Water protection areas

Handbook 2003:6 with general guidelines

Foreword

This handbook, complete with accompanying general guidelines for water protection areas (NFS 2003:16), is primarily intended as a guide for Sweden's county administrative boards and municipalities in their work with establishing water protection areas for surface water and groundwater bodies (= sources/supplies/wells) pursuant to Chapter 7 of the Swedish Environmental Code. It relates to both surface and groundwater bodies that are or can be used for drinking water supply.

It can also be used by those responsible for municipal or other water supply and consultants when drafting proposals for water protection areas and accompanying rules and regulations.

The handbook is primarily intended for use with water bodies which, in accordance with the European Water Framework Directive (2000/60/EC, Article 6), provide more than 10 m^3 per day as an average or serve more than fifty people, or are intended for such future use.

The handbook provides guidance on how to demarcate (= delineate) water protection areas and divide them into protection zones as well as on how to design rules and regulations. It also gives guidance on how the responsible body, applicant, county administrative board (CAB) or municipality should handle water protection area applications. The handbook can also be used when modifying existing water protection areas and also provides a basis for spatial planning.

It does not cover all the issues that may emerge in connection with the setting-up of a water protection area. The handbook may be supplemented once the Swedish Environmental Protection Agency has gained more experience in applying the provisions governing water protection areas.

This handbook and accompanying general guidelines relating to the provisions governing water protection areas and replaces the Swedish Environmental Protection Agency's earlier publications 1971:4 "Skydd av vattentäkter (Protecting water bodies)" and general guidelines 90:15 "Grundvattentäkter, skyddsområden - skyddsföreskrifter (Groundwater bodies, protection areas - protection regulations)".

The handbook and general guidelines have been produced by the Swedish Environmental Protection Agency. The Geological Survey of Sweden (SGU), the Swedish Meteorological and Hydrological Institute (SMHI), the county administrative boards of Västra Götaland, Örebro and Stockholm, as well as Sundsvall Vatten and SWECO VIAK in Göteborg have participated in some of the work.

Stockholm, September 2003.

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1. Water protection and water protection areas - purpose and statutory provisions

1.1 The purpose of water protection areas

> **Excerpt from the general guidelines to Chapter 7, Section 21 of the Swedish Environmental Code**
> County administrative boards and municipalities should promote the establishment of water protection areas at least for all public water supplies and larger private wells of their own or which they share with others. Groundwater and surface water resources, which will presumably be used for water abstraction at a later date, should also be protected.

Access to water for water supply is one of our most important natural resources. Careful utilization and protection against activities and measures that may have a negative effect on the quality and quantity of the water are consequently required. The water body also constitutes a vulnerable component of a safe water supply chain. The purpose of water protection areas is to provide water bodies that are important for our drinking water supply with sufficient protection so that raw water resources are safeguarded in a long-term perspective - a multi-generational perspective. Very high priority should be allocated to the protection of important raw water resources in order to achieve this purpose.

Protection should be given against both occasional and continuous anthropogenic pollution which can be either diffuse or emanate from point sources. Pollution may be caused by any substance that can have a negative effect on the water body as a source of drinking water supply. Water bodies also need to be protected against land use that may have a negative effect on water quality in the long term and in a worst-case scenario can cause irreversible damage. An important stage in such protection can be achieved by the county administrative board (CAB) or municipality establishing a protection area for a water body and designing protection regulations for it. These rules can be seen as a complement to regulations that already apply to the area and shall ensure achievement of the purpose of the water protection area.

Regulations for water protection areas enable the water protection aims of EU and Swedish legislation to be achieved insofar as they regulate high-risk activities and measures so that the water can be used for its intended purpose both now and in the future.

Declaring an area a water protection area and designing regulations for it:

- strengthens the protection of the drinking water body,
- clarifies the importance of the water body and the supply,
- clarifies the water body's importance from a spatial planning perspective and
- clarifies what is applicable to operators and others in the area, based on the Environmental Code, to ensure adequate protection of the water body.

1.2 The legislation

The provisions of the Environmental Code

The general rules of consideration laid down in Chapter 2 of the Environmental Code stipulate a number of principles that apply in general to all activities or measures that may cause damage or detriment to public health, humans or the environment. The type and scope of the activity and where it is pursued then determine what restrictions will be put on the operator in order to fulfil these principles. The general rules of consideration are based on the "precautionary principle". According to the preparatory work prior to the enactment of the Environmental Code (Government Bill 1997/98:45, part 1, p. 208), its purpose is to prevent not only predictable but also possible damage and detriment. The risk of damage to human health and the environment shall already be considered. The obligation to prevent and limit damage to human health and the environment comes into play as soon as there is a likelihood that the measure or activity might contravene the Code's objectives. If there is a lack of knowledge as to the link between the activity and the detriment, but there is still cause to assume that such a link exists, the lack of evidence of a causal link should not release the operator from the obligation to implement the measures that can reasonably be required (p. 210).

The principle has a bearing on water protection areas as regards the authorities' design of the protection area and the wording and application of the regulations as well as regarding the demands that may be put on an operator pursuant to the general rules of consideration. On the other hand, the principle must not result in inadequate surveys being carried out when establishing protection areas for water supplies and far too large a water protection area being established just to be on the safe side. If, however, an adequately extensive survey has been carried out, but the authority is still unsure whether a sufficient level of protection has been achieved, a larger area should indeed be established.

A land or water area may be designated a water protection area by a county administrative board or a municipality for the purpose of protecting surface water or groundwater supplies that are, or are likely to be, used for water abstraction (Chapter 7, Section 21 of the Environmental Code). Surface water or groundwater supplies should include groundwater reservoirs, lakes or other water area or parts thereof.

The regulations for water protection areas specify not only what is required in accordance with the general rules of consideration but also the additional restrictions on the disposal of the property that are needed to achieve the aim of the water protection area and national, regional and local environmental quality objectives, environmental quality

standards as well as the quality and quantity requirements placed on raw water. What already applies to the area in question pursuant to other provisions can be communicated via references and in “information” outside the regulations,

> **Excerpt from the general guidelines to Chapter 7, Section 25 of the Swedish Environmental Code:**
> When assessing how far a restriction of a person's rights may extend in order to satisfy the purpose of a water protection area, the fact that the purpose can normally only be achieved by implementing high protection levels and far-reaching restrictions should be taken into account.

Under Chapter 7, Section 22 of the Environmental Code, the municipality or county administrative board shall issue rules for water protection areas imposing any restrictions on the right to dispose of properties in the area that may be necessary in order to fulfil the purpose of the area. The Code specifies no special requirements for what is to apply within such an area. These are instead to be established by the county administrative board or municipality in the regulations.

Reserve water supplies (= bodies), potential drinking water supplies or alternative abstraction points need to be protected in the same way as ordinary supplies. They therefore need to have a water protection area and have adequate protection regulations. Restrictions on potential raw water supplies set aside for future use can be revised prior to them being utilized and therefore need not be so extensive to start with. They do need to be immediately protected against activities that may cause irreversible damage, however.

A water protection regulation only formally applies within the water protection area itself. An operator outside the protection area is, however, also obliged to take the area into consideration when performing his activity (cf Government Bill 1997/98:45 part 1, p. 214). This applies if the activity in question may have harmful effects on the groundwater or surface water in the area to be protected.

The county administrative board shall keep a register of decisions, including those on water protection areas, in accordance with Chapter 7 of the Environmental Code (Section 33 Area Protection Ordinance (1998:1252)). The Swedish EPA shall keep a comprehensive national register of such decisions. Decisions on water protection areas shall therefore, in accordance with Section 28, be sent from the county administrative board/municipality to the Swedish EPA. Further information on registers can be found in Chapter 10 “Further information”.

Municipal regulations

Regulations for the protection of surface water bodies and individual groundwater wells may also be issued pursuant to Section 40, Point 5 in the Ordinance (1998:899) concerning Environmentally Hazardous Activities and the Protection of Public Health. Under the Ordinance, a municipality may issue such regulations if it is necessary to prevent damage or detriment to human health within its boundaries. The regulations must be promulgated in the county’s code of statutes. The municipality decides whether regulations are necessary and drafts a basis for them.

Such municipal regulations must not involve unnecessary coercion of the public or any other unjustified restriction of individual freedom (Chapter 9, Section 13 of the Environmental Code). These do not form a basis for compensation which may, however, be the case with any restrictions stipulated in water protection regulations in accordance with Chapter 7, Section 22 of the Code. Furthermore, regulations stipulated pursuant to Section 4 of the Ordinance concerning Environmentally Hazardous Activities and the Protection of Human Health cannot circumscribe decisions on permits for various activities as stipulated under the Code (See Chapter 24, Section 1) as is the case with regulations under Chapter 7, Section 22. For example, an agricultural enterprise that has a permit under the Ordinance (1998:899) concerning Environmentally Hazardous Activities and the Protection of Human Health need not adhere to a municipal regulation issued pursuant to Section 40 of the same ordinance if the regulation circumscribes the permit.

The Swedish Association of Local Authorities has issued a basis for “Local regulations to protect human health and the environment” to aid the design of local regulations. This document gives examples of how different local regulations can be worded. For more information, please see Chapter. 5.

Other rules and regulations that may apply to a water protection area

Different types of regulations may already apply to an area that has been designated a water protection area. The Swedish EPA’s regulations on protection against land and water pollution when storing inflammable liquids (NFS 200:4) are a case in point. These regulations stipulate requirements for secondary protection for tank containers inside water protection areas. The authority and responsible body must be aware of what already applies to the water protection area in accordance with other provisions. Regulations for the water protection area can then be drawn up as a complement to these, thereby avoiding duplicate regulations and imprecision. For more information on the wording of regulations, please see Chapter 4.

Permit requirement for water abstraction

Water abstraction from a water body, which refers to the removal of surface or groundwater or artificial groundwater recharge, constitutes a water operation and as such requires a permit in accordance with Chapter 11, Section 9 of the Environmental Code. Under Chapter 11, a permit is not needed for water abstraction for one- or two-family properties or for domestic use or heat supply on agricultural properties (Section 11). Neither is a permit needed where public or private interests are manifestly not harmed by the impact of the water abstraction or the artificial recharge on water conditions (Section 12). Anyone wishing to conduct water operations may apply for a permit even where a permit is not required for such operations (Section 9). Applications are considered by the environmental court.

Even if a permit is not required pursuant to Chapter 11 of the Code, a municipality may prescribe that a permit must nevertheless be obtained or prior notification submitted before a new groundwater well is established and used in an area where there is a scarcity of fresh groundwater or a risk of scarcity in the future. The municipality may also require

notification to be submitted for existing wells in such areas (Chapter 9, Section 10 of the Environmental Code).

The Swedish Planning and Building Act

Under Chapter 8 Section 6 of the Swedish Planning and Building Act (PBL 1987:10), the municipality may, if there are special reasons, decide that a building permit is required to set up or substantial alter structures for groundwater collection referred to in Chapter 11, Section 11, paragraph 1 of the Environmental Code (water wells for one- or two-family properties or for domestic use on agricultural properties). Such provisions shall be contained in a detailed development plan or area regulations.

The European Water Framework Directive

Environmental objectives for surface waters and groundwaters are laid down in the European Water Framework Directive (WFD) of 23 October 2000, which came into force on 22 December of the same year. The Directive provides the foundation for a common regulatory framework within the EU for the protection of inland water, coastal water and groundwater. The Directive is not directly applicable to an operator other than as a basis for interpretation of Swedish provisions. The Directive is currently being incorporated into Swedish legislation.

The WFD offers new tools for more efficient and more sustainable water management and will lead to changes in how we currently deal with water issues in Sweden. The most important change is that work shall now be organized by river basin district, i.e. natural borders for the flow of water. This involves taking a holistic perspective of both protection and use of our water resources. As far as water protection is concerned, administrative borders will be less significant.

Under the Framework Directive, each river basin district shall establish binding programmes of measures no later than 2009. These programmes shall stipulate how the environmental objectives shall be achieved in order to safeguard the required protection for e.g. drinking water bodies. For protected areas, e.g. water protection areas, the programme of measures shall comply with any standards and objectives by 2015 at the latest. All groundwater bodies serving more than 50 persons or from which more than 10 m^3 per day are abstracted shall achieve good status by 2015. This involves compliance with environmental quality provisions and no further deterioration caused by the impact of human activity.

Under the Directive, registers are to be established of all areas lying within each river basin district which have been designated as requiring special protection. All bodies of water used for the abstraction of water intended for human consumption providing more than 10 m^3 a day as an average or serving more than 50 persons shall be included in the register. The register shall also include bodies of water intended for such future use. Member States shall ensure the necessary protection (Article 7) for the bodies of water identified with the aim of avoiding deterioration in their quality. Member States may establish safeguard zones for those bodies of water. It is the Swedish EPA’s assessment that the establishment of water protection areas is in compliance with the Framework

Directive's programme of measures and what is stipulated in the Directive concerning safeguard zones.

1.3 National environmental objectives

The Swedish Parliament, the Riksdag, adopted "Swedish environmental objectives - interim targets and action strategies" in Government Bill 2000/01:130. The bill refers to the following interim targets regarding water supply:

- By 2009, water supply plans, including water protection areas and protective provisions, will have been adopted for all public and larger private surface water supplies. Larger surface water wells/supplies refer to surface waters used to supply more than 50 persons or distribute more than 10 m^3 per day as an average (Environmental Objective: Flourishing Lakes and Streams).
- By 2010, long-term protection against development activities that restrict water use will be provided for water-bearing geological formations of importance in meeting present and future water supply needs (Good-Quality Groundwater).
- By 2010 the use of land and water will not cause changes in groundwater levels that adversely affect the water supply. (Good-Quality Groundwater).
- By 2010 all bodies of water used for the abstraction of water intended for human consumption, and providing more than 10 m^3 a day as an average or serving more than 50 persons, will meet the Swedish standards for good-quality drinking water with respect to anthropogenic pollution (Good-Quality Groundwater).
- Deposits of gravel that are valuable for the drinking water supply shall be preserved (Good Built Environment).

These national environmental objectives are benchmarks for environmental work without being directly legally binding for the authorities.

1.4 Protecting water in other ways than by establishing water protection areas

The Government's Environmental Objectives Bill (2000/01:130) stipulates that the establishment of water protection areas should be seen as one of several protection measures to guarantee a safe and sustainable water supply.

Apart from via the establishment of water protection areas, important drinking water bodies also need to be protected by the actions of other authorities, e.g. via municipal and regional spatial planning and supervision and permitting procedures.

The work with water protection areas is combined and supplemented with water protection efforts in several other areas, including the protection of other sites pursuant to

Chapter 7 of the Environmental Code and “Natura-2000 sites”, spatial planning, management plans for water districts, etc.

In the future, other forms of agreements with landowners can also be used to a greater extent to achieve water protection.

For more information, please see ANNEX 5 concerning further water protection measures

1.5 Dialogue between the authorities and landowners, rightholders and other citizens

To ensure that the work with water protection areas is successful, it is important to make it transparent, incorporate citizen dialogue and provide good information e.g. in connection with preliminary negotiations, referrals, announcements and other stages of the process where landowners, local residents, organizations, etc. can make their voices heard. Contacts should be open and respect be shown for the special interests of all stakeholders. Contact with landowners is particularly important, of course. For individual landowners, the regulations may involve substantial invasion of their ownership and disposition rights. The landowner should be consulted at an early stage to discuss how water protection can be achieved on his/her property. The entire process should be focused on finding solutions that lead to protection being achieved as far as possible in close collaboration with the landowner.

When the issue of establishing a water protection area arises, the following points need to be reviewed with the landowner and other stakeholders:

- *Information on water bodies and existing threats to them*
  Information on water supplies in the area that are in need of special protection measures is submitted to relevant landowners, property owners and other stakeholders, including the general public. The information should be straightforward, clear and preferably include maps. It is important to clarify the current and future risks/threats that warrant special protection measures. Is the threat critical? Is there a gradual change to the environment taking place? Is it more a question of a potential future threat?
- *Information on what is needed to achieve the desired purpose*
  This information should be based on an analysis of the factors (e.g. the local geology, water flows, etc.) that must be considered with respect to water protection. The information shall be adapted to the target group. Landowners normally need more detailed information than e.g. usufruct holders or the general public.
- *Compensation for intrusion, purchase price*
  Definitive compensation cannot be discussed with the landowner until there is a final proposal for demarcation of the water protection area and draft regulations. However, even if it is not possible to specify compensation amounts at an early stage, it is nevertheless of great interest to the landowner to be informed of the grounds on

which compensation for intrusion or, where appropriate, the purchase price (in the event of the state intending to acquire the area) is calculated. In this context, the landowner should also be informed of his/her right to legal representation at negotiations at the expense of the state or municipality.

2. Grounds for the establishment of a water protection area

2.1 General points of departure

Water bodies and water wells/supplies need to be protected against pollution caused by point emissions and diffuse sources and against sudden accidents.

Primary preventive protection that steers “hazardous” activities away from the water body’s vicinity is crucial. Furthermore, secondary protection in the form of natural barriers and/or various protection measures is needed to create respite before the pollution reaches the water intake.

Land and water areas that are not given effective, long-term protection or that are subject to activities or land use that may cause irreversible or prolonged damage, or where pollution could have major consequences, should not be used for water supply.

Protection of surface water and groundwater must often be coordinated. Many surface waters (even at high water) comprise groundwater that naturally runs into them. Surface waters can sometimes be naturally recharged to groundwater reservoirs but recharge of surface waters to groundwater reservoirs in connection with groundwater abstraction close to the surface water, known as “induced recharge”, is more common.

The need for protection should be assessed for both surface and groundwaters adjacent to water protection areas for both surface and groundwater bodies. A holistic approach must be taken as regards the protection of groundwater bodies/wells, where water abstraction affects groundwater reservoirs in soil and in bedrock.

Background data is required all along the chain (water body - value - vulnerability - consequences - **risks) in order to establish the need for protection.**

Background data produced when establishing water protection areas may also be of help in other contexts, e.g.:

- spatial planning
- drawing-up of management plans and action programmes for water districts,
- drawing-up of water conservation, emergency and remediation plans
- other area protection pursuant to Chapter 7 of the Environmental Code, and Natura-2000 sites.
- dispensations and permits pursuant to the protection regulations
- other permitting pursuant to the Environmental Code, e.g. water operations (Chapter 11) and hazardous activities (Chapter 9).

In addition to the protection that can be achieved by establishing a water protection area and accompanying regulations, other measures may also be needed, e.g. other regulation pursuant to the Environmental Code, water conservation and action programmes, warning systems, measures to cope with pollution from accidents (e.g. emergency- and remediation plans). Such preventive measures are not regulated within the framework of water protection areas and their accompanying regulations. The responsible body should however implement preventive measures and draw up emergency and remediation plans or update existing plans, in connection with the establishment of the water protection area. This work should be coordinated with the implementation of the European Water Framework Directive (and the yet-to-be adopted daughter groundwater directive). The framework directive specifies guidelines for how the water body should be analysed and supervised. Programmes of measures shall be formulated and implemented to achieve good water status.

Compensation demands should not affect the demarcation of the water protection area. Instead, demarcation should be based on current and future needs for protection, otherwise there is a risk of the required protection not being achieved.

2.2 Specific points of departure for different types of water bodies/supplies

2.2.1 Surface water

An important point of departure when demarcating water protection areas in lakes and watercourses is how to ensure detection of pollution and how to create respite for rescue initiatives so that water abstraction can be stopped before the pollution reaches the abstraction point.

It is important for preventive protection measures to be taken to reduce the likelihood of pollution-causing accidents, especially on high-risk sites where it is not possible to create respite for rescue initiatives, e.g. roads and railways on which dangerous goods are transported close to water supplies or other environmentally hazardous activities close to water bodies/supplies.

Warning and alarm systems can also be useful aids (technical barriers) to reduce the risks. Such systems should be seen as stop-gap solutions. The Göta River has an alarm system which notifies the constantly manned control room at one of Göteborg’s water treatment plants, where the water intake can be immediately closed off if pollution is detected.

Watercourses must also be protected against gradual pollution in their catchment areas in the same way as groundwater, see below.

When demarcating water protection areas for lakes, a strategy is required which considers both the high speeds of inflowing watercourses and the difficulties involved in remediating pollution that has already reached the lake.

2.2.2 Groundwater

The point of departure when demarcating water protection areas for groundwater is that the slow turnover in groundwater reservoirs and the major difficulties involved in remediating polluted groundwater require a strategy with a strong degree of preventive protection, which firstly involves not allowing potentially polluting activities and land use within the water protection area; secondly, detecting a pollution event in time and remediating the land before it reaches the groundwater; thirdly degrading, binding or diluting the pollution to acceptable levels, or being able to deal with it before it is transported in the groundwater to groundwater supplies/abstraction point.

2.2.3 Groundwater reservoirs with induced recharge

When groundwater is abstracted close to a lake or watercourse, where there is good communication between surface water and groundwater (e.g. when an esker has contact with the surface water), leakage may occur from the surface water to the groundwater reservoir, a process known as “induced recharge”. In such cases, the water protection area should also include the surface water. In some cases, induced recharge can also occur in rock-drilled wells.

2.2.4 Basin recharge

> **Excerpt from the general guidelines to Chapter 7, Section 21 of the Swedish Environmental Code:**
> A water protection area could also include a body of gravel or sand that is significant for the water supply and, as a result of its ability to clean or accommodate water, can be used for artificial groundwater recharge via surface water infiltration. An area for groundwater recharge could also be included.

A common method in Sweden is to increase natural groundwater recharge by pumping surface water to basins (e.g. on an esker) and then allowing the water to infiltrate and form groundwater, known as “basin recharge” (artificial groundwater recharge), see Hanson 2000.

