implies technical and economic evaluation by independent judicial technical experts of the Court and technical experts of the parties.** The number of the terms and the complexity of contestation/appeal procedures are leading to settlements in Court that can last a minimum of 12 months. Further procedures for implementing final decisions taken in Court may take another 12 months. Consequently, a legal process with a duration of more than 4-6 months will impede construction completion, regardless of the verdict.

6.5 Personnel and Equipment

488. **In order to have sustainable roads infrastructure, water and wastewater systems and social infrastructure, it is not enough to use the best materials on the market, but trained personnel and adequate equipment are also needed.** To keep up with the latest best practices, there is a need of continuous professional development for engineers and for the technical staff of construction enterprises.

489. **Lack of works' quality is due to unskilled staff (low salary employees), poor quality, inadequate or degraded materials, and poor or inadequate technology due to lack of modern equipment.** These situations are in fact consequences of the process for selecting the Constructor, conducted based on the 'lowest bid' criterion. This has led to awarding the contracts to companies without sufficient experience or without an adequate quality control system, in conjunction with the lack of quick and effective ways of imposing penalties when needed.

490. **A vital issue is related to the outdated equipment used on construction sites.** Usually they do not have any preliminary technical check-ups and can become dangerous for the operator and for the workers nearby.

491. **Delays from materials and equipment suppliers may also appear.** Due to market competition, these delays are relatively small-scale (hours or a maximum of a few days) in the case of imports. A flexible management of the Constructor may improve things and make such situations imperceptible to the total length of the project. An experienced Constructor, who owns a fleet of equipment, signs service contracts with rental clauses during potential interruption of operation, and is able to reduce delays to a few hours.



6.6 Verification and Control

492. **The construction technical book consists of the set of documents related to the design, execution, acceptance, operation, maintenance, repair, and follow up on the behavior of the construction.** The construction book is completed before the final acceptance and is kept, for each construction object, by the Beneficiary/Investor. The construction book is prepared by the Beneficiary/Investor for all final construction objects subject to building permit, regardless of the nature of the funds that finance such constructions or related ownership.

493. **When building or modernizing an infrastructure work, it is very important to follow the technical recommendations for temperatures and other specifications.** Authorized laboratories test the quality of the work through samples taken from the field, according to the norms in force. It is very important to take the samples correctly and verify if the conditions from the technical specifications are respected.

494. **For the payment of works, the Constructor drafts monthly and final payment situations/statements based on the unit prices of the contracted bill of quantities.** The accuracy/correctness of the amounts claimed by the Constructor is checked from different viewpoints (supporting documents, quantities, justification for any supplementary works, payment terms, etc.). The site inspector verifies once a month and confirms the quantities executed and registered in the measurement books, and also verifies the payment situations/statements for the quantities confirmed in the measurement books and the firm unit prices stipulated in the contracted bill of quantities. For the work amounts that are in addition or less than the contracted bill of quantities, supplementary works bills (NCS – *notă de cantități suplimentare*) or withdrawal bills (NR – *notă de renunțare*) are drafted and confirmed by the designer, using the unit prices of the contracted bill of quantities. Common issues include lack of supporting documents for the prices attached to bill of quantities, reports, measurements certified by topographic engineers and the Site Inspector. It is therefore necessary for the Beneficiary to accept in the supervision team specialized personnel for:

- measurement of quantities of works;
- verifying the supporting documents for payment certificates/statements/payment requests;
- verifying of payment terms provided in contract clauses for the Constructor;
- checking the justifications made by Constructor for additional works or additional quantities to existing items in the bills of quantities;
- verification of detailing costs.

495. **During execution, between the issuance of the Building Permit and the completion of works (Final acceptance), the construction is a continuous (12-36 months) improvement process.** During the execution of the construction at natural scale the Beneficiary may propose new ideas or solutions. Given the desired character of these changes, the financial aspects are solved in advance, but integration of changes in the execution process leads to delays and thus to calendar changes. In general, such situations are speculated by the Constructor to “encapsulate” in the new execution graphic the subjective delays due to own inefficiencies in execution.



496. **Sometimes additional works not covered by the contractual bills of quantities are found to be necessary during the execution period.** These works are registered in the work site provisions signed by the Beneficiary and they have firm contracted unit prices, bills of quantities with additional quantities and contracted firm unit prices, as accepted by the Beneficiary. The payment statements for the additional bills of quantities are prepared separately from the payment statements for the contracted bills of quantities provided under the offer. For any additional works that have no correspondence in the unit prices of the contracted bills of quantities provided under the offer, the Beneficiary/Investor can accept, based on supporting documents submitted by the contracting party (invoices, rates, etc. from at least 3 providers), new unit prices valid in the month when works are executed. The offsetting of values is achieved based on the supplementary works bills and withdrawal bills, and any excess is limited to the maximum value as provided under General Breakdown, chapter 5.3 – “diverse and unforeseen expenditures.” Exceeding of this limit as well as introduction of new items is subject to contract renegotiation, according to public procurement legislation.

497. **Delays/suspensions in the payment of executed works (from the Beneficiary to the Constructor) may appear during the process.** The bureaucracy of the financing body (bank, national budget, external funding) leads to delays in the release of funding tranches, despite the achievement of formalities and procedures by the Beneficiary and of physical stages of execution by the Constructor. At the same time the interruption of releasing funding tranches by the funding body (the bank, national budget, external financing) due to non-fulfillment of formalities and procedures by the Beneficiary and/or physical stages of execution by the Constructor is a frequent cause of delays. In case of financing from own resources, the capital flow for execution may endure reductions/interruptions. Investment activities such as execution of a new construction (road, water supply system, or building for social infrastructure) are the first to be suspended in case of a liquidity or economic crisis. If the general quality of works (not quantified in measurable indicators from the beginning) does not meet the quality standards of the Beneficiary, this may also lead to suspension of payment until the works disputed are corrected/remedied at the Constructor’s own expense.

498. **Reception/Acceptance of works is a component of the quality system in constructions and represents the document whereby the Beneficiary/Investor declares that it accepts, takes over the work “with or without reservations,” and that such work can be exploited/ operated.** By the acceptance document, it is certified that the Constructor has fulfilled its duties under the contract and the execution documentation. The work reception/acceptance happens in two stages: (1.) Acceptance at the completion of works by the Beneficiary, within a maximum of 15 calendar days from the notification of works completion; and (2.) Final acceptance by the Beneficiary within a maximum of 15 days after the warranty period’s expiry date (period provided in the works execution contract).

499. **Reception of the works shall be performed only for the constructions that comply with the essential quality requirements and for which the documentation necessary for the construction technical book has been submitted to the**



Beneficiary/investor. Art. 30 of Law 10 stipulates that all the parties/actors involved in the design and execution are liable, as per the undertaken obligations, for the hidden defects⁶⁷ of the construction occurring in a period of 10 years from the work acceptance date, as well as after this date, during the entire life of the construction, for any structural defects resulting from non-respecting the design and execution rules in force at the date of construction.

500. **Following reception of the site by the Constructor, problems caused by execution errors and delays may appear.** Supplementary costs corresponding to execution errors must cover re-construction/rehabilitation works at required quality and are supported by the Constructor. Delays in execution are penalized according to the contract. In case of water supply and wastewater investments, technological tests must be performed in order to certify the quality of works. Consumption and operation costs should be checked in order to fit/match with those guaranteed by the Constructor in his offer. If this is not the case two situations may appear:

- In case the input parameters in the plant (typically flow and biological loading) are in accordance with the Beneficiary's declared amounts in the technical specifications upon which the Constructor has prepared the offer, the Constructor will be penalized according to the contract (usually pay the difference in operating costs for certain number of years).
- In case the input parameters in the plant (typically flow and biological loading) are not in accordance with the Beneficiary's declared amounts in the technical specifications upon which the Constructor has prepared the offer, a technical expertise will be performed in order to set the percentage of the additional operational costs that will be paid by the Constructor and the percentage of the additional operational costs that will be paid by the Beneficiary. The percentages can vary from 0% to 100% depending on the variation of input parameter values related to the values declared by the Beneficiary in the technical specification.

6.7 Conclusions

501. **To reduce divergences between designers, beneficiaries, and construction companies in the implementation stage for PNDL projects, it is recommended to use "design and build" contracts, when possible.** This requires preparation of complete and sufficiently detailed feasibility studies that form the basis for public tenders for the award of "design and build" contracts. The winning bidder assumes responsibility for technical design development and implementation, therefore any discrepancies that may occur during the implementation stage must be remedied without additional costs for the beneficiaries, unless certain construction works are unpredictable, which makes them eligible.

502. **Design-build project delivery is a viable, acceptable, and attractive method for use.** It is especially applicable when:

⁶⁷ According to art. 1707 of the Civil Code—a defect is hidden if, on the contract date, such defect cannot be found by a prudent and diligent buyer/beneficiary without specialized assistance



- time is critical for project completion;
- there is a limited or designated budget;
- increased cost control and innovation are desired;
- constructability and savings are important considerations.

503. **A clearer provision on the designer's responsibility is needed to supply a high quality product: this provision would include penalties applicable in the event of clear errors that can be attributable to the design team.** One requirement could consist in the obligation of the designers to have professional indemnity insurance, which some of the beneficiaries have already started to require in their contract forms. There are companies that offer these types of professional indemnity insurances. In the long term, the insurance schemes are extremely useful to reward skilled service supplier and penalize those suppliers that provide inappropriate technical documentation.

504. **A schedule of activities and results, including payment terms, is a good option for a better development of the works.** Some beneficiaries already apply a tranches-payment system, ensuring that the designer receives the final payment only after successful completion of the project. This ensures a close contact between designers and beneficiaries throughout the entire implementation stage, as well as collaboration between designers, engineers and construction teams, to identify the optimum solutions.

505. **Clear requirements are needed to ensure that all the intellectual property rights for technical documentation stay with the beneficiary.** In some cases, when this provision was not explicitly included in the contract, the designers have refused to allow modifications to the projects, invoking property rights to the supplied contents, despite having been remunerated for a particular result.

506. **A general solution for issues related to the construction quality is a technical audit performed during or upon finalization of the construction works.** If the audit is carried out by financial auditors certified by the Chamber of Financial Auditors, the technical audit may be performed by engineers certified by MRDPA and State Inspectorate of Construction as Certified Technical Execution Responsible (RTE) and Site Inspectors, other than those involved in the investment implementation. Technical audit will include:

- Assessment of the existing situation of infrastructure projects;
- Assessment of the procurement processes applied for services and works in order to ensure economy, efficiency, transparency and also to identify the areas requiring improvement;
- Assessment of appropriateness of technical options and design proposed (verifies if the project is cost effective);
- Checking whether different structures are constructed as per design, drawings, and specification and assessment of the construction quality;
- Assessment of record keeping of different construction materials labors used and expenditure incurred.

507. **From a technical standpoint, strict rules should be established in certain areas: risk assessments, trainings, planning, procedures, and agreements.** Workers need to be



reminded the rules and to be corrected and urged to apply what they have learned. Working at height, lifting operations, excavation and digging or electrical works are activities that involve high risk and require strict rules in terms of health and safety at the workplace. Innovations may consist of daily training of workers, carried out by specialized staff, in relation with possible specific risks they may face on construction site during the day. A very useful international initiative is to organize the so-called “Safety Days” or “Safety Weeks”, during which personnel is involved in simulations and role-plays on construction site. This kind of training is designed to instruct the workers for various dangerous situations, at the same time offering them the necessary tools and expertise to help colleagues in need.

508. **Existing legislation in quality construction does not benefit from practical, high accuracy procedures for technologies’ verification, works quality, and materials’ quality.** In this respect, a mobile laboratory of the State Inspectorate in Constructions is needed. It is very important to take the samples correctly and verify if the conditions from the technical specifications are respected.

509. **Finalization of any publicly funded infrastructure project implies financial auditing.** Technical auditing is completed by the Reception at the completion of the works and the Final Reception (at the end of the warranty period) without being based on clear procedures and/or Technical Audit Manual.

510. **The warranty period is mentioned in the bidding technical specifications (case in which it can bring a higher score to the constructor) and in contracts, usually for a minimum of two years for most of the construction works.** This period should be regulated and established in national regulations, by taking into consideration the road technical class, traffic loads, type of road structure, type of water distribution system, characteristics of wastewater plant, and other factors. By adopting such a measure, the constructor will have a higher responsibility in building correctly and according to the standards in force.



7 Well-maintained Infrastructure

7.1 General framework

511. **A reliable infrastructure is primarily an *available* infrastructure.** It implies that external factors such as weather conditions and ad-hoc external shocks to the infrastructure systems as well as internal factors such as maintenance have little impact on its performance.

512. **Construction behavior monitoring over time is performed in order to meet the essential requirements of Law no. 10/1995 on quality in constructions:**

- strength and stability,
- safety in operation,
- fire safety,
- hygiene, human health, environmental rehabilitation and protection,
- thermal and waterproof insulation and energy saving,
- protection against noise,
- durability requirements, and
- operating capacity requirements.

Behavior monitoring during operation for the entire period between the Acceptance upon completion of works and the Final acceptance is the responsibility of the Contractor or of the Beneficiary, depending on the contractual terms agreed upon, under the Construction Contract; after the Final acceptance, it is the responsibility of the Beneficiary.

513. **Construction behavior monitoring during operation is established by several laws and Government Decisions, such as:** Government Decision (GD) no. 273/1994 – Rules for the acceptance of construction works and related installations; Law no. 10/1995 on quality in constructions, as subsequently amended, Rules for drafting the Building Log Book, GD no. 766/1997 – Regulation on behavior monitoring during operation, interventions over time and the post-decommissioning of the construction, Standard on construction behavior over time, index P 130-1999, approved by Order of the Minister of Public Works and Spatial Planning no. 57 / N / 1999, published in the Construction Bulletin no. 1/2001, Order no. 847 of 2 June 2014 for the approval of the Procedure on the control activities carried out for the implementation of the legal provisions on the routine and special monitoring of the buildings' behavior during operation - index PCU 004 and of the specific guides by categories of constructions: roads, bridges, tunnels, water and sanitation supply, social infrastructure buildings etc.

514. **Behavior monitoring during operation, interventions over time and the post-decommissioning of constructions apply to all construction categories.** The exception from this rule is for residential buildings with ground floor / ground floor plus one story and for annexes located in the countryside, as well as to temporary buildings. This



monitoring is mandatory for all natural and legal persons involved: investors, designers, executants, owners, managers, users. Construction behavior monitoring during operation, interventions over time and the post-decommissioning are separate and complementary actions and their performance should be arranged for by the owner, including at the request of the manager and of the user. Construction behavior monitoring is carried out during the life period of the buildings, starting with their execution. It is a systematic activity of observation, examination and investigation of how buildings respond / react during their use, under the influence of environmental agents, of operating conditions and of the interactions of the buildings with the users' environment and activities. The purpose of monitoring buildings over time is to obtain the necessary information in order to ensure their regular operating capacity, to assess the conditions for preventing accidents and damage and for reducing damages, loss of lives and environmental degradation, and to hold the necessary information for improving the construction activity.

515. Construction behavior monitoring can be performed in a continuous or discontinuous manner. Continuous monitoring involves using observers or installing devices that keep the construction under surveillance continuously, or record the results of the measurements made continuously. In terms of practical effectiveness, such monitoring can be oriented towards triggering an alarm in case of exceeding the critical values of the measured parameters and causing potentially risky situations. Discontinuous monitoring involves regular checks or inspections, thus routine observations and measurements, possibly also including tests or trials by load testing. The pace of the execution, the seasons, the succession of day and night or the occurrence of disasters may impose the intervals at which the inspections or checks are performed.

516. Construction behavior monitoring can be performed by routine or special monitoring. The category of construction behavior monitoring, the time intervals at which it is performed, and the methodology for carrying out such activities should be determined by the works' designer or by a technical expert, depending on the construction importance category; these data should be recorded in the event log that is kept under Chapter D of the Building Log Book.

517. Routine monitoring is the activity of construction behavior monitoring, consisting of observing and recording issues, phenomena or parameters that can indicate changes in the capacity of the construction in order to meet the strength, stability and durability requirements established in the projects. During such routine monitoring, if there is an occurrence of degradation that is considered to affect the strength, stability and durability of the construction, the owner, and manager or, if applicable, the user must order a thorough inspection of the construction, followed - if necessary - by a technical examination.

518. Routine monitoring is performed by direct visual inspection and, if necessary, with common, permanent, or temporary measuring tools, in accordance with the provisions of the Building Log Book and the technical regulations for behavior monitoring during operation. In the event of observing degradations, intervention



measures should be established. The owners, managers and, where appropriate, the users should arrange for organizing the routine monitoring of construction behavior, which can be performed by using their own staff and means or a specialized company may be contracted for this activity. The routine construction behavior monitoring should be carried out according to the routine monitoring instructions contained in the conceptual designs. For old buildings that do not have such instructions, a specialized design company should be contacted for drafting them. Routine monitoring should be performed at time intervals stipulated in the routine monitoring instructions, but no less than once a year and automatically after the occurrence of special events.

519. After an earthquake with a magnitude of over 6.0 on the Richter scale, an accidental impact resulting in damage to the finish of certain resistance elements, or after an explosion, investigations should be carried out, consisting of visual inspections (expanded inspections), measurement of subsidence, deformation, opening of cracks, etc. Since in the aftermath of a major event, a state of significant degradation is likely to occur in the structure, at the request of the Beneficiary, a site visit should be conducted by specialized staff (civil engineer) who - after the inspection – should ascertain if a specialized examination of the construction is required according to the law in force.

520. Special monitoring consists in measuring, recording, processing and systematically interpreting the values of the parameters that define the extent to which buildings maintain their requirements concerning strength, stability and durability established in the projects. Special monitoring of building behavior should be carried out in case of:

- new constructions of special or exceptional importance established in the project;
- constructions during operation, evolving dangerously - as assessed by the conclusions of a technical examination or an extended inspection;
- the request of the owner, of the State Inspectorate for Constructions, of the Ministry of Regional Development and Public Administration, or of the acknowledged bodies in the construction field.

The special monitoring of construction behavior is carried out by complex and specialized means of observation and measurement, tailored to each case, in accordance with the provisions of the current technical regulations or the technical examination that has stipulated this form of monitoring.

521. The establishment of special monitoring should be notified to the State Inspectorate for Constructions (ISC) by the investor, the owner, or the user. The objectives of the special monitoring of construction behavior are:

- ensuring construction safety and durability through timely detection of dangerous phenomena and the areas they occur in;
- supervising the evolution of certain phenomena, with possible negative effects on the operating capacity of the building;
- the operational reporting of exceeding the warning thresholds or the limit values of the measuring and control devices;
- checking the effectiveness of the applied intervention measures;



- checking the environmental impact of the construction;
- ensuring a large volume of data necessary for establishing the appropriate values for normal operating conditions throughout the lifetime of the building, for changes in the execution project if the reality on the ground is different from the calculation hypotheses, for the verification - under real conditions – of new materials and for the experimental verification of new methods of calculation.

522. **Special monitoring is performed with sophisticated technical means by the competent natural or legal persons with the aim of keeping under observation certain dangerous latent interaction phenomena during the operation phase of the constructions under supervision and in order to justify special intervention measures, such as consolidation.** While routine monitoring is stipulated in the instructions drawn up by the designer at the same time as the project and the operation and maintenance instructions, serving the owner directly, special monitoring is performed based on a special monitoring project, serving the owner only at the competent person's recommendations, following the latter's evaluation of the data resulting from this activity.

523. **All findings and proposed measures for the routine / special monitoring of constructions should be recorded in the Building Log Book, which is the basic documentation for the on-site construction behavior monitoring.** The person responsible for its storage and filling out is accountable to the Beneficiary. The Building Log Book includes the updated conceptual design, the execution control documents, the acceptance protocols, the documents related to the building operation, the data summary and the event logbook.

524. **The Regional Inspectorate for Constructions (RIC) and the County Inspectorate for Constructions (CIC) have an obligation to urgently inform the manager of the SIC about the technical accidents having taken place during building construction or operation.** The Committees verifying the causes and conditions under which technical accidents happen during the operation of buildings should draw up inspection reports, recording the findings that will likely highlight the status quo on the date of the verification, the causes that can generate technical accidents, the contributing factors on the date of the technical accident, the measures ordered for immediately bringing to safety the persons and goods housed in the buildings and in their immediate vicinity, with deadlines and persons responsible for carrying out these measures. When evaluating the technical status, the local public authority (and, where appropriate, with the support the certification authority) should ensure that a technical expert certified in this field for the essential requirement - mechanical resistance and stability will also be present for the assessment and establishment of the intervention decision.

525. **In the case of educational/cultural units located in protected areas and classified as architectural monuments or having architectural value, any interventions on the exterior of the buildings (fencing, pavements, gardens, etc.) will be performed as restoration activities.** They need to be approved first with a letter containing all the initial details concerning shape, material, color, etc., and seek the endorsement of the National Commission for Historical Monuments.



