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Guide to Local Groundwater Protection in Florida

Volume II
Planning and Regulatory Information

Prepared for

St. Johns River Water Management District

Southwest Florida Water Management District

Jeff Wade
Center for Governmental Responsibility
University of Florida College of Law
Gainesville, Florida 32611

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INTRODUCTION

Volume II of this manual is intended to assist the planning or regulatory authority in understanding the nature of the groundwater resource and the sources of withdrawal; the primary potential threats to groundwater; the existing state and federal regulatory scheme which addresses groundwater threats; the basic regulatory and nonregulatory tools available to local governments; and suggested regulatory approaches for effectively protecting potable aquifers.

As explained in Volume I, an essential step in the creation of aquifer protection programs is a research effort aimed at gathering as much information as possible concerning the extent and physical nature of the potable aquifer, the areas of existing and future groundwater withdrawal, and the degree of threat posed by existing and future land uses. Chapter I of Volume II is designed to assist in the research and analysis of basic planning data needed to develop effective protection programs. The chapter supplies basic information on groundwater and potable aquifers in Florida, explains the types and sources of important hydrogeological data, and the types and sources of data on groundwater use patterns, and discusses the primary threats to groundwater, including priority ranking systems. It concludes with an examination of the issues surrounding designation of protection zones, including general areas of concern, designation techniques and a site ranking system with the potential to aid in determining sensitive areas.

TYPES AND SOURCES OF GROUNDWATER DATA

A few basic concepts are important for a general understanding of the groundwater resource, how it may be threatened and how it may be protected. Potable water wells draw groundwater from the state's underground aquifers. ***Aquifers*** are geologic formations which contain sufficient saturated permeable material to yield significant quantities of groundwater. Groundwater is that which is found below the unsaturated subsurface zone known as the ***vadose zone***. Aquifers can be characterized by the types of subsurface material in which the groundwater is found. Most of Florida's primary aquifers are composed of saturated sand and gravel deposits, carbonate rock or fractured rock. These materials can be deposited as consolidated or unconsolidated aquifers. ***Unconsolidated*** aquifers appear as formations of sand and gravel with complex interspersed layers of clay, silt, sand and gravel. ***Consolidated*** aquifers in Florida include extensive sedimentary rock formations of limestone or dolomite. Such aquifers are particularly susceptible to ***karst formations***, created as infiltrating water slowly dissolves the limestone, enlarging existing faults and bedding planes into fissures, caves and sinkholes.

Aquifers are also characterized by the degree of natural confinement. ***Confined aquifers*** are those with layers of overlying, relatively impermeable geological strata. The groundwater in these aquifers is under pressure, and the height to which water will rise in a tightly cased well tapping a confined aquifer is known as the ***potentiometric surface*** for that aquifer. Aquifers with no clays or other overlying low permeability geologic formations are characterized as ***unconfined***. When at or near the land surface, they are called ***surficial aquifers*** or ***water table aquifers***, and their upper surface is known as the water table. Aquifers can also be ***semi-confined*** or ***leaky confined***, indicating that there are gaps in the overlying layers, or that the layers have more permeability than a true confining layer. ***Recharge areas*** are those areas hydrogeologically connected to an aquifer, which contribute significant amounts of water to the aquifer. For shallow aquifers, recharge areas are often fairly nearby. The recharge zone for a surficial aquifer includes the entire area overlying that aquifer. Generally, the deeper the aquifer, the farther away are its recharge areas and the longer it takes for percolating water to travel to the productive zone of the aquifer.

Florida's principal aquifers consist of sand at land surface and limestone and dolomite at depths of less than a few hundred feet. Their locations at or near the surface in many areas make them vulnerable to contamination from various activities and land uses. The state has four major aquifer systems, including the Biscayne Aquifer, the Sand and Gravel Aquifer, the Unnamed Surficial and Intermediate Aquifers, and the Floridan Aquifer System. The ***Biscayne Aquifer*** is a surficial carbonate aquifer in the southeastern part of the state which supplies water to most of the Gold Coast area, and is under tremendous stress. It underlies all of Dade and Broward counties and adjoining parts of Palm Beach and Monroe counties. The ***Sand and Gravel Aquifer*** is the major source of water supply in the western part of the Florida panhandle. It consists of surficial sediments that exceed 700 feet in northwestern Escambia county, and that thin out to the south and east. The water is under both confined and unconfined conditions, with the deep production zone being semiconfined.

Unnamed Surficial and Intermediate Aquifers are present over much of rest of the state, and where deeper aquifers contain nonpotable water, they are important sources of supply. The surficial deposits consist of sand and shell with minor limestone beds. The aquifers are used for public supply in areas southwest of Lake Okeechobee and in various localities along the east coast from Palm Beach county northward. In other areas, they are used mainly for rural supplies. The ***Floridan Aquifer System*** is one of the most productive systems in the United States, and extends across all of Florida, southern Georgia and parts of Alabama and South Carolina. It is the lowermost part of the groundwater reserve in Florida, consisting of very deep beds of limestone and dolomite, which are interconnected hydraulically to varying degrees. The Floridan Aquifer is at or near the surface in the western part of the peninsula that extends from Wakulla to Pasco counties and in most of Holmes and Jackson counties. In other areas it is buried to depths of 1,100 feet below sea level in southern Florida and 1,500 feet below sea level in the western panhandle. It is unconfined in about one-fourth of the state, and confined to varying degrees elsewhere. The Floridan Aquifer is a major source of drinking water for many public supply systems.

HYDROGEOLOGICAL DATA

Hydrogeological studies focus on where subsurface water is located in three dimensions, the character of the subsurface strata containing the water and the overlying soils and geological features, the direction and rate of groundwater movement, and the sources and amounts of groundwater withdrawal. Analysis of the hydrogeologic subsurface environment is needed for a clear understanding of the areas in which contamination from the surface is more likely, and of where and how contamination is likely to move within an aquifer. A comprehensive evaluation of the hydrogeology of an area will probably require use of consultants. However, the cost of consultants can be minimized, and the efficiency of the planning effort increased, by thoroughly researching and synthesizing the existing groundwater planning data related to the locality. Many types of such data are available from a variety of regional, state and federal agencies. Table 1 indicates the comprehensive nature of the data required for a hydrogeological study.[1]

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[1] See Office of Ground-Water Protection, "Hydrogeologic Mapping Needs for Ground-Water Protection and Management: Workshop Report," (1988); Office of Ground-Water Protection, "Hydrogeologic Mapping Needs for Ground-Water Protection and Management: Discussion Guide," U.S. Environmental Protection Agency, Washington, D.C. (1988).

TABLE 1
Information Used in Hydrogeological Investigations[2]

Information obtained for hydrogeologic investigations	Importance of information for understanding contaminant behavior in subsurface
I. Information on the hydrogeologic environment	
A. Topographic data	Provide partial information on flow (i.e., rate, directions, and pathways of unsaturated zone and groundwater flow and relationship of groundwater to surface water including: relative position of water levels in wells, locations of possible discharge and recharge areas, rates of infiltration and surface runoff, and general direction of groundwater flow).
B. Vegetative data	Provide partial information on flow (i.e., rate and pathways of water movement into and out of the subsurface). Also vegetation type and condition may reflect the quality of groundwater and be used to identify areas of contamination. Used to estimate depth to water table and identify possible discharge and recharge areas.
C. Climatic data (precipitation, evapotranspiration, site temperature)	Provide partial information on flow (i.e., the quantity, timing, and rate of movement of water and contaminants into the subsurface). Provide basic information to assess rate of reactions and biodegradation of contaminants.
D. Geologic data (surficial deposits, subsurface stratigraphy, lithology, structural geology)	Provide partial information on flow (i.e., location and volumes of potential groundwater supplies, pathways for water and contaminant movement into and out of underlying formations, and direction and rate of groundwater movement) and are used to identify possible recharge and discharge areas. Also, provide partial information on mechanical dispersion (mixing) and attenuation reactions of contaminants.
E. Surface hydrology data (overland flow, stream discharge, stage, recurrence interval, baseflow discharge)	Provide partial information on flow (i.e. quantity, rate, and timing of water movement into and out of subsurface). Used to identify and quantify possible discharge and recharge areas and to identify potential conduits for contamination. Surface water may affect concentrations of contamination at discharge points.

(continued)

[2] See Office of Technology Assessment, U.S. Congress, Protecting the Nation's Groundwater from Contamination, Vol. I, Table 25 (October 1984).

Table 1 (continued)

Information obtained for hydrogeologic investigations	Importance of information for understanding contaminant behavior in subsurface
F. Unsaturated zone data (water table; geometry; hydraulic properties: effective permeability, relative permeability, specific storage; flow parameters: pressure head, hydraulic gradient, fluid saturation; recharge/discharge: surface-water characteristics, precipitation/evapotranspiration)	Provide partial information on flow (i.e., on the flow regime, which influences the rate, direction, and quantity of water and contaminants moving from the surface into the saturated zone). Usually relatively unimportant in the humid areas such as the Eastern United States.
G. Groundwater hydrology (Saturated Zone) data (aquifer characterization: confined aquifers, unconfined aquifers, leaky aquifers; hydraulic parameters of aquifers: storativity, transmissivity, primary permeability, secondary permeability; primary porosity, secondary porosity; confining unit geometry; hydraulic parameters of confining units: hydraulic conductivity, specific storage; flow parameters: water levels, hydraulic gradient, flow velocity; recharge/discharge: surface-water characteristics, precipitation contributions, confining layer leakage, fracture/matrix flux)	Provide partial information on flow (i.e., the rate, direction, and quantity of groundwater and contaminant flow). Also, provide partial information on recharge and discharge characteristics.
H. Contaminant transport parameters (distribution coefficient; dispersivity co-efficients; flow velocities; relative saturations; cation exchange capacity; subsurface mineralogy; ambient water chemistry; microbiology)	Provide partial information on properties of the hydrogeologic environment that influence the potential for physical, chemical, and biological reactions resulting in contaminants moving at different rates than water through the groundwater flow system.
I. Groundwater use (current usage, projected usage)	Provides information on flow (i.e., the influence of groundwater pumping on the rate and direction of groundwater and contaminant flow). Also provides information on impacts of contamination.
II. Information on water quality (contaminants present, concentrations)	Provides data on concentrations and distribution of contaminants.
III. Information on sources of contamination (location; contaminants; release characteristics: location, volumes, contaminants, concentrations, timing)	Provides data on types of contaminants that are likely to be present, requirements for collecting and analyzing samples, and suitability of different types of corrective action. Also provides data on location, flow rate and direction of contaminants. *(continued)*

Table 1 (continued)

Information obtained for hydrogeologic investigations	Importance of information for understanding contaminant behavior in subsurface
IV. Information on properties of contaminants	
A. Molecular-based properties	Provide information to identify which contaminants are present and at what concentrations.
B. Media-based properties	Provide information used as a basis for deducing contaminant behavior (e.g., persistence and mobility).

Sources of Hydrogeological Data

Data is available from a number of sources. As explained below, these include: local government planning departments, environmental departments, utilities departments and health departments; the water management districts; regional planning councils, the Department of Environmental Regulation and Health and Rehabilitative Services; the Florida Geological Survey and U.S. Geological Survey; the U.S. Environmental Protection Agency; the Soil Conservation Service; many university research centers and academic departments; consultants; and several professional associations concerned with geology, hydrogeology and water resources. Volume III, Appendix C contains the addresses of most of the regional, state and federal agencies cited as potential sources of information, as well as several professional organizations and research centers.

In many cases, the local government itself will be an important source of information. The local planning department may have accumulated a fair amount of hydrogeological and hydrologic data in the course of developing the goals and objectives of the comprehensive plan elements. Local water utilities, health departments and environmental departments may also have useful data on the hydrogeology, water quality characteristics and water use patterns in the area. These sources of existing information should serve as a good starting point for more in-depth research.

Some of the most useful information will be available from Florida's water management districts, which are required to collect and share technical and planning data on several groundwater related topics. By July 1, 1991, each water management district must prepare and provide data to assist local governments in the preparation and implementation of local comprehensive plans or public facilities reports as required by Section 189.415, Fla. Stat.[3] Several districts have already begun gathering and disseminating such data. In addition to general

[3] Under Fla. Stat. § 189.415, the policy of the state is to foster cooperation between special districts and local general purpose governments as the local governments develop comprehensive plans under the LGCPLDRA. To further this goal, beginning March 1, 1991, special districts must submit reports to local governments describing various aspects of the operations and plans of the special district. "Special districts" are local units of special purpose government within a limited boundary, created by general law, special act, local ordinance or by rule of the Governor and Cabinet. The term does not include school districts, community college districts, special improvement districts for certain Indian reservations, municipal service taxing or benefit units, or boards providing electrical service and which are part of a municipality. Fla. Stat. § 189.403(1) (1989).

information on the regulations, programs and acquisitions plans of the district, the data must include:[4]

1.) A description of surface water basins, including regulatory jurisdictions, flood-prone areas, existing and projected water quality in water management district operated facilities, as well as surface water runoff characteristics and topography regarding flood plains, wetlands, and recharge areas;

2.) A description of groundwater characteristics, including existing and planned wellfield sites, existing and anticipated cones of influence, highly productive groundwater areas, aquifer recharge areas, deep well injection zones, contaminated areas, an assessment of regional water resource needs and sources for the next 20 years, and water quality; and

3.) Information reflecting the minimum flows for surface watercourses to avoid harm to water resources or the ecosystem and information reflecting the minimum water levels for aquifers to avoid harm to water resources or the ecosystem.

Each water management district is also required to develop "ground water basin resource availability inventories" covering areas deemed appropriate by the governing board. The inventories must include:[5]

1.) hydrogeologic studies to define the ground water basin and its associated recharge areas,

2.) site specific areas in the basin deemed prone to contamination or overdraft resulting from current or projected development,

3.) prime ground water recharge areas,

4.) criteria to establish minimum resource development within the ground water basin,

5.) areas suitable for future water resource development within the ground water basin,

6.) existing sources of wastewater discharge suitable for reuse as well as the feasibility of integrating coastal wellfields, and

7.) potential quantities of water available for consumptive uses.

The information is to be made available to local governments, which must consider the data when revising comprehensive plans and development regulations. The intent of the legislature is that future growth and development planning reflect the limitations of the available ground water or other available water supplies.[6] The water management districts should also be able to supply consumptive use permitting data, stormwater permitting and monitoring data, and water quality information related to the management and storage of surface waters for agricultural and citrus operations.

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[4] See Fla. Stat. § 373.0391 (1989).

[5] See Fla. Stat. § 373.0395 (1989).

[6] Id.

The Florida Department of Environmental Regulation (DER) is another valuable source of information for aquifer protection planning purposes. The Office of Planning and Research can be contacted for the results of research projects examining various aspects of surface and groundwater quality. In addition, the Bureau of Drinking Water and Ground Water Resources has instituted three statewide groundwater quality monitoring networks, in order to establish baseline water quality for major aquifer systems, detect and predict changes in groundwater quality from land use activities, and to disseminate the data to local governments. The Background Network generates baseline water quality data, and includes approximately 1800 wells tapping all major potable aquifers in the state. The VISA (Very Intense Study Area) network monitors the effects of various land uses on groundwater quality within aquifers in 15 select areas. The Private Well Survey network analyzes groundwater quality from fifty private drinking water wells in each of Florida's 67 counties, supplementing the Background Network and indicating the general quality of water consumed by private well owners. This survey is a joint effort of DER and the Florida Department of Health and Rehabilitative Services and will not be completed for several years. Though all three networks are potentially helpful for planning data purposes, the VISA network has particular value in helping determine appropriate land uses for sensitive aquifer protection areas. The network monitors the effects of multiple sources of contamination on water quality within segments of aquifers which are highly susceptible to contamination. Various land use categories are being tracked for their effects on groundwater, and analysis of the data should help provide reasonable predictions of the effects of siting similar land uses in hydrogeologically similar areas of the state. Information from the monitoring networks is being plotted on a series of maps to be published by the Florida Geological Survey.

The DER is scheduled to complete a mapping of the entire state in June 1991, using the DRASTIC system, which measures aquifer vulnerability. The water management districts may also have data on DRASTIC mapping within the district. The name DRASTIC is an acronym of the seven hydrogeological parameters considered most indicative of an area's relative pollution potential. These include: **D** - depth to water; **R** - net recharge; **A** - aquifer media; **S** - soil media; **T** - topography; **I** - impact of vadose zone; **C** - hydraulic conductivity. The parameters are mapped separately for each segment of the map, then combined and multiplied by a weighting factor. The weighted scores are summed, to produce the DRASTIC index for each segment on the composite map. Higher scores indicate higher relative pollution potential. Though DER's DRASTIC maps will not be sufficiently detailed to allow their direct use in establishing aquifer protection zones, they should supply valuable information for helping focus the efforts of the local government and any consultants. The potential use of the DRASTIC mapping system at the local level is discussed later in this chapter. The DER has also produced fairly low-resolution maps indicating high, medium and low recharge areas of the Floridan Aquifer. In addition, the Department should also be able to supply water quality monitoring data from facilities which are permitted to discharge to groundwater under the provisions of Chapter 17-28, Florida Administrative Code.

The Florida Geological Survey, previously known as the Florida Bureau of Geology, is a branch of the Florida Department of Natural Resources. The Survey has published many types of studies concerning the hydrologic and hydrogeologic character of the state. Most studies can be ordered directly from the office in Tallahassee, but there are 36 libraries across the state which serve as depositories for all Survey publications, including those which are out of print and otherwise unavailable.[7]

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[7] See Volume III, Appendix C for the address of the Florida Geological Survey and for locations of the receiving libraries.

The U.S. Geological Survey (USGS) is the principal source of scientific and technical expertise in the earth sciences for the federal government. Its studies cover a wide range of topics in the fields of geology, hydrology and cartography, and include extensive data on groundwater quantity and quality. Over 350 reports have been published on Florida groundwater resources. The Water Resources Division of the USGS is concerned with six primary issues in Florida: groundwater quality management, groundwater availability, seawater intrusion, contamination from wastewater disposal, contamination from landfills and hazardous waste sites, and contamination from agricultural practices. One of the most important ongoing efforts of the USGS is the generation of basic hydrogeological information for larger wellfields in several parts of the state. The study is being done in cooperation with the Florida Department of Environmental Regulation and may be expanded if funds become available. The USGS also maps and evaluates aquifers around the state to provide detailed information on hydrogeology and groundwater flow. There are nine USGS offices in Florida, located in Tallahassee (District Chief), Tampa, Orlando, Miami, Jacksonville, Fort Myers, Stuart, Sarasota and Ocala.[8]

The U.S. Environmental Protection Agency, Office of Ground-water Protection, has an extensive bibliography of documents on the establishment of groundwater protection programs,[9] while district and local offices of the EPA will be able to supply ambient and specific groundwater monitoring data for many areas.

The Soil Conservation Service within the U.S. Department of Agriculture is a source of extensive and fairly detailed data and maps of watersheds and soil characteristics in Florida. There are 63 Soil and Water Conservation Districts in the state, with offices located in almost every county, which can be contacted for assistance and planning information.

At the university level, the Florida Water Resources Research Center, at the University of Florida, conducts research into many aspects of Florida's hydrology and hydrogeology, and can supply additional information on groundwater interpretive studies and data collection. The Institute of Food and Agricultural Sciences, at the University of Florida, can provide additional information on soils characteristics. The Florida Sinkhole Research Institute, at the University of Central Florida, has published studies of the potential for groundwater pollution based on karst formations and overburden characteristics in Florida. Environmental, geology, soil science, and civil engineering departments and agricultural extension services at universities around the state will also serve as sources of studies and consulting assistance in developing a hydrogeologic data base.

Florida's eleven Regional Planning Councils may be sources of planning studies addressing regional resources, as well as areawide water quality management plans under Section 208 and 201 of the Clean Water Act, some of which include consideration of groundwater management. Their primary role however, will be to provide assistance and consultation for the development of local government comprehensive plans and land development regulations that satisfy the requirements of the Growth Management Act.

In addition to information derived from other agencies and institutions, local government utilities, and health and environmental departments should have certain amounts of information on water quality data from drinking water wells and monitoring wells in an area. When existing groundwater planning data have been fully researched, technical consultants should be utilized to

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[8] See Volume III, Appendix C for applicable addresses.

[9] See Volume III, Appendix B for a listing of references and documents available from the Office of Ground-Water Protection, U.S. Environmental Protection Agency.

fill out the data base and provide a complete picture of the hydrogeological character of the study areas. Technical studies conducted by the consultants may include construction of test wells, pumping tests, additional soil borings, compilation and analysis of unpublished data such as well logs, and development of maps and computer models for planning purposes. The costs of such studies can be significant, ranging into the hundreds of thousands of dollars, though less detailed studies can still supply valuable information. Several types of fees and assessments may be instituted to help offset the costs associated with the planning and implementation of an aquifer protection program.[10] A partial list of associations which may be able to provide technical studies and information on consultants includes: the American Institute of Professional Geologists; Association of Engineering Geologists; National Society of Professional Engineers; National Water Well Association; American Water Resources Association; American Water Works Association.

GROUNDWATER USE DATA

In addition to information on the hydrogeology and hydrology of the area, research must focus on groundwater use patterns, including location of existing and future public wells and areas with higher concentrations of private wells. Basically, this part of the planning study should reveal where groundwater is being withdrawn, which parts of the aquifer are being tapped, how much is being withdrawn, and the ways the groundwater is being used. The goal is to find areas where the potentiometric surface may be consistently lowered by users, drawing groundwater and potential pollutants toward them. The information should allow groundwater protection measures to be focused more critically, and if necessary, allow informed use of artificial recharge or modification of public well pumping rates, in order to alter groundwater flow patterns and create zones of contribution that avoid potential pollution sources.

Sources of Groundwater Use Data

Groundwater withdrawals should be identified in terms of the aquifer or aquifer segment being used, average and season-specific amounts of actual groundwater withdrawal, well capacity, and degree of water treatment. Though large wells are likely to have specific documentation of well depth and permitted capacity, this type of information may be more difficult to collect for private wells which were installed more than fifteen years ago. It may be necessary to conduct a local well survey, to gather information on types of wells, their depth, rate of pumpage, type of use, and information on water quality if available. Water use can also be estimated from house counts, recent census data, building permit records, and sewer system effluent flow rates. In areas to which public water supply lines have not been extended, water management district well permits or local well drillers' logs can be researched. Local codes enforcement and planning departments should also be able to provide information on locations and bedrooms/bathrooms for houses inside or outside of public water supply areas. Regional water supply authorities and local water utilities will have water use data for areas they supply.

In addition to well permitting data, the water management districts should be able to supply consumptive use permitting data, and other types of information they are required to develop under Sections 373.0391 and 373.0395, Florida Statutes, including:

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[10] See Office of Ground-Water Protection, Local Financing for Wellhead Protection, U.S. Environmental Protection Agency, Washington, D.C. (June 1989). Chapters 9J-29 and 9J-30, F.A.C. include the amounts of monetary assistance and disbursement procedures for communities which must adopt land development regulations before March 1, 1991, and between April 1, 1991 and December 1, 1991, respectively.

1.) A description of groundwater characteristics, including existing and planned wellfield sites, existing and anticipated cones of influence, highly productive groundwater areas, aquifer recharge areas, deep well injection zones, contaminated areas, an assessment of regional water resource needs and sources for the next 20 years, and water quality; and

2.) Information reflecting the minimum flows for surface watercourses to avoid harm to water resources or the ecosystem and information reflecting the minimum water levels for aquifers to avoid harm to water resources or the ecosystem.

3.) Site specific areas in the basin deemed prone to contamination or overdraft resulting from current or projected development.[11]

All groundwater related data, including groundwater use data, should be mapped for planning purposes. Important groundwater use data to be mapped include the locations of public and private water supply wells, the aquifers or aquifer segments from which they draw water and the average and seasonal withdrawal rates, and areas of incidental or deliberate recharge or discharge. These could include septic systems, irrigation facilities, artificial recharge basins, effluent reuse facilities, canals and springs or artesian wells. Groundwater use maps, when overlaid with maps of other groundwater related information, such as geological formations, aquifer characteristics, areas of groundwater flow and recharge and potential pollution sources, will allow the development of effective and efficient potable aquifer protection programs.

[11] See Fla. Stat. §§ 373.0391, 373.0395 (1989).

SOURCES AND PATHWAYS OF CONTAMINATION

INTRODUCTION

There are numerous land uses with the potential to contaminate potable aquifers, ranging from residential development, to commercial and industrial, to agricultural. Residential threats include stormwater runoff, onsite septic systems, package plants and even central sewer systems. The wide variety of potential threats from commercial and industrial development includes gasoline station storage tanks, aboveground and underground storage of hazardous materials, and wastewater discharges. Agricultural threats can include waste from animal feedlot operations, storage and application of fertilizers, and storage and application of pesticides. Table 2 lists many land uses which are potential sources of contamination.

Specific information on the location and nature of the threats in an area will require research into historic, as well as existing and future land uses. Ad valorem tax roles are one source of information on land use at the local level, though other available data bases, such as permitting records of the local government, water management district, and DER have potential value in locating land uses in the locality. Local planning agencies should have data on the distribution of land uses and land cover, as well as projections for population and economic growth. Regional planning councils may also be able to provide similar data. Local health departments should be able to supply information on known groundwater problem areas and the locations and densities of septic systems in the locality. Some local governments have mailed out surveys to retail, commercial and industrial uses, seeking detailed information on chemicals, processes and storage facilities used in the operations. Agricultural operations in an area should also be surveyed, if possible, to determine the size of operations, and to gather information on irrigation and pesticide application practices, animal feedlot operations and dairies.

Future land uses in the locality can be projected from local and regional planning agency data on population projections and economic growth, and should include careful consideration of local comprehensive plan goals in the future land use element, the capital improvements element, and the transportation elements, as required by Florida's Growth Management Act. The future land use element specifically requires the following uses to be shown on the future land use map: residential, commercial, industrial, agricultural, recreational, conservation, educational, public buildings and grounds, other public facilities, vacant or undeveloped land, and historic resources.[12] Future land use objectives must coordinate future land uses with the appropriate topography, soil conditions, and the availability of facilities and services, and must ensure protection of natural resources.[13] The policies for these objectives must address implementation activities to protect potable water wellfields and environmentally sensitive land.[14]

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[12] See Rule 9J-5.006(4), Fla. Admin. Code (1990).

[13] Rule 9J-5.006(3), Fla. Admin. Code (1990).

[14] Rule 9J-5.006(3)(c), Fla. Admin. Code (1990).

TABLE 2
Common Sources of
Groundwater Contamination[15]

AGRICULTURAL

Animal burial areas
Animal feedlots
Chemical application
(e.g., pesticides, fungicides, and fertilizers)
Chemical storage areas
Irrigation
Manure spreading and pits

COMMERCIAL

Airports
Auto repair shops
Boat yards
Construction areas
Car washes
Cemeteries
Dry cleaning establishments
Educational institutions (e.g., labs, lawns, and chemical storage areas)
Gas stations
Golf courses (chemical application)
Jewelry and metal plating
Laundromats
Medical institutions
Paint shops
Photography establishments/printers
Railroad tracks and yards/maintenance
Research laboratories
Road deicing operations (e.g. road salts)
Road maintenance depots
Scrap and junkyards
Storage tanks and pipes (i.e., above-ground, below-ground, underground)

INDUSTRIAL

Asphalt plants
Chemical manufacture, warehousing, and distribution activities
Electrical and electronic products and
Electroplaters and metal fabricators
Foundaries
Machine and metal working shops
Manufacturing and distribution sites for cleaning supplies
Mining (surface and underground) and manufacturing mine drainage
Petroleum products production, storage, and distribution centers

Pipelines (e.g., oil, gas, coal slurry)
Septage lagoons and sludge
Storage tanks (ie., above-ground, below-ground, underground)
Toxic and hazardous spills
Wells - operating and abandoned
(e.g., oil, gas, water supply, injection, monitoring and exploration)
Wood Preserving facilities

RESIDENTIAL

Fuel storage systems
Furniture and wood strippers and refinishers
Household hazardous products
Household lawns (chemical application)
Septic systems, cesspools, water softeners
Sewer lines
Swimming pools (e.g., chlorine)

WASTE MANAGEMENT

Fire training facilities
Hazardous waste management units
(e.g., landfills, land treatment areas, surface impoundments, waste piles, incinerators, treatment tanks)
Municipal incinerators
Municipal landfills
Municipal wastewater and sewer lines
Open burning sites
Recycling and reduction facilities
Stormwater drains, retention basins, transfer stations

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[15] See U.S. Environmental Protection Agency, Office of Ground-Water Protection, Wellhead Protection Programs: Tools for Local Governments, (workshop workbook), U.S. Environmental Protection Agency, Washington, D.C. (1990).

ON-SITE SEPTIC SYSTEMS

Over 22 million septic systems operating in this country discharge more than one trillion gallons of wastewater into soil and groundwater each year. In Florida, over 1.3 million households representing about 27% of the state's households utilize on-site septic systems. Discharge from septic tanks and cesspools has been identified as a major source of groundwater contamination. Typical contaminants associated with septic systems are disease causing pathogens, nitrates, phosphorous, and toxic materials. Many pathogens are commonly found in septic system waste water. These include bacteria such as salmonella, viruses such as polio and hepatitis, and parasites such as hookworm and tapeworm. Bacterial and viral pathogens can survive for significant periods of time under conditions readily obtainable with septic tanks and drainfields. Such pathogens have the potential to infiltrate potable aquifers, beginning an infectious cycle, passing from the water supply well, to the septic tank, to the drainfield and back to the water supply.

Nitrogen in wastewater also poses a threat to groundwater and surface water. Only approximately twenty to forty percent of the nitrogen in effluent is adsorbed onto soils before it reaches groundwater. Bacteria in the soil and waste convert nitrogen to nitrate which is easily transported through soils into the groundwater. High levels of nitrate are linked to methemoglobinemia, also known as "blue baby syndrome," a blood disorder leading to the asphyxiation of infants. Reduction of nitrate levels is promoted by dilution which may be achieved by regulation of septic tank density limits.

Toxic organic materials found in septic tank effluent include many household chemicals such as cleaners, detergents, and medicines containing organics that cannot be effectively treated by attenuation or microbial breakdown. Other organic chemicals are contained in septic tank cleaning products which claim to eliminate the need for routine pumping. Many of the chemicals used in septic tank cleaners are suspected carcinogens.

Septic tanks systems consist of a receiving tank connected by a piping system to a drainfield. When waste enters the tank, solids settle to the bottom. Biological interaction between microorganisms and organic material in the septic tank breaks down much of the waste. Waste water carrying suspended solids flows through pipes from the tank into the drain field. The drain field allows the solids to filter through the soils before reaching the groundwater. Because of the high bacteriological content and potentially harmful amounts of toxic materials and viruses associated with septic tank effluent, in areas with sensitive aquifers and high numbers of septic tanks, the potential for aquifer contamination is high.

Contamination may result from improper siting of septic tank systems, system failure, and unsafe disposal. Appropriate siting depends on many factors, but primary concerns are the ability of the soil to attenuate contaminants before they reach groundwater and sufficient distance between the system, potable aquifers and other septic systems.[16] Soils best suited for drainage fields meet permeability standards that allow effluent to drain through at a rate that ensures proper treatment. The system should be placed in areas where groundwater levels are low enough to promote drainage and prevent flooding. In locating the system, consideration should also be given to the densities of existing septic systems and the ability of the soil and groundwater to assimilate additional effluent. At densities of four septic tanks per acre, two to five feet above the water table, studies have shown that groundwater 95 feet distant from

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[16] See Livingston, et al., The Florida Development Manual: A Guide to Sound Land and Water Management, Chapter 7 ("Individual Wastewater Treatment and Disposal"), Nonpoint Source Management Section, Florida Department of Environmental Regulation, Tallahassee, Fl. (1988).

drainfields and at 20 foot depths can be unfit for drinking purposes. Where shallow private wells are used in conjunction with septic tanks near public wellfields, the increased rate of induced groundwater flow within the wellfield, caused by pumping operations, increases the probability that unattenuated contaminants from the drainage field will be drawn into private wells.

System failure may occur due to improper design or installation or lack of maintenance. Septic systems that are not designed to accommodate the waste load may clog or force the effluent to "breakout" to the ground surface without sufficient subsurface treatment. Using the system for disposal of waste not anticipated by the system design waste can result in more rapid degradation of the system or reduced effectiveness. If the waste materials are incompatible with the system tank and piping material, an increased likelihood of leakage exists. Leaks may also occur if improper piping connections are used. Poor maintenance is the leading cause of system failure. Without periodic pumping, solids accumulate in the septic tank and can overflow, clogging the system.

Improper installation may also cause system failure. Care should be taken to protect the integrity of the tank and piping system during installation. Compaction of drainage field soils should be avoided during tank placement. Compacted soils have reduced ability to attenuate waste materials and may severely restrict the flow of waste water, resulting in system backup. In addition, placement of the system too close to the surface increases the likelihood of breakout and flooding, which can result in human exposure to untreated pollutants.

To protect sensitive aquifer protection zones and high recharge areas from nitrogen and phosphorus contamination, complete prohibition of septic systems may be appropriate. In watershed areas, nitrogen and phosphorus may be transported through soils before attenuation or uptake is completed. Nitrogen and phosphorus contamination from septic systems has been documented in surface waters where systems were located within 150 feet of surface water. Even in low concentrations, these nutrients can increase eutrophication in surface water.

Preventive Technologies and Practices

A careful approach to the problem of groundwater contamination from septic tanks involves proper system siting, design, installation, operation and maintenance. Because of the risk inherent in sewage contaminants, careful siting of septic systems is critical. Many sewage contaminants require large amounts of travel time through soils in order to receive adequate attentuation, while others cannot be effectively treated by attenuation or uptake. In some areas, coarse grained sands or carbonate subsurface media allow rapid movement of contaminants with little or no attenuation. Therefore, sufficient setbacks from drinking water wells and surface waters are important. Density restrictions limiting the number of septic systems in a prescribed area will ensure adequate dilution of these contaminants to lower, less harmful concentrations.

Another important consideration relative to siting is the underlying geology and hydrology of the area. The subsurface structure should be sufficiently sound to hold the system and the anticipated waste volumes. Onsite soils should be carefully evaluated to assure that soil porosity factors and organic content are adequate to treat anticipated sewage loads. For best efficiency and aquifer protection, the wet season groundwater table should be three to four feet below the bottom of the drainfield system. Water saturated soils have reduced ability to effectively attenuate contaminants. Further, large volumes of waste water added to saturated soils can cause flooding and release of untreated contaminants.

Because treatment processes vary depending on type of waste, system design should reflect consideration of the type and volume of waste to be disposed. The materials used to construction the system should be compatible with the waste the system will accommodate.

Incompatibility can rapidly the degrade a system, increasing the likelihood of leaks or system failure.

Systems should be installed far enough below ground surface to reduce risk of flooding as waste water flows into the drainfield. During installation, care should be taken to protect the tank and piping system from damage. The soils or fill material used to construct the drainfield should be sufficiently permeable to allow adequate treatment of waste water. However, the soils should not be so permeable that effluent moves too quickly for attenuative mechanisms to act, and should be free of roots or other material which could serve as pathways for waste water to leach through without proper treatment. Compaction of drainfield soils during installation should also be avoided since compaction restricts waste water flow which can result in system backup or flooding.

Various alternative technologies are available for areas where geological or hydrological conditions are not suitable for conventional septic systems. In areas with inadequate soils and high groundwater, mound or fill systems create an elevated drain field to improve the attenuation of contaminants before the waste water reaches groundwater. Sand filters may also be installed in layers beneath the drain field to promote even flow and filtration of the waste water. Evapotranspiration systems employ the use of plants over the drainage field to absorb water and nutrients from the waste water.

Proper operation of septic systems requires an understanding of their limits and capabilities. Systems should be used for waste disposal, and only for those materials anticipated by the system design, since treatment processes vary depending on waste type. Many industrial waste and hazardous wastes are not adequately attenuated by the physical and biological treatment processes used in a conventional domestic septic system. Disposal of these wastes into a conventional septic system can jeopardize potable aquifers and cause system failure.

Normally, the life span of a septic system is twenty to forty years. The single most important factor in long-term operation of the system is proper maintenance. Improperly maintained septic systems can go undetected for many years, but can inflict harmful and costly effects. Routine inspection and pumping is recommended every three to five years. Without pumping, waste solids accumulate and can clog the system. Septic system products claiming to dissolve these solids also destroy helpful bacteria that aid in the break down of waste. The overall effectiveness of these products is suspect and many contain suspected carcinogens. Some municipalities require certification of inspection prior to property transfers. Others promote inspection and pumping by contracting with septic cleaning services to provide discounted rates to residents.

HAZARDOUS MATERIALS STORAGE AND MANAGEMENT

One of the most critical aspects of a local government aquifer protection strategy involves careful control of the design, installation and operation of aboveground and underground storage tanks for liquid hazardous materials. In many jurisdictions, fire codes discourage the use of aboveground tanks for certain products. Estimates are that, in Florida there are over 75,000 underground storage tanks installed at approximately 28,000 locations. Approximately 10,000 of the sites have reported petroleum leaks or spills. Typical uses of above- and underground tanks include gasoline service stations; electronics industries; dry cleaners; photographic processors; airplane, boat and motor vehicle service and repair; metal plating, finishing and polishing; pesticide and herbicide application; chemical and bacteriological laboratory operation; painting, wood preserving and furniture stripping. Small amounts of the hazardous materials involved in these and other businesses can contaminate large amounts of potable groundwater. In addition, leaks of volatile and flammable materials can result in fire or explosion hazards, and can lead to increased costs for owners and consumers.

Potential Leakage from Storage Tanks and Piping

The Office of Technology Assessment of the United States Congress has reported that the typical design life of underground storage tanks is between 15-20 years and is highly dependent on environmental conditions. Unprotected steel tanks may develop leaks within seven years in humid or saline environments, or may survive up to thirty years in arid areas. There are several ways in which tanks and associated piping can leak, including those caused by corrosion, improper installation, and poor operating practices.