For basin recharge, both the catchment areas of the surface water body and the catchment area of the groundwater reservoir should be included in the water protection area.

Groundwater recharge is primarily a method used to improve the quality of the groundwater. Groundwater is pumped from a well (raw water well), aired and recharged in basins on e.g. an esker, where iron, manganese and organic material are separated, primarily in the basin’s surface layer. Groundwater is then extracted from another well (pure water well). The method is widely applied in Sweden.

2.3 The catchment area

The point of departure for demarcating a water protection area is that there is a certain need for protection within a water body's entire catchment area and that the entire catchment area should therefore be included in the water protection area, i.e., a strictly topographical/hydrological/hydrogeological starting-point. This is true for both surface water and groundwater.

The entire catchment area should normally be included for groundwater and surface water bodies in smaller lakes and watercourses. For larger lakes and rivers, the water protection area needs to be limited to include certain areas of the lake or sections of the river.

For every water protection area that is less than the entire catchment area, a threat upstream of the water protection area's border carries a risk that any occurrence of pollution will not be sufficiently mitigated before it reaches the water body/abstraction point. Including the entire catchment area in the water protection area neutralizes any problems as regards such risks.

2.3.1 Surface waters

The catchment area of a surface water body is defined by the surface watershed and is the same as the river basin.

2.3.2 Groundwater

The catchment area of a groundwater reservoir is demarcated by the groundwater shed. The catchment area of a groundwater body can be the same as the catchment area of the groundwater reservoir, but is often smaller. The amount of water abstracted and the balance between this abstraction and new recharge of the groundwater determines the extent of the catchment area. A complication occurs when a surface water is in hydraulic contact with a groundwater reservoir. Under certain hydraulic conditions, surface water may leak into the groundwater reservoir (induced recharge). If this is the case, the surface water's catchment area is also considered when demarcating the water protection area.

2.4. Water bodies

The water body has normally been analysed prior to it being established as a drinking water supply and prior to water abstraction being considered by the court (previously the water court, now the environmental court). These analyses should normally have clarified the water resource and the water's quality. One experience gained from the establishment of water protection areas is that the water abstraction should have been considered by the environmental court before a water protection area is established, even if the activity does not require a permit as a water operation pursuant to Chapter 11 of the Environmental Code, see Chapter 1, Legislation - permit requirement for water abstraction.

Geological/hydrological background data is required when establishing a water protection area in order to be able to assess water balance, vulnerability and estimation/assessment of the spread of pollution. A lack of knowledge about the water resource can in itself convey a risk to a water body/well, e.g. as a result of over-abstraction.

Examples of surveys/information that may be needed for different types of water bodies/wells and their catchment areas are presented below:

- **Groundwater reservoirs/wells in soil**: mapping/determination of soil types and strata sequences within the catchment area, recharge and discharge areas, distance to the water table, any occurrence of artificial groundwater recharge by induced recharge, flow routes and residence times (e.g. tracer trials), water balance estimates/assessments, etc.
- **Groundwater reservoirs/wells in bedrock**: determination of rock types, fault and crush zones (e.g. aerial photograph interpretations, geophysics, drillings), recharge and discharge areas, soil types and strata sequences in the catchment area, distance to water table in soil and in bedrock, interaction between soil groundwater and rock groundwater, water balance (where does the water come from and in what proportions?)
- **Induced recharge**: mapping/determination of where recharge of the surface water occurs (leakage), soil types and strata sequences and determination of residence times between the surface water and groundwater bodies. Otherwise the same as for groundwater reservoirs in soil (in rock only in exceptional cases) as described above. Flow times in lakes and watercourses, see below on surface water bodies.
- **Basin recharge:** mapping/determination of soil types, soil strata and residence times between the recharge and abstraction points. Otherwise the same as for groundwater reservoirs in soil as described above.
- **Surface water bodies/supplies:** flow times in lakes and watercourses, turnover times in lakes, flow conditions, prevailing wind directions and speeds, etc.

2.5 Value

The value of a water body/supply depends primarily on the water resource (abstractable water volumes and quality of the water) and on current and possible future water use and access to other drinking water bodies.

2.5.1 The value of groundwater

Groundwater has both a value when abstracted for water supply (known as its “abstraction value”) and a value in the groundwater reservoir (its “in-situ value”), see Johansson et al, 2002.

Examples of in-situ values are:

- the value of groundwater for plants and animals (ecological value),
- contribution to surface water flows
- counteracts subsidence and saltwater intrusion.
- as a recipient

In connection with the establishment of the water protection area, these in-situ values normally don't need to be quantified but they should be described and can in certain cases be important enough to highlight in the analysis.

The abstraction value is of most interest for water supply purposes. The abstraction value is often established as a replacement value, i.e. the cost of replacing the water supply with a new one in the event of it becoming unusable as a result of pollution of otherwise. By way of example, Uppsala has calculated the replacement costs for its main water supplies at about SEK 1.1 billion (EUR 117 million) , which justified far-reaching protection measures when the E4 motorway was routed through the ridge over the groundwater reservoir.

It may be difficult to calculate replacement values in some cases. As an alternative to a quantitative estimate of the groundwater's value, the values can be described in words or by breaking them down qualitatively into value classes.

An example of how to break down surface and groundwater value qualitatively into four value classes is presented below

- **Extremely high protection value**: Water bodies and water supplies for current and/or future water supply that have been classified as being of national interest. Important public water supplies where there are no reserve water supplies.
- **Very high protection value**: Main public water supplies. Important large private water supplies where there is no reserve alternative, larger water bodies that are planned to or likely to be used for future public water supply.
- **High protection value:** Public reserve water bodies, private water wells (>50 persons or 10 m^3 per day), smaller water bodies that are planned to or likely to be used for future public water supply, larger water bodies for possible future public water supply.
- **Normal - low protection value:** Unprioritized public reserve water supplies, private reserve water supplies, conceivable water bodies for future private water supply.

2.5.2 The value of surface water

Surface water has many different values and water supply constitutes just part of its "technical value" as in the example below:

- social values: recreation, bathing, fishing, boating, culture, history, water aesthetics
- natural values: ecology, natural resources, open shorelines
- technical values: water supply, irrigation, recipient, shipping lanes, energy extraction, fisheries

The abstraction value (replacement value) can be calculated in the same way as for groundwater as above. As an alternative to calculating the replacement value, the value of the surface water body/facility can also be described in words or classified qualitatively into four value classes as for groundwater, see above. It is however also important to highlight other values that a water protection area can help maintain or preferably improve.

2.6 Vulnerability

The concept of vulnerability describes the resistance of a land or water area to pollution. Vulnerability assessments have mainly been performed as a basis for the protection of groundwater. The concept was not mentioned in previous General Guidelines 90:15 for the Protection of Groundwater Supplies.

2.6.1 The vulnerability of groundwater

Groundwater is protected to varying degrees by overlying geological formations. This constitutes the basis for groundwater vulnerability assessments. There may be vulnerability maps for some areas, but this information is unavailable for most areas. Vulnerability in these areas needs to be assessed in order to be able to demarcate the water protection area.

A large number of methods have been developed to assess groundwater vulnerability. The simplest methods are based purely on geological parameters (parameter methods) while more advanced methods also consider hydrogeological and hydrochemical parameters linked to the properties of different pollutants. The most important vulnerability parameters are the thickness, composition and permeability of the unsaturated zone. Comparison of the different parameter methods indicates that even quite simple methods using only a few parameters can produce the same results as more complicated methods.

The breakdown into vulnerability classes presented can also be used for other typical hydrogeological environments in addition to those stated here. If greater precision in terms of vulnerability is needed, the area can be divided into vulnerability classes based on distance from the ground to the water table and the permeability of the soil strata.

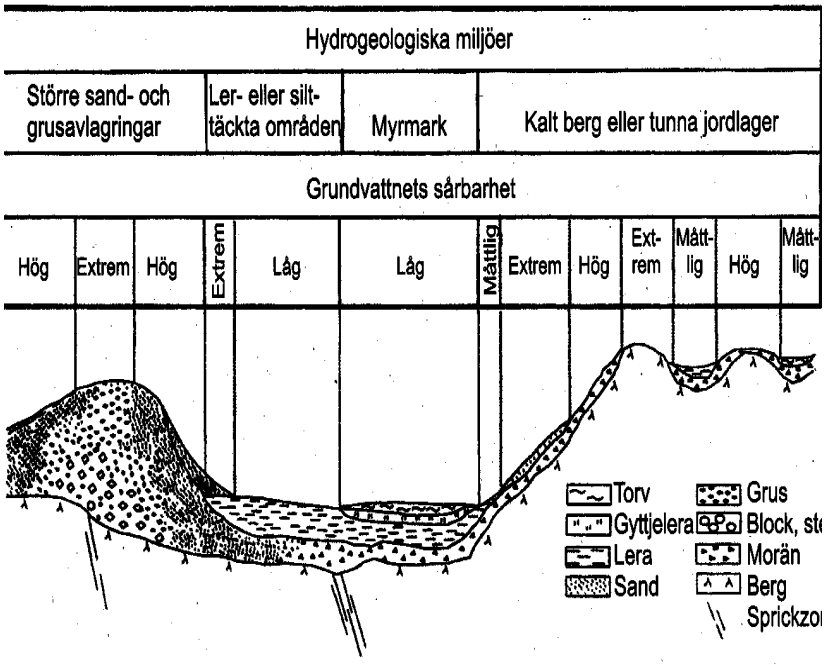


Fig 2.1 Cross-section of four typical hydrogeological environments with four vulnerability classes:

Extremely high vulnerability: ridge peak with sand and gravel above ground, fluvial sand on moraine in slopes, coarse fluvial material at the base of the ridge

High vulnerability: gravel esker slopes (gravel, sand and silt, rock above ground, moraine slopes)

Moderate vulnerability: hollows in mountains/moraine terrain with thin layer of peat or clay on rock, transition valley side/valley floor with no fluvial material.

Low vulnerability: clay or clay on peat

(from Maxe and Johansson, 1998)

Analogous to the general vulnerability presented in Figure 2.1, vulnerability for e.g. a large-scale fluid discharge, area-wise dispersed pollutants or for soil-less areas can also be presented, see Maxe and Johansson, 1998.

2.6.2 The vulnerability of surface water

A vulnerability classification for a surface water has two pollution scenarios: firstly, the pollution occurs directly on the water surface, or secondly, it occurs on surrounding land and must be transported a certain distance before it reaches the watercourse or lake.

Vulnerability is extremely high if the pollution occurs on the water surface. If it occurs on land, the converse to groundwater vulnerability basically applies. A dense soil type (e.g. clay) conveys high vulnerability for the surface water (low for groundwater) and vice versa, a coarse-grained soil type (e.g. sand and gravel) conveys low vulnerability for surface water (high for groundwater). Vulnerability is also affected by land use/vegetation (and hence varies during the year) and topography, proximity to ditches and small watercourses, etc.

Vulnerability to specific pollutants is influenced by the properties of the pollutant and various physico-chemical processes (adsorption, volatilization, oxidation, reduction, etc.) and biological changes (biological degradation, accumulation, etc.)

2.7 Consequences

The consequences of negative impacts on the quality and quantity of the water is determined by the product of the water's value and vulnerability.

The consequences for the water supply are different depending on the pollutant. Some pollutants can cause long-term or irreversible damage. This can occur as a result of oil pollution or chemical pesticides. It has been ascertained in recent years that there are chemical pesticide residues in many municipal water supplies. These come from pesticides that have long since been banned in Sweden. This indicates that the substances have not been broken down or bound as part of a natural process but have managed to persist in the water for a long time (for decades). This shows that the residence time of 1 year, as defined in previous General Guidelines 90:15 regarding water protection areas is insufficient for certain types of pollutants.

The consequences differ depending on the extent of the impact. If the water is unfit for human consumption in accordance with National Food Administration standards, the drinking water supply must be quickly rectified or replaced. If the impact only causes the water quality to deteriorate but it is still fit for human consumption, there is greater respite for measures. A rise in the salt content (chloride content), for example, will firstly cause technical problems (corrosion), but at higher concentrations, the water will be unfit to drink.

Some pollutants can cause irreversible damage, others may require a very long time before the original water quality can be restored, while the water quality can be restored relatively quicker for certain other types of pollutants. The consequences of an occurrence of pollution also differ between different types of water bodies/supplies.

Vulnerability for specific occurrences of pollution must therefore be considered in order to determine the consequences. For example, the consequences of a point emission (e.g. from an oil tank or cistern) for the water body/supply or of an oil transportation

accident can be assessed, as can the consequences of diffuse emissions, such as chemical pesticides and plant nutrients.

2.7.1 Groundwater reservoirs in soil

Even if the pollution has come from a point source, extensive remediation between the pollution source and the water abstraction point may be required. Damage from diffuse sources can normally not be remediated without restrictions being placed on the pollution source. A water supply that has been polluted by e.g. petroleum products or pesticides must as a rule be taken out of service and replaced by a new one.

2.7.2 Groundwater reservoirs in bedrock.

There is, as a rule, limited scope for remediating a polluted rock-bored well. If the pollution source is removed, pumping out water can in some cases improve the situation over time. Sealing deeper parts of a well can sometimes reduce salt concentrations. Remediation in the bedrock is normally completely impossible.

2.7.3 Groundwater reservoirs with induced recharge

If the surface water has been polluted, it is possible to save the water supply by stopping the abstraction of the groundwater. Access to reserve water is then needed until the damage to the surface water has been rectified. If damage occurs in the groundwater shed, the conditions will be the same as above.

2.7.4 Basin recharge

If the surface water has been polluted, the raw water intake can be closed off. In this case, groundwater can provide some respite (often weeks or months).

2.7.5 Surface water bodies

Similar to basin recharge, the raw water intake can be closed off in the event of the watercourse or lake being polluted. The respite period will be much shorter, however, and limited to the time it takes for the water in reservoirs and pipes to run out (hours - days), unless there is an alternative water supply.

If the pollution floats on the water and does not mix too much with the surface water and its water solubility is low, it may, in a best-case scenario, pass the raw water intake point without the abstracted water being polluted.

Pollution is generally much easier to detect, track and remediate in a surface watercourse than in a groundwater reservoir. In the case of surface water, a pollutant can become ice-bound and hence remain until the spring thaw. An example of this was the xylene accident in the Göta River in 1996.

2.8 Risks

By definition, the risk of an unwanted incident is made up of the product of the consequence and the probability of it happening. When establishing water protection areas, it is often not possible or reasonable to calculate probabilities of different risk categories and individual high-risk sites, but they should be assessed when performing risk assessments. Risk analyses may however be required when granting certain dispensations and permits within a water protection area.

2.8.1 Risk inventory

A risk inventory shall normally be performed for the entire catchment area and should include all high-risk sites, both existing pollution sources and operations that may become high-risk sites in the future. An inventory should also be taken of parts of the catchment area that might not ultimately be included in the water protection area. Swedish Armed Forces facilities also need to be catalogued.

Emissions can be sudden and unforeseen, e.g. as the result of an accident, or be more continuous in nature, e.g. from a private sewer or oil tank.

High-risk sites can mostly be put into the following categories:

- water operations
- operations and land use in the catchment area
- sabotage, crisis and war
- climate change

Water operations

Some examples of risks that water operations may pose:

- Risks in connection with works close to water supplies (e.g. oil leakages from construction machinery)
- Recharge by a polluted surface water (e.g. during basin or induced recharge)
- Water shortage or deterioration in quality due to over-abstraction (e.g. saltwater intrusion).

These risks should be dealt with by the body responsible for the water distribution. Terms and conditions for water abstraction and water quality should be established by the environmental court when considering applications for water operations pursuant to Chapter 11 of the Environmental Code and be discussed in emergency and remediation plans. Preventive measures and technical barriers are important tools for risk reduction in these respects. Control programmes should ensure that raw water quality does not deteriorate.

Operations and land use in the catchment area

- **The urban environment:** stormwater and wastewater pipes, road traffic, road salting, firefighting runoff water, pesticide use, energy plants, drilling for drinking water abstraction and other purposes, tunnel construction, excavation works and other earthmoving.
- **Agriculture and forestry:** sprinkling of timber stocks (phenol compounds), pesticide use, scarification (increased humus content in surface water), spreading fertilizer, drainage.
- **Roads, railways and sea transport:** road salting, stormwater, discharge of acidifying substances, pesticide use, transport of heavy traffic and dangerous goods, tunnel construction, excavation works, fuel leakage.
- **Industrial environments:** entire management of chemicals, waste, etc., design of operations, earthmoving, transports, stormwater, contaminated land.
- **Landfill sites:** leakage to soil and water, air emissions, transports.
- **Quarries and other excavation activities:** affect the condition of the ground, reduce its natural cleaning capacity, leakage from works machinery.

These operations and land use are examples of activities that can be regulated by issuing protection regulations.

Sabotage, crisis and war

Water supply is a sensitive sector for sabotage and in connection with crises and states of war. Even if the main function of the water protection area is to reduce the risks to water bodies and water distribution in peace time, the risks of sabotage, crises and states of war should still be highlighted. These aspects should be considered in the emergency and remediation plans drawn up in connection with the establishment of the water protection area but which are not established within the framework of water protection areas and their accompanying regulations.

Floods

Climate simulations indicate that we are moving towards a wetter and milder climate in most parts of Sweden. More water circulating in the natural environment increases the risk of floods and of pollutants spreading more easily to surface and groundwater. It may be a question of overloaded stormwater and wastewater systems, different types of pollution sources (cisterns, etc.) that become flooded, soil-bound pollutants that can be released during floods, high groundwater levels in gravel pits, increased surface water recharge to groundwater systems, etc. Flooding problems should be included when assessing the need to survey water protection areas and during the spatial planning process.

2.8.2 Transportation and spread of pollutants

Pollution sources and operations analysed as part of the risk inventory are to be assessed with regard to the type of pollutant, concentration, deposition method, duration and how easily they can be remediated.

Many substances are transported at a speed that is different to the flow speed of the water depending on their physical properties, capacity to accumulate and resistance to chemical and biological degradation. Pollution sources and high-risk operations should be roughly divided up into e.g. petroleum products, pesticides, plant nutrients, inorganic salts, solvents, phenols, coolants and microorganisms.

2.8.3 Barriers/risk reduction

Water and land areas possess a natural risk-reducing capacity as a result of various types of protective barriers that seem to play a preventive role (gradient): retardation (e.g. adsorption of pollutants); degradation (e.g. biological processes) or as a result of dilution. It should be noted that retarding processes may result in pollutants persisting over a longer period of time, being more difficult to remediate and, at worst, cause slow leakage to affect the water body for a very long time.

A large number of physical, topographical, geological, biological and chemical properties affect the transport of water, its quality and pollutant content. These “barriers” play an important role in nature’s capacity to prevent pollutant transport and should act as a guide when demarcating water protection areas.

Many barriers form the basis of a robust system that protects a water resource from pollution. Barrier capacity varies depending on the type of pollution. In this context, it is important to remember that different soil strata have different capacities to bind up or break down different types of pollutants. It is therefore particularly important to maintain the soil profile since it provides different types of chemical and biological environments with the capacity to reduce the levels of specific pollutants. Lakes and watercourses also have different capacities to bind up, dilute and break down different types of pollutants.

There are also technical barriers, such as booms, sealed ditches and alarm systems. The concept of barriers is also applied when selecting methods of combating microbiological contaminants at water purification plants.

The concentration of a pollution occurrence decreases as a result of dilution, but it can still remain a threat. More pollution can be fed in downstream. Dilution in a watercourse depends partly on the degree of turbulence. High turbulence leads to rapid dilution. Watercourses with sharp inclines and high turbulence can complete the dilution process within 100 metres whilst low or zero turbulence in a calm-flowing watercourse may not complete the dilution process even after 10 kilometres. In many cases it can be difficult to quantify degradation and uptake of pollutants. As a measure of these processes, “time” has instead been used when establishing water protection areas. The Swedish EPA’s General Guidelines 90:15 use “residence time” when demarcating water protection areas for groundwater. The guiding principle has been the time (60-100 days) that has been deemed necessary to reduce the risk of microbial contamination to a minimum level. “Flow time” is the equivalent term used for surface water.

How flow times are determined and examples of risk reduction in surface waters are presented in ANNEX 2. How residence times in groundwater are determined is presented in ANNEX 6.

Both natural and technical barriers work in such a way as to both reduce the risks in general as well as provide respite in terms of both time and space for the rescue services and for any other countermeasures to be taken against the pollution.

2.8.4 Risk assessment/risk analysis

Based on the risk inventory, an assessment of which risks are serious (threats) to the water body/supply is made. The most serious risks should then be included in the risk analyses/risk assessments.

A more definitive assessment based on the consequences is performed either as a risk analysis, in which the risk is the product of the consequence and the probability or as an overall impact assessment without probability calculations. Focus must then be placed more on the consequences of pollution or other unwanted event than on a more exactly calculated risk, see, for example, “Riskhandbok för dricksvattenförsörjning [Risk handbook for drinking water supply]” (National Food Administration, 1997) and the Swedish Rescue Services Agency series “Riskhantering i ett samhällsperspektiv [Risk management from a societal perspective]”,

2.9. Protection needs

2.9.1 General protection needs

The background data needed to establish the protection need for water bodies/supplies consists of different basic geological, hydrogeological and hydrological surveys and risk inventories. These also form the basis for assessing the water body’s/supply’s value and vulnerability to pollution. Based on this, the consequences and risks of pollution and other damage, along with the protection need, are assessed.