526. **The documents relating to constructions of any kind should be drafted, recomposed, filled out, and kept according to the legal provisions concerning the “Building Log Book.”** Only the designers should draft the basic documentation of the works and the general data necessary for the operation, and they should submit it to the Owner of the investment. The designers are under an obligation to make corrections to all execution plans, on all copies on which changes were made during the execution, and at the end, they are under an obligation to replace these plans with new, original and updated ones according to the real situation on the ground. The builders are under the obligation to hand over the designs, site plans, and execution plans changed in accordance with the real situation on the ground. In case no changes were made to the original plans, one copy of the plans should be submitted, with a written confirmation that no changes were made during the execution.

527. **The aim of the interventions performed in constructions over time is to maintain the building stock at the required level of compliance with the requirements and to ensure the functions of the buildings, including by expanding or modifying their initial functions because of upgrading.** Intervention works are:

- maintenance works caused by normal wear or degradation and aimed at maintaining the technical condition of the constructions;
- restoration works, caused by the occurrence of significant degradation and aimed at maintaining or improving the technical condition of the constructions;
- upgrading works, including extensions, determined by a change in the requirements for constructions or their functions and that can be achieved by maintaining or improving the technical condition of the constructions.

528. **Maintenance works are caused by normal wear or degradation and are aimed at maintaining the technical condition of the buildings.** Maintenance works consist in carrying out periodic remediation or repairs of the visible parts of the building elements – finishes, wear layers, and protective layers and coverings – or of installations and equipment, including the replacement of worn parts.

529. **In the case of roads, routine maintenance work during the summer is a set of actions regulating the performance of interventions aimed at maintaining, repairing and ensuring traffic safety.** The works and services for the routine maintenance of roads, tunnels, and bridges during the summer consist of all the intervention activities performed annually between April 1 and October 31, caused by wear or degradation under normal operating conditions, aiming at ensuring the technical conditions necessary for safe road traffic, in compliance with the regulations in force. For the national roads, a costs standard was approved for the routine maintenance of public roads of national interest during the summer.

530. **For county roads, County Councils may conclude framework agreements for maintenance works during the summer and for snow removal services for several years (3 or 4 years).** Tulcea County Council and Cluj County Council are examples of good practice in this regard.



531. **There are two distinct issues in the evaluation of any existing pavement structure: functional condition and structural condition.** The first is important for routine and periodic maintenance, i.e. with no structural improvement. The second is decisive in rehabilitation cases, i.e. when only structural improvements are made, and renovation cases, which comprise rehabilitation combined with road geometry improvements. Road safety should normally be part of all kinds of interventions.

532. **Both functional and structural conditions of the existing pavements are mostly relevant to county roads.** The functional condition of a road is preserved by routine and periodic maintenance. The routine maintenance ensures the safety of daily traffic and all-weather utilization of roads, especially in winter periods. Structural conditions are related to the main characteristics of road surface, such as roughness, impermeability and evenness, and to the defects that may appear on road surface, such as rutting, potholes, unevenness. All these parameters are easily measured using advanced specialized equipment.

533. **Evaluation of structural condition of the existing roads seeks to obtain the existing structural (bearing) capacity on which to focus the recommended rehabilitation or reconstruction actions.** Integrated advanced measuring equipment can provide a full needed range of data and information. These data can include a detailed network representation with location information (useful for updated road data register), several parameters describing road link geometric configuration, and road structural condition. Measuring equipment, augmented with various enhancements, can also be used to develop a program of recommendations for cost-effective road improvements. The collected data enable targeted design of interventions, which depends on road condition and anticipated road design life. Savings in road works from such targeted design procedures can be substantial and reach up to 40% compared to the currently used methods. Implementation of such system requires specialized knowledge and training in the use of the equipment.

534. **County roads require maintenance works during operation.** In many cases, the necessary works far exceed the budget assigned. In most cases, the necessary works exceed the annual amount allocated by the County Councils. For example, in 2015, in Sibiu County, for the entire network of county roads (906,794 km), a routine maintenance cost of about 3,277.72 EUR / km is estimated, almost half of what was estimated in the “Study on roads financing, classification and management”, elaborated for the Rural Development Project in Romania in 2005 (7,716 EUR/km).⁶⁸ The same is true for Bistrița Năsăud, with a 754km network of county roads and a maintenance cost of 2,210 EUR/km; Constanta with 889 km of county roads and a maintenance cost per unit of 446 EUR/km; Dolj – 1,096 km of county roads and a cost of 2,433 EUR/km, and Ialomița with 507 km of county roads and 1,797 EUR/km.

⁶⁸ The study estimated the maintenance cost based on the data collected in 100 Communes and 5 counties during the sites visits



Table 8. Costs per unit for routine maintenance

County	Length of county roads	Routine maintenance amount	Maintenance cost per unit ⁶⁹	World Bank amount (EUR/km)
Sibiu – County Roads 2015	906,794 km	13,375.00 thousand lei	3,277.72 EUR/km	7,716
Bistrița Năsăud 2015	754 km (NIS, 2013)	7,500,000 lei	2,210 EUR/km	7,716
Constanta 2015	889 km (NIS, 2013)	1,788.00 lei	446 EUR/km	7,716
Dolj, 2014	1,096 km (NIS 2013)	12,000 thousand lei	2,433 EUR/km	7,716
Ialomița 2014	507 km (NIS 2013)	4,1 million lei	1,797 EUR/km	7,716
Mehedinți, 2015	702 (NIS 2013)	12 million	3,798 EUR/km	7,716
Olt, 2015	1,026 (NIS 2013)	22,7 million lei	4,916 EUR/km	7,716

Source: County budgets and internet sources

535. In terms of maintenance during the winter, the available data also showed that the allocated funds were insufficient, considering the amount recommended in the study cited above:

Table 9. Costs per unit for maintenance during the winter

County	County road length	Amount allocated for maintenance during the winter	Maintenance cost per unit	World Bank amount
Ialomița, 2014	507 km (NIS 2013)	1,7 million lei	745 EUR/km	2,000
Bistrița Năsăud 2015	754 km (NIS, 2013)	1,500,000	442 EUR/km	2,000
Buzau 2015	959 km (NIS, 2013)	500,000 lei ⁷⁰	57.93 EUR/km	2,000
Alba	1,098 (NIS 2013)	6,000,000 lei	1,214 EUR/km	2,000

Source: County budgets and internet sources

536. Repair works are caused by the occurrence of significant degradation and are aimed at maintaining or improving the technical condition of the constructions. The solutions should be established only after knowing the technical condition of the buildings, including the causes of the degradation, if any, because of the technical expertise. In some cases where the buildings are badly affected, if temporary support works are needed before the actual restoration works, they will also be performed based on a design drawn up by the expert or by the designer, after having assessed the situation. Upgrading works are usually carried out through reconstruction, repair or consolidations, based on a design drafted, checked or analyzed by an expert, in accordance with the legal provisions applicable.

⁶⁹ EUR exchange reference rate = 4,5 lei

⁷⁰ Under Framework Agreement for 2 years (2015-2016 and 2016-2017)



537. **The Ministry of Transport is the administrator of roads of national interest, directly or through the Romanian National Company of Motorways and National Roads SA.** Seven Regional Directorates for Roads and Bridges (RDRB) are subordinated to the Romanian National Company of Motorways and National Roads, namely RDRB Bucharest, RDRB Craiova, RDRB Timisoara, RDRB Cluj, RDRB Iasi, RDRB Constanta, RDRB Brasov. The mission of these Directorates is to ensure the operation of the road network (national roads and highways) in conditions of safety, comfort and fluency through maintenance works, repairs, increasing the traffic capacity, rehabilitation and investment. This requires an ongoing assessment of the state of degradation of road systems subject to a complex set of actions due to external factors like heavy traffic, freeze and thaw, moisture, chemical factors - discharged accidentally or with a specific purpose, etc., leading to worsening traffic conditions.

538. **The roads of county interest are part of the county public property and include county roads, which provide the link between:**

- county seats and municipalities, cities, commune seats, spa and tourism resorts, ports and airports, important national defense attractions and important historical attractions;
- cities and municipalities, and between these and commune seats;
- commune seats.

County Councils manage the county roads, except for the county road sectors located within the built urban areas, including artwork and related facilities and accessories, which are administrated by the respective local councils.

539. **The roads of local interest belong to the public property of the local administrative unit on whose territory they are located and can be classified as:**

- commune roads,
- ancillary roads and
- streets - public roads within localities, regardless of their name: street, avenue, path, embankment, road, alley, dead end, lane etc.

Local councils provide the management of local roads, within their administrative and territorial range. If a specific road goes across two or more territorial-administrative units, the classification is approved by the decision of all those local councils.

7.2 Post-Implementation

540. **The current legal framework includes no details on requirements for the post-implementation phase – i.e., tracking the project’s performance after completion.** At least based on the methodological norms, once the actual works are finished, the beneficiary sends a copy of the completion report to the Ministry. If and when the warranty period expires, the local authority again sends a copy of the formula documentation (“procesul verbal de recepție final”) to the MRDPA. Beyond that, the two key post-implementation functions for any investment program – i.e., ex-post monitoring and evaluation (M&E) and knowledge sharing – appear to be missing at this point in the PNDL’s evolution. Put differently, there is no formal process for evaluating the impact of



completed investments and there are no institutionalized efforts for communicating good practices among past, current, and future beneficiaries of PNDL funds.

541. The most common incidents and failures that need to be considered during the routine monitoring of construction behavior during operation are:

- Roads:
 - emergence of potholes, bumps, cracks and grooves in the road coating;
 - emergence and development of fissures and cracks in the joints of decks or track items in roads, footbridges;
 - swelling or cracking of the land due to landslides occurred in the vicinity of the road;
- Bridges:
 - clogging of drainage openings and degradation of waterproofing around the drainage openings;
 - degradation of pedestrian and safety guardrails;
 - clogging of the abutment drainage holes during periods of high rainfall;
 - degradation of the protection of beam anchorages of pre-stressed elements, including those in the carriageway plate;
 - degradation of bearings and of anti-seismic devices;
 - corrosion of the reinforcement due to the degradation of the protective coating;
 - corrosion of metal profiles due to the degradation of primer and protective paint layers;
- Tunnels:
 - infiltration in the tunnel vault;
 - swelling, peeling of the gunite in tunnels with gunite walls;
 - degradation of joints between concrete rings;
 - degradation of concrete and corrosion of reinforcement in gunite covering sections;
- Water supply and sanitation works
 - common faults related to valve, elbows or tees tightness;
 - catchment malfunctions - the highest rate appears in catchments using deep wells under the following conditions:
 - well sanding;
 - filtration column failure;
 - pump engine burning due to a change in the operating conditions of wells;
 - malfunctions in treatment plants - the highest rate appears under the following conditions:
 - filter clogging due to water eutrophication during warm weather and low flow;



- filter clogging due to the ice sheet during cold weather;
- malfunctions in water transportation and distribution network malfunctions - the highest rate appears under the following conditions:
 - damage to manholes due to non-compliance by participants in road traffic of axle loads in accordance with the category of the road in which manholes are located;
 - damage to the pipelines of water transport and distribution due to the compaction and crumbling of the land where pipes are located;
 - clogging of pipelines of water transport and distribution due to inadequate quality of circulating water in terms of turbidity;
- malfunctions in wastewater collection and transport systems - the highest rate appears under the following conditions:
 - damage to manholes due to non-compliance by participants in road traffic of axle loads in accordance with the category of the road in which manholes are located;
 - damage to the pipelines of water transport and distribution due to the compaction and crumbling of the land where pipes are located;
 - clogging of pipelines of water transport and distribution due to inadequate quality of circulating water in terms of turbidity;
- malfunctions in wastewater treatment plants and sludge treatment and disposal plants - the highest rate appears under the following conditions:
 - stopping of the technological process for wastewater treatment and of the technological process for sludge treatment due to accidental interruption of electricity supply;
 - disruption of the technological process for wastewater treatment and of the technological process for sludge treatment due to a malfunction of the mechanical equipment (pumps, valves, scraper bridges etc.);
- malfunctions in sludge storage facilities - the highest rate appears under the following conditions:
 - change of the physical and chemical characteristics of the stored sludge due to insufficient supply of reagents of the quality required by the process;
 - mechanical failure of the transport system and dewatering of stored sludge.
- Social Infrastructure
 - changes in the position of the constructions in relation to the site, manifested by visible horizontal, vertical or inclined movements or by visible side effects such as sidewalks, stairs or other additional elements detachment from the socket or from the building body, causing joints, cracks, uprooting;



- opening or closing of compaction or anti-seismic joints between buildings;
- swelling or cracking of the field due to landslides occurred in the vicinity of the constructions;
- disadjustment or blocking of certain equipment such as elevators, machinery etc.;
- changes in the shape of construction objects by visible vertical, horizontal deformations or rotation, causing the blocking of doors or windows, machinery, modifying the route and form of the outer pipes, bending beams or other structural elements, shearing or pulling out connecting parts, such as rivets and bolts or causing weld cracking;
- changes in the degree of protection offered by the construction in terms of tightness, sound/ thermal/ water/ vibration/ fire/ radiant/ or aesthetic proofing, as well as surface wetting, exfoliation or cracking of constructive materials, water seepage, emergence of springs in the hillsides or dam walls, liquefaction of the earth after earthquakes, changing in surface colors, condensation, mold, harmful effects of vibration and noise on organisms;
- defects and degradation affecting the operation of construction elements: drainage plugging - downpipes, gutters, sewers and drains, emergence of porosity areas, cracks or crevices in watertight constructions intended for the storage of liquids - tanks, basins, pipes;
- defects and degradations occurred in the structural frame with implications on construction objects safety: fissures and cracks, corrosion of metal components and fittings, defects manifested by stains, cracks, flaking, erosion and other elements, buckling of compressed elements or breaking of the stretched ones, weakening or destruction of joints, side erosions of the foundation soil in the piles of bridges, destruction of wooden elements by rotting or of plastic materials, by biological attack etc.;
- particular attention should be paid to the foundation soil moisture for construction founded on moisture sensitive land and to the compliance with the measures provided for removing water from the foundations, measures for the containment of the joint between the building and the protection sidewalk, integrity of pipelines carrying liquids;

542. The current legislation (Regulation of 21/11/1997 on behavior monitoring during operation, interventions over time and post- decommissioning of constructions) provides, in Article 16, that the persons conducting the routine and special monitoring, referred to as professionals responsible for monitoring the behavior of constructions over time, have the following duties and responsibilities:

- to know all the details of the construction and to keep up to date the Building Log Book, including the event log;
- to conduct the routine monitoring works and, for the special monitoring, to supervise the implementation of programs and projects drawn up in this regard;



- to notify the owner or the manager of any situations that may entail the performance of a technical expertise.

543. **The norm on the behavior of constructions over time, indicative P130/1999, also provides that people responsible for monitoring the behavior of constructions over time should have the following duties and responsibilities:**

- to know in detail the content of the instructions or project for special monitoring of the behavior during operation of the objective for which they were authorized;
- to know in detail the Building Log Book; to draw up, maintain and keep up to date the event log;
- to participate in the acceptance and installation of measuring and control equipment according to the instructions or the special monitoring project;
- to monitor the compliance with the conditions contained in the instructions or project for special monitoring of the behavior during operation and with those provided in the Building Log Book;
- to inspect, at the agreed intervals and immediately after any special event (earthquake, flood, heavy rain, snow dump, accidental overload of materials, landslide, fire, explosion etc.), the technical condition of the building, in order to detect such building elements that, due to their degradation or operating conditions, pose a threat to the security and stability of the construction;
- to request an inspection, an expertise or other action by authorized specialists or companies, if degradation is found;
- to prepare reports on the routine monitoring of the building and to participate in the preparation of reports on the special monitoring of construction;
- to know the measurement schedule, correlated with the execution and exploitation phases;
- to notify the relevant parties on the occurrence of certain events or on exceeded control values, to allow them to take the appropriate measures.

544. **ISC does not authorize professionals responsible for monitoring the behavior of constructions.** Therefore, it recommends that the organization dealing with the routine monitoring of the in situ behavior of the construction should hire a site supervisor who is individually authorized for that specialty, having the responsibilities and obligations mentioned above.

7.3 Investment management

545. **The definition of good infrastructure investment management, called from here on asset management (AM), is given in numerous guidelines and standards, with the common themes being that of providing the desired level of service in the most cost effective manner.** The following definition is from AASHTO⁷¹: “[Transportation] Asset

⁷¹ America Association of State Highway and Transport Officials, Subcommittee on Asset Management, Strategic Plan 2011–2015



Management is a strategic and systematic process of operating, maintaining, upgrading and expanding physical assets effectively throughout their lifecycle. It focuses on business and engineering practices for resource allocation and utilization, with the objective of better decision making based upon quality information and well defined objectives.” For many infrastructure asset owning agencies, their traditional means of managing the assets better resembles a Facility Management approach, wherein the approach is to “find and fix as many faults as possible within the budget available”, with the level of service provided being an outcome of the works completed and little thought about minimizing whole of life costs.

546. **According to the EPA, asset management is maintaining a desired level of service for what you want your assets to provide at the lowest life-cycle cost.** Lowest life-cycle cost refers to the best appropriate cost for rehabilitating, repairing or replacing an asset. Asset management is a framework being widely adopted as a means to pursue and achieve sustainable infrastructure. It is the practice of managing infrastructure capital assets to minimize the total cost of owning and operating them while delivering the desired service levels. A high-performing asset management program incorporates detailed asset inventories, operation and maintenance tasks, and long-range financial planning to build system capacity, and it puts systems on the road to sustainability.

547. **Each utility is responsible for ensuring that its system stays in good working order, regardless of the age of components or the availability of additional funds.** Asset management programs with good data—including asset attributes (e.g., age, condition and criticality), life-cycle costing, proactive operations and maintenance (O&M) and capital replacement plans based on cost-benefit analyses—can be the most efficient method of meeting this challenge.

548. **AM is important because infrastructure (and in particular road infrastructure) is so critical to the functioning of modern societies, and will typically constitute the largest asset of any country.** Furthermore, any financial effort, in excess of that necessary, made on the physical infrastructure is reducing the funds available to be spent on the social services of a country. With good AM come benefits such as:

- Reduced Life-cycle Costs, prolonging asset life and aiding in rehabilitation, repair and replacement decisions through efficient and focused operations and maintenance;
- Consistent Levels of Service, meeting consumer demands with a focus on system sustainability;
- Ability to Monitor and Track Performance, meeting service expectations and regulatory requirements and setting rates based on sound operational and financial planning;
- Improved Transparency in Decision Making;
- Decreased Financial, Operational and Legal Risk leading to fewer surprises going forward;



- Better Financial Management; Budgeting focused on activities critical to sustained performance with ability to Predict Consequences of Funding Decisions and future funding needs;
- Better Communication.

549. **Asset management is centered on a framework of five core questions, which provide the foundation for many asset management best practices:**

1. What is the current state of the assets?
2. What is the required "sustainable" level of service?
3. Which assets are critical to sustained performance?
4. What are the minimum life-cycle costs?
5. What is the best long-term funding strategy?

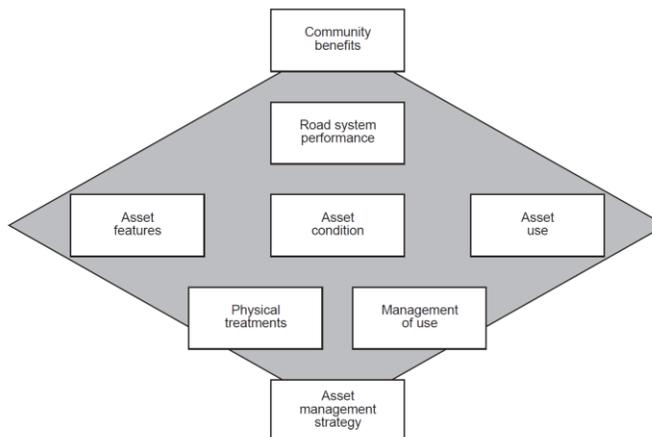
7.3.1 Asset Management in the Road Sector

550. **Each road administration is responsible for the management of its own unique set of assets.** However, the American Association of State Highway and Transportation Officials and the Federal Highway Administration (1997) broadly summarizes the typical assets of a road administration as:

- Physical infrastructure, such as pavements and bridges;
- Human resources (personnel and knowledge);
- Equipment and materials;
- Other items of value such as rights-of-way, data, computer systems, methods, technologies, and partners.

551. **Generally, the types of assets to be included in an AMS are dependent upon the administration.** Typically, the system will start with the administration's major assets and over time will expand to include other assets as data, or system capabilities, become available for them.

Figure 42. Asset management general framework





552. **An important aspect of the use of asset management systems is the need to monitor the performance of the asset against defined required outcomes or targets of performance.** One approach for this is the use of performance indicators to measure progress towards achieving the road administration objectives. Other simpler approaches include the straightforward recording of condition of the asset with time.