1. Corrosion

Basically, corrosion is the loss of tank and pipe material resulting from interactions between the tanks and piping and the surrounding environment, both internal and external. Tanks and piping made of plastics and other non-metallic materials can be susceptible to softening, cracking and swelling. This type of chemical deterioration can be eliminated through the proper selection and handling of tank and pipe materials, to ensure compatibility with the stored product. Metal tanks and piping corrode through an electrochemical process, either galvanic or electrolytic in nature, by which metals gradually lose the atoms of their base element. In the case of iron-based metals used in most existing underground tanks, corrosion occurs when iron atoms disengage from the surface of the metal and combine with hydroxyl groups (composed of an oxygen and hydrogen atom) to form iron oxide or rust.[17] Aboveground steel tanks with proper sealants are less susceptible to this type of corrosion.

Electrolytic corrosion is due to direct current from outside sources entering and then leaving a metal structure by way of the electrolyte. Surrounding materials serve as electrolytes, typically soil or water in the case of underground tanks. The tank is largely unaffected at the point the current enters (the cathodic area), but corrodes where the current leaves the tank (the anodic area).[18] One form of such corrosion occurs when stray current from, for example, DC power sources associated with street railway systems affect steel piping and tanks in an area. Nearby factories or shops can also induce electrolytic corrosion in underground tanks and pipes.

Galvanic corrosion *results from differences in electrical potential that develop when metal* is placed in an electrolyte. The differences in electrical potential can result from the direct coupling of dissimilar metals, or from variations in conditions which exist at the surface of a single metal. When two dissimilar metals are connected electrically and immersed in an electrolyte, current will be generated and galvanic corrosion will occur in one of the metals. Current from the corroding metal will flow into the electrolyte, over to the non-corroding metal, and then back through the connection between the two metals.[19] The corroding metal is known as the anode, and the metal receiving current is known as the cathode. If underground tanks are placed near

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[17] Conservation Law Foundation, Underground Petroleum Storage Tanks: Local Regulation of a Groundwater Hazard 35-43, Conservation Law Foundation of New England, Inc., Boston, Mass. (1984) contains an excellent explanation of the electrochemical and physical processes by which underground tanks corrode.

[18] Woods, P. and Webster, D., Underground Storage Tanks: Problems, Technology, and Trends, Pollution Engineering 30 (July 1984).

[19] Id.

one another, galvanic corrosion can occur if the tanks are of dissimilar metals, or if a new steel tank is placed near an older, rusted tank.[20]

On a single metal surface, two adjacent areas with differing stability can also create galvanic corrosion in the presence of water. Variations in stability can be the result of the location of iron atoms in the microstructure of the metal itself, with atoms located in the crystal lattice being more stable than those lying along a grain boundary.[21] Atoms located at points of residual strain resulting from inconsistencies in fabrication, or from active stress associated with improper installation, are more unstable than atoms in areas free of stress.[22] The steel used in underground tanks and piping is inherently non-homogenous due to the uneven distribution of alloying elements and contaminants.[23] Dissimilarity in the soils used to backfill a metal tank may also cause one part of the tank to become anodic, resulting in corrosion of that area.

With either form of metal corrosion, increases in acidity, salt content, sulfide content, moisture content, bacterial content, and temperature of the surrounding environment tend to increase corrosion rates. Available oxygen levels at the surface of a metal can also have effects on the location and rate of corrosion. In a moist environment, oxygen interacts with iron surfaces to create corrosion at points that are relatively oxygen deficient. In the case of underground steel tanks, oxygen is relatively more available near the top of the tank, making corrosion more likely at the bottom of the tank where the soil or backfill is less well oxygenated. Additionally, corrosion may occur where accumulations of clay, scale or other foreign material such as rocks on the surface of a metal create barriers between the metal and the external environment, or between the metal and the oxygen in the soil or backfill. The areas that are relatively inaccessible to oxygen will tend to become focal points for corrosion.[24]

2. Improper Installation

A second cause of leaks in underground storage tanks is that associated with their installation. Structural damage or scratches to tanks and piping during handling and installation can lead to problems with leaking or corrosion after the tank is in service. Improper bedding or backfilling may cause rupture of fiberglass-reinforced plastic tanks especially. Improper anchoring in areas subject to soil saturation may result in a tank floating, causing damage to the tank and to the overlying slab. Components which are improperly connected may cause leaks at piping joints and at fittings.

3. Improper Operating Practices

The third common cause of leaks and spills is related to poor operating practices. Most often, these occur with overfilling of tanks during transfer operations, and when tanks are punctured with dipsticks during inventory measurements.

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[20] Id. at 42.

[21] Conservation Law Foundation, Underground Petroleum Storage Tanks: Local Regulation of a Groundwater Hazard 39, Conservation Law Foundation of New England, Inc., Boston, Mass. (1984).

[22] Id.

[23] Id.

[24] Id. at 40.

Preventive Technologies and Practices

The importance of proper technical approaches and management strategies cannot be overemphasized. Prevention of spills and leaks involves proper equipment selection, installation practices and operating practices, as well as secondary containment, leak and spill monitoring, and tightness testing.

1. *Equipment Selection*

The necessary equipment for a storage system includes the tank, piping and fittings, overfill prevention devices, and transfer spill prevention equipment.

a. Tanks

Though in the past, carbon steel tanks were widely used in underground storage applications for their strength and chemical compatibility with a wide range of liquids, they have been found to be highly susceptible to corrosion, especially in moist or acidic soils. Current corrosion protection technology includes: cathodic protection, tank coatings, electrical isolation, a combination of these approaches, or use of corrosion-resistant materials. However, there are certain weaknesses in the technologies that do not recommend them for use in sensitive areas.

Cathodic protection involves reversing the electrochemical action of corrosion, inducing an electron flow toward the structure, thus prohibiting the corrosion that occurs when electrons are allowed to flow away from a structure. The two types of cathodic protection are the sacrificial anode (or galvanic) cathodic protection method, and the impressed current (or electromotive force) method.[25] With galvanic cathodic protection, a sacrificial anode such as magnesium or zinc is placed in electrical contact with the metal structure to be protected. The impressed current cathodic protection method uses direct current from an external source.[26] Potential problems with these types of corrosion protection include lack of maintenance, undetected losses of impressed current, and the undetected exhaustion of a sacrificial anode, all of which may leave a steel tank subject to corrosion.

Coatings and linings can be applied to the walls of tanks and pipes to protect them from contact with the external environment, thus reducing corrosion. These types of materials include rubber, epoxies, silicones, and fiberglass reinforced plastic. These coatings can be easily damaged or scratched during handling and installation, however, and should not be considered reliable long-term protection from corrosion, absent other preventive measures.

Electrical isolation involves the use of non-conductive dielectric fittings, bushings, and connections to electrically isolate metal components in a storage system. By minimizing the potential for generation of electrical currents between dissimilar metals, this approach reduces but does not eliminate the potential for corrosion from these sources.

Corrosion-resistant materials can also be used in the construction of tanks and piping. Though the range of potential materials is large, some common examples include special alloys,

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[25] Woods, P. and Webster, D., Underground Storage Tanks: Problems, Technology, and Trends, Pollution Engineering 30, 32 (July 1984).

[26] Id. See Fred Hart Associates, Inc., Technology for the Storage of Hazardous Liquids: A State-of-the-Art Review, prepared for New York State Department of Environmental Conservation, Albany, NY (1983).

fiberglass reinforced plastic, and fiberglass reinforced plastic coatings. In single wall applications, tanks constructed of fiberglass reinforced plastics are more susceptible to structural failure than are steel tanks. Special care should be taken to assure that the tank material is chemically compatible with the product to be stored.

Most currently available equipment uses some combination of the above technologies to reduce the potential for leaks. Pre-engineered steel tanks are available which provide three types of corrosion resistance: cathodic protection, some type of protective coating, and electrical isolation. Fiberglass reinforced plastic (FRP) tanks use a plastic resin which provides chemical resistance, and supplies structural strength to the tank. These types of tanks require careful consideration of the compatibility between the stored product and the tank, since various combinations of resins and glass materials may be used in the construction of FRP tanks. Tanks for storage of alcohol blend products require particular attention. FRP tanks also require careful choice and installation of backfill/bedding materials, to provide adequate structural support. Fiberglass reinforced plastic-clad (FRP-Clad) tanks are constructed of an inner layer of carbon steel fused to an outer layer of FRP, using a polyester resin bond.

Double-walled tanks are probably the best approach to preventing storage tank leaks in most underground applications. The interstitial space between the inner and outer walls can be placed under vacuum, pressurized, or filled with water. With a monitoring system in the interstitial space, breaches of the internal or external tanks can be detected by loss of pressure, loss of vacuum, or drop in the water level. Common construction materials include coated steel and fiberglass.[27] Double-walled tanks are basically a form of pre-engineered secondary containment, and several companies market systems meeting strict containment and monitoring standards. Other forms of secondary containment are discussed later in this section.

b. Piping

Many leaks can be traced to faults in the design, construction or installation of piping associated with storage tanks. Available materials and products have been developed that, with proper installation, can eliminate many of the problems previously encountered. Fiberglass reinforced plastic pipe has been developed and is widely used in underground piping systems for hydrocarbon storage and transfer, because of its inherent flexibility and corrosion resistance. Expansion joints are used to prevent or reduce stresses to piping from thermal expansion and contraction; to eliminate vibration and noise; to compensate for piping misalignment; and to reduce flange breakage from pipe movement. Swing joints provide rotational flexibility to pipes. Double-walled pipes are the best option for assuring that hazardous materials do not leak from storage systems.[28]

c. Overfill Protection

Overfill protection is achieved with a system to measure and control the liquid level in a tank. A very basic system might be a simple gauge to indicate liquid height in a tank. A more advanced system might include an automatic shutoff system and an audible high level alarm to warn an operator of emergency conditions. A comprehensive approach would involve a level sensing device; a level indicating device; a high level alarm; an automatic shutoff control system; an interlocking system that would prevent filling if the overfill prevention system was inoperative;

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[27] Woods, P. and Webster, D., Underground Storage Tanks: Problems, Technology, and Trends, Pollution Engineering 30, 33 (July 1984).

[28] Id.

a bypass prevention feature that prevented the overfill prevention system from being overridden by the operator.[29]

Many types of bulk storage level sensing devices are available. Most sense liquid characteristics, such as capacitance or thermal conductivity, or use principles of buoyancy, differential pressure, or hydrostatic head. Some use the propagation and reflection of light waves or sound waves to detect liquid levels.[30]

d. Transfer Spill Prevention

Transfer of product from one tank to another has the potential to result in leaks when residual liquids left in the hoses spill out after the tanks are filled. These types of spills can be minimized by using couplings with spring loaded valves which automatically block flow when the hoses are disconnected. Examples include quick-disconnect couplings equipped with ball valves and dry-disconnect couplings.[31]

2. Installation Practices

Many leaks in storage systems can be traced to mishandling of the tanks and components, or to improper installation practices. The primary areas of concern are: proper planning of the storage facility; careful handling of all equipment; proper selection and packing of all bedding and backfilling material; and proper anchoring of equipment.

a. Planning and Design

Many storage problems for underground systems are the result of poor site selection, or poor layout and design. Clays, wet soils, cinders and acid soils are highly corrosive, especially to metal tanks and piping, and should be avoided whenever possible. High groundwater levels or floodways require that tanks be properly anchored. Sites with abandoned tanks and pipes, agricultural drainage tiles, or landfill materials require special installation considerations. New metal components can become anodic to the old tanks and pipes. The existing fill may be corrosive. Drainage tiles or storm drains may breach secondary containment barriers. Existing tanks which were not filled when abandoned may collapse and cause foundation problems for new installations. Nearby underground power lines or improperly constructed electrical systems may accelerate corrosion rates.[32]

The design of an underground storage system should take in several additional considerations. Dissimilar metals within a new installation or between a new installation and existing tanks may cause accelerated corrosion. The type of tank, its dimensions, the type of pump system, and the engineering of the system chosen should be based on careful consideration of site conditions, including the type and amount of traffic and other physical loads. Each tank should be vented to prevent buildup of excessive pressure or the blowback of vapor or liquid at

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[29] Id. at 34.

[30] Id.

[31] Id. at 34.

[32] Id. at 35.

the fill opening when tank is filled.[33] Fill openings should be carefully located to assure that tank trucks can reach them easily, without creating traffic hazards. Fill openings and monitoring well covers should be clearly labeled and locked, to provide security to product tanks, and to assure that product is not mistakenly pumped into a monitoring well. As-built drawings should be prepared and filed with the permit, so that underground electrical circuits, pipes, tanks and testing points can be easily located on the ground.

b. Handling of Tanks and Equipment

Tanks are designed to withstand normal handling, but must not be dropped, handled with sharp objects, dragged or rolled prior to and during installation. Damage to tanks and components can result in direct leakage of product, or can accelerate corrosion rates or impair the structural integrity of the tank, allowing for possible structural failure and massive loss of product.

c. Bedding and Backfill

Since fiberglass-reinforced plastic tanks receive as much as 90% of their structural support from the bedding and backfill used, these materials should be carefully chosen and installed. Steel tanks and components are less dependent on bedding and backfill for structural support but may be susceptible to increased levels of corrosion if the materials used are not consistent with each other and compatible with the tank. Soil variations can cause corrosion in steel equipment.

d. Anchoring

To prevent flotation due to buoyant forces, underground tanks should be weighted or anchored in cases where the ground may become saturated with water, such as in areas with potentially high groundwater or in floodplains. Weighting involves covering the tank with a thicker surface slab. Anchoring involves strapping the tank to reinforced concrete pads buried beneath a foot or more of bedding, or strapping it to reinforced concrete deadmen laid along each side of the tank.

3. Operating Practices

Several types of fairly common practices have been recognized as contributing to leaks and spills. Dropping dip sticks into tanks to measure product levels has resulted in tanks being ruptured at the point the dip stick hits the bottom of the tank. Measurements should be carefully taken, and a strike plate should be required below all fillpipe and gauge openings in newly installed tanks. Generally, any operator of a loading or unloading system should be aware of all potential problems, and should be properly trained in emergency response procedures. Loading and unloading of vehicles should only be allowed in approved locations. Delivery vehicles should not be left unattended during the loading or unloading process. For transfer of flammable liquids, delivery vehicle motors and motors of auxiliary or portable pumps should be shut off during making or breaking of hose connections. If not required for the loading or unloading process, the delivery vehicle motor should be shut off for the entire transfer operation. All couplings and hoses should be clearly labeled, marked or color coded to prevent accidental mixing of incompatible liquids.[34]

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[33] Id.

[34] Id. at 37.

4. Secondary Containment

As is apparent, especially in underground applications, single-wall storage tank systems are susceptible to any of a number of potential problems which can cause a spill or leak of hazardous materials. Even in systems with the best preventive technology, leaks will almost inevitably develop after a certain period of time. Monitoring alone may not detect a leak for years after it has developed, if ever. Given these facts, the best approach is to require secondary containment of hazardous material storage systems in areas with any degree of importance to the quality of potable aquifers. Basically, secondary containment involves establishing a barrier around the storage tank so that leaked liquid is not allowed to escape from the storage area. It is important that the type of secondary containment chosen be compatible with the liquid being stored. The material must maintain its structural integrity and impermeability when exposed to the stored product.

The types of applicable secondary containment include: synthetic membrane liners, concrete vaults, and double-walled tanks.[35] Soil sealants such as soil cement or bentonites, and soil liners with low permeability such as clay will not be effective in applications involving hydrocarbons and other hazardous materials. The sensitivity of the area with regard to potable aquifers will also affect which type of secondary containment is required. Secondary containment which is subject to the intrusion of water should have sufficient capacity to handle the additional volume of reasonably foreseeable rainfall events, and should include methods for removing the accumulated product and water without allowing it to drain to storm sewers or the outside environment.

5. Leak and Spill Monitoring

In order to determine if a leak or spill has occurred, and to facilitate a timely response, it is important to require a monitoring system for all types of hazardous materials storage. These can include early warning systems that provide continuous surveillance, and area-wide methods such as monitoring wells.

a. Inventory Control

Inventory control or inventory monitoring involves regular reconciliation of tank inventory and book inventory, regular inspection of the visible parts of the system, and recognition of conditions indicating a leak. The technique is widely applicable but its accuracy is limited by several factors in underground systems. The first is that liquids expand and contract with changes in temperature. Though temperatures in underground environments can remain relatively stable, the addition or transfer of product at a different temperature can make accurate inventory calculations difficult. The second limiting factor is that, especially in high capacity bulk tanks, very small differences in dip stick measurements indicate large changes in product volume. It can be difficult to achieve sufficient accuracy in these measurements. As a result, inventory monitoring programs can only detect leaks that accumulate to something in the vicinity of 0.5-1% of the tank volume.[36]

Additional problems involve the uncertainties caused by delivery discrepancies, sales error, vapor loss, pilferage, and meter calibration error. Statistical methodologies have been developed which allow the tank operator to break out tank leakage from other potential causes of inventory

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[35] Id. at 37.

[36] Id. at 35.

discrepancy, but owners and operators of most underground storage systems have not shown a necessary commitment to careful, regular measurement of product levels. Thus, by itself, inventory monitoring cannot be relied upon as an effective early warning system in underground tanks.

b. Interstitial Monitoring in Double-Walled Tanks

Probably the most effective method of early leak detection involves monitoring of the space between the walls of a double-walled tank, using either fluid sensors or pressure sensors that can detect the presence of liquid or the change in pressure that indicates leaks. Systems in which the interstitial space is filled with a fluid detect breaches of primary or secondary containment by registering changes in the level of liquid. Other systems induce a vacuum within the interstitial space and register losses of the vacuum. Any interstitial monitoring system should include visual or audible alarms.

c. Excavation Monitoring Systems

The second most effective method of early leak detection (after interstitial monitoring in double-walled tanks) involves placement of monitoring systems within the secondary containment sealing a tank excavation. Though breaches of the primary containment or secondary containment will not be immediately detected as with interstitial monitoring, leaked product will not be lost to the environment outside the secondary containment and should be detected by monitors fairly quickly. The sensitivity and placement of monitors and sloping of the secondary containment to a monitored sump area will affect the timely detection of leaks. The weakness of this approach is that breaches of the secondary containment will not be detected by monitors.

Monitoring within tank excavations takes two forms: systems for excavations without secondary containment, and systems for excavations with secondary containment. External monitoring normally involves use of monitoring wells or sumps located near the storage facility, designed so that in the event of a leak, an identifiable amount of the escaped liquid reveals its presence in the well or sump. In its simplest form, this type of external leak detection is monitored manually by visual inspection, smell or by periodic sampling. Continuous monitoring is more effective and can be achieved by means of an automatic sensing device. Leak sensors are available which detect the presence of hydrocarbons in the soil or backfill around a tank without the need for wells or sumps. These operate by detecting changes in the thermal conductivity of the subsurface environment surrounding the tank or in the electrical conductivity of a buried test wire or wire grid. Gas sensors can detect gasoline vapors associated with leaks.[37]

In excavations or storage systems without secondary containment, monitoring systems are limited in their ability to detect leaks and spills of product. Depending on the location of monitors and the path taken by the leaking product, it may be weeks, months or even years before the discharge is detected. Even in situations where a discharge is detected quickly, if the underlying aquifer is close to the surface or is poorly protected by confining layers, or if the quantity of discharged product is more than minimal, monitors will not prevent the contamination of the aquifer. Cleanup of aquifers contaminated with hazardous materials has proven to be technically almost impossible, in most cases, and extremely expensive. For these reasons, in sensitive areas, monitoring of systems without secondary containment should only be allowed on an interim basis, while provision is made for the secondary containment of the hazardous materials.

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[37] Conservation Law Foundation, Underground Petroleum Storage Tanks: Local Regulation of a Groundwater Hazard 52, Conservation Law Foundation of New England (1984).

6. Tightness Testing

A basic approach to assuring the integrity of storage systems will include testing the tanks, piping and other components for tightness, before installation in order to detect flaws in the equipment itself, and after installation in order to detect damage in handling or improper connection of piping and other components of the system. In certain other circumstances, testing may also be required. The standard for accuracy of tank tightness tests was established by the National Fire Protection Association (NFPA). A Precision Test, as defined by the NFPA, must take into consideration the temperature coefficient of expansion of the product being tested as related to any temperature change during the test, and must be capable of detecting a loss of 0.05 gallons (190 ml) per hour. The factors that a qualifying test must consider include: temperature changes, evaporation losses, the presence of vapor pockets, tank and piping characteristics, the water table, and tank end deflection.[38]

Two of the qualifying tests most often used are the Heath Petro-Tite Test and the Hunter Leak Lokator Test. Other qualifying tests may be available. The Petro-Tite test is a hydrostatic test that compensates for temperature, pressure and viscosity variations. It exerts a pressure head on the tank by means of a standpipe filled with the same liquid stored in the tank. A pump circulates the liquid in order to produce a uniform temperature throughout the tank. The test accounts for expansion and contraction of the liquid by measuring temperature changes with a thermal sensor. Volumetric measurements taken in the standpipe are then adjusted for the changes in temperature.[39]

The Leak Lokator test utilizes a sensor, an analytical balance, and two chart recorders. The sensor is suspended from the analytical balance and partially submerged in the tank liquid. The buoyancy of the sensor changes as the liquid level in the tank changes. The change of mass displacement measured by the analytical balance indicates the volume changes within the tank, and is graphically represented over time on one of the chart recorders. The test compensates for temperature variations using a thermal sensor lowered into the center of the tank, with temperatures recorded continuously on the second chart recorder.[40] It should be noted that even tests capable of detecting leaks of 0.05 gallons per hour will not register losses amounting to 1.2 gallons of product per day.

Pressure testing, using air or other gases, of tanks or piping containing flammable or combustible liquids is not recommended and should not be required by regulations or ordinances. These types of tests are unlikely to detect a leak that is below the liquid level in the tank, and there is the danger of rupturing a tank, or expelling liquid through normal openings.[41] However, the tests are generally less expensive than other tightness tests and may be appropriate for testing of certain tanks, piping and components before a storage system is filled or put into service. Basically, air pressure tests involve coating joints and connections with a soap solution, pressurizing the storage system to between 3 and 5 pounds per square inch, and checking for bubbles and sounds caused by escaping air.

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[38] Woods, P. and Webster, D., Underground Storage Tanks: Problems, Technology, and Trends, Pollution Engineering 37 (July 1984).

[39] Id.

[40] Id.

[41] Id.

In addition to hydrostatic testing, piping involved in the transfer or dispensing of product can be tested using one of two techniques, depending on whether the system uses a remote (usually submerged) pump or a suction pump to deliver product. If the pump for an underground tank is itself aboveground, then the product delivery pipe operates under a suction head, and a leak will allow air into the piping system. Several pumping characteristics can indicate the presence of a piping leak, including: skipping or jumping of the display wheels at the meter; a running pump not pumping liquid; a pump overspeeding at first then slowing down as it begins to pump liquid; a rattling sound in the pump and erratic liquid flow indicating that air and liquid are being mixed.[42]

For submerged pump systems, a pipeline leak detector can be used to indicate leaks in the product delivery or transfer line. The detector is a pressure sensing valve mounted on the discharge line above the tank. When the pump is turned on, the detector allows only three gallons per hour to flow. If a leak is present, pressure does not build up in the piping system. Once the dispenser nozzle is opened, if pressure is low, the detector acts to restrict flow, which is an indication of a leak.[43]

STORMWATER MANAGEMENT

Most development creates the need to manage stormwater. Normally, when rain falls on natural ground with supporting vegetation, it does not represent a management problem, since infiltration processes usually assure that the volume is small and relatively clean. It is when natural lands are converted to other uses, especially urban uses, that stormwater becomes a management concern. Impervious surfaces prevent rain from soaking into the soil, and allow accumulation of pollutants. Traditionally, stormwater management concerns have focused on controlling the volume and peak discharge rate, both of which increase dramatically when impervious surfaces cover an area. It is only in the past ten to fifteen years that stormwater as a source of pollutants in surface water has also become a subject of concern.

Throughout the state, stormwater and other nonpoint sources of pollution are responsible for the majority of pollutants entering Florida's waters. Pet wastes appear to be a source of the high coliform bacteria counts often found in stormwater from single family residential areas. In commercial and transportation sites, high levels of lead and zinc are associated with stormwater. Multi-family land use generates a combination of the pollutants found in other uses, including high levels of nitrogen and phosphorus. Parking lots are considered some of the greatest contributors to runoff pollution. In industrial areas, hazardous materials usage makes stormwater control critical.

Groundwater is not immune to contamination from stormwater, though research is only beginning to define the extent of the problem. Drainage wells and sinkholes, particularly, can serve as direct conduits into the underlying aquifer for untreated stormwater carrying bacteria, nutrients and metals. Drainage wells are designed to deal with large quantities of stormwater but offer no attenuation of pollutants. Preliminary evidence has also shown that uncased agricultural wells, considered a form of drainage well, are highly susceptible to contamination by agricultural run-off.

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[42] Id.

[43] Id.

Stormwater Pollutants and Associated Land Use Categories

The typical pollutants associated with stormwater are sediment, oxygen demanding substances, heavy metals, and nutrients such as nitrogen and phosphorus. **Sediment** is solid material originating primarily from disintegrated rocks, or eroded soil or accumulated organic materials deposited on the land surface. Particle size and density can vary greatly, and both influence the rate at which sediment will settle out of stormwater. The most common measure of stormwater sediment is total suspended solids (TSS). The most effective method of reducing sedimentation is erosion control, though sedimentation (or settling) basins are also important in reducing TSS.

Oxygen demanding substances are organic materials for the most part, including greases and oils from vehicle operations, and are decomposed by microorganisms which require oxygen to live. Biological oxygen demand (BOD) or chemical oxygen demand (COD) are the two most common measures of oxygen demand, though COD may be the better indicator, since several types of toxins often found in stormwater may interfere with the BOD test. To aid the processes which decompose such substances, a stormwater system such as a retention or detention lake must include mechanisms to maintain high oxygen levels and prevent anaerobic conditions. Examples include natural mechanisms such as shallow lake depth, adequate lake length and width to induce wind mixing, and proper orientation to maximize opportunity for wind mixing. Aerators or fountains are examples of mechanical oxygenators.

Heavy metals are found primarily in highway runoff, and are a result of the operation of motor vehicles, direct fallout and degradation of highway materials. Lead, zinc and copper account for about 90% of the dissolved metals, and 90-98% of total metal concentrations. Except for copper and cadmium, most metal species are present in particulate form, and removal efficiencies of 60-95% can be realized by using appropriate management practices. The physical configuration of retention and detention basins should encourage gradual reduction in flow velocity to promote particle settling. The length of the flow path from inlet to discharge point should be maximized, and designs should prevent short circuiting of flow paths or creation of hydraulically "dead zones." Aquatic plants should be planted in sinuous littoral areas to promote attenuation of dissolved metals.

Nitrogen and phosphorus are the primary nutrients found in stormwater. Both contribute to the growth of algae and other aquatic plants, and accelerate the eutrophication process in lakes and streams. The mix of particulate to dissolved forms of nutrients is approximately 6:4, thus stormwater management should include provisions for settling out the particulate forms and provisions for assimilation of the dissolved forms. In detention and retention basins, a littoral zone planted with aquatic plants should be concentrated near the discharge point, to aid in nutrient assimilation. Particulate nutrients can be reduced by employing swale conveyance, sediment pumps or a perimeter swale and berm system.

The five major categories of land use include residential, commercial, roadway, industrial, and mixed urban. Typically, different types of land use will contribute different proportions of contaminants to stormwater runoff, though in some cases, these differences are not statistically significant. A comparison of research findings by the South Florida Water Management District[44] indicated that nitrogen showed no statistically significant differences between land uses, though commercial sites seemed to exhibit slightly lower total Kjeldahl nitrogen (TKN) levels. Comparison

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[44] Whalen, P. and Cullum, M., An Assessment of Urban Land Use/Stormwater Runoff Quality Relationships and Treatment Efficiencies of Selected Stormwater Management Systems, Technical Publication 88-9, South Florida Water Management District (July 1988).

of phosphorus levels showed that residential land uses were responsible for significantly higher (95% confidence interval) total phosphorus event mean concentration (EMC). The EMC is determined by dividing the total pollutant mass discharged by the total discharge volume. Commercial sites reported significantly lower EMCs for phosphorus (95% confidence interval).

Lead, which is the predominant heavy metal in stormwater runoff, had significantly higher (90% confidence interval) concentrations in commercial and roadway land uses than in residential, industrial or mixed urban uses. Oxygen demand, as measured by COD tests, is significantly higher (95% confidence interval) in residential and roadway areas than in other land use groups. Comparisons of the several land uses revealed no clear pattern with regard to total suspended solids (TSS), a measure of sediment quantity.

Priority pollutant organics such as polycyclic aromatic hydrocarbons are largely petroleum by-products, and have also become of particular concern in recent years because of their impact on human health. Though monitoring studies focusing on such pollutants are limited, they have been detected most often in samples from heavy and light industrial and commercial land use categories. In one study examining sites in 28 cities, the most serious water quality criteria exceedances in the human carcinogen category were a-hexachlorogyclohexane, Y-hexachlorocyclohexane (lindane), chlordane, phenanthrene, pyrene, and chrysene.[45]

Thus, as summarized, the data demonstrate that no one land use category is responsible for the majority of all stormwater pollutants. The following table identifies the land use classifications which were statistically shown to export the highest EMCs for various pollutants.

Table 3
Statistical Association of Land Use Categories and Primary Stormwater Pollutants[46]

Pollutant	Land Use Classification				
	Residential	Commercial	Light Industrial	Roadway	Mixed Urban
TKN					
Total P	•				
Lead		•		•	
COD	•			•	
TSS					

[45] Id. at 28.

[46] Id. at 33.

Principles of Stormwater Management

The basic objectives of stormwater management should be to assure that stormwater volume, peak discharge rate and pollution loads leaving a site after development are similar to those occurring prior to development. Some general principles are developed in a publication titled, "The Florida Development Manual: A Guide to Sound Land and Water Management" by the Stormwater Management Section, Florida Department of Environmental Regulation (June, 1988). The following principles are quoted from Chapter 4 of that text, and include measures specific to both surface water and groundwater.

It is much more efficient and cost-effective to prevent problems than to attempt to correct problems after the fact. Sound land use planning decisions based on the site planning principles (discussed in Chapter 2 of "The Florida Development Manual") are essential as the first, and perhaps the most important, step in managing stormwater related problems. All new development plans (e.g., subdivisions, shopping centers, industrial parks, office centers, etc.) and redevelopment plans should include a comprehensive stormwater management system.

Every piece of land is part of a larger watershed. A stormwater management system for each development project should be based on, and should support a plan for the entire drainage basin.

Optimum design of the stormwater management system should mimic (and use) the features and functions of the natural drainage system which is largely capital, energy and maintenance cost free. Every site contains natural features which contribute to the management of stormwater under the existing conditions. Depending upon the site, existing features such as natural drainageways, depressions, wetlands, floodplains, highly permeable soils, and vegetation provide natural infiltration, help control the velocity of runoff, extend the time of concentration, filter sediments and other pollutants, and recycle nutrients. Each development plan should carefully map and identify the existing natural system. "Natural" engineering techniques should be used to preserve and enhance the natural features and processes of a site and to maximize the economic and environmental benefits. Natural engineering is particularly effective when combined with open space and recreational use of the site, or in "blue-green" developments using cluster techniques. Engineering design can and should be used to improve the effectiveness of natural systems, rather than negate, replace or ignore them.

The volume, rate, timing and pollutant load of stormwater after development should closely approximate the conditions which occurred before development. To accomplish these objectives two overall concepts must be considered: (1) the perviousness of the site should be maintained to the greatest extent possible; and (2) the rate of runoff should be slowed. Preference should be given to stormwater management systems which use best management practices (BMPs) that maintain vegetative and porous land cover and include on-site storage mechanisms. These systems will promote infiltration, filtering and slowing of the runoff.

Maximize on-site storage of stormwater. Provision for storage can reduce peak runoff rates; aid in groundwater recharge; provide settling of pollutants; lower the probability of downstream flooding, stream erosion and sedimentation; and provide water for other beneficial uses. Where practical, the "blue-green" approach to development should be employed; it inherently provides storage, environmental protection and enhancement of community amenities. (The "blue-green" concept refers to the incorporation of stormwater lake systems into the open space and landscape plan for a development.)

Stormwater runoff should never be discharged directly into surface or ground waters. Runoff should be routed over a longer distance, through grassed waterways, wetlands, vegetated buffers and other works designed to increase overland "sheet" flow. These systems increase infiltration and evaporation, allow suspended solids to settle, and remove pollutants before they are introduced to Florida's waters.

Stormwater management systems, especially those emphasizing vegetative practices, should be planned, constructed and stabilized in advance of the facilities that will discharge into them. This principle is frequently ignored thereby causing unnecessary off-site impacts, extra maintenance, re-working of grades, re-vegetation of slopes and grassed waterways, and extra expense to the developer. The stormwater management system, including erosion and sedimentation controls, should be constructed and stabilized at the start of site disturbance and construction activities.

The stormwater management system must be designed beginning with the outlet or point of outflow from the project. The downstream conveyance system should be evaluated to ensure that it contains sufficient capacity to accept the design discharge without adverse downstream impacts such as flooding, streambank erosion and sedimentation. It may be necessary to stabilize the downstream conveyance system, especially near the stormwater system outlet. Another common problem is a restricted outlet which causes stormwater to back up and exceed the storage capacity of the collection and treatment system resulting in temporary upstream flooding. This may lead to hydraulic failure of the stormwater management system causing resuspension of the pollutants and/or expensive repairs to damaged structures or property. In such circumstances it is advisable to use more than one outlet or to increase the on-site storage volume.

Whenever possible, construct the components of the stormwater management system on the contour following the topography. This will minimize erosion and stabilization problems caused by excessive velocities; it will also slow the runoff allowing for greater infiltration and filtering.

Stormwater is a component of the total water resources which should not be casually discarded but used to replenish those resources. Stormwater represents a potential resource out of place, with its location determining whether it is a liability or an asset. Treated stormwater has a great potential for providing many beneficial uses such as irrigation (farm, lawn, parks, golf courses), recreational lakes, groundwater recharge, industrial cooling and process water, and other nonpotable domestic uses.

Whenever practical, multiple use temporary storage basins should be an integral component of the stormwater management system. All too often, storage facilities planned as part of the system are conventional, unimaginative ponds which are aesthetically unpleasing. Recreational areas, neighborhood parks and even parking facilities provide excellent settings for the temporary storage of stormwater. Such areas are not usually in use during periods of precipitation and the ponding of stormwater for short durations does not seriously impede their primary functions.

Storage areas should be designed with sinuous shorelines. Shorelines which are sinuous rather than straight increase the length of the shoreline thereby creating greater development opportunities if a blue-green concept of permanent lakes is being used. The increased shoreline also provides more space for the growth of littoral vegetation this providing for greater pollutant filtering and for increased and diversified aquatic habitat.

Vegetated buffer strips should be retained in their natural state or created along the banks of all water bodies. Vegetated buffers prevent erosion, trap sediment, filter runoff, provide public access, enhance the site amenities, and function as a floodplain during periods of high water.

They also provide a pervious strip along a shoreline which can accept sheet flow from developed areas and help minimize the adverse impacts of untreated stormwater.

The stormwater management system must receive regular maintenance. Failure to provide proper maintenance reduces the pollutant removal efficiency of the system and reduces the system's hydraulic capacity. Lack of maintenance, especially to vegetative systems which may require revegetating, can increase the pollutant load of stormwater discharges. The key to effective maintenance is the clear assignment of responsibilities to an established agency (local government) or organization (homeowners association) and a regular schedule of inspections to determine maintenance needs. Even better, stormwater system designers should seek to make their systems as simple, natural and maintenance free as possible.

Representative Best Management Practices (BMPs)

Since about 90% of the thunderstorms in Florida result in one inch or less of rainfall, and since about 90% of the pollution load is carried in the first inch of run-off, the best approach is to develop an integrated stormwater management system utilizing various "best management practices" (BMPs) to deal with the initial flush. An extensive number of these are explained and put into context in Chapter 6 of "The Florida Development Manual: A Guide to Sound Land and Water Management," Stormwater Management Section, Florida Department of Environmental Regulation (June, 1988).

The BMPs can be divided into nonstructural controls for reducing pollutants, erosion and sediment controls, and structural runoff controls. Nonstructural controls include those for fertilizer application, pesticide use, solid waste collection and disposal, source control on construction sites, and street cleaning. Erosion and sediment controls are subdivided into structural practices and vegetative practices. Structural erosion and sediment controls can be categorized under road stabilization techniques, sediment barriers, dikes and diversions, sediment traps, flumes, and waterway and outlet protection. Vegetative practices include those for site preparation, grass establishment, mulches, other vegetation and other miscellaneous controls.

Structural stormwater controls include the following representative BMPs which, ideally, should be fitted to the physical characteristics of the individual site. In some areas, the soils, underlying geology, or other physical characteristics will require that certain techniques not be used. Chapter 6 of "The Florida Development Manual: A Guide to Sound Land and Water Management" contains definitions of each BMP, its purpose, conditions in which the technique is applicable, planning considerations, and design criteria. The most effective approach to stormwater management will utilize nonstructural as well as structural techniques and configure them into "treatment trains" which in combination, provide effective attenuation of stormwater pollutants.

1. Infiltration BMPs

One of the most effective methods of decreasing pollution loads is by infiltrating stormwater back into the ground. This provides full treatment and provides good groundwater recharge, but is limited to areas with moderately porous soils and relatively low groundwater tables. Infiltration systems are natural or artificially constructed landscapes which hold stormwater, either for later discharge to surface water, or with no discharge to surface water. During the holding period, stormwater is allowed to percolate into the soil and into the underlying aquifer. These techniques cannot be expected to adequately attenuate hazardous materials however, and also require very careful consideration in karst terrain, where highly porous limestone is near the surface. The failure of one of these systems in an area underlain with karst formations could allow contaminants to be rapidly introduced into the underlying aquifer.[47]

Swales or grassed waterways are probably the oldest but most misused stormwater infiltration BMPs. They must be completely vegetated to prevent erosion, and to provide filtration and nutrient uptake. To also allow for flood protection, an innovative design can combine a swale for water quality purposes with a storm sewer. The storm sewer inlet includes a raised lip which holds the first one inch of stormwater run-off for infiltration and allows the remainder to be conveyed to a detention area for release at the pre-development peak discharge rate.