As previously described, the starting-point should be that there is a certain protection need within the entire catchment area. The protection need is particularly great where operations and land use occur that may cause irreversible or long-term damage to water bodies and water wells. These parts of the catchment area should be covered by the protection regulations that contain significant restrictions on land use and operations with the aim of reducing the risks to an acceptable level, see Chapter 5.

2.9.2 Specific protection needs for different types of facilities

Surface waters

Within the watercourse or lake and its immediate surroundings (approx 50 m) where water is abstracted, there is a major need to protect against sudden pollution from accidents. There is also a general protection need within the entire catchment area to guard against slow pollution sources, both diffuse and point sources.

Groundwater

There is a general protection need within a groundwater area. This need is greatest in the recharge area, where new groundwater is formed. Special attention is paid if recharge occurs from a surface water (induced recharge). In such cases, there is also a protection need for the surface water. Since the occurrence of induced recharge has not always been highlighted in the surveys conducted for water supplies, this aspect should be given special attention.

For rock groundwater (rock-drilled wells), special attention must be paid to local protection around the water abstraction point, especially if the caulking between well pipes and the bedrock is insufficient. The protection needs are also considerable if the groundwater is recharged to the rock in areas with thin or non-existent soil strata.

Artificial groundwater recharge

There is a protection need both for the surface water and the groundwater when groundwater is recharged artificially, e.g. by basin recharge, induced recharge, sprinkler recharge or deep recharge (infiltration in wells).

From a protection point of view, deep recharge lacks the barrier made up of the unsaturated zone since the water is injected directly from the saturated zone.

During basin recharge and sprinkler recharge, there is normally an unsaturated zone that acts as a barrier against pollution. During induced groundwater recharge, a certain barrier effect is achieved as a result of the residence time in the saturated zone until the induced surface water reaches the abstraction wells.

3. Demarcation (Delineation) of water protection areas

3.1 General points of departure for demarcating water protection areas

> **Excerpt from the general guidelines to Chapter 7, Section 21 of the Swedish Environmental Code:**
> A water protection area should include the water body's catchment area, unless the background data indicates that protection can be achieved by establishing a smaller area as the water protection area.

Water bodies and water supplies shall be protected against both present and future risks. Pollution can occur as a result of incidental emissions in connection with accidents or as a result of continuous diffuse and concentrated leakage. Areas close to a water abstraction point or those that are especially vulnerable to pollution need stronger protection against both sudden and continuous pollution. Outside these areas, protection is above all needed against pollution that can have an adverse effect on water quality in the long term (multigenerational perspective). The rapid processes occurring in surface watercourses at risk of sudden contamination require slightly different strategies than the slow processes in groundwater.

The points of departure for demarcating (=delineating) water protection areas for surface watercourses are: a) creating respite for countermeasures in the event of pollution reaching the water, e.g. as a result of an accident and b) helping to improve water quality. Technical barriers, e.g. installation of warning systems to report accidents or automatic closure of raw water intakes in connection with sudden pollution, can be considered in order to reduce the size of the water protection area.

The points of departure for demarcating water protection areas for groundwater are: a) the requirement for a strategy that creates respite, in the event of sudden pollution, as a result of the slow turnover in groundwater reservoirs and the difficulties involved in cleaning polluted groundwater, and b) detecting and remediating the damage preferably before the pollution reaches the groundwater, or otherwise before it is transported to the abstraction wells. Water protection areas shall also be demarcated so that pollutants can be bound up, broken down or otherwise neutralized before they reach a groundwater abstraction point. Establishing suitable restrictions will also ensure that harmful substances never reach the groundwater.

The entire catchment area should normally be included for groundwater and surface water supplies in smaller lakes. For larger lakes and rivers, the water protection area may need to be limited to include certain areas of the lake or certain river sections. The demarcation can be adapted to existing property boundaries, easily identified sites, etc.

See Section 4.3 regarding the work procedure for demarcating water protection areas.

3.1.1 Impact

> **Excerpt from the general guidelines to Chapter 7, Section 21 of the Swedish Environmental Code:**
> When demarcating a water protection area for surface water or groundwater supply, special consideration should be given to the question of whether existing operations or facilities, that may have a bearing on whether the purpose of the water protection area is achieved or not, need to be inside the protection area and hence be covered by the accompanying regulations.

The point of departure for demarcating the water protection area is that everything that occurs within the catchment area of a water body or water supply has a bearing on the quality and quantity of the water seen in a long-term, multigenerational perspective.

If the entire catchment area is not to constitute a water protection area, each sub-area, from the watershed and downstream towards the abstraction point, should be considered for inclusion or omission from the water protection area. When considering whether an operation should be within the water protection area or not, it may be beneficial to include it so that it is covered by the protection regulations.

As mentioned previously, no general guidelines for the demarcation of surface water supplies have been issued before. Water protection areas for surface water supplies have often previously only been demarcated in the water system surrounding the raw water intake. As a result, no water protection areas have been established at all or those established have been far too small to satisfy the need for protection.

Accidents have led to a break in water supply and major financial consequences, e.g. The Karlshamn accident (diesel tanker) and the Göta River accident (xylene cargo ship).

Under General Guidelines 90:15, the entire catchment area of a groundwater body should be included in the water protection area, or alternatively, as large a proportion of the catchment area (the groundwater reservoir) as possible so that all the water abstracted from the well has a nominal residence time of at least a year.

In recent years, evidence of pesticide residues, e.g. from substances that have long since been banned in Sweden, have been detected in groundwater supplies, including those with established water protection areas. This suggests that the demarcation of the water protection areas has, in many cases, been incorrect and/or the restrictions have been inadequate. Increasing nitrate and chloride levels in some groundwater bodies suggest that the protection has been poorly designed.

Groundwater bodies have also been affected by pollution from accidents.

3.1.2 Artificial groundwater recharge

> **Excerpt from the general guidelines to Chapter 7, Section 21 of the Swedish Environmental Code:**
> A water protection area could also include a body of gravel or sand that is significant for the water supply and, as a result of its ability to clean or accommodate water, can be used for artificial groundwater recharge by recharge of surface water. An area for groundwater recharge could also be included.

Around half of all the groundwater used for public water supply in Sweden is artificial, i.e. natural groundwater recharge has been reinforced by surface water recharge, a process

known as “artificial groundwater recharge”. The most common techniques are basin recharge and induced recharge. Less common techniques include sprinkler recharge and recharge in wells (deep recharge). It is appropriate for the water protection area to cover the area between the recharge point and the abstraction point. It is very important to preserve and safeguard the different ways of reinforcing natural groundwater recharge and consequent improvements in quality. Many of the water supply systems based on artificial groundwater recharge currently lack proper protection. Regarding natural and induced groundwater recharge, for example, there are only a small number of established water protection areas.

As regards artificial groundwater recharge, there is generally a protection need both for the surface and the groundwater. For basin and sprinkler recharge, there is normally an unsaturated zone that acts as a natural barrier against pollution. This barrier is not there in deep recharge since the water is injected directly into the saturated zone. Even during induced recharge, the recharge occurs directly into the groundwater zone.

3.2 Principles for demarcating water protection areas

3.2.1 General principles

Water protection areas can be demarcated in accordance with two general principles and working methods - barrier-focusing and risk-focusing.
General guidelines 90:15 for groundwater supplies use residence times for demarcation, i.e. a barrier-focused method. The pros and cons of these two methods are considered below.

As regards surface water supplies, there are demarcation methods based on the following principles:

- Topographical demarcation (at the surface watershed)
- Buffer zones around watercourses
- Fixed flow times in the water system
- Vulnerability assessments and classifications
- Empirical experiences
- Risks/risk acceptance

The equivalent methods for groundwater bodies/wells are based on:

- The groundwater shed
- Fixed distances from the groundwater abstraction point
- Residence times in the groundwater
- Vulnerability assessments and classifications
- Empirical experiences
- Risks/risk acceptance

As described below, water protection areas should be demarcated based on a combination of several of these principles.

3.2.2 Selected demarcation principles

> **Excerpt from the general guidelines to Chapter 7, Section 21 of the Swedish Environmental Code:**
> A water protection area should include the water body's catchment area, unless the background data indicates that protection can be achieved by establishing a smaller area as a water protection area.

The main principle for both surface water and groundwater bodies/supplies is that the entire catchment area should be included in the water protection area. This tallies with applicable main principles for groundwater supplies in accordance with General Guidelines 90:15. This should at least apply to groundwater reservoirs, small lakes and smaller watercourses with small catchment areas. For larger lakes and watercourses, and possibly for larger groundwater reservoirs, a narrower demarcation may be necessary. Such a demarcation of the water catchment area can only be done if the risks in the excluded area can be accepted.

Point of departure for demarcation - the water protection area includes the entire catchment area.

- According to this main principle, the surface watershed constitutes the protection area border for lakes and watercourses and the groundwater shed constitutes the protection area border for groundwater. In certain cases where the groundwater shed is unknown, the surface watershed may need to be used as an approximation. For groundwater bodies/supplies with artificial groundwater recharge, both a groundwater shed and a surface watershed can constitute the protection area border.

The advantage of including the entire catchment area in the water protection area is that the demarcation is precise and that the catchment area's entire barrier capacity can therefore be utilized.
The risk of impact on a water body/supply is generally less if the water protection area is demarcated in this way than if the risk balancing approach is used (see below), since there is always an inherent uncertainty factor when balancing risks.

Alternative demarcation - the water protection area includes only part of the catchment area

- If the water protection area is less than the entire catchment area, there is a risk of a threat upstream of the border not being sufficiently mitigated before it reaches the raw water intake. When it is proposed to make the water protection area less than the catchment area, the demarcation should be based on a thorough assessment of natural and technical barriers, and of current and potential high-risk sites within the catchment area. These assessments should be made based on the watershed (surface

or groundwater shed) in the direction of the water body/abstraction point. The water protection area should be demarcated where the risks (current and potential) are balanced by natural and possible technical barriers. The risks outside the water protection area must be acceptable. When demarcating, safety margins must also be applied, but not within the water protection area border.

A necessary safety margin should be included in the considerations, especially since it can often be difficult to predict any additional risks that may arise in a long-term perspective. If there is uncertainty as to future risks, a reduction in the water protection area may in certain cases be justified if the barriers (natural and technical) are deemed sufficiently effective against virtually all feasible occurrences of pollution.

3.3 Methods for demarcating water protection areas

3.3.1 Topographical and hydrological demarcation

Surface waters

For a surface water body/supply, the main alternative is to include the entire catchment area in the water protection area. The water protection area border should therefore coincide with the surface watershed. This is demarcated with the help of topographical maps or other topographical data (aerial photographs, considerations, etc.).

Groundwater

For a groundwater reservoir, the demarcation should also be done based on the catchment area. The protection area border should coincide with the groundwater shed. In certain cases, where the groundwater shed's location is not known, the surface watershed can constitute an approximation of the groundwater shed.

The catchment area of a groundwater body may be the same as the catchment area of the groundwater reservoir. It is common, however, that the groundwater abstraction and the balance between it and its recharge mean that the catchment area of the groundwater body is less than the groundwater reservoir.

It is not uncommon for a groundwater reservoir to be in contact with a surface water body via natural or induced recharge. If this is the case, either all or part of the catchment area of the watercourse or lake should also be included in the water protection area. The issue of whether induced leakage occurs from a surface water to the groundwater reservoir should be clarified, e.g. by making water balance calculations or doing field studies (temperature measurements, tracer element surveys, hydrochemical studies, etc.) In such cases, the water protection area is demarcated based on a combination of the groundwater shed and the surface watershed.

3.3.2 Risk-focused methods

Surface waters

To demarcate water protection areas for surface water supplies using the risk balancing approach, there are no obvious, tried and tested methods available.

Liedholm (VBB VIAK 1998) has, in connection with the design of these general guidelines, drawn up a proposal for a template for the demarcation of protection areas for surface water supplies using a risk balancing method. Fig. 3.1 illustrates the principle of risk balancing by considering barrier capacity and impacts/threats/risks.

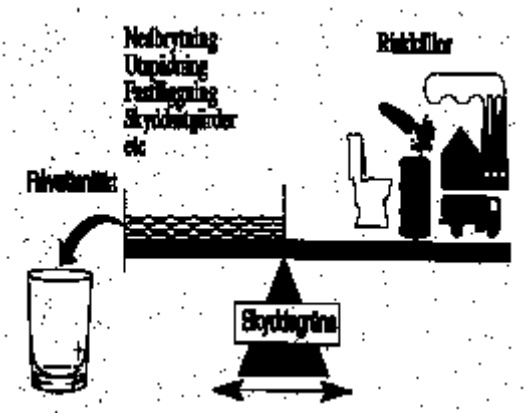


Figure 3.1 Risk balancing by weighing up barrier capacity and impacts/threats/risks (according to Liedholm, VBB VIAK, 1998).

Land and water conditions (topography, hydrography, geology, hydrogeology, vulnerability, hydrochemistry, etc.), high-risk sites, availability of data, etc., all influence the scope and type of risk assessment/analysis.

Risk assessments/analyses should be performed based on the vulnerability of the catchment area (see Chapter 2) as well as existing and potential high-risk sites. They can either be performed for groups of pollutants, e.g. petroleum products and chemical pesticides or for known specific pollutants or a “worst possible” pollutant. The assessments/analyses require good knowledge of pollutant transport and barrier mechanisms.

The risks should then be weighed against natural and technical barriers. Natural barriers are mostly approximated using flow times. Dilution (flow increase) also constitutes a natural barrier.

If technical barriers are introduced (warning systems and alarms, physical protection, etc.), the size of the water protection area can in some cases be reduced. This can at best lead to better protection and at the same time lower costs for establishing the water protection area (lower costs for surveys, administration, possible compensation, etc.).

A case study has been conducted on Fjugesta surface water supply in the river Svartåan (VBB VIAK, Liedholm 1998) based on risk balancing. This case study presents a proposal for nomograms and scales for the demarcation of water protection areas based on risk classification, flow times (average residence) and dilution (flow increase).

Methods based on empirical experiences and qualitative reasoning of risks and impacts in similar land and water conditions could also (in exceptional circumstances) be applied.

Groundwater

Regarding groundwater, there are different methods based on vulnerability classification that also consider different pollutants. There is no method that can be recommended in general. Instead, the choice of method must be done on a case-by-case basis, bearing in mind the potential water protection area's natural and other conditions.

As for surface water, methods based on empirical experiences and qualitative reasoning of risks and impacts in similar land and water conditions could also (in exceptional circumstances) be applied.

3.3.3 Reviewing the demarcation

Using the methods presented above, a preliminary demarcation of the water protection area can be performed. After the water protection area has been demarcated, it is divided up into protection zones, see Chapter 4. The demarcation may then need to be adjusted to achieve sufficient minimum residence/flow times.

4. Dividing the water protection area into protection zones.

4.1 Zones

> **Excerpt from the general guidelines to Chapter 7, Section 22 of the Swedish Environmental Code**
> Regulations may need to be drawn up for water protection areas to impose far-reaching restrictions on the right to dispose of properties. A water protection area should be divided into zones with regulations adapted to the natural conditions and protection need in each zone respectively. A water protection area can be divided into water abstraction zones, primary and secondary protection zones and, where necessary, tertiary protection zones.

After the water protection area has been demarcated, as presented in Chapter 3, it is then further divided up into protection zones.

As regards surface water bodies, the established water protection area has in many cases consisted only of a smaller area adjacent to the abstraction point (intake area). Some have been divided into intake areas and inner and outer protection zones. others have had a protection area with no sub-division into protection zones. In some cases, there has been an observation zone adjacent to the water protection area. This zone has not, however, been part of the water protection area with accompanying regulations.

Previously for groundwater reservoirs/supplies, the water protection area has normally been divided into well areas as well as inner and outer protection zones. Using the demarcation methods presented in Chapter 3, a third zone is needed. Changing a well-established nomenclature can be a drastic measure. The term “inner protection zone” has met with some conceptual resistance since vulnerable areas (e.g. recharge areas) with a considerable protection need (inner/primary protection zone) can be located a considerable distance away from a groundwater well, whilst the area immediately surrounding it may have a low level of vulnerability (outer/secondary protection zone).

The following zone terms are proposed:

- (water) abstraction zone
- primary protection zone (previously called the “inner protection zone”)
- secondary protection zone (previously “outer protection zone”)
- tertiary protection zone (where necessary)

The division into protection zones for surface water and groundwater is shown in Fig. 4.1 and Fig. 4.2.

4.2 General points of departure when dividing water protection areas into protection zones

The water protection area often needs to be divided up into zones since differentiated restrictions are needed in different parts of the water protection area. The water protection area can be divided into protection zones based on different starting-points.

4.2.1 General starting-points for division

The general starting-points are basically the same for surface water and groundwater when dividing water protection areas into protection zones. Different transport speeds and vulnerability to pollution for surface and groundwater mean however that the bases for division will differ somewhat.

The following main starting-points apply to the different protection zones:

Abstraction zone

- to safeguard effective local protection for water abstraction/intake. In principle, the area shall be inaccessible for everyone apart from the operator.

Primary protection zone

- to create respite in the event of sudden pollution.

Secondary protection zone

- to maintain a high surface and groundwater quality or to improve quality.

Tertiary protection zone

- to include in the water protection area land and water use that may have an adverse effect on water bodies and water wells in a long-term perspective.

4.2.2 Dividing surface water bodies/supplies into protection zones

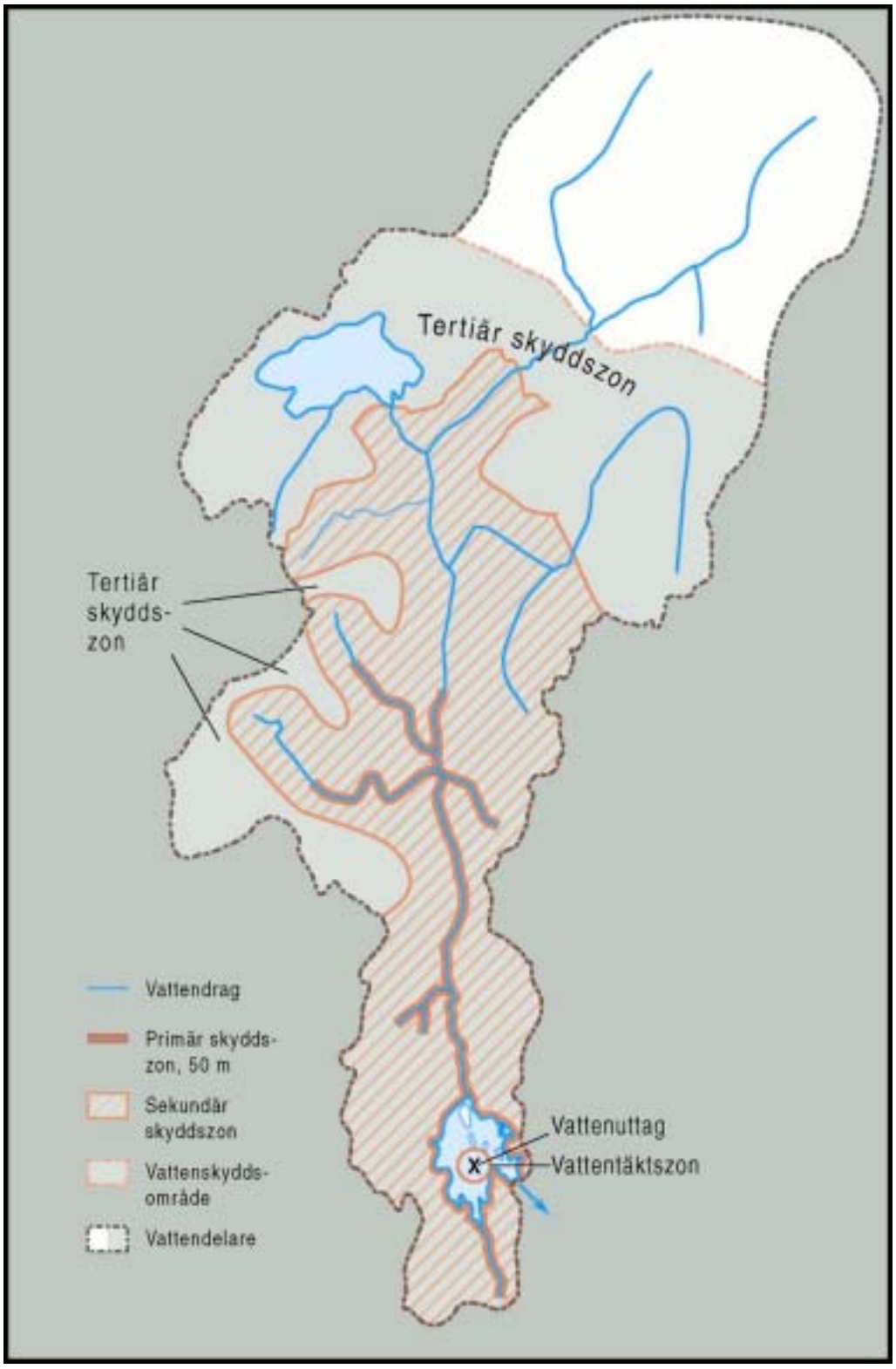


Figure 4.1 Basic sketch for demarcating water protection areas for surface water bodies/supplies and division into protection zones

The division into protection zones for surface water bodies/supplies should be based on flow times in lakes and watercourses and possible technical barriers (e.g. warning systems, physical protection measures and other protective measures).

Even if the conditions in a lake or watercourse vary over the course of a year, it is unrealistic to have different zones for different seasons. Instead, zones are chosen that cover the whole year.