553. **Some of the different ways that performance can be represented are percentile of level of condition, effects on users, levels of safety, effects on the environment, and economic aspects of the network.** Each of these represents different measures of performance of the asset and may be defined by more than factor (e.g. various aspects of condition may represent the overall condition or noise and pollution may combine to represent overall environmental performance).

554. **The use of performance indicators as a means of performance monitoring and target setting has been examined by the OECD (1997) in its report Performance Indicators for the Road Sector.** This identified 15 performance indicators used by OECD Member countries to monitor the performance of the road agencies and include the results of a field test of their use. The following performance indicators (PIs) were identified in the report:

- Average road user costs;
- Level of satisfaction regarding travel time and its reliability and quality of road user information;
- Protected road user risk;
- Unprotected road user risk;
- Environmental policy/programmes;
- Processes in place for market research and customer feedback;
- Long-term programmes;
- Allocation of resources to road infrastructure;
- Quality management/audit programmes;
- Forecast values of road costs vs. actual costs;
- Overhead costs (percentage);
- Value of assets;
- Roughness;
- State of road bridges;
- Satisfaction with the road system.

555. **The same measures of performance are useful by all stakeholders of the asset, but the importance given to each measure may differ for the different stakeholders.** To consider the performance of the asset, the stakeholders can be divided into three categories: owners (e.g. government), road administration and users, with each category equal in importance. The OECD report on performance indicators uses these three categories of stakeholders and allocates the performance indicators, in terms of each aspect of performance.



556. **Performance-based contracting (PBC) are a key Asset Management tool.** They are defined as “a type of contract in which payment for the deliverable is explicitly linked to the contractor’s successfully meeting or exceeding certain clearly defined performance indicators”. PBC involves a significant shift away from more traditional approaches to the delivery and maintenance of road infrastructure and associated services by departing from the client having responsibility for the design and supervision of construction and maintenance activities, to focus upon the key outcomes that the client wishes to achieve and incentivizing the achievement of those outcomes. Most PBC’s consist of a subset of the following six components: design, build, finance, operate, maintain, and transfer.

557. **The World Bank (Bank) has supported different types of PBCs in the road sector over the last 15 years.** The Bank developed sample bidding documents for PBC in 2002 (Performance-based management and maintenance of roads – PMMR (World Bank (2002)), and again in 2006 (Output- and Performance- Based Road Contracts – OPRC (World Bank 2006)) to secure minimum standards of quality for PBC implementation. In addition, the Bank published Transport Note no.27 (World Bank 2005) and a supporting web based resource Guide (World Bank 2006) in 2006, to assist national and sub-national road agencies launching or enhancing PBC projects for constructing, operating and maintaining their road networks.

558. **The process of implementing a PBC forces those responsible for the funding, governance and management (at all levels) of the asset to answer the questions that have the potential to drift on, lacking answers, without the contractual pressure of the PBC timeframe.** Specifically, to successfully implement a PBC, answers are needed to questions such as:

- What assets are own and which of these are to be managed under this contract?
- What is the level of service that to be provided to the road user?
- What condition are the assets in?
- What is the forward works program required to deliver the least whole-of-life-cost solution?
- What risks exist in the delivery of the levels of service, and how are those risks best managed?

559. **PBCs also tend to:**

- Provide a better focus by the road agency on governance as a result of the separation from the day-to-day operational activities;
- Deliver a more consistent (and/or better) service level across the network;
- Reduce costs and/or set costs at a fixed level to enable for long term fiscal planning by the road agency;
- Better allocate risk;
- Improve workmanship; and
- Address internal labor shortages wherein the authority may not have the internal resources/capacity to manage a network according to the traditional model.



While many of these desired outcomes might be achieved via alternative contracting means, it is the PBCs requirement to address all of these at once that is often perceived as the key benefit to the contract model as they force a paradigm shift.

560. **While PBC is mainly used for main roads, it can be a viable alternative for county and local roads if properly managed.** To reduce the risk and attract the private sector interest, county and local roads in rather good condition, preferably right after construction or with limited amount of rehabilitation to be done, can be packaged in groups of roads forming a total length adapted to the size of local and regional contractors. Simplified monitoring and evaluation system relying on easy verifiable criteria along with easy payment system need to be implemented for better efficiency.

561. **Modern road maintenance must take into account environmental considerations.** Many countries have developed processes for environmental protection and conservation of natural resources. Funds are also invested in R&D in maintenance and recycling and for staff training to improve cost-effective maintenance and building practices and to attract and retain competent personnel.

7.3.2 Asset Management in the Water and Wastewater Sector

562. **Asset management for water utilities is more complex than for most other sectors because of the number, variety, age, condition, and location of assets; the magnitude of asset investment; and the difficulty of inspecting and maintaining buried assets.** This complexity is often compounded by lack of finance, information, and skills that can impede acquiring, commissioning, maintaining, overhauling, and replacing assets at the optimum time⁷².

563. **One of the main characteristics asset management should have is comprehensiveness.** This feature allows utility managers to obtain better information on the age and condition of existing assets, determine the level of maintenance needed to optimize asset performance and useful life, assess the risks associated with the failure of various assets and set priorities for their maintenance and replacement. In addition, a better understanding of the trade-offs and implications of management decisions about the assets, and use better information to justify proposed rate increases or capital investments are expected. According to the U.S. Government Accountability Office, water industry officials agree that by making informed decisions about investments in capital assets, drinking water and wastewater utilities can better justify the rate increases associated with making needed improvements to their infrastructure.

564. **At its most basic level, comprehensive asset management involves the systematic collection of key data and the application of analytical tools such as life-cycle cost analysis and risk assessment.** Asset management thus provides information that managers can use to make sound decisions about their capital assets and allows decision makers to better identify and manage needed investments in their organization's

⁷² Water Utility Asset Management – A Guide for Development Practitioners, ADB, 2013



infrastructure. By following this approach, organizations also change the process they use to make decisions, including the types of information they bring to bear, and which segments of the organization participate in the decision-making process. Using a fully integrated decision process, many segments of an organization, including accounting, engineering, finance, maintenance, and operations, are expected to exchange relevant information, share in the decision-making process, and take an organization-wide view when setting goals and priorities.

565. **For drinking water and wastewater utilities, an integral part of a comprehensive asset management program is ensuring that adequate funds are available through user rates or other means.** This way asset management decisions can be implemented (e.g., ensuring that planned maintenance can be conducted and capital assets can be repaired, replaced, or upgraded on schedule).

566. **Experts within and outside the water industry have published manuals and handbooks on asset management practices and how to apply them.** While the specific terminology differs, some fundamental elements of implementing asset management appear consistently in the literature, such as:

- Collecting and organizing detailed information on assets: Collecting basic information about capital assets helps managers identify their infrastructure needs and make informed decisions about the assets.
- Analyzing data to set priorities and make better decisions about assets: Under asset management, managers apply analytical techniques to identify significant patterns or trends in the data they have collected on capital assets; help assess risks and set priorities; and optimize decisions on maintenance, repair, and replacement of the assets.
- Life cycle cost analysis: Managers analyze life-cycle costs to decide which assets to buy, considering total costs over an asset's life, not just the initial purchase price.
- Risk/ criticality assessment: Managers use risk assessment to determine how critical the assets are to their operations, considering both the likelihood that an asset will fail and the consequences—in terms of costs and impact on the organization's desired level of service—if the asset does fail. Based on this analysis, managers set priorities and target their resources accordingly.
- Integrating data and decision making across the organization: Managers ensure that the information collected within an organization is consistent and organized so that it is accessible to the people who need it. Among other things, the organization's databases should be fully integrated.
- Linking strategy for addressing infrastructure needs to service goals, operating budgets, and capital improvement plans: An organization's goals for its desired level of service—in terms of product quality standards, frequency of service disruptions, customer response time, or other measures—are a major consideration in the organization's strategy for managing its assets. As managers identify and rank their infrastructure needs, they determine the types and amount of investments needed to meet the service goals.



567. **The implementation of the basic elements of asset management is an iterative process that individual organizations may begin at different points.** Within the water industry, for example, some utilities may start out by identifying their infrastructure needs, while other utilities may take their first step by setting goals for the level of service they want to provide. The interrelationship between the elements of asset management can alter an organization's strategy for managing its assets. For example, once an organization has completed a risk assessment, it may scale back its efforts to compile a detailed inventory of assets to focus initially on those assets determined to be critical. According to advocates of asset management, while many organizations are implementing certain aspects of the process, such as maintaining an inventory of assets and tracking maintenance, these organizations are not realizing the full potential of comprehensive asset management unless all of the basic elements work together as an integrated management system.

Better information enabled the Massachusetts Water Resources Authority to improve its maintenance decisions and eliminate some unneeded maintenance activities. For example, in an effort to optimize maintenance practices in one of their treatment plants, utility officials reassessed maintenance practices for 12 equipment systems, such as different types of pumps. By using the assessment results to improve maintenance planning for these assets, the utility decreased the labor hours spent on preventive maintenance by 25 percent from the hours recommended by the original equipment manufacturers, according to utility officials. Similarly, in analyzing its maintenance practices, the Massachusetts Water Resources Authority found it was lubricating some equipment more often than necessary. By decreasing the frequency of oil changes, the utility reported it saved approximately \$20,000 in oil purchase and disposal costs. In addition, the utility extended the life of its assets by decreasing the lubrication—over-lubrication can cause equipment parts to fail prematurely. (Source: Water Infrastructure: Comprehensive Asset Management Has Potential to Help Utilities Better Identify Needs and Plan Future Investments GAO-04-461: Published: Mar 19, 2004. Publicly Released: Apr 20, 2004)

7.4 Asset Management in infrastructure projects funded by PNDL

568. **Asset Management covers asset management activities, irrespective of their form – financial or tangible.** This is an umbrella term for various activities, from managing financial assets to managing the infrastructure (roads, water, and sanitation).

ROAD INFRASTRUCTURE SECTOR

569. **“Asset management” as applied to the roads sector can be considered to be “a systematic process of maintaining, upgrading and operating assets, combining engineering principles with sound business practice and economic rationale, and providing tools to facilitate a more organized and flexible approach to making the decisions necessary to achieve the public’s expectations.”**⁷³ In practice, an asset

⁷³ OECD - Asset Management for the Roads Sector, 2001



management system (AMS) will include all the processes, tools, data, and policies necessary for the effective management of all the assets for which the road administration is responsible, including physical infrastructure such as pavements and bridges as well as human resources, equipment and materials and other items of financial and economic value.

570. **Asset management is ultimately about managing a road administration's resources more like a business.** In many countries, road administrations are now required to implement standardized asset inventory, valuation and depreciation approaches and enhance the information provided as part of their annual financial statements, in a manner more in line with those used by private sector companies.

571. **In 2005, under the World Bank's Rural Development Program (RDP), a project/survey was initiated for developing a road maintenance management system for the Romanian roads.** Five counties were selected: Botoșani, Călărași, Dolj, Sălaj, and Tulcea, each with 20 communes (totaling 100 communes in the country). The study performed an analysis for the development of a multiannual program of works. A management and maintenance system for local roads was also achieved and HDM4⁷⁴ was used as a working tool for this purpose. Based on the works schedule average annual funds to be used for economically efficient maintenance are calculated. The survey results are useful for preparing future budgets necessary for the local road network. The reports include both technical and economic models for scientifically based analysis and could be considered as potential guidelines for future analyses. Nationally, the study can be considered a good starting point for enhancing the experience in other Romanian counties.

Water and wastewater sector

572. **In Romania, the management of water supply and sanitation services is delegated to the Regional Operators.** While there is little *asset management* as defined before, some features are presented in the following part.

573. **A high volume of piping characterizes supply / treatment plants and water supply / sanitation networks.** The operation of these constructions depends decisively on their proper functioning. For all equipment, technical sheets will be drawn up, containing

⁷⁴ HDM-III simulates the conditions and costs for the lifetime of a road or a group of roads starting from a number of construction and maintenance strategies for modernized or not modernized roads. HDM4 (Highway Development and Management Model) has been realized starting from HDM-III as a result of international effort of British Overseas Development Administration, Asian Development Bank, Road Administration of Sweden, Inter-American Federation of concrete Manufacturers and World Bank. Based on the knowledge accumulated from previous use of road management HDM-III has been extended with: i) Updated and calibrated technical relations to the most recent level of knowledge; ii) Supplementary facilities for traffic congestion treatment and for non-motorized vehicles, concrete pavements, effects on the environment and traffic safety; iii) Improvement of the analysis and decision framework, so it might be used at different levels of planning, financing/budgeting, evaluation and management. HDM-III simulates the conditions and costs for the lifetime of a road or a group of roads starting from a number of construction and maintenance strategies for modernized or not modernized roads.



all data from the project, the technical documentation submitted by suppliers or executants and from the operational data taken on the ground and certified by acceptance protocols upon takeover, which must confirm their conformity with reality.

574. **During operation, the data sheets should be filled out with data concerning:**

- incidents or damages;
- equipment damaged as a result of the incident or damage;
- incidents or damages to other equipment caused by the incident or damage in question;
- repairs made to remove the incident / damage;
- the cost of repairs;
- the list of parts and / or subassemblies replaced during repair;
- the duration of the repair period;
- the behavior during operation between two scheduled repairs;
- the due date and the type of the next scheduled repair (routine maintenance works, technical revisions, routine and capital repairs);
- the due date of the following regular check;
- periodic testing and after repair reports according to the technical specifications and legal requirements.

575. **The technical data sheets for the basic machinery should also include data on foundations, equipment, earthing systems, protection devices, control, remote transmission, and telecommunications systems.** For adduction and exhaust channels, buildings, tanks and the like, as well as for lifting equipment, boilers and pressure vessels, the documentation required by the applicable regulations in force should be prepared and used.

576. **Apart from the technical data sheets, a record of routine maintenance works, technical revisions, and regular and capital repairs is kept for basic equipment.** The basic machinery, the auxiliary equipment (pumps, motors), and the major mechanical systems (tanks, dams, gantries, cranes) must be provided with indicative signs containing the identification data for that equipment in accordance with the rules in force. All the mentioned equipment, as well as the pipelines, must be marked according to a system that would allow rapid and easily visible identification during operation.

577. **The operating staff should prepare daily operational data sheets if these data are not recorded and stored by a computer system.** The data stored in the computer system or prepared by the operating staff represent the primary form of technical evidence. The main works to be carried out by the operating staff, in relation to the operating activities, consist of:

- a) facility surveillance;
- b) regular facility checks;
- c) performing various tasks;



- d) periodic maintenance works;
- e) unscheduled maintenance works;
- f) accidental intervention works.

The periodic maintenance works are those stipulated in the instructions of the equipment suppliers, in the Technical operating rules and in the internal instructions / technical procedures and should be executed, usually without stopping the basic machinery. Unscheduled maintenance works are performed in order to prevent or eliminate degradation, damage or incidents.

578. **Analysis and recording of incidents and failures should be done.** In order to increase the operational safety of the water supply and sanitation service and the continuity of the service, the Operator prepares operative and systematic analysis procedures for undesirable events that occur in the water supply and sanitation system. This way measures are established on increasing the reliability of the equipment and technological schemes, on improving operational/maintenance/repair activity and on increasing the level of training and discipline of the operating staff.

579. **Events that are analyzed refer mainly to:**

- common faults;
- malfunctions in the catchment systems, treatment plants, water transport and distribution networks;
- malfunctions in the collection and transport systems, in wastewater treatment plants and sludge treatment and disposal plants;
- incidents and failures;
- systematic deviations of distributed water parameters.

Failure analysis should be performed immediately after the event occurrence by the Operator's staff in charge.

580. **The analysis of each incident or failure should include:**

- place and time of the occurrence of the incident or failure;
- situation prior to the incident or failure, whether the work was performed under the usual scheme, indicating possible deviations from it;
- causes that favored the emergence and development of the incident or failure;
- maneuvers carried out by the staff during the occurrence and removal of the incident or failure;
- operation status of signaling, protection and automation systems;
- effects produced by the incident or failure on plants, whether the equipment was damaged, describing the damage;
- effects on users, utilities not delivered, duration of the work discontinuation, estimated amount of damage or other effects;
- technical causes and factors that caused each event in the sequence of events causing the incident or failure;



- behavior of staff during the incident or failure and the observance of the technical instructions and internal procedures applicable to them.

581. **A thorough analysis of an incident or failure should show the basic cause, which produced it.** This might be the result of a deficient design of the plant, of deficiencies in system installation, as well as of equipment deficiencies, of poor quality materials or due to the action or inaction of certain individuals on or in connection with the system or equipment under analysis. The incident or failure analysis results are transmitted to those involved in order to obtain their viewpoint. The analysis of the failure or incident should be performed at the headquarters of the Operator of the respective facilities, with the participation of the designer, the equipment supplier and/or the contractor, as appropriate, their participation being compulsory at the request of the Operator.

582. **Ensuring system operational safety is a key aspect of asset management.** To increase the operational safety of the water supply and sanitation services and water supply and wastewater takeover continuity, the Operator should prepare internal technical instructions and procedures establishing rules for conducting maneuvers in the facilities belonging to the water supply and sanitation system. Commissioning of the equipment newly installed should be performed according to the design and/or equipment provider instructions on the mechanical and technological tests and commissioning. During the mechanical testing of the equipment, maneuvers and operations performed are the responsibility of those who perform the installation, with the participation of the operating personnel. After the completion of mechanical tests, construction - installation works acceptance is performed and works are taken over by the recipient based on an acceptance report.

Social infrastructure

583. **In this area, Romania has no experience on asset management.** Behavior monitoring during operation and maintenance could be considered preliminary phases; they are shown below.

584. **Routine maintenance and behavior monitoring of buildings that are part of the social infrastructure is a permanent activity required throughout the lifetime of a building.** The schedule for the maintenance and behavior monitoring (maintenance) of socio-cultural buildings consists of all technical and administrative actions, including surveillance operations, undertaken by the community where the school is located, in order to extend the functional, structural and aesthetic characteristics and the useful life of the building.

585. **The local or county council should appoint a team that, every six months, will check all the social infrastructure buildings that are owned/ managed by the County Council or by the City Hall.** The inspection team should consist of 5-7 members including:

- a member of the education/culture/urban and spatial planning boards within the city hall/county or local council; the school principal or another teacher; staff qualified in maintenance activities, the school administrator;



- specialists, consultants, companies, employees dedicated to this work, if the board so determines, who are remunerated on a contract basis from the local budget; and
- representatives of the designer and constructor: architect and engineer, site supervisor; cost assessment expert. This team should prepare, for each building, an inspection report on the existing situation and should make budgetary proposals to fix the problems and keep the building at standard operating technical parameters.

586. **The elements that determine the maintenance activities' planning are:**

- inspection performed by the designated team;
- identification of the type of work (very urgent, urgent, routine);
- organization of the maintenance work (planning of deadlines and responsibilities) and cost identification and their planning;
- activity planning and budgeting;
- identification and allocation of financial resources;
- monitoring of works during execution;
- works acceptance / final acceptance and filling in the construction log book.

587. **The team should establish three categories of works:**

- *Very urgent*: whose nonperformance can lead to accidents, damages etc. (e.g. gas installation faults). To be immediately remedied.
- *Urgent works*: works whose non-performance would lead to a poor educational process in terms of quality. To be remedied until the start of the following school year.
- *Routine or planned works*: to be planned for the following year, during holidays, etc.

588. **The mayor/deputy mayor or vice-president of the County Council, as appropriate, should supervise the prioritization of the maintenance works proposed by the inspection team.** Employees of specialized services within city halls and each unit manager should keep a record of the planning activity. The commission for urban and spatial planning/technical projects/investment and the management of the institution (represented by the inspection team) should be responsible for carrying out the works and should be present at the reception of the works.

7.5 Conclusions

589. **Asset management is of crucial importance for infrastructure works.** New transparent and standardized methods are needed for a better development of the process.



590. **Specialists working on projects funded under PNDL acquire valuable knowledge and extensive practical experience.** However, this knowledge is not shared and is often lost when projects are completed. To build on the experience gained and to avoid repeating errors, it is extremely important to share experience and knowledge. In this way, beneficiaries can find more information about similar projects in the same county. To that end, seminars can be organized to disseminate knowledge on two levels: detailed information can be shared among projects of the same type (roads, water and sanitation, social infrastructure), while general information can be disseminated to the public.

591. **During the warranty period, the Constructor is required to deal only with faults that arise from the operation, not under routine maintenance.** Currently, the legislation allows framework agreements to be concluded for maintenance during winter or summer time (for road maintenance works), possibly with a different company than the one that performed the works. The intervention of another company on the works executed by the Constructor may invalidate the warranty provided by the Constructor to the Beneficiary during the period between works acceptance (on completion) and the final acceptance. For example, the degradation of the wear layer caused by snow removal activities performed by the maintenance company can be attributed to the latter's lack of professionalism, leading to the Constructor's refusal to remedy the degradation of the items concerned. Therefore, when contracting the Constructor, the Beneficiary should include in the specifications the requirement for maintenance after the completion of the works, during the warranty period. This relates to the recommendation to supplement the legislation with the FIDIC Design-Build-Operate type of contract. Another important recommendation for PNDL is related to the eligibility of maintenance costs within the PNDL budget.