Retention areas are a type of infiltration BMP which retain stormwater onsite, allowing it to slowly percolate back into the soil. Retention systems generally allow for greatest treatment efficiencies and when properly located, designed and constructed, pose the least threat to groundwater resources. Such systems require at least two feet between the bottom of the system and the seasonally high groundwater level. They also require sandy soils which are not so pervious that stormwater percolates through too quickly. In karst areas, such systems must be carefully designed and constructed to avoid loss of stormwater and sediments into underlying geological formations. Integrating the retention areas into the site's open space and landscaping plan works to reduce operation and maintenance needs, increase aesthetics and reduce the total amount of land needed for stormwater management. For cluster and PUD developments especially, the review process should include criteria aimed at combining open space and landscaping requirements with those for stormwater management, including for example, retention areas. Such facilities are practical wherever soil permeability allows suitable percolation, and they are especially useful in areas where rapid urbanization and saltwater encroachment threaten potable water supplies. However, potential groundwater contamination may be a problem associated with these systems and should be carefully considered in their location and design.

Exfiltration trenches involve the excavation of pits or trenches which are backfilled with sand and/or graded aggregates. Stormwater runoff from impervious surfaces can be directed to these facilities for detention and infiltration. Permeable soils are required, and the potential for groundwater pollution must be carefully evaluated. One major unanswered question is the life expectancy of such a system. High sediment loads may lead to clogging of the backfill over time. An exfiltration trench must be sealed from accepting inflow during construction of areas which will discharge to the system. If not, sediment loads during construction may reduce or destroy the efficiency of the system. Since many of these types of facilities are located under paved areas, another problem involves the difficulty of maintaining or repairing clogged trenches.

Underground percolation systems are basically retention systems placed underground, often beneath parking lots or other types of developed surfaces. In urban areas especially, this approach reduces the costs associated with acquiring expensive land for stormwater facilities. A typical system allows stormwater to enter through an inlet containing a catch basin or trash rack to remove leaves and litter. The stormwater is then directed into a large perforated pipe which rests within a gravel envelope. Filter cloth surrounds the backfill to prevent natural soils from clogging the backfill. Stormwater slowly flows out of the holes in the pipe and eventually percolates back into the underlying soils. Infiltration systems do not work well where soils do not percolate water well or where the water table is very high and the terrain is flat.

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[47] See Draft Applicant's Handbook: Karst Sensitive Areas, Department of Resource Management, St. Johns River Water Management District (May, 1988). Explains the hydrogeology of karst areas, assessment of stormwater pollutants and principal abatement mechanisms, and project design standards and guidelines for stormwater systems in karst sensitive areas.

2. Detention BMPs

Detention BMPs are designed to detain water for later release at the pre-development peak discharge rate while providing treatment through filtration and other means.

Detention areas may be integrated into the landscape where topographic changes are relatively large, or may be constructed in relatively flat areas. Detention basins may be either wet or dry systems. The typical wet detention system involves construction of a lake, which serves as a source of fill to raise streets and building pads, and provides an aesthetic amenity to the development. These systems include biological, physical and chemical mechanisms to attenuate the pollutants in stormwater, including substances such as metals. The pollutants settle and attach to bottom sediments, where they remain, unless anaerobic conditions or low pH conditions develop, releasing the pollutants and allowing them to re-enter the water column. A perimeter swale/berm is important, as well as a littoral zone comprising about 30% of the pond, concentrated near the discharge point and planted with aquatic plants to help absorb pollutants and nutrients. Littoral zone plants are an essential component of a wet detention system. They help to remove dissolved pollutants by holding them in roots and associated sediments, and by providing a substrate for various algae and other plants, which act to uptake the dissolved pollutants. A detention lake should be oriented to take advantage of prevailing winds, to promote mixing and aeration, or should include mechanical aerators such as fountains. Sinuous shorelines are important in order to increase flow paths and increase attenuation, provide aesthetic appeal, and promote overall treatment efficiencies.

Detention with filtration basically involves detention ponds with soil filters, usually made of sand. However, these systems are difficult to design, construct and maintain, and they only filter out particulate pollutants associated with sediment.

Wetland systems, under certain circumstances, may be used for stormwater treatment. If soils in the area under consideration are advantageous to creation of wetlands, a manmade wetland has the ability to perform the functions of a natural wetland. The advantages of using wetlands include reduced operation/maintenance needs, the preservation of wetlands or restoration of drained wetlands, and preservation of upland systems. It is important to protect the natural mechanisms that break down the pollutants, including those of wetland plants and soils. Too many nutrients, pollutants or sediments can effectively ruin a wetland's functions. One approach is to have a pre-treatment pond or lake into which stormwater is routed before entering the wetland. The pond or lake would reduce sediment loads, remove oils and greases and moderate stormwater volumes. Stormwater should be allowed to sheet flow through the wetland to increase contact with plants, sediments and microorganisms, and maximize treatment efficiencies. Monitoring requirements are important, to assure that treatment efficiencies and wetland functions are maintained over time.

3. Low Cost Retrofit BMPs

Within existing urban areas, the unavailability and cost of land may make conventional approaches impractical for new development or for modification of existing systems. The following are representative approaches which contribute to stormwater infiltration and attenuation, but which are less costly. They will serve to enhance though not replace the treatment capabilities of a conventional "treatment train."

Curb cuts are required by many local governments, however in traditional form, they tend to concentrate stormwater and require management by means of capital intensive stormwater infrastructure. Curb cuts which route some of the stormwater to flow onto adjacent grassed areas will allow infiltration and percolation, and reduce loads on downstream stormwater facilities.

Inlets within grassed areas allow stormwater to be pretreated by the grass and soil, removing oils, greases, heavy metals and other pollutants.

Turf block can be placed in parking areas which receive heavy use only occasionally, allowing much less use of impervious surface and much more infiltration of stormwater. The pavement normally includes concrete grids or other structural units alternated with pervious fillers such as sod, gravel or sand.

Porous concrete or asphalt involves special pervious paving material which allows infiltration of stormwater and prevents buildup of rainwater on road surfaces. Infiltration water is stored below the pavement in a high-void aggregrate base. A significant problem with such approaches is that in most cases, pavement specifications require sub-grade material to be at 90% compaction, which would cause a porous pavement system to be essentially impervious. Where applicable, the technique provides stormwater detention and can increase infiltration in some cases.

Underdrains and stormwater filter systems usually consist of a conduit, such as a pipe or gravel filled trench to intercept, collect and convey drainage water following infiltration and percolation through the soil, aggregate or filter fabric. These systems can be used in combination with other measures to enhance pollutant removal where space limitations, lack of soil permeability or high water tables limit the degree of treatment otherwise obtainable.

AGRICULTURAL LAND USES

Aquifer and surface water contamination can result from agricultural activities such as improper or excessive use of agricultural chemicals or improper management of animal wastes. Pesticides, fertilizers, and runoff from animal waste contain pollutants which may not be adequately treated in certain geologic areas. An aquifer protection program in agricultural areas should address the management of chemicals, such as pesticides and fertilizers, and wastes from concentrated livestock operations.

Agricultural Chemicals

Pesticides are designed to be toxic to certain crop pests and weeds and are applied in agricultural settings across large areas of land. Under federal law, registration of pesticides is required, as well as proof that the pesticides will not "cause unreasonable adverse effects on man and the environment." Over 50,000 pesticides have been registered and it is estimated that over 700 million pounds are applied annually. The Florida Department of Agriculture and Consumer Services has developed a list of restricted pesticides. Among other characteristics, many of these pesticides have a greater tendency to leach. Application of restricted pesticides can only be performed by licensed professionals.

Despite the registration and application requirements, the toxicity and fate of all pesticides are not known. Whether a pesticide will reach ground water depends on interactions between the soil, the water and the pesticide which determine how long the pesticide survives in the soil and how far it moves. The persistence and mobility of pesticides is determined by several characteristics of the chemical: water solubility, volatility, soil sorption, and degradation. Soil conditions such as temperature, moisture, precipitation, and ground water flow also affect the persistence and mobility of pesticides.

Nitrogen-containing fertilizers can pose a serious threat to groundwater. When properly applied in appropriate quantities, fertilizer is taken up by the crops. However, when fertilizer application is excessive or overly broad, nitrogen remains in the soil where it is converted by microorganisms to nitrates and nitrites. Nitrates are soluble and tend to flow with the ground water rather than being treated by the soil. Nitrates in ground water have been linked to methemoglobinemia, "blue baby syndrome," which causes asphyxiation in infants. Other health effects such as impairment of the nervous system, cancer, male sterility, and birth defects are suspected, but have not been proven.

Improper disposal of agricultural chemicals and chemical waste can cause groundwater contamination. Label directions on chemicals generally describe appropriate measures for disposal of the chemical and the chemical container. Washdown of chemical application equipment generates waste water which should be collected and treated or recycled. Discharge of the waste water can result in over-application and can increase the likelihood that the chemicals will migrate through the soil to groundwater.

Chemigation, the direct mixing of pesticides and fertilizer with irrigation water, is an agricultural practice which may also threaten groundwater. Chemigation allows farmers to apply chemicals to crops while irrigating. However, a malfunction of the irrigation pumps can result in backflow of chemicals directly into the water source, if proper antisyphon devices are not installed on irrigation equipment. Furrow chemigation, especially, can increase the potential for chemicals to leach to groundwater.

Irrigation water alone contains small quantities of salt which can build up in the soil damaging crops and eventually leaching into groundwater. The return flows from irrigation can also increase the likelihood of leaching of nitrates and pesticides. The quantities of water required by many irrigation techniques can have serious effect on ground water levels. Irrigation consumes approximately seventy percent of all ground water used. If large withdrawals of water are made for irrigation, nearby shallow wells may be affected. Particularly in the coastal plain areas, intensive pumping for irrigation can induce the intrusion of saltwater into freshwater aquifers. Drip irrigation techniques are recommended to lower leaching rates and decrease water withdrawals.

Best Management Practices for Agricultural Chemicals

Preventing significant quantities of chemicals from entering ground water depends on the solubility of the chemical, proper application, uptake ability of the crops, and the ability of the soil to attenuate residual chemicals. Selection of best management practices for protecting groundwater from agricultural chemicals requires consideration of many factors including the chemical characteristics, permeability of the soil, climate and hydrology.

The best approach to ground water protection is to avoid the use of toxic pesticides in shallow groundwater areas or in sensitive hydrogeologic areas where soluble and persistent pesticides are likely to migrate. Other approaches to pesticide management may include adjusting the method, rate and timing of application rates to plant needs and soil attenuation capacity. Pesticides are most effective and least likely to migrate when applied to ensure they remain in the crop root zone. As oxygen and biological activity around the zone interact with the pesticide, the pesticide tends to degrade and attenuate more rapidly. When applied before rainfall or during irrigation, pesticides are less likely to remain in the root zone and will have a greater tendency to leach to ground water.

Contaminant leaching and ground water recharge occur primarily when crops are not growing. The use of crops with long growing season improves the uptake potential of pesticides.

Reducing pesticide concentrations during low or no growth periods reduces the likelihood of leaching. The use of rotation can also reduce pesticide concentrations. Some crops will take up residual nitrate from previous crops. Other rotation sequences can disrupt insect life cycles and plant diseases which reduces the need for pesticide applications.

These and other approaches to pesticide management can be part of an integrated pest management program (IPM) which emphasizes the combined use of biological and other nontraditional methods to control pests. These methods include trapping male insects, releasing sterile male insects into the population to prevent reproduction, development of resistant crop varieties, changing planting times to avoid peak pest populations, and the use of natural pest predators. The practice of IPM advocates minimal use of pesticides by carefully adjusting the timing of application and improving the accuracy of the application by equipment calibration. This approach represents a departure from typical pest control practices, and until recently has had limited acceptance from the agricultural community. Its promotion may be essential to protecting groundwater in many areas.

Other general measures for protecting groundwater from agricultural chemicals include the use of appropriate storage containers, proper container disposal, and installation of antisyphon devices on chemigation equipment. The application of fertilizer should based on realistic crop yield expectations and should be limited to the amount necessary to meet projected crop plant needs. The timing of the application should be determined based on the period of maximum crop uptake, and the method of application should be designed to limit application to areas where maximum uptake will occur. If chemigation is used to apply fertilizer and irrigation water, care should be taken to ensure over-irrigation does not occur, forcing fertilizer below the crop root zone and into the groundwater.

Animal Feedlots and Livestock Operations

Livestock production generates over 160 million dry-weight tons of manure annually. In karst areas, ground water may be contaminated by a relatively small livestock operation, but the greatest threat is from concentrated animal confinement and feeding operations such as feedlots for beef cattle, confined hog feeding operation, poultry operations, and large dairy operations. Facilities that treat or dispose of animal waste are also potential contaminant sources.

When properly managed, animal wastes can be readily assimilated into the soil. However, in areas where waste loads are high and ground water is shallow or soil is more permeable, waste creates a contamination problem for surface water and ground water. Animal wastes contain nitrogen creating similar risks in ground water as those posed by nitrogen-containing fertilizers -- blue baby syndrome, cancer, and birth defects. In surface water, the nitrogen promotes algal growth which can lead to eutrophication. Animal wastes also contain bacterial pathogens which can transmit viruses and diseases. The use of hormones, antibiotics, and chemical feed additives in livestock production raise concerns about the impact of these compounds on ground water.

Best Management Practices for Feedlot and Livestock Operations

Groundwater contamination from livestock operations can best be prevented by siting operations in areas with sufficient soil attenuation capacity and by controlling animal densities. Feedlot operations and manure application should be restricted in areas of saturated soils, sinkholes, or in highly permeable soils.

Even in less sensitive hydrogeologic areas, a manure management plan should be developed addressing containment and treatment methods, monitoring programs, and surface runoff control measures. Feedlots should be graded and paved to promote collection of waste into a lined impoundment area. Impermeable embankments should be installed to prevent runoff of waste into surface water. The application of manure to soil should be permitted only in such quantities as can be adequately attenuated by the soil and utilized by crops. A regular monitoring program should be implemented to measure nitrogen levels.

UNDERGROUND INJECTION AND DRAINAGE WELLS

The injection of waste water into nonpotable aquifers is a method of effluent disposal. Injection wells are also used for other purposes. Underground injection wells are drilled through several geologic layers and water-bearing zones, and waste water is pumped under pressure into a brackish water zone typically lying beneath a low permeability clay or rock layer (confining layer). Failure of well casings or leaks through the confining layer can contaminate overlying aquifers.

Injection wells are divided into five classifications. Class I wells are used for disposal of industrial or municipal waste. Class II wells inject brine from oil and gas production or are used to enhance recovery of oil and gas through the injection of water. Class I and Class II wells cannot inject into or above a potable aquifer but may be installed through the aquifer. Class III wells provide injection for the extraction of minerals or solution mining of minerals. Class IV wells are designated for injection of hazardous or radioactive waste. These types of wells were banned in Florida in 1981. Class V wells are the most common and include drainage wells, connector wells, recharge wells, cooling water return wells, and other injection wells not identified in Classes I through IV. These wells may inject into drinking water aquifers, if the injected fluids meet drinking water standards.

Before an injection well can be installed, the underlying geologic formations must be identified to determine if the site is suitable for injection. Soil samples taken from a test borehole at varying depths indicate the type and thickness of underlying geologic formations. This information identifies potential confining layers and suitable injection zones. Water samples also collected from the test borehole identify the location of potable and nonpotable water supplies.

Typical fluids disposed in injection wells and drainage wells are industrial wastes, organic chemicals, acids, and brines. While many of these fluids are treated prior to injection, the concentrations are generally too high to bring the fluids within drinking water standards. The danger of contamination arises with injection wells if initial investigation was in error regarding the ability of the confining layer to protect potable aquifers from the injected wastes. In addition, any geologic shifts or pressure may breach the well casing and permit fluids to migrate into potable aquifers or permeable soil layers before reaching the injection zone.

Underground injection and drainage wells should not be sited in recharge areas or other sensitive aquifer zones. Design considerations should include the testing of wastes for compatibility with the well equipment and with other wastes to be injected into the zone. If the waste is incompatible with the material forming the confining layer, the layer may be breached and allow leakage into potable aquifers. Monitoring of drinking water aquifers in the vicinity of the disposal well should be conducted to monitor the effectiveness of the disposal system.

LANDFILLS

Florida generates over 42,000 tons of solid waste per day, a figure expected to double by the year 2000. Landfills are used as the ultimate point of disposal not only for unprocessed solid waste, but also for waste from recycling, composting and waste-to-energy facility processes. Landfills pose an inherent threat to groundwater. Leachate is produced from precipitation or other moisture seeping through landfill waste to the base of the landfill, taking with it soluble waste materials. Leachate volumes tend to be higher in humid areas, where precipitation exceeds evaporation. EPA's Office of Solid Waste has estimated that a 17-acre disposal site with annual precipitation of 10 inches can generate 4.6 million gallons of leachate a year.

The contaminants generated by landfills vary according to the type of waste. The typical municipal landfill contains primarily paper, food waste, yard trash, glass, metal, and plastics. This includes potentially toxic materials such as household containers with cleaning products, solvents, paint, pesticides, oils and acids. The contaminants generally associated with sanitary landfills include disease causing organisms (pathogens), organic chemicals, and heavy metals. Pathogens carried by insects or vermin can exist in soil conditions beneath landfills and are not adequately treated by attenuation processes. Organic compounds adsorb to soil particles at varying rates, but tend to be more mobile and less likely to degrade through biological interaction. These compounds are linked to impairments of the central nervous and circulatory systems. Heavy metals do not degrade through biological interaction and tend to accumulate in the body, contributing to central nervous system disorders, gastrointestinal disturbances, birth defects, and cancer. EPA studies have shown that even ten years' pumping of groundwater containing leachate with hazardous materials may have little or no effect on groundwater contaminant levels.[48] The costs of such efforts can be extremely high.

The level of risk associated with landfills depends largely on the type of waste, site conditions, and facility design and operation. Siting of landfills in areas where unstable soil or geological conditions can cause landfill liners to fail under the weight of accumulated wastes. High ground water areas are also unsuitable since the likelihood of groundwater contamination is greater in the event of a liner breach.

In Florida, landfills are classified into three categories. Class I sanitary landfills receive an average of 20 tons or more of solid waste per day and receive an initial cover at the end of each working day. Class II sanitary landfills receive an average of less than 20 tons per day and must be covered once every four days or more frequently if they receive sewage or industrial sludges, dead animals, or other nuisance wastes. Class III landfills receive only trash and yard trash, including vegetation, debris, cardboard, cloth, glass, street sweepings, and vehicle tires. Construction and demolition debris landfills accept such materials as asphalt, concrete, wallboard, glass, shingles, lumber, tile and other materials from the construction or demolition of a property.

Liners are required for landfills accepting more potentially hazardous materials, though many older existing landfills are not lined. Liners may be constructed of synthetic materials or soil (clay). Material selection depends on the type of waste disposed and site conditions. Synthetic liners are required to meet certain design and performance standards specifying thickness, durability, and stress resistance. Soil material selected for liners must meet certain standards of impermeability and be free of fractures, roots, or other potential contaminant migration pathways. If soil liners are not sufficiently thick, leachate may seep through the liner through intervening soils and into ground water.

Landfills accepting more potentially hazardous materials are required to have a leachate collection system constructed of a network of perforated pipes at the base of the landfill, connected to sumps. Beneath the leachate collection system is a protective liner constructed of soil or synthetic material. If the containment and collection system materials are incompatible

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[48] Travis, C. & Doty, C., 24 Environ. Sci. Technol. 1464 (1990), cited by Abelson, P., "Inefficient Remediation of Ground-Water Pollution," 250 Science 733 (Nov. 1990).

with the waste, the system is likely to function less efficiently or fail entirely. Leachate collection systems should be inspected regularly to ensure constant operating efficiency.

Preventive Technologies and Practices

Though probably impossible to eliminate entirely, the numbers of landfills can be drastically reduced by other measures such as recycling, composting, and waste-to-energy processes. Such approaches can increase the lifespan and reduce the risks posed by landfills by reducing the amount of waste disposed in landfills. Under its Waste Reduction Assistance Program, the Department of Environmental Regulation provides the free services of retired engineers who have been trained to identify waste reduction opportunities, including ways to reduce or eliminate production of solid and hazardous wastes in business, industry and government facilities.

Proper siting is the most important approach to preventing groundwater contamination from landfills. It is vital that no landfill be located within hydrogeologically vulnerable areas for existing or future public wellfields, or near higher concentrations of shallow private wells. The most suitable areas for landfills are those with no potential impact on potable groundwater supplies. Where all sites will have some potential to impact groundwater, it is advisable to site a landfill in areas with very low groundwater and well protected aquifers, providing the greatest distance between the landfill liner and sources of potable water. Concerns about runoff and leachate migration may require that landfills be prohibited within large distances of surface waters.

Adequate design and performance of the liner and leachate collection system are critical to groundwater protection, since these components serve as the primary preventive technologies for contaminant migration. Materials used for construction of the liner and leachate collection system should be compatible with the type of waste anticipated. Care should be taken during installation to ensure that these systems are not damaged and will function as expected. Inspection and testing should be performed prior to any waste disposal. Landfills should also have a monitoring program to detect the presence of leachate in groundwater. Strict closure requirements should include a compacted clay cap to retard leachate formation, with vents provided for the escape of gases generated by the contained wastes.

RANKING OF GROUNDWATER POLLUTION THREATS

In addition to collecting information on the number, nature and distribution of potential groundwater threats in an area, prioritizing them according to the degree of threat each poses will assist in establishing regulatory priorities and in assigning levels of importance to protection zones. One general approach is to prepare a simple chart or table representing the percentage of the study area which is affected by each type of threat. This can be refined by evaluating the degree of hazard that these land uses pose and the vulnerability and flow of the aquifer in those areas. Generally, attempts to determine the relative risk of land uses in an area should:

1.) determine the contaminants associated with each type of land use and the relative toxicity of the contaminants;

2.) estimate the average load of those contaminants expected to be discharged to groundwater, given the age, density, level of technology and maintenance history of the applicable facilities;

3.) combine these loading level figures for each potential source of pollution in the area; and

4.) evaluate the relative risk of the threat with respect to the protection zones established for existing and future public wells. This might include evaluation of travel time from public wells, but at the least should measure proximity to the zones of contribution of those wells. It should also measure proximity to recharge areas for these wells, and proximity to areas of high density for private wells.

Several methods of prioritizing pollution hazards have been researched and developed. The first two methodologies presented are capable of yielding information concerning the relative risk posed by several potential sources of pollution over larger areas. This section also summarizes other systems which are designed to allow comparisons of the pollution potential within certain categories of land use.

GROUNDWATER POLLUTION POTENTIAL RISK ASSESSMENT INDEX (Holman, 1984)

Rock County, Wisconsin has developed a "Groundwater Pollution Potential Risk Index System," which uses a two-step process to evaluate the threats posed by single sources of contamination, as well as threats posed by the total discharges of many individual sources.[48] The system is a less detailed approach which does not require technical expertise, and which can be used to rank and compare a wide variety of groundwater threats across a broad area. The system recognizes that there are potential risk factors associated with each pollution source, as well as risk factors associated with natural and artificial controls needed to prevent the pollutant from reaching groundwater.

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[48] See Holman, D., "A Groundwater Pollution Potential Risk Index System," in Groundwater Protection Principles and Alternatives for Rock County, Wisconsin, Wisconsin Geological and Natural History Survey, Special Report 8, Madison, Wi. (1985); see also Holman, D., "A Ground Water Pollution Potential Risk Index System," in Proceedings of a National Symposium on Local Government Options for Ground Water Pollution Control, Environmental and Ground Water Institute, University of Oklahoma, Norman, Ok. (1986).

The first step of the process is to look at potential pollution sources and assign risk weights to four *pollution source* risk factors for each possible pollution source. The four factors, potential toxicity, potential concentration, potential loading rate and potential frequency of discharge are each assigned risk weight numbers, either 3 (high risk), 2 (moderate risk), or 1 (low risk). The risk weight is determined by placing the pollution source within general categories associated with each number (see Risk Factors and Risk Weights, Table 4). The numbers for these four factors are multiplied together (see first Risk Index Equation, Table 4).

The second step of the process assigns risk weight numbers to three *pollution control* risk factors for the site, including level of natural protection, level of prevention control and/or regulations, and relative distance from public water supplies. These three risk weight numbers are also multiplied together (see first Risk Index Equation, Table 4). Since the goal of local protection programs should be to provide protection to the drinking water sources of the entire community, consideration should be given to users of private potable wells. For the purposes of this manual, the pollution control risk factor which evaluates the relative distance of a pollution source from public water supplies (Factor G, Table 4) should be modified to also evaluate the relative distance from higher concentrations of private potable wells. The protection areas so designated might be based on data that indicate a certain number of shallow or unprotected wells within, for example, a specified acreage.

The third step is to multiply together the numbers previously obtained by multiplying pollution source risk factors and pollution source control risk factors. The figure yielded by this equation is the "groundwater pollution source risk index number" for the particular pollution source (see first Risk Index Equation, Table 4). The risk index number generated by this method indicates the pollution potential of a single source. A high "groundwater pollution source risk index number" indicates high potential risk of a pollutant source contaminating a nearby well within a short period of time following the discharge of the pollutant.

If the risk index number is derived for all facilities within one class of potential pollution source then divided by 1,000 and multiplied by the discharge acreage for those facilities, the resulting figure indicates the community-wide pollution potential for that class of pollution source. (see second Risk Index Equation, Table 4). A high "community groundwater pollution risk number" indicates a potentially high risk of polluting a community groundwater supply over a long period of time. Generally, combinations of factors such as large amounts of high-risk pollutants or large acreages of discharge within the study area equate to high "community groundwater pollution risk numbers" while combinations of low amounts of low-risk pollutants and low discharge acreage will equate to low numbers. When all potential pollution sources have been evaluated in this manner, they can be ranked to indicate priorities in an area. Table 5 illustrates the rankings of several selected pollution sources using this process. Table 6 presents the modified rankings of the selected pollution sources, derived by factoring in the discharge areas for each source.

TABLE 4
Groundwater Pollution Potential Risk Index System (Rock County, Wisconsin)

Risk Factors and Risk Weights

Pollution Source Risk Factors	Risk Weight*
A. Potential toxicity of pollutant discharged:	
Toxic chemicals	3
Bacterial and viruses (pathogenic)	2
Materials affecting taste, flavor or color	1
B. Potential concentration of pollutant discharged:	
50% to 100% - high concentration	3
10% to 50% - moderate concentration	2
Less than 10% - low concentration	1
C. Potential loading rate of pollutant discharge:	
Over 1.0 gal./sq.ft./day	3
0.5 to 1.0 gal./sq.ft./day	2
0 to 0.5 gal./sq.ft./day	1
D. Potential frequency of pollutant discharge:	
30 - 365 day/yr.	3
8 - 30 day/yr.	2
0 - 7 day/yr.	1

Pollution Control Risk Factors	Risk Weight*
E. Level of natural protection:	
Discharge to geologic formations	3
Discharge into soil	2
Discharge to surface of soil	1
F. Level of prevention control and/or regulations:	
Low level	3
Moderate level	2
High level	1
G. Relative distance from public water supplies:**	
Within 1/2 mile	3
Within 2 miles	2
Within 5 miles	1

* Risk Weight: high risk-3; moderate risk-2; low risk-1.
**Up flow source more critical than down flow source.

Risk Index Equations

Potential Pollution Source Risk Factors (A x B x C x D) x Potential Pollution Control Risk Factors (E x F x G) = Groundwater Pollution Source Risk Index Number

$$\frac{\text{Groundwater Pollution Source Risk Index}}{1{,}000} \times \text{Discharge Area} = \text{Community Groundwater Pollution Risk Number}$$

TABLE 5
Groundwater Pollution Source Risk Index
Rock County, Wisconsin (selected pollution sources)

Potential Source of Pollution	Pollution Source Risk Factors (A x B x C x D)	x	Pollution Control Risk Factors (E x F x G)	=	Groundwater Pollution Source Risk Index Number
Underground chemical tanks	(3 x 3 x 3 x 1) = 27		(3 x 3 x 3) = 27		729
Aboveground chemical tanks	(3 x 3 x 3 x 1) = 27		(1 x 2 x 3) = 6		162
Toxic and hazardous spills	(3 x 3 x 3 x 1) = 27		(1 x 2 x 3) = 6		162
Transmission pipes	(3 x 3 x 3 x 1) = 9		(3 x 2 x 1) = 6		54
Private sewage systems	(2 x 1 x 2 x 3) = 12		(2 x 2 x 2) = 8		96

TABLE 6
Community Groundwater Pollution Risk Index
Rock County, Wisconsin (selected pollution sources)

Potential Source of Pollution	Pollution Source Risk Index Number / 1,000	x	Discharge Areas In Acres*	=	Community Risk Index Number
Underground chemical tanks	.729		83		61
Aboveground chemical tanks	.162		85		14
Toxic and hazardous spills	.162		5		<1
Transmission pipes (toxic materials)	.054		6		>1
Private sewage systems	.096		154		15

*Number of sources x estimated potential discharge area, or: projected number of acres of discharge from known or projected land use data.

TABLE 7
Ranking of Selected Pollution Sources in Rock County, Wisconsin (according to risk index)

Potential Pollution Source Risk*	Potential Community Groundwater Pollution Risk**
1. Underground chemical tanks	1. Underground chemical tanks
2. Accidental toxic spills collection system	2. Private sewage systems
3. Aboveground chemical tanks	3. Aboveground chemical tanks
4. Private sewage systems	4. Accidental toxic spills
5. Transmission pipes (toxic materials)	5. Transmission pipes (toxic materials)

*Potential Pollution Source Risk: Potential risk to lower drinking-water quality of nearby wells to a level that the groundwater is unsuitable to drink in its natural state. (See Table 5)

**Potential Community Groundwater Pollution Risk: Potential risk to lower the quality of drinking water to a level that the groundwater in the community is unsuitable to drink in its natural state. (See Table 6)

WEST MICHIGAN SHORELINE REGIONAL DEVELOPMENT COMMISSION (WMSRDC)

The WMSRDC method is a simplified "fast track" approach for establishing management priorities for many pollution sources. The system uses readily available information, does not demand specialized training and normally will require about one-half working day to evaluate an individual site.[49] The procedure assigns hazard rankings to industrial activities based on their Standard Industrial Classification (SIC) code, which in turn is based on the types of materials the particular industry commonly uses. The system only looks at the most critical hydrogeologic factors in making its risk evaluations.

There are four steps in the WMSRDC fast track method.[50] The first step assigns a "site hazard potential" rating to the particular activity on a scale of 1-9, with 1 being low hazard and 9 a very high hazard. The points can be established on either of two bases. The first of these is the SIC code for the land use, which indicates the intrinsic hazards associated with the materials commonly used or stored, or the types and amounts of wastes discharged (Table 8). Site hazard potential points can also be assigned on the basis of materials known to be used, stored or disposed of at a particular site (Table 9). Any inconsistency between the two point scores to be assigned is resolved in favor of the higher score. When a range of values is given, the final site hazard potential score is modified to reflect special characteristics or mitigating factors at a particular site. The ratings are adjusted above the midpoint score for factors such as high concentrations, high toxicity, or large volumes of materials, and for relevant site histories and other factors indicating higher hazard conditions. They are adjusted below the midpoint for factors such as low concentrations, low toxicities, small volumes, pretreatment and other mitigating conditions. Adjustments are based on subjective evaluations of the person performing the analysis.

Landfills are rated separately. When they are located away from populated areas, no information is available on proximity to groundwater, and the contents consist of general debris, landfills are assigned a value of 5 as a site hazard potential rating. Where judged to be in close proximity to groundwater, but with no information on contents, they are assigned a rating of 7. When it is known or suspected that a landfill has received industrial or chemical wastes, that landfill receives a rating of 9.

The second step of the WMSRDC procedure evaluates the number of households within a one-mile radius of the site, to estimate the population that might be exposed to any hazardous materials discharged from the site (Table 10). In order to distinguish between households at risk because of proximity and households at risk from groundwater contamination, step 3 looks at households within one mile of the facility that depend on or have access to groundwater for their water supply. There is no consideration of whether the households are upgradient or downgradient of the potential pollution source. The fourth step estimates the potential for surface water pollution, by considering the distance from the site to all surface waters within a one mile radius (Table 11). It should be noted that this system does not evaluate groundwater flow patterns, and does not consider whether there are public water supply wells near the site.

The WMSRDC method prioritizes sites, based on the information generated, using the procedure illustrated in Figure 1. Sites with site hazard potential ratings under 6 are considered

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[49] See Jaffe and DiNovo, Local Groundwater Protection, 91-96, American Planning Association, Washington, D.C. (1987).

[50] West Michigan Shoreline Regional Development Commission, A Pollution Nature Sampling Plan for Groundwater Contamination in Region 14, Muskegon, Mi. (Nov. 1980).

low priority. Those with ratings of 6 or over are considered either medium-, high-, or very high-priority, depending on whether the site is close to surface water, has households within one mile of the site, or has households within one mile which are using groundwater as drinking water. Three categories of very high-priority sites are distinguished, based on potential combinations of risk factors.

TABLE 8

Contaminant Hazard Potential Ranking of Waste, Classified by Source (WMSRDC)

SIC No.	Description of Waste Source	Hazard Potential Initial Rating
01	**Agricultural Production—Crops**	1-2
02	**Agricultural Production—Livestock**	
021	Livestock, except Dairy, Poultry, and Animal Specialties	3 (5 for Feedlots)
024	Dairy Farms	4
025	Poultry and Eggs	4
027	Animal Specialties	2-4
029	General Farms, Primarily Livestock	2
10	**Metal Mining**	
101	Iron Ores	4
102	Copper Ores	6
103	Lead and Zinc Ores	5
104	Gold and Silver Ores	6
105	Bauxite and Other Aluminum Ores	5
106	Ferroalloy Ores Except Vanadium	5
108	Metal Mining Services	4
1092	Mercury Ore	6
1094	Uranium-Radium-Vanadium Ores	7
1099	Metal Ores Not Elsewhere Classified	5
11	**Anthracite Mining**	7
12	**Bituminous Coal and Lignite Mining**	7
13	**Oil and Gas Extraction**	
131	Crude Petroleum and Natural Gas	7
132	Natural Gas Liquids	7
1381	Drilling Oil and Gas Wells	6
1382	Oil and Gas Field Exploration Services	1
1389	Oil and Gas Field Services Not Elsewhere Classified	Variable, Depending on Activity
14	**Mining and Quarrying of Non-Metallic Minerals, Except Fuels**	
141	Dimension Store	2
142	Crushed and Broken Stone, Including Riprap	2
144	Sand and Gravel	2
145	Clay, Ceramic, and Refractory Minerals	2-5
147	Chemical and Fertilizer Mineral Mining	4-7
148	Nonmetallic Minerals Services	1-7
149	Miscellaneous Nonmetallic Minerals, Except Fuels	2-5
16	**Construction Other Than Building Construction**	
1629	Heavy Construction, Not Elsewhere Classified (Dredging, Especially in Salt Water)	4
20	**Food and Kindred Products**	
201	Meat Products	3
202	Dairy Products	2
203	Canned and Preserved Fruits and Vegetables	4
204	Grain Mill Products	2
205	Bakery Products	2
206	Sugar and Confectionery Products	2
207	Fats and Oils	3
208	Beverages	2-5
209	Misc. Food Preparation and Kindred Products	2
22	**Textile Mill Products, All Except Listings Below**	
223	Broad Woven Fabric Mills, Wool (including dyeing and finishing)	6
226	Dying and Finishing Textiles, Except Wool Fabrics and Knit Goods	6
2295	Coated Fabrics, Not Rubberized	6
24	**Lumber and Wood Products, Except Furniture**	
241	Logging Camps and Logging Contractors	2
242	Sawmills and Planing Mills	2
2435	Hardwood Veneer and Plywood	4
2436	Softwood Veneer and Plywood	4
2439	Structural Wood Members, Not Elsewhere Classified (laminated wood-glue)	3
2491	Wood Preserving	5
2492	Particle Board	4
2499	Wood Products, Not Elsewhere Classified	2-5
26	**Paper and Allied Products**	
261	Pulp Mills	6
262	Paper Mills Except Building Paper Mills	6
263	Paperboard Mills	6
28	**Chemicals and Allied Products**	
2812	Alkalies and Chlorine	7-9
2813	Industrial Gases	
2816	Inorganic Pigments	3-8
2819	Industrial Inorganic Chemicals, Not Elsewhere Classified	3-9
2821	Plastic Materials, Synthetic Resins, and Nonvulcanizable Elastomers	6-8
2822	Synthetic Rubber (Vulcanizable Elastomers)	6-8
2823	Cellulose Man-Made Fibers	6-8
2824	Synthetic Organic Fibers, Except Cellulosic	6-8
2831	Biological Products	6-9

(continued)

Table 8 (continued)

SIC No.	Description of Waste Source	Hazard Potential Initial Rating
28	**Chemicals and Allied Products** *(continued)*	
2833	Medicinal Chemicals and Botanical Products	3-8
2834	Pharmaceutical Preparations	6-9
2841	Soap and Other Detergents, Except Specialty Cleaners	4-6
2842	Specialty Cleaning, Polishing, and Sanitation Preparation	3-8
2843	Surface Active Agents, Finishing Agents, Sulfonated Oils and Assistants	6-8
2844	Perfumes, Cosmetics, and Other Toilet Preparations	3-6
2851	Paints, Varnisher, Lacquers, Enamels, and Allied Products	5-8
2861	Gum and Wood Chemicals	5-8
2865	Cyclic (coal tar) Crudes, and Cyclic Intermediates, Dyes and Organic Pigments (Lakes and Toners)	6-9
2869	Industrial Organic Chemicals, Not Elsewhere Listed	3-9
2873	Nitrogenous Fertilizers	7-8
2874	Phosphatic Fertilizers	7-8
2875	Fertilizer Mixing Only	5
2879	Pesticides and Agricultural Chemicals, Not Elsewhere Listed	5-9
2891	Adhesives and Sealants	5-8
2892	Explosives	6-9
2893	Printing Ink	2-5
2895	Carbon Black	1-3
2899	Chemicals and Chemical Preparations, Not Elsewhere Listed	3-9
29	**Petroleum Refining and Related Industries**	
291	Petroleum Refining	8
295	Paving and Roofing Materials	7
299	Misc. Petroleum and Coal Products	7
30	**Rubber and Miscellaneous Plastics Products**	
301	Tires and Inner Tubes	6
302	Rubber and Plastic Footwear	6
303	Reclaimed Rubber	6
304	Rubber and Plastics Hose and Belting	4
306	Fabricated Rubber Products, Not Elsewhere Classified	4
31	**Leather and Leather Products**	
311	Leather Tanning and Finishing	8
	(Remaining Three-Digit Codes)	1-3
32	**Stone, Clay, Glass, and Concrete Products**	
321	Flat Glass	4
32	**Stone, Clay, Glass, and Concrete Products** *(continued)*	
322	Glass and Glassware, Pressed or Blown	4
324	Cement, Hydraulic	3
3274	Lime	3
3291	Abrasive Products	3
3292	Asbestos	3
3293	Gaskets, Packing, and Sealing Devices	3
33	**Primary Metal Industries (Except as Noted Below)**	3
3312	Blast Furnaces, Steel Works, and Rolling and Finishing Mills	6
333	Primary Smelting and Refining of Nonferrous Metals	7
34	**Fabricated Metal Products, Except Machinery and Transportation Equipment (Except as Noted Below)**	5
347	Coating, Engraving, and Allied Services	8
3482	Small Arms Ammunition	7
3483	Ammunition, Except for Small Arms, Not Elsewhere Classified	7
3389	Ordnance and Accessories, Not Elsewhere Classified	7
349	Misc. Fabricated Metal Products	3-6
35	**Machinery, Except Electrical**	5-7
36	**Electrical and Electronic Machinery, Equipment and Supplies (Except as Noted Below)**	5-7
3691	Storage Batteries	8
3692	Primary Batteries, Dry and Wet	8
37	**Transportation Equipment**	5-8
38	**Measuring, Analyzing, and Controlling Instruments; Photographic, Medical, and Optical Goods; Watches and Clocks (Except as Noted Below)**	4-6
386	Photographic Equipment and Supplies	7
39	**Miscellaneous Manufacturing Industries**	3-7
49	**Electric, Gas, and Sanitary Services**	
491	Electric Services	3-5
492	Gas Production and Distribution	3
494	Water Supply	2
4952	Sewerage Systems	2-5
4953	Refuse Systems (Landfills)	5-9
496	Steam Supply	2-4

Source: WMSRDC, *A Pollutant Nature Sampling Plan for Groundwater Contamination in Region 14* (Muskegon, Mich.: West Michigan Shoreline Regional Development Commission, November 1980).

