



Living with Flood Risk in a Changing Climate

FLOWs report WP3Bv-1

Improved decision support on planning and development in hazard areas on rivers

Proposal for revised guidelines

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Summary

The challenge underlying this project is how to make local authorities take flood risk properly into account in their spatial planning procedures. The Norwegian Water Resources and Energy Directorate (NVE) plays the dual roles of advisor and controller of municipal planning related to flood management. An important tool is “Guidelines for planning and development in hazard areas on rivers” issued by NVE 1999 (NVE Guidelines no 1/ 1999, hereafter called R99). R99 defines the safety levels which NVE considers to be “satisfactory” according to the Planning and Building Act.

As part of project 3Bv in FLOWS, experiences of practising R99 have been evaluated and proposals for a revision are presented in order to simplify and improve the guidelines.

This work was carried out by a project group which included participants from NVE, the County Governor of Telemark, the National Office of Building Technology and Administration and the Norwegian Geotechnical Institute. Other relevant institutions and end-users from selected municipalities have been involved through meetings.

For a number of reasons a revision of the guidelines is proposed. It is considered a general weakness that R99 only refers to building categories and does not advise how the guideline would apply to land use categories according to the Planning and Building Act. Such advice has been strongly requested by local government users as well as within NVE. Other issues are related to how flood risk should be taken into account in unmapped areas, as well as more detailed questions related to the interpretation of safety classes, etc. New information and an initiative to protect against quick-clay slides in rivers have also produced a need for revisions.

The project group has studied in detail a number of issues related to relevant sections of the Planning and Building Act. These include responsibilities, conditions for development and regulations on sequence of development, the implementation of Environmental Impact Assessments related to flood risks and more technical issues related to types of hazard and safety levels.

The outcome of this is synthesised into a proposal for a revised set of guidelines now being presented by FLOWS, which incorporate the following two main elements:

- 1) **Some adjustments to safety standards (See Table 1).** Simplification through fewer classes - the 200 year flood is the standard design flood for inundation. For other processes such as debris flows and landslides the equivalent safety level is a 1000 year event. Hospitals, other emergency institutions and infrastructure, whose failure would leave society very vulnerable (electricity, telephone services) should as far as possible be situated in non-risk areas.

Table 1: Safety classes concerning inundation, erosion, ice dams

Safety class	Land use, building category	Largest, nominal, annual probability
		<i>Inundation, erosion, ice dams</i>
F 1	Small garages, boat houses, sheds	1/20
F 2	Houses, cabins, industry, offices, important infrastructure	1/200
F 3	Hospitals, emergency institutions, critical infrastructure	< 1/1000

- 2) Based on a Regulation of 1 April 2005 on Environmental Impact Assessments, the project group expect municipalities to assess potential hazard zones related to rivers and lakes as part of their planning programme for Municipal master plans and Zoning plans. **A detailed procedure for impact assessment is offered as guidance to local authorities (see Table 2).** Detailed advice is included on how to define land-use categories in a Municipal master plan or a Zoning plan, included proposals/examples of text for provisions and/or guidelines.

Table 2: Procedure for risk assessment in a Municipal master plan (short version).

	Flooding in the municipal plan		
	Stepwise approach		Observations/references
1	Hazards mapped?	Yes	Define the parts of the planning area that need to be assessed for flood hazard. Exceptions will apply to parts where building is not permitted – typically, protected areas. If yes: If a flood-zone map has been produced the inundation topic can go directly to point 5. For other processes, all steps should be followed.
	No		
2	Are there rivers, streams or lakes that can influence the planning area?	No	Identify relevant rivers, streams and lakes. Note that these may lie outside the planning area or outside the designated building areas. If no: area OK
	Yes		
3	Are ground conditions such that there is a potential hazard?	No	Identify the potential extent of flood hazard in the plan. Evaluate erosion, debris flows, floods carrying gravel or deposits, slow floods, ice blockages. Criteria are defined in the Technical Guidelines. If no: area OK
	Yes		
4	Potential hazard-exposed area marked in municipal plan?	Yes	Regulations and guidelines are related to the areas, regarding requirements for zoning plans etc. and requirements for more detailed studies; see proposal in section 4.6
	No		If this area is too large, further studies must be carried out in accordance with points 7 – 9 of the zoning plan; see following points (6 – 8).

In addition to its proposals for a revision of R99, the project group has initiated work on technical guidance documents aimed at consultants who will perform impact assessments, related to the three main hazard categories: flooding, debris flow and quick-clay slides.

A draft proposal for “Technical guidelines” concerning flooding includes criteria for identifying potential hazard zones, as shown in Figure 1.

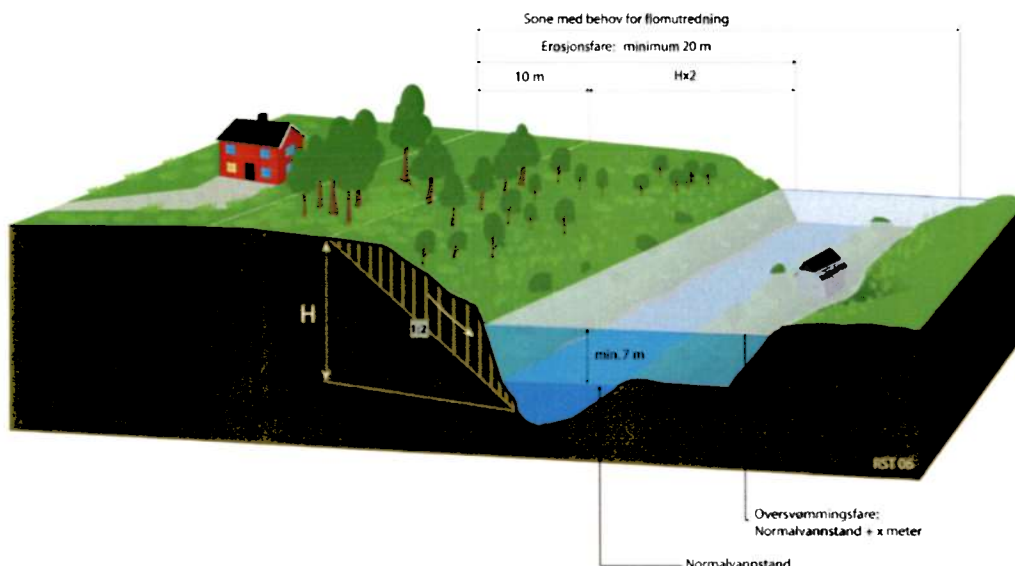


Figure 1: Identification of potential hazard zones related to flood inundation and erosion (draft).

Whenever a plan includes the development of areas within the limits of the standard design flood, the project group expect detailed mapping to be carried out to clarify the actual risks related to water depth, velocity and debris. In the draft technical guidelines, criteria for defining “high hazard” and “low hazard” areas are proposed; these are related to water depth and velocity, as shown in Table 3. A particular area might shift hazard degree for instance by filling the area. Conditions related to such safety measures would then have to be included in the land use plan.

Table 3: Criteria for the definition of high-hazard and low-hazard areas concerning flooding and their implications for development

Hazard categories	Implications for development
High hazard: Depth > 1.5m or velocity * depth >1.5 (m²/s)	No development accepted
Low hazard: Depth < 1.5m or velocity * depth <1.5 (m²/s)	Development could be accepted provided protection measures will prevent damage to property and people. Damage to small garages etc., can be accepted provided the annual probability of damage is less than < 1/20

The technical guidance is aimed at a different target group than the revision of R99 and will have to be developed further. For this reason, it has not been included in the proposal for revised guidelines.

Proposal for revised guidelines

Contents

1. PREFACE..... 13

1.1 BACKGROUND..... 13

1.2 TARGET GROUP 13

1.3 AREA OF APPLICATION 14

2. INTRODUCTION..... 15

2.1 NATIONAL OBJECTIVES AND INTERESTS IN MUNICIPAL PLANNING 15

2.2 THE ROLE OF LOCAL GOVERNMENT 15

2.3 STATE PARTICIPATION IN THE LAND USE PLANNING PROCESS..... 17

2.3.1 NVE 17

2.3.2 The County Governor 17

2.4 GENERAL REGULATIONS CONCERNING BUILDING PROHIBITIONS..... 17

2.5 EIAs AND RVAS..... 18

2.5.1 Environment impact assessments (EIA)..... 18

2.6 OBJECTIONS 19

2.7 DEVELOPMENT AGREEMENTS..... 19

2.8 PLANNING FOLLOW-UP OR LACK THEREOF 19

2.8.1 Case-handling of building applications..... 19

2.8.2 Exemptions 20

3. SAFETY LEVELS..... 22

3.1 SAFETY LEVELS IN AREA AT RISK OF FLOODING 22

3.2 SAFETY LEVELS IN CASES OF RISK OF DEBRIS FLOWS AND LANDSLIDES..... 23

3.2.1 Safety levels in areas at risk of quick-clay slides..... 24

4. ASSESSMENT OF HAZARDS..... 25

4.1 FLOODS 25

4.2 ASSESSMENT OF FLOOD RISK 27

4.2.1 Municipal plan..... 28

4.2.2 Zoning plan..... 31

4.2.3 Case-handling of building applications..... 33

4.2.4 Special regulations regarding flood barriers 34

4.2.5 Use of safety margins 35

4.2.6 Special problems..... 35

4.3 DEBRIS FLOWS 35

4.4 QUICK-CLAY SLIDES..... 37

4.5 ASSESSING THE RISK OF QUICK-CLAY SLIDES 39

4.5.1 Municipal plan..... 39

4.5.2 Zoning plan..... 40

4.5.3 Case-handling of building applications..... 43

4.6 GENERAL ADVICE CONCERNING THE REGULATIONS/GUIDELINES 44

5. CONCEPTS AND DEFINITIONS..... 47

Foreword

Norwegian Water resources and Energy directorate (NVE) drew up its first set of guidelines regard land use in flood-prone areas in 1999. Following a study and revision based on the experience gained from their use, we now present this proposal for a revised version of the guidelines.