592. **The designer should draw, solely at the request of the Beneficiary, the specifications for monitoring over time the behavior of constructions that require routine maintenance works.** It is recommended that this type of specifications be mandatory for every type of work within the infrastructure projects financed under PNDL.

593. **According to standards for asphalt mixes, the wear layer can be replaced every 5 years.** To ensure legislative consistency throughout the project, the proposed interval for road maintenance should be of at least 5 years. No roads should be rehabilitated/modernized before this period. PNDL should not finance road works on sections that were built/rehabilitated over the previous 5 years (from whatever source of financing), as argued in the other reports developed as part of this technical assistance.

594. **Maintenance/modernization/rehabilitation of county/communal/local roads could be managed by the current Regional Directorates for Roads and Bridges, subordinated to the CNADNR.** Communes do not receive adequate resources for planning and programming road maintenance works. Only urgent actions or minimum annual actions are planned in order to keep the road network at least in minimum conditions for use and operation. This is natural, given that the budgets of most communes are low, and road infrastructure is not considered as a priority by the decision-makers. In addition to the lack of financial resources, communes are also confronted with the lack of qualified technical staff. An important benefit of this proposal is the unified prioritization of



maintenance during the summer and especially during the winter (Regional Directorates for Roads and Bridges subordinated to CNADNR take action for snow removal on national roads, but in order to reach the localities, snow removal on local and county roads is also required, which is under County Councils for county roads, or U.A.T. for DC/DS/streets).

595. **Alternatively, the Government should consider establishing eight Regional Directorates for the implementation of maintenance/ rehabilitation/modernization projects for county/local roads.** Local needs should continue to be determined locally, based on the strategies of communes and counties. In contrast, the proposed Directorates should carry out the implementation of projects at regional level. This would allow for an easier implementation of local road projects, taking this burden off the shoulders of local councils in rural areas, as most of the time they lack specialized staff. A Regional Directorate should also have a unified vision regarding the maintenance/modernization/rehabilitation of county roads, which will allow the financing of the maintenance/rehabilitation/modernization of entire county roads that run over several counties. The eight Directorates should have specialized technical personnel from the County Directorates for Roads and Bridges of the County Councils. The MRDPA and the Ministry of Finance can act as coordinating entities of the proposed Regional Directorates.

596. **The proposed Regional Directorates should have responsibilities such as:**

- Regular inspection and continuous assessment of public roads;
- Development of proposals for the maintenance plan;
- Coordination and supervision of maintenance projects during the summer;
- Coordination and supervision of maintenance projects during the winter;
- Coordination and supervision of urgent works and minor maintenance works;
- Execution of routine administrative works;
- Preparation and payment of the maintenance works performed.



8 Conclusions and recommendations

8.1 Targeted strategies and specific action steps proposed for public investments in Romania

597. **Any strategy should demonstrate/provide information regarding the involvement of the community and interested stakeholders in the formulation process.**

Public and online consultations for the strategies, including the list of priority projects, should be carried out and the input of the stakeholders should be clearly specified in a dedicated chapter of the document and integrated in the content of the planning document. In order to ensure the sound involvement and accountability of each stakeholder in the implementation stage, partners and local authorities should elaborate and sign a partnership contract. This contract should contain both benefits and penalties for the parties that assumed clear responsibilities in implementing priority projects. Another report (under Component 1 of the current technical assistance), to be finalized in late August 2015, explores the potential use of territorial contracts, drawing on best practices and experiences from other EU member states (e.g., Poland, the UK, etc.).

598. **The periodic evaluation of strategy implementation, based on a set of objective indicators, should be carried out at least every 2-3 years, while monitoring should be continuous.** This way, the ongoing revision of the strategy will be allowed or the corrective measures will be undertaken.

599. **Local strategies should take into consideration strategic projects identified by the higher-level (national, regional or county) development strategies.** For example, if the General Transport Master Plan foresees the rehabilitation of a certain national road or the development of a new highway, local authorities should invest with priority in the county and local roads ensuring the connection to that specific road.

600. **Investment projects should be territorially integrated at local level in order to maximize their effects.** For example, if a certain urban or rural area is targeted for road extension or rehabilitation, the investment in utilities or social infrastructure for that particular zone should be also considered with priority. A good example in this sense is the PIDU approach for urban areas or the integrated rural renewal projects under 2007-2013 PNDR.

601. **Authorities should consider the establishment of an inter-department steering group at the beneficiary level (in case of municipalities and counties) led by one department/project implementation unit to help the process and ensure ownership of the development strategy.** Law no. 215/2001 should be revised in order to clearly state that the local / county authorities should elaborate and adopt a decision on both strategies and lists of priority projects, with clear provisions related to financing sources (reflected also in the multi-annual budget of that particular authority).



602. **A sound prioritization process of the investment projects, correlated with the real financial and human resources of the communities, should be conducted.** In this sense, this report argues for the use of prioritization criteria for each investment project proposed (road, water and wastewater, social infrastructure). A full list of potential criteria (to be applied to the state-funded National Local Development Program) has been delivered by the World Bank under the Component 2 of this Technical Advisory Service.⁷⁵ Particularly important are the criteria related to the beneficiary's capacity of co-financing the projects.

603. **Alternative sources of finance should be explored.** Although EU funding will continue to be the main financing source for most investment project in the 2014-2020 programming period, development strategies should consider all potential financial sources (a financing mix), including own budgets (if available), PPPs, and PNDL funds or credits.

604. **In order to improve the quality and the use of the planning instruments for the next EU programming cycle, several measures can be devised.** First, all infrastructure strategies, as well as the actual related projects, should be correlated in space and time. One relevant example would be the road and utilities infrastructure, with many newly rehabilitated roads being affected by the water, wastewater or gas construction work. The report on coordination (also developed as part of this technical assistance) covers this topic in great depth.⁷⁶

605. **Priority projects should be better promoted especially to private stakeholders.** This way they could better plan and connect their own investments to those envisaged by public stakeholders/administration (multiplying effect).

606. **Multi-annual financing and the correlation between investment priorities and budgets are needed.** Although the county or local councils approve strategies, these documents do not typically contain a financing need assessment for the entire programming period or the potential financing sources for each of the proposed projects, and/or there is no specific allocation in the local budget for the priority projects identified in the strategy.

607. **A stronger "partnership culture" among stakeholders in general is needed.** So far, most PPP alternatives for the implementation of strategic projects are completely ignored, while the only focus is on EU-funded programmes, with limited resources made available to innovative schemes.

608. **For Infrastructure Planning and Facilities, every construction project begins with an idea – whether it is a sidewalk repair, a new bridge, rehabilitation of a road sector, new water and wastewater system, or modernization of social infrastructure.** First, someone identifies a probable need. From there, the idea is either studied to determine if

⁷⁵ See "Improved Prioritization Criteria for PNDL Projects," World Bank, 2015

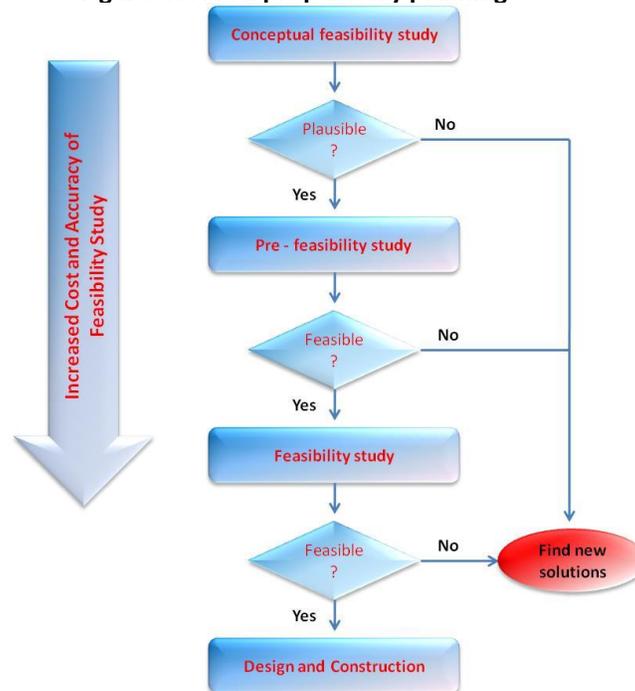
⁷⁶ See "Coordination of Strategies and Programs for EU and State-Funded Investments in Romania's Infrastructure," World Bank, 2015



there is truly a need, or it is given to an estimator for a calculation on the cost of the idea. If approved, the idea is then sent to the planning stage.

609. **The stages for preparatory planning should follow the scheme below:**

Figure 43. Ideal preparatory planning



610. **The cost-benefit analysis can become more useful – for demonstrating the feasibility of the proposed investments** – with clear definition and role and **by including a minimal, yet standardized methodology that does not require great efforts on the part of the applicants**. Consequently, all projects would be analyzed by using the same unit of measurement, thus helping with the prioritization of the funding proposals. Drafting an economic analysis, albeit a minimal one can ensure the beneficiary that the FS can be submitted for financing from multiple sources. Most European funding programs require an economic analysis, irrespective of the project value.

611. **Introducing a phase of technical and economic assessment of the documentation would ensure that technical non-conformities could be corrected at minimum cost**. Thus, it can be determined whether solutions adopted meet standards in force and can be implemented without additional costs.

612. **It is also recommended to consider introducing a standardized financial model to facilitate the Beneficiary's work and to prevent errors at the same time**. Errors were found in the calculation of the General Estimate: failing to comply with the unit costs and maximum limits for certain types of expenses laid down in the cost standards – GD no. 363/2010, as subsequently adjusted (e.g., the program's estimated contribution and the beneficiary's own contribution were inaccurate).



613. **Feasibility studies for major projects should be reviewed and analyzed by experts in order to enhance their quality.** This process can be done in the following sequence:

- Asking the award winning consultant who is preparing the feasibility study to submit a draft of the study to the beneficiary before submitting the final feasibility study report for approval.
- After getting the draft study, the beneficiary needs to ask experts in this area to review the document. Peer reviewers can be selected from local and/or international consultant offices, economic experts, and academic people. They can be inside resources (e.g., City Hall staff) or outside consultants.
- Peer reviewers are required to answer the primary question: Is the study appropriately prepared? They would submit a report that includes: (a) a critical review of the draft feasibility study; (b) identification of major deficiencies and/or areas of weakness in the draft, if any; and (c) specific recommendations to improve the study.
- The award-winning consultant should include this review as an appendix in the final submitted study, and should respond and address all comments in these reviews to the satisfaction of the owner of the project.

614. **A recommended solution would be compliance monitoring, which is a fundamental activity within environmental protection and is one of the ways by which adherence to limits and laws can be assessed for regulatory purposes.** It may include a range of inspections and reporting activities undertaken to determine compliance with regulatory requirements. The achievement of best practice in compliance monitoring requires careful consideration of key stages:

- Reasons for monitoring;
- Responsibility for monitoring (by whom);
- How to set limits and parameters which can be monitored;
- Principles of practical monitoring;
- How to judge compliance;
- Response to compliance failings;
- Summary and communication of findings and conclusions.

615. **Also, for a better administration, a document management system (DMS) is recommended, which is a computerized method of storage, management hosting and distribution of project documentation.** It is an essential tool to store, track and distribute documentation and data to users groups who may be correlated or distantly located. It provides a component of enterprise content management relative to digital asset management, document imaging, workflow systems and records management.

616. **Public procurement law must find a compromise between excessive regulation, meant to ensure strict compliance with governing principles, and freedom of decision, which would allow contracting authorities to select those tenders that suit best their particular needs.** The following list of recommendations offers potential solutions for addressing the issues related to the current public procurement framework and ease the burden on ROP beneficiaries implementing projects. It is important to note that some of



these ideas are particularly technical, while others require a national-level resolution. That said, the hope is that these suggestions help advance the conversation on an extremely complex and sensitive topic – public procurement – and enable PNDL beneficiaries to organize efficient and effective procedures for awarding contracts. At a minimum, some of these ideas could form the basis of upcoming changes to Romania’s public procurement law (Government Emergency Ordinance 34/2006), in line with corresponding dynamics at the EU level:

- An improved public procurement framework should aim to reduce, to a minimum, the number of contracts awarded on the basis of the “lowest bid” criterion and instead rely, in most cases, on the “most economically advantageous tender” (MEAT) criterion.
- Contracting authorities would benefit from recommended sets of evaluation factors, based on broad types of public contracts. These factors should be synthetic and allow for an objective assessment of the tenders, but they have to be, at the same time, relevant to the object of the contract.
- Better support is needed to help contracting authorities prevent and avoid potential conflicts of interests. This can be achieved by providing PNDL beneficiaries with detailed checklists as a mandatory component of the tender evaluation process.
- The usage of professional liability insurances should be expanded.
- Public procurement procedures can be launched under a “suspension clause”. Taking into account the significant duration of the selection, the evaluation, and the contracting stages, the deferred launching of the award procedure, after the signing of the financing contract, can lead to failure to comply with the schedule of activities, because of possible delays in public procurement. From this point of view, a possible solution consists in the launch of award procedures under a “suspension” conditional clause (“clauză suspensivă”), the effect intervening after the designation of the successful tender, but prior to the signing of the public contract.
- Recommended templates should be designed for contractual variation clauses. In the case of public works contracts, the actual performance of the contracts may reveal differences against the quantities estimated by the technical documents. In order to regulate such changes of the object of the contract, where they do not involve a review of the technical solution adopted or of the technical requirements laid down in the specifications agreed to by the contractor, the contracting authorities can include, in the contract template, certain variation clauses according to which the final price of the contract is to be determined as the product between the prices/quantities initially tendered and the actual costs resulted from works on the ground.
- Support for PNDL beneficiaries in the procurement process should be provided. Establishing a new professional body of assessors for the alternative technical solutions. The assessors may be required by the beneficiaries to evaluate bids and payments from the PNDL budget and they must be MRDPA certified engineers as site inspector (*Diriginte de șantier*) of Technical Responsible with Execution (RTE).

617. Maintenance/modernization/rehabilitation of county/communal/local roads could be managed by the current Regional Directorates for Roads and Bridges,



subordinated to the CNADNR. Communes do not receive adequate resources for planning and programming road maintenance works. Only urgent actions or minimum annual actions are planned in order to keep the road network at least in minimum conditions for use and operation. This is natural, given that the budgets of most communes are low, and road infrastructure is not considered as a priority by the decision-makers. In addition to the lack of financial resources, communes are also confronted with the lack of qualified technical staff. An important benefit of this proposal is the unified prioritization of maintenance during the summer and especially during the winter (Regional Directorates for Roads and Bridges subordinated to CNADNR take action for snow removal on national roads, but in order to reach the localities, snow removal on local and county roads is also required, which is under County Councils for county roads, or U.A.T. for DC/DS/streets). It is mandatory to have technical standards to establish the necessity of maintenance works depending on the degradation degree of the infrastructure, but also the costs for such works.

618. **A continuing professional training system should be implemented to ensure the best possible working environment in the field of infrastructure investments.** Such a system should be mandatory for all professionals in this field and should be targeted at both training on the current legislation and correct implementation of investments.

8.2 Efficient and innovative designs and technologies for public infrastructure investments in Romania

619. **In the planning process, stakeholders should look for modern, efficient, and sustainable infrastructure to be reliable, green, safe, and smart.** This report considers that these are the main pillars (families of characteristics) desired and researched in the design of new infrastructure, which respond to current requirements and concerns:

- **Reliable** infrastructure is available and durable, i.e. demonstrates high quality and low maintenance of the infrastructure components. The concept is closely related to lifetime engineering and involves the project optimization, with particular attention to maintenance, upgrades, and refurbishments.
- **Green** infrastructure features energy efficient and environmentally friendly designs. The concept can be applied to the design, building, and operation, including materials, techniques, and management for all the inputs, processes and outputs.
- **Safe** infrastructure minimizes accident risks for users and operators/workers. It also implies that, in case of an accident, the infrastructure is designed to minimize consequential effects.
- **Smart** infrastructure communicates with users, operators, and with other infrastructure. Modern infrastructure is more and more connected with the real and virtual world through direct information sent to users about its real time conditions, to operators about maintenance status, energy consumption, etc., and adapt itself to the conditions of use.



620. **There are multiple recommendations for improving the design of public infrastructure projects in Romania.** For one, it is mandatory to adapt the technical standards in force to European standards, reflecting climate change, traffic modifications, and other new concepts environment friendly. Some standards are too old and their content is not up to date compared to international best practices.

Cross-sectoral aspects

8.2.1 Energy efficient and environment friendly infrastructure

621. **Green infrastructure uses vegetation, soils, and natural processes to manage water and to create healthier environments.** It seeks to provide a better resolution and integration of man-made heavy polluting and high energy consumer environment, by building with nature. Green infrastructure can refer to rainwater harvesting, rain gardens, planter boxes, flood protection, green streets and alleys, permeable pavements, green roofs and others. This type of solutions can enhance or even replace a functionality that is traditionally provided by man-made structures.

622. **A low energy infrastructure in a life cycle concerns the amounts of energy spent in its embodied energy, energy needed for operation and demolition.** The European Union is aiming for a 20% reduction in annual primary energy consumption by the year 2020. The commission has proposed measures to increase efficiency in all stages in the energy chain – generation, transformation, distribution and consumption.

623. **Romania has a good potential of solar radiation, which can be used in photovoltaic applications as an alternative energy source.** According to statistical data for Romania, annual solar radiation on a horizontal surface varies between 1500 kWh/sqm (in Dobrogea - South/East of Romania) and 1300 kWh/sqm (Transylvanian Plateau) so that autonomous photovoltaic systems may cover a large territory, especially in isolated areas with low demand for electricity.⁷⁷This type of photovoltaic applications can be applied in new technologies for roads, water, wastewater, and social infrastructure, such as facades or rooftops for buildings, solar powered road signs, traffic lights, power stations, rural electrification, solar lamps, water pumps, parking meters, and many others.

8.2.2 Smart infrastructure

624. **Information availability and exchange is a key characteristic of our society and it does not exclude infrastructure.** Modern infrastructures communicate with users, operators and between themselves. A smart infrastructure responds intelligently to changes in its environment, including user demands and other infrastructure, in order to achieve improved performance.

625. **Intelligent transportation systems (ITS) are advanced applications that aim to provide innovative services relating to different modes of transport and traffic**

⁷⁷ Romania National Report, Harghita Energy Management Public Service & UEM CARDT, Wide the SEE



management and enable various users to be better informed and make safer, more coordinated, and 'smarter' use of transport networks. Although ITS may refer to all modes of transport, EU Directive 2010/40/EU (7 July 2010) defines ITS as a system in which information and communication technologies are applied in the field of road transport, including infrastructure, vehicles and users, and in traffic management and mobility management, as well as for interfaces with other modes of transport.

626. **A variable-message sign, often abbreviated VMS, CMS, or DMS, and in the UK known as a matrix sign, is an electronic traffic sign often used on roadways to give travelers information about special events.** Such signs warn of traffic congestion, accidents, incidents, roadwork zones, or speed limits on a specific highway segment. In urban areas, VMS are used for parking guidance and information systems to guide drivers to available car parking spaces. They may also ask vehicles to take alternative routes, limit travel speed, warn of duration and location of the incidents, or just inform of evolving traffic conditions.

627. **While Romania already uses e-vignette, satellite-based tolling systems could also be considered.** Following the successful German experience, many countries have adopted or are considering adopting advanced tolling technologies which are distance-based and can be applied to specific categories of vehicles (only heavy trucks, all trucks, all vehicles) and to specific parts of the network (only motorways, motorways and national roads, etc.).

628. **Smart water systems are important in delivering more integrated and resilient water, wastewater and flood protection infrastructure in order to meet the current and emerging global sustainability and climate change challenges.** New strategies currently being implemented or considered around the world include smart closed-loop wastewater systems with energy recovery, both small and large scale (UK); water resource and flood information and management response systems (Netherlands, China); holistic catchment management integrated with water supply and wastewater management (US)⁷⁸.