TABLE 9
Contaminant Hazard Potential Ranking of Wastes, Classified by Type[1] (WMSRDC)

Description	Hazard Potential Initial Reading	ID Number*
Solids		
Ferrous Metals	1-4[2]	1100
Non-Ferrous Metals	1-7[2]	1200
Resins, Plastics, and Rubbers	2	1300
Wood and Paper Materials (except as noted below	2	1400
Bark	4	1401
Textiles and Related Fibers	2	1500
Inert Materials (except as noted below)	2	1600
Sulfide Mineral-Bearing Mine Tailings	6	1601
Slag and Other Combustion Residues	5	1602
Rubble, Construction, and Demolition Mixed Waste	3	1603
Animal Processing Wastes (except as noted below)	2-4	1700
Processed Skins, Hides, and Leathers	6	1701
Dairy Wastes	4	1702
Live Animal Wastes—Raw Manures (Feedlots)	5	1703
Composts of Animal Waste	2-4	1704
Dead Animals	5	1705
Edible Fruit and Vegetable Remains—Putrescables	2-3	1800
Liquids		
Organic Chemicals (must be chemically classified)[2]		2000
Aliphatic (Fatty) Acids	3-5	2001
Aromatic (Benzene) Acids	7-8	2002
Resin Acids	—	2003
Alcohols	5-7	2004
Aliphatic Hydrocarbons (petroleum derivatives)	4-6	2005
Aromatic Hydrocarbons (benzene derivatives	6-8	2006
Sulfonated Hydrocarbons	7-8	2007
Halogenated Hydrocarbons	7-9	2008
Alkaloids	7-9	2009
Aliphatic Amines and Their Salts	1-4	2010
Anilines	6-8	2011
Pyridines	2-6	2012
Phenols	7-9	2013
Aldehydes	6-8	2014
Ketones	6-8	2015
Organic Sulfur Compounds (Sulfides, Mercaptans)	7-9	2016
Organometallic Compounds	7-9	2017
Cyanides	7-9	2018
Thiocyanides	2-6	2019
Sterols	—	2020
Sugars and Cellulose	1-4	2021
Esters	6-8	2022
Inorganic Chemicals (must be chemically classified)[2]		2100
Mineral and Metal Acids	5-8	2101
Mineral and Metal Bases	5-8	2102
Metal Salts, Including Heavy Metals	6-9	2103
Oxides	5-8	2104
Sulfides	5-8	2105
Carbon or Graphite	1-3	2106

(continued)

Description	Hazard Potential Initial Reading	ID Number*
Other Chemical Process Wastes Not Previously Listed (must be chemically classified)[2]		2200
Inks	2-5	2201
Dyes	3-8	2202
Paints	5-8	2203
Adhesives	5-8	2204
Pharmaceutical Wastes	6-9	2205
Petrochemical Wastes	7-9	2206
Metal Treatment Wastes	7-9	2207
Solvents	6-9	2208
Agricultural Chemicals (Pesticides, Herbicides, Fungicides, etc.)	7-9	2209
Waxes and Tars	4-7	2210
Fermentation and Culture Wastes	2-5	2211
Oils, Including Gasoline, Fuel Oil, etc.	5-8	2212
Soaps and Detergents	4-6	2213
Other Organic or Inorganic Chemicals, includes	2-9	2214
Radioactive Wastes	4-8	2300
Conventional Treatment Process Municipal Sludges		
From Biological Sewage Treatment	4-8	2301
From Water Treatment and Conditioning Plants (must be chemically classified)[2]	2-5	2302

*ID Number is for identification of waste types in the Reporting Form.

1. Classification based on material in Environmental Protection Agency Publication, 670-2-75-024, pp. 79-85, prepared by Arthur D. Little, Inc., and published in 1975.

2. For individual material ranking, refer to solubility-toxicity tables prepared by Versar, Inc., for the Environmental Protection Agency (source: MDNR, June 1980).

Source: WMSRDC. *A Pollutant Nature Sampling Plan for Groundwater Contamination in Region 14* (Muskegon, Mich.: West Michigan Shoreline Regional Development Commission, November 1980).

TABLE 10
"Fast Track" Rating Schedule for Steps 2 and 3

Number of Households	Rating
0	0
1-10	1
11-100	3
101-500	5
501-1,000	7
more than 1,000	9

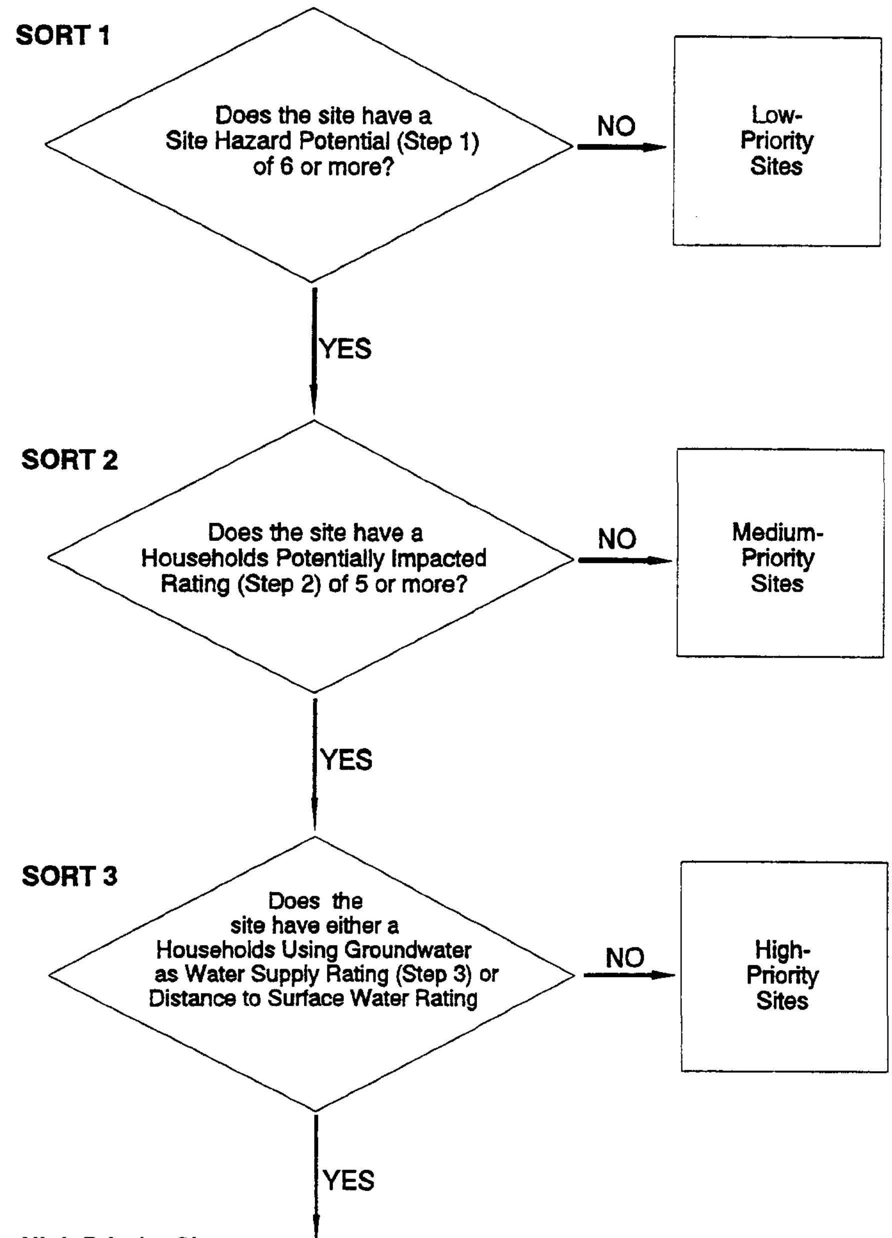
Source: WMSRDC. *A Pollutant Nature Sampling Plan for Groundwater Contamination in Region 14* (Muskegon, Mich.: West Michigan Shoreline Regional Development Commission, November 1980).

TABLE 11
"Fast Track" Rating of Distance to the Nearest Surface Water

Distance (Miles)	Rating
0 to 1/8 miles	8
1/8 to 1/4	6
1/4 to 1/2	4
1/2 to 1	2
More than 1	0

Source: WMSRDC. *A Pollutant Nature Sampling Plan for Groundwater Contamination in Region 14* (Muskegon, Mich.: West Michigan Shoreline Regional Development Commission. November 1980).

FIGURE 1
"Fast Track" Priority Ranking Strategy (WMSRDC)



Very-High-Priority Sites

Category 1: Sites exhibiting both a Households Using Groundwater as Water Supply Rating (Step 3) of 5 or more and a Distance To Surface Water Rating (Step 4) of 4 or more.

Category 2: Sites exhibiting only a Households Using Groundwater as Water Supply Rating (Step 3) of 5 or more.

Category 3: Sites exhibiting only a Distance to Surface Water Rating (Step 4) of 4 or more.

LE GRAND (1983)

The Rock County, Wisconsin and West Michigan Shoreline Regional Development Commission index systems are used in ranking and comparing a wide range of potential pollution sources and the risks they might pose to groundwater or drinking water supplies. The LeGrand rating system, developed in 1983 to evaluate the groundwater contamination potential of waste disposal facilities, is narrower in scope.[51] The system is based on an evaluation of seven factors, three involving siting considerations and four involving management issues. The eight-step process uses data that are normally available, and can be utilized by those without high levels of technical skills in groundwater hydrology, though training in the environmental sciences will be required and the process is somewhat labor intensive.[52]

The three siting factors are groundwater contamination potential, adjacent land use, and zoning or planning constraints. The four management factors include storage system reliability, monitoring, facility maintenance, and handling practices. In Steps 1-4, point ratings are assigned for key hydrogeologic factors, including horizontal distance from the facility to the nearest water supply well; the depth of the water table below the facility; the approximate slope of the water table; and the character of the underlying soils and materials. Step 5 involves adding together the ratings derived in steps 1-4. Step 6 is the classification of the aquifer into one of three types: sensitive (very productive), moderately sensitive (variably productive), or insensitive (relatively unproductive). In Step 7, the hazard rating of the materials stored on-site is identified according to position on a Contaminant Hazard Potential Rating Chart. Step 8 grades the site from A (excellent) to F (very poor), based on evaluation of the contaminant severity and aquifer sensitivity.

LE GRAND (1964)

An earlier version of the LeGrand system, developed in 1964, is used to evaluate the contamination potential of waste disposal sites with contaminants that attenuate in time or by oxidation, chemical or physical sorption, and dilution through dispersion. These include such contaminants as sewage, detergents, viruses and radioactive wastes, but not mixed waste sites such as refuse dumps and sanitary landfills, where the critical factor will be the movement of chemical wastes which attenuate slowly.[53] The system characterizes a site in terms of five factors, including depth to water table, distance to a point of water use, ground water gradient, soil permeability, and sorption. Tables 12 and 13 illustrate the factors and the ranking system.

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[51] LeGrand, H., A Standard System for Evaluating Waste-Disposal Sites, National Water Well Association, Worthington, OH (1983).

[52] Jaffe and DiNovo, Local Groundwater Protection 90, American Planning Association, Washington, D.C. (1987).

[53] Yates, M., Septic Tank Siting to Minimize the Contamination of Ground Water by Microorganisms, 18 Office of Ground-Water Protection, U.S. Environmental Protection Agency, Washington, D.C. (1987).

TABLE 12
Factors Used in LeGrand System for Evaluation of Contamination Potential of Waste Disposal Sites (1964)

Factor Name	Description	Value
Water Table	Distance from base of disposal unit to the average position of the highest water table	0 (0 ft.) to 10 (1000 ft.)
Sorption	Extent to which contaminant is retained on the earth material by chemical and physical sorption	0 (coarse gravel) to 6 (clay); for 2-media sites: 0 (fractured rock) to 4 (clay)
Permeability	Flow of water through soil pores, joints and fractures	0 (coarse gravel) to 3 (clayey sand) to 1 (clay)
Water Table Gradient	Direction and rate of flow of ground water	0 (60% gradient in an unfavorable direction) to 7 (60% gradient in a favorable direction)
Distance to Point of Use	Distance between source of contamination and point of water use	0 (0 ft.) to 11 (10 miles); for 2-media sites: 0 (under 50 ft.) to 10 (10 miles)
Thickness	Thickness of porous granular materials below the disposal point	For 2-media sites: 0 (less than or equal to 12 ft.) to 6 (100 ft.)

TABLE 13
Contamination Potential of Waste Disposal Site Predicted Using the LeGrand System (1964)

Total Point Value	Contamination Potential
0-4	imminent
4-8	probable or possible
8-12	possible, but not likely
12-25	very improbable
25-35	impossible

SURFACE IMPOUNDMENT ASSESSMENT SYSTEM (U.S. Environmental Protection Agency)

This assessment and ranking system is a modification of the 1983 LeGrand system, used to provide a quick estimation of the groundwater contamination potential of wastewater impoundments, to allow their prioritization for management purposes.[54] The system evaluates impoundment sites based on five factors: the unsaturated zone, the availability of groundwater, groundwater quality, the hazard potential of the waste, and the potential for endangering a water supply. Once the factors are evaluated individually, the values are added to yield an index ranging from 1-38. The procedure does not require detailed data, and can be performed by those without specialized training.[55] Table 14 describes the factors and range of values for each.

The unsaturated zone assessment is based on earth material characteristics and the thickness of the zone. Earth materials are evaluated on permeability and sorption character. Where two or more dissimilar materials are present, the site receives the rating for the most permeable material (see Table 15). Evaluation of groundwater availability considers the ability of the aquifer to transmit water and is dependent on permeability and saturated thickness (see Table 16). The letters associated with the numerical ratings in Tables 15 and 16 supply the origin of the rating and document the process. Groundwater quality is evaluated based on criteria developed in the Underground Injection Control program of the U.S. EPA (see Table 17). Sites where groundwater has high total dissolved solids are rated lower, groundwater uses in those areas have preexisting limitations. Regardless of TDS content, if the groundwater is serving as a drinking water supply, the site receives a rating of 5. The waste hazard potential of a site involves evaluation of the hazard to human health. Ratings are based on consideration of waste toxicity, mobility, persistence, volume and concentration. Table 18 contains examples of hazard potential ratings of waste materials classified by source. There are ranges of potential ratings for several of these sources, allowing a lower value to be assigned to sites with good pretreatment programs. The waste hazard potential rating can also be based on classifications of wastes by type.[56]

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[54] U.S. Environmental Protection Agency, Surface Impoundment Assessment National Report, U.S. Environmental Protection Agency, Washington, D.C. (1983); Canter, Knox & Fairchild, Ground Water Quality Protection 279, (Lewis Publishers, Chelsea, mi.) (1988).

[55] Yates, M., Septic Tank Siting to Minimize the Contamination of Ground Water by Microorganisms 18, U.S. Environmental Protection Agency, Washington, D.C. (1987).

[56] Canter, Knox & Fairchild, Ground Water Quality Protection 281, (Lewis Publishers, Chelsea, Mi.) (1988).

TABLE 14
Factors Used in the Surface Impoundment Assessment Method
(U.S. Environmental Protection Agency, SIA Method, 1983)

Factor Name	Description	Value
Unsaturated Zone	Based on the combined rating of the thickness of the unsaturated zone and the earth material (both consolidated and unconsolidated) in the unsaturated zone.	0 - 9
Groundwater Availability	The ability of the aquifer to transmit groundwater. Based on the permeability and saturated thickness of the aquifer.	0 - 6
Groundwater Quality	A determinant of the ultimate usefulness of the groundwater. Based on whether or not it is a current drinking water source and the total dissolved solids concentration.	0 - 5
Waste Hazard Potential	Potential for causing harm to human health. Contaminant sources are ranked using the Standard Industrial Classification (SIC) numbers. Contaminant types are classified based on U.S. EPA publication 670-2-75-024.	0 - 9
Potential Endangerment to a Water Supply	Based on the distance from the impoundment to a ground or surface water source of drinking water and the anticipated flow direction of the waste plume.	1 - 9

TABLE 15
Rating of the Unsaturated Zone (SIA Method)

Earth Material Category	I	II	III	IV	V	VI
Unconsolidated rock	gravel, medium to coarse sand	fine to very fine sand	sand with <15% clay, silt	sand with >15% but <50% clay	clay with <50% sand	clay
Consolidated rock	cavernous or fractured limestone, evaporites, basalt lava fault zones	fractured igneous and metamorphic (except lava) sandstone (poorly cemented)	sandstone (moderately cemented) fractured shale	sandstone (well cemented)	siltstone	unfractured shale, igneous and metamorphic rocks
Representative permeability						
in gpd/ft²	>200	2–200	0.2–2	<0.2	<0.02	<0.002
in cm/sec	$>10^{-2}$	10^{-4}–10^{-2}	10^{-5}–10^{-4}	$<10^{-5}$	$<10^{-6}$	$<10^{-7}$
Rating Matrix						
Thickness of the unsaturated zone (in meters) >30	9A	6B	4C	2D	OE	OF
>10≤30	9B	7B	5C	3D	1E	OG
>3≤10	9C	8B	6C	4D	2E	OH
>1≤ 3	9D	9F	7C	5D	3E	1F
>0≤ 1	9E	9G	9H	9I	9J	9K

TABLE 16
Rating Ground Water Availability (SIA Method)

Earth Material Category	I	II	III
Unconsolidated rock	gravel or sand	sand with 50% clay sand	clay with 50% sand
Consolidated rock	cavernous or fractured rock, poorly cemented sandstone, fault zones	moderately to well cemented sandstone, fractured shale	siltstone unfractured shale and other impervious rock
Representative permeability			
in gpd/ft²	>2	0.02–2	<0.02
in cm/sec	$>10^{-4}$	10^{-6}–10^{-4}	10^{-6}
Rating Matrix			
Thickness of saturated zone (meters) ≤30	6A	4C	2E
3–30	5A	3C	1E
≤ 3	3A	1C	OE

TABLE 17
Rating Ground Water Quality (SIA Method)

Rating	Quality
5	$\leq$500 mg/l TDS or a current drinking water source
4	>500 - $\leq$ 1,000 mg/l TDS
3	>1,000 - $\leq$3,000 mg/l TDS
2	>3,000 - $\leq$10,000 mg/l TDS
1	>10,000 mg/l TDS
0	No ground water present

TABLE 18
Examples of Contaminant Hazard Potential Ratings of Waste Classified by Source (SIA Method)

SIC	Number	Description of Waste Source	Hazard Potential Initial Rating
02		Agricultural Production—Livestock	
	021	Livestock, except dairy, poultry and animal specialties	3 (5 for feedlots)
	024	Dairy farms	4
	025	Poultry and eggs	4
13		Oil and Gas Extraction	
	131	Crude petroleum and natural gas	7
	132	Natural gas liquids	7
	1381	Drilling oil and gas wells	6
20		Food and Kindred Products	
	201	Meat products	3
	202	Dairy products	2
	203	Canned and preserved fruits and vegetables	4
	204	Grain mill products	2
28		Chemicals and Allied Products	
	2812	Alkalies and chlorine	7–9
	2816	Inorganic pigments	3–8
	2819	Industrial inorganic chemicals, not elsewhere classified	3–9
29		Petroleum Refining and Related Industries	
	291	Petroleum refining	8
	295	Paving and roofing materials	7
	299	Miscellaneous products of petroleum and coal	7

ADDITIONAL POLLUTION SOURCE PRIORITIZATION SYSTEMS

In addition to those summarized above there are systems developed to evaluate individual types of potential pollution sources. These may be less suited to producing the relative rankings of several different types of potential pollution sources, but may offer more detailed rankings of potential pollution sources within a particular category.

Septic tank siting factors are addressed in a methodology developed for the U.S. Environmental Protection Agency entitled, **"System to Evaluate the Potential for Microbiological Contamination of Ground Water."**[57] The procedure is a modification of the DRASTIC site rating system. It is based primarily on empirical data gathered from reports of experiments performed on microorganisms and field observations of the movement and persistence of microorganisms in the subsurface environment. The system uses eight factors, ranked in terms of their relative importance and assigned weighting factors of from 1 (least important) to 5 (most important). The eight factors and their weights include: depth to water (5), net recharge (2), hydraulic conductivity (3), temperature (2), soil texture (5), aquifer medium (3), application rate (4), distance to well (5). The ratings for each factor can vary from 0 (least negative impact) to 10 (most negative impact). The final rating index for a site is calculated by multiplying the rating for each factor by its weight and adding the results for all factors. The developer of the system advises that the index number is not to be substituted for consideration of conditions on the site. The methodology is intended for use in evaluating individual sites and in ranking regions for their susceptibility to groundwater contamination by pathogenic microorganisms. Information needed to determine the ratings can be obtained from several sources, including U.S. and state geological surveys, the U.S. Department of Agriculture (Soil Conservation Service), on-site soil surveys, water utilities, local universities, agricultural extension services, state health and environmental protection agencies, and the Army Corps of Engineers.

New and existing sanitary landfills can be evaluated with the nine-step **LeGrand-Brown method**, which develops ratings for four factors: 1.) distance from a contamination source to the nearest well or point of water use; 2.) depth to the water table; 3.) gradient to the water table; 4.) permeability and attenuation capacity of the subsurface materials through which the contaminant is likely to pass. The system may be used to evaluate and rank sites for new landfills, or to prioritize the pollution potential of existing landfills in an area.[58]

Sites where industrial solid or liquid wastes are discharged to land can be assessed using the **Waste-Soil-Site Interaction Matrix**, which involves adding the evaluations of various waste-site-soil factors. The procedure considers ten factors related to the waste, and seven factors related to the site of waste application. The resulting index number is placed within one of ten classes of interpretation. The methodology can also be used to rank potential waste disposal sites, and prioritize the pollution concerns for existing waste disposal sites or septic tank systems

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[57] Yates, M., Septic Tank Siting to Minimize the Contamination of Ground Water by Microorganisms, 30, Office of Ground Water Protection, U.S. Environmental Protection Agency, Washington, D.C. (1987).

[58] Canter, Knox & Fairchild, Ground Water Quality Protection 283-288, Lewis Publishers, Chelsea, Mi. (1988); see LeGrand, H., "System of Reevaluation of Contamination Potential of Some Waste Disposal Sites," 56 Journal American Water Works Association 959-974 (Aug. 1964).

in an area.[59]

Chemical landfill site selection and evaluation can be made using a **Site Rating System** developed by Hagerty, Pavoni and Heer, Jr.[60] The method rates waste materials on human toxicity, groundwater toxicity, disease transmission potential, biological persistence, and waste mobility. It also rates sites by evaluating ten factors in three groups involving soil, groundwater and air. The soils group includes infiltration potential, bottom leakage potential, filtering capacity and adsorptive capacity. The groundwater group includes organic content, buffering capacity, potential travel distance and groundwater velocity. The air group includes prevailing wind direction and a population factor around the site. The system is useful for ranking potential waste disposal sites, and evaluating and ranking the pollution potential for existing sites.

A methodology developed by the U.S. Environmental Protection Agency can be used to select new sites for waste disposal or prioritize sites for inclusion in the Superfund program. The **Hazard Ranking System** is designed to evaluate the full range of problems associated with releases of hazardous materials, including air, groundwater and surface water contamination, fire and explosion hazards and the dangers of direct contact.[61] The system evaluates three migration routes of exposure--groundwater, surface water and air--with the scores combined to yield a value representing the relative risk of the site. Assessment of two other routes of exposure, fire/ explosion and direct contact, indicates the need for emergency response. Three overall scores are compiled: one reflects the potential for harm to humans or the environment as a result of migration of hazardous substances; another indicates the potential for harm from substances which can explode or cause fires; a third represents the potential for harm from direct exposure to humans at the facility.

A procedure known as the **Site Rating Methodology**[62] has three general parts: 1.) a method for rating the general hazard potential of a site; 2.) a system for modifying the general rating based on site-specific factors; and 3.) a procedure for interpreting the ratings. The first system bases its rating on 31 generally applicable factors, each with a four-level rating scale, and can be implemented using generally available information from published sources, public and private records, interviews, or site visits. The second system considers the applicability of additional points, based on special site features related to location, design or operation, which

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[59] Phillips, Nathwani & Mooj, "Development of a Soil-Waste Interaction Matrix for Assessing Land Disposal of Industrial Wastes," 11 Water Research 859-868, (November 1977); see also Canter, Knox & Fairchild, Ground Water Quality Protection 288-293, Lewis Publishers, Chelsea, Mi. (1988); Canter and Knox, Septic Tank Effects on Ground Water Quality, Lewis Publishers, Chelsea, Mi. (1985).

[60] See Hagerty, Pavoni & Heer, Jr., Solid Waste Management 242-262, Van Nostrand Reinhold, N.Y. (1973); Canter, Knox & Fairchild, Ground Water Quality Protection 294-296, Lewis Publishers, Chelsea, Mi. (1988).

[61] See Caldwell, Barrett & Chang, "Ranking System for Releases of Hazardous Substances," in Proceedings of the National Conference on Management of Uncontrolled Hazardous Waste Sites 14-20, Hazardous Materials Control Research Institute, Silver Spring, Md. (1981); Canter, Knox & Fairchild, Ground Water Quality Protection 296-300, Lewis Publishers, Chelsea, Mi. (1988).

[62] See Kufs, C. et al., "Rating the Hazard Potential of Waste Disposal Facilities," in Proceedings of the National Conference on Management of Uncontrolled Hazardous Waste Sites 30-41, Hazardous Materials Control Research Institute, Silver Spring, Md. (1980); Canter, Knox & Fairchild, Ground Water Quality Protection 300-308, Lewis Publishers, Chelsea, Mi. (1988).

might not be reflected in the general rating system. The third system normalizes the scores from the first two systems, measures reliability of scores by considering percentages of missing and assumed data, and allows for several types of site rankings.

A **Pesticide Index** has been developed by Rao, Hornsby and Jessup, which ranks the relative potentials of different pesticides to migrate into groundwater.[63] The system yields an attenuation factor which evaluates pesticide transport through the crop root zone and the intermediate vadose zone. It does not require the extremely detailed information on pesticide and site characteristics that a complete mathematical model would require. However, it does employ several equations requiring information such as the degradation half-life of the pesticide, the distance from the soil surface to the groundwater, net recharge rate, soil bulk density, soil organic carbon, sorption coefficient of the pesticide on soil, air-filled porosity of soil, and Henry's constant for the pesticide. Thus, its use will require professional expertise in soil science and chemistry.

The Cooperative Extension Service, Institute of Food and Agricultural Sciences at the University of Florida, has recently published a series of circulars and fact sheets, designed to allow determinations of the proper pesticides to use for approximately 30-40 agricultural commodities, in order to minimize groundwater contamination from leaching and surface water contamination from runoff. The methodology allows the ranking of sites, pesticides and crops in terms of the potential for groundwater contamination. The Extension Service series, **Managing Pesticides for Crop Production and Water Quality Protection,**[64] utilizes Soil Conservation Service soil survey maps, available for most of Florida's counties. The system assigns high, medium or low ratings for both leaching and runoff characteristics to the soil names and map unit identifiers within each county. These ratings tables, available for the soils in most counties at a fairly detailed level, will aid in determining where leaching of pesticides (herbicides, insecticides, nematicides and fungicides) registered for crops is more likely to occur. Other tables indicate a "relative leaching potential index" and a "relative runoff potential index" for each of the registered pesticides for each crop, as well as the HALEQ (Lifetime Health Advisory Level or Equivalent) value, and aquatic toxicity value for each pesticide. Worksheets and pesticide selection criteria are supplied, to allow evaluation of soil and pesticide characteristics, and selection of the pesticide with least impact on health and groundwater for a particular crop, in a particular location.

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[63] See Rao, Hornsby & Jessup, "Indices for Ranking the Potential for Pesticide Contamination of Groundwater," 44 Proceedings of the Soil and Crop Science Society of Florida 1-8, (1985); Canter, Knox & Fairchild, Ground Water Quality Protection 311-312, Lewis Publishers, Chelsea, Mi. (1988).

[64] Cooperative Extension Service, Institute of Food and Agricultural Sciences, University of Florida, Gainesville, Fl. (based on the research of A. Hornsby, R. Brown, T. Buttler, D. Colvin, F. Johnson, R. Dunn and T. Kucharek, University of Florida, and G. Hurt, U.S.D.A. Soil Conservation Service).

DESIGNATION OF PROTECTION ZONES

INTRODUCTION

When analysis of information on the hydrogeology, water use patterns and potential pollution sources in an area has been completed, it will be possible to determine areas in which a local protection program will apply. Hydrogeological information will indicate sensitive areas where potable water aquifers have less natural protection from potential pollutants, including surficial aquifers, recharge areas, leaky confining layers, karst features, and proximity to public water supply wells or higher concentrations of private shallow wells. Water use patterns will yield information on the locations and quantities of existing and future water withdrawals. Areas with higher withdrawals will require consideration as protection zones, since they supply potable water and since pollutants which reach groundwater near such areas are more likely to be drawn into the wells. The location of existing and planned land uses with higher pollution potentials will indicate where discharge of contaminants is more likely to occur.

Overlaps between areas of hydrogeological sensitivity, threatening land uses and higher withdrawals will be regions of special concern. Zones containing a highly sensitive aquifer, higher groundwater withdrawal rates and higher levels of potential contamination represent obvious areas for application of a strict aquifer protection program. A careful approach to zone delineation will treat recharge areas, whether currently subject to groundwater threats or not, as special zones requiring prohibition of many land uses and careful permitting of others. Other areas may have one or more of the factors in different combinations, requiring the designation of different categories of protection zones. Analysis of the permutations of these factors will help determine where protection zones should be located, how large they should be and what level of control should be exercised over land uses in the zones.

Recommended approaches to full aquifer protection strategies will involve designation of as many of a community's sensitive areas as is possible, given the resources available to implement such a program. These would include not only existing and future public wells, and their recharge zones, but possibly areas with higher densities of private shallow wells. In areas with higher numbers of private shallow wells, a careful approach to aquifer protection <u>must</u> seriously consider techniques that will address potential threats to these sources of drinking water. All of the designations explained below have been used as overlay protection zones, but several of the approaches offer greater protection to the most important parts of the aquifer from which a community draws its drinking water.

Where aquifers are characterized as unconfined or leaky confined, essentially the entire overlying land surface may serve as recharge to the potable aquifer feeding a wellfield. An initial decision for local governments in these areas is whether to create a program covering the entire region, or to focus on areas of existing and likely withdrawals for drinking water. With unlimited resources, a local program could be designed and administered to address every potential threat within larger zones. For most local governments, however, effective use of available administrative resources will require that, at least for permitting programs, protection zones be limited to a certain extent. Critical zones should be subject to strict permitting programs. Zones of lesser sensitivity may receive baseline regulatory coverage or be addressed by non-regulatory approaches.

Criteria on which protection zone delineations can be based include distance, drawdown of the water table, travel time, flow system boundaries and the capacity of an aquifer to assimilate contaminants. The distance criterion defines a protection zone by establishing a radius or dimension measured from a pumping well or sensitive area out to a particular point. The drawdown criterion defines a zone in terms of the degree to which the normal, unaffected water table (for unconfined aquifers) or potentiometric surface (for confined aquifers) is lowered or drawn down by the water withdrawals in an area. Time of travel (TOT) criteria define protection zones in terms of the amount of time it would take a contaminant discharged to the land surface to reach the point of withdrawal. For example, a five year travel time criterion would indicate the distance from which a contaminant would take five years to reach a well at a particular pumping rate. A flow boundaries criterion incorporates information on the locations of physical or hydrologic features such as groundwater divides, which control the movement of groundwater. The assimilative capacity criterion is based on the ability of subsurface formations to attenuate contaminants to acceptable levels before they reach wells.

DESIGNATION TECHNIQUES

The six primary methods of delineating wellhead protection zones in order of increasing technical sophistication, include: reasonable fixed radii; calculated fixed radii; simplified variable shapes; analytical methods; hydrogeological mapping; and numerical flow/transport models. More than one method can be used in defining protection zones. Both technical and nontechnical considerations will influence the choices made in designating the zones. An important reference for these purposes is the U.S. EPA manual, "Guidelines for Delineation of Wellhead Protection Areas."[65] Figures 2 - 7 have been adapted from illustrations in the EPA manual.

The most important focus of a potable aquifer protection program should be on the public wells from which a community draws its drinking water. There are several approaches available which serve to designate wellhead protection zones. One simple approach to this has been to draw fixed radius zones around the wells. ***Reasonable fixed radii zones*** are based on circles with specified absolute radii, normally drawn around wells or wellfields. The radius chosen may have no scientific basis, or may for example be based on generalized hydrogeological considerations and professional judgment, or some average of the distances associated with adopted zones for similar hydrogeologic settings around the state. These zones are easily and inexpensively applied. However especially for circles with larger radii and in areas with more complex hydrogeology, the approach may not take into account many of the hydrogeologic parameters affecting the movement of contaminants, thus making these types of zones subject to potential legal challenge.

Calculated fixed radii zones are drawn with radii calculated under a volumetric formula, based on a particular TOT criterion, at a specified pumping rate, and a specified aquifer porosity. (Figure 2) The approach requires more data and time than arbitrary fixed radii zones. Though relatively simple and inexpensive, this method of delineation provides more accuracy, depending on local hydrogeological conditions. The method will require accurate data on the effective aquifer porosity in the area, and an adequate justification for the time of travel criterion. One important consideration in establishing the time of travel criterion should be based on the time normally required to detect and respond to contamination incidents from various types of threatening land uses. The technique may be less applicable to areas of greater hydrogeological complexity.

In 1986, the Florida Department of Environmental Regulation attempted to adopt a wellhead protection rule which would have established two zones of protection around major

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[65] U.S. Environmental Protection Agency, Office of Ground-Water Protection, <u>Guidelines for Delineation of Wellhead Protection Areas</u>, 4-1, EPA 440/6-87-010, U.S. Environmental Protection Agency, Washington, D.C. (June 1987).

public drinking water wells. The first was a 200-foot absolute radius zone in which most land uses would have been prohibited. The outer zone included a calculated fixed radius boundary, based on a volumetric formula, calculated using a five year time of travel and a fixed effective porosity factor for the Floridan Aquifer. The proposed rule was challenged, and parts of it were found to be invalid, including the use of the five year travel time and a fixed effective porosity factor. Since the porosity of the Floridan Aquifer varies around the state, a static figure was not acceptable in a formula that would have been applicable statewide. The hearing officer also found the five year designated travel time criterion to be invalid. Studies within the DER were cited which indicated that the average time between the time a contaminant is introduced to groundwater and its discovery is seven to eight years, and that normally 10 to 15 years pass between the time the contaminant is discovered and cleanup starts.[66]

Another relatively uncomplicated approach is the use of ***simplified variable shapes***, which are standardized forms generated using analytical models, with flow boundaries and TOT as criteria. (Figure 3). The type of aquifer material and pumping conditions applicable to a particular well can be compared to those used to generate the several standard shapes. Selection of the most applicable shape is based on the closest match between conditions applicable to the well and those used to generate the particular standardized form. The selected form is then oriented around the well according to groundwater flow patterns. The method requires a relatively small amount of field data or technical expertise, though more than is necessary to calculate fixed radii zones. The technique may not accurately represent conditions in areas with complex hydrogeological conditions and many hydrologic boundaries.