The proposed version has been drawn up by a working group made up of representatives of NVE, National Office of Building Technology and Administration, County Governor of Telemark and Norwegian Geotechnical Institute.

As well as with the instances and companies represented on the group itself, the working group has enjoyed close cooperation with a number of other relevant institutions and municipalities. We thank everyone involved for their useful contributions to the efforts of the working group.

The working group have made a proposal for a guideline which in the final version will be NVEs official advices to municipalities in their planning and development. The working group have therefore written this document in NVEs name. This version of the guidelines has not yet been approved by head of the department, so by the time being the proposals in this document are statements presented by the working group.

Oslo, June 1, 2006

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1. Preface

1.1 Background

In 1999, Norwegian Water resources and Energy directorate (NVE) published its “Guidelines for land use and protection in flood-prone areas” (NVE Guidelines 1/1999, hereafter called R99). These have generally been well received, as a clarification of the safety levels that NVE believes ought to apply for dealing with flood hazards near rivers.

After some years of utilising the guidelines, however, NVE realised that they needed to be revised and updated.

A consistent weakness of R99 was that the guidelines rather unilaterally focused on building types and did not capture planning objectives according to the Planning and Building Act (PBA). There was a need for more concrete indications of how the guidelines should be implemented in land use planning processes.

NVE’s Programme for Improved Landslide Safety has supplied detailed maps of quick-clay zones, and it has become clearer that in practical terms, the danger of quick-clay slides occurring is closely linked to being in the vicinity of a river. This effort on the part of NVE revealed a need in both local governments and NVE for clearer indications of how this danger should be dealt with in the land use planning process.

R99 has been most directly used in areas for which risk-zone maps are available, i.e. where the degree of risk has been identified. There was a need for clarification of how local authorities ought to deal with potential risks, i.e. in areas for which risk-zone maps are not available.

In areas at risk of erosion, landslides and movements of deposits, the current guidelines have been little used. There was a desire to better capture other types of hazard than the risk of flooding. There was also a wish to see the safety classes employed in R99 being more precisely defined and clarified.

1.2 Target group

The target group for these guidelines is primarily composed of land use planners and building application case officers. A secondary target group comprises county governors and NVE itself in their land use planning follow-up efforts. Others may also benefit from the product (contingency planning authorities, developers, etc.), although in the process of preparing this material, NVE has had the primary target group in mind.

1.3 Area of application

The guidelines clarify the safety levels demanded in planning and development, and the assessment requirements of these processes.

The guidelines apply to all types of hazard related to rivers, including floods, inundations, erosion, ice movements and landslides.

The guidelines do not deal with anthropogenic hazards resulting from river regulations, such as the risk of dam breaches. Risks of this type are regarded as being dealt with by inspections carried out in accordance with special legislation.

In practice, several different types of landslide are due to rivers, either because they are triggered by erosion caused by rivers or because the slide itself ends up in the river. The consequences may be particularly dramatic in areas at risk of quick-clay slides. For this reason, these guidelines aim to deal with the risk of landslides occurring when areas containing quick clay are being developed. Debris flow is a process naturally linked to rivers, but other major movements of sedimentary material would have to be due to erosion caused by rivers in order to be covered by these guidelines.

The guidelines will be of use in the production of land use plans in areas that are exposed to risks from rivers and in all new building and construction activities. There is also a clear ambition to include building in agricultural, natural and recreational (LNF) areas, including agricultural buildings. The use of land for agriculture and forestry is not covered by the guidelines, and must be followed up via special legislation.

Exceptions apply to buildings and to road and river structures which, because of their functions, need to lie in areas that are exposed to hazards (dams, bridges, pumping houses, etc.). These must be built to withstand design loads according to § 77 of the Planning and Building Act, technical regulations for the Planning and Building Act and other applicable special regulations.

The guidelines are not intended for direct application to protective measures in rivers. Where new buildings are to be protected, however, the safety requirements will come indirectly into force. Where the protection of existing buildings or infrastructure is concerned, it will be possible to adapt the design criteria for river regulation measures to what can be justified in technical, economic or environmental grounds. New structures in the same area will therefore have to be protected by other types of measure, such as modifications to buildings or raising the ground level by means of landfill.

2. Introduction

2.1 *National objectives and interests in municipal planning*

Planning in accordance with the Planning and Building Act is dependent on coordinated planning efforts. National objectives and interests must be taken into account at municipal planning level and be adapted to local conditions. It has been stated that a strategy in which the security of society is integrated into general social planning is desirable; see:

- “National objectives and interests in county and municipal planning”, circular T-2/98, Ministry of Environment
- White Paper no. 17 (2001 – 2002), “Security of society: the way to a less vulnerable society”.
- White Paper no. 42 (1996 – 1997), “Flood-prevention measures”.

The circular emphasises that reducing vulnerability demands conscious planning, and that risk and vulnerability analyses at municipal level are an important tool in support of such efforts.

2.2 *The role of local government*

Risk and vulnerability can be prevented through land use planning. One of the objectives of the Planning and Building Act is to ensure that land is used in ways that do not lead to hazard; see § 2 of the Planning and Building Act. Local government has the responsibility to ensure that areas that are being developed enjoy sufficient security, and thus the duty to avoid development in risk-prone areas; see § 68 of the Planning and Building Act.

The land use partial plan of the municipal master plan and zoning and building plans are the central plans in land use planning, as these plans are legally binding.

It is important that investigations should take place as early as possible in the planning process in order that they can function as premises for the rest of the planning process. A plan should be predictable. It is therefore important to obtain knowledge about whether an area can be built on, and if necessary under what conditions, before the developer has gone too far in his planning preparations.

A circular from the Ministry of Environment in collaboration with the Ministry of Local Government and Regional Development: T-5/97, “Land use planning and Development in Hazard Zones”, states:

The local authority is responsible for ensuring responsible use and conservation of areas and buildings within municipal boundaries. (...) The local authority itself has an independent duty to investigate hazards, both when it draws up land use plans and in dealing with property-division and building applications. (...) The local authority should ensure that adequate expert advice regarding hazards is obtained before a plan is adopted or building permits are issued. (...) The local authority is responsible for carrying out such advance studies as are required and for ensuring that the results of such studies are used as a basis in subsequent phases of the planning process.

At an early point in the planning process, the local authority should contact the relevant national authorities, including NVE and the County Governor; see §§ 20-5 and 27-1 of the Planning and Building Act.

The NVE guidelines provide answers regarding the requirements as to what studies should be performed in its processing of planning and building applications; see section 4.

The studies and responsibilities involved will differ, according to whether plans, including planning level, or building applications, are involved.

In drawing up their land use partial plans, local authorities are responsible for performing an overarching study aimed at identifying potentially hazardous areas. The land use partial plan must include guidelines regarding further detailed investigations and regulations regarding the location of buildings.

Zoning and building plans are usually drawn up by private bodies. The proposer has an independent duty to document that the area can be built on, and if necessary under what conditions, at an early stage of the planning process. The proposer should submit this information as part of his case documentation, when the proposal is sent to the local authority. This means that the proposer will bear the economic burden of obtaining the necessary expert opinions.

If the local authority possesses information regarding flood or clay slide hazards, such information must be reported to the proposer at an early stage of contact with the local authority. This is particularly important when information of this sort has become available since the land use plan was drawn up. The local authority should reject the application unless satisfactory documentation regarding adequate levels of safety can be presented; see § 30 of the Planning and Building Act. This means that the planning proposal should not be made available for public inspection.

Information regarding hazard areas may emerge in connection with public access to the proposal, at which point the zoning plan proposal will have changed from being a private matter to a public affair. From this point on, the local authority is responsible for performing the necessary investigations. If these studies are not carried out, the case must be submitted to the municipal council with a negative recommendation. The municipality should not make a final planning decision if the investigation requirement for measures related to the plan have not been fulfilled; see "Zone plan/building plan" (Guidelines issued by the Ministry of Environment, 2001, section 4.2.3).

2.3 State participation in the land use planning process

NVE and the County Governor have an obligation to help and guide local authorities in their planning efforts in order to identify the factors that must be taken into consideration in land-use planning in the vicinity of rivers; see § 9-3 of the Planning and Building Act. NVE and the County Governor should participate in drawing up the land use partial plan of the municipal master plan (municipal plans) and zoning and building plans, both at the early stages (issue of notice) and when they are made available for public inspection.

2.3.1 NVE

NVE is the central professional authority for energy supply and rivers. NVE is the responsible governmental authority where hazards related to rivers are concerned, and should contribute to ensuring that areas where the risks of flooding, erosion, ice movement or landslides are unacceptably high are not built on.

All plans for protective measures in connection with rivers should be dealt with by NVE in accordance with the Water Resources Act. In dealing with individual cases, the usefulness of the measures should be weighed against their effects on nature and the landscape.

2.3.2 The County Governor

The County Governor should inform, guide and influence local authorities so as to ensure that the security of society is a premise in municipal plans and zoning and building plans.

In the event of a crisis situation such as a landslide or flood, it is important to minimise its consequences. The County Governor will follow up the local authorities concerned through inspections and exercises in order to ensure that they have crisis and contingency plans that will enable them to deal with such situations.

2.4 General regulations concerning building prohibitions

Temporary building prohibitions may be introduced in potential hazard zones until the question of zoning has finally been decided (§ 33 of the Planning and Building Act). § 68 of the Planning and Building Act is a “safety valve” for cases in which the local situation has not been satisfactorily dealt with by the plan – for example, when a local authority possesses new information that was not available at the time when the current plan was drawn up.