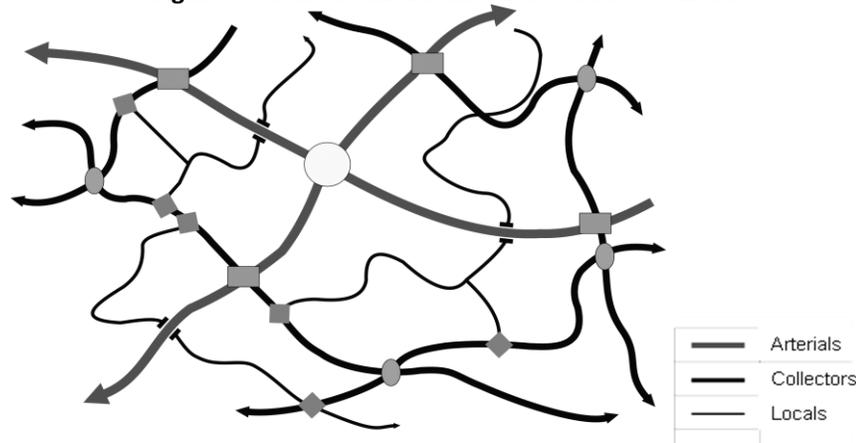
629. **Building automation is the automatic centralized control of a building's heating, ventilation and air conditioning, lighting and other systems through a Building Management System or Building Automation System (BAS).** The objectives of smart buildings are improved occupant comfort, efficient operation of building systems, and reduction in energy consumption and operating costs.

Road infrastructure

630. **In developed countries, road management is usually based on functional classification of the road network.** Normally, there are three road classes: Arterial, Collector, and Local roads. Arterials serve mobility, collectors serve mobility and access to land equally, and local roads primarily access to land with mobility as a lesser function. There can also be foot and bicycle paths.

⁷⁸ Smart Infrastructure: the future. The Royal Academy of Engineering. January 2012

Figure 44. Functional classification of road network



Source: AND 600-2010⁷⁹

631. **The actual stage of road design should include phases related to the elaboration of the traffic study, Environmental Impact Study, Road Safety Audit, Road Safety Inspection, topographic studies, geotechnical studies, geometric design, pavement design, drainage design, and art works design.** Noise protection of urban areas, in the vicinity of the roads where noise arising from vehicles exceeds certain thresholds, is less documented.

8.2.3 Self-explaining roads

632. **A self-explaining road can be defined as a road designed and constructed to elicit correct assessments from road users on appropriate driving behavior matched to the road environment, thereby reducing the likelihood of driver errors and enhancing driving comfort.** A self-explaining road environment can be facilitated by properly categorizing the road scene according to existing schemes, i.e., through a set of standardized “signals” in each road category, easily recognized and acted upon by road users. Drivers have to cope with increasingly complex traffic environments, including different types of road layout and all kinds of signposting, many of which are supported by telematics. In some cases, this may lead to an excessive workload imposed on the driver. This workload may include striving to read a VMS (variable message sign), while seeking the correct route in an unfamiliar environment (often in a foreign language and even with unfamiliar signs). It may also include attempts to detect the required, relevant piece of information from an abundance of information sources (including in-car navigation system, traffic management and information center or radio announcements, VMS signs, road signs, ADAS [advanced driver assistance systems] messages, etc.).⁸⁰

⁷⁹ AND 605, Norm for the design of junctions, 2010

⁸⁰ Implementation scenarios and further research priorities regarding forgiving and self-explaining roads, IN-SAFETY EU Project, 2005



633. **The most important quality of a self-explaining road is its ability to communicate to the road users what behavior they should adopt in certain traffic conditions.** For example, it is imperious for a road environment to suggest a low speed for a driver in a resident area, with many vulnerable road users, by using traffic calming measures.

8.2.4 Forgiving roads

634. **A forgiving road⁸¹ is defined as a road that is designed and built in such a way as to counteract or prevent driving errors and to avoid or mitigate the negative consequences of such.** Forgiving road environments can be considered a basic tool to prevent or mitigate an important percentage of road accidents related to driving errors. More specifically, statistics show that about 25%-30% of fatal accidents involve crashes with fixed roadside objects. Those accidents are mainly caused by driving errors, leading to departure from the road. The existence of a forgiving road environment would prevent accidents of this type (and generally accidents that involve driving errors) or, at least, reduce the seriousness of the consequences of an accident.

635. **The main elements to design a forgiving road are:**

- The clear zone, which is a key safety concept used in road design. It represents the area that begins at the edge of each travelled lane and is available for emergency use by errant vehicles that run off the road. This zone includes any adjoining lane/s, road shoulders, verges and batters.
- New drainage systems that can cope with the expected amount of rainfall yet do not create unsafe conditions for traffic users, for example permeable drainage systems, nu concrete.
- Frangible poles, specially designed to break away on impact and to reduce the severity of potential injuries; they consist in a main mast, designed for heights of up to 15 m. The base is made up of two plates joined by three evenly-spaced screw bolts. These plates and bolts break away on impact, in order to allow the pole mast to collapse at the base for minimum impact on the vehicle.
- Shock-absorbing poles ensure adequate safety on impact at low speeds (e.g. less than 80 km/h). They are particularly suitable on low-speed roads and/or pedestrian-intensive areas. The shock absorbing poles differ from frangible poles by staying attached to the supporting structure and absorbing the entire impact energy. The deformation of the pole is controlled by the designed weakening of the pole mast in the lower 4 m part from the total 5 m length.
- Safe barriers with shock absorbers.
- Shoulder rumble strips have been proven a low cost and extremely effective treatment in reducing single vehicle run-off-road crashes and their severity.

⁸¹ Evangelos Bekiaris and Evangelia Gaitanidou. Towards Forgiving and Self-Explanatory Roads, in *Infrastructure and Safety in a Collaborative World - Road Traffic Safety*, Springer 2011



8.2.5 Complete streets

636. **A complete street⁸² is designed and built not only for vehicles, but for all types of road users.** It is very important to create an infrastructure with proper means of transportation for pedestrians, such as sidewalks, crosswalks - including median crossing islands and raised crosswalks, accessible pedestrian signals - including audible cues for people with low vision and pushbuttons reachable by wheelchair users, and sidewalk bulb-outs; traffic calming measures to lower driving speeds and define the edges of car travel ways; bicycle accommodations, such as dedicated bicycle lanes or wide shoulders; mass transit accommodations, such as bus pullouts.

637. **Planning and designing roads to make them safer for all users and more inviting to pedestrians, bicyclists, and transit users can increase overall capacity and efficiency without a negative impact on automobile travel.** For example, improving intersections for pedestrian safety can reduce the time needed for a pedestrian crossing signal phase, keeping vehicular traffic flowing. Complete streets improve access to public transportation and assist transit vehicles in moving efficiently along the road, making it an attractive and viable option to more people. Increasingly popular are the use of bus rapid transit and bus priority signal systems, which allow buses to extend green lights and shorten red lights.

8.2.6 Technologies for sustainable roads

638. **Better integration of infrastructure in its surroundings is rather a matter of willingness to give natural habitats a chance to survive than a lack of road engineering solutions.** Proper design and modelling of the verges and the creation of barrier-free ecological areas using eco ducts are examples of ecological engineering that can already be found in some European countries. Local circumstances and demands will ultimately determine the best solutions.

639. **Green design solutions for roads have started to be implemented in developed countries.** A good example is represented by the permeable drainage systems, which are commonly used in the proximity of roads, following the idea that they will be more dry than wet, even in areas with heavy rain. If the side of the trench is porous, evaporation is faster, and not just for the water seeped through the sides of the trench in the ground, but for any other type of infiltration. This is also a sensible ecological measure and it is called "shallow green ditches." It has been discovered that most of the critical pollutions of the water from the road, such as oil and petrol will be destroyed by soil bacteria. For the case in which the water permeability of the soil is low, a subsurface piped solution is recommended.

640. **At present, the international focus is on improving mechanization in road superstructure works and on introducing new and advanced technologies with greater economic efficiency, in order to ensure rational use of resources.** Increasing traffic volumes, increased axle load, and increased tire pressure on the European road network have led to the need for stronger and more durable infrastructure, while also ensuring

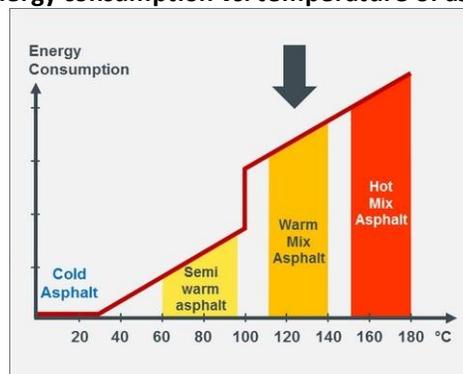
⁸² <http://www.completestreets.org/>



reduced downtime due to traffic maintenance and rehabilitation. For this, at the European level the following trends may be observed:⁸³

- Large scale use of polymer modified bitumen and additives;
- Recycling both asphalt mixtures and cement concrete road. Recycling makes its presence felt increasingly in the construction and rehabilitation of roads, helping optimize the use of natural resources, the introduction into the market of unsuitable materials called “waste,” and contributing to the development of performant materials with high durability;
- In terms of cement concrete road, the new worldwide trend is the use of precast cement concrete pavements, continuous armed pavements, and cement concrete road rehabilitation for roads with asphalt mixtures as wearing layer;
- Recently, cold recycling raised high interest for construction and maintenance using various technologies such as foamed bitumen, bitumen emulsion or cement, with beneficial effects in terms of reducing emissions and energy consumption.
- Technologies that reduce the temperature of mixing and placing asphalt mixtures - the concept of low-temperature asphalt (“warm mix” or “cold mix”);
- The road network occupies a large area with a high potential for energy production. Thus, currently, new technologies for the use of this energy through various systems are developed – e.g., piezoelectric, sewer pipe networks that absorb heat during the summer, which will be returned to fight icing during winter.
- Use of photo-catalytic paving slabs, especially in urban areas. They are made of materials designed to minimize air pollution. Laboratory testing showed higher effectiveness in reducing the NOx concentration in air, these slabs being increasingly used in Belgium, United Kingdom, Italy, Japan and France.

Figure 45. Energy consumption vs. temperature of asphalt mixture



Source: Marini-Ermot Fayat Group⁸⁴

641. **The efforts toward saving natural resources must be extended to saving energy.** Handling of thousands of tons of building materials is a very energy consuming business for road construction. Nevertheless, important savings can be made by focusing more on

⁸³ Adrian Burlacu. “Road Infrastructure Technologies – Course Notes”, Bucharest, 2015

⁸⁴ <http://en.marini-ermont.fayat.com/TECHNOLOGY/Warm-mix>



the treatment of these materials on site and in plants. Hot asphalt mixes are the main components of pavement constructions. The development of high quality low temperature binders and mixes produces substantial savings in energy and production costs. In this context and in view of the increasing scarcity of natural oil, the development of so-called Bbo-binders (binder burn out) is a potential option.

642. **In case of local roads, such as current communal or rural dirt roads, the existing gravel can be used provided it has the appropriate features of a subbase layer, or can be otherwise treated to become a shape layer capable to withstand traffic and environments loads.** This requires the use of additional materials such as hydraulic binders (both cement and hydraulic road binders), bitumen emulsions, foamed bitumen or environmentally-friendly enzymes, all of them with the role of securing a layer capable to withstand higher vertical loads than the current gravel layer. These new, innovative methods can yield thinner road structures which are able to withstand similar loads as regular road structures.

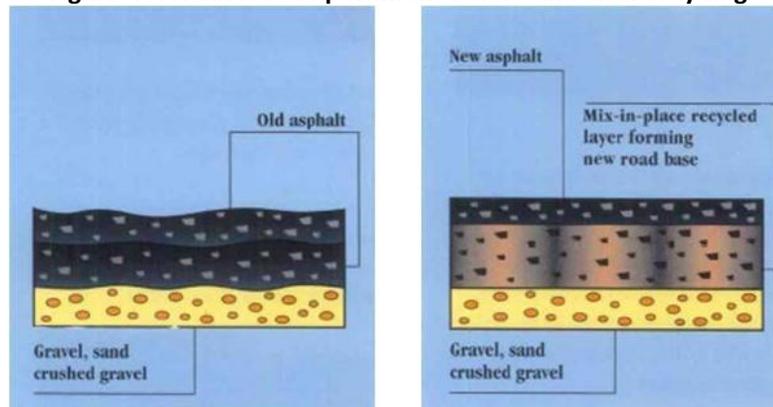
8.2.7 Recycling

643. **Utilization as much as possible of local materials in order to minimize costs of transportation from remote areas.** Thus, the initial assessment of the existing road infrastructure is of particular importance, and the existing road structure materials should be used based on reliable technical and economic studies. In case of roads with an existing structure but which are either very degraded or obsolete in terms of load-carrying capacity, the following recycling techniques may be reliably used: hot recycling in the asphalt mixing plant, in-place hot recycling, in-place cold recycling, and full recycling of the road structure.

644. **Asphalt recycling reduces the amount of virgin aggregate and liquid asphalt used, and mitigates the cost, logistics, and environmental impact of trucking this material to the paving site.** It can quickly fix deteriorating pavements, including problems in the subgrade. Using asphalt recycling, the new road is often built better than the original. The final wearing course can be something as minimal as a chip seal or as sturdy as a full layer of hot mix asphalt. Asphalt recycling can also be used to expand lane widths or shoulders.



Figure 46. Flexible road pavement before and after recycling



Source: Bomag⁸⁵

645. **The hot recycling technology for bitumen road pavements may be applied in the following variants:**

- a) by cold grinding of the existing bituminous layers, followed by proper recycling by hot mixing of the milled mixture with the additives in a mobile dryer-mixer plant;
- b) by infrared heating (radiant panels) of the existing bituminous layers, followed by scarifying and mixing the hot asphalt mixture with additives, either directly on the base or in a vat or mixer above the base.

646. **In-place hot recycling is a method for the rehabilitation of degraded road pavements.** This operation is entirely carried out in-place, by means of a machine assembly (recycling train) and begins by the application of heat to “soften” the road surface. The softened asphalt material is removed by grinding devices, and subsequently mixed with or without the addition of recycling agents. The recycled asphalt mixture is then laid along the road and compacted to complete the recycling process. Although this recycling method is 100% effective, certain remixing options such as the addition of new hot asphalt mixture or new mineral aggregates may be required for the structural correction and improvement of the geometrical features of the road.

647. **The full recycling of the road structure is a cold technological process which consists in grinding the entire road structure and mixing it with in-place additive binders, a material which will serve as the base for the future road structure.** The usual additive binders are bitumen emulsion, foamed bitumen, power plant ash and lime.

648. **Using this technology saves power, mitigates the aggregate transportation costs and construction waste and preserves natural non-renewable resources such as bitumen or new aggregates.** The recycling of asphalt mixtures creates an optimum usage cycle for the natural resources and supports the asphalt producing industry.

649. **Types of recycling-suitable materials in road construction works:**

- **Slags:** The first experiences in using slags as an aggregate in asphalt mixtures dates back to 1969, when an experimental road section was built in Toronto. For

⁸⁵ http://www.bomag.com/worldwide_replacement



this road section, steel furnace slag was used as an aggregate in both the base course layer and the wearing layer. The asphalt mixtures reviewed showed very good results in terms of load-carrying capacity, resistance to external factors and durability.⁸⁶

- **Crumb rubber:** Crumb rubber modified bitumen is a mixture of hot bitumen and ground rubber from waste or scrap tires. It is widely used in the transportation sector in both Europe and the United States. As far as noise is concerned, the Rubber Pavements Association (RPA) declared that the addition of rubber in asphalt mixtures cuts noise levels by up to 50%.
- **Glass:** Currently, up to 10% glass can be used instead of aggregates for base course layers in the US. The maximum glass size must be 4.75 mm for safety reasons, but also since coarse-grained glass surfaces will not have the required granularity. The best results were achieved with a glass content of at least 10% of the total weight and a glass size less than 6 mm.
- **Plastic:** UK-based studies on asphalt mixtures containing recycled plastic, particularly low-density polyethylene (LDPE), which replace approximately 30% of the 2.36 - 5 mm diameter aggregates, showed benefits such as increased Mashall stability and tensile strength. The most significant advantage is that the production process does not require any alteration of the current LDPE-asphalt mixture mixing plants.⁸⁷
- **Crushed concrete:** The American Concrete Pavement Association estimates that approximately 322 kilometers of cement concrete roads are recycled each year, and that approximately 1750 tons of crushed concrete can be recovered from 1 km of cement concrete road with a 25 mm average thickness. This means that 2.6 million tons of concrete are recycled each year in the United States. Concrete from roads, sidewalks, buildings and other sources can be crushed for reuse. Before crushing, the concrete should be stripped of reinforcements or other enclosed materials. Concrete crushing produces hard granular aggregates made of inert minerals, such as sand, gravel or crushed stone. Due to cement plaster bonding on the concrete aggregates, the aggregates resulting from the crushing of concrete are hard textured, have an apparent low density, and their water absorption exceeds that of similar sized natural aggregates.

Water and wastewater infrastructure

8.2.8 Control Systems and water management technology

650. **All potable water systems will have a certain quantity of water that is not paid.** A well run utility will keep the level in the low teens. The best utilities will achieve around 3 percent. Ideally, each consumer should have a water meter. The meter readings shall be the basis for payment for water. Romania has not yet achieved this level and water is often paid for on another basis such as pro rata – depending, for example, on the number

⁸⁶ J. J. Emery. "Slag utilization in pavement construction. Extending aggregate resources", in *American Society for Testing and Materials*

⁸⁷ W. H. Chesner, R. J. Collins, M. H. Mackay. "User Guidelines for Waste and By-Product Materials in Pavement Construction", no. FHWA-RD-97-148, April 1998



of inhabitants. Many apartment buildings in Romania have water supplies entering in two or three locations meaning that more than one water meter may be required per property. More than 90% of the apartment buildings have about four water meters, including two for cold water and two for hot water. Since 1990, practically all buildings have been provided with individual water meters. In order to lower the reading costs, the water companies have started to use water meters with electronic distance reading. However, the installation cost may be too high for old buildings, and in any case incentives must be in place for users to comply with any meter installation policy.

651. **Water quality must be monitored on a continuous basis, because problems will only be detected with regular sampling.** Sampling and analyses should be undertaken at the well, at the intake, where water exits the waterworks, and throughout the distribution system. Fortunately, various modern methods, sensors, and measurement equipment have made it quicker and less costly for utilities to monitor water quality throughout the process, thereby detecting irregularities in both treatment and supply. Sensors can be given online links to management systems that ensure alarms and data capture regarding process irregularities.

652. **The longer the water remains in the pipeline, the poorer the quality of the water reaching the customers.** Hydraulic models are used to optimize the quality of the drinking water when it reaches consumers by calculating the age of the water in the network. In order to establish a functional hydraulic distribution network model, reliable data about pipeline locations and dimensions is necessary. Further data or estimates about consumer demands around the distribution network are also required. The more accurate the information about consumption and time-dependent demand variations for each supply zone, the more advanced the model simulation of the distribution network that can be established.

653. **Ensuring constant pressure throughout the distribution network is one of the most important aspects that could benefit from advanced technology, tools, and designs.** Any pressure drop will not only affect the pressure at the tap, but also involve a huge risk that contamination will be sucked into the distribution network. This is often the case in the event of a fire, because in many cities firefighting is based on the use of fire hydrants using water taken from the distribution network. The optimum starting point to solve this is also with hydraulic models combined with GIS systems, which provide a great platform for decision-making regarding the distribution network design and rehabilitation. Real-time modeling may then provide information for daily operation and management of pressure in the drinking water network — and be even more effective when combined with pressure sensors installed in the distribution system.

8.2.9 Wastewater management

654. **Numerous processes can be used to clean up wastewaters depending on the type and extent of contamination.** There are two basic approaches: to use the waste in the water as a resource (such as constructed wetlands) or strictly as pollution (such as the majority of today's treatment plants). Most wastewater is treated in industrial-scale



energy intensive wastewater treatment plants (WWTPs), which include physical, chemical, and biological treatment processes. However, the use of septic tanks and other On-Site Sewage Facilities (OSSF) is widespread in rural areas, serving up to 20 percent of the homes in the U.S.⁸⁸

655. The most important aerobic treatment system is the activated sludge process, based on the maintenance and recirculation of a complex biomass composed by microorganisms able to absorb and adsorb the organic matter carried in wastewater. Anaerobic wastewater treatment processes (UASB, EGSB) are also widely applied in the treatment of industrial wastewaters and biological sludge. Some wastewater may be highly treated and reused as reclaimed water. Wastewaters ecological approaches using reed bed systems such as constructed wetlands are being increasingly used. Tertiary treatment is increasingly applied and most common technologies are microfiltration or synthetic membranes. After membrane filtration, the treated wastewater is indistinguishable from waters of natural origin of drinking quality (without its minerals). Nitrates can be removed from wastewater by natural processes in wetlands but also via intensive microbial denitrification, for which a small amount of methanol is typically added to provide the bacteria with a source of carbon. Ozone wastewater treatment is becoming more popular and requires the use of an ozone generator that decontaminates the water as ozone bubbles percolate through the tank. The solution is, however, energy intensive. Latest and very promising treatment technology is aerobic granulation.