There are three situations in which the use of reasonable fixed radii zones and simplified variable shapes are potentially effective. It is possible to adopt these types of zones based on less technical information if the zones are small and close to high withdrawal areas, thus easily related to protection purposes. In situations where available local resources restrict the sophistication of the hydrogeological studies of an area, these simpler zones may also be used over larger areas, if necessary to adequately protect a community's drinking water. A local government can adopt permitting provisions which allow applicants who wish to challenge their location within such a zone to perform more site specific studies showing that the location of the proposed land use is not within the designated protection zone. Finally, in situations requiring use of interim protection measures, simpler zones can remain in place until more detailed hydrogeological studies are completed and a comprehensive wellfield protection approach adopted.

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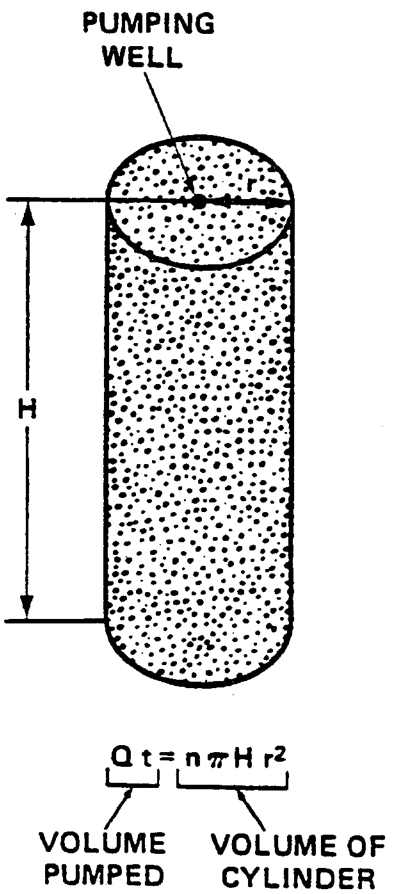
[66] See Alliance for Rational Ground Water Rules and Adam Smith Enterprises, Inc. v. Department of Environmental Regulation, D.O.A.H. Case No. 86-4492R, Final Order, 10 FALR 2419, 2446 (April 18, 1988), affirmed, Adam Smith Enterprises, Inc. v. Department of Environmental Regulation, 553 So.2d 1260 (Fla. 1st DCA 1989).

FIGURE 2
Wellhead Protection Zone Delineation
Volumetric Flow Equation
(Calculated Fixed Radius)



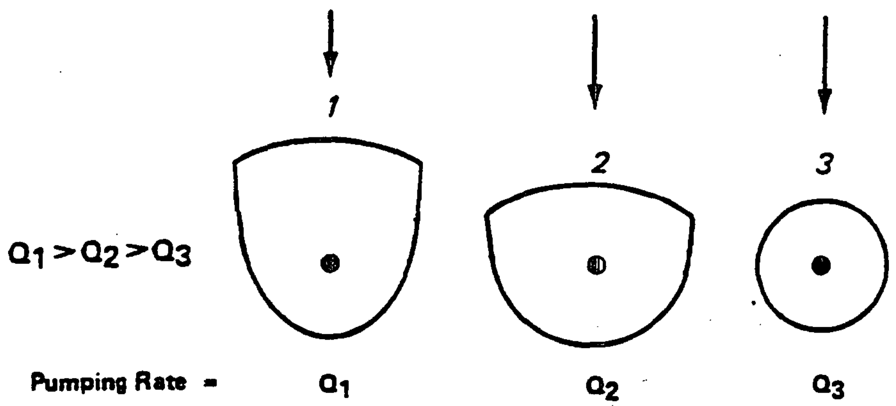
$$r = \sqrt{\frac{Q\,t}{\pi\, n\, H}} = 1138 \text{ ft}$$

WHERE
Q = Pumping Rate of Well = 694.4 gpm = 48,793,668 ft^3/yr
n = Aquifer Porosity = 0.2
H = Open Interval or Length of Well Screen = 300 ft
t = Travel Time to Well (5 Years)

(Any consistent system of
units may be used.)

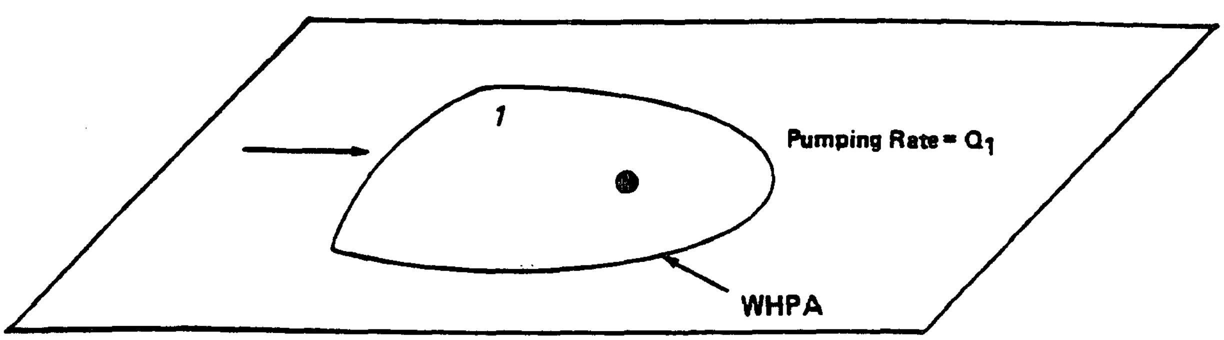
FIGURE 3
Wellhead Protection Zone Delineation
(Simplified Variable Shapes Method)

STEP 1: DELINEATE STANDARDIZED FORMS FOR CERTAIN AQUIFER TYPE



- Various standardized forms are generated using analytical equations using sets of representative hydrogeologic parameters.
- Upgradient extent of WHPA is calculated with TOT equation; downgradient with uniform flow equation.

STEP 2: APPLY STANDARDIZED FORM TO WELLHEAD IN AQUIFER TYPE



- Standardized form is then applied to well with similar pumping rate and hydrogeologic parameters.

LEGEND:

● Pumping Well

↓ Direction of Ground-water Flow

NOT TO SCALE

Other techniques for designating protection zones around wells are based on the effect the well has on groundwater flow in the area, and include the zone of influence and the zone of contribution. These areas are sensitive, because contaminants introduced into them have a greater likelihood of being drawn into the well. The ***zone of influence (ZOI)***, also known as the ***cone of depression***, is the area encompassing that part of an aquifer where the water table (for unconfined aquifers) or potentiometric surface (for confined aquifers) is drawn down or influenced by the pumping well. (Figure 4) Theoretically, the outermost limit of such a zone could be set at the point at which the well's effect on the groundwater table was barely felt, however many similar approaches designate the boundaries of such a zone on the basis of for instance, the one-foot drawdown, where the water table is depressed one foot by the pumping well.

The ***zone of contribution (ZOC)*** or ***capture zone***, is the area surrounding a well which encompasses all areas or features that actually supply groundwater recharge to the well. It includes all parts of an aquifer from which groundwater will eventually reach a pumping well, from the upgradient groundwater divide or null point to the downgradient line beyond which the well cannot overcome gravity to pull the water back. The concept is different than that of the ZOI, since in certain circumstances, the zones will include different areas. When a well is located in an area with a flat water table or potentiometric surface, both the ZOC and ZOI will be essentially the same, and use of either approach will serve to effectively delineate those areas which could contribute to the well. (Figure 4)

In areas where there is a slope to the water table or potentiometric surface, with groundwater flowing downgradient, as well as being affected by the pumping well, the two zones do not coincide, and will not provide equivalent levels of protection. In sloping water tables, the ZOI approach does not designate as protection zones areas upgradient of the well which are within the capture zone, but which are not yet within the ZOI. These include upgradient areas from which groundwater will eventually flow into the ZOI of the well. (See Figure 5) In this situation, the ZOI approach will fail to designate some areas as protection zones which do have the potential to affect the well. Additionally, at a certain point downgradient of the well, though the water table is depressed by the pumping well (within the ZOI), the effect of gravity on the sloping water table pulls groundwater out of the capture zone. In this situation, a ZOI approach will designate some areas as protection zones which have no potential to affect that well, thus for wellhead protection purposes, wasting local government resources by focusing on areas that will not contribute to the well. (Figure 5) Carefully considered aquifer protection programs may, however, require protection of areas downgradient of wells. It should be noted that in most areas there is some degree of slope to the water table or potentiometric surface.

Analytical methods can delineate these types of protection zones through use of equations to define groundwater flow and contaminant transport. Such methods as uniform flow equations are often used to define the zone of contribution to a pumping well in a sloping water table.[67] (Figure 6) Analytical methods require consideration of various hydrogeologic parameters in calculating distance to the downgradient divide, or the stagnation point, and the width of the zone of contribution to a well. Required parameters include the transmissivity, porosity, hydraulic gradient, hydraulic conductivity, and saturated thickness of an aquifer. For sloping water tables, the uniform flow model can be used to calculate the ZOC, but generally will not calculate drawdown, which determines the ZOI. For flat water tables, the method will calculate both ZOC and ZOI, since the two coincide.

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[67] Id. at 4-14.

FIGURE 4
Aquifer with Flat Water Table and High Rainfall Conditions, Where Boundaries of ZOI and ZOC Approximately Coincide (Conceptual)

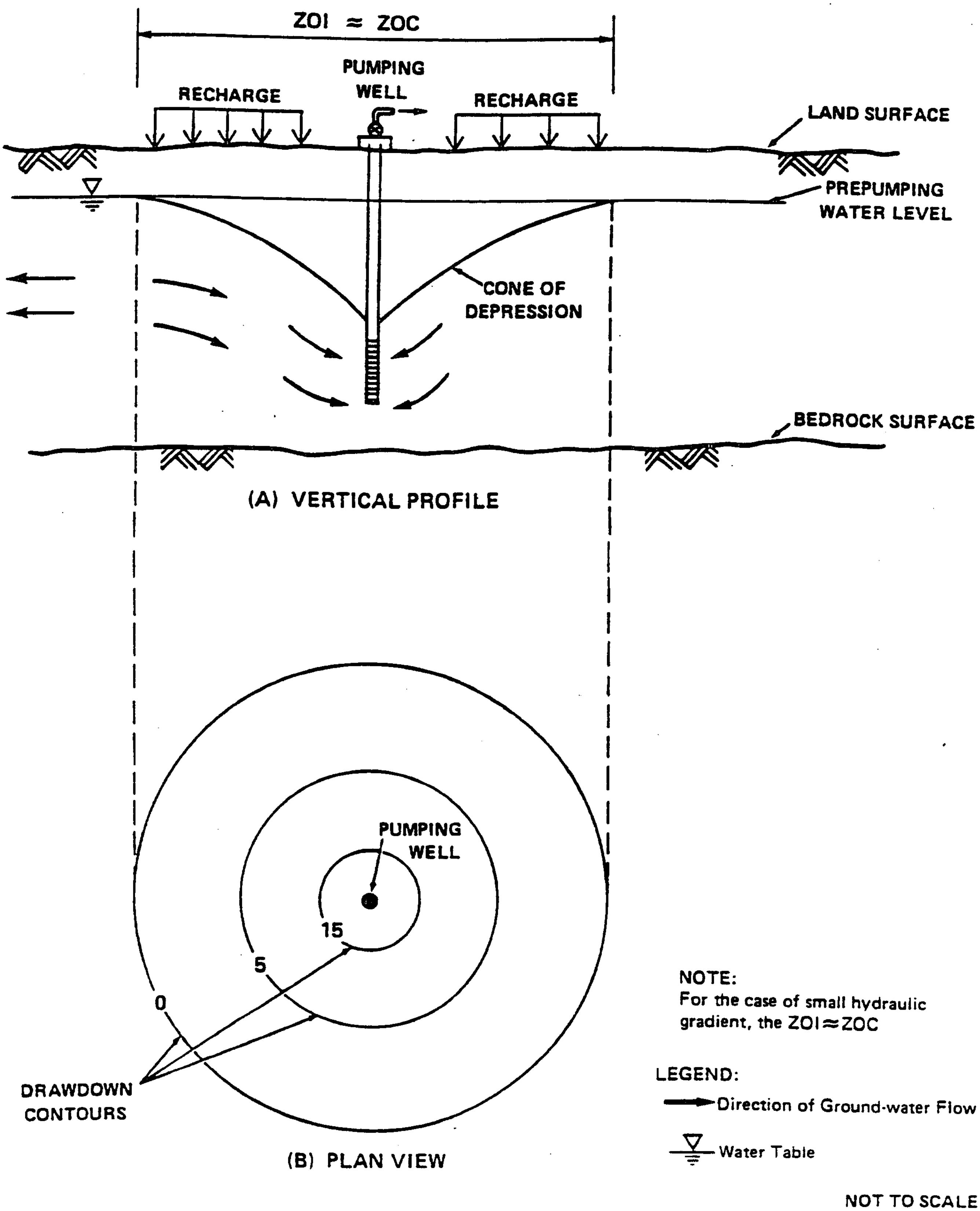
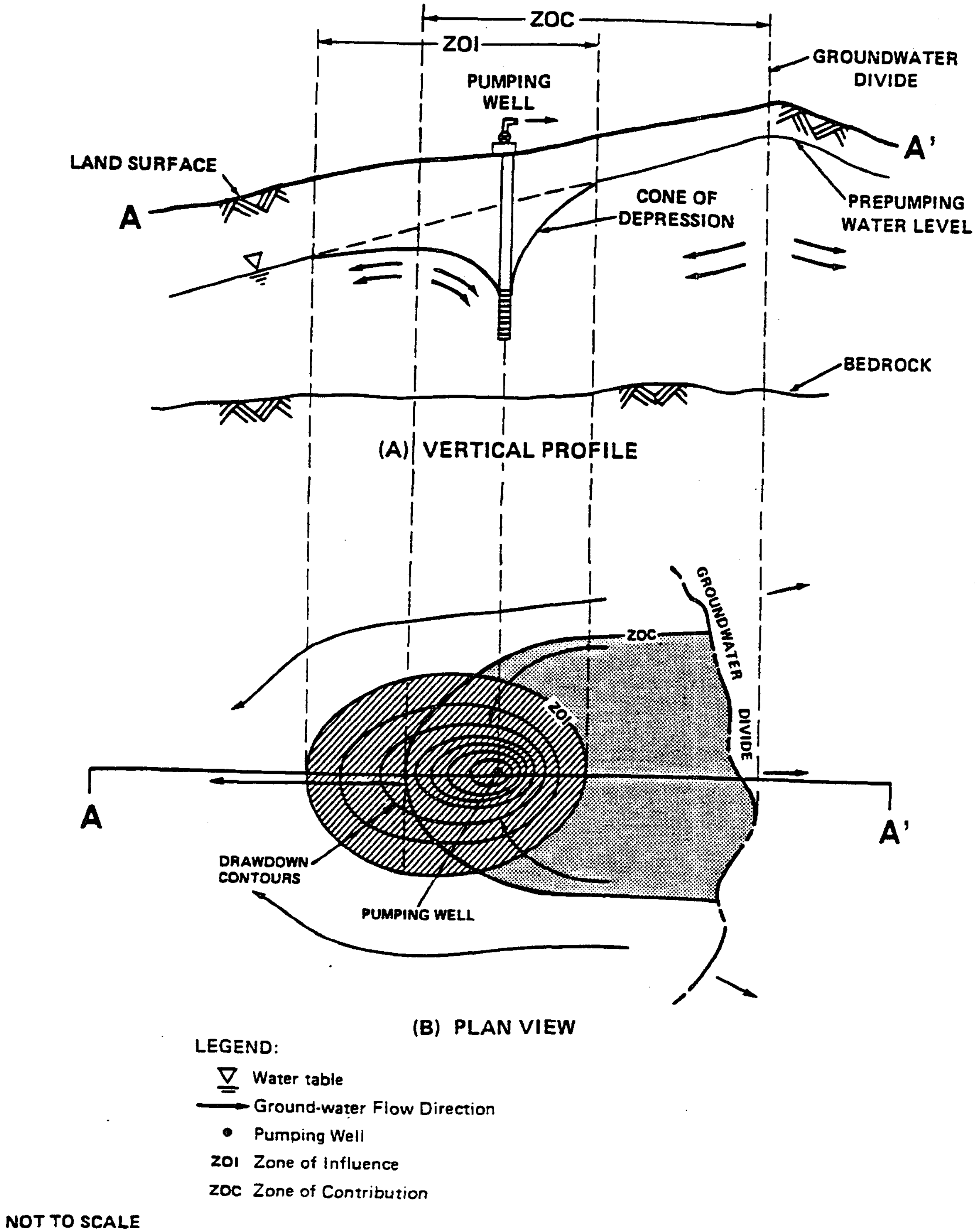


FIGURE 5
Aquifer with Sloped Water Table, Where Boundaries of ZOI and ZOC Differ (Conceptual)



Using an analytical method, the upgradient extent of a wellhead protection zone can be calculated based on a time of travel or flow boundaries criterion. An example of a flow boundaries criterion is a distinct groundwater divide, while a travel time criterion could also be used to establish the upgradient boundary line. There are many computer-assisted analytical flow and transport models available for determining these types of zones.[68] The method uses equations which are easily understood and solved by hydrogeologists and civil engineers, and takes into account more hydrogeologic parameters than the approaches above. It is considered a particularly valid approach for assessing drawdown in the area closest to a pumping well, but requires site-specific hydrogeologic data for each well. (Figure 6)

Any number of ***time of travel (TOT)*** zones can be configured around a pumping well, offering different sensitivity rankings of zones based primarily on the distance from the well and the time that would be available to detect and respond to discharges of pollutants. Zones based on time of travel can also be incorporated into other approaches, if necessary. One example is a fixed or calculated radius central zone around a well, with several additional zones added, based on the time of travel from the well. Dade County has taken a similar approach in the flat, homogenous, surficial Biscayne Aquifer of southeast Florida. Particularly in flat, homogenous, and unconfined aquifers, in which most or all of the groundwater could eventually be drawn into a pumping well at high enough withdrawal rates, travel time zones offer a way to designate and rank the zones for differential regulation, based on the relative risk of wellfield contamination. Though useful in certain circumstances, if the travel time chosen for the outermost zone corresponds to a distance that does not reach the upgradient groundwater divide, these types of approaches will not protect the entire capture zone. They also fail to protect potentially important areas downgradient of wellfields.

The ***recharge areas*** for the potable aquifers feeding public water supply wells can be located some distance away, particularly for deep confined aquifers. For shallower aquifers, the recharge areas may be closer, while surficial aquifers are recharged by the entire land surface overlying that aquifer. Serious consideration should be given to designating recharge areas as protection zones, since contaminants entering such areas will eventually be drawn into the wellfield tapping that aquifer. In areas where development pressures indicate the need for additional water supplies in the future, general areas for the location of ***future wellfields*** should be identified and, if not already owned by the local government, should be targeted for purchase of the fee or of the development rights. If such acquisition is not possible, a well considered aquifer protection plan should designate these future wellfields as protection zones, as well as their recharge areas and zones of contribution.

Designation of protection areas for zones of contribution, zones of influence, drawdown, and time of travel, as well as recharge zones can be based on information derived through hydrogeologic mapping. Hydrogeologic mapping (Figure 7) involves use of geological, geophysical and dye tracing methods, to map flow boundaries and TOT criteria, with flow boundaries defined by lithologic variations or permeability contrasts within the aquifer. The method is suited to settings dominated by near-surface flow boundaries, as are found with glacial and alluvial aquifers, and with fractured bedrock and conduit-flow karst aquifers. The technique requires specialized expertise in geologic and geomorphic mapping, and costs can be variable, depending on availability of existing information and the type of technique used. In order from most to least costly, these are: geophysical techniques, mapping of geologic contacts, dye tracing, regional

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[68] See U.S. Environmental Protection Agency, Office of Ground-Water, Model Assessment for Delineating Wellhead Protection Areas, U.S. Environmental Protection Agency, Washington, D.C. (1988).

water level mapping, and basin delineation using topographic mapping. If information needs require test holes or pump tests, costs may be high.

Numerical flow/transport models are a final method for designating any of the more complex protection zones. Numerical flow/transport models are computer generated models that approximate groundwater flow and solute transport equations in numerical terms. Such models are particularly useful in delineating protection zones around wells where boundary and hydrogeologic conditions are complex. Hydrogeologic parameters include: permeability, porosity, specific yield, saturated thickness, recharge rates, aquifer geometries, and locations of hydrologic boundaries. There are a number of numerical models available, both commercially and through the U.S.G.S., Holcomb Institute's International Ground-Water Modeling Center, and the National Water Well Association.[69] The method can provide a high degree of accuracy, can be applied to many hydrogeologic settings, and can predict changes in the designated areas as a result of natural or man-made effects.[70] The costs of such approaches can be high, depending on the availability and quality of data, number of wells, and complexity of the hydrogeology.

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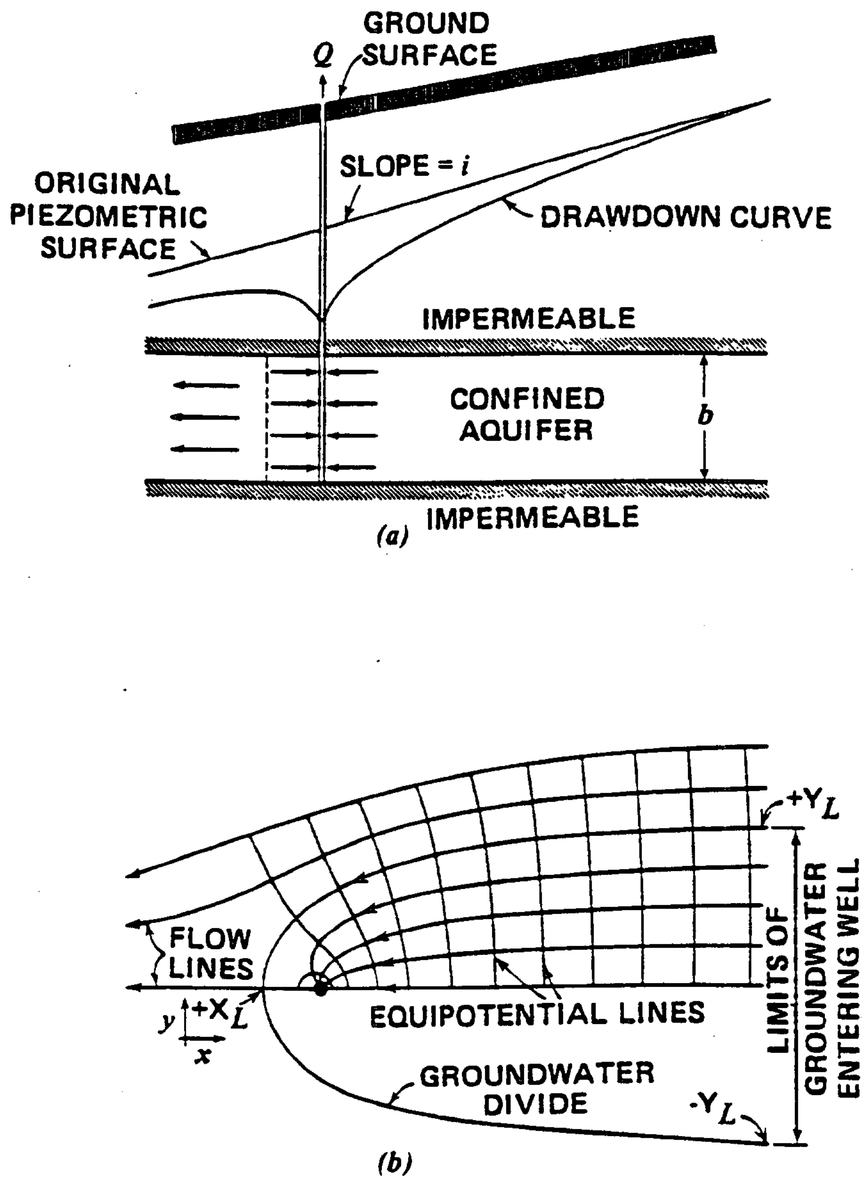
[69] See id. at D-5, for descriptions of many models and the agencies to contact for information.

[70] See id. for explanation of specific advantages and disadvantages of each model.

FIGURE 6
Wellhead Protection Zone Delineation
(Uniform Flow Analytical Model)



$$-\frac{Y}{X} = \tan\left(\frac{2\pi Kbi}{Q} Y\right)$$

UNIFORM-FLOW EQUATION

$$X_L = -\frac{Q}{2\pi Kbi}$$

DISTANCE TO DOWN-GRADIENT NULL POINT

$$Y_L = \pm \frac{Q}{2Kbi}$$

BOUNDARY LIMIT

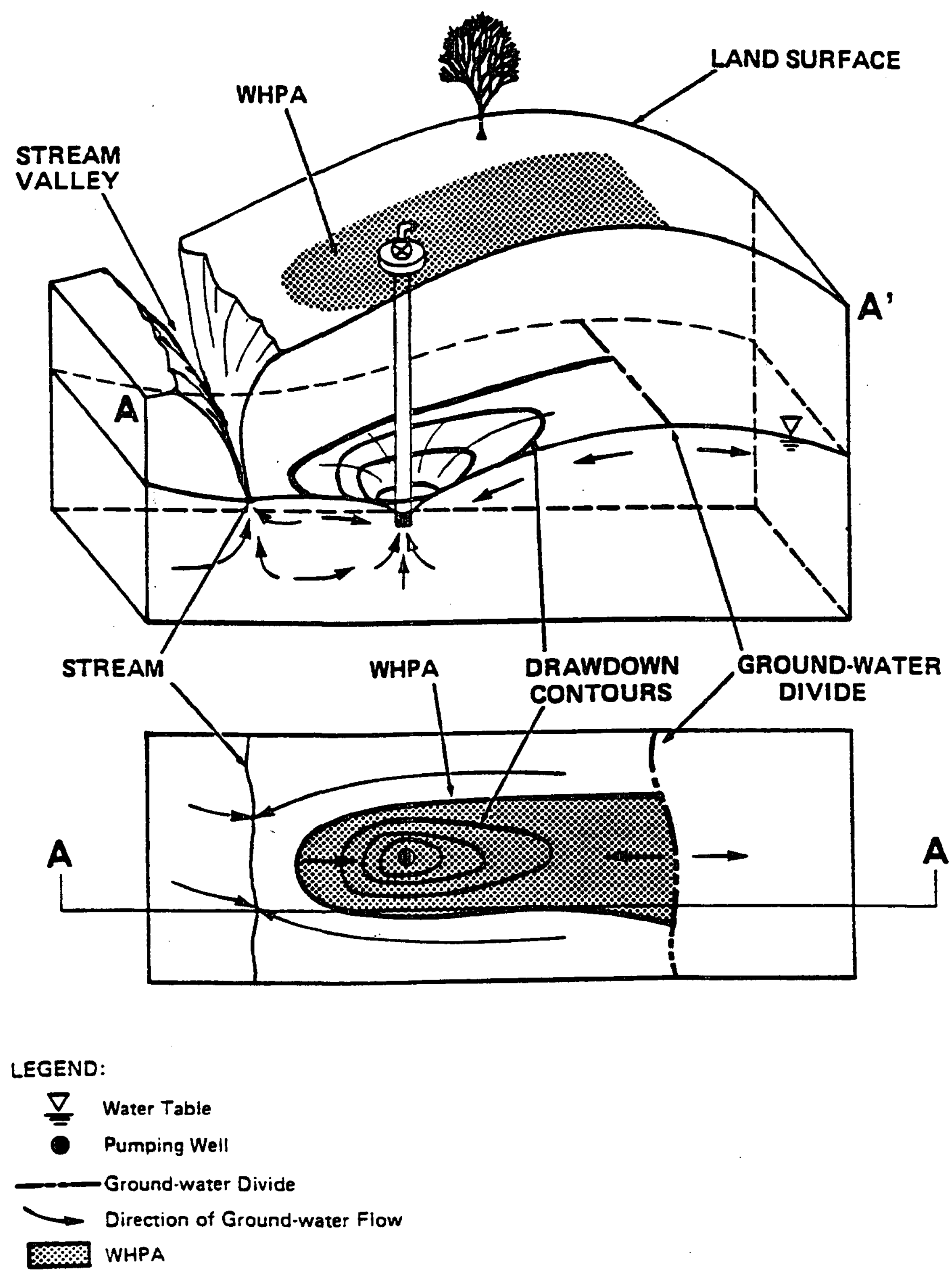
LEGEND:

- ● Pumping Well

Where:
Q = Well Pumping Rate
K = Hydraulic Conductivity
b = Saturated Thickness
i = Hydraulic Gradient
π = 3.1416

NOT TO SCALE

FIGURE 7
Wellhead Protection Zone Delineation
Using Hydrogeologic Mapping
(Use of Ground-water Divides)



"DRASTIC" STANDARDIZED SITE RATING SYSTEM

A potentially useful tool for delineating sensitive areas is known as DRASTIC. The DRASTIC rating methodology was developed to estimate the potential for groundwater pollution at any site, based on evaluation of seven hydrogeological factors judged by ground water scientists as being the most critical.[71] The factors have been assigned weights reflecting their relative importance, and are assigned points based on ratings scales. The word DRASTIC is an acronym derived from the seven factors:

D = depth to groundwater
R = recharge rate (net)
A = aquifer media
S = soil media
T = topography
I = impact of the vadose zone
C = conductivity (hydraulic) of the aquifer

The DRASTIC pollution potential index for a site is generated by multiplying the point rating for each factor by the factor weight and adding the totals for all factors. Higher total values are associated with areas with greater potential for groundwater contamination. The DER and most water management districts have developed DRASTIC maps covering the state, at resolutions of 1:100,000.

The following tables and figures illustrate the process. Table 19 indicates the rating and weights for the factor assessing depth to groundwater. Two weights are offered, one for general usage and a second for evaluation of settings in which agricultural chemicals are used. Table 20 displays the ratings and weights for the net recharge factor. Figure 8 presents a range of ratings as well as weights for the aquifer media factor. Table 21 contains information for rating and weighting of the soil media factor. Table 22 supplies the relevant information for evaluating the topography or slope of an area. Figure 9 represents the range of ratings and weights to assess the impact of the vadose zone. Table 23 provides the information necessary to rate and weight the hydraulic conductivity of the aquifer.

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[71] Aller, L., et al., DRASTIC: A Standard System for Evaluating Ground Water Pollution Potential Using Hydrogeologic Settings, U.S. Environmental Protection Agency, Washington, D.C., EPA/600/2-85/018 (May 1985); see also Canter, Knox & Fairchild, Ground Water Quality Protection, 313-317, Lewis Publishers, Chelsea, Mi. (1988).

TABLE 19
Evaluation of Depth to Ground Water Factor (DRASTIC)

Depth to Ground Water (feet)	
Range	**Rating**
0–5	10
5–15	9
15–30	7
30–50	5
50–75	3
75–100	2
100+	1
Weight: 5	Agricultural Weight: 5

TABLE 20
Evaluation of Net Recharge Factor (DRASTIC)

Net Recharge (inches)	
Range	**Rating**
0–2	1
2–4	3
4–7	6
7–10	8
10+	9
Weight: 5	Agricultural Weight: 5

TABLE 21
Evaluation of Soil Media Factor (DRASTIC)

Soil Media	
Range	**Rating**
Thin or absent	10
Gravel	10
Sand	9
Shrinking and/or aggregated clay	7
Sandy loam	6
Loam	5
Silty loam	4
Clay loam	3
Nonshrinking and nonaggregated clay	1
Weight: 2	Agricultural Weight: 5

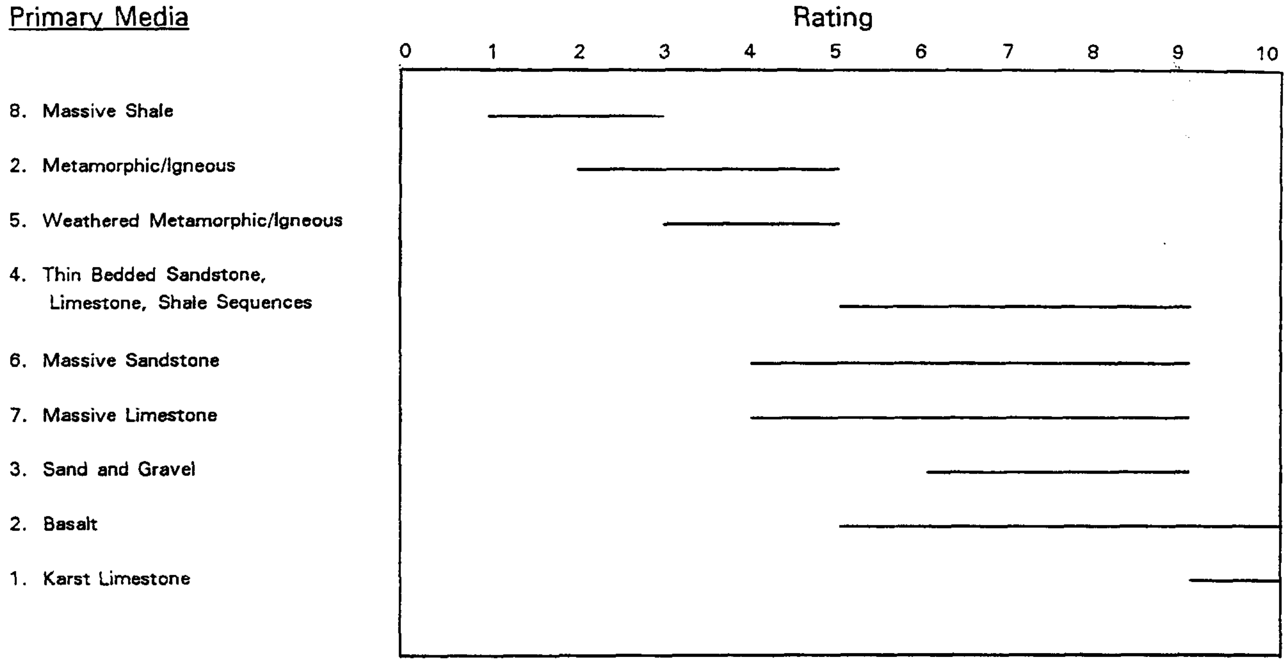
TABLE 22
Evaluation of Topography Factor (DRASTIC)

Topography (percent slope)	
Range	**Rating**
0–2	10
2–6	9
6–12	5
12–18	3
18+	1
Weight: 1	Agricultural Weight: 3

TABLE 23
Evaluation of Hydraulic Conductivity Factor (DRASTIC)

Hydraulic Conductivity (GPD/Ft^2)	
Range	**Rating**
1–100	1
100–300	2
300–700	4
700–1000	6
1000–2000	8
2000+	10
Weight: 3	Agricultural Weight: 2

FIGURE 8
Evaluation of the Aquifer Media Factor (DRASTIC)



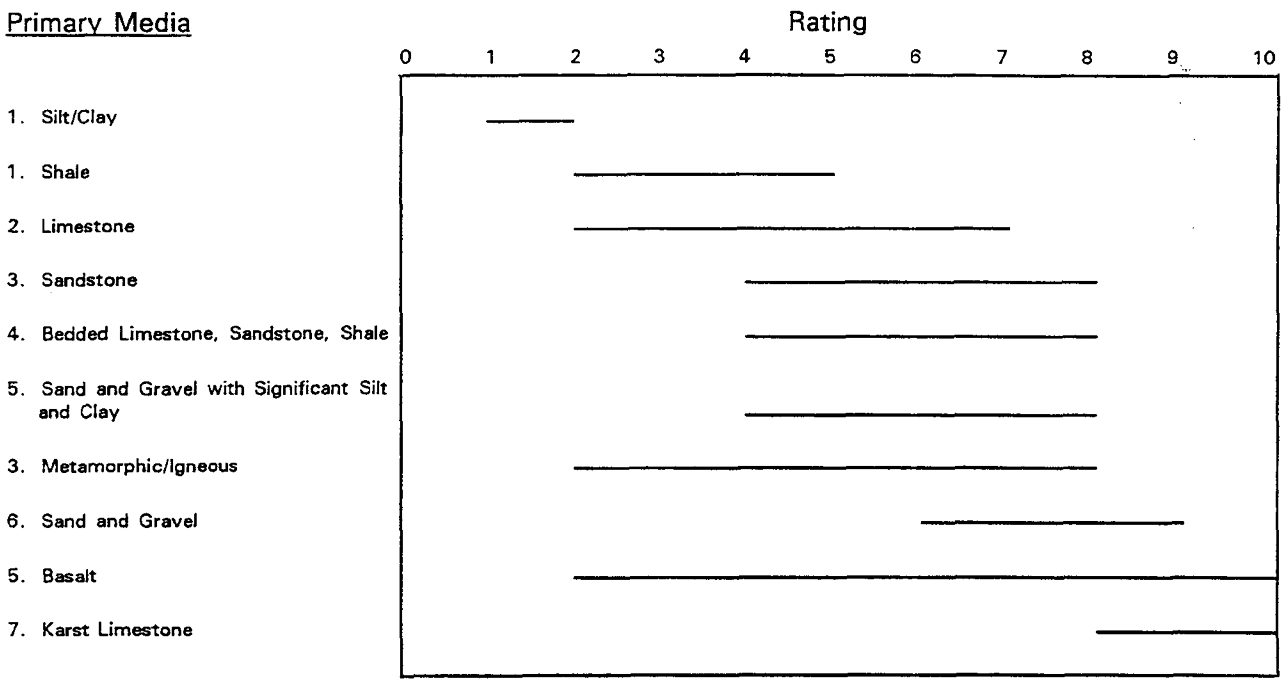
Relative ranges of ease of pollution for the Principal Aquifer types. Ranges based upon:

a) route length and tortuosity
b) potential for consumptive sorption
c) dispersion
d) reactivity
e) degree of fracturing

Primary factors affecting rating:

a) Reactivity (solubility and fracturing)
b) Fracturing
c) Route length and tortuosity, sorption, dispersion -- all essentially determined by grain size, sorting, and packing
d) Route length and tortuosity as determined by bedding and fracturing
e) Sorption and dispersion
f) Fracturing, route length and tortuosity, influenced by intergranular relationships
g) Reactivity (solubility) and fracturing
h) Fracturing and sorption

FIGURE 9
Evaluation of the Impact of the Vadose Zone (DRASTIC)



Relative impact of the principal Vadose Zone Media types. Range based upon:

a) path length and tortuosity
b) potential for dispersion and consequent dilution
c) reactivity (solubility)
d) consumptive sorption
e) fracturing

Primary factors affecting rating:

a) Consumptive sorption and fracturing
b) Fracturing and reactivity
c) Fracturing; path length as influenced by intergranular relationships
d) Fracturing; path length and tortuosity as influenced by bedding planes, sorption, and reactivity
e) Path length and tortuosity as impacted by bedding grain size; sorting and packing; sorption
f) Path length and tortuosity as influenced by grain size, sorting, and packing
g) Reactivity and fracturing

Chapter II Applicable State and Federal Law

FEDERAL LAW SUMMARY

INTRODUCTION

Unlike federal programs specifically dedicated to air and surface water protection, there are no federal laws that represent a comprehensive approach to groundwater protection. Rather, several laws have certain groundwater protection components. These include the Safe Drinking Water Act;[1] the Resource Conservation and Recovery Act;[2] the Comprehensive Environmental Response, Compensation, and Liability Act;[3] the Emergency Planning and Community Right-To-Know Act of 1986;[4] the Clean Water Act;[5] the Federal Insecticide, Fungicide, and Rodenticide Act;[6] and the Toxic Substances Control Act.[7]

FEDERAL GROUNDWATER PROTECTION STRATEGY

In 1984, the EPA published its Ground-Water Protection Strategy which recognized the need to prevent future groundwater contamination and emphasized the protection of the public health and "critical environmental systems."[8] The strategy gives priority to protecting aquifers that are presently used as drinking water supplies or are hydrologically linked to unique ecosystems.[9]

The strategy has four major components. The first component promotes the expansion of groundwater protection at the state level by allowing states to divert funds from existing water quality programs for the development of groundwater protection programs.[10] The second component of the strategy advocates future regulation and research of presently unregulated sources of groundwater pollution.[11]

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[1] 42 U.S.C. §§300f et seq. (1989).