2.5 EIA and RVAs

2.5.1 Environment impact assessments (EIA)

Environment impact assessments (EIA) form part of the planning process in accordance with the Planning and Building Act and should be coordinated with its application; see changes in provisions of the Act dated April 1, 2005. These rules always apply when land use plans are being drawn up, as they do to a great extent in zoning plans; see regulations for §§ 3 and 4 of the EIA provisions. The security of society must be taken into account when considering whether plans and measures can be implemented. This means that flood and landslide hazards must be evaluated when areas close to rivers are to be built on. The guidelines will make an important contribution to such evaluations. Proposals for planning programmes and plans requiring EIA should be put on public view and must also be sent to NVE and the County Governor for their comments.

2.5.2 Risk and vulnerability analyses (RVA)

Local authorities should ensure that complete information about a case is available before any decision regarding it is made; see § 17 of the Public Administration Act. The security of society is an important prerequisite of all planning. This applies for example to vulnerability to natural forces such as flood and landslide risks. If this obligation is to be met, and only sufficiently safe ground is to be built on, potential hazard areas must be investigated and evaluated in the land use planning process; see circular no. T-5/97, "Land use planning and Development in Hazard Zones".

Studies can be carried out in the course of performing an RVA. The risk part of the analysis covers conditions related to the area itself, while the vulnerability aspect covers the condition that result from the use of the area. The analysis will provide a status description and will be a planning premise for the subsequent stages of the planning process, and should therefore take place as early in the planning process as possible. In those cases where a EIA must be carried out, such an analysis will form a natural part of the process. The depth and scope of the analysis will depend on the risk of the area. It is important that all relevant aspects of the area should become known and if necessary, be reflected in the land use plan. The way in which the area is used will be based on expert evaluations.

In the local authority's presentation of the case, the security of society – the relationship to landslides and floods, must be discussed. The consequences of the planning proposal for the security of the community must be described. If risk and vulnerability are not relevant topics, this should also be commented on in the case presentation.

2.6 Objections

NVE and the County Governor should help to ensure that local authorities do not approve building on areas that lack adequate security or that such building is only permitted on condition that protective measures are implemented. If the local authority puts forward a planning proposal in which safety in the vicinity of a river is not documented or ensured, NVE and the County Governor may present objections to both land use partial plans and to zoning and building plans. Such objections may be based on formal aspects of the plan or to its realities; see circular from the Ministry of Environment T-5/95, Guidelines for the use of objections in planning cases according to the Planning and Building Act”. The basis for objections on formal grounds will be that the local authority has not carried out studies that have documented a satisfactory level of security or provided guidelines for future planning efforts at zoning plan level. Objections based on real aspects of the plan will be that the risk of flooding or landslides is not sufficiently low.

Changes in the Planning and Building Act, adopted on May 7, 2004, mean that the objecting authority must provide a reasoned warning that objections can only be presented on the basis of a more detailed plan; see the Ministry of Environment’s circular T-2/2004.

2.7 Development agreements

Development agreements are regulated in accordance with Chapter XI-A §§ 64 passim. of the Planning and Building Act, with regulations that come into forces on July 1, 2006. Such agreements may include contributions from the developer, which are a prerequisite for follow-up of § 68 of the Planning and Building Act, or which are necessary for implementation of the plan and are related to the scope of the development and the performance/inconvenience suffered by the local authority. This means that agreements may be made regarding various types of protective measure resulting from the regulations regarding the sequence of operations, conditions or prerequisites for localization.

2.8 Planning follow-up or lack thereof

2.8.1 Case-handling of building applications

According to the first sub-paragraph of § 68 of the Planning and Building Act, a property may not be divided or built on in the absence of adequate protection against hazards or disadvantages in consequence of natural or environmental forces. It is a basic principle that structures must not be located where conditions exist that constitute a danger or significant inconvenience for occupants or other users.

According to § 68, sub-paragraph 2 of the Planning and Building Act, the building authorities may prohibit building, or set special conditions for building in such areas.

The question of adequate protection against natural hazards arises when building permit applications are being drawn up and processed. In such cases the local authority needs to decide whether it agrees with the responses of the applicant to the application regarding whether there is adequate protection according to § 68 of the Planning and Building Act. See NBR form 5175 and Bygg Søk's electronic application forms. Links can be found on the home page of the National Office of Building Technology and Administration, www.be.no. For more details of § 68 of the Planning and Building Act, see circular T-5/97, "Land use planning and Development in Hazard Zones", which was published by the Ministry of Environment in collaboration with the Ministry of Local Government and Regional Development.

If it is likely that building works will be commenced in areas where adequate, updated information regarding flood and landslide hazards is lacking, contact may be made with companies, public bodies or others who can evaluate and identify hazards or risks. Doing so will contribute to studies and surveys before building applications are processed, so that decisions can be made on the basis of adequate study and information.

Investigations and possible studies are of particular importance in cases where, after the plan currently in force has been approved, new information regarding hazards or hazard zones has come to light. The conditions for zoning, e.g. as a building area, may have changed. For example, buildings may have been damaged by a landslide, or new estimates of the rate of recurrence of floods, landslide hazard, etc., may have emerged.

If the local authority possesses information regarding flood or landslide risk, such information must be reported to the developer during the earliest contact with the authority regarding the case in question. This is particularly important when such information or suspicions have emerged after the municipal plan or a zoning plan has been approved.

The local authority can issue general permission on condition that satisfactory documentation regarding protection against natural hazards is submitted, even if the answer to this question is negative as a point of departure. The municipal case officers should not decide or approve which practical protective measures are to be adopted. Consultants and the responsible construction companies should be responsible for designing the specific protective measures, and for their control.

2.8.2 Exemptions

According to § 7 of the Planning and Building Act the local authority may make exemptions from planning and building regulations.

§ 68 of the Planning and Building Act deals with safety. This is a regulation from which exemptions cannot be made. The background for this is that permits cannot be issued for projects that would involve building in hazard zones or where adequate protection is not available.

When exemptions are being made from a plan, it is important to be aware of:

- The case treatment regulations regarding alerting the professional authorities/advance expressions of opinion.
- Requirements regarding exemptions.

If the project is dependent on obtaining an exemption from an area, zoning or building plan, the 12-week deadline for processing does not apply; see the regulations regarding case treatment and control in building matters (SAK) § 23.

Applications for exemptions for building in flood- and landslide-prone areas should be sent to NVE and the County Governor before the local authority makes a final decision (advance expression of opinion). An advance expression of opinion will be appropriate if, for example, the matter concerns an exemption from the requirement in the land use partial plan that a zoning plan should be drawn up, from the LNF objective with information regarding hazard area, from the zoning objective where building is not permitted or from the conditions for building permission as set out in the zoning regulations.

Where the requirements for exemptions are concerned, a prerequisite for exemption is that there should be special grounds for issuing such an exemption. General and social considerations should be weighed against such specific relevant grounds as are set out in the application. An advance expression of opinion should be regarded as advice or help for the local authority in the specific evaluation that is to be made. If NVE and the County Governor are negative to the issue of an exemption, this will be strong support for the idea that special grounds do not exist.

The main consideration of the security of the community, i.e. that there should be adequate protection before building is undertaken in the vicinity of a river, should form the basis of allowing exemptions from a plan. The special grounds claimed must weigh particularly heavily. When an area is exposed to risk, this involves danger to life, health or material damage, all of which are values that cannot be ignored. The plans are the result of a comprehensive process in the course of which investigations have been made of hazard zones. It should not be a matter of course to be given an exemption in such cases. This is to say that exemptions cannot normally be made when hazard zones are involved or from planning conditions that are intended to cover safety aspects.

Even if special grounds exist, the applicant does not have a legal right to an exemption. A rejection may cite, for example, a wish to be loyal to the plan, or the potential consequences of admitting the application, e.g. that others would be encouraged to apply for permission to build in the hazard area.

Conditions may be attached to an exemption. However, the prerequisite is that the requirements for issue of an exemption must be fulfilled. There must be a reasoned connection between the exemption and the conditions attached to it. As far as possible, the conditions should compensate for any disadvantages resulting from the issue of the exemption, for example that the building should be built at a minimum contour height of x metres above sea level, be built without cellar, etc.

3. Safety levels

These guidelines are based on the safety requirements set out in the Technical Regulations (TR) with guidelines (GL). The guidelines contain details and supplementary guidelines regarding hazards related to rivers. For areas at risk of quick-clay slides, the safety requirements are indicated with the help of a safety factor (material factor); see section 3.3

Risk-prone is defined here as the area of influence of probable events in the river.

3.1 Safety levels in area at risk of flooding

Table T1 illustrates the safety levels that apply to various types of area use. It indicates some typical processes in river areas as a guide to when the table would be employed.

The safety classes are inspired by the TR, but the levels are lower than that applying to landslides. Debris flows and landslides triggered by erosion in rivers are covered by the TR and are described in more detail in section3.2. The hazards should be evaluated in terms of their consequences both in terms of the risk of loss of human life and of the risk of material damage. Within the area of influence of floods there will be sub-areas at great risk of loss of human life. The Technical Guidelines for Assessment of Flood Risk (in preparation) define the criteria for evaluating the degree of risk in more detail.

Where hazard areas covered by protective measures are concerned, the consequences of events that surpass the design level should also be evaluated. The point of departure should be the consequences of a breach in the protection system, and hazard zones should be defined on the basis of criteria as set out in the Technical Guidelines for Assessment of Flood Risk.

Safety class	Area use, building, construction	Greatest nominal annual probability
		Inundation, erosion, ice movements
F1	Small garages, boathouses, sheds	1/20
F2	Houses, cabins, industry, offices, important infrastructure, etc.	1/200
F3	Hospitals, emergency institutions, critical infrastructure	<1/1000

Table T1: Safety levels and flooding hazard

Safety class F1: This covers structures with a low level of occupation and of limited financial or other social significance. Examples would include simple structures such as small garages, boathouses and storage sheds. If the financial consequences of flooding are likely to be important, safety class F2 should be employed.

Safety class F2: This covers most types of buildings under continuous occupation, including housing and industrial and office premises. The financial consequences of damage to buildings of these types can be great, but critical social functions must not be put out of action; see safety class F3.