656. Dewatered sludge can be dried to lower moisture contents by various processes termed sludge drying. For transportation, sludge benefits from being as dry as possible and a cost balance must always be made between transport costs and drying costs. For use of sludge as a fuel, dry solids matter must generally exceed 50%. Wastewater sludge can be mixed with the purifiable elements of domestic waste to make a so-called “compost-like” output that can be used for soil enhancement. Prior to 2008, available disposal solutions for wastewater sludge included incineration, and sludge was used as an agricultural fertilizer and disposed to landfills. However, since 2008, following amendments to the landfill, the option to dispose of sludge into landfill is no longer allowed. While Romania is still considering the use of wastewater sludge in agriculture, the other Western European countries are moving towards incineration as a prime disposal process. The disposal of sludge to agricultural land is prohibited in certain nitrate sensitive regions and requires considerable storage areas because there is only a narrow window of time when soil and crop conditions are amenable to receive sludge.

657. Another optimizing action is enhancing treatment processes with microorganisms. Specialized microorganisms can positively affect solids management and odor control in wastewater treatment operations. It is also possible to degrade specific substances with specialized microorganisms to lower substance levels in the plant effluent. In sludge and biomass treatment, adding actively growing, specialized microbial strains enhance the response of the biomass to process fluctuations or to degradation of

⁸⁸ U.S. Environmental Protection Agency. “Septic Systems Fact Sheet”. EPA Publication no. 832-F-08-057, Washington, DC, 2008



certain components. Bio-augmentation, as it is called, offers many advantages over traditional technology platforms such as chemicals and has for years proven its effectiveness at degrading organic compounds. Other technologies can also improve effluent quality, but those technologies are often much more expensive and more difficult to handle.

658. **The aeration process in biological wastewater treatment normally takes up more than half of the total energy demand of the plant and increasing the efficiency will have a high impact on total operating costs.** Generally, surface-aerated basins do not achieve the same energy performance as diffused bottom aeration. Taking it one step further, supplying the exact amount of clean air required in the process with optimized aeration technology makes it possible to achieve great savings. Analyzing a plant's current set-up and an alternative configuration calculated by aeration experts will make it possible to estimate potential savings.

659. **A new trend is coupled control.** Nowadays most of the developed countries' wastewater treatment plants have online measurement equipment for optimization of biological processes and plant hydraulics. Now this technology also emerges for the optimization of sewer systems to avoid massive investments in large retention basins or increase of sewer network capacity. Online monitoring instruments such as flow meters, sewage level loggers, and precipitation gauges combined with weather radar at regional and local levels in advanced storm water drainage and treatment models are now the new trend for coupled control of drainage system and wastewater treatment plants.

660. **Intelligent regulation, control, and coordination in the management of drainage systems and wastewater treatment plants may be the first defense against floods and sewer overflows for cities facing higher risks of extreme weather with heavy rainfall, saving them from new massive investments in climate adaptation.** Intelligent wastewater management is primarily a solution for cities of a certain size and with combined sewer systems that require special operational rules during heavy rainfall to avoid hydraulic overload and resulting discharge of untreated wastewater. Integrated solutions are the new trend to connect the wastewater treatment plant with a drainage model and get a coherent model for the entire wastewater system. Advanced technology such as sensors, flow meters, and intelligent software ensure that the capacities of sewer pipes are maximized. This means that rather than blindly expanding the capacity of the sewer system to cope with heavy rainfalls, the intelligent system sends the water where there is room for it.

661. **Many countries also use the decentralized treatment for wastewater that is not discharged to a municipal treatment plant.** These solutions are applied mainly in rural areas, but may also include relatively large areas, such as university campuses or industrial parks with their own treatment plants. Decentral wastewater treatment thus takes place at widely different scales from clusters within a mega-city to scattered individual households in rural areas. The rapid urban growth in many developing countries makes decentralist solutions attractive in order to maintain a manageable size of sewer networks, which can be make use of the topography for gravity drainage and avoid escalating pumping costs. The cluster approach is also attractive in cities with large



differences in service levels between the urban center and surrounding shantytowns or satellite cities as a gradual upgrading of water supply and sanitation can be achieved via local collection and decentral treatment of wastewater. Still it is important to be aware that wastewater treatment plants located within cities are difficult to manage due to risk of foul smell from the treatment basins and the heavy transport required for disposal of sludge.

662. If treated properly, wastewater can be reused as drinking water in industry (cooling towers), in artificial recharge of aquifers, in agriculture, and in the rehabilitation of natural ecosystems. There are numerous benefits to using recycled water for irrigation, including the low cost, consistency of supply (regardless of season, climatic conditions and associated water restrictions), and general consistency of quality. Irrigation of recycled wastewater is also considered as a means for plant fertilization and particularly nutrient supplementation. Furthermore, organic content can be used for energy production when concentrated in sludge. Phosphorus can be extracted from the wastewater or sludge and applied as fertilizer replacing mineral phosphorus, which rapidly is becoming an increasingly scarce resource. Energy wise, excess heat can be withdrawn for production of heat and electricity and the remaining mineral and organic content in the sludge can be used as soil conditioner or as additional fertilizer.

8.2.10 New materials

663. There are two families of materials available for water pipework systems: metallic and non-metallic. Of these, the most commonly used materials for drinking-water supply piping are galvanized steel or iron, copper, polybutylene, unplasticized polyvinylchloride (PVC), chlorinated polyvinylchloride (CPVC), and polyethylene (PE). Metal alloys, which far exceed the performance specifications of their respective parent materials, are also widely used. New materials and construction technologies are continually developed for the building industry and the plumbing industry. Without some form of control at the respective levels within the plumbing and building industries, it would be easy for unscrupulous manufacturers to use inferior materials to the detriment of installers and end-users. This can ultimately damage the environment and the health of the community and lead to greater costs later when systems fail prematurely.

664. Copper tubing is extremely flexible in the hands of a competent installer and smaller in overall diameter than the equivalent galvanized steel pipes and fittings. Corrosion can be a problem, though usually to a lesser degree than with galvanized steel; care must be exercised to avoid contact with dissimilar metals. Copper tubing, due to its thinner wall section, is relatively light to handle and is available in coil form or straight lengths as required.

665. Chlorinated polyvinylchloride is widely used in water and sanitary systems for hot and cold-water distribution. It is a thermoplastic produced by polymerization of vinyl chloride, with additional chlorination. It offers much better resistance to corrosion and has a high tolerance to acids. It is fire resistant, though toxic fumes are emitted when it is burned.



666. **Unplasticized polyvinylchloride PVC, when used with a solvent cement jointing system, is comparable in bulk to galvanized steel or iron for drinking-water piping, but much lighter.** It does not suffer the same corrosion problems internally or externally as galvanized steel. However, it is susceptible to physical damage if exposed above ground and it becomes brittle when exposed to ultraviolet light. The pipe is light to handle, but it is too bulky for aesthetically acceptable internal use in domestic buildings.

667. **Polyethylene (PE) pipes and fittings of numerous types and designs have been available for over forty years.** The market requirements today have been refined to three general groupings, as follows:

- High-density PE is available in a post-manufactured stress-relieved state (best practice PE), or as extruded product with no treatment; it is used mainly for drainage applications where it can withstand higher temperature discharges than PVC;
- Medium-density PE is more flexible than the high-density pipe. It has a slightly thinner wall thickness and is capable of withstanding higher internal pressure; it is the preferred material for long-distance drinking-water piping;
- Low-density PE is suitable for the irrigation industry, where operating pressures are very low and a high degree of flexibility and low cost is required; low-density PE pipe and fittings are not acceptable for use for connection to the water mains in many countries because of the low pressure rating of the material and its high leakage rate.

668. **Fiberglass pipe also referred to as Fiberglass Reinforced Plastic (FRP), Glass Reinforced Plastic (GRP), and Reinforced Thermosetting Resin Pipe (RTRP), is one of the latest trends regarding water and wastewater systems materials.** FRP Pipe resistance to corrosive chemical environments and cost effectiveness has proven its ability to replace carbon steel and stainless steel pipe at a lower overall cost. Their main qualities are Light weight, Strength to weight ratio, Dimensional Stability, Electrical properties - Standard fiberglass pipe is nonconductive.

669. **Glass reinforced resin pipe is one of the strongest piping material by weight in use today.** Most of these piping products are made by using filament winding or centrifugal casting techniques. Varying conditions of service has resulted in the use of three major FRP piping resins: epoxy, polyester, and vinyl ester. Like most plastic piping systems, FRP is durable, safe and easy to install. In addition, it is very cost competitive when compared to many metal-alloy piping systems. Most FRP piping has both internal and external chemical resistant barriers.

Social infrastructure

8.2.11 Safe and accessible buildings

670. **All public buildings, such as those that are part of social infrastructure, must be accessible and easily used by disabled people.** A noticeable change in some parts of the



world is the installation of elevators, automatic doors, wide doors and corridors, transit lifts, wheelchair ramps, curb cuts, and the elimination of unnecessary steps where ramps and elevators are not available, allowing people in wheelchairs and with other mobility impairments to use public sidewalks and public transit more easily and more safely.

671. Fire safety measures include those that are intended to prevent ignition of an uncontrolled fire, and those that are used to limit the development and effects of a fire after it starts. Fire safety measures include those that are planned during the construction of a building or implemented in structures that are already standing. The technical design documentations of a building that is part of the social infrastructure must specify the fire risk (including smoke control) and the protection systems of the rooms, spaces and departments for the whole building.

8.2.12 Sustainable buildings

672. Energy efficiency is the first step toward achieving sustainability in buildings. Energy efficiency helps control rising energy costs, reduces environmental footprints, and increases the value and competitiveness of buildings. Mostly, energy losses in social buildings are due to inadequate state of the building envelope, including walls, floors, roofs, doors and windows. Therefore, any social building older than 20 years is poorly insulated, needs thermal rehabilitation, in order to save about 50% of energy consumption and support achieving thermal comfort in winter and in summer. The most commonly used materials for social infrastructure buildings with thermal insulation can be classified as:

- Vegetable: cork, fiber (chips) of wood, flax, straw, etc.
- Mineral: fiberglass, mineral wool, expanded clay, glass foam, etc.
- Synthetic materials: expanded polystyrene, polyurethane and phenolic foam, etc.

673. Recycling provides the opportunity to reduce the embodied energy by using recycled materials and reusable/recyclable materials/components. The recycling potential is between 35% and 40% of the embodied energy of a building, which represents around 45% of the total energy needed.⁸⁹

674. As an integral part of innovative and efficient design as well as to meet the future EU requirements for nearly zero energy buildings, a comprehensive approach is necessary to be taken, in order to utilize the benefits and facilities provided by building controls and management systems. Numerous computerized systems already exist on the market but it is advisable for designers to take a comprehensive approach and to integrate fully the building envelope construction and performance with the solar energy collectors, heating methods, insulation, temperature control, building shading, ventilation, lighting, metering, water supply, drainage, and waste.

⁸⁹ Catarina Thormark. Building and Environment Volume 37, Issue 4, April 2002, Pages 429–435



675. **Energy efficiency can be improved in different ways.** For existing social infrastructure buildings in Romania, especially for education and health facilities, thermal rehabilitation may be accomplished by replacement of heating system (from stoves to thermal plants), thermal insulation of the building (walls, roof and basement), new entrance doors, efficient new lighting system and rehabilitation of internal installations.

676. **Solar energy, in particular by direct conversion of solar energy into electricity, can be considered the most common type of renewable energy for buildings that are part of the social infrastructure.** Photovoltaic – PV - systems require light and not necessarily direct sunlight in order to generate electricity. PV systems can be installed on roofs or facades, thus contributing to reducing energy consumption in those buildings. They do not produce pollutants and can be integrated in various aesthetic solutions.

8.2.13 Building Information Modelling (BIM)

677. **Building Information Modelling and 3D modelling involves the creation and management of digital representations of physical and functional characteristics for designed elements and forms.** BIM software is used by businesses and government agencies to plan, design, construct, operate and maintain physical infrastructure ranging from water and wastewater treatment plant, refuse disposal, electricity and gas supply services, communications utilities through to roads, bridges, housing and schools. At the beginning of a project and during the whole life cycle BIM facilitates predictability of outcome as well as options for change and modification in good time to allow the most effective decisions to be made often on a “just in time” basis.

678. **The use of BIM goes beyond the planning and design phases.** It extends through all stages and supporting processes of cost management and facilities operations. In a number of EU countries there is an objective to harmonize BIM standards to improve inter- operability and cooperation.

8.2.14 New green building materials

679. **For social infrastructure, there are many building materials typically considered ‘green’.** These include lumber from forests that have been certified to a third-party forest standard, rapidly renewable plant materials like bamboo and straw, dimension stone, recycled stone, recycled metal, and other products that are non-toxic, reusable, renewable, and/or recyclable. For concrete a high performance or Roman self-healing concrete is available. The EPA (Environmental Protection Agency) also suggests using recycled industrial goods, such as coal combustion products, foundry sand, and demolition debris in construction projects.

680. **Existing buildings are subject to structural assessment before deciding whether they should be demolished or rehabilitated.** The seismic risk category depends primarily on the construction timeframe, as described in the Figure 36.

Figure 47. Seismic risk category of buildings according to construction timeframe

Seismic intensity (MSK)	Construction timeframe				
	Prior to 1940	1941 - 1963	1964-1977	1978- 1990	after 1990
VI					
VII					
VIII		Pre-code level: Seismic risk category 1	Low code level: Seismic risk category 2	Moderate code level: Seismic risk category 3	Moderate-high code level: Seismic risk category 3
IX					

Source: *Buildings in strong earthquake-prone areas - Dan Dubina and Dan Lungu, 2003*

681. **The structural rehabilitation solution will be established based on the state of degradation of the building (seismic risk category), the structural system (frames, walls, mixed), the building materials used (reinforced concrete, steel, masonry, wood, etc.) and the Importance-exposure class.** Some of these methods are described below.

682. **The reinforced plaster shotcreting and reinforced concrete lining methods are suitable for brick and reinforced concrete buildings.** They consist in the total or partial jacketing of the structural elements (pillars, girders, reinforced concrete or brickwork walls) with a layer of concrete reinforced with steel bars. This method increases the load-bearing capacity of the structural elements and improves the overall quality of the building.

Figure 48. Reinforced shotcreting of walls (left); reinforced concrete lining of girders and pillars (right)



683. **The carbon fiber or glass fiber lining is similar to the above, the difference being that carbon fiber or glass fiber is used instead of reinforced concrete as lining material.**

Figure 49. Carbon fiber lining of pillars in an office building (Japan)



Source: *Technical Seminar on Seismic Retrofit Construction using Continuous Carbon Fiber Reinforced Materials*



684. **The use of reinforced walls or steel bracing consists in the insertion of structural strengthening elements.** This method is suitable for reinforced concrete or steel frame buildings. Thus, the hollow frames may be fitted with reinforced concrete walls or steel bracing. This increases the overall stiffness and stability of the building.

Figure 50. Building of a reinforced concrete wall in a framework hole (left); fitting of steel bracing in framework holes – Cocor store building, Bucharest (right)



Source: UTCB course – Methods for structural rehabilitation of existing buildings

685. **The fitting of exterior reinforced concrete or steel frames has the advantage of being carried out mainly on the outside of the building, thus avoiding any disruption of the normal activities indoors.** The works consist in building an outside frame connected to the supporting structure of the building. It improves the overall stiffness and stability of the building.

Figure 51. Reinforced steel frames on the outside of an existing building – school in Japan (left); steel braced frames on the outside of an existing building – the Emergency Hospital of Slobozia (right)



Source: UTCB course – Methods for structural rehabilitation of existing buildings

686. **In this case, buildings are earthquake-protected by the fitting of elastic neoprene dampers between the building foundation and the superstructure.** Thus, the building is isolated from its substructure and the effects of potential seismic action on the building are mitigated. This method is suitable for all structural systems. It is particularly suited to highly important buildings which are critical in post-earthquake situations, such as hospitals, emergency centers, buildings that house sensitive equipment such as nuclear power plants, IT or telecommunication centers. Furthermore, it represents an ideal solution for heritage buildings, which cannot be subject to works that would alter their architectural features.



Figure 52. Diagram of an isolation system laid beneath the pillars of a building (left); elastomer dampers placed under pillars – the Bucharest City Hall (right)



Source: UTCB course – Methods for structural rehabilitation of existing buildings



Annex 1: Road suppliers owned by the County Councils

No.	County	Road suppliers owned by the County Councils
1.	ALBA	S.C. D.P.L. ALBA S.A.
2.	ARAD	NO
3.	ARGES	R.A.D.J.
4.	BACAU	NO
5.	BIHOR	NO
6.	BISTRITA-NASAUD	S.C. L.D.P. S.A.
7.	BOTOSANI	D.J.D.P.
8.	BRASOV	NO
9.	BRAILA	NO
10.	BUZAU	NO
11.	CALARASI	S.C. DRUMURI ŞI PODURI S.A.
12.	CARAS SEVERIN	NO
13.	CLUJ	R.A.A.D.D.P.
14.	CONSTANTA	R.A.J.D.P.
15.	COVASNA	S.C. DRUMURI ŞI PODURI S.A.
16.	DAMBOVITA	NO
17.	DOLJ	S.C. L.D.P. S.A.
18.	GALATI	S.C. DRUMURI ŞI PODURI S.A.
19.	GIURGIU	NO
20.	GORJ	S.C. I.D.P. GORJ S.A.
21.	HARGHITA	NO
22.	HUNEDOARA	NO
23.	IALOMITA	S.C. DRUMURI ŞI PODURI S.A.
24.	IASI	D.J.A.D.P.
25.	ILFOV	S.C. CONTRANS ILFOV S.A.
26.	MARAMURES	S.C. DRUMURI SI PODURI S.A.
27.	MEHEDINTI	NO
28.	MURES	NO
29.	NEAMT	NO
30.	OLT	NO
31.	PRAHOVA	S.C. DRUMURI ŞI PODURI S.A.
32.	SATU MARE	NO
33.	SALAJ	NO
34.	SIBIU	S.C. DRUMURI ŞI PODURI S.A.
35.	SUCEAVA	S.C. DRUMURI ŞI PODURI S.A. / D.J.D.P.
36.	TELEORMAN	NO
37.	TIMIŞ	D.A.D.P.
38.	TULCEA	NO
39.	VASLUI	S.C. L.D.P. S.A.
40.	VALCEA	R.A.J.D.P.
41.	VRANCEA	NO

Data source: County Councils



Annex 2: ADI and Regional Operator by County

No.	County	Intercommunity Development Associations (ADIs)	Regional Operator
1.	ALBA	ADI APA ALBA	S.C. APA CTTA ALBA S.A.
2.	ARAD	ADIAC	S.C. COMPANIA DE APĂ ARAD S.A.
3.	ARGES	ADI ARGES	S.C. APA CANAL 2000 S.A.
4.	BACAU	ADIB	S.C. COMPANIA REGIONALA DE APA BACAU S.A.
5.	BIHOR	ADI APAREGIO	S.C. COMPANIA DE APA ORADEA S.A.
6.	BISTRITA-NASAUD	ADI SAAC	S.C. AQUABIS S.A.
7.	BOTOSANI	ADI AQUA	S.C. NOVA APASERV S.A.
8.	BRAILA	ADI DUNAREA	S.C. COMPANIA DE UTILITATI PUBLICE S.A.
9.	BRASOV	ADIAC	S.C. COMPANIA DE APA BRASOV S.A.
10.	BUZAU	ADI BUZAU 2008	S.C. COMPANIA DE APA S.A.
11.	CALARASI	ADI ECOAQUA	S.C. ECOAQUA S.A.
12.	CARAS-SEVERIN	ADI ACVABANAT	S.C. AQUACARAS S.A.
13.	CLUJ + SALAJ	ARDI BAZINUL SOMES-TISA	S.C. COMPANIA DE APA SOMES S.A.
14.	CLUJ	ADI APA VAII ARIESULUI	S.C. COMPANIA DE APA SOMES S.A.
14.	CONSTANTA+IALOMITA	ADIAC	S.C. RAJA S.A.
15.	IALOMITA (SLOBOZIA)	ADI PERIURBANA SLOBOZIA	S.C. URBAN S.A.
16.	COVASNA	ADI AQUACOV	S.C. GOSPODARIA COMUNALA S.A.
17.	DAMBOVITA	ADI APA DAMBOVITA	S.C. COMPANIA DE APA TARGOVISTE DAMBOVITA S.A.
18.	DOLJ	ADI OLTENIA	S.C. COMPANIA DE APA OLTENIA S.A.
19.	GALATI	ADI SERVICIUL REGIONALA APA	S.C. APA CANAL S.A.
20.	GIURGIU	ADI SANATATE ASIGURATA PRIN APA CURATA	S.C. APA SERVICE S.A.
21.	GORJ	ADIA	S.C. APAREGIO GORJ S.A.
22.	HARGHITA	ADI HARGHITA VIZ	S.C. HARVIZ S.A.
23.	HUNEDOARA	ADI AQUA PREST	S.C. APA PROD DEVA S.A.
24.	HUNEDOARA	ADI APA VALEA JIULUI	S.C. APA SERV VALEA JIULUI S.A.
25.	IASI	ADI ARSACI	S.C. APA VITAL S.A.
26.	ILFOV	ADIA ILFOV	S.C. APA CANAL ILFOV S.A.
27.	MARAMURES	ADI-MM	S.C. VITAL S.A.
28.	MEHEDINTI	ADIAC	S.C. SECOM S.A.
29.	MURES	ADI AQUA INVEST MS	S.C. COMPANIA AQUASERV S.A.
30.	NEAMT	ADI AQUA NT	S.C. COMPANIA JUDETEANA DE



			APA SERV S.A.
31.	OLT	ADI OLTUL	S.C. COMPANIA DE APA OLT S.A.
32.	PRAHOVA	ADI PARTENERIATUL PENTRU MANAGEMENTUL APEI PH	S.C. HIDRO PRAHOVA S.A.
33.	SATU MARE	ADI PENTRU SERVICII IN SECTORUL DE APA SI APA UZATA SM	S.C. APASERV SATU MARE S.A.
34.	SIBIU	ADI APA TARNAVEI MARI	S.C. APA TARNAVEI MARI S.A.
35.	SIBIU	ADI ASOCIATIA DE APA SIBIU	S.C. APA CANAL S.A.
36.	SUCEAVA	ADI AJAC SV	S.C. ACET S.A.
37.	TELEORMAN	ADI TELEORMANUL	S.C. APA SERV S.A.
38.	TIMIS	ADIAC TM	S.C. AQUATIM S.A.
39.	TULCEA	ADI DEZVOLTAREA DURABILA A SERVICIILOR DE APA – CANALIZARE TL	S.C. AQUASERV TULCEA S.A.
40.	VALCEA	ADI APA VALCEA	S.C. APAVIL S.A.
41.	VASLUI	ADI APC VC	S.C. AQUAVAS S.A.
42.	VRANCEA	ADI VRANCEAQUA	S.C. COMPANIA DE UTILITATI PUBLICE S.A.