Abstraction zone

A water abstraction zone should be demarcated around the abstraction point (raw water intake) in the watercourse/lake. The area should be protected against unauthorized persons by being enclosed or marked with the help of buoys/booms. The land inside the water catchment area may only be utilized by the owner of the water plant. Activities other than water abstraction should not occur within this zone

Primary protection zone

A primary zone should be demarcated so that the flow time in a lake/watercourse allows for an accident to be detected and measures to be taken before the pollution reaches the abstraction zone.

Design flow times for the primary zone for lakes and watercourses should refer to high-water flows. The flow time recommended for demarcation of the primary protection zone is 12 hours. If technical barriers are installed, e.g. warning systems and alarms, or if rescue efforts or other countermeasures against a pollution incident can be rapidly implemented, a shorter design flow time could be justified in certain cases. The converse applies if a water supply is not supervised daily or has no warning system. In such cases, a longer design flow time may be necessary.

Throughflow and wind-generated currents play an important role in lakes. It is important to point out that wind-generated currents can also come from downstream towards the water abstraction point, which means that the primary zone can also extend downstream in relation to the water intake.
For some of the larger lakes, there are mathematical models from e.g. the Swedish Meteorological and Hydrological Institute (SMHI) that can be used for dispersion calculations.

The shore zone constitutes a very important barrier to reduce and prevent pollution from reaching the surface watercourse/lake and should therefore be included in the primary zone. The shore zone (or buffer zone) should be at least 50 m wide and include all inflows in the form of rivers, streams and larger ditches and closed ditches from which the flow time to the water abstraction zone is estimated at 12 hours.

Secondary protection zone

The secondary protection zone shall protect the surface watercourse/lake from pollution dispersion via runoff directly on the ground and/or via the groundwater. For a surface water supply, the secondary zone also provides stronger protection against pollution.

The secondary zone is demarcated in two different ways:

- an area comprising the surface watercourse/lake and its inflows and all small-scale surface water drainage on or under the ground with a maximum flow time to the primary zone of 12 hours at high water,
- an area corresponding to the flow time (residence time in groundwater) of 100 days, although at least a 100 m wide land area around the surface water recipients

To avoid having to calculate the flow time distance for and to all the relevant small flows, these can be classified in groups with different estimated standard water speeds for e.g. streams in undulating terrain, ditches and rivers on flat agricultural land, ditched and pipe-drained land, wastewater and stormwater networks, etc. ANNEX 2 presents flow times for rivers, streams and ditches in different types of terrain in extreme high-flow situations. The values vary from 0.4 m/s in a flat-sloped ditch to 2.1 m/s in an river with a 1% incline.

Tertiary protection zone

The tertiary zone includes those parts of a water protection area not covered by other zones, normally the area between the outer border of the secondary zone and the border of the water protection area. This tertiary zone may not be needed in some water protection areas. The outer border of the secondary zone then coincides with the border of the water protection area.

4.2.3 Dividing groundwater bodies/supplies into protection zones

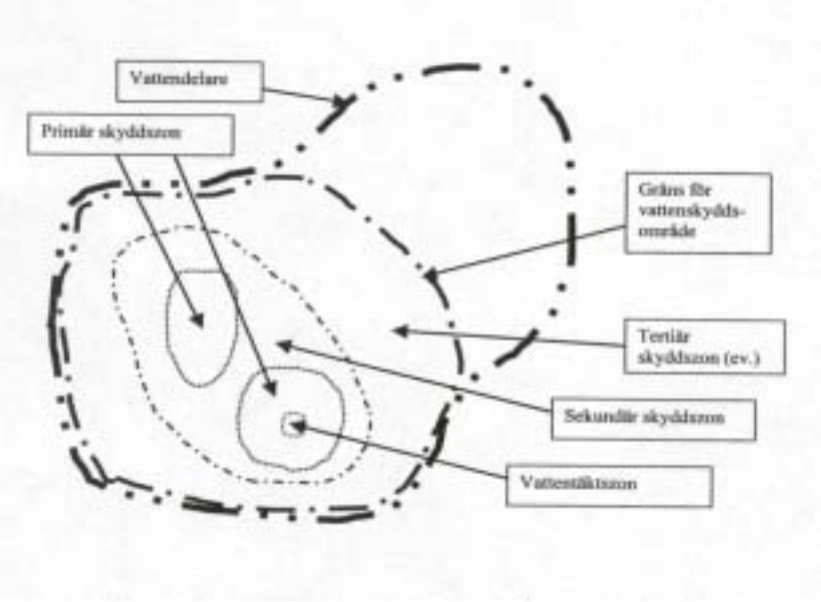


Fig. Simple sketch showing the demarcation of water protection areas for groundwater reservoirs/supplies and their division into protection zones.

Abstraction zone

The water abstraction zone is demarcated as an area around an abstraction well. The abstraction zone should be protected against unauthorized persons in an appropriate manner, e.g. in a locked enclosure.

The land inside the water catchment area may only be utilized by the body responsible for the water plant. No other activities, apart from water supply operations, are allowed within this zone.

Many groundwater bodies are polluted at the well itself, due to inappropriate or poor procedures/execution. It is therefore important for the land around a well to be sealed and drained so that polluted surface water can not penetrate and reach the immediately surrounding groundwater.

If there are several abstraction areas, all of them must be demarcated as water abstraction zones.

Primary protection zone

When identifying primary protection zones for groundwater, especially sensitive (vulnerable) recharge areas must be considered. It is hence possible for there to be primary protection zones at several locations within a water protection area.

The primary protection zone is demarcated in such a way as to minimize the risks of sudden pollution from an accident. It should be possible to detect sudden pollution in time and take countermeasures before it reaches the water abstraction zone and the abstraction wells. Furthermore, the primary protection zone should be protected against land use and activities that may risk polluting the groundwater.

The border between primary and secondary protection zones is drawn so that the residence time in the groundwater zone to the border of the water abstraction zone is estimated to be at least 100 days for groundwater recharged in the secondary zone. In cases where the area close to the groundwater abstraction point is made up of thick soil strata with very limited permeability or where there is a steeply rising groundwater gradient even at maximum abstraction, areas with shorter residence times in the groundwater zone than 100 days can also be included in the secondary protection zone.

Estimated residence times are given in ANNEX 6.

Secondary protection zone

The secondary protection zone should at least cover a sufficiently large part of the water protection area so that the estimated residence time for the groundwater from the outer border of the protection zone to the water abstraction zone is at least one year.

Tertiary protection zone

The tertiary protection zone includes those parts of the water protection area not covered by other zones.

4.2.4 Dividing groundwater reservoirs/supplies with basin recharge

Abstraction zone

- the abstraction wells (same basis for division as for groundwater reservoirs/bodies)
- the abstraction point in surface watercourses/lakes (same basis for division as for surface water bodies/supplies)
- the recharge basins (the basins should be enclosed, only water operations are permitted)

Primary protection zone

- in watercourses/lakes for raw water (same basis for division as for surface water bodies/supplies)
- the area between the recharge basins and the abstraction points of groundwater is included around the groundwater reservoirs/wells (same basis for division as for groundwater reservoirs/wells) in the catchment area

Secondary protection zone

- one or more protection zones around recharge and extraction points (same basis for division as for groundwater reservoirs/wells).
- around primary protection zones in watercourses/lakes (same basis for division as for surface water bodies/supplies)

Tertiary protection zone

- those parts of the water protection area not covered by other protection zones.

4.2.5 Dividing groundwater reservoirs/supplies with induced recharge into protection zones

Abstraction zone

- around the recharge areas in surface water/lakes (the areas should be suitably marked)

Primary protection zone

- from the water abstraction zone (recharge areas in surface watercourses/lakes) to abstraction wells. For the majority of facilities, this means the entire distance between the recharge and extraction points, around water abstraction zones in watercourses/lakes (same basis for division as for surface water supplies)
- around groundwater reservoirs/wells (same basis for division as for groundwater reservoirs/wells).

Secondary protection zone

- around groundwater reservoirs/wells (same basis for division as for groundwater reservoirs/wells). (Area between the recharge areas in surface watercourses/lakes and groundwater wells is included in the catchment area).
- around the primary zone in watercourses/lakes (same basis for division as for surface water bodies/supplies).

Tertiary protection zone

- those parts of the water protection area not covered by other protection zones.

4.3 Work procedure and surveys for the demarcation of the water protection area and dividing it into protection zones

4.3.1 Surface water bodies/supplies

The following is a general work procedure for surface water that may need to be modified based on the conditions of the potential water protection area:

- study the surface water body with respect to water flows and water quality (including nitrogen, phosphorus, metals and organic material)
- present the topography in the catchment area, including drainage and watershed, with special attention to detail in the intended water protection area
- present the water balance in the catchment area and the intended water protection area.
- perform a risk inventory of all current and future high-risk sites in the catchment area, with special attention to detail in the intended water protection area.
- identify key risks to the water body (threats)
- study vulnerability in the catchment area/intended water protection area based on geological/hydrogeological background data
- assess the value of the water body/supply
- perform impact and risk assessments/analyses for all key current and future high-risk sites in the water protection area.
- establish the protection requirement for the water body
- perform a preliminary demarcation of the water protection area
- study natural barriers (including flow times and dilution rates)
- present any occurrence of technical barriers (warning systems, protective measures)

- demarcate a water abstraction zone around the abstraction point in the watercourse/lake
- demarcate the primary protection zone. The zone shall consist of the water in lakes and surface watercourses and draining based on high-water transport with a flow-time of 12 hours with the accompanying 50 m wide shore zone/buffer zone. The flow time may be reduced if there are technical barriers.
- demarcate the secondary protection zone as :
- a) surface water drainage with a maximum flow time to the primary zone of 12 hours calculated at high water
  b) a land area with 100 days flow time (residence time in groundwater), although at least a 100 m wide area around the surface water recipients.
- demarcate other parts of the water protection area as tertiary protection zones (normally from the outer border of the secondary zone to the border of the water protection area).
- check the preliminary demarcation of the water protection area based on the zoning (check that the minimum requirements for residence times and flow times have been achieved) and adjust the demarcation if necessary.
- present a final proposal for demarcation of the water protection area and division into protection zones.

4.3.2 Groundwater bodies/wells

The following is a general work procedure for groundwater that may need to be modified based on the conditions of the potential water protection area:

- present the geology (soil and rock types) and hydrogeology in the catchment area
- present the topography in the catchment area
- present the hydrology (direction of flow in ditches and streams) within the catchment area
- present the groundwater shed
- present assessed recharge and discharge areas
- present a conceptual model of the surface and groundwater system with water balance (general). Present any induced recharge.
- study natural barriers (vulnerability and residence times in saturated and unsaturated zones) within the catchment area
- assess the value of the groundwater body/supply
- perform a risk inventory of all current and future high-risk sites in the catchment area.
- identify key risks to the groundwater body/well (threats)

- perform impact and risk assessments/analyses for all key current and future high-risk sites in the catchment area
- present any occurrence of technical barriers (warning systems, protective measures, etc.)
- demarcate a water abstraction zone around abstraction wells
- demarcate a primary protection zone. The border between primary and secondary protection zones is drawn so that the residence time in the groundwater zone to the border of the water abstraction zone is estimated to be at least 100 days for groundwater recharged in the secondary zone
- demarcate a secondary protection zone. The secondary protection zone should at least cover a sufficiently large part of the water protection area so that the estimated residence time for the groundwater from the outer border of the protection zone to the water abstraction zone is at least one year.
- demarcate the area between the outer border of the secondary zone and the border of the water protection area as a tertiary protection zone.
- Make adjustments to any demarcation of the water protection area.
- present a final proposal for demarcation of the water protection area and division into protection zones.

5. Water protection areas – designing regulations

5.1 The function and wording of the regulations

The county administrative board or municipality may designate a land or water area as a water protection area (Chapter 7, Section 21 of the Environmental Code). The county administrative board or municipality shall issue the regulations needed to safeguard the purpose of the area. Such regulations shall take the form of restrictions in the right to dispose of properties in the area. Where necessary, the county administrative board or municipality may stipulate that signs or fences be set up and that another's land may be used for this purpose (Chapter 7, Section 22 of the Environmental Code).

Before protection regulations are drafted, an inventory of real and potential pollution sources within the catchment area is performed and a study of what already applies in the area in accordance with other regulations is carried out.

The applicable scope of the restrictions in the right to dispose of properties in the area should be related to the purpose of the water protection area and the desired objectives as regards the quality and quantity of the water and a risk level for activities and measures which the authority deems acceptable in relation to the objectives. The restrictions are established in more detail by carrying out an assessment of just how risky the real and potential pollution sources are and the area's vulnerability and barrier capacity.

> **Excerpt from the general guidelines to Chapter 7, Section 22 of the Swedish Environmental Code**
> Regulations for water protection areas should be designed so that they guarantee adequate protection in both the short and the long term, i.e. from a multigenerational perspective. They should be adapted to local conditions and to the protection need.
>
> Regulations may need to be drawn up for water protection areas to impose far-reaching restrictions on the right to dispose of properties.
>
> The consequences of both sudden and continuous emissions from pollution sources should be considered in the regulations. This may be a question of both point sources as well as diffuse ones.

It is important that the regulations and their design really do guarantee protection of the water body. The restrictions do not need to go further than that, however. Restrictions in the rights of private individuals to use land or water may not be more stringent than is necessary in order to achieve the purpose of the protection (Chapter 7, Section 25 of the Environmental Code). This applies to both the decision to establish a water protection area and its accompanying regulations.

If the authority, e.g. regarding the handling of chemicals, deems that all handling does not need to be stipulated in regulations, it must consider carefully which types of handling should be subject either to prohibition or a permit requirement and state this in the

regulations unless the handling is already subject to prohibition or a permit requirement in accordance with other statutes. When explaining the term “handling”, the definition in Chapter 14, Section 4 of the Environmental Code can be used as a basis.

5.2 What is applicable to the water protection area in accordance with other regulations?

A number of provisions incorporated in regulations issued by municipalities, county administrative boards or central government agencies may already apply to a water protection area. When designing regulations for a water protection area, it is therefore important to firstly find out what applies for the area under other provisions or decisions in order to avoid unnecessary duplication of rules. Certain legal actions and penal provisions are associated with the regulations governing a water protection area including the right to compensation in certain cases (Chapter 31 of the Environmental Code). Other legal actions may apply for obligations originating from other provisions or decisions. Avoiding duplication is just a question of ensuring a regulation with exactly the same content is not introduced. Reference to other provisions can however be given in what is known as an “information paragraph”. , e.g.: “Under the Swedish EPA’s regulations on the spreading of chemical pesticides, SNFS (1997:2), the following applies ....”. This gives the reader a good overview of the regulations applicable to the area.

It is also possible to stipulate more stringent requirements in a water protection area’s regulations than in other regulations or to define such requirements in more detail. The permit requirements for a wastewater facility stipulated in other provisions may be inadequate in a water protection area. Instead, water protection regulations prohibiting such facilities within e.g. the primary protection zone can be issued.

It must furthermore be made clear that provisions also include exemption clauses. If another regulation stipulates a prohibition that is required for the water protection area but also an exemption clause that is wider than is required for the water protection area, it may be necessary to reintroduce the prohibition into the water protection regulation. Dispensations are hence considered in accordance with the water protection regulations and bearing in mind the purpose of the water protection area. It is possible for example to stipulate that cabling, piping and other technical equipment connected to a private wastewater facility must be of a certain quality prior to a permit being approved pursuant to the water protection regulations.

Regulations that may apply/apply to water protection areas include:

- municipal regulations for the protection of surface water bodies and private wells in accordance with Chapter 9, Section 12 of the Environmental Code and Section 40 of the Ordinance concerning Environmentally Hazardous Activities and the Protection of Human Health,

- municipal regulations on the spreading of manure and sludge, etc. (Section 40 of the Ordinance concerning Environmentally Hazardous Activities and the Protection of Human Health),
- municipal regulations on the keeping of animals in an area that is included on a detailed development plan or is subject to area regulations (Section 39).
- municipal regulations on permit requirements for the establishment of sewage treatment facilities, about which notification must be given to the authorities, in certain parts of the municipality, and on the requirement to notify the authorities in the event of such a facility being modified (Section 13).
- municipal regulations on permit requirements for establishing a heat pump station for the extraction of heat from earth, surface water or groundwater.
- municipal regulations on permit requirements, if a permit is not required pursuant to Chapter 11 of the Environmental Code, for establishing and using a new facility for groundwater extraction in areas where fresh groundwater is already or may in the future become scarce. The municipality may also stipulate a notification requirement for such facilities that already exist within specified areas (Chapter 9, Section 10 of the Environmental Code),
- provisions in a detailed development plan or area regulations stipulating that a building permit is required to set up or substantially alter structures for groundwater bodies referred to in Chapter 11 Section 11 of the Environmental Code (Chapter 8, Section 6 of the Swedish Planning and Building Act). Other issues can also be regulated, including land use, building, scarification and drainage measures.
- Swedish EPA regulations on pesticides (SNFS 1997:2) and General Guidelines 97:3 and NFS 2000:7 stipulating rules on the spreading of pesticides, e.g. in water protection areas,
- Swedish EPA regulations (NFS 2003:24) and General Guidelines on protection against soil and water pollution when storing inflammable liquids, with special rules for water protection areas,
- Swedish EPA's Cooling Agents Notification (SNFS 1997:3) with General Guidelines (1997:2) on the installation of refrigeration and heat pump facilities,
- local traffic regulations issued by the municipality or county administrative board pursuant to the Road Traffic Ordinance (SFS 1998:1276)
- regulations from county administrative boards or municipalities on the right to travel and be in a water protection area and to other matters of order in the area (Chapter 7, Section 30 of the Environmental Code).
- regulations on environmental concern drawn up by the Swedish Forest Agency and the Swedish Board of Agriculture.
- county administrative board regulations pursuant to the Seafaring Ordinance (1986:300)

Furthermore, the following may be implemented for water protection areas in the future:

- programmes of measures for the water district included in its management plan (pursuant to the European Water Framework Directive, 2000/60 EC)
- binding action programmes to comply with environmental quality standards (Chapter 5 of the Environmental Code)

5.3 Restrictions in the right to dispose of properties, etc.

> **Excerpt from the general guidelines to Chapter 7, Section 22 of the Swedish Environmental Code:**
> Certain activities should be prohibited within a water protection area. This applies, for example, to such activities that may cause irreversible damage or harm that may have far-reaching consequences for water quality and quantity. Damage can depend either on individual emissions, the combined effect of many small-scale emissions or the consequences of an intervention in the environment. Restrictions in the right to dispose of properties should, where necessary, cover both current and future activities.

The wording of Chapter 7, Section 22 of the Environmental Code states that it is not possible to formulate protection regulations containing a requirement for an individual to take active measures. Pursuant to this provision, a water protection regulation shall imply a restriction in an individual's right to use the land. The only concrete measure the county administrative board or municipality may stipulate is an obligation on the responsible body to put up signs or fences. Section 22 states that the county administrative board or municipality may in special circumstances grant exemption from the regulations issued. Under Chapter 16, Section 2 of the Environmental Code, conditions may be attached to permits, approvals or exemptions granted pursuant to the Code or regulations issued in pursuance thereof. It is therefore still possible to require active measures to be taken in conjunction with the granting of a permit or exemption from a prohibition on taking certain measures or pursuing certain activities within the area. All in all, such a regulation implies a restriction in the right to dispose of property.

It is possible to design regulations so that a permit is required for a certain activity or measure or as a prohibition. Concerning the latter case, Chapter 7, Section 22 of the Environmental Code stipulates that exemption can be granted by the regulatory authority. According to an amendment to Section 22, the county administrative board may delegate the granting of an exemption to an environmental council in the event of a person affected by the decision applying for such an exemption. The preparatory work prior to the provision (Government Bill 2001/02:65, p. 41) makes it clear that the term "exemption" shall also refer to permits since the content of the regulations constitutes restrictions in the right to dispose of properties. The county administrative board could therefore delegate both permit application and notification procedures and exemption application procedures to an environmental council.

The choice between a prohibition with possible exemptions and a permit requirement is significant in at least two ways (cf. Government Bill 1997/98:45, part 2, p. 76). Firstly, the conditions for a permit are easier to meet than the conditions for an exemption. A

prohibition is hence a more stringent regulation than a permit requirement and should be used if the rule of thumb shall be that the activity or measures are not to be pursued/implemented. Secondly, the choice is important from a compensation point of view. In cases where a protection rule is formulated so that an activity or measure requires a permit, compensation can become an issue only if a permit is subsequently refused or special conditions are attached to it and not already in connection with the permit requirement being decided. As regards a prohibition, however, compensation can become an issue as soon as the decision to adopt it has been made, on condition that there are indeed grounds for compensation, see Chapter 6 below.

A more precise definition of a requirement originating from other regulations may apply, e.g. that the land may not be used to store chemicals unless it has firstly been hardened or dammed, or limiting the maximum permitted volume that may be stored at the same time. The regulation is thereby made more precise for the area in question. Under Chapter 7, Section 26 of the Environmental Code, an exemption from e.g. water protection regulations may only be granted if it is consistent with the purpose of the prohibition or regulation.

It is also possible to formulate a protection regulation so that an activity or measure is in itself allowed within the water protection area, though only under certain circumstances directly stipulated in the regulation. It is important for the authority to remember to formulate the regulation as a restriction in the right to dispose of properties and not as a requirement for implementing certain measures, e.g. management of land areas. Pursuant to a new addendum to Section 22 of the Environmental Code, it may also be decided that notifications of an activity or measure within a water protection area are to be made to the environmental council. According to the preparatory work to this addendum (Official Government Report SOU 2000:116, p. 71), a notification requirement can be imposed on measures that constitute less of a risk to the water body/supply.