[2] 42 U.S.C. §§6901 et seq. (1989).

[3] 42 U.S.C. §§9601 et seq. (1989).

[4] 42 U.S.C. §§11001 et seq. (1989).

[5] 33 U.S.C. §§1251 et seq. (1989).

[6] 7 U.S.C. §§136 et seq. (1989).

[7] 15 U.S.C. §§2601 et seq. (1989). See Page, Planning for Groundwater Protection, at 44 (1987) (hereinafter cited as Page).

[8] Office of Groundwater Protection, U.S. Environmental Protection Agency, "A Ground-Water Protection Strategy for the Environmental Protection Agency, 3 (August 1984).

[9] Id. at 4.

[10] Id. at 35.

[11] Id. at 37.

Part three of the strategy creates an aquifer classification system to guide future regulations and to establish enforcement priorities.[12] The groundwater classification system divides aquifers into three categories, each receiving a different level of protection. Class I aquifers, or "special ground waters," are defined as aquifers that are highly vulnerable to contamination and are either irreplaceable as drinking water supplies or are ecologically vital and should receive the greatest amount of protection.[13] Class II aquifers are all other groundwaters that are currently used or are potentially available for drinking water.[14] Class III aquifers are groundwaters that are not considered potential drinking water sources and are of limited beneficial use. These aquifers are usually heavily saline or contaminated and receive the least amount of protection.[15]

The fourth facet of the strategy promotes the EPA's internal organization within its Washington, D.C. headquarters and regional offices by vesting the Assistant Administrator for Water with the responsibility for groundwater programs and establishing the Office of Groundwater Protection to coordinate the EPA's programs. Further, regional offices of the Office of Groundwater Protection have been established to provide regional protection policies, technical assistance and grants for groundwater protection programs.[16]

SUMMARIES OF MAJOR LAWS AFFECTING GROUNDWATER PROTECTION

The Safe Drinking Water Act (SDWA)

The Safe Drinking Water Act (42 U.S.C. §300f et seq.) was enacted in 1974 to ensure the quality of public water supplies. Its jurisdiction extends to groundwater aquifers which are the source of drinking water supplies. States are given primary responsibility for implementing the programs, which must meet the federal standards.

The SDWA established four programs, including:

a.) A system of national drinking water standards and treatment technologies that provide end-of-the-pipe protection;
b.) a system that regulates the disposal of wastes through an underground injection control (UIC) program;
c.) a program to protect aquifers that are the primary source of drinking water for a community, the sole source aquifer program; and
d.) strengthening amendments which add a new program designed specifically for groundwater supply protection, known as the "wellhead protection area" program.

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12 Id. at 7.

13 Id. at 5.

14 Id. at 6.

15 Id.

16 Id. at 8.

a. **Drinking Water Standards**

The law requires the EPA to set primary (health-based) and secondary (welfare-based) groundwater quality standards for all national drinking water supplies. These standards apply to "public water systems," supplying water regularly to at least 15 connections or to at least 25 persons for at least 60 days per year. The definition includes most industrial or commercial sites which supply water to employees or customers.[17]

The EPA has issued the national interim primary drinking water regulations by establishing Maximum Contaminant Levels (MCLs) for specific pollutants.[18] MCLs are set as close as possible to the concentration level which would have "no known or anticipated adverse effects on...health" and provide an "adequate margin of safety."[19] The secondary standards pertain to the aesthetic qualities of drinking water and are intended to serve as guidelines to those states that have met primacy standards for state program approval.[20] Florida has met the primacy standards, and generally adopts the primary and secondary drinking water standards established by EPA.

The EPA is also considering establishing MCLs for pathogens and chemicals which are not currently regulated under the interim standards because their potential health effects are not yet known. Recommended Maximum Contaminant Levels (RMCLs), also known as Suggested No Adverse Reaction Limits (SNARLs), are being considered for many of the substances in proposed SDWA regulations. Generally, the list of pathogens and chemicals to be regulated includes three types of microbiological pathogens, thirteen inorganic chemicals, twenty-eight synthetic organic chemicals, approximately twelve volatile organic chemicals and two radionuclides.[21] The 1986 SDWA amendments require the EPA to establish MCLs for these substances. Primacy states may regulate these substances under their own drinking water standards.

Exemptions are available for sites that only store or distribute water, obtain water from a regulated water supply or do not sell water or do not carry people in interstate commerce. Public water supply systems which are unable to meet an MCL despite their best technological attempts may also obtain variances and exceptions from the primary drinking water standards.[22]

b. **Underground Injection Control**

The purpose of the Underground Injection Control (UIC) program is to prevent the contamination of groundwater by the underground disposal of wastes via wells.[23] Such well

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[17] 42 U.S.C. 300(f) (1989).

[18] Jaffe and DiNovo, Local Groundwater Protection, 38 (American Planning Association, 1987) (hereinafter cited as Jaffe and DiNovo).

[19] 42 U.S.C. § 300g-1 (1989).

[20] 42 U.S.C. § 300g-2 (1989).

[21] See 47 Federal Register 9352 (March 4, 1982); 48 Federal Register 45502 (October 5, 1983).

[22] 42 U.S.C. § 300g-4 (1989); see Miller, "Safe Drinking Water Act," Environmental Law Handbook, at 41-4 (8th ed. 1985).

[23] Miller, "Safe Drinking Water Act," Environmental Law Handbook, at 41-4 (8th ed. 1985).

injections pose a serious potential threat to groundwater quality since there is no way of ensuring that the waste will not leak or migrate into potable water supplies. The UIC provisions authorize the EPA to regulate this type of waste disposal as part of a consolidated permit program. States which meet the minimum federal UIC standards may also be authorized to regulate underground injections.[24] *Florida is one of the states which has received this authorization, and it regulates* underground injection through the provisions of Chapter 17-28, Florida Administrative Code.

c. Sole Source Aquifers

The EPA, by petition from the states or at its own discretion, has the authority to designate and protect aquifers which are the principal or sole source of drinking water for an area.[25] Once the sole source aquifers are designated, federal funds may be withheld for projects which could contaminate the aquifer and pose a significant threat to public health. However, the restrictions associated with a sole source designation only applie to federally funded projects, therefore, private facilities may continue to be established in these areas, subject to state or local regulation.[26]

The 1986 amendments also require the EPA to set criteria for identifying "critical aquifer protection areas" within areas designated as sole source aquifers. At a minimum, the regulatory criteria must consider the vulnerability of the aquifer, the number of persons that rely on the underground source for drinking water, and the costs and benefits of protection versus degradation.[27]

States, municipal governments or regional planning entities with jurisdiction over an area may apply to the EPA to have areas designated as aquifer protection demonstration areas. The application must include the boundary of the area, the lead planning agency, procedures for public participation in the project, an assessment of the surface and groundwater resources in the area, and must contain a comprehensive plan of protection including schedules of implementation.[28] The EPA has 120 days to grant approval or disapproval based on whether the application satisfies the regulatory criteria. Once approved, the EPA and the applicant may enter into a cooperative agreement, and the EPA may grant up to 50% of the project cost up to a limit of $4,000,000 per aquifer.[29]

d. Wellhead Protection Areas

The 1986 SDWA amendments require the states to adopt programs to protect the wellhead areas of public water supply wells from contaminants posing health risks. Wellhead protection areas are defined by the amendments to include "the surface and subsurface area surrounding a well or wellfield, supplying a public water system, through which contaminants are

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[24] See 42 U.S.C. §§ 300h--300h-3 (1989).

[25] 42 U.S.C. § 300h-3 (1989).

[26] Page at 49.

[27] 42 U.S.C. § 1428(e) (1989).

[28] 42 U.S.C. §§ 1427(e), (f) (1989).

[29] Page at 50.

likely to move toward and reach such well or wellfield."[30] To qualify for funding, states must have submitted their programs to the EPA for approval by 1989. Further, the amendments require the states to make reasonable efforts to implement their well protection programs within two years after submission to the EPA. If the EPA approves a program, the state may receive 50% to 90% federal funding support. Congress authorized the appropriation of $35,000,000 for the years 1989-1991.[31] For the past two years, Florida has been attempting to create and implement an approved state wellhead protection rule.

The Resource Conservation and Recovery Act (RCRA)

The Resource Conservation and Recovery Act is a regulatory statute intended to provide "cradle-to-grave" management of hazardous and other solid wastes from their point of production to their point of ultimate disposal. It is designed to control waste disposal practices by preventing unregulated discharges, releases, or seepage into the environment. Permits are required for hazardous waste treatment, storage, and disposal (TSD) facilities. These permit requirements include groundwater monitoring. Spills, leaks, and solid or hazardous wastes that may migrate into groundwater and threaten public health or the environment are regulated by the imminent hazard and corrective action provisions of the Act. These provisions authorize the EPA, or states with approved RCRA programs, to compel containment or cleanup.

a. Hazardous Waste Management - Subtitle C

The EPA's "cradle-to-grave" management system for hazardous wastes is established in Subtitle C of RCRA. The Act includes provisions for: the identification and listing of hazardous wastes; tracking wastes by requiring manifests to accompany waste shipments; standards for treatment, storage and disposal (TSD) facilities; and requiring federal permits for TSD facilities.[32] The four factors used by the EPA to classify wastes as hazardous include: ignitability, corrosivity, reactivity, and toxicity. The EPA, however, does not consider carcinogenicity, infectiousness, mutagenicity or teratogenicity (the ability of wastes to cause birth defects.)[33] The first set of RCRA regulations, published in May 1980, established the hazardous waste listing criteria and a list of many hazardous constituents, the generator and transporter regulations, the state delegation guidelines, and explanations for obtaining interim status and final permits for TSD facilities.[34]

Hazardous waste landfills are currently regulated under Interim Status Standards by the EPA, and by states whose programs have been approved by the EPA.[35] Interim status regulations require TSDs to set up a groundwater monitoring system to detect any releases from their facilities into the groundwater and to characterize any contaminants found. If monitoring systems establish that hazardous wastes have migrated from the facility, then cleanup and containment

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[30] 42 U.S.C. 1428(e) (1989).

[31] Page at 51.

[32] Jaffe and DiNovo, at 42.

[33] Id. at 43.

[34] 40 C.F.R. Parts 261-266 (1989).

[35] Id. at 44.

strategies become conditions of the facility permit, or where no application for a final (Part B) permit is submitted, the EPA will bring an enforcement action under RCRA §§3008(h) and 7003, or CERCLA §106.[36]

In 1984, Congress amended RCRA, requiring design and performance standards that use adequate and available control technologies.[37] Under these standards, all new landfills, waste piles and surface impoundments receiving permits must meet minimum design standards which require the use of double liners, extensive groundwater monitoring systems, and leachate collection systems.[38] Existing land disposal facilities under this provision will be required to retrofit to varying degrees, based on the type of facility.[39]

In addition, the 1984 amendments require the EPA to develop rigorous standards pertaining to the location of all new hazardous waste facilities. Treatment and disposal facilities may be given up to 10-year fixed term permits which must be reviewed every five years. As a condition of permit issuance, facility operators must remedy all releases from hazardous waste facilities, or establish schedules for corrective action if the problem cannot be remedied before a permit is issued.[40] RCRA requires post-closure planning for 30 years after a hazardous waste facility is closed. In addition, operators must meet financial responsibility and insurance requirements for Interim Status Standard permits.[41]

b. Other Solid Wastes - Subtitle D

RCRA also established a framework for managing nonhazardous wastes. Under Subtitle D of the Act, the EPA develops minimum criteria for the landfilling of such wastes, and prohibits nonhazardous wastes to be disposed of in "open dumps."[42] The 1984 RCRA amendments require EPA to define open dumping, especially where a landfill receives large quantities of hazardous wastes through the disposal of household chemicals or illegal dumping.[43]

Subtitle D gives the EPA no direct management authority. Rather, the states must grant management permits and enforce the solid waste provisions of the Act. The EPA's only management mechanism is to withhold grants and other funding to states that have not met the federal standards. However, the EPA may bring an enforcement action when hazardous wastes are being disposed of in private or municipal landfills.[44] Solid waste plans, similar to the water

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[36] Page at 31.

[37] 42 U.S.C. § 6925 (1989).

[38] Id.

[39] Id.

[40] Jaffe and DiNovo, at 45.

[41] Id.

[42] 42 U.S.C. § 6941 et seq. (1989).

[43] Jaffe and DiNovo at 46.

[44] Id.

quality management plans funded under the Clean Water Act, require states to develop the plans, monitor existing and new facilities and assess the need for additional facilities.[45]

c. Underground Storage Tanks

The 1984 amendments to RCRA (Subtitle I) address problems created by leaking underground storage tanks.[46] Under the provisions, tanks containing "hazardous materials" regulated by CERCLA, as well as those containing oil and oil by-products, are subject to regulation if 10 percent of the volume, including attached pipes, is beneath the surface of the ground. Tanks containing "hazardous wastes" are regulated under the TSD provisions of Subtitle C. Generally, Subtitle I contains the following provisions: a ban on installation of unprotected tanks; a tank notification program; EPA development of new tank performance standards and release detection, prevention, and correction regulations; substitution of state release detection, prevention, and correction programs for the federal program; tank inspection monitoring and testing requirements; and EPA enforcement of the subtitle requirements.[47] While Congress charged the EPA with the responsibility for drafting regulations and guidance, states are assigned the major implementation responsibilities.

RCRA's definition of underground storage tank excludes the following: farm and residential USTs which store less than 1,100 gallons of motor fuel for non-commercial purposes; tanks which store heating oil for use on the premises; septic tanks; pipeline facilities; surface impoundments; stormwater or waste water collection systems; flow-through process tanks; liquid traps directly related to oil or gas production; and storage tanks in an underground area.[48] In addition, the EPA has deferred five classes of tanks from its rules while it decides whether to subject these tanks to its rules. However, the deferred tanks are subject to interim prohibition requirements and corrective action.[49] Exempt from the regulations are UST systems with capacities of 110 gallons or less; any wastewater treatment tank that is part of a wastewater treatment facility regulated under section 402 or 307(b) or the Clean Water Act; UST systems containing de minimus concentrations of regulated substances; and any emergency spill or overflow containment UST system that is quickly emptied after use.[50]

The UST regulations require owners and operators of storage tanks that are within the jurisdiction of the law to notify state agencies of regulated tanks, and comply with release

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[45] 42 U.S.C. § 6943 et seq. (1989).

[46] See 42 U.S.C. § 6991 et seq. (1989) [Subtitle I of the Resource Conservation and Recovery Act, passed as part of the Hazardous and Solid Waste Amendments of 1984, amended by the Superfund Amendments and Reauthorization Act of 1986].

[47] See 42 U.S.C. §§ 6991a--6991e (1989).

[48] 42 U.S.C. § 6991 (1989).

[49] See 40 C.F.R. §§ 280.10(c), 280.11 (1989). The deferred types of UST systems include wastewater treatment tank systems; any UST system containing radioactive material regulated under the Atomic Energy Act of 1954; any UST system that is part of an emergency generator system at nuclear power generation facilities; airport hydrant fuel distribution systems; and UST systems with field-constructed tanks. Id.

[50] 40 C.F.R. § 280.10(b) (1990).

detection, prevention, and corrective regulations.[51] The release detection and prevention provisions require the EPA to develop regulations requiring tank owners and operators to set up leak detection and correction systems; to specify standards for tank designs, construction, installation, and compatibility; and to establish financial clean up capabilities and closure requirements.[52]

Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA)

CERCLA (42 U.S.C. §9601 et seq.) was the first comprehensive federal law aimed at responding directly to environmental threats caused by chemical spills or releases of hazardous materials. CERCLA authorizes the EPA to initiate the removal or cleanup of hazardous substance disposal sites, to seek compensation for the cost of cleanup or other corrective actions from responsible parties, and to initiate cleanup, abatement, and enforcement actions to minimize the threat to health and the environment from spills of hazardous substances.[53]

The Act establishes two trust funds to pay for corrective actions. The Hazardous Substance Response Fund, or "Superfund," is intended to finance government containment or cleanup measures of actual or threatened releases of substances that may harm human health or the environment including groundwater. The Post-Closure Liability Fund pays for the damages caused by the releases of hazardous materials and for post-closure care.[54]

CERCLA, which regulates a greater number of hazardous substances than does RCRA, also has a lower reporting requirement triggered by the release of more than one pound of hazardous substances. Further, the Act requires that the EPA be notified of all inactive hazardous waste sites and authorizes stiff penalties for failure to keep adequate records or failure to file reports with the EPA which are mandated by law.[55] Once notified, the EPA has the authority to take either removal or remedial actions.

Removals are short-term emergency response actions that are limited to $1 million of cleanup costs and/or six months of work after the initial release.[56] Remedial actions, on the other hand, are long-term responses and require the states to enter into cooperative agreements with the EPA to bear a part of the costs before any money from the trust funds may be released.[57] The EPA may also use fund monies to remedy loss or damage of natural resources, including groundwater, which is owned or managed, or held in trust by federal, state or local

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[51] 42 U.S.C. §§ 6991a, 6991b (1989).

[52] 42 U.S.C. § 6991b (1989). See also 40 C.F.R. Part 280 (Subparts A-H) (1990).

[53] 42 U.S.C. §§ 9601-9604 (1989).

[54] 42 U.S.C. §§ 9611(a), 9631(a) (1989).

[55] Id. at 47-48.

[56] 42 U.S.C. § 9601(23) (1989).

[57] 42 U.S.C. § 9601(24) (1989).

governments.[58] However, there is some question whether groundwater wells contaminated by pesticides from farm runoff are eligible for remedial action under the Act.[59]

CERCLA imposes strict liability on parties responsible for waste spills and releases of toxic substances into the environment. Transporters and generators of hazardous wastes may be found liable along with current owners and operators of waste facilities, and owners or operators at the time of a release.[60] The federal government or any state may sue all responsible parties to recover the full costs of remedial actions, environmental damages, and administrative expenditures. However, problems often result when the responsible parties cannot be found. Also, complications exist because liability does not extend to a release that was anticipated in an environmental impact statement or in a permit decision, or that occurred before CERCLA was adopted.[61] Further, there are limitations on the use of the trust funds to compensate governments. Under CERCLA, the cost-sharing ratio between the federal government and the states is 90:10, unless the facility is publicly owned, in which case the state must pay for 50% or more of the cost.[62]

An important feature of CERCLA is the National Contingency Plan which establishes guidelines for evaluating hazardous material releases, determines appropriate remedial responses, and establishes a national priority list.[63] In 1982, a revised EPA plan was adopted for on-site response, for the establishment of intergovernmental emergency response teams, and for the identification of federal, state, and private-sector responsibilities.[64] In addition, the National Oil and Hazardous Substances Pollution Contingency Plan includes a national priority list of problem sites selected by the use of a hazard ranking system that considered the gravity and likelihood of potential harm.[65]

Emergency Planning and Community Right-To-Know Act (EPCRA)

The Emergency Planning and Community Right-To-Know Act of 1986 (42 U.S.C. § 11001 et seq.), which originated in the 1986 Superfund amendments, establishes a chemical emergency planning and response program, and imposes three new non-emergency reporting requirements on industry, including:

a.) "notification by a facility that it is subject to EPCRA's emergency planning requirements,

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[58] 42 U.S.C. §§ 9631(c)(1)(C), 9601(16) (1989).

[59] See Comment, "Using CERCLA to Clean Up Groundwater Contaminated Through the Normal Use of Pesticides," 15 Envtl. L. Rep. 10,100 (April 1985).

[60] 42 U.S.C. § 9607(a)(1)-(4) (1989).

[61] Jaffe and DiNovo, at 48.

[62] 42 U.S.C. § 9604(c)(3) (1989).

[63] 42 U.S.C. § 9605 (1989).

[64] 42 U.S.C. § 9605 (1982).

[65] See 40 C.F.R. pt. 300, app. A (1989).

b.) annual reporting by covered facilities of the amount of certain chemicals present during the year, and

c.) annual reporting by covered facilities of the total amount of certain chemicals released during the year."[66]

Facilities subject to the reporting requirements must inform local communities about the nature and amount of chemicals present at the facility.[67] EPCRA established three broad reporting requirements which include: 1.) a material safety data sheet (MSDS), with relevant chemical information,[68] 2.) an emergency and hazardous chemical inventory form, reporting the amounts of certain hazardous chemicals present at a facility,[69] and 3.) a toxic substance release form, reporting the amount of any emissions into the environment from the facility.[70] These reports are submitted to the appropriate local emergency planning committee, the state emergency response commission, and the fire department with jurisdiction over the facility, or to the EPA and state designated official in the case of toxic substances.[71]

EPCRA provides procedures and substantive standards for chemical trade secret protection. The specific chemical identity of any chemical or substance covered by either the emergency planning section or the reporting requirements can be withheld as a trade secret subject to one exception. If a specific chemical identity is claimed as a trade secret, a generic class or category of the hazardous chemical, extremely hazardous substance, or toxic chemical must be substituted for the chemical identity. However, facilities may not claim chemical identity as a trade secret under the Act when giving emergency notification of the release of an extremely hazardous substance.[72]

EPCRA contains provisions for enforcement by federal and state authorities and private citizens. Emergency response plans, MSDSs, inventory forms, toxic chemical release forms, and follow-up emergency notices must be made available to the general public subject to trade secret limitations by locations designated by the EPA, the state, or the local committee. Each committee is required to publish an annual notice in local newspapers that the information is available for

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[66] Hall, Watson, Schwartz, Bryson and Davis, Superfund Manual: Legal and Management Strategies, (Government Institutes, Inc.), at 9-1 (3d ed. 1985).

[67] 42 U.S.C. § 11002 (1989).

[68] 42 U.S.C. § 11021 (1989). MSDSs are required for many hazardous materials under the Occupational Safety and Health Act of 1970 (15 U.S.C. § 651 et seq.). The owner or operator of a covered facility may also submit a list of chemicals for which it holds MSDSs, but must group the chemicals on the list in five categories of health and physical hazards. See 40 C.F.R. § 370.2 (1989).

[69] 42 U.S.C. § 11022 (1989).

[70] 42 U.S.C. § 11023 (1989).

[71] Hall, Watson, Schwartz, Bryson and Davis, Superfund Manual: Legal and Management Strategies, (Government Institutes, Inc.), at 9-15, 9-16, 9-35 (3d ed. 1985).

[72] Id. at 9-38. See 40 C.F.R. Part 355, Appendices A and B for listing of of extremely hazardous chemicals subject to planning and reporting requirements.

public review.[73] Nothing in EPCRA preempts a state or local right-to-know law.

The Clean Water Act (CWA)

The Clean Water Act has two major objectives: to ensure that water quality can provide for the protection and propagation of fish and wildlife and for recreation in and on the water, and to eliminate the discharge of pollutants into waters of the United States. The definition of waters of the United States does not include underground aquifers, though several provisions within the Act have indirect effects on groundwater quality.

The CWA's planning provisions require the EPA to oversee the development of comprehensive management plans by states for "nonpoint sources" of pollution.[74] The planning provisions include Section 208 which requires designated state and local agencies to plan for "disposal of pollutants on land or in subsurface excavations ... to protect ground and surface water quality"[75] and Section 303 which gives the EPA the authority to require states to enact groundwater quality standards where a clear "hydrologic nexus" has been established between ground and surface waters.[76] States have used Section 208 and 303 planning funds to develop groundwater management area protection plans and regulatory programs in certain areas.

Section 201 of the Act controls federal grants for sewage treatment plant construction, and authorizes the EPA to establish grant conditions to protect groundwater.[77] Projects which employ land application of processed wastewater, to reuse and recycle nutrients, must protect groundwater for present and projected future uses, based on present quality.[78]

The Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA)

Under FIFRA (7 U.S.C. §136 et seq.), the EPA is authorized to regulate pesticide use through registration.[79] The EPA has developed testing and registration guidelines for determining the potential for pesticides to leach to groundwater through normal use. The EPA has the authority to require pesticide manufacturers to monitor the use of pesticides in recharge areas and where monitoring shows that groundwater contamination has occurred, the EPA may limit potential damage by banning the use of a pesticide in recharge areas.[80]

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[73] 42 U.S.C. § 11044 (1989).

[74] 33 U.S.C. § 1252 (1989).

[75] 33 U.S.C. § 1288 (1989).

[76] 33 U.S.C. § 1313 (1989).

[77] 33 U.S.C. § 1281 (1989).

[78] Page at 59.

[79] 7 U.S.C. § 136a (1989). See also 40 C.F.R. §§ 155.23, 157.20, 158.20, 162.1 et seq. (1989).

[80] Page at 59.

Toxic Substances Control Act (TSCA)

The Toxic Substances Control Act (15 U.S.C. §2601 et seq.) authorizes the EPA to regulate the manufacturing, processing, use and disposal of toxic chemicals through notification. Where a chemical could contaminate groundwater and pose an unreasonable risk to health or the environment, the EPA may place restrictions on the use of the chemical, require warning labels, mandate that users adopt application procedures to control pollution or require special disposal plans.[81] The EPA's PCB regulations contain requirements to prevent and clean up spills that threaten groundwater. Also, landfills which are permitted by the EPA to receive PCB wastes are required to conduct groundwater monitoring pursuant to 40 CFR § 761.75. However, the EPA rarely uses its TSCA authority to regulate activities with potential impacts on groundwater.[82]

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[81] 15 U.S.C. § 2605 (1989).

[82] Page at 60.

STATE ADMINISTRATIVE RULES SUMMARIES

DEPARTMENT OF ENVIRONMENTAL REGULATION

Statutory Authorization

The general policy authorizing adoption of pollution control regulations is stated in section 403.021(2), Florida Statutes:

> "It is declared to be the public policy of this state to conserve the waters of the state and to protect, maintain, and improve the quality thereof for public water supplies, for the propagation of wildlife and fish and other aquatic life, and for domestic, agricultural, industrial, recreational, and other beneficial uses and to provide that no wastes be discharged into any waters of the state without first being given the degree of treatment necessary to protect the beneficial uses of such water."

Section 403.88, Florida Statutes, prohibits discharges into "waters within the state" of any waste which causes violation of water quality standards for that classification of water, while section 403.031(12), Florida Statutes, defines "waters" to include groundwater.

The responsibility for implementing state rules regulating the use of groundwater and activities affecting it is distributed among several agencies, including: the Department of Environmental Regulation (DER), the five water management districts (Northwest Florida Water Management District, Suwannee River Water Management District, St. Johns River Water Management District, Southwest Florida Water Management District, and South Florida Water Management District), the Department of Health and Rehabilitative Services (HRS), and the Department of Agriculture and Consumer Services (DACS).

DER has promulgated a number of different regulations under Title 17 of the Florida Administrative Code, which function to regulate several types of activities with potential impacts on groundwater. The primary applicable rule administered by HRS is codified as Ch. 10D-6, Florida Administrative Code, while the Department of Agriculture and Consumer Services has promulgated several applicable rules within Title 5 of the Florida Administrative Code. Rules of the water management districts are codified in various chapters of Title 40 of the Florida Administrative Code.

For most of its program responsibilities, the DER may approve local pollution control programs which meet or exceed the requirements of rules established under Chapter 403, Florida Statutes.[1] The local program must provide regulatory controls, enforcement provisions, administrative staff and other necessary resources. The DER will enforce the rules of the approved municipal or county program if those rules are stricter than those of DER.[2]

Chapter 17-40, F.A.C.: Water Policy

Chapter 17-40, F.A.C., is intended to clarify water policy as expressed in Chapter 373, F.S., and provide guidance to the DER and water management districts in establishing programs, rules and plans. Generally, DER's policy is to manage the state's water resources so as to

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[1] Fla. Stat. § 403.182 (1989).

[2] Fla. Stat. § 403.182(6) (1989). Fourteen local programs have been approved by DER to date: the counties of Alachua, Brevard, Broward, Dade, Duval, Hillsborough, Lake, Manatee, Orange, Palm Beach, Pinellas, Sarasota, Seminole and Volusia.

conserve and protect them. Under the policy, DER's programs seek to assure an adequate and affordable water supply for all reasonable and beneficial uses. The amount of water necessary to support essential non-withdrawal demands, including navigation, recreation, and protection of fish and wildlife will be reserved from use, which includes establishing minimum flows and levels to protect water systems ecology.

Reclaimed water use is advocated whenever consistent with protection of public health, and surface and groundwater quality. Water should be used of the lowest quality acceptable for the purposes intended. Natural water management systems, including and the water storage and water quality enhancement functions of wetlands, floodplains, and aquifer recharge areas are to be protected and restored. Impacts from prior alteration of natural hydrologic systems are to mitigated. Nonstructural alternatives to water problems should be considered when structural solutions are proposed. The policy is to encourage development of local and regional water supplies instead of interdistrict transportation of water supplies, and control point and nonpoint sources of pollution.

Rule 17-40.401, F.A.C., "Water Use and Reuse," applies to water regulated pursuant to Part II of Chapter 373, F.S. Permits will not be granted for water use unless the proposed use is a reasonable-beneficial use, will not interfere with current authorized uses, and is consistent with the public interest. Water conservation is required unless not economically or environmentally feasible. These rules do not preempt any local reuse plans. DER requires some reuse of reclaimed water from domestic water treatment plants. Water quality standards are enforced pursuant to Chapter 403, F.S., to protect waters of the state from point and nonpoint sources of pollution.

Chapter 17-40, F.A.C. is currently being revised by DER through a five docket procedure. Recently promulgated amendments to the rule include additional general water policies emphasizing the importance of protecting aquifer recharge areas, preventing aquifer contamination and providing high levels of treatment for stormwater and wastewater.[3] The first docket also reorganized the rule for clarity, required additional definitions, and required that the new definitions be used by DER and the water management districts in their rules and orders.[4] During the next two years, other dockets will address state stormwater goals, water program administration and evaluation, resource protection and management, and water program development.

Chapter 17-3, Part IV; Chapter 17-28, Part VII: Permitting of Discharges to Groundwater

Permitting of Discharges to Groundwater

The Department of Environmental Regulation's general permitting provisions are contained in Chapter 403, Florida Statutes. Chapter 403 requires that all discharges to groundwater be permitted by DER unless exempted, and that they comply with technology based effluent limitations (TBELs), such as secondary treatment for domestic waste, and water quality based effluent limitations (QBELs), such as the treatment necessary to meet water quality standards and protect beneficial uses.

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[3] Rule 17-40.310(8), (9), (16), Fla. Admin. Code (Oct. 1990).

[4] 16 Fla. Admin. W. 2731 (June 15, 1990).

Basically, DER's groundwater rules perform three functions: 1.) classify groundwater into four categories, depending on ambient water quality and level of natural protection; 2.) establish "minimum criteria" (groundwater criteria applicable to all groundwater unless exempted) and "standards" (maximum levels of specific contaminants allowed in groundwater of a particular class); and 3.) establish a permitting system based on allowable discharges within "zones of discharge." Unless exempted, no installation may directly or indirectly discharge to groundwater any contaminant that causes a violation of any of the water quality criteria and standards except within a zone of discharge established by permit or rule.[5]

Applicable Groundwater Standards

Chapter 17-3, Part IV, F.A.C. contains several important provisions of DER's groundwater rule. First, it establishes the "minimum criteria" applicable to all groundwater.[6] These are also known as "free froms," since the language of the rule states that all groundwater at all times and places must be "free from" any humanly induced, nonthermal components of discharges in concentrations which alone or in combination with other components:

a. "Are harmful to plants, animals, or organisms that are native to the soil and responsible for treatment or stabilization of the discharge relied upon by Department permits."

b. "Are carcinogenic, mutagenic, teratogenic, or toxic to human beings, unless specific criteria are established for such components in Rule 17-3.404..."

c. "Are acutely toxic to indigenous species of significance to the aquatic community within surface waters affected by the groundwater at the point of contact with surface waters..."

d. "Pose a serious danger to the public health, safety or welfare..."

e. "Create or constitute a nuisance..."

f. "Impair the reasonable and beneficial use of adjacent waters."[7]

The second set of applicable groundwater standards are the primary and secondary drinking water standards for public water systems established pursuant to the Florida Safe Drinking Water Act. Primary drinking water standards are those necessary to prevent an adverse effect on the health of persons. The rule specifies maximum contaminant levels for several types

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[5] Rule 17-28.700(2)(a), Fla. Admin. Code (1990).

[6] Rule 17-3.402, Fla. Admin. Code (1990). Groundwater is defined as "water beneath the surface of the ground within a zone of saturation whether or not flowing through known and definite channels." Rule 17-3.021(11), Fla. Admin. Code (1990).

[7] Reasonable-beneficial use is defined as "the use of water in such quantity as is necessary for economic and efficient utilization for a purpose and in a manner which is both reasonable and consistent with the public interest." Fla. Stat. § 373.19(4). Criteria for determining reasonable-beneficial use are codified in Rule 17-40.401(2), Fla. Admin. Code (1990). The DER has compiled a booklet entitled Groundwater Guidance Concentrations listing many chemicals and concentrations, and providing guidelines for the review of groundwater quality data for minimum "free from" requirements.

of organics, volatile organics, inorganics, turbidity, microbiological agents and radionuclides.[8] Secondary drinking water standards are oriented more to protection of the public welfare, including factors such as taste, odor and color. The list of maximum contaminant levels includes those for chloride, color, copper, corrosivity, fluoride, foaming agents, iron, manganese, odor, pH, sulfate, zinc and total dissolved solids.[9] The ERC normally adopts all federal Environmental Protection Agency standards in these areas.

Groundwater Classifications

Chapter 17-3, Part IV, F.A.C. classifies all groundwater according to its designated use, level of confinement and level of dissolved solids. Class G-I is identified as potable water use groundwater in a single source aquifer with total dissolved solids (TDS) of less than 3000 mg/l.[10] No aquifers have been classified as G-I. Class G-II is potable water use groundwater in aquifers with TDS content of less than 10,000 mg/l, unless otherwise classified by the Environmental Regulation Commission (ERC).[11] Most of Florida's accessible groundwater is classified in this category. Class G-III is nonpotable groundwater in unconfined aquifers with TDS of over 10,000 mg/l, or which has TDS of 3,000 to 10,000 mg/l and has either been reclassified by the ERC as having no reasonable potential as a future source of drinking water or has been designated as an exempt aquifer under Rule 17-28.130(3).[12] Examples of this classification are coastal aquifers with substantial saltwater intrusion, saline water below the fresh water in the Floridan Aquifer and below the Biscayne Aquifer in South Florida. Class G-IV is nonpotable groundwater in confined

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[8] See Rule 17-550.310, Fla. Admin. Code (1990).

[9] See Rule 17-550.320, Fla. Admin. Code (1990).

[10] Rule 17-3.403, Fla. Admin. Code (1990). "Aquifer" is defined as a "geologic formation, group of formations, or part of a formation capable of yielding a significant amount of groundwater to wells, springs, or surface water." Rule 17-3.021(2), Fla. Admin. Code (1990). A "single source aquifer" is an aquifer or aquifer segment which has been determined by the Environmental Regulation Commission to be the "only reasonably available source of potable water to a significant segment of the population." Rule 17-3.021(27), Fla. Admin. Code (1990).

[11] Rule 17-3.403, Fla. Admin. Code (1990).

[12] An aquifer which actually supplies drinking water or which has been classified as a G-I or G-II aquifer can be exempted by DER after notice and public hearing, based on the following criteria:

1.) It does not currently serve as a source of drinking water;

2.) It cannot now and will not in the future serve as a source of drinking water because:

a.) it is mineral, hydrocarbon, or geothermal energy producing, or can be demonstrated by a permit applicant for a Class III operation to contain minerals or hydrocarbons that considering their quantity and location are expected to be commercially producible;

b.) it is situated at a depth or location which makes recovery of water for drinking water purposes economically or technologically impractical;

c.) it is so contaminated that it would be economically or technologically impractical to render that water fit for human consumption; or

d.) it is located over a Class III well mining area subject to subsidence or catastrophic collapse.

3.) The TDS content of the groundwater is more than 3000 and less than 10,000 mg/l and it is not reasonably expected to be or become a supply of drinking water. Rule 17-28.130(3), F.A.C.

aquifers with TDS of 10,000 mg/l or greater.[13] An example of this classification is the so-called "boulder zone" lying deep below all other aquifers in the South Florida area.