Data source: County Councils



Annex 3: Recommendations for improving applicants' technical documentation

1. Type of documentation & annexes

- *Roads*: Choose carefully between the feasibility study (FS) and the DALI. For modernization works of existing infrastructure, always pick the DALI
- *Water and wastewater*: For new projects aimed at building new infrastructure, the FS is required. For existing/ongoing projects (with new investment components), the SF and the technical expertise shall be submitted. For modernization of current infrastructure the DALI shall be prepared
- Update specialty studies and technical expertise studies
- Include the geotechnical study with proper seal of approval (“verificat la cerința Af”)
- If the detailed technical design is available and is submitted, also include the FS / DALI. Also include the project verifiers' notes and expertise, for each specialty
- Include all documents needed to prove/establish ownership of new/modernized infrastructure
- Include the “urbanism certificate” with all corresponding permits required*

2. Content of documentation

- Make sure that the description of the need and opportunity for the investment fulfils the requirements of GD 28/2008;
- Include information of how the project correlates/fits under local/regional/national strategies in the relevant sector;
- Develop the cost-benefit analysis in accordance with the EU Guide (as part of FS and only for those applications that require FS);
- Make explicit the commitment to operate and maintain the project upon completion;

3. Local/County Council Decision

- Make sure the decision explicitly mentions the co-financing amount;
- Make sure to include in the decision the key technical-economic indicators;

4. Budget

- Check that respective expenses are within the GD 363/2010 limits on cost standards;
- Include sources of financing along with the overall budget (“deviz general”).

*Note: The urbanism certificate should not be released by the relevant authority without the permits/approvals required for the construction permit (requires amendment to Law 50/1991). All investments in the power distribution sector shall be supported by the beneficiary of the works subject to the urbanism certificate, with 6-month or even 1-year prior notification to the power distributor.



Annex 4: Proposal – Short Form of Contract

GENERAL CONDITIONS	SPECIAL CONDITIONS
1 GENERAL PROVISIONS	

1.1 Definitions

In the Contract defined hereinafter, the stated words and expressions shall have the following meanings, unless the context requires otherwise.

The Contract

1.1.1 “**Contract**” means the Contract Agreement and the other documents listed in the Annex.

1.1.2 “**Specification**” means the document listed in the Annex that includes the Employer’s Requirements regarding the design to be drafted by the Contractor, if any, as well as any Variation to such document

1.1.3 “**Drawings**” means the Employer’s drawings of the Works, as listed in the Annex, as well as any Variation to such Drawings.

Parties and Persons

1.1.4 “**Beneficiary**” means the person named in the Contract Agreement and the legal successors to it, as well as any authorized representatives (provided that the Contractor has given his consent). The following wording shall be added at the end of Sub-Clause 1.1.4:
“**Beneficiary** can also mean **Contracting Authority.**”

1.1.5 “**Entrepreneur**” means the person named in the Contract Agreement and



the legal successors to it, as well as any authorized representatives (provided that the Beneficiary has given his consent).

the end of Sub-Clause 1.1.5:
“**Entrepreneur** shall have the same meaning as **Contractor**.”

1.1.6 “**Party**” means the Beneficiary or the Entrepreneur, as the context requires.

Dates, Deadlines and Time periods

1.1.7 “**Commencement Date**” means the date falling 14 days after the date at which the Contract Agreement becomes effective, or any other date agreed by the Parties.

1.1.8 “**Day**” means a calendar day.

1.1.9 “**Time for Completion**” means the time for completing the Works as stated in the Annex (or extended according to Sub-Clause 7.3), calculated from the Commencement Date.

Currency and Payments

1.1.10 “**Cost**” means all expenditure reasonably incurred (or to be incurred) by the Contractor, whether on or off the Site, including overhead or similar charges, but not including the profit.

Other Definitions

1.1.11 “**Entrepreneur’s Equipment**” means all the plant, machinery, vehicles, facilities and other things necessary for the execution of the Works, excluding the Materials and Equipment.

1.1.12 “**Country**” means the country in which the Site is located.

1.1.13 “**Beneficiary’s Risks**” means all the responsibilities listed in Sub-Clause



6.1.

1.1.14 “**Force Majeure**” means an exceptional event or circumstance beyond a Party’s control, which such Party could not have reasonably foreseen before entering into the Contract, which, having arisen, such Party could not reasonably have avoided or overcome, and which is not attributable to the other Party.

1.1.15 “**Materials**” means products of all kinds (other than the Equipment), intended to form or forming part of the permanent works.

1.1.16 “**Equipment**” means the machinery and plant intended to form or forming part of the permanent works.

1.1.17 “**Site**” means the places provided by the Beneficiary where the Works are to be executed, and any other places as may be specified in the Contract as forming part of the Site.

1.1.18 “**Variation**” means any change to the Specifications and/or the Drawings (if any), as instructed by the Beneficiary under Sub-Clause 10.1.

1.1.19 “**Works**” means all the works and designs (if any) to be carried out by the Entrepreneur, including temporary works and any Variation thereto.

1.1.20 A new Sub-Clause 1.1.20 shall be added to read as follows:

“**Accepted Contract Amount**” means the amount accepted in the Contract Agreement for the design (if any), the execution and completion of the Works and for remedying all defects.”



1.2 Interpretation	The words indicating persons or parties shall include companies and organizations. The words indicating the singular or one gender shall include the plural or the other gender, as the context requires.	The following wording shall be added at the end of the first sentence of Sub-Clause 1.2: <i>“or other legal entities, except where the context requires otherwise.”</i>
1.3 Priority of Documents	The documents forming the Contract are to be taken as mutually explanatory of one another. If an ambiguity or discrepancy is found in the documents, the Beneficiary shall issue to the Entrepreneur any necessary instruction, and the priority of the documents shall be as stated in the Annex.	
1.4 Law	The law governing the Contract is stated in the Annex.	
1.5 Communications	Whenever a person must issue notices, instructions or other communications, such communications shall be drafted in the language stated in the Annex unless otherwise instructed and shall not be unreasonably withheld or delayed.	
1.6 Legal Obligations	The Entrepreneur shall comply with the laws of the country where the Works are being executed. The Entrepreneur shall give all notices and shall pay all taxes and other fees in relation to the Works.	

2 THE BENEFICIARY

2.1 Right of Access to the Site	The Beneficiary shall make available the Site and the access routes to the Site by the deadlines stated in the Annex.
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2.2 Permits and Licenses	The Beneficiary shall provide, at the request of the Entrepreneur, such reasonable assistance as to obtain any permits, licenses and approvals required for the execution of the Works.	The following wording shall be added at the end of Sub-Clause 2.2: "The Beneficiary shall obtain the building permit for the execution of the Works."
2.3 Instructions issued by the Beneficiary	The Entrepreneur shall comply with all the instructions given by the Beneficiary on the execution of Works, including on the suspension of the execution of all works or any part thereof.	
2.4 Approvals	No approval, consent or lack of remarks from the Beneficiary or the Beneficiary's representative shall relieve the Entrepreneur from his obligations.	

3 BENEFICIARY'S REPRESENTATIVES

3.1 Authorized Person	The Beneficiary shall appoint a person from its own staff who shall have the authority to act on the Beneficiary's behalf. Such authorized person shall be the one named in the Annex or otherwise notified by the Beneficiary to the Entrepreneur.	
3.2 Beneficiary's Representative	The Beneficiary may also hire a legal or natural person to fulfil certain tasks. Such person may be named in the Annex or the Beneficiary may notify the Entrepreneur about him/her from time to time. The Beneficiary shall notify the Entrepreneur of the tasks and powers delegated to such Beneficiary's Representative.	Sub-Clause 3.2 shall be deleted and replaced to read as follows: "The Beneficiary shall appoint a legal or natural person to provide the inspection of the Works' accurate execution. The Beneficiary may appoint a legal or natural person to fulfil certain tasks, other than the inspection of the Works' execution. Such persons may be named in the Annex or designated by the Beneficiary in a notice given to the Entrepreneur. The Beneficiary shall



notify the Entrepreneur of the power and duties delegated to the Beneficiary's Representative or Representatives."

4 THE ENTREPRENEUR

4.1 General Obligations

The Entrepreneur shall execute the Works properly and in accordance with the Contract provisions. The Entrepreneur shall entirely provide the supervision, labor, Materials, Equipment and Plant necessary for the execution of the Works. All the Materials and Equipment on the Site shall be considered to be the Beneficiary's property.

4.2 Entrepreneur's Representative

The Entrepreneur shall submit to the Beneficiary's approval the name and particulars of the person authorized to receive instructions on the Entrepreneur's behalf.

4.3 Subcontracting

The Entrepreneur shall not subcontract the Works in their entirety. Parts of the Works may be subcontracted provided that the Beneficiary gives its consent.

The following wording shall be added after the first paragraph of Sub-Clause 4.3:

"The Entrepreneur shall not subcontract Works worth more than the amount stated in the Annex.

If parts of the Works are to be executed by one or several Subcontractors, when signing the Contract Agreement, the Entrepreneur shall provide the Beneficiary with the contracts concluded by the Entrepreneur with the Subcontractors stated in the offer. The subcontracting agreements shall comply with the FIDIC conditions of contract, with the conditions included in the Offer and shall be annexed to the Contract.



The Entrepreneur shall not be entitled to replace any of the Subcontractors stated in the offer unless the Beneficiary consents thereto.”

4.4 Performance Security

If specified in the Annex, the Entrepreneur shall deliver to the Beneficiary, within 14 days from the Commencement Date, a performance security in such form and from such third party as the Beneficiary approves.

Sub-Clause 4.4 shall be deleted and replaced to read as follows:

“The Entrepreneur shall deliver the Performance Security to the Beneficiary, in the form and for the amount established by the Beneficiary, within 14 days from the date of signing the Contract Agreement, if specified in the Annex.

The Performance Security of a joint venture or consortium shall state the name of such joint venture and consortium.

The Beneficiary shall release/return to the Entrepreneur the Performance Security, as follows:

- (i) **70%** of the Performance Security amount, within 14 days after the Acceptance Protocol has been drafted at Works completion, unless the Beneficiary claims enforcement of the Performance Security before such date;
- (ii) **30%** of the Performance Security amount when the Final Acceptance protocol is issued, unless the Beneficiary claims enforcement of the Performance Security before such date.”

5 DESIGN BY THE ENTREPRENEUR

5.1 Design by the Entrepreneur

The Entrepreneur shall draft the design necessary for the execution of Works

Under Sub-Clause 5.1, the following wording shall be inserted at the end of



as and to the extent specified in the Annex. The Entrepreneur shall promptly deliver all the drafted designs to the Beneficiary. Within 14 days after receiving the design, The Beneficiary shall give notice of all his comments or, if the delivered design fails to comply with the Contract, the Beneficiary shall reject it, stating his reasons. The Works included in the design submitted for the Beneficiary's approval may not be executed within the 14 day period of submission. Likewise, rejected parts of the design may not be executed. The rejected design shall be rectified and resubmitted without delay. The Entrepreneur shall resubmit all the designs on which comments were made, taking into consideration such comments, where applicable.

the first sentence:

"The Entrepreneur's Design shall be made by qualified Designers and shall be checked by certified design verifiers, whose qualifications and know-how shall be submitted to the Beneficiary's approval."

5.2 Responsibility for the Design

The Entrepreneur shall be responsible for the design included in the submitted offer and for the design drafted in accordance with this Clause, and both designs must be in line with the purposes defined in the Contract. The Entrepreneur shall also be liable for the infringement of any patent or copyright when drafting the design. The Beneficiary shall be responsible for Specifications and Drawings.

6 BENEFICIARY'S RISKS

6.1 Beneficiary's Risks

Under this Contract, the Beneficiary's Risks are:

- (a) war, hostilities (whether war be declared or not), invasion, actions by foreign enemies within the Country;
 - (b) rebellion, terrorism, revolution, insurrection, military coup or coup d'état, civil war, within the Country;
 - (c) riot, commotion or disorder by persons other than the Entrepreneur's staff and other employees, affecting the
-



Site and/or the Works;

(d) ionizing radiation, contamination by radio-activity from any nuclear fuel or any nuclear waste produced by nuclear fuel burning, toxic radioactive explosives or other hazardous properties of a nuclear explosive plant or a nuclear component of such plant, except as may be attributable to the Entrepreneur's use of such radio-activity;

(e) pressure waves caused by aircraft or other aerial devices travelling at sonic and supersonic speeds;

(f) use or occupation by the Beneficiary of any part of the Works, except as may be specified in the Contract;

(g) design of any part of the Works by the Beneficiary's staff or by others for whom the Beneficiary is responsible;

(h) any operation of forces of nature affecting the Site and/or the Works, which was unforeseeable or against which an experienced Entrepreneur could not be expected to have taken adequate preventive precautions;

(i) a Force Majeure event;

(j) any suspension of the execution of the Works, as provided by Sub-Clause 2.3 [*Instructions issued by the Beneficiary*], unless attributable to the Entrepreneur;

(k) the Beneficiary's failure to meet his obligations;

(l) obstacles or physical conditions, other than the climate conditions encountered on the Site during the execution of Works, that could not have been foreseen by an experienced Entrepreneur and of which the Entrepreneur notified the Beneficiary with no delay;

(m) any delay or interruption caused by a Variation;

(n) any amendment to the law governing the Contract, made after the Entrepreneur's offer was submitted, as



stated in the Contract Agreement;
(o) losses resulting from the Beneficiary's right to have the permanent Works executed on, over, under, in or through any land and to occupy such land for the permanent Works, and
(p) damage that is an unavoidable result of the Entrepreneur's obligations to execute the Works and to remedy any defects.

7 TIME FOR COMPLETION

7.1 Execution of Works

The Entrepreneur shall initiate the Works on the Commencement Date, shall act promptly and with no delay and shall complete the Works within the Time for Completion.

7.2 Schedule

The Entrepreneur shall submit to the Beneficiary, during the time stated in the Annex, a Schedule of Works in the form stated in the Annex.

Under Sub-Clause 7.2, the following wording shall be added at the end of the sentence:

"and in such detail as provided in the Contract."

7.3 Extension of the Time for Completion

The Entrepreneur is entitled to an extension of the Time for Completion if there is or will be delays caused by any Beneficiary's risk, provided that Sub-Clause 10.3 [*Timely Notice*] is complied with.

When receiving the Entrepreneur's request, the Beneficiary shall take into consideration the explanatory details provided by the Entrepreneur and shall extend the Time for Completion, if applicable.

7.4 Delays in the Execution of Works

If the Entrepreneur fails to complete the Works within the Time for Completion, the Entrepreneur's liability to the



Beneficiary for the delay shall be limited to the payment of the penalties provided in the Annex for each day when the Works' completion is delayed.

8 ACCEPTANCE OF THE WORKS

8.1 Completion of the Works

The Entrepreneur may notify the Beneficiary when he considers the Works to be completed.

Sub-Clause 8.1 shall be deleted and replaced to read as follows:

"The Entrepreneur shall notify the Beneficiary no later than 14 days before the Works are completed and ready for acceptance, based on the Entrepreneur's judgment."

8.2 Acceptance Notice

The Beneficiary shall notify the Entrepreneur when he considers that the Entrepreneur has completed the Works, specifying the date of completion. The Beneficiary may also notify the Entrepreneur that, although the Works are not totally completed, they can be taken over, specifying the date of acceptance.

Sub-Clause 8.2 shall be deleted and replaced to read as follows:

"The Beneficiary shall give notice to the Entrepreneur of his decision to initiate the take-over of the Works, of the date set for the take-over initiation and the structure of the Acceptance Committee, within 7 days of receiving the notice as provided by Sub-Clause 8.1 [*Completion of the Works*], if the Beneficiary considers that the Entrepreneur has completed the Works.

After such notice has been delivered, the Beneficiary shall take over the Works. The Entrepreneur shall promptly complete the outstanding works and shall clear the Site, in accordance with Clause 9 [*Remedying Defects*].

The Acceptance Committee shall issue and sign the Acceptance Protocol at Works Completion, as provided by Law. The Beneficiary shall notify the Entrepreneur of his decision regarding the take-over of the Works.

The Entrepreneur shall promptly complete the outstanding works and/or shall rectify any defect and shall clear the Site, as provided by Clause 9 [*Remedying Defects*]."



9 REMEDYING DEFECTS

9.1 Remediating Defects

The Beneficiary may notify the Entrepreneur of any defect or outstanding work, at any time before the expiry of the period specified in the Annex. The Entrepreneur shall rectify, at no costs for the Beneficiary, any defects attributable to the fact that the Entrepreneur's design, the Materials, the Equipment or the labor do not comply with the Contract provisions.

The costs of rectifying defects attributable to any other cause shall be evaluated as a Variation. The failure to rectify defects or complete the outstanding works within a reasonable time period after the Beneficiary has been notified shall entitle the Beneficiary to carry out all the necessary Works, at the Entrepreneur's cost

The first paragraph of Sub-Clause 9.1 shall be deleted and shall be replaced to read as follows:

"Before the expiry of the period specified in the Annex, the Beneficiary may notify the Entrepreneur of any visible or hidden defects, or outstanding works. The Entrepreneur shall rectify, with no additional costs for the Beneficiary, any defects attributable to the fact that the Contract's design, the Materials, the Equipment or the execution quality do not comply with the Contract provisions."

9.2 Uncovering and Testing

The Beneficiary may instruct to uncover and/or test any work. The Entrepreneur shall be paid for any uncovering and/or test and for any Variation as provided by Sub-Clause 10.2 [*Evaluation of Variations*], unless it is determined that, following the uncovering and/or testing, the Contract's design, the Materials, the Equipment or the labor do not comply with the Contract provisions.

The following wording shall be added at the end of Sub-Clause 9.2:

"If the Beneficiary determines that, following the uncovering and/or testing, the Entrepreneur's design, the Materials, the Equipment or the labor do not comply with the Contract provisions, when Sub-Clause 10.3 [*Timely Notice*] is observed by the Beneficiary, the Entrepreneur shall act in line with the other obligations under the Contract, and the Accepted Contract Amount shall be reduced by the amount necessary to indemnify the Beneficiary for the consequences of the Entrepreneur's errors. The reduction made for covering the consequences of the Entrepreneur's errors shall be (i) agreed by both Parties or (ii) determined based on the method of calculation defined in the Contract and



paid before the Acceptance Protocol at Completion has been issued for the parts of Works that comply with the Contract provisions."

10 VARIATIONS AND CLAIMS

10.1 Right to Vary

The Beneficiary may instruct a Variation.

10.2 Evaluation of Variations

Variations may be evaluated based on:

- (a) a flat rate agreed between the Parties, or
- (b) the prices included in the Contract, where applicable, or
- (c) the prices included in the Contract, if there are no appropriate prices, or
- (d) new appropriate prices which may be agreed by the parties or which the Beneficiary deems as appropriate;
- (e) the prices of direct labor operations stated in the Annex, for which the Entrepreneur shall keep records of the labor hours, of the Entrepreneur's Equipment, and of the Materials used, if so instructed by the Beneficiary.