It is therefore possible to choose different methods to ensure that an operator observes certain precautionary principles or restrictions when pursuing an activity/implementing a measure, depending on what one wants to achieve. The choice is between a prohibition with possible exemptions, a permit or notification requirement for certain activities or measures or a clause stating that certain activities or measures are allowed but only under certain circumstances specified in the regulation. The choice of method depends on what the authority wishes to achieve, what already applies and what is deemed most effective and appropriate.

It should be pointed out that it is the person applying for a permit or exemption from a prohibited activity or measure who must show compliance with the obligations laid down in the relevant provisions (Chapter 2, Section 1 of the Environmental Code). The burden of proof therefore lies with the operator that he is pursuing an activity or implementing a measure in such a way and in such a location as to ensure compliance with the relevant legislation.

Regulations under Chapter 7, Section 22 of the Code only apply within the water protection area. An operator who is outside the area, whose activities may have a harmful effect on groundwater or surface water in the area, is obliged to take the water protection area into consideration when pursuing the aforesaid activities. (Government Bill

1997/98:45 part 1, p. 15 and p. 94). This is pursuant to the general rules of consideration in Chapter 2 of the Environmental Code.

Examples of how regulations can be formulated are given in ANNEX 3.

5.4 The content of the regulations and other measures

In the protection regulations, prohibitions can be laid down against e.g. the handling of petroleum products and other chemicals, the spreading of manure or pesticides, infiltration of household wastewater spillages and municipal stormwater, industrial operations, transportation of dangerous goods, construction of roads, buildings, excavations, quarrying, bathing, boating and fishing. The rules may concern activities pursued with a permit and may imply restrictions in existing permits pursuant to Chapter 24, Section 1 of the Environmental Code (Government Bill 1997/98:45 part 2, p. 94). The rules may, in this way, constitute restrictions in existing permits for e.g. water operations or environmentally hazardous activities. The protection regulations mainly regulate new activities, changes and special requirements for existing activities within the water protection area that do not require a permit. Activities that do not fulfil permit conditions or that contravene the rules of the Environmental Code in some other way may need to be rectified by implementing supervision measures in connection with the decision to establish a water protection area with accompanying regulations.

If there are special reasons, the county administrative board or municipality may grant exemption from regulations it has issued. The county administrative board may also delegate the granting of exemptions from the regulations governing a water protection area to the municipality (Chapter 7, Section 22 of the Environmental Code).

If it seems as though the purpose of the water protection area is not being achieved using the current regulations, these should be changed to achieve the necessary level of protection.

Abstraction zones and areas for artificial groundwater recharge

> **Excerpt from General guidelines p. 1 and 2 to Chapter 7 Section 22 of the Environmental Code:**
> The regulations for a water protection area should stipulate that only water supply activities are allowed in the water abstraction zone and that this area should be enclosed or, if it includes surface waters, be clearly demarcated.
> The regulations should also state that the water abstraction zone and land used for recharge (for artificial groundwater recharge) may only be disposed of by the water plant owner and for water supply activities.

The area closest to surface water and groundwater abstraction points is especially sensitive to disturbances. No other operations should therefore be permitted in this area. This also means that the water plant owner must be especially careful when working in the area. The water abstraction zone should be enclosed/cordoned off or marked. The area closest to the surface water or groundwater abstraction point and land used for

recharge purposes for artificial groundwater recharge should be owned or utilized only by the water plant owner. It is included in the water abstraction zone.

Petroleum products

> **Excerpt from General guidelines p. 3 to Chapter 7 Section 22 of the Environmental Code:**
> The regulations for a water protection area should stipulate for primary protection zones that the handling of petroleum products must not occur other than to supply residential and agricultural properties with oil, for which a permit is required. For secondary protection zones, the regulations should stipulate that a permit is required for the handling of petroleum products which may counteract the purpose of the protection in the short or the long term. The authority should state in the regulations which type of handling this refers to.

The regulations should not cover fuel in vehicles, works machinery and the like nor fuel in households. It is mainly the storage of such products that should be regulated, but this may need to be made clear in the regulations.

The Swedish EPA has designed regulations and general guidelines on the protection against land and water pollution when storing inflammable liquids (NFS 2003:24). These clarify that special restrictions apply in water protection areas. The material used as a basis for decisions on regulations for water protection areas should preferably refer to these and supplementary regulations be issued to achieve satisfactory protection for the water protection area in question.

Even very low levels of oil in the water give it an unpleasant taste. Oil in land areas or in groundwater is difficult to remediate. For this reason, an inventory of potential pollution risks from petroleum products should be performed and suitable protective measures established in each individual case.

For tertiary protection zones, and in cases where the authority has granted a permit for handling within secondary protection zones, it is important that the regulations clarify whether any restrictions on the handling of petroleum products apply to professional handling, general handling or just for household purposes.

For information about the term “handling”, please refer to Chapter 5.1.

Pesticides and plant nutrients.

> **Excerpt from General guidelines p. 4 to Chapter 7 Section 22 of the Environmental Code:**
> The regulations for a water protection area should stipulate that the handling of chemical pesticides in primary protection zones is prohibited. For secondary protection zones, the regulations should stipulate that a permit is required for the handling of chemical pesticides. The regulations should stipulate that a permit is required for the handling of plant nutrients in water protection areas. The authority should state in the regulations which type of handling this refers to.

Pesticides are developed to combat harmful organisms and include agents that are mainly used to protect plants and plant products in agriculture, forestry and horticulture. Pesticides are also used to combat harmful organisms, e.g. vermin, and are used primarily in the printing and vacuum impregnation industry.

The handling of chemical pesticides is also regulated in Swedish EPA regulations 1997:2 with appurtenant general guidelines 97:3 and NFS 2000:7.

Swedish EPA regulations 1997:2 refer to the spreading of chemical pesticides both outside and inside water protection areas. General guideline p.4 to Chapter 7, Section 7 of the Environmental Code therefore also stipulates that a permit requirement should also be considered for the handling of chemical pesticides (in addition to wood preservatives) in secondary protection zones.

Chapter 14, Section 19 of the Environmental Code stipulates a general prohibition against spraying forests with pesticides to control deciduous brush. Under Section 22 of the Pesticides Ordinance (1998:947), the Swedish Chemicals Agency may issue exemptions from the prohibition for scientific testing purposes. These rules should be referred to in the material used as a basis for establishing water protection areas and supplementary regulations should be issued to achieve adequate protection for the water protection area in question.

The applicable drinking water regulations, issued by the National Food Administration (SLVFS 2001:30), state that detectable levels of pesticides must not be present in raw water. According to these regulations, the limit for when drinking water becomes unfit for human consumption is 0.1 μg/l for each individual pesticide.

Despite restrictions on their handling, pesticides and their breakdown products have been detected in both groundwater and surface water. Stringent restrictions should therefore be in place regarding the handling of chemical pesticides within water protection areas. A permit should hence only be considered in the secondary protection zone under certain conditions.

Instructions and restrictions may also need to be introduced for private handling of pesticides in gardens and greenhouses. It is appropriate to clarify whether the regulations refers to all handling or just professional handling.

A prohibition against chemical treatment of a lake for fish preservation purposes may be included in the regulations.

For information about the term “handling”, please refer to Chapter 5.1.

It is as a rule not necessary to regulate the painting of buildings and similar maintenance, animal parasite control and the like in regulations for water protection areas.

Diffuse pollution sources often have a long-term effect on land, surface water and groundwater and are difficult to rectify. Eutrophication is a major problem for many of our water supplies. A number of differentiated environmental protection measures are therefore needed primarily concerning land-based industries. These industries are also taking action to reduce their environmental impact.

The storage of silage where pressed juice is produced may need to be regulated.

The risks associated with shoreline grazing and the spreading of manure primarily at surface water bodies need to be considered regarding waterborne infection caused by parasites.

Stores of timber

> **Excerpt from General guideline p. 5 to Chapter 7 Section 22 of the Environmental Code:**
> Regulations for a water protection area should stipulate that the permanent storage of bark and timber is prohibited in primary and secondary protection zones. Storage of timber from one logging season may occur in secondary protection zones. The regulations should stipulate that a permit is required for such temporary storage in primary protection zones.

Quality problems may occur in a water body when bark, timber, chips and shavings are stored nearby. Storage of these items normally involves some kind of chemical treatment to combat pest infestations. Brushwood, bark and excavation material containing plant residue can pollute the water as a result of degradation or the leaching of e.g. phenols. They can also reduce the oxygen content of recharged water.

Forest management can be further regulated in the regulations apart from aspects that are already covered in other acts of legislation. This may relate to harvesting methods, scarification, ditching, forest fertilization, as well as forest roads, when such measures can have a considerable impact on the water quality as a result of increased nutrient leakage and humus levels. It applies in particular to forest and forestland closest to lakes and watercourses. Logging within 20 metres of a lake or watercourse should therefore be carried out very carefully in order to avoid damaging the land and water. Within water protection areas, it is particularly important to ensure compliance with Swedish Forest Agency regulations and general guidelines appurtenant to the Forest Conservation Act on protection zones, clear-felled areas, damage to land and water and the routing of forest roads (Section 30).

The storage of harvesting machine fuel is regulated in point 3 of the general guideline. Fuel and hydraulic oil can leak.

Forest should primarily be regenerated naturally or using non-chemically treated plant material. Natural regeneration techniques should be employed at least within primary protection zones and where there is suitable forest soil. Ditching and mechanical scarification should also be avoided in these zones.

Diversion of household spillages and stormwater, and waste management

> **Excerpt from General guidelines p. 6 and 7 to Chapter 2 Section 22 of the Environmental Code:**
> The regulations for a water protection area should stipulate a prohibition against additional recharge plants for household spillage and discharges of other wastewater in primary protection zones. The regulations should also stipulate that a permit is required for such plants in secondary protection zones.
>
> The regulations for a water protection area should also state that the storage of waste or of snow from roads in a protection zone may not occur in a protection zone with more stringent regulations.

Wastewater is defined in Chapter 9 Section 2 of the Environmental Code. Waste is defined in Chapter 15 Sections 1 and 2 of the Environmental Code and the Waste Ordinance (2001:1063).

Wastewater pipes must be well sealed, be regularly inspected and when necessary be relaid or renovated. There should be no municipal wastewater pipes in the primary protection zone. If such pipes are necessary, they must be well sealed and regularly inspected. Wastewater treatment plants and pump stations should be designed so as to avoid overflow and they must also be regularly inspected. It may, in certain cases, be appropriate to distinguish between existing and future wastewater facilities. Existing facilities can often be left where they are or replaced by better facilities whilst the municipality may wish to have a prohibition against further installations. When considering permit applications, an assessment must be made of the incremental consequences of having several facilities in the same water protection area.

The landfilling of waste should not be allowed. Snow from areas outside the water protection area may not be stored within the water protection area.

Hazardous activities

> **Excerpt from General guidelines p. 13 to Chapter 7 Section 22 of the Environmental Code:**
> The regulations for a water protection area should stipulate that hazardous activities that involve a risk of pollution to surface water or groundwater may not be established in primary protection zones. The regulations should stipulate that new hazardous activities, of which prior notification must be given to the authorities, require a permit.

Hazardous activities are also regulated in other provisions under the Environmental Code.

The regulations for water protection areas shall supplement other provisions under the Environmental Code in order to achieve adequate protection. The regulations can regulate all forms of production, storage, use and handling of chemical products and goods, disposal of waste and discharges of wastewater along with other emissions from these activities. A change to an ongoing activity that has an adverse effect on the water protection should not be permitted without consideration by the supervisory authority. Wastewater discharges and the landfilling of waste should also be prohibited.

Planning provisions for the area should also be worded so that hazardous activities cannot be established within the water protection area.

Quarrying, other excavation works and dredging

> **Excerpt from General guidelines p. 9 and 10 to Chapter 7 Section 22 of the Environmental Code:**
> The regulations for a water protection area should stipulate that the quarrying of material is prohibited in primary and secondary protection zones around groundwater supplies and in primary protection zones around surface water supplies. The regulations should stipulate that subsistence quarrying (for private use) in a water protection area requires a permit. Oil spills must not occur. It should also be stipulated that access roads to quarries/wells shall as far as possible be cordoned off.
>
> The regulations for a water protection area should stipulate that excavation work, e.g. in connection with road building or other construction, and dredging may not be performed without a permit. As regards pile-driving, grooving and underground work, the regulations should stipulate a permit requirement in primary and secondary protection zones for a groundwater body and in primary protection zones for a surface water body.

Material quarrying refers to extraction of gravel, rock and the like. The prohibition does not extend to ongoing mining operations with a valid permit.

Quarrying operations often increase the vulnerability of the land and water. Taking away the overburden when quarrying and excavating removes the natural layer that protects the earth from pollution. This increases the risk of impact on the underlying land and water. A reduced overburden above the water table increases the speed at which both water and pollution travels, which also increases the groundwater recharge and may lead to more irregular water quality.

Quarry areas stripped of natural protection from vegetation and surface overburden should therefore be protected as far as possible against bacterial contaminants and other uncontrolled pollution. Oil spills must therefore not occur. This is also important to consider when designing planning provisions for the area.

The impact on groundwater from a gravel pit depends on the geological structure of the area, the thickness of the soil strata above the groundwater, the direction thickness the groundwater flow, the flow speed and the location and scope of the quarrying area. The local conditions must be taken into account when decisions on any new permits for continued quarrying operations are taken. It is important to consider aspects such as on which part of the ridge is being quarried, the groundwater flow from the quarry to the water intake point, the impact on groundwater recharge, what proportion of the ridge is being quarried and how much scope there is for good remediation.

The transport time from the bottom of the gravel pit to the water table should act as a guide for how long quarrying activities should be permitted and for determining the thickness of the protection layers. It is important to consider long-term fluctuations and the fact that removal of soil strata can increase groundwater recharge and hence the water table level. This means that the thickness of remaining soil strata/protective layers must be adapted to the type of soil material. The layer should be thick enough to allow time to deal with any spillage or leakage.

The protective layer of quarry areas stripped of natural protection in the form of vegetation and surface soil strata should be recreated. In open quarry areas, vegetation cover should be recreated as soon as possible after mining. Remediation measures should

be well detailed and adapted to suit the area. The aim of this is to increase protection against changes in groundwater quality, the spread of pollution, acidification of the groundwater and changed water table levels.

As regards quarrying operations, special attention shall also be paid when planning them, removing overburden, blasting, using dust binding agents, etc.

Maintenance of surface drainage facilities under Chapter 11 of the Environmental Code and normal operation and maintenance of roads should be exempt from the permit requirement.

Energy plants

> **Excerpt from General guidelines p. 11 to Chapter 7 Section 22 of the Environmental Code:**
> The regulations for a water protection area should stipulate that facilities for the storage and extraction of heat energy from rock, soil and water, abstraction of water from rock and soil, as well as other types of drilling that may affect water supply/quality are forbidden in primary protection zones and that a permit is required for such facilities in secondary protection zones for groundwater bodies and in primary protection zones for surface water bodies.

Special conditions may be attached when granting permits for the establishment of energy plants or when abstracting water from rock and soil. The risks to be considered include leakage of coolant fluid to the groundwater, risk of contamination or other impact in connection with drilling and operation of the plant, risk of saltwater intrusion and possible proximity to the well, etc.

When establishing such plants, the conditions of the ground may be adversely affected due to the elimination or weakening of natural protection in the form of dense soil strata that act as a barrier to pollutants as a result of changes in flow direction and in communication between groundwater bodies. The risk of increased contact between various water-bearing strata should be given special consideration. In sedimentary bedrock areas in particular, a mixture of water from strata with a poorer water quality can have adverse consequences.

The regulations for a water protection area shall stipulate special requirements for the establishment of heat pump systems in rock, soil or water or the abstraction of water from rock or soil.

In cases where hydrogeological data has been compiled, for example in connection with the planning of water bodies or the establishment of protection areas and accompanying regulations, the municipality could perform a risk assessment as to whether heat pump facilities, water wells or other drillings in the area shall be approved or not. Where there is no hydrogeological data, the municipality must decide for each water body whether such data shall be compiled as a basis for an assessment.

When considering each permit application, an assessment must be made of the incremental effect of many facilities.

It may be appropriate in certain cases when granting permits for energy wells to stipulate requirements for existing oil cisterns to be removed to increase the environmental benefit. An inventory should be taken of disused wells and where necessary, these should be sealed off.

The location of pipes on undeveloped land and in water areas should be documented and the documentation be easily accessible in case problems occur or to prevent problems during excavation work.

A permit may be required to establish wells pursuant to other legislation. See Chapter 1.

Transport of dangerous goods

> **Excerpt from General guidelines p. 12 to Chapter 7 Section 22 of the Environmental Code:**
> The regulations for a water protection area should stipulate that the transport of dangerous goods within primary protection zones may only occur on designated transport routes.

Accidents with dangerous goods can have far-reaching consequences for water supply and may even eradicate it completely in the long term.

Local traffic regulations pursuant to the Traffic Ordinance (1998:1276) can be promulgated to regulate the traffic in sensitive water areas. The advantage of issuing traffic regulations is that they are published in the Swedish Rescue Services Agency atlas and everyone transporting such goods will be made aware of them. The police are responsible for enforcing these regulations.

The county administrative board determines which roads are recommended for dangerous goods transport and the Swedish Rescue Services Agency is the competent authority. Railways should be considered a designated transport route.

The regulations for a water protection area can regulate not only transports of dangerous goods through the protection zone but also transports to and from facilities within it. As regards roads, the authority should work to ensure requirements are stipulated pursuant to other legislation as to how transport routes should be designed, e.g. with safety barriers, sealed ditches, kerbstones and the design of road gullies.

It is inappropriate to have parking bays or spaces and information signs located within water protection areas as they can give rise to “unnecessary” parking. Stormwater from roads, parking spaces and the like may need to be taken care of separately.

How the municipality wants dangerous goods to be transported should be evident from its comprehensive plan.

“Dangerous goods” are defined by the Swedish Rescue Services Agency as substances and articles, the transport of which is prohibited or only permitted under certain conditions pursuant to the RID/RID-S regulations.

It is also important to stipulate how the water protection area shall be signposted for hauliers and others visiting the area.

A reminder that all accidents must be immediately reported to the emergency services on telephone 112 should be incorporated into the regulation.

Boat traffic, shipping, vehicle washing

The regulations can regulate how boat traffic and other shipping is to be run, speed restrictions, as well as types of fuel and how they shall be handled on board and on land at jetties and marinas. See also Chapter 5.5.

The county administrative board also has the option of, under other legislation, imposing a speed limit in a lake, which can limit less desirable activities of importance for the protection.

Vehicle washing, when people use degreasing agents and the like, can be regulated as needed. This type of washing can be prohibited or only permitted in e.g. garages, carports or other places with wastewater drainage pipes.

In water protection areas where commercial shipping and/or leisure boat traffic occur, there should be a prohibition against emptying sanitary tanks and on the discharge of microbiologically or chemically contaminated ballast water. The county administrative board also has the option of adopting such regulations pursuant to the Seafaring Ordinance.

Road and railway maintenance

> **Excerpt from General guidelines p. 8 to Chapter 7 Section 22 of the Environmental Code:**
> Regulations for a water protection area should stipulate that the storage of asphalt, oil gravel or road salt is prohibited in primary and secondary protection zones. A permit requirement for the spreading of road salt in primary protection zones should also be stipulated.

Road salt has caused major problems mostly in groundwater bodies. Chloride ions are very volatile and are carried with road runoff down to the groundwater. To avoid impact on groundwater from the use of road salt, a permit should be required within primary protection zones. Increased chloride concentrations can cause more corrosion and at high levels, they risk affecting the taste and may cause negative health effects. The occurrence of salt in water bodies may indicate the presence of other road-related pollutants.

Permits for road salting in primary protection zones should mostly be avoided by implementing alternative methods, more optimum salt usage and optimizing the diversion of road runoff. This should always be weighed against the risk of accidents happening. Salt mixed with sand should be exempted from the permit requirement.

The use of pesticides for road and rail maintenance should be regulated. See above for pesticide use in agriculture, etc.

Tertiary protection zone

> **Excerpt from General guidelines p. 14 to Chapter 7 Section 22 of the Environmental Code:**
> Regulations for a water protection area should, if it is necessary to achieve adequate protection, stipulate a prohibition and restrictions in the right to dispose of properties in the tertiary protection zone. Such restrictions can e.g. cover modified land use. They may in certain cases be identical with regulations for other protection zones.

Where necessary, such activities can be regulated within the tertiary protection zone, which in turn can be regulated within other protection zones.

5.5 Regulations under Chapter 7, Section 30 of the Swedish Environmental Code and Section 40 of the Swedish Ordinance (1998:899) concerning Environmentally Hazardous Activities and the Protection of Public Health

Regulations for water protection areas can also be issued pursuant to the abovementioned enactments. Regulations under Chapter 7. Section 30 of the Environmental Code may refer to the right to travel and be in e.g. a water protection area and to other matters of order in the area. Regulations may be issued by the county administrative board (Section 22 of the Area Protection Ordinance (1998:1252) or by the municipality in cases where the municipality decides to establish a protection area (Chapter 7, Section 30 of the Environmental Code). These regulations may regulate activities/actions that otherwise would have been permitted pursuant to the right of public access, including entering certain sensitive areas, camping, parking a caravan, lighting fires, driving motorboats, laying anchor or laying up boats on land. Compensation cannot be payable because of regulations pursuant to Chapter 7 Section 30. It is appropriate to issue regulations that apply to the general public pursuant to Chapter 7, Section 30 of the Environmental Code since regulations under Chapter 7 Section 22 are primarily aimed at landowners and rights holders.