Reclassification of an aquifer or aquifer segment can be initiated by any substantially affected person or one of the water management districts by filing a petition with the DER. The DER can also pursue reclassification by initiating rulemaking under Rule 17-102, F.A.C. After a petition is filed or rulemaking is begun, generally the rule requires published notice, written notice to affected local governments, and public hearings.[14] To reclassify, there must be an affirmative finding that the reclassification will establish the present and future most beneficial use of the groundwater, and that the reclassification is clearly in the public interest.

There is an extended procedure for designating G-I single source aquifers.[15] It was as a result of an attempted G-I aquifer designation procedure that another groundwater classification was created, known as F-I.[16] The F-I classification is defined as "potable water use in groundwater in the single source surficial aquifers in N.E. Flagler Co. [legally described], with total dissolved solids less than 3000 mg/l."[17] The water quality standards applying to Class G-I and G-II groundwater also apply to F-I groundwater.

All classifications of groundwater must meet the "free from" criteria except for G-IV groundwater, although G-IV must also meet these criteria if there is a danger to the public health, safety or welfare from not meeting them. For Class G-I and G-II groundwater, in addition to the minimum groundwater criteria known as the "free froms," the rules specify more stringent standards. Outside of a zone of discharge, Class G-I and G-II must meet the primary and secondary drinking water standards.[18] Within a zone of discharge located in a G-I or G-II area, the primary and secondary drinking water standards do not apply, although the "free from" minimum criteria remain applicable. If natural background levels of any of the listed constituents are higher than the stated maximum, the background value becomes the prevailing standard for a particular G-I or G-II aquifer. Class G-III groundwater only has to meet the "free from" criteria, and Class G-IV criteria are established on a case by case basis.

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[13] "Confined aquifer" is defined as one "bounded above and below by impermeable beds or by beds of distinctly lower permeability than the aquifer itself." Rule 17-3.021(7), Fla. Admin. Code (1990).

[14] Rule 17-3.403(5), Fla. Admin. Code (1990).

[15] Rule 17-3.403(6), Fla. Admin. Code (1990).

[16] Only one F-I designation has been created. In the course of events surrounding a large development in the N.E. Flagler county area, the ERC interpreted its single source rule to mean that if drinking water was imported or piped into an area, that the potable aquifer in that area could not be considered the "only reasonably available source of potable water," thus denying it a G-I classification. In Schatz v. Environmental Regulation Commission 500 So.2d 167 (1st DCA 1986), Florida's 1st District Court of Appeals reversed the ERC on this ruling. Certiorari was denied by the Florida Supreme Court in Environmental Regulation Commission v. Schatz (504 So.2d 766). Subsequently, the ERC created the F-I classification, defining it to apply only to the aquifer in that area.

[17] Rule 17-3.501, Fla. Admin. Code (1990).

[18] Rule 17-3.404, Fla. Admin. Code (1990).

Permitting Zones of Discharge

In addition to classifying aquifers and setting the groundwater quality criteria applicable to each classification, the DER's groundwater rules establish permitting and monitoring requirements. The DER attempts to incorporate groundwater permitting considerations into other appropriate permits, and attempts to coordinate its permitting with that of the water management districts.[19] Basically, the rule states that unless exempted, no installation may directly or indirectly discharge to groundwater any contaminant that causes a violation of any of the water quality criteria and standards established in Chapter 17-3, Part IV, except within a "zone of discharge" established by permit or rule.[20]

No zone of discharge (ZOD) is allowed for direct discharges into wells or sinkholes that connect to G-I or G-II groundwater, except for recharge projects from surface water or other groundwater of comparable quality. In addition, no ZOD is allowed for discharges that may cause an imminent hazard to the public or environment through contamination of groundwater supplies of drinking water or surface water affected by groundwater.[21]

Installations discharging to G-III groundwater are exempt from obtaining a ZOD permit as long as the discharge does not threaten to impair the designated use of adjacent waters, such as G-I or G-II groundwater, and complies with any other applicable provisions of Chapter 17-28, F.A.C.[22] Installations discharging to G-IV groundwater are also exempt from ZOD permit requirements so long as they comply with applicable provisions of Chapter 17-28. Reverse osmosis installations which use land application to dispose of non-hazardous reverse osmosis concentrate are exempt, provided the applicant demonstrates that the receiving surficial aquifer contains over 1500 mg/l TDS, and that no violation of primary or secondary drinking water standards occurs at any private or public water supply well outside the installation's property boundary.[23]

Existing installations[24] discharging to G-II groundwater are exempt from complying with

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[19] Rule 17-28.700(1), Fla. Admin. Code (1990).

[20] Rule 17-28.700(2)(a), Fla. Admin. Code (1990). Zone of discharge is a "volume underlying or surrounding the site and extending to the base of a specifically designated aquifer or aquifers, within which an opportunity for the treatment, mixture or dispersion of waste into receiving groundwater is afforded." Rule 17-3.021(34), Fla. Admin. Code (1990). An "installation" is defined as "any structure, equipment, facility, or appurtenances thereto, operation or activity which is or may be a source of pollution as defined in Ch. 403, F.S...." Rule 17-4.020(4), Fla. Admin. Code (1990).

[21] Rule 17-28.700(2)(b), Fla. Admin. Code (1990).

[22] Rule 17-28.700(2)(c), Fla. Admin. Code (1990).

[23] Rule 17-28.700(2)(c), Fla. Admin. Code (1990).

[24] "Existing installation" is "any installation having filed a complete application for a water discharge permit on or before January 1, 1983, or in fact discharging to groundwater on or before July 1, 1982. (It) shall not include any installation under Department Order to obtain a groundwater permit." Rule 17-28.700(c), Fla. Admin. Code (1990). Booker Creek Preservation, Inc. v. Mobil Chemical Co. 481 So.2d 10 (Fla. 1st DCA 1985) held that a DER order to obtain an "approval to discharge to groundwater" is equivalent to being required to obtain a permit. Without the permit, an installation was not permitted to claim status as an existing installation.

secondary drinking water standards outside a zone of discharge, unless the DER determines that compliance with one or more of the standards is necessary to protect groundwater used or reasonably likely to be used as a potable water source.[25] However, all installations discharging to G-II groundwater are prohibited from violating secondary drinking water standards at any private or public water supply well outside of a zone of discharge.[26] Section 17-28.700(8)(b) allowed an applicant to avoid application of one or more secondary drinking water standards on a demonstration that the economic, social, and environmental costs outweighed the economic, social and environmental benefits of compliance. However, the rule section was declared invalid on procedural grounds, and the section has been withdrawn.[27]

For G-I and G-II groundwater, the rule includes specific criteria for the location and size of a permitted ZOD. Generally, the only ZOD allowed in a G-I area will be for domestic wastewater and stormwater sites. The ZOD will extend no more than 100 feet from the site boundary or to the installation property boundary, whichever is less.[28] If a smaller ZOD is necessary to protect designated uses of adjacent waters outside the ZOD, then the smaller zone will be required.[29] Other discharge sites in G-I areas may be granted the same sized ZOD if the discharge generally is as clean in chemical, physical and microbiological quality as secondarily treated domestic wastewater. If an aquifer is reclassified to G-I, any installation that was authorized to discharge to groundwater at the time the aquifer was reclassified will receive the ZOD specified in the original permit or extending to the property line. The ZOD may be modified at the time of permit renewal or modification, and any increase or change in the waste stream must meet the requirements applicable to new discharges.[30]

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[25] The decision must be based on:

1.) A determination that the portion of the aquifer(s) reasonably likely to be affected by the discharge:

  a.) is used as a potable water source, or

  b.) is identified in a planning document as a future potable water source by a state agency, water management district, regional water supply authority or local government, and is reasonably likely to be used as such.

2.) A site specific hydrogeologic characterization of the receiving aquifer which defines:

  a.) direction and rate of ground water flow, and

  b.) depth and degree of confinement.

3.) A waste stream characterization, site specific hydrogeologic characterization, and review of monitoring data which demonstrates that the discharge is likely to cause a violation of one or more secondary standards outside the zone of discharge in:

  a.) the portion of the receiving aquifer identified in 1.b., or

  b.) a known public or private potable water supply well.

  Rule 17-28.700(8)(a), Fla. Admin. Code (1990).

[26] Rule 17-28.700(8), Fla. Admin. Code (1990).

[27] Manasota-88, Inc. v. State Department of Environmental Regulation, 15 Fla. L.W. 1095 (Fla. 1st DCA Apr. 27, 1990). See 16 F.A.W. 3130 (July 6, 1990) for notice of withdrawal.

[28] A "site" is the "area within an installation's property boundary where effluents are released or applied to groundwater." Rule 17-3.02(28), Fla. Admin. Code (1990).

[29] Rule 17-28.700(3), Fla. Admin. Code (1990).

[30] Rule 17-28.700(3)(c), Fla. Admin. Code (1990).

For new installations discharging into Class G-II and for non-exempt discharges into Class G-III groundwater, the owner must first demonstrate that a discharge will not impair the designated uses of contiguous waters outside a ZOD.[31] If the applicant chooses, it can allow the DER to establish the ZOD, 100 feet from the site boundary or to the installation's property boundary, whichever is less, unless a smaller zone is necessary to protect the designated uses of contiguous waters.[32] A larger ZOD may be permitted by the DER on an affirmative demonstration by the applicant that: 1.) the size and shape of the requested ZOD will not cause violations of groundwater standards in present and future potable water supplies; 2.) the requested zone will not interfere with existing or designated uses of contiguous waters or cause violation of applicable surface water quality criteria of contiguous waters outside the mixing zone; and 3.) the economic and social benefits associated with a larger zone are higher than the economic, social and environmental costs resulting from the larger zone.[33] With multiple sites in close proximity, a single ZOD may be established for all the sites, using the same processes as above.

Existing installations receive the ZOD specified in the permit or, if not specified, extending to the property line, until modification or renewal of the permit.[34] Several types of installations are automatically permitted by rule, unless a permit defining a ZOD is otherwise required by DER. These include: agricultural fields, ditches and canals; livestock waste lagoons exempted from permitting under Rule 17-6.300 (limiting the number of livestock permitted in an area);[35] and stormwater facilities.[36] These types of installation are permitted a ZOD 100 feet from the site or to the property boundary, whichever is less. If the discharge threatens to violate groundwater

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[31] Rule 17-28.700(4), <u>Fla. Admin. Code</u> (1990).

[32] Rule 17-28.700(4)(a)2, <u>Fla. Admin. Code</u> (1990).

[33] Rule 17-28.700(4)(a)1, <u>Fla. Admin. Code</u> (1990).

[34] Generally, under Rule 17-28.700(5)(b), F.A.C., modification of a permit may be ordered by the DER or may be requested by the permit holder, for any of the following reasons:

1.) Monitoring data indicates that the discharge plume has resulted or may in the foreseeable future result in the violation of applicable water quality standards beyond the boundary of the existing ZOD;
2.) Continuation of the existing ZOD will impair the designated use of underground sources of drinking water or the surface waters immediately affected by the groundwater;
3.) Continuation of the existing ZOD will result in an imminent threat to public health or the environment;
4.) A smaller ZOD will afford necessary protection to the water resources at a cost that is commensurate with the benefits to the public of the added protection;
5.) Monitoring data provided by the owner are inadequate to allow a determination of compliance with applicable ZOD limitations and the owner fails to provide reasonable additional data requested by DER;
6.) A change in the chemical, physical or microbiological composition, or the volume or the location of the discharge, necessitates a change in the ZOD or the monitoring scheme to assure compliance.

[35] Chapter 17-6, <u>Fla. Admin. Code</u> has been repealed.

[36] In <u>Florida Wildlife Federation v. Admiral Corp.</u> (DOAH Case No. 86-3272), the hearing officer ruled that discharges into stormwater ponds that intersect the surficial aquifer may be permitted as a discharge to surface water rather than a direct discharge to groundwater if found to be a pond rather than a well.

standards at the boundary of the ZOD, or threatens to impair the designated uses of contiguous waters, the DER requires the owner to obtain a groundwater permit, define or modify an appropriate ZOD, and institute appropriate monitoring.[37]

Monitoring

The DER requires monitoring programs for any installations discharging to groundwater, though monitoring plans required by a local ordinance may be substituted if the requirements are in substantial compliance with the DER's requirements.[38] New installations must submit the program in conjunction with the permit application, while existing installations were to have completed the establishment of a monitoring plan by March of 1984. Monitoring plans must show the location of the wells proposed for measuring background and downgradient levels of groundwater quality. The plans must also include construction details, a water sampling and chemical analysis protocol to determine background quality of the groundwater and any deviation of groundwater quality in the downgradient wells. Information supplied must include hydrogeological information on the characteristics of the aquifer; the waste disposal rate, and frequency and method of discharge; the characteristics of the waste; and other potential pollution sources within one mile.[39]

At a minimum, monitoring wells must be located as follows: one upgradient well to determine natural unaffected background quality of the groundwater; one well at the edge of the ZOD, downgradient from the discharge site; one intermediate well downgradient from the site and within the ZOD, in order to detect the chemical, physical, and microbiological characteristics of the discharge plume; and other wells required as necessary, based on the complexity of the hydrogeology, size or toxicity of the plume, threat to public health, etc.[40]

Discharges to Class G-III groundwater must be monitored for compliance with the minimum "free from" criteria, or the permittee may establish a groundwater monitoring program which must demonstrate that the criteria are not being violated. Installations which discharge to Class G-IV groundwater have monitoring requirements established on a case by case basis by the DER.[41] Exemptions to monitoring include:

1.) Domestic sewage treatment installations with less than 100,000 gallons per day (GPD) design capacity;

2.) stormwater facilities;

3.) agricultural fields, ditches and canals; and

4.) livestock waste lagoons exempted under old Rule 17-6.300 (limiting the number of animals).

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[37] Rule 17-28.700(4)(c), Fla. Admin. Code (1990).

[38] Rule 17-28.700(6), Fla. Admin. Code (1990).

[39] Rule 17-28.700(6)(d), Fla. Admin. Code (1990).

[40] Rule 17-28.700(6)(g), Fla. Admin. Code (1990).

[41] Rule 17-28.700(6)(h),(i), Fla. Admin. Code (1990).

The exemptions above apply only so long as the discharges present no potential hazard to human health, the environment, or a source of drinking water, and as long as the facilities do not discharge directly to groundwater.[42]

5). wastewater ponds, cooling ponds or other discharge waters meeting the minimum "free from" criteria and the applicable standards for the receiving groundwater and contiguous surface waters are also exempted.

If necessary to insure that standards are being met, applicants may be required to check the background quality of the receiving groundwater and to regularly sample the discharge prior to contact with groundwater.[43]

Reporting requirements are part of a monitoring plan and generally include: 1.) a report within 90 days from the date of the plan approval which states the volume and chemical, physical and microbiological composition of the discharge at the point of release or contact with the groundwater at the site boundary; and 2.) quarterly reports from the discharge site and all monitoring wells indicating the type, number and concentration of discharge constituents or parameters indicated by the "90 day" report that have been identified as having the potential to exceed the "free from" criteria and the appropriate standards for the class of water adjacent to the ZOD. These reports must also state the characteristics of the discharge plume relative to the previous report with regard to its size, direction and rate of movement.[44]

Proposed Amendments to G-I Permitting Scheme

In an unsuccessful attempt to comply with the wellhead protection requirements of the federal Safe Drinking Water Act, the Florida Department of Environmental Regulation proposed a new groundwater classification scheme, which was adopted by the Environmental Regulation Commission in 1986. The rule would have restricted the G-I classification to certain zones of protection around major public community drinking wells drawing from unconfined or leaky confined aquifers, and would have altered the permitting scheme within those zones. It would not have affected the regulatory scheme for Class G-II, G-III, or G-IV groundwater. "Zones of protection" were to include two areas around major public community drinking water supply wells or wellfields. The first zone was to be a circle with a 200 foot radius centered on the well. The boundary of the second, outer zone was to be calculated from a formula yielding the distance from which groundwater would travel to the well in five years, using a constant effective porosity factor for the Floridan Aquifer.

Several groups challenged the rule, and certain of its provisions were held to be invalid.[45] The hearing officer found that the use of five years as the designated travel time for the outer zone was not based on fact or reason, because among other reasons, the DER's own research had shown that it took seven or eight years between the time a contaminant was introduced into

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[42] Rule 17-28.700(6)(j)1, Fla. Admin. Code (1990).

[43] Rule 17-29.700(6)(j)2, Fla. Admin. Code (1990).

[44] Rule 17-28.700(6)(k), Fla. Admin. Code (1990).

[45] See Alliance for Rational Ground Water Rules and Adam Smith Enterprises, Inc. v. Department of Environmental Regulation, D.O.A.H. Case No. 86-4492R, Final Order, 10 FALR 2419 (April 18, 1988), affirmed, Adam Smith Enterprises, Inc. v. Department of Environmental Regulation, 553 So.2d 1260, (Fla. 1st DCA 1989).

groundwater and its discovery, and 10 to 15 years between the time a contaminant was discovered and cleanup begun.[46] The final order also examined the formula used to calculate the extent of the five year groundwater travel time zone, and found that the use of a fixed effective porosity factor for the Floridan Aquifer was unreasonable, since the effective porosity of the Floridan Aquifer can vary significantly.[47] As of this writing, the DER has not attempted to promulgate another version of the rule.

The proposed rule defined "leaky confined aquifer" as an aquifer confined from above by a formation which allowed groundwater to move vertically from the water table to the top of the leaky confined aquifer in five years or less. A "confined aquifer" was one bounded above and below by impermeable beds or by beds of distinctively lower permeability than that of the aquifer, with the top confining layer impermeable enough to slow the movement of groundwater vertically through the layer to more than five years. A "major public community drinking water supply" was defined as a water system permitted by a consumptive use permit to withdraw an average of 100,000 GPD or greater.

According to the proposed rule, a Class G-I aquifer or aquifer segment referred to potable water use groundwater with total dissolved solids of less than 3000 mg/l in an unconfined or leaky confined aquifer, restricted to zones of protection around major public community drinking water supplies, and reclassified as G-I by the Environmental Regulation Commission (ERC). To be reclassified, it was required that the aquifer or aquifer segment be mapped by the DER; meet the definition of confined or leaky confined; and be within a zone of protection. The ERC would consider environmental, technological, water quality, institutional, public health, public interest, social and economic factors in determining whether or not to reclassify an aquifer as G-I. The rule also reserved other categories for consideration for reclassification, including high recharge areas, future public water supplies, and "only locally available sources of drinking water" on coastal barriers.

Permitting and monitoring would have been handled differently within the proposed G-I zones of protection. All new discharges and installations were to be prohibited within the 200 foot zone of protection. For permitting purposes, between the 200 foot zone and the five-year travel time zone of protection, four classifications of discharges were delineated. General discharges included all activities at an installation that generated a discharge to groundwater, except stormwater discharges, underground storage facilities for pollutants and contaminants, and underground facilities for transportation of pollutants and contaminants. The last three types of activities comprised the other categories of discharge, which were dealt with separately.

Within the five year zone of protection, no new sanitary landfills, or discharges of industrial waste with hazardous materials above background levels would be permitted. New discharges of treated domestic waste would have been allowed within the five year zone, under conditions controlling the quality of the treatment plant and its level of reliability. However, the discharge from permitted plants would have been required to meet primary and secondary drinking water standards at the end of the pipe, unless there was an affirmative showing that the standards would be met prior to contact with groundwater. The designated method of discharge was slow rate land application. The rule would have required existing general discharges within

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[46] Alliance for Rational Ground Water Rules and Adam Smith Enterprises, Inc. v. Department of Environmental Regulation, D.O.A.H. Case No. 86-4492R, Final Order, 10 FALR 2419, 2446 (April 18, 1988).

[47] Id. at 2448.

the five year zone to meet the G-II permitting standards, including zone of discharge requirements and more stringent monitoring criteria.

Other categories of regulated activities included stormwater discharges, underground storage facilities for pollutants or contaminants, and underground facilities for transportation of pollutants or contaminants. Within the five year zone, industrial facilities using hazardous constituents could not discharge to a stormwater facility unless they provided containers, paving and curbing sufficient to totally contain any release of hazardous material and to prevent it from contacting stormwater, surface water or the ground. This requirement did not apply to strictly residential developments. Additionally, there could be no new stormwater discharge to groundwater through sinks or wells. New agricultural facilities receiving stormwater runoff from agricultural fields and containing hazardous substances such as pesticides would have been prohibited within the five year zone. Normal application of agricultural pesticides was exempted, so long as there was no discharge to a stormwater facility.

Within the five year zone, new underground storage facilities for pollutants[48] or contaminants[49] would have been required to include double-walled containment with continuous leak detection monitors, or impervious secondary containment with monitoring wells or automatic leak detection. Integral piping systems for these facilities were to be held to the same standards, or could be configured to lie within impervious underground catchment basins with monitoring wells. Existing underground storage facilities in the five year zone, which did not meet the retrofit standards of the general DER rule governing underground tanks on the date an aquifer was reclassified to G-I, were required to retrofit to meet the above standards for new facilities, following the retrofit schedule in the underground tank rule. If, on the date of reclassification, a facility did meet the retrofit standards of DER's underground tank rule, that facility was exempt from the standards of the proposed G-I rule.

New underground facilities for the transportation of waste water, pollutants or contaminants would have been required to meet certain leakage standards within the five year zone of protection. Domestic raw waste water piping could not leak more than fifty gallons per inch of pipe diameter per mile per day. Underground piping for the transportation of industrial waste water could leak no more than twenty-five gallons per inch of pipe diameter per mile per day. Underground piping for the transportation of pollutants or contaminants would have to be constructed so as to ensure no leakage.

In addition to the monitoring requirements of the existing G-I rule, the proposed rule would have required more stringent monitoring of existing and newly permitted facilities within the five year zone, and would have removed the monitoring exemption for waste treatment facilities under 100,000 gallons per day capacity. New facilities which served an area forty acres or larger with a forty percent impervious surface excluding building tops, would have been required to monitor stormwater discharges.

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[48] Defined as any commodity made from oil or gas, or their derivatives, as well as pesticides, ammonia, chlorine and their derivatives, but not liquefied petroleum gas. See Fla. Stat. §§ 376.301(12), 377.19(11) (1989).

[49] Defined as any substance which is harmful to plant, animal, or human life. See Fla. Stat. § 403.031(1) (1989).

Chapter 17-25, F.A.C.: Regulation of Stormwater Discharge

General Requirements

Generally, the chapter requires new stormwater discharge facilities, and modifications to existing facilities which will increase their discharge or pollutant loads beyond design capacities, to apply for a construction permit from DER. A stormwater discharge facility is defined as the "designed features of the property which collect, convey, channel, hold, inhibit or divert the movement of stormwater" and which discharge stormwater to surface waters.[50] The applicant must provide reasonable assurance based on plans, test results and other information, that the construction, expansion, modification, operation or activity of the facility will not violate DER water quality standards in "waters of the state," (defined to include groundwater)[51] codified in Chapter 17-3 F.A.C.[52]

The DER assumes that the necessary reasonable assurances will be met if the design of the facility provides treatment equivalent to either retention,[53] or detention[54] with filtration, of the runoff from the first one inch of rainfall, or for projects with drainage areas less than 100 acres, the first one-half inch of runoff, provided that adequate provisions have been made for operation and maintenance of the facility. Facilities discharging directly to Outstanding Florida Waters must provide additional treatment equivalent to fifty percent of the above figures. In evaluating whether reasonable assurances have been provided, the DER will also consider the use of appropriate best management practices, including but not limited to those in the following publications, available from the DER:

"Stormwater Management Manual (October, 1981)"

"A Manual of Reference Management Practices for Urban Activities (July, 1978)"

"A Manual of Reference Management Practices for Construction Activities (December, 1977)"

"A Manual of Reference Management Practices for Agricultural Activities (November, 1978)"

"Silviculture Best Management Practices Manual (1979)"

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[50] Rule 17-25.001, Fla. Admin. Code (1990).

[51] Fla. Stat. § 403.031(12), defines "waters" as including "underground waters (which) include, but are not limited to, all underground waters passing through pores of rock or soils or flowing through in channels, whether manmade or natural."

[52] Rules 17-25.025, 17-25.040(4), Fla. Admin. Code (1990).

[53] Retention is defined as the prevention of the discharge of a given volume of stormwater runoff into surface waters of the state by complete on-site storage. Rule 17-25.001(12), Fla. Admin. Code (1990).

[54] Detention is defined as the collection and temporary storage of stormwater in such a manner as to provide for treatment through physical, chemical, or biological processes with subsequent gradual release of the stormwater. Rule 17-25.001(5), Fla. Admin. Code (1990).

According to Rule 17-25.025, retention basins must recover the required treatment volume within 72 hours following a storm event, with the recovery based only on percolation through soil, evaporation or evapotranspiration. Detention basins must also recover the required volume within 72 hours after a storm event. Filtration systems must be at least as permeable as surrounding soils, and must be designed with a safety factor of two, unless the engineer demonstrates that a lower safety factor is specifically appropriate.[55] The section is not intended to preclude the use of multilayered filters or materials that increase ion exchange, precipitation or pollutant adsorption. Swales[56] must percolate 80% of the runoff from a three-year, one-hour design storm within 72 hours after a storm event.[57] Wetlands may be included in the design of stormwater discharge facilities, but the system will be subject to the requirements of Rule 17-25.042, F.A.C., aimed at protecting the wetland from the potential impacts of stormwater quantity and quality.

Wet retention and detention basins must either be fenced or otherwise restricted from public access, or contain side slopes no steeper than 4:1 out to a depth of two feet below the control elevation. All side slopes must be stabilized with vegetation or other material to reduce erosion and subsequent sedimentation of the basins. Local regulations which are more restrictive will take precedence. Discharge facilities which receive stormwater from areas which are potential sources of oil and grease in concentrations over applicable water quality standards must include a baffle, skimmer, grease trap or other mechanism suitable for preventing oil and grease from violating receiving water quality standards. During construction of stormwater discharge facilities, grading of land, or erection of buildings, erosion and sediment control best management practices must be used as necessary, to retain sediment on-site.[58]

Rule 17-25.001, F.A.C., defines regional stormwater discharge facilities as those which accept stormwater from multiple parcels within the drainage area served by and/or contributing stormwater to the regional facility. In order to qualify for a construction permit, such facilities must provide retention, or detention with filtration, of the runoff from the first inch of rainfall, or for facilities with less than 100 acres drainage area, the first one-half inch of runoff. Facilities which discharge directly into Outstanding Florida Waters must provide an additional level of treatment equal to fifty percent of the above values. Facilities must also be designed to meet these treatment criteria for projected future land uses and stormwater volumes. The owner of a regional facility must notify DER, on a semi-annual basis of all new projects and stormwater volumes allowed to discharge into the facility, and must certify that the maximum allowable

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[55] This includes, but is not limited to, reducing the design percolation rate by half, doubling the length of underdrain, or designing for the required drawdown within 36 hours, rather than 72 hours. Speeding up percolation rates may provide a marginal safety factor for potential problems with excess water quantity, but may significantly decrease the stormwater quality treatment capacity of a basin.

[56] A swale is defined as a manmade trench with a top width-to-depth ratio of the cross-section equal to or greater than 6 to 1, or side slopes equal to or greater than 3 feet horizontal to 1 foot vertical; with contiguous areas of standing or flowing water only after a rainfall event; with stabilized vegetation suitable for soil stabilization, stormwater treatment, and nutrient uptake; and designed to take into account soil erodibility, percolation, slope, slope length and drainage area, to prevent erosion and reduce pollutant concentration of any discharge. Rule 17-25.001(16), Fla. Admin. Code (1990).

[57] Rule 17-25.025, Fla. Admin. Code (1990).

[58] Rule 17-25.025, Fla. Admin. Code (1990). See published manuals of best management practices, referenced above.

treatment volume has not been exceeded. Adequate provision must be made for the operation and maintenance of the proposed facility.[59]

Exemptions

Certain types of new stormwater discharge facilities are exempt from the notice and permit requirements of Chapter 17-25. These include:

1.) facilities designed to accommodate only one single family dwelling unit, duplex, triplex, or quadruplex, provided none are a part of a larger common plan of development or sale;
2.) facilities which are designed to serve single family residential projects of less than 10 acres total land area and which have less than 2 acres impervious surface provided that the facilities comply with all regulations or ordinances applicable to stormwater management and adopted by a city or county; and are not apart of a larger common plan; and discharge into a stormwater discharge facility exempted or permitted by the DER, etc.;
3.) stormwater discharge facilities whose functioning treatment components consist entirely of swales;
4.) facilities that discharge into a regional stormwater discharge facility;
5.) facilities for agricultural lands; and
6.) facilities for silvicultural lands.[60]

Noticed Exemptions

There are several conditional exemptions, requiring notice. First, within the region for which the Southwest Florida Water Management District has stormwater permitting authority, certain facilities are conditionally exempted from permitting requirements, provided the owner files notice and an engineer certifies to the District that the facilities meet certain specified criteria found in Rule 17-25.030(2), F.A.C.[61] Rule 17-25.030(3), F.A.C., also provides for DER's issuance of noticed permits, exempting from Class III criteria artificially created waters of the state which are upstream of manmade stormwater discharge facilities, by demonstrating that water quality criteria will be met downstream of the discharge facility, and that within the artificially created waters compliance with the presently specified criteria is unnecessary for protection of public water supplies or human health.

General Permits

Except within the geographical area for which Southwest Florida Water Management District has been delegated stormwater permitting authority, Chapter 17-25, F.A.C., allows construction of several types of stormwater discharge facilities by general permit, including those

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[59] Rule 17-25.040, Fla. Admin. Code (1990).

[60] Rule 17-25.030(1), Fla. Admin. Code (1990).

[61] These include permitted or exempt facilities which meet the treatment criteria of Chapter 17-25; those which provide retention, or detention with filtration, of applicable volumes of runoff; modification or reconstruction by public entities for existing facilities, which will not increase impacts; and facilities which include combinations of management practices which will provide for the percolation of the runoff from a three-year one-hour design storm. See Rule 17-25.030(2)(a)-(2)(d), Fla. Admin. Code (1990).

which discharge into a stormwater facility which has gone through permitting procedures or been granted a noticed exemption.[62] The general permit also applies to facilities discharging into a facility which provides retention, or detention with filtration, of the runoff from the first inch of rainfall.[63] For projects with less than 100 acres of drainage area, the acceptable standard is a facility which provides retention or detention with filtration of the first one-half inch of runoff. Facilities discharging directly to Outstanding Florida Waters must provide additional treatment equal to fifty percent of the applicable figures above.

In addition, general permits may be granted for the modification or reconstruction of an existing stormwater management facility not intended to serve new development, and which will not increase pollution loads or change points of discharge in a manner that would adversely affect designated uses of waters of the state, including groundwater. This section only applies to such modification or reconstruction by a city, county, state agency, special district with drainage responsibility, or water management district.[64] Finally, general permits are granted for construction of facilities which include a combination of practices including but not limited to retention basins, swales, pervious pavement, landscape or natural retention storage that provides for percolation of the runoff from a three-year, one-hour design storm.[65]

Delegation

Rule 17-25.050, F.A.C., allows for delegation of authority to a local government or water management district to issue or deny permits, initiate enforcement actions, and monitor for compliance. Delegation does not include authority for a local government or water management district to issue or deny permits for its own activities, except for replacement or maintenance of existing facilities. Once delegation is authorized, the requirements of a water management district which have been approved by the Environmental Regulation Commission will apply in lieu of the provisions of Chapter 17-25. Generally, the districts' requirements mirror those of Chapter 17-25, except within certain basins, which may have more stringent criteria responding to more specific problems. A local government to which authority has been delegated may also establish alternative requirements from those in Chapter 17-25, provided the DER determines that the alternative requirements are compatible with, or more stringent than those of Chapter 17-25.[66]

As of May of 1990, the Southwest Florida Water Management District, St. Johns River Water Management District, South Florida Water Management District and Suwannee River Water Management District had been delegated certain levels of authority under the rule.[67] The applicable Southwest Florida district rules are published as Chapters 40D-4 and 40D-40, Florida Administrative Code, and incorporate by reference the district publication entitled, "Management and Storage of Surface Waters: Permit Information Manual (Volume I)" (March 1988). The applicable St. Johns River district rules are contained in Chapters 40C-4, 40C-40, 40C-41, 40C-42, and 40C-43, Florida Administrative Code, and incorporate by reference the district publication

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62 Rule 17-25.035, Fla. Admin. Code (1990).

63 Id.

64 Id.

65 Id.

66 Rule 17-25.050, Fla. Admin. Code (1990).

67 Rule 17-25.090, Fla. Admin. Code (1990).

entitled, "Applicant's Handbook: Management and Storage of Surface Waters" (1988).

The applicable South Florida district rules are codified in Chapters 40E-4, 40E-40 and 40E-41, Florida Administrative Code, and incorporate by reference the district publication entitled, "Management and Storage of Surface Waters: Permit Information Manual (Volume IV)" (June 1987). The applicable Suwannee River district rules are published as Chapter 40B-4, Florida Administrative Code. As of May, 1990, the Northwest Florida Water Management District had not been delegated authority to regulate stormwater discharges under the rule.

Chapter 17-28, F.A.C.: Underground Injection Control

This chapter codifies DER's regulatory requirements for underground injection systems. The purpose of the rule is to protect the quality of the state's underground drinking water supply and to prevent the degradation of the quality of aquifers adjacent to the injection zone. Five general classes of underground injection wells are defined. Classes I, III, IV, and V injection wells are regulated under Chapter 17-28, while Class II wells are regulated by the Department of Natural Resources under Chapters 16C-2, and 16C-26 through 16C-30, F.A.C. The DER utilizes a Technical Advisory Committee to provide advice and information on the technical aspects of underground injection for waste disposal. The committee is composed of representatives from the DER's district and Tallahassee offices, the appropriate water management district, the U.S.G.S., and the U.S. EPA.

Class I wells include those used by hazardous waste generators or owners or operators of hazardous waste facilities to inject hazardous waste beneath the lowest formation containing an underground drinking water source within one quarter mile of the well bore. Also included under this class are other industrial and municipal disposal wells injecting fluids beneath the lowest formation containing an underground source of drinking water within one quarter mile of the well bore. Class II wells are used to inject fluids: (a) which are brought to the surface during petroleum or natural gas production, and may be commingled with waste water from gas plants, unless those fluids are hazardous wastes at the time of injection; (b) for enhanced recovery of petroleum and gas; and (c) for storage of hydrocarbons which are liquid at standard temperature and pressure. Class III wells inject for extraction of minerals. Class IV wells are used by hazardous or radioactive waste generators, owners, or operators to dispose of hazardous or radioactive wastes into or above a formation which, within one quarter mile of the well, contains either an underground source of drinking water or an exempted aquifer.

Class V injection wells are grouped together by their expected quality of fluid. Within the Class V designation five groups are identified. Group 1 consists of air condition return flow wells and cooling water return flow wells. Group 2 consists of aquifer recharge wells, salt water intrusion barrier wells, subsidence control wells (for use in water overdraft area, not involved in oil or gas production), and connector wells used to connect two aquifers. Group 3 consists of wells which are a part of domestic waste water treatment, swimming pool drainage wells, wells used to return water removed for the extraction of salts, and injection wells used in experimental technologies. Group 4 consists of dry wells used for the injection of wastes, sand backfill wells, wells other than Class IV wells used to inject radioactive wastes of concentrations within drinking water standards, and injection wells used in borehole slurry mining. Group 5 injection wells are drainage wells used to drain surface fluids, primarily for stormwater runoff or lake level control, into a subsurface formation by gravity flow. Lastly, Group 6 wells are injection wells associated with the recovery of geothermal energy, and other wells.[68]

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[68] Rule 17-28.130, Fla. Admin. Code (1990).

The rule exempts wells used for disposal of brine of water produced in oil or gas exploration or production activity, including associated wastes normally generated in the course of such activities, but not sanitary wastes or wastes generated by associated recovery facilities. These wells are regulated by the DNR under Rule 16C-2.006, F.A.C. Installations discharging to G-I or G-II (both potable) groundwater may also be exempted from the minimum ("free from") water quality criteria of Rule 17-3.402, and the primary and secondary drinking water standards. Among other requirements, applicants must show that such discharges are in the public interest, will not interfere with existing or designated uses of contiguous waters, that compliance with the criteria is unnecessary for the protection of present and future potable water supplies, and that a monitoring program has been established to detect any leakage of the effluent to other aquifers or surface waters, and to detect any adverse effect on underground geologic formations or waters.[69] Installations discharging to G-III or G-IV (nonpotable) groundwaters may also be exempted on an affirmative showing that the exemption is a.) for disposal of municipal wastewater, industrial wastewater or stormwater and is clearly in the public interest; b.) there is no reasonable relationship between the economic, social and environmental costs of compliance with existing criteria and the economic, social and environmental benefits of compliance; c.) suitable technology is available; and d.) the discharge will not cause a violation of standards for adjacent G-I or G-II groundwater or surface water affected by groundwater.[70]

The rule prohibits the construction of Class I hazardous waste injection wells as of July 1, 1983. Hazardous waste injection wells permitted on or before that date are regulated under the provisions of 40 C.F.R. Part 146, Subpart G, "Criteria and Standards Applicable to Class I Hazardous Waste Injection Wells." Other types of Class I wells and Class III wells must apply for construction permits, operation permits and plugging/abandonment permits. Other requirements for these types of wells include those for: evaluation of geologic and hydrologic environment;[71] well construction standards;[72] operating requirements;[73] monitoring well construction standards;[74] monitoring requirements;[75] reporting requirements;[76] plugging and abandonment criteria and procedures.[77] The evaluation of potential impacts from Class I and Class III wells must include an "area of review" which includes all land within the "zone of endangering influence" of the wells or wellfield. The area of review must be based on consideration of several factors, including the characteristics of the injection fluids, hydrogeology, models for computing anticipated changes in the injection zone, population, and groundwater use and dependence. The minimum area of

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[69] Rule 17-28.130(7)(b), Fla. Admin. Code (1990).

[70] Rule 17-28.130(7)(c), Fla. Admin. Code (1990).