The following wording shall be added at the end of Sub-Clause 10.2:

"Any Variation involving an increase in or a reduction of the Accepted Contract Amount shall form the object of an addendum to the Contract"

10.3 Timely Notice

Each Party shall notify the other Party as soon as it has become aware of any circumstances that may delay or prevent the execution of Works or may generate a claim for additional payment. The Entrepreneur shall take all reasonable measures to mitigate such effects to the minimum.

The Entrepreneur's right to extend the Time for Completion or to be paid for any additional costs shall be limited to the time and payment to which it would be entitled if it were promptly notified and took all reasonable measures.



10.4 Right to Claim

If the Entrepreneur incurs Costs as a result of any of the Beneficiary's Risks, the Entrepreneur shall be entitled to the payment of such Costs. If any adjustment of Works is necessary as a result of the Beneficiary's Risks, such adjustment shall be deemed as a Variation.

10.5 Variation and Claim Procedure

The Entrepreneur shall submit to the Beneficiary a detailed list of the amounts of all Variations and claims, within 28 days after the instruction has been given or after the event generating the claim has occurred. The Beneficiary shall verify and, if possible, accept the amount suggested by the Entrepreneur. If the amount suggested by the Entrepreneur is not accepted by the Beneficiary, the latter shall determine such amount.

11 CONTRACT PRICE AND PAYMENT

11.1 Evaluation of Works

The works shall be evaluated as stated in the Annex, provided that Clause 10 [Variations and Claims] is complied with.

11.2 Monthly Statements of Works

The Entrepreneur shall be entitled, on a monthly basis, to the payment of:

- (a) the value of the Works executed;
- (b) the percentage specified in the Annex of the value of Materials and Equipment delivered on the Site on a reasonable date, considering any due amounts to be added or deducted.

Under Sub-Clause 11.2, the following wording shall be added at the end of the last paragraph:

"and appropriate invoices."

The Entrepreneur shall submit a payment statement to the Beneficiary



on a monthly basis, showing the amounts to which the Entrepreneur considers himself to be entitled.

11.3 Interim Payments

Within 28 days after the submission of each monthly payment statement, the Beneficiary shall pay to the Entrepreneur the amount specified in the Entrepreneur's statement of payment, minus the retention money set forth in the Annex and any amount with which the Beneficiary reasonably disagrees. The Beneficiary shall be under no obligation in relation to any amount that it considered before as payable to the Entrepreneur.

The Beneficiary may suspend the interim payments until it receives the performance security as provided by Sub-Clause 4.4 [*Performance Security*] (if any).

The following wording shall be added at the end of the first paragraph of Sub-Clause 11.3:

"The Entrepreneur shall issue the appropriate invoices after having received the Beneficiary's notification about the amount certified for payment"

The last paragraph of Sub-Clause 11.3 shall be deleted.

11.4 Payment of Half of the Retention Money

The first half of the Retention Money shall be paid by the Beneficiary to the Entrepreneur within 14 days after the notice provided under Sub-Clause 8.2 [*Acceptance Notice*] has been issued.

11.5 Payment of the Second Half of the Retention Money

The remaining part of the Retention Money shall be paid by the Beneficiary to the Entrepreneur within 14 days after the expiry of the period stated in the Annex or after the remedy of the reported defects and the completion of outstanding works, as described in Sub-Clause 9.1 [*Remedying Defects*], unless carried out within the period provided in the Annex.

The following wording shall be added at the end of Sub-Clause 11.5:

"The Entrepreneur's obligations shall not be deemed as complied with until the Beneficiary has notified the Entrepreneur of his decision regarding the final take-over of Works, after the issue of the Final Acceptance Protocol under the Law, indicating the date when the Contactor totally carried out his obligations under the Contract"



11.6 Final Payment

The Entrepreneur shall submit to the Beneficiary the final statement of works with supporting documents, within 42 days after the conditions laid down in Sub-Clause 11.5 [*Payment of the Second Half of the Retention Money*] have been met, in order to enable the Beneficiary to determine the final contract amount.

Under Sub-Clause 11.6, the following wording shall be added at the end of the last paragraph 6:

"The Entrepreneur shall issue the appropriate invoices after having received the Beneficiary's notification specifying the amount certified for final payment."

The Beneficiary shall pay the amounts owed to the Entrepreneur within 28 days after the final statement of works have been submitted. If the Beneficiary does not totally agree to the final statement of works submitted by the Entrepreneur, it shall specify, when making the payment, the reasons why it does not agree to the total payment.

11.7 Currencies of Payment

The payments shall be made in the currency named in the Annex.

11.8 Delayed Payment

The Entrepreneur shall be entitled to receive interest on the unpaid amount, equal to the percentage provided in the Annex, for each day when the payment is delayed by the Beneficiary.

The following wording shall be inserted at the end of Sub-Clause 11.8:

„The Beneficiary shall pay such interest based on an invoice issued by the Entrepreneur.”

12 NON-COMPLIANCES

12.1 Entrepreneur's Non-Compliance

If the Entrepreneur abandons the Works, refuses or fails to comply with the Beneficiary's reasonable instructions or fails to execute the works promptly and with no delay and infringes the Contract provisions, despite receiving a letter of dissatisfaction, the Beneficiary may issue a notification under such Sub-Clause, specifying the non-

Under Sub-Clause 12.1, the following wording shall be added after the first sentence of the second paragraph:

"The Contract shall be legally terminated, without any summons, notice of delay, court order, arbitration award or other formalities, upon the expiry of the 21 day period after the second notification has been given to the Entrepreneur."



compliances.

If the Entrepreneur does not take all the possible measures to remedy the non-compliance within 14 days of receiving the notification issued by the Beneficiary, the Beneficiary may terminate the Contract by a second notification issued within 21 days. After termination, the Entrepreneur shall leave the Site, leaving on the Site the Materials, Equipment and all the Entrepreneur's Equipment stated by the Beneficiary in the second notification, which are to be used until completion of works.

Under Sub-Clause 12.1, the words "*which are to be used until completion of works*" shall be deleted from the last sentence of the second paragraph.

**12.2 Beneficiary's
Non-Compliance**

If the Beneficiary does not make the payment as provided by the Contract or infringes the Contract provisions despite receiving a letter of dissatisfaction, the Entrepreneur may issue a notification regarding such Sub-clause, specifying the non-compliance. The Entrepreneur may suspend the execution of all Works or any part thereof if the non-compliance is not remedied within 7 days after the Beneficiary has received the notification.

Under Sub-Clause 12.2, the following wording shall be added after the first sentence of the second paragraph:

"The Contract shall be legally terminated without any summons, notice of delay, court order, arbitration award or other formalities, upon the expiry of the 21 day period after the second notification has been given to the Beneficiary."

If the non-compliance is not remedied within 28 days after the date when the Beneficiary receives the Entrepreneur's notification, the Entrepreneur may terminate the Contract by a second notification issued within 21 days. The Entrepreneur shall leave the Site after the Contract termination.

12.3 Insolvency

If either Party is declared insolvent under any applicable law, the other Party may terminate the Contract immediately, by a notice. After termination, the Entrepreneur shall leave the Site and, if insolvent, shall leave on the Site all the Entrepreneur's Equipment specified by the Beneficiary



in the notice, which are to be used until completion of works.

**12.4 Payment upon
Contract
Termination**

After termination, the Entrepreneur is entitled to the remaining payment related to the value of the Works executed, the Materials and the Equipment reasonably delivered on the Building Site, subject to the following corrections:

- (a) any amounts to which the Entrepreneur is entitled, as provided by Sub-Clause 10.4 *[Right to Claim]*;
- (b) any amounts to which the Beneficiary is entitled;
- (c) an amount equivalent to 20% of the value of the outstanding parts of the Works on the Contract termination date, to which the Beneficiary is entitled, if the Beneficiary terminated the Contract under Sub-Clauses 12.1 *[Entrepreneur's Non-Compliance]* or 12.3 *[Insolvency]*;
- (d) The cost of suspension and removal, together with an amount equivalent to 10% of the value of the outstanding parts of the Works on the Contract termination date, to which the Contactor is entitled, if the Entrepreneur terminated the Contract under Sub-Clauses 12.2 *[Beneficiary's Non-Compliance]* or 12.3 *[Insolvency]*.

The net payable amount due shall be paid or reimbursed within 28 days after the date of the notice of Contract termination.

13 RISK AND RESPONSIBILITY

**13.1 Entrepreneur's
Care of the Works**

The Entrepreneur shall take full responsibility for the care of the Works from the Commencement Date until the date of the notice given to the Beneficiary under Sub-Clause 8.2



[Acceptance Notice]. After such date, the responsibility shall be passed to the Beneficiary. If any loss or damage happens to the Works during the abovementioned period, the Entrepreneur shall rectify the loss or damage so that the Works conform with the Contract.

The Entrepreneur shall indemnify the Beneficiary, the Beneficiary's agents and employees and the other Beneficiary's Entrepreneurs on the Site for any loss or damage caused to the Works or for all the claims or expenses resulting from the non-compliance with the Contract provisions attributable to the negligence or fault of the Entrepreneur, the Entrepreneur's agents or employees, unless such loss or damage is the result of the Beneficiary's risk.

13.2 Force Majeure related to the Project

If either Party is or is to be prevented, as a result of a Force Majeure event, from carrying out any of his obligations, the affected Party shall promptly give notice to the other Party. The Entrepreneur shall suspend the execution of Works, if necessary, and shall withdraw the Entrepreneur's Equipment from the Site, if agreed so with the Beneficiary.

If such situation lasts for 84 days, either Party may give a notice of Contract termination that is to take effect within 28 days after the date of giving the notice.

Following the Contract termination, the Entrepreneur shall be entitled to the payment of the outstanding amount of



the Works executed and of the Materials and Equipment delivered on the Site, subject to the following corrections:

- (a) any amounts to which the Entrepreneur is entitled, as provided by Sub-Clause 10.4 *[Right to Claim]*;
- (b) the cost of suspension and removal;
- (c) any amounts to which the Beneficiary is entitled.

The net payable amount agreed shall be paid or reimbursed within 28 days after the date of the notice of Contract termination.

14 INSURANCE

14.1 Object of the Insurance

Before the Works' initiation, the Entrepreneur shall effect and maintain insurance on behalf of both Parties for:

- (a) losses and damages caused to Works, Materials, Equipment and the Entrepreneur's Equipment,
- (b) both Parties' liability for losses, damages, death or injuries caused to third parties or their properties, as a result of the Contract performance by the Entrepreneur, including the Entrepreneur's liabilities for any damages caused to the Beneficiary's property, other than the Works,
- (c) the liability of both Parties and any Beneficiary's representative for the death or injury of the Entrepreneur's personnel, unless the liability is attributable to the negligence of the Beneficiary, any Beneficiary's representative or employees.

14.2 Rules

Any insurance shall comply with the requirements detailed in the Annex. Policies shall be issued by insurance companies under conditions approved



by the Beneficiary. The Entrepreneur shall provide to the Beneficiary the proof that all the necessary policies are effective and that the insurance premiums have been paid.

All the payments received from insurance companies for losses or damages to Works shall be jointly kept by the Parties and used to cover the losses or damages that occurred or to compensate for certain irreparable losses or damages.

14.3 Failure to provide insurance

If the Entrepreneur fails to effect or maintain any of the insurance specified under the previous Sub-Clauses, or if it fails to provide satisfactory evidence, policies or receipts, the Beneficiary, without any harm to any of his other rights or remedies, may take out the necessary insurance, pay the agreed insurance premiums and recover the value of the amounts paid by deducting them from any other amounts owed to the Entrepreneur.

15 DISPUTES

15.1 Settlement Procedure

Any dispute or conflict arising between the Entrepreneur and the Beneficiary as a result of the Agreement or in connection therewith, unless settled amicably, as well as any evaluation or other decision by the Beneficiary shall be referred by either party to an adjudicator, as provided by the Procedural Rules enclosed (the Rules). The adjudicator shall be any person agreed by the Parties. In the event of a disagreement, the adjudicator shall be appointed according to the Rules.



15.2 Notice of Dissatisfaction

If either Party is not satisfied with the adjudicator's decision or if no decision has been issued during the period provided by the Rules, the respective Party may give a notice of dissatisfaction regarding such Sub-clause, within 28 days after receipt of the decision or the expiry of the time period necessary to issue the decision. If no notice of dissatisfaction is given during the specified time period, the decision shall become final and binding upon the Parties. If a notice of dissatisfaction is given during the specified time period, the decision shall be binding on the Parties which shall implement it without delay until the adjudicator's decision is revised by an arbitrator, if applicable.

15.3 Arbitration

The final settlement of a dispute forming the object of a notice of dissatisfaction shall be provided by one arbitrator, according to the rules specified in the Annex. If no agreement can be reached on the arbitrator's appointment, the arbitrator shall be designated by the relevant authority specified in the Annex. The hearings shall be held in the location specified in the Annex and in the language stated under Sub-Clause 1.5 [Communications].

16 INSPECTIONS AND AUDIT

A new Clause, "16. INSPECTIONS AND AUDIT", shall be added to read as follows

16.1 Inspections and Audit

A new Sub-Clause 16.1 shall be added to read as follows:

"For the projects financed from non-repayable funds of the European Union budget and/or from funds of Financial Institutions, the Entrepreneur shall allow all inspection and audit bodies to inspect the Contract implementation, by examining documents or making on-the-



spot checks and, if applicable, to conduct a comprehensive financial audit, and shall provide all accounting documents and any other relevant documents regarding the financing of the Contract, according to the procedures provided by the EU and Romanian law to ensure the protection of the European Community's financial interests against irregularities, frauds or other infringements of the applicable legislation. Such inspections may take place for up to 7 years after the Final Payment.

For this purpose, the Entrepreneur undertakes to allow the audit and inspection bodies' representatives to have unrestricted Access to the Site or the locations where the Entrepreneur carries out his activity, including his IT systems, all documents and the data base regarding the technical and financial – accounting management of the Project and shall take all measures necessary to facilitate the inspection and audit bodies' activity. Access to the representatives of the inspection and audit bodies shall be given provided that the third parties' confidentiality is observed, without infringing the law. Documents must be available to facilitate the examination thereof, and the Entrepreneur shall inform the Beneficiary of the location thereof.

The Entrepreneur warrants that the inspection and audit bodies' right to conduct audits, inspections and checks shall apply to the same extent, subject to the conditions of and in accordance with the rules provided in this Clause, to all Subcontractors or any parties that receive non-repayable funds.”



Annex 5: Maintenance costs

County roads require maintenance works during operation. In many cases, the necessary works far exceed the budget assigned. In most cases, the necessary works exceed the annual amount allocated by the County Councils. For example, in 2015, in the Sibiu County, for the entire network of county roads (906,794 km), a routine maintenance cost of about 3,277.72 EUR / km is estimated, almost half of what was estimated in the STUDY ON ROAD FINANCING, CLASSIFICATION AND MANAGEMENT prepared for the Rural Development Project in Romania in 2005 (7,716 EUR / km).⁹⁰ The same is true for Bistrita Nasaud, with a 754 km network of county roads and a maintenance cost of 2,210 EUR / km, for Constanta – with 889 km of county roads and a maintenance cost per unit of 446 EUR / km, for Dolj – 1,096 km of county roads and a cost of 2,433 EUR / km, and for Ialomita – with 507 km of county roads and 1,797 EUR / km.

County	Length of county roads	Routine maintenance costs	Maintenance cost per unit ⁹¹	World estimated cost (EUR/km)	Bank cost
Sibiu County roads, 2015	906,794 km	13,375.00 thousand lei	3,277.72 EUR/km	7,716	
Bistrita Nasaud, 2015	754 km [National Institute of Statistics (NIS), 2013]	7,500,000 lei	2,210 EUR/km	7,716	
Constanta, 2015	889 km (NIS, 2013)	1,788.00 lei	446 EUR/km	7,716	
Dolj, 2014	1,096 km (NIS, 2013)	12,000 thousand lei	2,433 EUR/km	7,716	
Ialomita, 2014	507 km (NIS, 2013)	4,1 million lei	1,797 EUR/km	7,716	
Mehedinti, 2015	702 (NIS, 2013)	12 million	3,798 EUR/km	7,716	
Olt, 2015	1,026 (NIS, 2013)	22,7 million lei	4,916 EUR/km	7,716	

⁹⁰ The study estimated the maintenance cost based on the data collected in 100 communes and 5 counties during site visits.

⁹¹ EUR exchange reference rate = 4,5 lei



In terms of maintenance during the winter, the available data also showed that the allocated funds were insufficient, considering the amount recommended:

County	County road length	Amount allocated for winter maintenance	Maintenance cost per unit	World Bank estimated cost (EUR/km)
Ialomita, 2014	507 km (NIS, 2013)	1,7 million lei	745 EUR/km	2,000
Bistrita Nasaud, 2015	754 km (NIS, 2013)	1,500,000	442 EUR/km	2,000
Buzau, 2015	959 km (NIS, 2013)	500,000 lei ⁹²	57.93 EUR/km	2,000
Alba	1,098 (NIS, 2013)	6,000,000 lei	1,214 EUR/km)	2,000

The STUDY ON ROAD FINANCING, CLASSIFICATION AND MANAGEMENT prepared for the Rural Development Project in Romania in 2005 highlighted the evaluation of the maintenance and rehabilitation costs, based on the data collected in 100 communes and 5 counties during site visits.

Maintenance costs

<i>DJ - county roads</i>	occurrence in years	thickness or surface (m ²)	unit price (EUR / m ²)	total per occurrence (EUR / m ²)	total per year (EUR / m ²)
Routine maintenance					
Pothole repairs	1	0	8.75	0	0.00
Dressing	5	1	2.00	2	0.40
Asphalt	10	0.06	6.00	0.36	0.04
Clearing ditches	1	1	0.8	0.8	0.80
Routine maintenance of culverts	5	1	0.25	0.25	0.05
EUR / m ² per occurrence				3.41	
				EUR / m ² per year	1.29
				EUR / km per year	7,716

⁹² Under Framework Agreement for 2 years (2015-2016 and 2016-2017)



Winter maintenance

EUR / km per year

Summer maintenance

EUR / km per year

<i>DC - communal roads</i>	occurrence in years	thickness or surface (m ²)	unit price (EUR / m ²)	total per occurrence (EUR / m ²)	total per year (EUR / m ²)
Routine maintenance					
Pothole repairs	1	0.05	8.75	0.4375	0.44
Dressing	5	1	2.00	2	0.40
Asphalt	1	1	0.8	0.8	0.80
Clearing ditches	5	1	0.25	0.25	0.05
EUR / m ² per occurrence				3.4875	
				EUR / m ² per year	1.69
				EUR / km per year	8,438

Winter maintenance

EUR / km per year

Summer maintenance

EUR / km per year



<i>DS</i> - Village Roads	occurrence in years	thickness or surface (m ²)	unit price (EUR / m ²)	total per occurrence (EUR / m ²)	total per year (EUR / m ²)
Routine maintenance					
Pothole repairs	1	0.2	2.4	0.48	0.48
Clearing ditches	1	1	0.8	0.8	0.80
Routine maintenance of culverts	5	1	0.25	0.25	0.05
EUR / m ² per occurrence				1.53	
				EUR / m ² per year	1.33
				EUR / km per year	6,650

Winter maintenance

EUR / km per year

Summer maintenance

EUR / km per year

<i>DEV</i> - Agricultural Roads	occurrence in years	thickness or surface (m ²)	unit price (EUR / m ²)	total per occurrence (EUR / m ²)	total per year (EUR / m ²)
Routine maintenance					
Leveling with graders	0.5	1	0.0125	0.0125	0.03
Clearing ditches	1	1	0	0	0.00
Routine maintenance of culverts	5	1	0	0	0.00
EUR / m ² per occurrence				0.0125	
				EUR / m ² per year	0.03
				EUR / km per year	100



Winter maintenance

EUR / km per year

Summer maintenance

EUR / km per year

For all 5 counties, the necessary maintenance costs are the following:

Maintenance costs at the requested level									
Road	Type	length	unit cost for routine maintenance	cost of routine maintenance	unit cost for winter maintenance	cost of winter maintenance	unit cost for summer maintenance	cost of summer maintenance	total costs for maintenance
		Km	EUR / km	EUR	EUR / km	EUR	EUR / km	EUR	EUR
DJ	asphalt	3,421	7,716	26,392,871	2,000	6,841,076	300	1,026,161	34,260,109
DC	dressing	3,098	8,438	26,140,936	1,500	4,647,278	150	464,728	31,252,941
DS	gravel	11,417	6,650	75,925,378	500	5,708,675	0	0	81,634,053
DEV	earth	20,160	100	2,015,954	0	0	0	0	2,015,954