Safety class F3: Certain types of land use/building used by particularly vulnerable social functions should in principle not be located in areas exposed to risk:

- areas or buildings used by particularly vulnerable sections of the population (nursing homes, etc.)
- functions on whose continuing operation society is critically dependent (electricity supply, telephone system)
- buildings that will be used in emergency situations, such as flood crises (hospitals, fire-stations, police stations, civil defence installations, etc.).

Where such social functions are concerned, the point of departure should be protection against at least a 1000-year event. There will be a high level of uncertainty regarding the area of influence of such events. We therefore emphasise that functions of this sort should be located as far as possible to where there is a good margin of safety outwith the hazard zone of a 1000-year flood.

3.2 Safety levels in cases of risk of debris flows and landslides

The safety levels are defined in the TR. Certain types of slide are the result of processes that take place in rivers and are therefore covered by these guidelines, e.g. debris flows and other types of landslide that are triggered by processes in rivers or in the course of which the slide deposits end up in a river. For more detailed guidelines regarding the use of these safety classes, see the GL.

Safety class	Area use, building, construction	Greatest nominal annual probability
		Debris flows, landslides
S1	Garages, boathouses	1/100
S2	Houses, cabins, etc.	1/1000
S3	Hospitals, schools, etc.	<1/1000

Table T2: Safety levels in landslide hazard areas

3.2.1 Safety levels in areas at risk of quick-clay slides

In areas at risk of quick-clay slides the safety evaluation should encompass both an evaluation of the probability of a slide occurring (degree of risk) and an estimate of the safety factor (material factor).

The method used to evaluate the degree of risk has been developed through NVE's Programme for Improved Landslide Safety. More detailed requirements regarding assessment and documentation have been drawn up on the basis of the method; see section 4.5. An evaluation of the degree of risk will indicate the relative degree of risk of a landslide occurring, and also provide a basis for determining the extent to which a landslide or its deposits could affect the building area.

The material factor indicates the relationship between the available sheer forces and mobilised shear stress. Safety, as defined in terms of an annual probability of occurrence as indicated by the TR, is thus not utilised directly in safety analyses of clay slopes. This is because at present, good correlations are not available that would allow us to determine the normal probability of occurrence of slides in clay deposits. The safety levels utilised in geotechnical stability analyses are set out in NS 3480.

The safety levels utilised in geotechnical operations depend on the scope and reliability of the underlying data, how these are interpreted, analysed, controlled and followed up. The safety factor chosen is only one of several factors that will affect safety. A more detailed discussion of recommended safety levels in estimating the stability of quick-clay slopes is provided in "Guidelines for stability evaluations of naturally occurring quick-clay slopes" (NGI, 2006).

4. Assessment of hazards

This chapter describes various types of hazard and procedures for documenting the existence of adequate protection against hazards in the vicinity of rivers.

Objective: Early identification of areas on which it may be necessary to place restrictions due to the risk of floods or landslides, or to prohibit building.

It is important to have adequate documentation regarding hazard assessments that is appropriate to the decisions that are to be made in the course of the planning process. A stepwise assessment procedure has therefore been designed, with a rise in the level of detail from municipal plan via the zoning plan to the actual processing of the building application. Irrespective of the type of hazard involved, we recommend the following:

- Municipal plan: This is where potential hazard should be identified.
- Zoning plan: This is where the actual hazard should be described.
- Building case: This is where a satisfactory level of safety should be documented.

We emphasise that this stepwise approach to the municipal plan is no more than a recommended minimum. The effort put into hazard assessment should also be weighed against the likelihood of the plan being implemented, i.e., the extent to which there is a need for knowledge about the areas involved, in order to be able to implement the strategies that the plan is aimed at. Will strategies for the structure of the centre, transport, schools, infrastructure, etc., have to be set aside if it turns out that an area cannot be adequately secured against floods or landslides? Proper land use planning will therefore often require supplementary studies to be carried out in order to provide a more precise delimitation of hazard zones and the degree of risk of floods and landslides; see the first points in the tables for the zoning plan in sections 4.2 and 4.5. This would also provide a better basis for evaluating and estimating appropriate protective measures and the costs of these.

A limited study could typically leave LNF areas remain with guidelines regarding restrictions and requirements for further studies. More detailed studies of built-up areas, areas planned for development or/and LNF areas with the possibility of low-density building would be investigated in more detail.

4.1 Floods

The dangers of flooding are the result of three main components:

- Water velocity
- Water depth
- Material transported by floodwaters (gravel, stones, debris, ice).

Interactions among these three factors can lead to a danger of loss of human life and/or of material damage, depending on the forces that arise and how rapidly the processes develop. Where large quantities of material are transported there will be a gradual transition to debris flow. In such cases professional judgement must be used to evaluate whether safety levels for landslides or floods should be employed; see sections 3.1 and 3.2. The Technical Guidelines for Assessment of Flood Risk (in preparation) will be of help here.

In all rivers there will be a certain risk of erosion of the deposits that make up the riverbank. High water velocities or waves can lead to landslides. This process may be rapid when the flood develops rapidly or where protective measures suddenly fail, but in most cases the situation can be monitored and people can be evacuated from locations at risk.



Figure 4.1: Erosion in gravel slope falling to river

In rivers with a relatively slight fall, water speeds will be small and the hazards produced by floods will be due to inundation of areas close to the river. Inundation is caused by a rise in water level caused by the flood or by water being dammed up by ice blockages or landslides. Inundations can produce serious material damage and, in certain cases, may put human life at risk. The relationship between water depth and speed is decisive and criteria for this relationship are defined in more detail in the Technical Guidelines for Assessment of Flood Risk.

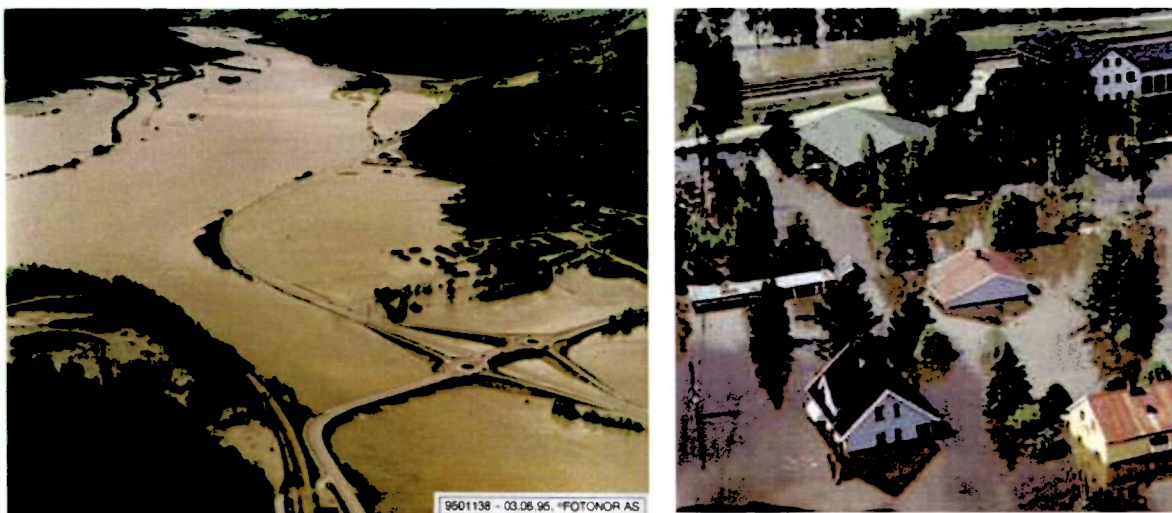


Figure 4.2: Inundation

Ice blockages are not necessarily related to floods, but they are nevertheless defined as an aspect of flood hazards in these guidelines. Ice in movement involves large forces which may cause buildings to collapse or put human life at risk. When ice blocks a river, it may lead to an inundation upstream in the same way as an ordinary flood does.



Figure 4.3: Ice blockages

4.2 Assessment of flood risk

The following paragraphs describe a stepwise procedure for surveying hazards in connection with land use planning processes, and in order to ensure adequate flood protection when applications for building permits are being approved. The procedure aims to identify important problems, such as potential flood hazards and the need for protective measures, early in the planning process. The procedure indicates the problems that should be identified at each level of planning.

Qualified professionals should carry out such investigations.

4.2.1 Municipal plan

The following questions must be answered: Are there areas at risk of flooding which have been built on or where building is planned?

The points set out in the table below outline a process for investigating potential hazards and identifying what consequences actual or potential hazards ought to have for the planning process.

In principle, the procedures demands a “clean sheet” start, i.e. that the whole of the municipality should be studied, or at least the planning area for a municipal partial plan. Note that the hazard may arise from a river, stream or lake outside the planning area. It is also important to note that even if a process in a river has been surveyed in detail, for example in the form of a flood-zone map, the plan will still need to be checked with respect to other relevant hazards in the river.

How far it will be necessary to take such investigations will depend on the extent to which the local authority regards it as appropriate to place restrictions on building in potential hazard areas, and how far uncertainty can affect important strategies set out by the plan. If such studies go far enough at the municipal planning stage, the restricted area will be reduced and a more transparent situation for developers and the long-term development strategy will be the result.