Municipal regulations pursuant to Section 40, Point 5 in the Ordinance concerning Environmentally Hazardous Activities and the Protection of Human Health may be issued if they are needed to prevent detriment to human health in a municipality and to protect surface water bodies and private groundwater wells. These regulations cannot form the basis of compensation either.

6. Water protection areas – cost aspects and compensation issues

6.1 Long-term planning

The earlier the interests of water supply and water body protection are considered when planning land and water areas, the easier it will be to take them into account. The total costs for information, consideration and protective measures will also normally be lower.

It is important that the water body receives the protection needed to safeguard the quality and quantity of the water in the long term. Compensation and costs in connection with establishing the water protection area and accompanying regulations should be seen in a long-term perspective. As a result, the initial costs of establishing preventive, effective protection can provide long-term economic gains when the supply is in use. Any compensation can be seen as an investment, similar to other investments in water protection areas, and not just as a cost. Voluntary agreements have been struck in some cases between the responsible body and landowners governing how land and water areas within the water protection area are to be used.

If a protection regulation pursuant to Chapter 7, Section 22 of the Environmental Code prevents land being utilized or severely restricts ongoing land use in part of a property, the landowner is entitled to financial compensation under Chapter 31, Section 4 of the Code. This also applies to a person who has special rights to a property.

Experience shows that municipalities don't always give notice of the protection that should be given to a drinking water body by demarcating a protection area and issuing appurtenant regulations. This may be due to a fear of compensation claims from landowners and special rights holders if they are not permitted to pursue activities which they have previously pursued in the prospective water protection area or if they cannot make the changes they intend to in the future.

6.2 The Swedish Groundwater Inquiry (grundvattenutredningen)

The Swedish Groundwater Inquiry (Official Government Report SOU 1995:45) pointed out, among other things, the hesitation shown by municipalities in establishing water protection areas and came to the conclusion that this was primarily due to their uncertainty about how compensation rules were to be applied.
The Inquiry claimed that it was possible to issue more far-reaching regulations than is normally the case, without any compensation obligation arising. It stresses that

“regulations on protective measures, restrictions and precautionary principles do not entitle stakeholders to compensation if the regulations are covered by additional rules of consideration (in Chapter 19, Swedish Water Act). When a regulation is justified from environmental reasons and remains within the scope of the abovementioned rules of consideration, it is irrelevant whether the regulations are felt to significantly restrict ongoing land use or not.” (p. 166 ff). These conclusions are partly based on the minister’s statements in the Government Bill (1981/82:130, p. 606) proposing a new water act. This opinion is shared by the Swedish EPA and is a condition that still applies.

6.3 When does compensation become an issue?

The preparatory work prior to enactment of the Environmental Code (Government Bill 1997/98:45, part 1, p. 550 ff) discusses compensation and the Environmental Code’s rules of consideration: “The Environmental Code will contain relatively far-reaching rules of consideration. An operator shall observe these rules on his own initiative and responsibility. The supervisory authority can take direct action pursuant to the rules of consideration to demand redress and the rules shall form the basis of the terms and conditions considered by the courts and other authorities when assessing or reassessing permit applications. A tacit and obvious limitation of the term “ongoing land use” is that only lawful use of land or buildings is entitled to compensation. A person therefore has no right to compensation if action is taken by an authority in order to ensure compliance with the precautionary rules and consideration requirements laid down in legislative acts.”

Compensation for intrusion in ongoing land use, etc., is regulated in Chapter 32 of the Environmental Code. Property owners and special property rights holders are entitled to compensation if a regulation for a water protection area severely restricts ongoing land use in the relevant part of the property. The same applies if the land is requisitioned. Compensation is not payable however for loss due to expected changes in the way the land is used not being realized as a result of protection regulations.

Neither is compensation payable if restrictions in a water protection area are the result of obligations the landowner nonetheless must consider pursuant to the general rules of consideration (Environmental Code Government Bill, part 1, p 551 ff).

The vast majority of protection regulations needed in a water protection area are made up of restrictions that the operator is obliged to tolerate without compensation being payable.

Chapter 19, Section 1 of the previously applicable Water Act stipulates some fundamental precautionary rules of care that were aimed at protecting water supplies. It can be noted that in two rulings from May 2002 (M 4900-00 and M4902-00 appealed to the Supreme Court, where reasons was not found to grant leave to appeal, cases T 2301-02 and 2302-02), the Superior Environmental Court gave its opinion on the implications of the precautionary rule in Chapter 19, Section 1 of the Water Act (1983:291). The court stated that this rule is worded so that when assessing what constitutes reasonable precaution, one should not in principle consider the economic effect of a requirement on the property owner. The Court stated that instead, the deciding factor as regards the more

precise implications of the precautionary rule in individual cases should be the normal protection need for groundwater supplies. When assessing what might constitute normal protection, the court based its assessment on the Swedish EPA recommendations and general guidelines, in these case the guideline stipulating that protection regulations should specify 3 m over the water table as the maximum permitted digging depth within the inner protection zone of a water protection area. Property owners are thereafter deemed to be obliged to endure such restrictions without receiving compensation. Similar precautionary rules to those laid down in the Water Act are now incorporated in the general rules of consideration in the Environmental Code. The rule of thumb pursuant to Chapter 2, Section 3 of the Environmental Code is that persons who pursue an activity or take a measure, or intend to do so, shall implement protective measures, comply with restrictions and take any other precautions, that are necessary in order to prevent, hinder or combat damage or detriment to human health or the environment. This rule is applicable regarding e.g. protection of a surface water and groundwater supply. Naturally, the other general rules of consideration in the Environmental Code also apply. Hence, a person pursuing any kind of activity that may jeopardize a water supply shall, among other things, observe the knowledge requirement in Chapter 2, Section 2, the site selection rule in Chapter 2, Section 4, the requirement to conserve raw materials and energy in Chapter 2, Section 5 and the product selection rule in Chapter 2, Section 6.

Examples of measures covered by the general rules of consideration in Chapter 2 of the Code include digging, blasting, establishing storage facilities and the spreading of fertilizer or pesticides. An obligation to observe precautionary measures may include a property owner refraining from certain activities that may damage the water supply, e.g. discharging wastewater or handling chemicals.

A regulation for a water protection area may sometimes constitute a prohibition against taking a certain measure without permission. In such cases, the rule of thumb that there may already be a compensation obligation when the regulations are issued does not apply. Pursuant to Chapter 31, Section 5, first paragraph, compensation shall instead be paid only after the permit application has been considered and resulted in a refusal or when special conditions have been attached to the permit.

If a prohibition against taking a measure without a permit has been issued in the form of a temporary ruling on, for example, water protection regulations pursuant to Chapter 7, Section 24 of the Environmental Code and such a permit is refused, the same provisions apply, i.e. compensation is only payable once the permit has been refused. As regards exemptions, the right to compensation in applicable cases is valid in conjunction with the prohibition itself. The landowner may, on the other hand, be obliged to refund the compensation if he subsequently is granted exemption from the prohibition (Chapter 31, Section 15 of the Environmental Code).

As regards activities for which a permit has been granted, the legal effect of the permit may imply that the rules of consideration need not be observed more than what is pursuant to the permit. A permit may, however, be revoked or its conditions reassessed in the event of further requirements having to be placed on the activities. No compensation is payable in such a case since this is based on the activity no longer fulfilling the applicable rules and hence being prohibited. The permitting authority would then

intervene based on the fact that the activity was contravening applicable rules of consideration (Government Bill 1997/98:45, part 1 p.551 ff).

To sum up, any entitlement to compensation as regards regulations on measures and restrictions governing water protection areas only becomes an issue if land is requisitioned or ongoing land use within the relevant part of a property is exacerbated as a result of the water protection area regulations. What "ongoing land use" refers to is specified in the preparatory work to the Environmental Code (Government Bill 1997/98:45, part 1 p. 550 ff).

The general rule of thumb is that compensation will probably not become an issue:

- if the regulations only amount to a more precise definition of what the property owner is nevertheless obliged to observe pursuant to the general rules of consideration, or
- if it is a question of restrictions pursuant to legislation other than the water protection regulations, in accordance with Chapter 7, Section 22 of the Environmental Code, and which are not linked to the compensation rules stipulated in Chapter 31 of the Code, or
- if it is not a question of an actual restriction or measures (signs or fences). Hence a provision stipulating a requirement for a permit does not provide entitlement to compensation until a permit is refused in the individual case.
- if the scope of the intrusion into the property is under what is known as the "qualification level", which corresponds to what the property owner is obliged to endure without compensation. In other words, the intervention must be of a certain significance before entitlement to compensation becomes an issue.

It should be emphasized that no entitlement to compensation arises as a result of an obligation, stemming from legislation other than Chapter 7, Section 22 of the Environmental Code and that does not form the basis of compensation, being included in regulations for water protection areas. A more precise definition of an obligation or an extended requirement relating to a water protection area may need to be included in the regulations for water protection areas. This is then also formal grounds for examining the compensation issue. It is thereafter incumbent on the authority that will examine the compensation issue to decide which part of the requirement stems from the water protection regulation and may involve compensation and which part stems from other rules to be observed without compensation.

6.4 Who should pay any compensation?

The main rule, as regards protected areas in accordance with Chapter 7 of the Environmental Code, is that compensation is paid by the state. If the regulations have been adopted by a municipality, the compensation shall be paid by the municipality instead. If the regulations have been adopted by a county administrative board, following application from a municipality or the party in whose interest the water protection area

was established, the compensation shall be paid by the applicant. The same applies if such regulations have been adopted by a municipality subsequent to an application by the party in whose interest the regulations were issued (Chapter 31, Section 7 of the Environmental Code).

The county administrative board or municipality may, on its own initiative, declare an area a water protection area and issue the necessary protection regulations. No special application is therefore needed, even though this is the common procedure to follow when a water protection area is established. The authority making the decision then pays the compensation. If this is the county administrative board, the compensation will be paid by the state.

A municipality, that does not independently decide to establish a water protection area, someone else who wishes to have special protection for a water supply, may contact the county administrative board and ask it to decide on the matter. The party requesting this will then pay the compensation.

7. Routines when applying to establish a water protection area

It is normally a municipality that, in its capacity as responsible body for a water well, applies for an area to be declared a water protection area. The water plant may have a different responsible body than the municipality. An application should include the proposals for protection regulations which the responsible body feels shall apply to the area. It should be emphasized that the county administrative board or municipality, on its own initiative, can declare an area a water protection area and issue the necessary regulations.

> **Excerpt from the general guidelines to Chapter 7, Section 21 of the Swedish Environmental Code:**
> If a water protection area or its catchment area affects two or more municipalities, the decision to establish the water protection area should be taken by the county administrative board.

If the county administrative board establishes the majority of water protection areas, the appropriate skills can be more easily gathered and maintained. The county administrative board can also support the municipalities when they establish water protection areas. Because it assesses Swedish Armed Forces facilities, the county administrative board is better placed to consider their impact.

7.1 Work procedure for applicants

The water plant owner provides background data as a basis for the decision, with proposals for a water protection area and accompanying regulations. The municipality's environment department, planning department and the responsible body for the water property need to cooperate. The protection should be designed in cooperation and consultation.

The Swedish EPA believes that information meetings should be held at an early stage with landowners and special land rights holders when a water protection area is to be established. It is also useful to send out information. From experience, many questions and thoughts can be answered and clarified by doing this, and it can also lead to greater participation in the process. The information received by stakeholders plays an important part in protecting the drinking water resource. Experience from routines for consultation meetings pursuant to the Planning and Building Act and environmental impact assessments (EIA) can be put to good use.

7.2 Content of the application

Applications may include:

Applicant's name

Stating the name of the applicant and any representative

Reason for the application

The purpose of the water protection area is clearly stated. This facilitates the assessment of a matter which is conflict with the water protection and application of the regulations.

Presentation of the need for the protection area

Providing general text on the conditions in the area as a basis for the decision to establish the water protection area.

Technical/hydrological description

Giving a technical and hydrological description of the water body's catchment area, including a hydrological and hydrogeological map. For groundwater bodies, the map shall specify the basic geological structure of the soil strata and the groundwater and surface water level conditions before and during continuous water abstraction. The map should preferably be based on the economic map sheet and a suitable scale would be about 1:10 000.

The map should also present the location, or proposed location, of the water abstraction/intake itself along with proposals for protection area borders, divided into well areas/intake areas and protection zones. Guidelines and justification for demarcation of the protection area should also be described here. If there is uncertainty about the area's demarcation, the applicant should contact the county administrative board/municipality for consultation. Consultation at an early stage in the process will save both time and money.

In words, supplemented by appropriate diagrams, a general description should be given of the technical installations (wells, pumps, pipes, treatment facilities, etc.) that are part of the facility.

Information that should be included in the technical/hydrogeological survey of groundwater supplies includes:

- Wells - number, type, depth, diameter and water supply
- The long-term capacity of the supply
- Water consumption – stipulated in m^3/day
- Water requirement - forecast for the next 20-25 years
- Reserve water supplies - reserve supplies or other water bodies that can be used in the event of the regular raw water intake being eliminated

- Water users - distribution area, number of people connected, likelihood of other large-scale water users, etc.
- Possible recharge area - extension, capacity, groundwater reservoir's catchment area
- Well area including recharge facility - owner and name of property. Documents that prove the applicant's right of ownership of the property or tenancy agreement/lease if the applicant is not the property owner
- Permit/water court ruling - number and year of the permit, and a summary of the water court's ruling
- Water quality - presentation of the water's bacteriological and physico-chemical analyses over a time period long enough to indicate possible trends. Information on water treatment
- The hydrogeological survey should also include results of pump tests.
- Information should also be presented on wells in soil strata and/or rock-drilled wells.

Information that should be included in a surface water survey

- Raw water intakes - number, type, depth
- Pump capacity - stipulated in m^3/day
- Water consumption – stipulated in m^3/day
- Water requirement - forecast for the next 20-25 years
- Reserve water supplies - reserve intakes or other water supplies that can be used in the event of the regular raw water intake being eliminated
- Water users - distribution area, number of connected persons and likelihood of other possible large-scale water users, etc.
- Area for raw water intake and pump stations - owners and name of property Documents that prove the applicant's right of ownership of the property or tenancy agreement/lease if the applicant is not the property owner.
- Permit/water court ruling - number and year of the permit, and a summary of the water court's ruling.
- Water quality - presentation of the water's bacteriological and physico-chemical analyses over a time period long enough to indicate possible trends. Information on water treatment
- The surface water survey - presents the water body's catchment area and the occurrence of inflowing watercourses and any residence reservoirs, flow times based on high-water transport, as well as turnover times for lakes. In lakes, the throughflow time caused by the rivers and the action of the wind is considered.

Planning provisions

Current planning provisions with regulations on land use and any planned changes to these are presented. These can be comprehensive plans, detailed plans, nature reserves,

area regulations. When the protection area in question is established, it is important that both the area itself and its catchment area are presented in the comprehensive plan. Applicable provisions from the municipality, county administrative board and central agencies affecting the regulations are presented.

The programme of measures and management plan for the district, in accordance with the Water Framework Directive, are presented insofar as they affect the water resource.

Presentation of potential pollution sources

A field inventory of potential specific pollution sources is performed, including petrol stations, industrial facilities, storage sites, gravel pits, barns, energy plants, oil cisterns, wastewater facilities inside the proposed protection area and close by. This inventory is presented. An assessment is made of the risk of them polluting the water supply and which measures need to be taken. Water and wastewater systems supply inside the area is also presented. How any deficiencies in the function of pollution sources are to be rectified and their risks are also to be presented. The inventory is most suitably presented in map form in a scale of 1:10 000.

At high water and in the event of flooding, the water may rise much higher than normal and extend over a much wider area. An inventory of the risk of flooding should be performed and presented.

The application shall also contain a list of all relevant properties with the registered owners and operators within the water protection area.

Draft protection regulations

Draft protection regulations, adapted to the prevailing specific conditions, and an overview of preventive protection against future disturbances are to be presented. The draft regulations should also give a more detailed description with regard to the specific conditions emerging from the technical description, planning provisions and the above-mentioned inventory.

Consultation/information

In connection with the abovementioned inventory and as preparation for assessment of the application, it is important to inform the general public, residents, usufruct holders and operators that a water protection area is being planned and of the likely consequences. This can most suitably be done in the form of an information meeting with the stakeholders, in which the consequences of the water protection area are looked at, compensation issues discussed, etc. This will avoid any unnecessary conflicts at an early stage. A requirement for consultation is contained in the Area Protection Ordinance.

Any consultations in the municipality or municipalities included within the water protection area are to be presented. If the municipality is the applicant, any consultations with its own municipal administrations/committees are to be presented.

Submission of the application

The application is addressed to the county administrative board or the municipality.

It helps the decision-making authority if the application is also submitted electronically.

8. Work procedure for county administrative boards/municipalities

8.1 Processing of the application

The application can be processed in different ways depending on whether it is the county administrative board or the municipality that is establishing the water protection area. However, some parts of the process are regulated by the provisions of the Environmental Code.

- A proposal for a water protection area and accompanying regulations are drafted by the applicant after consultation with the relevant persons at the municipality and county administrative board. In some cases, the county administrative board/municipality performs a preliminary technical examination which is circulated for comment internally at the county administrative board and other relevant authorities. A desk officer at the authority reviews the received documents to determine whether they need to be supplemented or revised and then expresses an opinion. The applicant makes final adjustments to the application.
- This final version of the proposal is then sent to the county administrative board/municipality for approval.
- Any further supplements/revisions of the documentation are done in consultation with the applicant.
- The county administrative board checks to see whether the municipality has adopted the proposal, if the municipality is the applicant, and the county administrative board/municipality checks to ensure the applicant has the legal authority to apply.
- Before the county administrative board or municipality takes the decision to declare an area a water protection area, landowners and special rights holders are called upon to comment on the proposal within a given time limit. This time limit may not be less than one month. The parties shall normally be served with an order to comment. (Section 24 of the Area Protection Ordinance pursuant to the Environmental Code). The order shall be publicly announced if a large number of stakeholders are involved or if it otherwise would be expensive to contact each one individually (Section 21 of the Administrative Procedure Act) The parties served with the order should include property owners, leaseholders, holders of fishing rights, hunting rights, reindeer herding rights, easement rights, wayleave rights, hunting/fishing concessions and tenancy rights.
- The county administrative board and the municipality shall consult each other prior to taking the decision to declare an area a water protection area (Section 25 of the Area

Protection Ordinance). Regarding water protection areas, the Geological Survey of Sweden (SGU) shall also be asked to comment unless it is obvious that the matter is of no significance to them (Section 26 of the Area Protection Ordinance). The Swedish Board of Fisheries shall also be asked to comment (Section 25a). The Swedish Maritime Administration may also be affected. The proposal is circulated for comment to the relevant municipal committees, county administrative board units and other relevant authorities (if comments received from other parties require changes to be made to the proposal). Extracts of the minutes of meetings can be enclosed as proof that the relevant committees/units have approved the proposal.

- The applicant is notified of the comments received regarding the proposal. If new information that is of significance to the matter emerges, the referral bodies may need to be consulted again.
- The county administrative board/municipality performs an equity assessment in accordance with Chapter 7, Section 5.
- Before disseminating maps supplemented with information about the water protection area, the author shall authorize use of the map.
- The county administrative board/municipality takes a decision in the matter.
- Decisions on water protection areas shall be announced in the way prescribed in statutes generally and also be announced in local newspapers. If it is obvious that the decision only affects one or just a few parties, the decision may be communicated to them privately instead of being publicly announced (Section 27 of the Area Protection Ordinance).
- Decisions shall be sent to the responsible body/applicant, landowner, the Swedish EPA, the county administrative board or municipality, as well as to other authorities such as the Swedish Board of Fisheries, National Board of Housing, Building and Planning, Swedish Maritime Administration, National Land Survey of Sweden, the road maintenance authority and SGU, unless it is obvious they do not need to know about the decision (Sections 28-31 of the Area Protection Ordinance).
- The county administrative board's decision on a water protection area may be appealed (Section 41 of the Area Protection Ordinance) in writing to the Government. A municipality's decision on a water protection area, etc., may be appealed to the county administrative board (Section 41 of the Area Protection Ordinance). The county administrative board/municipality may in certain cases correct its decision.
- The county administrative board shall keep a register of decisions on water protection areas (Section 33 of the Area Protection Ordinance). Remember the decisions made by municipalities!

Any compensation issues are assessed by the environmental court by special order.

Please consult the Handbook for Nature Reserves (2003) for further information.

Template that can be used for decisions. See ANNEXES 3 and 4.

Municipal regulations for the protection of surface water supplies and private groundwater wells pursuant to the Ordinance concerning Environmentally Hazardous

Activities and the Protection of Human Health (1998:899) are adopted by the municipal council but the application is processed by the municipal executive board.

8.2 Signs

Where necessary, the county administrative board or municipality may stipulate that signs or fences be set up and that another's land may be used for this purpose. Recommendations on the design and erection of signs to demarcate a water protection area can be found in the information brochure "Utmärkning av vattenskyddsområde [Marking out a water protection area]" from 1998, produced jointly by the Swedish Rescue Services Agency, National Road Administration, Swedish Association of Local Authorities, Swedish Water and Wastewater Association, Swedish Maritime Administration and the Swedish EPA. Signs are an important part of the information on the protection of the water protection area.

8.3 Impact analysis

Pursuant to Sections 27-28 of the Government Agencies and Institutes Ordinance (1995:1322) and Section 2 of the Ordinance (1998:1820) concerning special impact analyses of the effects of regulations on conditions for small enterprises known as the "Simplex Ordinance"), authorities shall perform an impact analysis on regulations pursuant to the Swedish Code of Statutes Ordinance (1976:725) before they are adopted. Regulations pursuant to the Swedish Code of Statutes Ordinance refer to regulations pursuant to Chapter 8 of the Swedish Instrument of Government, which is a legislative act of general application. Regulations pursuant to Chapter 7, Section 22 of the Environmental Code for water protection areas do not constitute such generally applicable regulations. They are aimed at property owners and owners of special rights to properties. There is therefore no statutory requirement to perform an impact analysis in accordance with the Government Agencies and Institutes Ordinance or the Simplex Ordinance for such decisions.