	Flooding in the municipal plan		
	Stepwise approach		Observations/references
1	Hazards mapped	Yes	<p>Define the parts of the planning area that need to be assessed for flood hazard. Exceptions will apply to parts where building is not permitted – typically, protected areas. As a point of departure, both LNF areas (agricultural buildings) and all areas that are either built up or are planned for development will require potential hazards to be surveyed.</p> <p>If yes: If a flood-zone map has been produced the inundation topic can go directly to point 4. For other processes, all steps should be followed.</p>
	No		
2	Are there rivers, streams or lakes that can influence the planning area?	No	<p>Identify relevant rivers, streams and lakes. Note that these may lie outside the planning area or outside the designated building areas (particularly in the case of municipal partial plans). Underlying material: discharge data, catchment, previous events in the river, elevation above normal water level.</p> <p>If no: area OK</p>
	Yes		
3	Are ground conditions such that there is a potential hazard	No	<p>Identify the potential extent of flood hazard. Evaluate erosion, debris flows, floods carrying gravel or deposits, slow floods, ice blockages. Criteria are defined in the Technical Guidelines. See also Figure 4.4, Tables T1 and T2.</p> <p>If no: area OK</p>
	Yes		
4	Potential hazard-exposed area marked in municipal plan	Yes	<p>Regulations and guidelines are related to the areas, regarding requirements for zoning plans etc. and requirements for more detailed studies; see proposal in section 4.6</p>
	No		<p>If this area is too large, further studies must be carried out in accordance with points 6 – 8 of the zoning plan; see following points (5 – 7).</p>
5	Necessary studies to be carried out		<p>Analyse flood situation Flood: inundation – erosion – ice blockage Debris flow: mass transport with separation area Carry out evaluation of degree of risk</p>

			according to Technical Guidelines in order to identify areas that lie within area affected by 200-year or 1000-year flood, according to process involved.
6	Hazard areas to be identified and checked against requirements for adequate protection; see requirements as set out in these guidelines.		<p>The area which needs to be subjected to restricted use as a result will normally be significantly reduced. Relevant restrictions on building must be applied to the remaining zones.</p> <p>1: No development; the land use category is a hazard area and regulations are issued that no development can take place.</p> <p>2: Development in hazard area; go to point 7</p>
7	Degree of risk is identified (for alternative 2 in point 7 above)		Carry out analysis of degree of risk according to Technical Guidelines. Does the study indicate that water depth, speed, erosion or a combination of these will affect the area; see Tables T1 and T2. Is the degree of risk acceptable, or can measures be put into effect that will make it so?
8	Land use categories, with regulations and guidelines, are established		<p>Red zones: Land use category: building area. Other building area – hazard area (see point 2 in list in section 4.6). Regulations; further building prohibited (see bullet points 4, 5, 8 and 9 in section 4.6).</p> <p>Yellow zones: Land use category: Building area - other building area – hazard area. Regulations: zoning plan requirements, localisation requirements, building heights, if appropriate, regulation on succession of development and protection measures should be implemented (see bullet points 2,6 and 7 in section 4.6)</p>

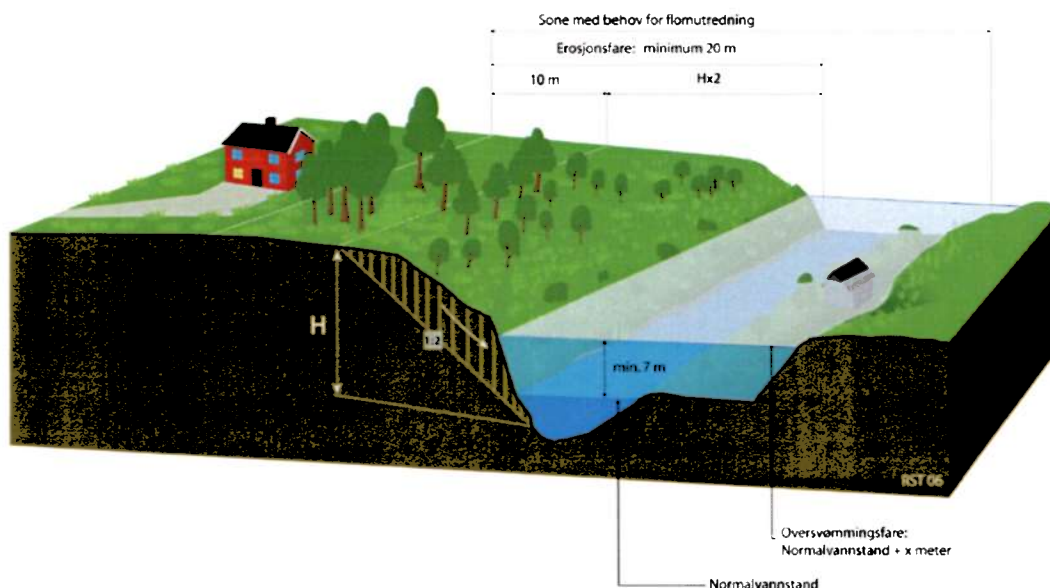


Figure 4.4: Identification of potential hazards zones related to flood inundation and erosion (draft).

4.2.2. Zoning plan

At this planning level, the following question should be answered: Is there an actual risk of flooding that affects the planning area.

If the possibility of flooding risk has not been evaluated at municipal planning level, an evaluation of potential hazard areas must be carried out; see points 1 – 4 above.

Alternatively, we can go directly to an evaluation of the degree of risk if it appears to be clear that there may be a conflict between the current planning objectives and potential risk of flooding .

Before the zoning plan is made available for public inspection, it is recommended that it should be documented that the following steps should have been carried out:

	Flooding in the zoning plan		Assumes that step 1-4 in the municipal plan have been carried out, or if not, that they will be carried out in the course of the zoning plan process.
	Stepwise approach		Observations/references
5	Does the measure require further study?	No	If no: Area OK – go to points 9 and 10
	Yes		
6	Necessary studies to be carried out		Analyse flood situation Flood: inundation – erosion – ice blockage Debris flow: mass transport with separation area Carry out evaluation of degree of risk according to Technical Guidelines in order to identify areas that lie within area affected by 200-year or 1000-year flood, according to process involved.
7	Hazard areas to be identified and checked against requirements for adequate protection; see requirements as set out in these guidelines.		The area which needs to be subjected to restricted use as a result will normally be significantly reduced. Relevant restrictions on building must be applied to the remaining zones. 1: No development; the area is zoned as a hazard area and regulations are issued that no development can take place. 2: Development in hazard area: go to point 8.
8	Degree of risk is identified (for alternative 2 in point 7 above)		Carry out analysis of degree of risk according to Technical Guidelines. Does the study indicate that water depth, velocity, erosion or a combination of these will affect the area; see Tables T1 and T2? Is the degree of risk acceptable, or can measures be put into effect that will make it so? The hazard zone is re-evaluated, taking into account any planned protective measures and safety requirements in these guidelines.
9	Land use categories, with regulations and guidelines, are established		Red zones: Land use category: building area. Regulations: Prohibition against new development until protective measures allow rezoning to yellow zone; see proposals in section 4.6 Yellow zones: Land use category: Hazard zone, possibly in combination

			with other uses. Special physical measures for access to flood prevention systems in emergency situations may need to be regulated for. Special area: particularly relevant for flood protection systems. Regulations: Layout and use of areas, localisation of buildings, possibly order of development and implementing protective measures.
10	Design of protective measures		<p>Hazard zones are re-evaluated on the basis of any protective measures that have been implemented. See separate discussion of embeankments.</p> <p>Remaining red zones: hazard zone; building prohibition.</p> <p>Remaining yellow zones: relevant regulations are incorporated into the plan.</p> <p>Potential protective measures inside and outside the planning area are identified. Planned measures are costed. The measures must be evaluated with respect to their effects on nature and the environment and their hydrological consequences (including the possibility of requiring a permit in accordance with the provisions of the Water Resources Act).</p>

4.2.3 Case-handling of building applications

Hazards, whether of flooding or landslides, which have not been studied or taken into account in connection with the municipal plan or the zoning plan, must be evaluated in the process of processing the building application itself.

One of the three question in the application form that concerns § 68 of the Planning and Building Act deals with just these hazards. The documentation that is submitted together with the application or is later submitted by the responsible contractor/applicant should conclude by stating that the safety requirements have been met; see application form, NBR form 5175 and ByggSøks electronic form.

This documentation must have been submitted before permission to commence building is given.

Development should not increase run-off and thus contribute to increased flood peaks in rivers.

4.2.4 Special regulations regarding flood barriers

Embankments may be a suitable method of bringing safety up to an acceptable level.

The usual criteria for hazard evaluation will be adopted for areas lying behind embankments. The hazard assessment is primarily related to the possibility of breaches, irrespective of the safety level that this represents.

An embankment designed to provide protection against a 200-year flood will initially mean that the whole of the area behind the barrier can be declared “fit” for development. However, new potential hazards arise in connection with breaches of the barrier. These hazards need to be evaluated with respect to the design flood for the embankment, irrespective of the recurrence interval of the flood that the embankment is designed to withstand.

An evaluation of this sort will typically mean that some of the area behind the barrier is defined as high-risk. This area will be a zone close to an overtopping point and area that would flood to a great depth. Restrictions will have to be placed on these areas in order to prevent development taking place before any measures that can lead to them being reclassified as lower hazard zones have been implemented.

Access to the embankment of inspection, maintenance and crisis action in the event of a flood must also be ensured. A flood barrier is such a large-scale measure, which needs to be specially regulated in order to ensure general safety, that it should normally be covered by a zoning plan.



Figure 4.5: Major flood overtopping embankment

4.2.5 Use of safety margins

When building limits and other restrictions on development are being defined, the uncertainty in the estimates must be incorporated in the form of safety margins. A safety margin should be added to estimated flood levels, particularly where detailed analyses have been made, such as for flood-zone maps. Where only rough expert evaluations have been made, the expert concerned should allow for uncertainty when estimating areas and flood levels.

4.2.6 Special problems

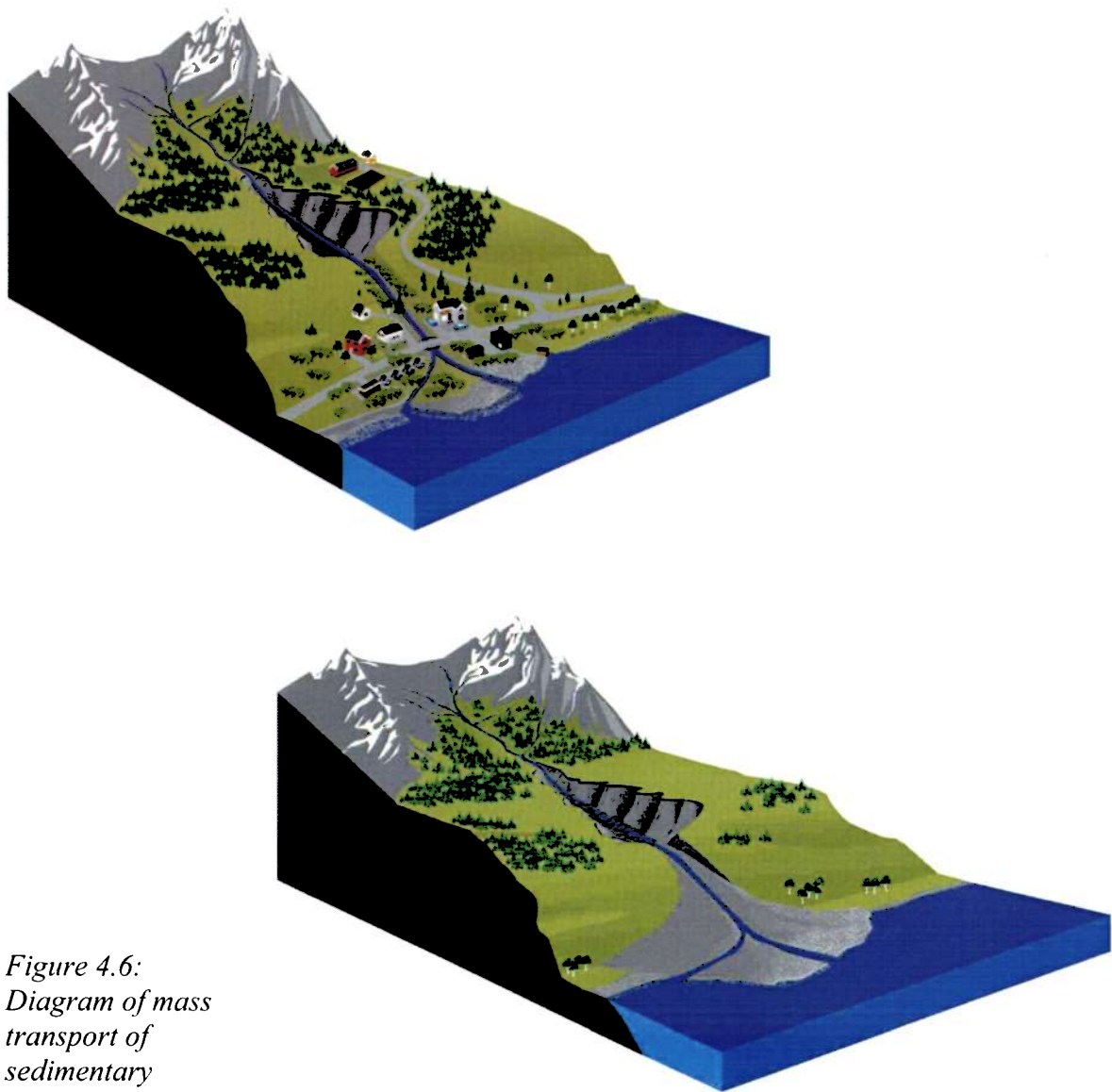
Temporary or transportable constructions for human habitation, such as caravans, must also be evaluated with regard to § 68 of the Planning and Building Act and the safety levels of the guidelines. In such cases the specific hazards must be evaluated. Camping sites are very typical areas of use for areas close to rivers and are thus liable to be flooded. There is every reason to draw attention to the location of buildings in which people spend the night. The hazards are particularly closely related to the fact that these are lightweight structures which thus provide poor protection to people inside them, combined with flood episodes that are capable of developing rapidly in the course of a few hours of heavy rain. Caravans can easily be carried off by floodwaters. A related point is that transportable structures that are taken by floodwaters may be trapped by bridges, etc., thus putting other people in danger.

As a point of departure, the hazard should be estimated in terms of safety class F2 and the evaluation of hazard zones. In low-hazard areas camping sites may be established, as long as buildings which people may occupy have a satisfactory degree of protection.

4.3 *Debris flows*

High velocities in flood waters produce conditions in which severe erosion can take place, resulting in collapse of the riverbank and the transport of large amounts of material by the river. A flood event in which extremely large quantities of sediments are carried down a steep river is known as a debris flow. Where the slope flattens out or where such a river enters a larger river system, an alluvial fan is formed; see Figure 4.5. During a flood material will be deposited on the upper part of the fan, where the slope changes or the valley bed widens. This in turn means that the river will burst its banks, and erode and deposit material at other sites than within the river itself. As a point of departure all parts of the fan should be regarded as a potential hazard zone. It is particularly important to be cautious about areas in the uppermost part of the delta, where the course taken by the river is particularly unstable and the force of the water is great. The forces gradually diminish further down the fan, but both the water and the sediment mass are capable of causing significant material damage; see illustration

below. Special study procedures for debris flows have not been drawn up, and we refer readers to the procedures for floods described in chapter 4.2.



*Figure 4.6:
Diagram of mass
transport of
sedimentary
material by a debris
flow*



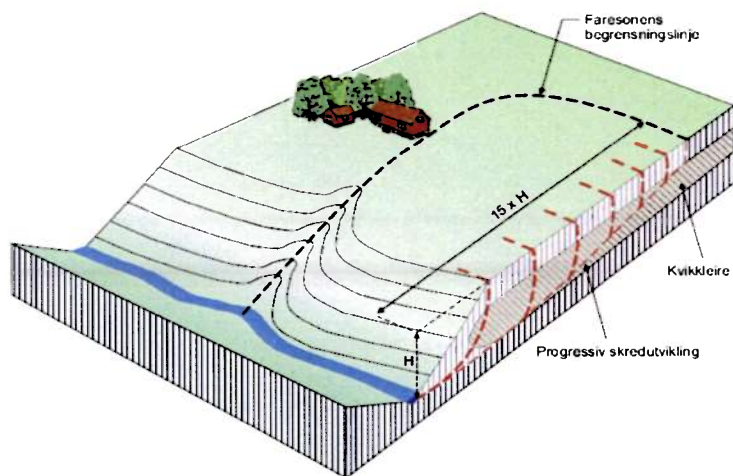
Figure 4.7: Debris flow in Eikesdalen, Nesset Municipality in Møre og Romsdal, August 2003

4.4 Quick-clay slides

Quick-clay slides are triggered by two causes:

- Natural processes such as erosion and precipitation
- Human interventions such as ground loads and excavations.

Quick-clay slides often happen rapidly and without warning, and they can be quite fair-sized in extension. Evacuation can be difficult. Slides of this sort therefore involve the risk of loss of human life and of serious material damage. Quick-clay slides can have such catastrophic consequences because the clay loses its strength and liquifies into a soup-like consistency. Depending on the conditions involved, quick-clay slides may move for distance of several kilometres.