The county administrative board must however perform impact analyses for regulations pursuant to Chapter 7, Section 30 of the Environmental Code, since these are of general application. The impact on small enterprises needs be analysed only if the regulations have a significant impact on their working conditions, competitiveness or other conditions.

If the regulations pursuant to Chapter 7, Section 30 of the Environmental Code are of a standard nature or only marginally restrict the freedom to act, a fairly brief impact assessment should be sufficient.

Such impact analysis requirements do not exist for municipalities since they only apply to authorities under the Government. The Local Government Act does however contain some statutory requirements pertaining to how matters are prepared. Even though the

impact analysis requirements do not formally apply to municipalities, it may be useful for them to perform similar analyses.

8.4 Information in decisions

As comments or to supplement the decision, details can be given of compensation issues, supervision, other legislation, new legislation, the erection of signs and information boards.

8.5 Revoking decisions on water protection areas

If the county administrative board/municipal council establishes revised protection areas and protection regulations, the applicant must request that water protection areas declared by the district water courts be annulled. The county administrative board itself annuls decisions it has announced. Decisions by the water court should, where appropriate, be annulled by the county administrative board. An annulment provision may be needed stating that old decisions cease to apply when the decision to establish a new protection area gains legal force. See ANNEX 4.

Decisions to annul a protection area shall be announced publicly (Section 27 of the Area Protection Ordinance)

8.6 Interim prohibitions

When the issue of protecting an area by declaring it a water protection area is raised or if an area that is already protected shall be enlarged, the county administrative board or municipality may impose a prohibition for a specified period of not more than three years against measures without prior permission which would affect the area or conflict with the purpose of the intended protection (Chapter 7, Section 24 of the Environmental Code). In special circumstances, the prohibition may be extended for a period of not more than one year.

9. Supervision of the water protection area

Once the drinking water body is legally protected, the work to apply the regulations by dealing with applications for permits or exemptions continues. Based on the required background data used as a basis for decision-making, the authority shall decide whether a permit or exemption from the water protection area regulations can be issued or not and under what conditions. It can be emphasized that the purpose of water protection areas can often only be achieved by imposing far-reaching restrictions.

Informing residents and operators about the protection and ensuring compliance with it and observance of it in other contexts are part of the subsequent monitoring procedure. This can also be done within the framework of the remits of the various expert committees and responsible body. Regarding environmental protection, an increasing amount of emphasis is being put on different forms of cooperation that can facilitate decisions and the implementation of action programmes and on increasing the commitment, participation and motivation of various actors (including business operators, landowners, decision-makers, civil servants, politicians, etc.). This differs perhaps from traditional environmental work, where proposals and requirements can often be experienced as coming “from the top down”. Cooperation between different local actors, such as farmers and residents in a sub-catchment area or part thereof, can help them safeguard their local environment. This can be part of local Agenda 21 efforts. The European Water Framework Directive highlights different forms of cooperation in order to increase public participation, which in turn can facilitate the implementation of measures. Cooperation can create greater interest among residents and the general public in protecting their drinking water resources.

A work plan can be produced for the water protection area presenting the purpose of the established protection zones, spatial plans, water supply plans, nature conservation plans etc., on the municipal and regional level. It is then necessary for these intentions to be considered in and have an impact on day-to-day work. For example, compliance with protection area regulations must be enforced through supervision, the impact of guidelines monitored, etc., and any shortcomings in the protection rectified. It is therefore necessary for everyone who has the opportunity to affect the water protection, as a result of their activities, to have a good knowledge of planning and the requirements that apply to water protection.

Water protection areas need to be reviewed at regular intervals. Changes in and upstream of the water protection area may require the demarcation of the area and the content of the regulations to be reviewed.

9.1 Information

Well-adapted information is a cost-effective tool to help prevent undesirable activities and near-accidents in and outside the water protection area. One option is to send out customized information about the water protection to the general public and operators within the water protection area at the same time as they are sent water/wastewater/refuse collection bills. Regular information initiatives are very useful.

Signposting the water protection area is an important information component.

9.2 Supervision and self-inspection

It is obviously in the interest of the responsible body to take initiatives to protect its water bodies/supplies and to monitor what happens in the water protection area so that the water doesn't become polluted. This should be done in consultation with those who live and work in the water protection area and with the municipal authorities. If the responsible body becomes aware of a violation of the protection regulations, it should contact the supervisory authority. The responsible body can also initiate legal proceedings by reporting the violation.

Provisions governing supervision and charges can be found in the Ordinance concerning Supervision under the Environmental Code (1998:900) and the Ordinance concerning Charges for Examination and Supervision under the Environmental Code (1998:940).

Pursuant to the appendix to the Supervision Ordinance (1998:900), point A 19, the municipal executive board exercises supervision over water protection areas approved by

the municipality and pursuant to point A 18, it is the county administrative board that exercises supervision over water protection areas approved by the county administrative board. The county administrative board may delegate supervision to a municipal committee.

Operators are also obliged to carry out self-inspection in accordance with Chapter 26, Section 19 of the Environmental Code. This includes examining how the activity affects the protection of the area and preventing detriment (see Swedish EPA general rules 2001:2 and the self-inspection handbook 2001:3).

Under Chapter 26. Section 9 of the Environmental Code, the supervisory authority may issue injunctions and prohibitions that are necessary in individual cases to ensure compliance with a water protection regulation. An authority may also take direct action pursuant to the general rules of considerations in Chapter 2 of the Environmental Code. This means that a supervisory authority may intervene to protect a water supply even if no water protection regulations have been issued for it.

Under Chapter 28, Section 1 of the Environmental Code, the supervisory authority shall be given access to properties, buildings and other structures and means of transport. This right of access applies if it is needed for supervision purposes. The supervisory authority may perform e.g. surveys there.

Furthermore, under Chapter 29, Section 8, point 7 of the Environmental Code, a person who contravenes a regulation issued pursuant to Chapter 7, Section 22 of the Code is criminally liable. This refers to situations such as when property owners violate a restriction in the right to use their property. Under Chapter 29, Section 9 of the Environmental Code, any person who infringes any of the regulations issued pursuant to Chapter 7, Section 30 of the Code is also criminally liable.

Under Chapter 26, Section 2 of the Environmental Code, the supervisory authority shall report any infringements of the provisions of the Environmental Code and regulations issued in pursuance thereof, e.g. a water protection rule. Any suspected infringement shall be reported to the police or prosecution authorities.

If the water supply has been damaged, the responsible body may sue for compensation in accordance with the provisions on environmental damage in Chapter 32 of the Environmental Code.

Regardless of whether environmentally hazardous activities are covered by the obligation to have a permit or to notify the authorities pursuant to the Ordinance concerning Environmentally Hazardous Activities and the Protection of Human Health, the supervision exercised over such activities, both in accordance with the water supply protection regulations and pursuant to the Environmental Code, needs to be substantially extended. Municipal environmental committees, the county administrative board and the responsible body may therefore need to cooperate to a greater degree in this issue in order to prevent further problems and improve the protection. It is important for water protection issues to be highlighted.

Protection can also be strengthened by improving control of the conditions inside and around the water protection area. This includes checking the water quality through environmental monitoring and supervision of environmentally hazardous activities. Conditions can change, which may require a review of both the demarcation of the water protection area and accompanying regulations.

9.3. Supervision fees

Under Chapter 27, Section 1 of the Environmental Code, the municipal council may issue regulations imposing charges to cover the costs of examination and supervision in accordance with water protection regulations issued pursuant to the Environmental Code. The Ordinance concerning Examination and Supervision Charges under the Environmental Code (1998:940) applies for provisions issued pursuant to the Environmental Code and for other costs incurred by the authorities connected to examination and supervision (Chapter 1, Section 1). Types of cases in accordance with the Environmental Code include exemptions under Chapter 7, Section 22 from water protection area regulations (Chapter 7, Section 1 of Ordinance 1998:940) and applications for new or modified conditions of an exemption or permit. The provisions in Chapter 10 of the Fees Ordinance (1992:91) apply as regards the size of fees (fee categories 5 and 4 respectively).

Fees cannot be charged by county administrative boards or municipalities for the work involved in establishing water protection areas.

10. Further information

10.1 Requirement for raw water quality and quantity

Before a water body/supply can be brought into service, a survey of its water quality, lasting long enough to reflect seasonal impact, should be performed. The survey should last at least one year, although a longer period may be needed, e.g. to study how periods of low or high precipitation affect the water quality. Raw water quality has a significant impact on water supply. Some water types are more difficult to process at water treatment plants, e.g. water with a high humus content, or of a high or varying temperature.

The quality survey differentiates between natural and anthropogenic impact in order to determine where environmental protection measures can be most effectively employed. The Swedish EPA report on assessment principles for environmental quality is a classification system/tool to facilitate interpretations of environmental data. Using this system, we can assess whether measured values are low or high compared to the national average, surrounding area or original levels.

The raw water shall be of a sufficiently high quality so that it can be converted into drinking water using appropriate and reliable methods. These requirements are based partly on experience related to health aspects and partly on aspects of water treatment technology to make them as simple and safe as possible. The specific quality requirements placed on raw water from surface water bodies do not apply to, inter alia, surface waters that are used to recharge groundwater. On the other hand, polluted water must not be recharged in the ground.

The National Food Administration (SLV drinking water regulations, SLVFS 1993:35) has specified which raw water quality requirements must be fulfilled for a surface water body to be used for drinking water supply. There are also requirements places on drinking water. Water from many supplies is consumed without prior treatment. In such cases, the drinking water requirements are placed on the raw water. These requirements from the National Food Administration are less stringent than the ecologically related requirements on “biotope water” and in the European Habitats Directive and Water Framework Directive. Based on the fact that groundwater, as a link in the ecological system, can also affect the habitats of plants and animals, the ecologically related requirement for the environmental quality objectives is more stringent than for drinking water. Many plants and animals are in constant contact with the groundwater and they consequently need a higher nitrate level than humans need in their drinking water.

The National Food Administration (NFA) adopted new drinking water regulations in 2001 (SLVFS 2001:30), which came into force on 25 December 2003. As a result, NFA regulations on drinking water stipulating a requirement for analysis of raw water will cease to apply. The Surface Water Directive is included in the Water Framework Directive. Regulations on surface waters that are used for drinking water production will be drawn up.

Environmental quality objectives are set for water in every river basin district in accordance with the framework directive. These may not be lower than the objectives specified in the water directive.

It is worth remembering that the environmental quality objective “Good-Quality Groundwater”, adopted by the Swedish Riksdag, stipulates that even lower pollutant concentrations than those specified in the directive are to be achieved in some groundwater bodies.

There are no general rules for quantity requirements. Applicants must instead consider what is required to be able to satisfy a long-term future need for water.

Svenskt Vatten (previously the Swedish Water and Wastewater Association) has specified key ratios to be used to calculate the water needs of households and business units (Swedish EPA report 4492). Furthermore, for emergency preparedness reasons, the National Food Administration has presented key ratios to calculate the water needs of households and priority customers (SLV report 6/96).

10.2 List of water protection areas

Under the Water Framework Directive (Article 6), registers of all areas lying within each water basin district which have been designated as requiring special protection are to be drawn up. These registers shall include all bodies of water (drinking water sources) used for the abstraction of water intended for human consumption and providing more than 10 m3 per day as an average or serving more than 50 persons and those bodies of water intended for such future use.

According to Section 33 of the Area Protection Ordinance, the county administrative board shall keep a register of decisions taken on, inter alia, water protection areas, pursuant to Chapter 7 of the Environmental Code, including water protection areas approved by the municipalities. The Swedish EPA shall keep a comprehensive national register of such decisions. The county administrative board or municipality shall therefore send decisions on water protection areas to, inter alia, the Swedish EPA in accordance with Section 28 of the Area Protection Ordinance.

10.3 List of wells

Those pursuing commercial drilling, pipe-laying, digging or similar activities in order to examine the presence of groundwater or to utilize groundwater or produce geothermal heat are obliged to submit a written account of their work and the results to the Geological Survey of Sweden (SGU). (Act relating to the obligation to report on the exploration for groundwater and drilling of wells, 1975:424).

11. List of references

Not translated.

12. Annexes

Annex 1 Definitions of terms used in the handbook

Not translated.

Annex 2 Surface water transports - risk assessments

A great deal of surface water consists of groundwater that runs out naturally into surface waters. Surface waters can in exceptional circumstances recharge groundwater reservoirs. The protection of surface water and groundwater can therefore not be seen as an isolated phenomenon regarding what happens in the ground, in the groundwater and in the surface water.

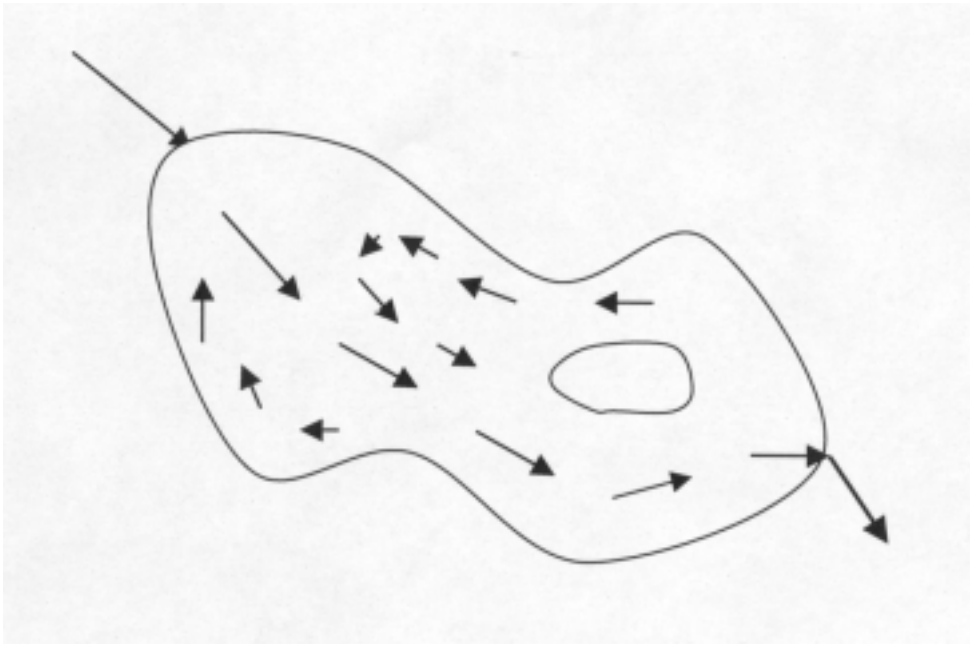
Previously, when demarcating water protection areas, attention has not been paid to the rapid processes, with the result that far too small a part of the water body's catchment area has been designated a protection area. The rapid processes in surface watercourses require a different approach to the slow processes in e.g. groundwater, since there is insufficient time to detect and take measures to deal with or remediate the pollution before it reaches the surface water's intake.

Regarding rapid transports of pollutants in surface watercourses, the point of departure should be to base the protection on preventive protection measures that reduce the risk of pollution accidents as far as possible, supplemented by an extensive warning system. Regarding for example facilities or sections of road with hazardous goods, that constitute potential risks within the water protection area, where there is insufficient time for information to be disseminated at sites of potential pollution incidents, adequate preventive measures must be taken to substantially reduce the risk of a pollutant reaching the water body.

The barrier capacity of the watercourse is governed by flow times, stretches of rapids, to what degree the watercourse meanders, intermediate lakes, degree of dilution with unaffected water, the location of the raw water intake in relation to the main watercourse, etc. The barrier capacity is important for risk reduction.

Water transport and circulation in a lake depends on the catchment and its size in relation to the lake, the shape of the lake, its depths, stratification and wind conditions. A large flux can lead to rapid throughflow, involving only parts of the lake's water volume. What is known as the "theoretical turnover time", i.e. the time it takes to replace all the water in a lake with new water, is a measure of the renewal time, but does not give the transport time, which is quicker.

When calculating the theoretical turnover time, it is assumed that only old water runs out to be replaced by new water, i.e. by dividing the volume of the lake by the flux into the lake, you obtain a measure of the throughflow. In reality, the entire volume of the lake is never involved in the replacement process, and in a lobate throughflow lake, a much smaller volume of the lake is involved than in a more evenly shaped lake.



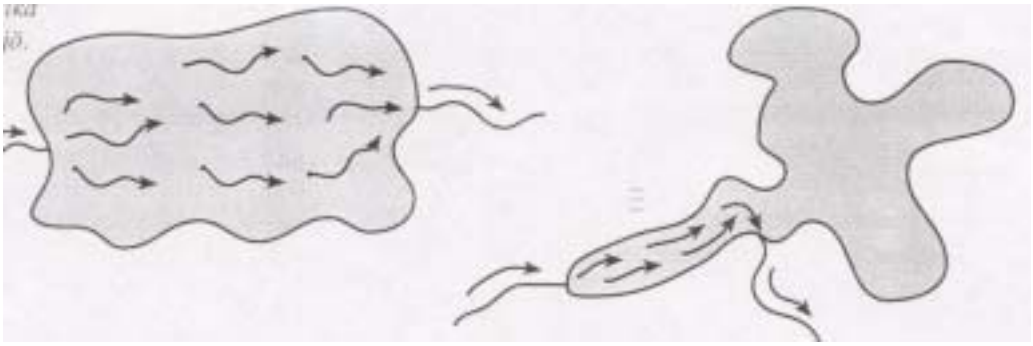


Diagram 2.1. Examples of different throughflows in a lake (the diagram at the bottom is from the SLV Risk Handbook 1997)

In slightly large lakes, the wind drives the surface currents and creates circulation, which is affected by the lake's morphology and possible stratification. The lake bottom topography, its shoreline contours and friction conditions are significant. The currents in a lake can therefore not normally be generalized. Numerical models can be of help to calculate the currents.

Several factors must be considered when calculating transport times. There can be major differences in flow times depending on whether it is a stretch of watercourse or a lake.

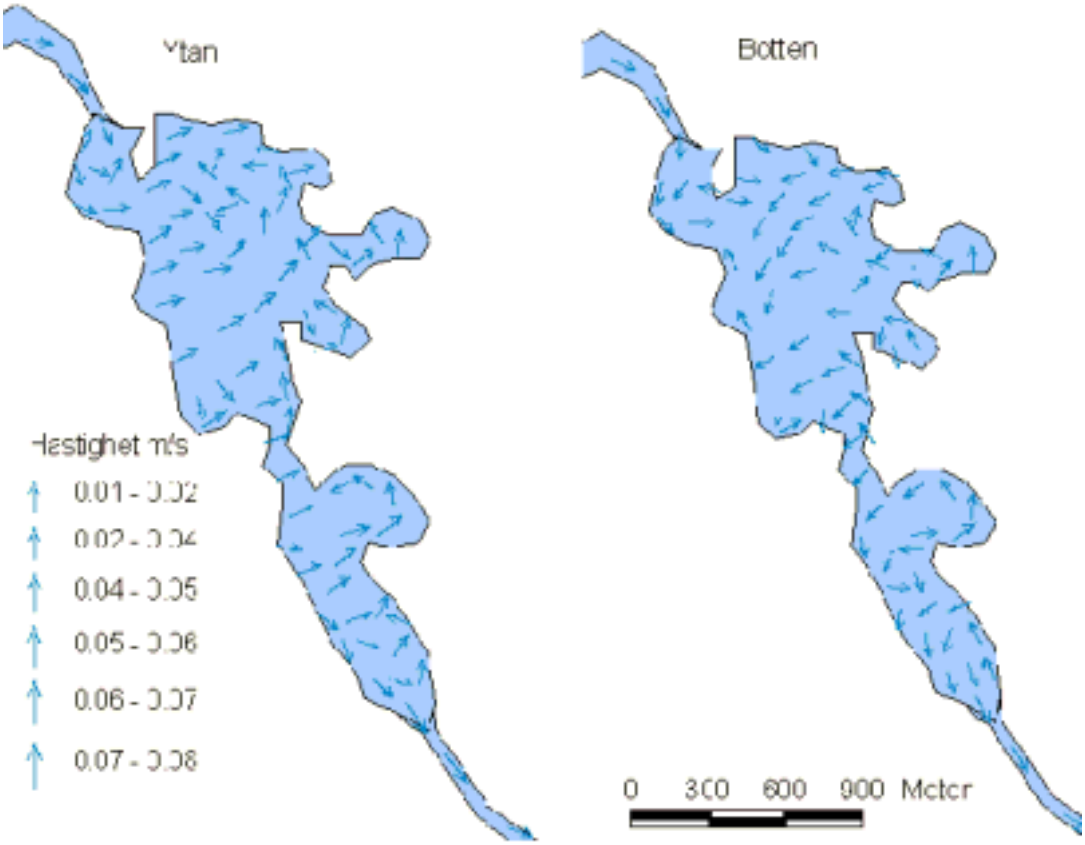


Diagram 2.2. The diagram shows a watercourse flowing through a lake. The calculation shows the flow conditions at low throughflow, SW wind 6 m/s and when the lake's water volume is stratified. The arrows show the flow situation at the surface and at the bottom. The flow pattern is clearly affected by the wind and by the shape of the lake at surface level, whilst in the deep water, it is partly flowing in the opposite direction. Swedish Meteorological and Hydrological Institute (SMHI)

Experience from the Karlshamn accident in 1994 shows that the transport time at the site of the oil accident had been overestimated. Instead of an estimated transport time of 4-5 days, the actual transport time was 2-3 days from the site of the accident to the water

intake. The actual flow times in a worst-case scenario (i.e. in the worst possible conditions) must be calculated/measured. The transport time must be long enough so that the water intake can be closed before the pollution reaches it. It is also possible to assess flow times based on measurements in adjacent areas or on standard values.