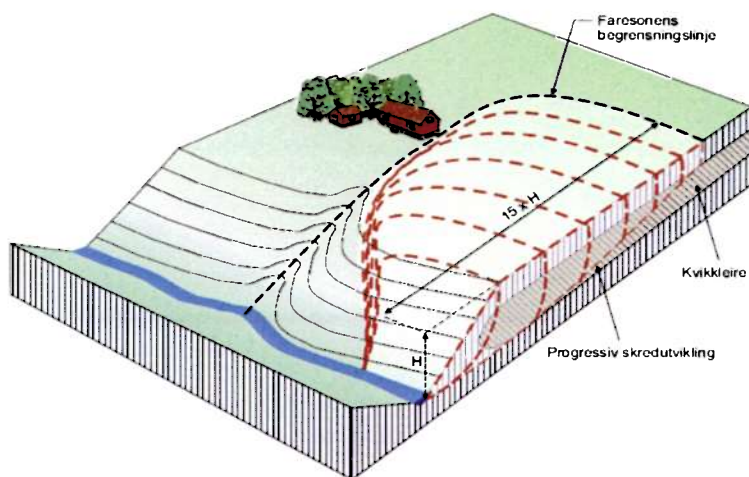


Figure 4.8: Development of quick-clay slide

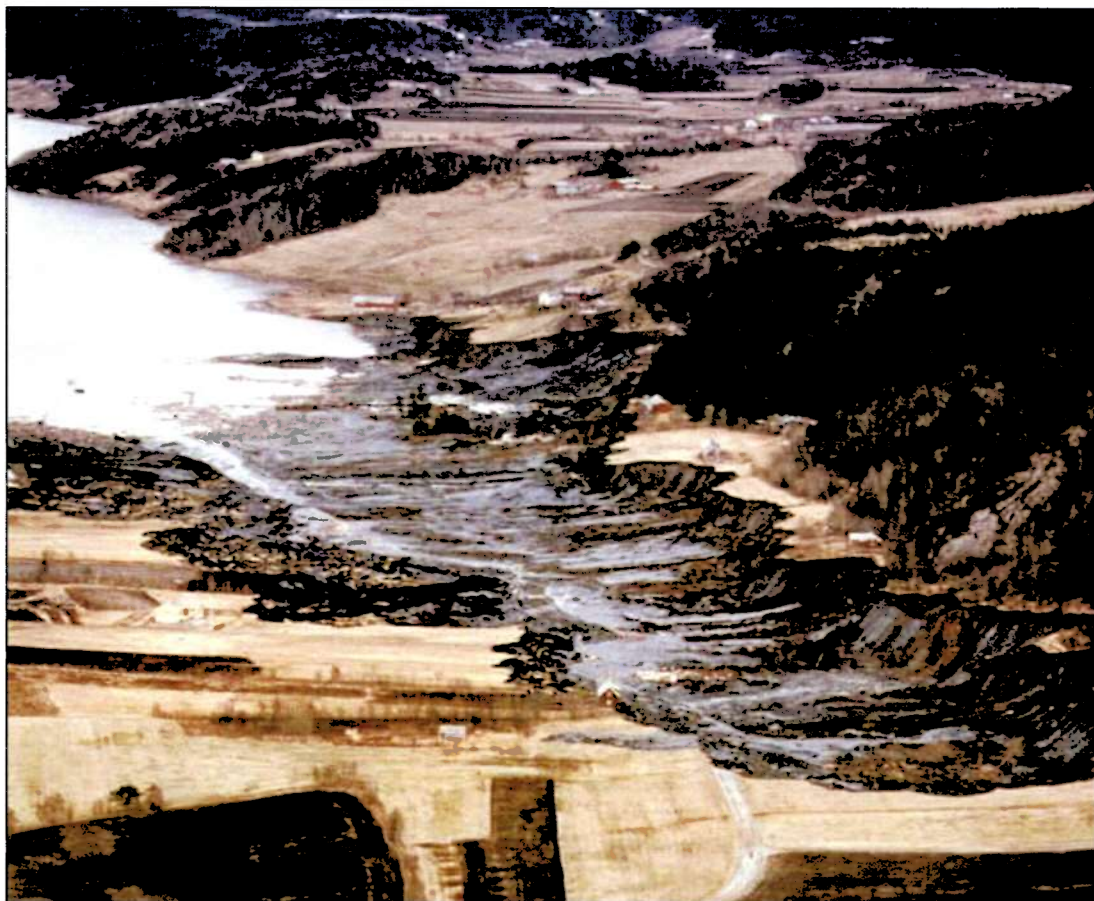


Figure 4.9: The quick-clay slide in the River Rissa on April 29, 1978 was triggered by excavation materials that had been deposited at the edge of Lake Botnen. (Photo: Aftenposten)

4.5 Assessing the risk of quick-clay slides

The following paragraphs describe a stepwise procedure for mapping hazards in connection with land-use planning and in order to ensure that safety levels are adequate when building applications are being processed. The procedure aims to ensure that important problems such as potential landslides, questions of stability and the need for protective measures are identified at an early stage in the planning process. The procedure indicates which problems should be identified at the various planning levels.

Qualified experts, i.e. geotechnical consultants, are expected to carry out such assessments.

4.5.1 Municipal plan

The following question should be answered: Are there potential landslide areas that affect other areas that have been developed, or for which there exist development plans?

The objective of an assessment at this level of planning is to identify whether an area is liable to suffer landslides or be affected by landslide deposits from a potential slide that has been released outside of the planning area. Potential hazard zones should be marked in the municipal plan or on thematic maps attached to the municipal plan.

Quick clay in the municipal plan			
Stepwise approach			Remarks/references
1	Hazard mapped	Yes	If a hazard-zone map has been drawn up, go to point 5. Maps are available for eastern Norway and the Trøndelag Counties showing the locations of major hazard zones, classified by degree of hazard, consequences and risk; see www.skrednett.no
	No		
2	Is there marine clay in the area?	No	Underlying information material: quaternary geological map, location of marine boundary, existing ground investigation. If no: the area is not at risk of quick-clay slides. For marine areas below the marine boundary, the danger of a slides occurring must be evaluated. This will involve one or more of the following activities: <ul style="list-style-type: none">• Checking the occurrence of marine clay with the aid of maps of the quaternary geology and maps of the marine boundary (MG)

			<ul style="list-style-type: none"> • Study of previous landslide events. • Comparison of data with currently available geotechnical surveys. • Study of topographic conditions.
	Yes		
3	Are ground conditions such that there is a danger of slides?	No	<p>Evaluate contour differences in elevation and ground slopes.</p> <p>If no: area OK</p>
	Yes		
4.	Evaluation of hazard		The hazard evaluation (probability) is a systematic survey of the relevant parameters. If the assessment indicates that the risk of a landslide cannot be excluded, a hazard evaluation must be carried out, and a programme for any necessary studies at zoning plan level must be drawn up. The process is described in more detail in the Technical Guidelines.
5	Potentially hazardous area is marked in municipal plan.		Regulations and guidelines are drawn up for the areas concerned, in order to take into account the requirements of the zoning plan etc. (for building areas/low-density building in LNF areas) and requirements regarding further investigations. See proposal in section 4.6.

4.5.2 Zoning plan

At this planning level an answer should be provided to the following question: Is there a real danger of slides, that affects the planning area?

The objective of the assessment at zoning plan level is to determine whether there is a real danger of slides occurring within the planning area or a real danger that the planning area could be affected by deposits from slides released outwith the planning area.

If the possibility of landslide risk has not been evaluated at municipal planning level, an evaluation of potential hazard area must be carried out; see points 1 – 5 above.

Alternatively we can go directly to an evaluation of the degree of risk because it appears to be clear that there may be a conflict between the current planning objectives and the potential risk of slides.

Before the zoning plan is made available for public inspection, it is recommended that it should be documented that the following have been carried out:

	Quick-clay in the zoning plan		Assumes that step 1-5 in the municipal plan have been carried out, or if not, that they will be carried out in the course of the zoning plan process.
	Stepwise approach		Observations/references
6	Does the measure require further studies of hazards?	No	If no: Area OK – go to points 10 and 11
	Yes		
7	The necessary supplementary ground studies are carried out.		Provides underlying data for mapping the presence and distribution of sensitive or quick- clays, and for analysis of stability.
8	Do the ground studies show that there is sensitive or quick –clay in the area, and that such clays lie in locations that lands-slides could occur.	No	If no: Area OK
	Yes		
9	Stability analyses are carried out for relevant types of slide for the situation before and after the planned development is carried out.		Requirements regarding analytical methods and the determination of strength parameters are set out in the Technical Guidelines.
10	Zoning objectives with regulations and guidelines are drawn up.		See section 4.6. The hazard zone is re-evaluated on the basis of planned protective measures and the safety requirements set out in these guidelines. Such protective measures as are required should be implemented before development, in accordance with work sequencing regulations. Requirements regarding assessments at zoning plan level will depend on the safety class of the project and the hazard class of the zone; see table T3.
11	Stability improvement measures are designed and planned		Any protective measures outside the development area itself are identified, planned and costed. Such measures should be evaluated with respect to their impact on nature and the environment and their hydrological consequences (e.g. possible requirement for permit in accordance with the Water Resources Act.

Safety classes and hazard classes

Table T3 lists the security assessments that should be carried out at zoning plan level in order to satisfy the requirement regarding assessing the security of the area with respect to landslides. As the table makes clear, the demands will depend on the use of the area (safety classes K1 – K3) and the hazard class of the area to be developed (low, medium or high).

Safety class Description of structure	Hazard class before development		
	Low	Middle	High
K1: Small uninhabited structures. No significant effect on ground stability.	Guidelines, ref. no 3	Guidelines, ref. no 3	Risk assessment Stability analysis a) estimate γ_M or b) no deterioration External control
K2: Uninhabited small structures. Capable of affecting ground stability	Risk assessment Stability analysis a) estimate γ_M or b) no deterioration External control	Risk assessment Stability analysis a) estimate γ_M or b) improvement External control	Risk assessment Stability analysis a) estimate γ_M or b) improvement External control
K3: Structures with human occupation. Important social functions: Housing, schools, institutions, industrial buildings, E-routes and national highways, railway lines, water and sewage plants, central power grids, etc.	Risk assessment Stability analysis a) estimate γ_M or b) improvement External control	Risk assessment Stability analysis a) estimate γ_M or b) significant improvement External control	Risk assessment Stability analysis a) estimate γ_M or b) significant improvement External control

Table T3: Safety assessment requirements for structures in areas at risk of quick-clay slides.

Explanation of Table T3

The simplest form of safety evaluation consists of using the “Guidelines for minor encroachments in or near quick-clay slopes” (NGI 2005). The guidelines are used in the case of small structures (safety class K1) in areas of low or middle hazard classes and do not require the assistance of a geotechnical consultant.

In all other cases a hazard degree evaluation, stability analyses and external control of geotechnical planning must be performed.

The hazard degree evaluation should be performed when changes have been made in the extent of the zone and for the situation during and after the implementation of the measure (structure).

The stability analyses may be carried out in either of two ways; by estimating a material factor, γ_M , or by estimating a relative percentage improvement in security by altering the topography of the area. The relative improvement is divided into three levels, no improvement, improvement and significant improvement. The absolute values of γ_M and the percentage improvement are evaluated by geotechnical planners in each individual case. "Guidelines regarding stability assessments of natural slopes in quick-clay" NGI 2006, provides recommended minimum values.

Geotechnical consulting services are subject to external control, in accordance with NS 3480.

4.5.3 Case-handling of building applications

Hazards, whether of flood or landslide, which have not been studied or taken into account in connection with the municipal plan or the zoning plan, must be evaluated in the process of processing the building application itself.

The one of the three questions in the application form that concerns § 68 of the Planning and Building Act deals with just these hazards. The documentation that is submitted together with the application or is later submitted by the responsible contractor/applicant should conclude by stating that the safety requirements have been met; see application form, NBR form 5175 and ByggSøks electronic form.

This documentation must have been submitted before a building permit can be issued.

Where there is a quick-clay problem, any stability improvement measures outwith the building plot itself must have been implemented before the commencement of building or construction on the plot.

4.6 General advice concerning the regulations/guidelines

The municipal master plan and municipal partial plans

- The text part of the plan must cover flood, erosion, landslide and ice-movement risks, and how these are dealt with by the plan.
- For building areas a zoning plan may be required; see §20-4, second paragraph, letter a, of the Planning and Building Act, which states that the plan must be well provided with documentation about safe building ground. Similarly, a building plan may be required for areas within LNF areas with low-density building and commercial/industrial building not connected with location-dependent commercial activity, and for leisure-related building; see same regulation, letter c.
- Areas at risk may also be marked on the map as a form of guidance without legal force; for example flood-prone areas in LNF may be marked as such. Such information can be useful, for example when applications for exemptions are being dealt with.
- Localisation requirements in building areas and LNF areas with low-density building may be set out, in order to avoid the problems of developing flood-prone or landslide-prone areas; see §20-4, second paragraph, letter b, final point and letter c, of the Planning and Building Act. Such localisation requirements may be followed up by more detailed mapping or surveys in order to delimit the areas at risk of flooding or landslides. Regulations may be drawn up for risk-exposed building areas and LNF areas with low-density building, setting out limits on ground level for buildings (indicate contour line) that take into account for example flood risk, and/or set out special requirements regarding the technical design and use of the building; for example that houses may not have cellars, or that a cellar must be capable of withstanding flooding; see §20-4, second paragraph, letter b, of the Planning and Building Act.
- For areas set aside for development it may be required that development should take place in a particular sequence, and that development within such areas must not take place before the technical infrastructure, etc. is in place. Such requirements might, for example, refer to protective measures.
- In areas that border on areas for special use or protection of marine areas and rivers, regulations may be issued that prohibit particular types of building and construction activities (§20-4, second paragraph, letter f, of the Planning and Building Act), for example in order to conserve vegetation or to prevent erosion and earthslips.
- NVE's guidelines for planning and development in risk-prone areas in the vicinity of rivers will also cover agricultural buildings with defined safety requirements for various types of building, primarily by requiring that building may only take place on areas that are regarded as being safe. Agricultural structures are also covered by §§ 68 and 70 of the Planning and Building Act and by §20-4, second paragraph, letter f of the same Act.

List of examples of regulations and guidelines that may be utilised.

1. §20-4, second paragraph, letter a, of the Planning and Building Act): Areas in which structures according to § 93 a), h), c), i) and j) (building, division, change of use, significant encroachments on the terrain and road works) are not permitted until the area has been incorporated in a zoning plan.
2. Hazard areas may be utilised as a sub-objective in the municipal plan; see §25 of the Planning and Building Act.
3. Around Lake X, new buildings are not permitted if parts of the structure lie below contour Y m.a.s.l.; see estimated 200-year flood + safety margin according to the flood-zone map and profile number entered in the planning map. The minimum level in the interzones is calculated as the slope between these heights.
4. §20-4, second paragraph, letter f of the Planning and Building Act: in areas bordering rivers up to 100 m from the shoreline, measured in the horizontal plane at mean flow level, it is forbidden to begin the erection of permanent, transportable or temporary structures. Guidelines: Particular caution should be shown with respect to building on gravel deposits also beyond the 100 metre belt near River Z, because of the risk of slips or erosion during extreme floods.
5. §20-4, second paragraph, letters b and c of the Planning and Building Act: For building areas at potential risk of flooding or landslides (to be specified) expert documentation regarding safe building ground must be submitted, and this must be in accordance with the height contours mentioned in the regulations with guidelines.
6. Documentation should be drawn up at the same time as the planning proposal. It may not be postponed until the presentation of the building plan.
7. In agricultural, natural and leisure areas, low-density housing and commercial/industrial building may be permitted also for non-agricultural purposes. A building plan must be drawn up for groups of more than three buildings closer than 100 m from each other; see §20-4, second paragraph, letter c of the Planning and Building Act. Before development commences, an expert evaluation of the building ground in the individual building plot must be provided. Building must not be erected in areas that are at risk of flooding or slides.

Special conditions regarding flood protection measures

8. Below the level of floods with a 100-year rate of recurrence, buildings with cellars or insulated construction should not be raised.
9. Behind flood barriers, the contour level of the floor of the ground floor should not be lower than the 20-year flood level.
10. Large public and commercial/industrial buildings, as well as infrastructure of particular importance to society, should not be raised below the level of floods with a recurrence rate of 1000 years.

General remarks regarding regulations for zoning and building plans:

- Areas at risk of inundation, erosion/earthslips, mass deposits, ice-movement damage, etc. may be designated as hazard areas (§25, no. 5 of the Planning and Building Act). This means that all building is forbidden, or will only be permitted under special conditions that will mitigate the hazard. Such areas may be combined with other objectives, such as leisure area, agricultural area, camp-site, protective belt, nature conservation area, free area, parking site, etc; see circular T-5/97 from the Ministry of Local Government and Regional Development and the Ministry of Environment "Land use Planning and Development in Hazard Zones" and "Plan and Map according to the Planning and Building Act", from the Ministry of Environment, electronic edition, 2006.
- Work sequencing regulations: Conditions may be attached to risk-prone areas (§26 of the Planning and Building Act). For example, conditions regarding protective measures before building commences in building areas. In such cases the measures must be entered in the map and be described in the detailed regulations.
 - Guidelines: requirements regarding surveys that provide evidence of sufficiently safe building ground must be presented before the zoning plan is approved.

General remarks regarding case-handling of building applications

- If the municipality consider the application not to provide sufficient documentation of safe building ground, the municipality has to ask for this, or return the application attached a message of what is required.
- §68, second paragraph of the Planning and Building Act permits the local authority to impose conditions for building or division of an area which is initially subject to the prohibition in the first paragraph of this section of the Act. The conditions set must have a direct connection with the risk in question.
- Development may take place on condition that specified technical solutions are implemented; for example, that in areas at risk of being inundated a lowest contour level for permitted floor level (m.a.s.l.) is set, in order to take the possibility of flooding into account. Another condition might be to require the developer to evaluate and document protective measures in more detail, for example by implementing protective measures in order to raise safety to a satisfactory level. Documentation regarding such protective measures must in any case be sent to the local authority.

5. Concepts and definitions

Area at risk of flooding:

Collective term for areas exposed to risks directly or indirectly due to flooding. Such risks include inundation, erosion, movement and deposit of material mass, debris flows, ice in movement and damming up/blocking.

Environment Impact Assessment (EIA):

Has the objective of identifying the effects of a plan or measure that could have important consequences for life, health, the environment, natural resources or other aspect of society. An EIA should ensure that the impact of a plan or measure on the above-mentioned aspects are taken into consideration during the planning process. Risk and vulnerability analyses are integral parts of an EIA.

Flood:

Discharge greater than mean flow rate (average of the greatest flow rate every year during the period of observations).

Flood protection measures:

All physical measures employed to protect values against damage caused by flooding, erosion or ice movement. Such measure can be roughly divided into the following: erosion protection, embankments or land-fills, mass storage basins, lowering of river bed and correction of river courses (straightenings) and embankments against debris flows or ice movements.

LNF

Agricultural, natural and recreational areas.

MG

Marine boundary.

Risk:

the danger represented by undesirable events to human beings, the environment or material values. Often expressed in the form of the probability and consequences of such undesirable events.

Risk and vulnerability analysis (RVA):

This can be understood as a collective term for a number of systematic approaches to identifying, describing and/or estimating risk and vulnerability. A number of methods have been developed for such purposes and areas of application within this general definition; e.g. Rough analysis.

RVA:

Rough analysis: survey of risk and vulnerability at overview level, with associated wide-meshed assessments. The rough analysis provides guidelines for how any further studies should be carried out.

Detailed analysis: Thorough analysis of one or a few topics in order to evaluate the probability and/or consequences of a given undesirable event occurring; e.g. geotechnical studies. Utilised in case of need for more details.

Risk analysis:

“Risk” is an expression of the danger that undesirable events represent for human beings, the environment, economic values or socially important functions. Risk is a result of the probability (degree of hazard) and the consequences of an undesirable event. NVE’s Programme for improved clay-slide protection has developed a qualitative method for risk analysis of areas at risk of quick-clay slides (ref. 1).

Risk-prone area:

The area of influence of likely events in rivers.

Sensitivity:

Relationship between the undrained shear strengths of undisturbed and agitated material.

Sensitivity < 8 is defined as low, $8 - 30$ as medium and > 30 as high.

Sensitive clay:

A clay that displays a high degree of brittle fracture behaviour. Clays of this type may have sensitivities $> 12 - 15$ and a low agitated strength. They do not necessarily meet the definition of quick-clays.

Security of society:

The ability of society to maintain important social functions and to secure the lives, health and basic needs of its citizens under various types of stress. The concept is used in its widest sense and embraces protection against the whole spectrum of challenges from limited natural occurrences via major crises that represent large-scale hazards to life, health, the environment and material values to challenges to security that threaten the independence or existence of the nation.

Quick-clay:

Any clay that liquifies when agitated, i.e. its agitated strength $< 0.5 \text{ kN/m}^2$

Quick-clays are marine clays from which the salt in the pore-water has gradually leached out. The salt in the pore-water acts as a binder in the clay. When the salt disappears the clay becomes quick, i.e. it liquifies when agitated, when it is overloaded or starts to move.

Quick-clay zone:

A potential landslide area of quick or sensitive clay or silt. Such zones often descend to rivers. A zone indicates the maximum extent of a slide.

Quick-clay slide:

A slide in a quick or sensitive deposit of clay or silt. Slides in quick or sensitive clays differ from slides in other types of deposit in that they may extend very widely and that they take place very rapidly and without warning.

Vulnerability:

The ability of a system of function and achieve its aims when it is exposed to stress;
e.g. the vulnerability of persons and structures to physical stresses.

References:

“Zone plan/building plan”. Guidelines. Ministry of Environment, Revised edition 2001.

“Land use partial plan of the municipal plan”. Guidelines. Ministry of Environment, Revised edition, 2001

“Evaluation of landslide risk. Method for classification of hazard zones in quick-clay. Report 20001008-2, Revision no. 2, December 16, 2002

“Guidelines for minor encroachments in or near quick-clay slopes”. NGI 2005.

“Guidelines regarding stability assessments of natural slopes in quick-clay”. NGI 2006.

“Recommended requirements for geotechnical planning and design in the development of areas exposed to the risk of quick-clay slides”. NVE, 2006.