The flow time in a watercourse depends on:

- The gradient of the terrain. The gradient affects the flow speed in the water system. The table below gives generalized water speeds based on idealized situations for smaller water systems. The table therefore shows rough estimations of possible speeds. Assessments of flow times often require special examination in each individual case. The water speed varies depending on the cross-sectional area and can in the rapids of larger watercourses reach 3 m/s. A topographical map with a 1:50000 scale with a contour interval of 5 m gives a rough indication of the gradient per kilometre.
- Flooding. Heavy rain on already saturated ground substantially increases the flow time in a watercourse. Up-to-date flood information and forecasts can be obtained from SMHI. Statistical water discharge measurements provide flood information at low, normal and high water. This data is calculated from existing measurement series and is extrapolated to unmeasured watercourses and sites by SMHI. The SMHI publication "Avrinning i Sverige [Runoff in Sweden]" shows how average runoff expressed in litres/second/km^2 varied throughout the country, average figures for the period 1961-1990. The variation around these average figures is considerable.
- The cross-sectional area of the watercourse. The flow speed depends on the cross-sectional area and can be expected to increase from close-meshed networks of ditches and streams to large rivers. In stretches of smooth water and lakes, the speed normally drops considerably.

Gradient in m/km	Ditch m/s	Stream m/s	River m/s
1	0.4 (ca 1.4 km/h)	0.6 (ca 2.2 km/h)	0.8 (ca 2.9 km/h)
5	0.7 (ca 2.5 km/h)	1.1 (ca 4 km/h)	1.6 (ca 5.8 km/h)
10	0.9 (ca 3.2 km/h)	1.5 (ca 5.4 km/h)	2.1 (ca 7.6 km/h)

Table. Examples of rough general estimates of transport speeds as an average per kilometre for surface waters in different terrain in extreme flood situations. The cross-sectional area in the watercourse determines its type.

Regarding large watercourses, the flow image can show complicated features, e.g. whirlpool formation and currents that can move upwards (10 - 20 m) in the watercourse, but which cannot be described by a hydraulic model or simpler calculations. These currents may be important for the dispersion and dilution of a substance and it is therefore suitable to draw the protection zone's border somewhat downstream of the water intake.

Oil pollution is presumed to spread on the surface of the water at about 3 percent of the wind speed. For the other 1-metre stratum, 1.5 percent can be used as a guideline value for surface current, a wind of 10 m/s gives a current speed of 0.15 m/s.

For most of the year, the temperature of water flowing into lakes from watercourses deviates from that of the lake water. Because the density in the water volumes is different, the inflowing water is introduced at different levels instead of being divided equally from the surface to the bottom. The calculations are not as significant for small lakes as they are for large lakes. When the lake is covered in ice, the wind has very little impact and throughflow often occurs in a thin stratum under the ice since the temperature of inflowing water is often close to zero. Whilst the lake is ice-covered, there is a risk of increased water abstraction coupled with less water throughflow changing flow directions in the lake and watercourse.

The properties of pollutants

Pollutants can have different properties. Organisms that periodically develop toxins can sometimes appear in our lakes. Particles that do not dissolve in water can be of organic origin, e.g. from the degradation of plants and animals or humus, or of inorganic origin, e.g. clay. Even if the particles themselves are harmless, they can attract substances that cause problems when treating water. Inorganic pollutants can include heavy metals, iron and manganese, and various nitrogen and phosphorous compounds. Dissolved organic substances may stem from natural processes but can also include a number of pollutants from normal wastewater, pesticides, petroleum products, etc. They can be difficult to treat in a conventional water treatment process in a normal water treatment plant. The substances may also be sinking, floating or neural, i.e. they mix with water. These properties determine their dispersion and how they mix and are important when choosing a location for the water intake.

Water intake

The intake structure’s location is also very important for the quality of the water entering the water treatment plant and for how it is to be treated. The abstraction of water from a body of groundwater, lake or watercourse is done via one or more intake points. The intake is constructed and placed at a location and at a depth which protects the water as much as possible from different kinds of pollution, e.g. discharges of municipal and industrial wastewater, stormwater or via streams from arable land.

In lakes, there are often currents that can convey pollutants to an intake despite the distance from the discharge being relatively large. Intakes to water treatment plants should, if possible, be located under the lake’s thermocline. It may also be suitable to have intakes at different depths. Raw water can also be abstracted via what are known as “shore intakes” or via wells constructed in a sand and gravel formation, into which water is recharged from the open water.

The protection around water supplies is part of the design of a water treatment plant construction via different barrier systems. The protection can be of both a technical and a legal nature. But it is also part of a long-term safe water supply.

Annex 3 Sample regulation wordings

Alternative 1: Prohibition against possible exemptions pursuant to Chapter 7, Section 22 of the Environmental Code.

Section X. The handling of chemical pesticides within the primary protection zone is prohibited.

Alternative 2: Prohibition against possible exemptions pursuant to Chapter 7 Section 22 of the Environmental Code and permit/notification requirements for residential housing.

Section X. The following applies within the primary protection zone:

The handling of (or alternatively more than 250 litres of) petroleum products is prohibited. To supply oil to existing residential properties, however, domestic fuel may be stored once a permit has been obtained from or notification has been given to the municipal environment committee.

Alternative 3: Prohibition against possible exemptions under Chapter 7, Section 22 of the Environmental Code and exceptions directly in regulations for residential housing.

Section X. The following applies within the primary protection zone.

The storage of petroleum products is prohibited. Such storage may however be effected to supply oil to existing residential properties.

Alternative 4 : Reference to other applicable regulations supplemented for water protection areas

Section X. The handling of petroleum products is regulated in Swedish EPA regulations .....

In addition, the following applies to the primary protection zone ....

Annex 4 Wording of decisions on water protection areas

Not translated.

Annex 5 Further important measures, other than water protection areas, for protecting water

Proposal for control programmes

The county administrative board does not establish a control programme in connection with decisions on water protection areas, but such a programme should be presented and designed considering use of the area for other purposes and potential pollution sources. The aim of a control programme is to be able to discover changes in water quality and deviations from established targets and requirements at an early stage. This will link it to supervision work and measure implementation.

Raw water can be controlled both in groundwater pipes in lakes or watercourses and at pump stations and/or water treatment plants. The wording of the control programme should make it clear how the programme relates to both specific pollution sources and to more diffuse pollution in the protection area.

This control can be coordinated and be seen as a complement to self-inspection that must be performed in accordance with special programmes to control raw water quality and that are established by the municipal committee (following the National Food Administration's guidance). The control should also be coordinated with environmental monitoring programmes.

Additional environmental protection measures for the water protection area should be implemented in cases where the established environmental quality objectives are not being achieved.

The control programme should be linked to the requirements for monitoring laid down in Article 7 and Article 8 of the Water Framework Directive or preferably to the corresponding rules in Swedish legislation, which regulate the control more specifically.

Emergency plans and remediation plans

A plan of measures is needed both to prevent the consequences of an accident to safeguard safer water supply and to establish what should be done from a practical point of view once an accident has occurred.

No decision is made on the remediation plan when applying for the establishment of water protection areas, but it is useful to have such a plan drawn up. It should be a concrete list to follow in the event of emergency pollution situations and should also contain operation instructions to be followed in the event of emergency pollution situations and accidents.

An emergency plan, including a remediation plan (action plan) should have been drawn up in the event of an accident close to a municipal water supply since an accident can have a major impact for the municipality's water supply. By ensuring that threats and problems are not built into the water supply in peace time, the municipal emergency plan can also help safeguard a safe water supply in times of crisis and war. The Emergency Planning Handbook for Municipalities [Handbok för kommunens beredskap] (1998 Swedish Agency for Civil Emergency Planning) stresses the following: The objective of municipal water supply is to maintain water supply via regular distribution systems. The

requirement for the microbiological quality of drinking water is just as stringent in times of heightened preparedness as in peacetime. In connection with spatial planning and water planning, the municipality should lay the foundation for safe water supply in times of heightened preparedness. The municipality should be able to achieve the water supply objective even in wartime. This may require reserve water supplies to be constructed, water bodies to be protected against pollution and sabotage and the emergency water supply to function when needed.

A remediation plan should be in place for emergency pollution discharges, particularly accidents when transporting and handling various pollutants and in connection with floods, which we cannot completely safeguard against through protection regulations alone. The plan should contain instructions for alerting remediation staff, in most cases the municipality's rescue services or sea rescue services, and general instructions on how remediation should be implemented in different parts of the protection area. The conditions often vary, however. This may mean that hydrologically/geohydrologically skilled staff will need to be quickly called in. Such competence is often not available within the municipality's organization.

The remediation/action/emergency plan should stipulate who is responsible and what shall be done in an emergency situation. The plan should be drawn up in consultation/cooperation with various municipal administrations and with the rescue services since they are often first on site in emergency situations. The plan should include information in the form of maps, an action/remediation plan, lists of contacts etc., to be able to implement the right measure in the right place. Preventive measures should also be presented. The plan should also include how the water supply will be safeguarded while the regular water supply cannot be used. The body responsible for the water distribution shall also be responsible for drawing up and maintaining the plan.

For water bodies in Lake Mälaren, Lake Vättern and Lake Vänern, the Swedish Maritime Administration is also involved as the responsible body for national sea rescue services.

As regards surface water bodies, data on the watercourses that may be affected by an accident is essential to ensure the right decisions are taken. This data should be compiled in advance. Relevant data includes water flow at the time of the accident, the gradient of the entire water area, presence of lakes or wetlands, any ice-covering, wind speed and direction. This data can be obtained from SMHI. Type of pollutant is also an important variable, which will be part of the assessment of dispersion, mixing and transport speed. The water flow data is the most relevant. It is important to consider when implementing measures since it tells us how much time we have before the pollution reaches sensitive areas.

If the water body in danger is a large lake, it is recommended that a numerical model be set up for the entire lake. Using this model, local managers can simulate different sequences of events and choose different types of substances, which then can be used for different teaching scenarios as well as for forecasts in the event of an accident. Much of this data also forms some Vander the basis for the design of a water protection area. Models like these have been developed for, among others, Lake Vättern.

For groundwater bodies, information on the polluted substances handled in the water protection area, volumes, soil conditions, depth to the water table, flow conditions, the

water table gradient, surface watercourses etc., constitutes the input data for an analysis of the risks and measures for water bodies.

Water supply plans

The Government's Environmental Objectives Bill (2000/01:130) stipulates that the establishment of water protection areas should be seen as one of several protective measures to guarantee a safe and sustainable water supply. Accordingly, water supply plans shall also be drawn up in addition to the establishment of water protection areas as an overarching measure. This should be done within the framework of other municipal planning work, such as spatial planning, nature conservation planning and the planning of activities. All these options should be utilized in order to provide the best possible protection for these water resources. The establishment of water supply plans also includes supervision of areas that currently have protection regulations under the Environmental Code. Municipalities and county administrative boards are primarily responsible for the implementation of water supply plans.

Spatial planning

Local and regional spatial planning lays the foundation for a safe drinking water supply.

Under the Environmental Code and the Planning and Building Act, municipalities can control and affect land use via comprehensive plans, detailed planning plans and area regulations, primarily as regards buildings and other development measures, including roads, power lines and quarry activities. Land use and activities that may involve high risk from a water protection point of view can be controlled by spatial planning so that important drinking water supplies and potential supplies can be safeguarded. Comprehensive plans can stipulate objectives and guidelines for future planning and broad approaches, such as how areas should be considered with regard to the water supply. Areas that are valuable for water supply are presented in the comprehensive plan.

Regarding the detailed planning level, land use can be determined in more detail. This may concern the location and demarcation of land plots, buildings, roads, power lines, water and wastewater pipes and industrial activities. This can be particularly significant for protection areas for existing water supplies, especially if the detailed development plan allows for a certain amount of building within the closest zone. Possible requirements should be based on a balanced approach, where the interest of maintaining an undetermined water quality is weighed against other interests. It is a question of avoiding an elevated risk for the water as a result of tendencies to "nibble" at the protection area when high-risk development interests are asserted. It is crucial that the consequences of the water protection are fully considered and scope is given for a holistic approach to spatial planning.

Difficult and clearly political or economic decisions must be taken to promote water supply interests when weighing them against powerful, opposing development interests. This can be an issue both when establishing a water protection area and when applying its accompanying protection regulations. It is necessary from a long-term perspective. Compared to other interests, water supply must be afforded much more weight and value in spatial planning than is currently the case. Water supply also has a major economic value. Consideration methods need to be developed for water supply as regards spatial

planning, water protection areas and other environmental work. When considering the use of an area for water supply as opposed to other use, the purpose which promotes long-term sustainable land and water use in the most appropriate way shall be prioritized (cf Chapter 4, Section 10 of the Environmental Code. Since public water supply constitutes a fundamental condition for people's capacity to live and work in an area, protection of water bodies should in the long term be given greater priority than other individual interests.

Management plans and programmes of measures in accordance with the Water Framework Directive.

According to the European Water Framework Directive, each river basin district shall draw up management plans. These shall include protected areas, a list of environmental objectives and a summary of the programme or programmes of measures adopted by the district, including the ways in which the objectives established are thereby to be achieved. Under the directive, protected areas can be bodies of water that are important for drinking water supply. The management plan shall stipulate how these are to be protected.

Once the Water Framework Directive has been totally implemented in Sweden, the management plans of each river basin district shall list all the water protection areas in the district and what protection they enjoy.

Nature conservation planning

An important element in the nature conservation work and nature conservation planning of municipalities is the protection of water quality. To help ensure protection of surface water and groundwater, nature conservation planning should result in guidelines that can be incorporated into other planning activities. As a result of the coordinated overview it creates, nature conservation planning can also add weight to the argument and requirement for long-term preventive measures that safeguard protection of important water resources.

Annex 6 The role and occurrence of groundwater and pollutants

Not translated.

Water protection areas

Handbook 2003:6 with general guidelines

This handbook, which supplements The Swedish Environmental Protection Agency's general guidelines on water protection areas (NFS 2003:16), is primarily intended as a guide for Sweden's county administrative boards and municipalities in their work with establishing water protection areas for surface water and groundwater pursuant to Chapter 7 of the Swedish Environmental Code (SFS 1998:808). It can also be used by those responsible for municipal or other water supply and consultants when drafting proposals for water protection areas or regulations governing such areas.

It is primarily intended to be applied to water resources that, in accordance of the European Water Framework Directive (2000/60/EC Article 6 on "Waters used for the abstraction of drinking water"), provide more than 10 m^3 of water per day as an average or serve more than fifty persons or that are intended for such future use.

In accordance with the Swedish Government's Environmental Objectives Bill "Swedish environmental objectives - interim targets and action strategies" (2000/01:130), which stipulates that the Swedish EPA's general guidelines on protection areas need to be revised and adapted to the European Water Framework Directive, this handbook replaces and Swedish EPA general guidelines on water protection areas NFS 2003:16 the Swedish EPA's earlier publications 1971:4 "Protection of water supplies" and Swedish EPA general guidelines 90:15 "Groundwater supplies"

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Swedish Environmental Protection Agency general guidelines on water protection areas (to Chapter 7, Sections 21, 22 and 25 of the Swedish Environmental Code).

NFS 2003:16
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adopted 24 September 2003.

These general guidelines replace Swedish Environmental Protection Agency general guidelines (AR 90:15) - Groundwater supplies.

To Chapter 7, Section 21 of the Environmental Code

Decisions on water protection areas

County administrative boards and municipalities should promote the establishment of water protection areas at least for all public water supplies and larger private wells of their own or which they share with others. Groundwater and surface water bodies, which will presumably be used for water supply at a later date, should also be protected.

A water protection area should include the water body's catchment area, unless the background data indicates that protection can be achieved by establishing a smaller area as a water protection area.

When demarcating (= delineating) a water protection area for surface water or groundwater supply, special consideration should be given to the question of whether existing operations or facilities, that may have a bearing on whether the purpose of the water protection area is achieved or not, need to be inside the protection area and hence be covered by the accompanying regulations.

A water protection area could also include a body of gravel or sand that is significant for the water supply and, as a result of its ability to clean or accommodate water, can be used for artificial groundwater recharge by recharging surface water. An area for groundwater recharge could also be included.

If a water protection area or its catchment area affects two or more municipalities, the decision to establish the water protection area should be taken by the county administrative board.

To Chapter 7, Section 22 of the Environmental Code

Wording of the regulations

Regulations for water protection areas should be worded so that they guarantee adequate protection in both the short and the long term, i.e. from a multigenerational perspective. They should be adapted to local conditions and to the protection need.

Regulations may need to be drawn up for water protection areas to impose far-reaching restrictions on the right to dispose of properties. A water protection area should be divided into zones with regulations that are adapted to the

natural conditions and need for protection in each zone respectively. A water protection area can be divided into (water) abstraction zone, primary and secondary protection zone and, where necessary, tertiary protection zone.

The consequences of both sudden and continuous emissions from pollution sources should be considered in the regulations. This may be a question of both point sources as well as diffuse ones.

Certain activities should be prohibited within a water protection area. This applies, for example, to such activities that may cause irreversible damage or harm that may have far-reaching consequences for water quality and quantity. Damage can depend either on individual emissions, the combined effect of many small-scale emissions or the consequences of an intervention in the environment. Restrictions in the right to dispose of properties should where necessary cover both current and future activities.

The content of the regulations in more detail

Points 1-13 below with advice on wording of the regulations refer mainly to primary and secondary protection zones.

The following should apply as a point of departure for the content. Supplementary regulations may need to be issued.

1. The regulations for a water protection area should stipulate that only water supply activities are allowed in the abstraction zone and that this area should be enclosed or, if it includes surface waters, be clearly demarcated.

2. The regulations should also state that the abstraction zone and land used for recharge (for artificial groundwater recharge) may only be disposed of by the water plant owner and for water supply activities.

3. The regulations for a water protection area should stipulate for primary protection zones that the handling of petroleum products must not occur other than to supply residential and agricultural properties with oil, for which a permit is required. For secondary protection zones, the regulations should stipulate that a permit is required for the handling of petroleum products which may counteract the purpose of the protection in the short or the long term. The authority should state in the regulations which types of handling this refers to.

4. The regulations for a water protection area should stipulate that the handling of chemical pesticides in primary protection zones is prohibited. For secondary protection zones, the regulations should stipulate that a permit is required for the handling of chemical pesticides. The regulations should stipulate that a permit is required for the handling of plant nutrients in water protection areas. The authority should state in the regulations which type of handling this refers to.

5. The regulations for a water protection area should stipulate that the permanent storage of bark and timber is prohibited in primary and secondary protection zones. Storage of timber from one logging season may occur in secondary protection zones. The regulations should stipulate that a permit is required for such temporary storage in primary protection zones.

6. The regulations for a water protection area should stipulate a prohibition against additional infiltration plants for household spillage and discharges of other wastewater in primary protection zones. The regulations should also stipulate that a permit is required for such plants in secondary protection zones.

7. The regulations for a water protection area should also state that the storage of waste or of snow from roads in a protection zone may not occur in a protection zone with more stringent regulations.

8. The regulations for a water protection area should stipulate that the storage of asphalt, oil gravel or road salt is prohibited in primary and secondary protection zones. A permit requirement for the spreading of road salt in primary protection zones should also be stipulated.

9. The regulations for a water protection area should stipulate that the quarrying of material is prohibited in primary and secondary protection zones around groundwater supplies and in primary protection zones around surface water supplies. The regulations should stipulate that subsistence mining (for private use) in a water protection area requires a permit. Oil spills must not occur. It should also be stipulated that access roads to quarries/wells shall as far as possible be cordoned off.

10. The regulations for a water protection area should stipulate that excavation work, e.g. in connection with road building or other construction, and dredging may not be performed without a permit. As regards pile-driving, grooving and underground work, the regulations should stipulate a permit requirement in primary and secondary protection zones for a groundwater body and in primary protection zones for a surface water body.

11. The regulations for a water protection area should stipulate that facilities for the storage and extraction of heat energy from rock, soil and water, extraction of water from rock and soil, as well as other types of drilling that may affect water supply/quality are forbidden in primary protection zones and that a permit is required for such facilities in secondary protection zones for groundwater supplies and in primary protection zones for surface water supplies.

12. The regulations for a water protection area should stipulate that the transport of hazardous goods within primary protection zones may only occur on designated transport routes.

13. The regulations for a water protection area should stipulate that hazardous activities that involve a risk of pollution to surface water or groundwater may not be established in primary protection zones. The regulations should stipulate that new hazardous activities, of which prior notification must be given to the authorities, require a permit.

14. Regulations for a water protection area should, if it is necessary to achieve adequate protection, stipulate a prohibition and restrictions in the right to dispose of properties in the tertiary protection zone. Such restrictions can e.g. cover modified land use. They may in certain cases be identical with regulations for other protection zones.

15. If it seems as though the purpose of the water protection area is not being achieved using the current regulations, these should be changed to achieve the necessary level of protection.

To Chapter 7, Section 25 of the Environmental Code

When assessing how far a restriction of a person's rights may extend in order to satisfy the aim of a water protection area, the fact that the aim can normally be achieved by implementing high protection levels and far-reaching restrictions should be taken into account.

SWEDISH ENVIRONMENTAL PROTECTION AGENCY

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