[71] Rule 17-28.210, Fla. Admin. Code (1990).

[72] Rule 17-28.220, Fla. Admin. Code (1990).

[73] Rule 17-28.230, Fla. Admin. Code (1990).

[74] Rule 17-28.240, Fla. Admin. Code (1990).

[75] Rule 17-28.250, Fla. Admin. Code (1990).

[76] Rule 17-28.260, Fla. Admin. Code (1990).

[77] Rule 17-28.270, Fla. Admin. Code (1990).

review is a circle with a radius of one mile from the well.[78]

Class IV wells may not be constructed or operated after April 1, 1982. For the purposes of the rule, Class IV wells include septic tanks or cesspools used by generators of hazardous waste, or by owners or operators of hazardous waste management facilities, to dispose of fluids containing hazardous waste into or above an underground source of drinking water. The owners of existing Class IV wells must comply with extensive monitoring plans and reporting requirements. All Class IV wells were to have been closed nine months after the April 1, 1982 rule adoption date, though longer closure periods could be approved if necessary, and if there were no significant threats to human health and the environment.[79]

Class V wells inject non-hazardous fluids into or above formations that contain underground sources of drinking water, defined to include aquifer segments that supply drinking water for consumption or which are classified as G-I or G-II.[80] The rule requires that the use of any Class V well, within any of the six listed groups, must not present a hazard to the existing or future use of an underground source of drinking water. Class V, Group 5 wells include stormwater and road runoff drainage wells, and lake level drainage wells. Class V wells must not cause or allow movement of fluid containing a contaminant into underground sources of drinking water which might cause violation of any primary drinking water standard.[81] If an existing Class V well may cause a violation of a primary drinking water standard, the DER must: require a permit for the well; order the injector to take action necessary to prevent the violation, including closure of the well; require monitoring; or take enforcement action. The DER may also take any action necessary to prevent a Class V well from adversely affecting human health.[82]

Two-part construction/clearance permits are required for Class V wells. Construction permits require information such as name, address and license number of the water well contractor; well location and depth, casing diameter and depth for all onsite water supply wells, and locations of all water supply wells of public record within 1000 feet of the proposed well; description and proposed use the system, including quantities, chemical and bacteriological analyses and any pretreatment. Applicants may also be requested to submit additional information on inspection reports by local programs and water management districts, and bacteriological analysis of the proposed injection fluid, onsite monitoring wells, and the nearest downgradient domestic or public water supply well within a 1000 foot radius, if drilled to same formation as the proposed injection well.[83] Except for Groups 1, 2 and 5, most other groups and categories are required to obtain operating permits, with five-year durations. The owner or operator of Class V wells must apply for plugging and abandonment permits, to be carried out by

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[78] Rule 17-28.130(4), Fla. Admin. Code (1990).

[79] Rules 17-28.410 through 17-28.460, Fla. Admin. Code (1990).

[80] Such an aquifer can be exempted if it does not currently serve as a source of drinking water, and cannot serve as drinking water now or in the future, because of its depth, contamination, potential for mineral or hydrocarbon production, or location over mining areas subject to collapse. Rule 17-28.130(3), Fla. Admin. Code (1990).

[81] Rule 17-28.610(2), Fla. Admin. Code (1990); see Rule 17-550, Fla. Admin. Code (1990) for listings of primary drinking water standards.

[82] Rule 17-28.610(2), (3), Fla. Admin. Code (1990).

[83] Rule 17-28.620, Fla. Admin. Code (1990).

licensed water well contractors, when the wells are no longer used or usable for intended purposes or other purposes approved by DER.[84]

The rule grants general permits for the construction of closed loop air conditioning return flow wells, and for swimming pool drainage wells, under general permitting standards. General permits are also available for pesticide waste degradation systems, providing there is no discharge of water or pesticide from the system to surface or groundwater, or to the soil.[85]

Chapter 17-61, F.A.C.: Stationary Tanks

Chapter 17-61, F.A.C., "Stationary Tanks," establishes rules regulating underground and aboveground storage facilities. **Note: For most underground storage tanks, Chapter 17-61 has been superceded by Chapter 17-761, F.A.C. Most aboveground storage tanks will be regulated under the provisions of Chapter 17-762, F.A.C., which becomes effective in late February 1991.**

Chapter 17-61 applies only to facilities which receive, store, or use petroleum products and which distribute such products as fuel in vehicles. An additional requirement is that the facilities must receive, store, or use more than 1000 gallons in any one calendar month, or more than 10,000 gallons in any one calendar year. Tanks with lower capacities must only comply with Rules 17-61.060(1)(b)1 or (2)(b)1, F.A.C., relating to new tank construction standards for aboveground or underground facilities.

Exempt from the requirements under this chapter are stationary storage systems which contain liquified petroleum gas; or whose contents have a softening point above 100 degrees Fahrenheit. Generally, above ground tanks must include an impervious containment system under and around them, and sealed to their supports.[86] Above ground tanks in compliance with this requirement must only comply with registration and notification requirements, discharge cleanup requirements,[87] and drainage and repair requirements for tanks which show signs of damage or leakage.[88] These rules do not apply to new large petroleum storage facilities with more than five above ground storage tanks whose combined storage capacity exceeds 500,000 gallons of stored petroleum product at any one time. DER regulates these facilities on a case-by-case basis.

Chapter 17-63, F.A.C.: Local Tank Regulation Programs

"Local Tank Regulation Programs" are defined and regulated under Chapter 17-63, F.A.C. The state preempts the regulation by local governments of facilities which utilize underground storage of petroleum for use in vehicles and have a single tank capacity equal to or less than 40,000 gallons at any time. County governments are authorized to adopt county wide ordinances that regulate underground storage tanks that are more stringent or extensive then DER's rules

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[84] Rule 17-28.640, Fla. Admin. Code (1990).

[85] Rule 17-28.822, Fla. Admin. Code (1990). See Rule 17-660.802, Fla. Admin. Code (1990) for specific conditions attached to general permits for pesticide waste degradation systems.

[86] Rule 17-61.060(1)(c)2., Fla. Admin. Code (1990).

[87] Rules 17-61.050(1) and (4)(b), Fla. Admin. Code (1990).

[88] Rule 17-61.060(1)(d)2, Fla. Admin. Code (1990).

provided the original ordinance was adopted and in force prior to September 1, 1984, or it is approved by DER. A county may also petition the Secretary of DER for approval of a local tank ordinance. Criteria to approve or disapprove the petition include: proximity of the county to a sole source or G-I aquifer; potential threat to the public water supply; detection of petroleum products in public or private water supplies; burden on the facility owners and operators by different or stronger regulations; consistency of local program with DER rules; and the capability of the county to administer the local ordinance.

Chapter 17-150, F.A.C.: Hazardous Substance Release Notification

Chapter 17-150, F.A.C., requires an owner or operator with knowledge of a release of a hazardous substance in an amount greater than or equal to a reportable amount to notify DER by calling the State Warning Point phone number within one working day of the discovery of the release.

Chapter 17-524, F.A.C.: New Potable Water Well Permitting in Delineated Areas

This chapter sets out the well permitting requirements for delineated areas identified and located by the Department as areas within which ground water contamination is known to exist. The purpose of this chapter is to encourage the prevention of potable water well contamination and promote cost-effective remediation of contaminated potable water supplies by using the Water Quality Assurance Trust Fund. The Trust Fund will be used for certain contaminated potable wells except those constructed after January 1, 1989 which were not permitted and constructed according to the standards adopted by the Department.[89]

"Delineation area" is defined as a surface area identified pursuant to Rule 17-524.420, F.A.C., where groundwater contamination is present. DER has the responsibility of identifying and locating areas where groundwater contamination is present. To the extent practicable, potable water wells will be sited outside a contaminated area. If a potable water well must be located in a delineated area, the potable water wells should be located upgradient of the source and direction of groundwater flow as known and in areas least subject to inundation.

The Department will present delineated areas to the Environmental Regulation Commission for approval at rule making public hearings where the Commission will consider the known ground water contamination and its projected movement until the next delineation update. Following each update, the Department will make maps and other information available to water management districts, regional planning councils, the Department of Health and Rehabilitative Services, and county building and zoning departments.[90]

Permits are required to drill new potable water wells, and may be obtained from DER or an entity with delegated authority. If groundwater contamination is found in any new potable well pursuant to testing as provided in the rule, that well will not be cleared for use and no certificate of occupancy will be issued or approved for the residence to be served without a filter or other device.[91] Construction permits for new potable water wells must be obtained from the

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[89] Rule 17-524.420, Fla. Admin. Code (1990).

[90] Rules 17-524.420 (7)(a) and (9), Fla. Admin. Code (1990).

[91] Rules 17-524.420 and 17-524.550, Fla. Admin. Code (1990).

Department or the appropriate delegated authority pursuant to Rule 17-524.800, F.A.C. Applicants must submit a proposed well design with the completed application, and the permit fee, to the permitting authority. The Department or permitting authority may conduct inspections to ensure conformity with the requirements during the construction, repair or conversion from non-potable use, or abandonment of any well subject to permit under this chapter.[92]

Exemptions to Rule 17-524.800, F.A.C. may be granted to an applicant by the permitting authority upon demonstration (using hydrogeological, water quality, and other pertinent information) that the exemption will not result in the impairment of the intent and purpose of this chapter. Detailed requirements for each exemption must be negotiated between the permit applicant and the permitting authority on a case by case basis.[93]

For wells, sites, or sources with known ground water contamination, where insufficient site specific ground water data exist for determination of contaminant plume boundaries, a delineated area is established with a 500-foot setback from the well, site or source boundary. Where data on the movement of ground water contamination indicate that a 500-foot setback is insufficient the Department shall establish an alternative setback based on such data.[94] For sites with a history of application of ethylene dibromide where insufficient site-specific ground water data exist for determination of contaminant plume boundaries, the Department shall delineate an area which encompasses the area of application and a 500-foot setback.[95]

For sites where a hydrogeologic investigation of ground water has been conducted and the nature and extent of contamination is known, the Department shall delineate an area which encompasses the ground water contamination for the next two years. For sites where a hydrogeological investigation of ground water has been conducted and the nature and extent of a contaminant plume is documented and sufficient data exist for predictive ground water modelling, the Department shall delineate an area which encompasses the ground water contamination and its predictive movement for the next two years.[96]

Chapter 17-531, F.A.C.: Water Well Contractors

The rule requires those who wish to conduct business as water well contractors to obtain a license from the applicable water management district. A water well contractor is defined as an individual who is responsible for the construction, repair, or abandonment of a water well and who is licensed under this chapter to engage in the business of construction, repair, or abandonment of wells.[97]

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[92] Rule 17-524.730, Fla. Admin. Code (1990).

[93] Rule 17-524.710, Fla. Admin. Code (1990).

[94] Rule 17-524.420(1)(a), (b), Fla. Admin. Code (1990).

[95] Rule 17-524.420(2), Fla. Admin. Code (1990).

[96] Rule 17-524.420(3), (4), Fla. Admin. Code (1990).

[97] Rule 17-531.200(7), Fla. Admin. Code (1990).

Chapter 17-532, F.A.C.: Water Well Permitting and Construction Requirements

Well water permitting and construction requirements are established pursuant to Chapter 17-532, F.A.C. This chapter implements DER's powers, duties, and responsibilities under Chapter 373, Part III, F.S. and establishes minimum water well construction standards to conserve and protect the state's ground water. The permitting system established in the rule may be administered by a water management district to which the authority has been delegated. The rule requires a permit before the construction or repair of any water well and is valid for one year. Where construction or repair is not completed within a year, the permit may be extended upon request.[98] An emergency water well permit may be granted under certain conditions. The districts will establish a permit system for the abandonment of water wells where such a system is necessary to protect the groundwater.

The permitting authority must issue an intent to deny whenever it determines that an application for a permit fails to meet the requirements of the rule. Any person receiving an intent to deny may petition for a hearing by filing a written petition with the permitting authority within 30 days of the receipt of the intent notice.[99] In addition, during the construction, repair, or abandonment of any well, the Department or permitting authority may conduct inspections as are necessary to ensure conformity with applicable standards.[100]

Chapter 17-550, F.A.C.: Drinking Water Standards, Monitoring and Reporting

The federal government enacted the Safe Drinking Water Act (SDWA) to assure that public water systems meet minimum requirements.[101] The SDWA gives primary responsibility for public water system programs to the states. In response to this mandate, Florida enacted the Florida Safe Drinking Water Act (FSDWA), Sections 403.850-403.864, Florida Statutes. The DER promulgated Chapters 17-550, 17-555, and 17-560 of the Florida Administrative Code to implement the requirements of the FSDWA and has adopted the National Primary and Secondary Drinking Water Regulations.

Part III of Chapter 17-550, F.A.C. establishes maximum contaminant levels (MCLS) for water within public water systems, which may not be exceeded unless a variance or exemption is granted, or the system is excluded pursuant to the standards of the chapter. Maximum contaminant levels are established for certain inorganic, organic, turbidity, microbiological and radionuclidic contaminants.[102] The chapter also sets secondary drinking water standards.[103]

Monitoring requirements for primary drinking water contaminants are set in Rule 17-550.510, F.A.C. Water supplies are monitored for presence and amounts of inorganic, organic,

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98 Rule 17-532.430(1), (6), Fla. Admin. Code (1990).

99 Rule 17-523.430(1), (3), Fla. Admin. Code (1990).

100 Rule 17-532.510(1), Fla. Admin. Code (1990).

101 See Rules 17-550.300 - 17.550.335, Fla. Admin. Code (1990).

102 See Rule 17-550.310, Fla. Admin. Code (1990).

103 Rule 17-550.320, Fla. Admin. Code (1990).

trihalomethane, volatile organics, microbiological, and readionuclidic contaminants. Monitoring requirements for secondary contaminants are found in Rule 17-550.520, F.A.C.

Chapter 17-555, F.A.C.: Permitting and Construction of Public Water Systems

The scope of Chapter 17-555 differs from Chapter 17-550 in that it focuses on permitting requirements for public water systems, including the siting and construction of wells. The rules dictate that raw water be obtained from the most desirable source available. Buffer zones of 100 feet and 200 feet are to be constructed around the potable water well fields. Public potable wells that supply water systems having more than 2000 gals./day total sewage flows must be placed at least 200 feet from on-site sewage disposal systems other than areas for the land application of reclaimed water. Wells supplying water systems having total sewage flows equal to or less than 2000 gals/day must be protected by a 100 foot buffer. Public drinking water supply wells must be protected from areas of land application of reclaimed water by several widths of buffers described in Chapter 17-610, F.A.C., ranging from 50 to 500 feet, depending on the type of land application system.[104] A 300 foot buffer is required between public wells and storage and treatment facilities (high intensity areas) of dairy farms, and a 100 foot buffer is required between public wells and other sanitary hazards.[105]

The potable water wells must be located in areas least subject to flooding and must be upgradient from sanitary hazards. The DER or water management districts will increase or decrease distances of buffers with evidence of the presence or absence of natural barriers, adequate protection by treatment, or proper construction practices. DER requires permits to abandon a potable water supply well, as well as to construct a new well. General permits for public drinking water wells provide that the well must not infringe on any federal, state, or local laws and regulations. The general permit does not eliminate the need to obtain other federal, state, and local permits that may be required. Furthermore, the general permit does not give the permittee the authority to violate any more stringent standards set by federal or local law. A public water system construction permit is also needed. This permit is available from DER or an approved County Public Health Unit.[106]

Chapter 17-560, F.A.C.: Public Water System Non-compliance Requirements

Chapter 17-560, F.A.C., describes violations of Chapters 17-550, 555, and 560; public notification requirements for public water systems that exceed a maximum contaminant level, or contain lead (Part IV); requirements for variances, exceptions, and waivers (Part V); and Best Available Technology and Treatment Techniques. DER grants variances when reasonable assurances by the applicant demonstrate that granting a variance will not result in unreasonable risk to health, and that application of Best Available Technology and Treatment Techniques to the raw water has not resulted in compliance with a maximum contaminant level. Compliance must be achieved as soon as practicable.

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[104] See Rule 17-610.110(5), Fla. Admin. Code (May 1990) for references to other rule sections containing applicable setbacks.

[105] See Rule 17-555.312, Fla. Admin. Code (May 1990).

[106] See Chapter 17-555, Part IV, Fla. Admin. Code (May 1990).

The requirements of this chapter apply to all public water systems except those that meet specific criteria. The public water system must meet all the following criteria: (a) the system must consist of distribution and storage facilities only; (b) the system must obtain all water from a public system which is governed under these rules; (c) the system must not sell water to any person; and (d) the system cannot be carriers of passengers in interstate commerce.

Chapter 17-600, F.A.C.: Domestic Wastewater Facilities

Rule 17-600 implements the Florida Air and Water Pollution Control Act which establishes that no waste waters are to be discharged to any waters of the state without first being treated to protect the beneficial uses of such waters. The purpose of the rule is to provide minimum design standards, and waste treatment and disinfection standards for domestic wastewater treatment facilities. Permits are required for the construction or modification of wastewater treatment plants. The rule also provides exemptions for existing facilities and allows certain variations from the requirements.[107]

New wastewater treatment plants and modifications of existing plants must be designed in accordance with sound engineering practice.[108] There are three types of wastewater treatment facilities. Type I wastewater facilities are those with a design average daily flow of 500,000 gallons per day or greater. Type II facilities have a design average daily flow of 100,000 up to but not including 500,000 gallons per day. Type III facilities have a design average daily flow of over 2,000 but not including 100,000 gallons per day.[109]

Innovative or alternative treatment processes for Type I and Type II facilities must be reviewed on their merits. When sufficient supporting information has been presented, installation may be allowed on an experimental basis for the period of time necessary to evaluate the new technology.[110] Type III conventional wastewater treatment plants and the treatment units commonly referred to as "package plants" must be designed according to a proven treatment processes, using proven equipment that will "efficiently and reliably meet required effluent limitations."[111] The design must be conservative and sufficiently provide for alternative process adjustments necessary to adequately treat the wide variations in hydraulic, organic, or toxic loadings which these plant often experience.[112]

Wastewater treatment plants permitted for construction after January 1, 1982 and plants existing prior to that date which have had modifications which require compliance with the reclaimed water or efficient limitations required by this rule, must be operated and maintained to attain, at a minimum, the reclaimed water or effluent quality required by the operational criteria specified in Rules 17-600.440 and 17-600.740(1), F.A.C. Treatment plants existing prior to

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[107] See Rule 17-600.120 Fla. Admin. Code (1990).

[108] General technical guidance is provided by references listed under Rule 17-600.300, Fla. Admin. Code (1990).

[109] Rule 17-600.200 (96) (97) (98) Fla. Admin. Code (1990).

[110] Rule 17-600.400, Fla. Admin. Code (1990).

[111] Rule 17-600.400(1)(c), Fla. Admin. Code (May 1990).

[112] Rule 17-600.400, Fla. Admin. Code (1990).

January 1, 1982 must, at a minimum, meet reclaimed water effluent limitations as specified in currently valid permits.[113]

The rule provides both technology-based effluent limitations and water quality-based effluent limitations for the design of domestic wastewater facilities.[114] The waste treatment standards contained in Part II and III of the rule must generally be met before discharge into holding ponds, reuse systems, disposal systems, or surface waters classified pursuant to Rule 17-3, F.A.C. Monitoring requirements for domestic wastewater treatment plants are codified in Chapter 17-601, F.A.C. Operator certification requirements are contained in Chapter 17-602, F.A.C.

Chapter 17-604, F.A.C.: Collection Systems and Transmission Facilities.

Section 403.051(2)(a), Florida Statutes requires DER to promulgate rules for the planning, design, construction, modification or operating standards for wastewater collection/transmission. Chapter 17-604, F.A.C. provides minimum design, operation and maintenance standards for these systems. Unless specifically provided otherwise, the rule applies only to new domestic wastewater collection/transmission facilities for which construction permit applications are approved by the Department after January 1, 1982. It also applies to all facilities existing prior to January 1, 1982 which are to be modified or expanded. Exemptions and variations may be available pursuant to Rules 17-600.120 and 17-103.100, F.A.C.

Construction permits for new and modified collection/transmission systems must be designed in accordance with the provisions of Rule 17-604.300 which preclude the deliberate introduction of storm water runoff, air conditioning system condensate water, closed system cooling water, and sources of uncontaminated wastewater. Rule 17-604.400, F.A.C. contains additional criteria to be incorporated.[115]

The "Design and Specification Guidelines for Low Pressure Sewer Systems" manual (June 1981) must be used in evaluation of the design and contruction of low pressure systems in Florida. Rule 17-604.410, F.A.C. provides the specifications for low pressure sewer systems which can be used as an alternative to conventional sewerage systems.[116] The design of new reclaimed water application/distribution systems and replacement of existing systems must be designed in accordance with Rule 17-610.419, F.A.C., in addition to the provisions of this rule.

General permits are typically used for collection/transmission systems as specified in Part III, Rule 17-4, F.A.C. and Rule 17-604.700, F.A.C. However, for collection/transmission systems involving innovative designs or features not complying with the design/performance criteria in this rule, a specific permit will be required. Operation permits are not issued for collection/transmission systems. Prior Departmental approval is required to place new systems or modifications of existing systems into operation.[117]

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[113] Rule 17-600.410, Fla. Admin. Code (1990).

[114] Rules 17-600.420 and 17-600.430, Fla. Admin. Code (1990).

[115] Rule 17-604.400, Fla. Admin. Code (1990).

[116] Rule 17-604.410, Fla. Admin. Code (1990).

[117] Rule 17-604.600, Fla. Admin. Code (1990).

Chapter 17-610, F.A.C.: Reuse of Reclaimed Water and Land Application

The reuse of reclaimed water is regulated under Chapter 17-610, F.A.C. The chapter supplies guidelines for the design, operation, maintenance, and monitoring of land application systems that may discharge reclaimed waters or domestic wastewater effluent to Class G-II groundwater. The rule provides additional technical guidance by incorporating by reference standard manuals and technical publications in Rule 17-610.300, F.A.C. Individual types of application systems separately addressed are slow-rate land application systems, rapid-rate land application systems, absorption field systems, overland flow systems, and other land application systems.

Buffer zones are required between land application areas and surface waters and shallow supply wells. Varying width buffer zones are also required between the land application area and potable water supply wells.[118] The boundary of the such land application areas must be at least 100 feet from outdoor eating, drinking and bathing facilities. Only a single permit for the reuse-land application system is necessary for a wastewater management entity. Individual property owners who utilize reclaimed water do not need to obtain permits. Individual users will be regulated by the wastewater management entity.

Chapter 17-611, F.A.C.: Wetlands Application

Wetlands application of domestic wastewater facilities is regulated pursuant to Chapter 17-611, F.A.C., addresses the use of wetlands for wastewater treatment purposes. Any discharge of reclaimed water to treatment or receiving wetlands must not adversely affect endangered or threatened species. Additionally, the discharge of reclaimed water to treatment or receiving wetlands must minimize channelized flow and maximize sheet flow, and minimize loss of dissolution. The use of wetlands as treatment wetlands will not be permitted when the wetlands are within Outstanding Florida Waters as listed in Rule 17-3.081, F.A.C.; and areas designated as areas of critical state concern. Wetlands are not permitted as treatment wetlands or receiving wetlands when the wetland is a herbaceous wetland, unless the herbaceous groundcover of the entire wetland consists of less than 50% cattail, or is within Class I or Class II waters.

Chapter 17-660, F.A.C.: Industrial Wastewater Facilities

This chapter regulates industrial wastewater, defined as wastewater which is not domestic wastewater, and including the runoff and leachate from areas that receive pollutants from commercial or industrial storage, handling or processing areas. The rule establishes requirements for industrial wastewater facility permits and details the effluent limitations which must be met. "Wastewater" includes the combination of liquid and water-carried pollutants from residences, commercial buildings, industrial plants and institutions together with any groundwater surface runoff or leachate that may be present.[119] "Wastewater facilities" are collection/transmission systems, treatment plants, and disposal systems.[120]

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[118] See Rule 17-610(5), Fla. Admin. Code for references to other rule sections designating applicable setbacks.

[119] Rule 17-660.200, Fla. Admin. Code (1990).

[120] Rule 17-660.200(14), Fla. Admin. Code (1990).

One type of exemption is available for the experimental use of wetlands for low-energy water and wastewater recycling. This exemption encourages experiments that encourage the development of new information regarding low-energy approaches to the advanced treatment of domestic, agricultural and industrial wastes. Exemptions are approved if it is demonstrated that the wetlands ecosystem may reasonably be expected to assimilate the waste discharge without significant adverse impact on the receiving water's biological community and public health is not adversely affected.[121]

The rule allows an exemption for existing permitted discharges comprising the principal flow. Basically, the DER will issue an order and substitute appropriate alternative criteria exempting waters of the state which are not used for potable water supplies, or recreation, and contain no significant population of fish and wildlife. Reasonable assurances must be given that the alternative criteria will adequately protect the designated uses of adjacent downstream waters and are not less stringent than the very basic minimum standards prescribed for all surface waters at all times in Rule 17-302.500, F.A.C. Exemptions are also provided for existing effluent ditches which are artificial; contain water only after rainfall; are legally controlled by petitioner, sufficient to restrict access; will not allow migration of indigenous aquatic organisms; and are not used for recreation, with no significant population of fish or wildlife.[122]

All non-exempt plants and installations which discharge industrial wastes into the waters of the state must meet effluent limitations. Section 301 of Public Law 92-500, the Federal Water Pollution Control Act Amendments of 1972 (FWPCA), requires all existing point source discharges of pollutants to meet uniform technology-based effluent limitations as a minimum, on two levels. The first level is defined as "best practical control technology currently available" (BPT). The second level is defined as either "best available technology economically achievable" (BAT) or "best conventional pollutant control technology" (BCT), which is not an additional effluent limitation for industrial dischargers, but rather, replaces BAT for the control of conventional pollutants.[123] In addition to technology-based effluent limitations, the rule includes water quality-based considerations. Section 403.088(2)(b), Florida Statutes, requires the DER to deny an application for a permit if it finds that the proposed discharge will reduce the quality of the receiving waters below the classification established for them.[124]

The DER has adopted by reference many of the EPA effluent guidelines and standards, published in the United States Code of Federal Regulations, for 51 specific categories of wastewater effluent listed in Rule 17-660.440(1)(e), F.A.C.[125] Included in these categories are: feedlots, fertilizer manufacture, phosphate manufacture, and pesticide chemicals manufacturing. All Department permits issued pursuant to Sections 403.087 and 403.088, Florida Statutes, must at a minimum, require compliance with these effluent limitations. The effluent guidelines listed in the rule represent minimum levels of treatment based upon available technology, not on the quality of the waters which receive the industrial waste discharges. More stringent effluent

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[121] Rule 17-660.300(1), Fla. Admin. Code (1990).

[122] Rule 17-660.300(2), (3), Fla. Admin. Code (1990).

[123] Rule 17-660.440, Fla. Admin. Code (1990).

[124] Rule 17-660.440, Fla. Admin. Code (1990).

[125] See 40 C.F.R. §§ 401-469 (1989).

limitations may be required in order to meet any of applicable water quality standards.[126] Industrial waste sources which are reasonably expected to be sources of water pollution and are not listed in this rule must, at a minimum, provide secondary waste treatment as required by Section 403.085, Florida Statutes.[127]

All sources of industrial waste reasonably expected to be sources of pollution to Class G-II (potable) or G-IV (confined, nonpotable) groundwaters, which are not included in the 51 classes or categories of sources contained in Rule 16-660.400(1)(e), F.A.C., must provide a minimum level of treatment such that the waste does not affect the mechanical integrity of the confining zone, and does not alter the hydrologic characteristics of the injection zone to the point of endangering underground sources of drinking water.[128]

The rule provides specifications for general permits (not requiring extensive departmental review) for laundromat wastewater disposal systems and for pesticide waste degradation systems. The general permit for laundromats requires that within thirty days of completion of construction, the engineer must certify to the DER that the permitted construction is complete and that it was done in accordance with the plans submitted, except where minor deviation was necessary. This general permit does not relieve the permittee of the responsibility for obtaining a dredge and fill permit where required.[129]

A general permit will also be granted for the construction and operation of pesticide waste degradation systems which have been designed and will be operated in accordance with the provisions of the rule. These are systems designed for the evaporation and degradation of pesticide rinse water generated in the cleaning of pesticide application equipment. The general permit requires that there be no discharge of water or pesticide from the system to the surface or groundwater, or to the soil outside of the tank. The owner of the system must notify the appropriate DER district office within two working days if a leak or spill exceeds 25 gallons. Also, the permittee must either own the land or have an agreement from the owner that the land owner will be responsible for the operation of the system.[130] The general permit is also subject to the general conditions of Rule 17-4.540, F.A.C. which include a permit term of five years, and specify that the permit may be modified or revoked under several circumstances, including any violations of water quality standards.

Specifically, pesticide waste degradation systems must not be placed in the 100-year floodplain of a river; within 100 feet of a lake, pond, wetland system or flowing stream; within 75 feet of a drinking water well; or within 25 feet of a property boundary. Among other design specifications, the wash down slab must be concrete with a 6-mil or thicker plastic underliner; the evaporation tank must not be constructed of earthern material; an automatic alarm or pump cut-off switch must activate when the evaporation tank overfills; an in-ground tank must have a second larger tank completely enclosing it, equipped with continuously operating leak detection (checked on a weekly basis) and an automatically activated pump to transfer leakage back to the primary tank; aboveground tanks must be underlain by a concrete slab with 6-mil underlining and

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[126] Rule 17-660.440(1)(m), Fla. Admin Code (1990).

[127] Rule 17-660.400(n), Fla. Admin. Code (1990).

[128] Rule 17-660.400(p), Fla. Admin. Code (1990).

[129] Rule 17-660.801. Fla. Admin. Code (1990).

[130] Rule 17-660.802(1), Fla. Admin. Code (1990).

a slab or plastic-lined gravel berm extending one foot high completely surrounding the tank and slab.[131] Recommended construction and operation details are contained in Institute of Food and Agricultural Sciences Bulletin No. 242, University of Florida.

Chapter 17-670, F.A.C.: Feedlot and Dairy Wastewater Treatment and Management Requirements

Chapter 17-670, F.A.C. imposes wastewater treatment requirements for concentrated animal feedlot operations statewide and for dairy farms in the Lake Okeechobee Drainage Basin.[132] The Effluent Guidelines and Standards for Feedlots contained in 40 C.F.R. 412, as incorporated in Rule 17-660.400(1)(e)8, F.A.C., are applicable to Ch. 17-670 unless this rule is more specific.

The rule requires concentrated feedlot operations proposing to discharge pollutants to complete and file an application with DER. "Concentrated animal feeding operation" is defined to include facilities confining more than specified numbers of ten categories of animals, but it does not include such facilities which contain process wastewater and runoff from the 25-year 24-hour storm.[133] Facilities with less than the required numbers of confined animals may also be designated as concentrated feedlot operations, on a case by case basis, on consideration of factors such as size, location relative to waters of the state, amount of waste reaching state waters, and slope, vegetation, rainfall and other factors indicating the likelihood or frequency of discharges into waters of the state.[134] This provision only applies where operations actually discharge directly to state waters or where waters of the state pass through the operations and come into direct contact with the animals.

The dairy operation requirements of the rule apply to areas within the Lake Okeechobee Drainage Basin. Regulation of dairies in other drainage basins under this rule is proposed when the DER determines that the additional regulations are required to meet or maintain water quality standards.[135] For areas within the Lake Okeechobee Drainage Basin, the rule states that discharge of untreated wastewater and runoff from dairy farms can be expected to pollute waters of the state, including groundwater, and it requires that discharges of runoff and wastewater from dairies must not cause or contribute to violations of water quality standards. The rule requires

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[131] Rule 17-660.800(2)-(6), Fla. Admin. Code (1990).

[132] Defined as the drainage basin consisting of the following sub-drainage basins:

a.) lower Kissimmee River basin below structure S-65;
b.) Taylor Creek--Nubbin Slough basin;
c.) Fish Eating Creek basin;
d.) Indian Prairie and Harney Pond basins;
e.) C-41A basin;
f.) Nicodemus Slough basin; and
g.) drainage areas tributary to the South Florida Water Management District Pump Stations designated as S-127, S-131, S-135, S-2, S-3, and S-4. Rule 17-670.200(8), Fla. Admin. Code (1990).

[133] Rule 17-670.200(3), Fla. Admin. Code (1990).

[134] Rule 17-670.400(3), Fla. Admin. Code (1990).

[135] Rule 17-670.500(2), Fla. Admin. Code (1990).

dairy cattle to be fenced at least 25 feet away from all watercourses, drainage ditches with a drainage area of 100 acres or more, that will transport storm runoff to surface waters.[136] It also requires wastes and flushings from milking barns and runoff from high intensity use areas to be centrally collected for storage and disposal by land application, or treated prior to discharge. The size of high intensity use areas is to be minimized through adoption of appropriate site designs and management practices as developed in management plans, prepared in accordance with USDA Soil Conservation Service standards.[137]

The design of lagoons, storage ponds and other impoundments for wastes from "high intensity use areas"[138] must include volumes large enough to store accumulated manure and wash water, direct rainfall, and runoff for the longest anticipated period between emptyings. The bottom of storage facilities must be sealed, when necessary, to prevent leakage to groundwater.[139] Land application of wastes must be managed to maximize water quality benefits from plant uptake of nutrients, and must include consideration of nutrient content of all wastes, and nutrient needs of crops. Land applications may only be made when water tables are 18 inches or more below ground level, and irrigation with such wastewaters must be managed to prevent any discharge to surface waters of the state.[140]

New dairy farms, beginning operations after June 3, 1987, must not permit storage and treatment facilities, or high intensity areas within 300 feet of drinking water supply wells, 200 feet of natural watercourses, or 100 feet of drainage ditches. Land application areas must be at least 200 feet from drinking water supply wells, 50 feet from natural watercourses, and 50 feet from drainage ditches. Other distances may be specified based on consideration of soils and hydrogeology. Existing dairy operations will be reviewed for applicable setbacks on a case by case basis.[141] Groundwater quality monitoring is required on a quarterly basis near storage ponds and land application areas, with wells also located upgradient to determine background water quality.[142]

Major egg production facilities[143] which generate wastewater must have wastewater treatment, containment and disposal facilities permitted by DER prior to construction or operation,

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[136] Rule 17-670.510, Fla. Admin. Code (1990).

[137] See Rules 17-670.510, 17-670.200(12), Fla. Admin. Code (1990).

[138] "High intensity use areas" include areas of concentrated animal density, such as "milking barns, feedlots, holding pens, travel lanes and contiguous milk herd pasture where the permanent vegetative cover is equal to or less than 80 percent, under average annual worst-case conditions...." Rule 17-670.200(7), Fla. Admin. Code (1990).

[139] Rule 17-670.510(3)(b), Fla. Admin. Code (1990).

[140] Rule 17-670.510(4), Fla. Admin. Code (1990).

[141] Rule 17-670.520, Fla. Admin. Code (1990).

[142] Rule 17-670.530, Fla. Admin. Code (1990).

[143] Defined as egg production facilities with more than 100,000 laying hens, or more than 30,000 laying hens when the facility has a liquid manure system, or which has on site facilities which process at least the number of eggs produced by 100,000 laying hens, not necessarily from on site hens, on a daily basis. Rule 17-670.200(10), Fla. Admin. Code (1990).

based on "reasonable assurance" that the requirements of the rule will be met.[144] Such facilities with dry manure systems that combine egg wash wastewater with dry manure and dispose of it according to an approved Soil and Water Conservation District Board Plan are not subject to the requirements of the rule. Existing major egg production facilities must submit an application for an operating permit by October 1, 1990, and existing permits must be modified to meet the rule requirements on renewal. Egg production facilities not defined as "major" are exempt from permitting if all process wastewater and runoff from the 25-year, 24-hour storm event is contained, unless it is expected that the facility will cause or contribute to water quality violations.[145]

Major egg production facilities must pretreat egg wash wastewater prior to spray irrigation or other land disposal approved by DER, and the pretreatment must be designed, operated and monitored to maintain aerobic conditions at the soil surface of the sprayfield. Minimum pretreatment must include: sedimentation using a settling tank or clarifier to reduce settleable solids; aeration adequate to maintain aerobic conditions within the pretreatment system; neutralization or adjustment of treated effluent to a pH of 6.5 to 8.5; treatment to assure that levels of oils, detergents, solvents, cleaners or other substances will be kept low enough not to interfere with the spray irrigation or other land disposal system.[146] Spray irrigation is not allowed where the seasonal high groundwater level is 18 inches or less below ground level. Any land application areas must be at least 200 feet from drinking water supply wells, 50 feet from natural watercourses, and 50 feet from drainage ditches, though alternative distances may be specified based on soil types and hydrogeology.[147]

When egg wash wastewater is combined with liquid chicken manure, the slurry must be routed through regularly maintained settling basins before disposal in ponds or lagoons, which must be capable of containing the additional volume of the 25-year, 24-hour storm event. In G-I or G-II (potable) groundwater areas[148] which are subject to contamination, ponds must be lined to prevent groundwater pollution.[149] Egg wash wastewater does not require pretreatment when disposed of in ponds or lagoons which are also used for liquid manure treatment. When combined with dry manure, egg wash wastewaters are subject to the requirements of an approved Soil and Water Conservation District Board Plan, or to the requirements of the rule if an approved plan has not been acquired. Major egg production facilities must submit groundwater monitoring plans pursuant to Rule 17-28.700, F.A.C. and must include monitoring for egg wash water spray sites, lined and unlined lagoon systems, and unlined hen houses.[150]

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[144] Rule 17-670.600(2), Fla. Admin. Code (1990).

[145] Id.

[146] Rule 17-670.600(3), Fla. Admin. Code (1990).

[147] Rule 17-670.600(3)(b)6, Fla. Admin. Code (1990).

[148] The DER permits other discharges to groundwater under the provisions of Chs. 17-3, 17-28, Part IV, F.A.C. (1990).

[149] Rule 17-670.600(4)(a)3., Fla. Admin. Code (1990).

[150] Rule 17-670.600(5), Fla. Admin. Code (1990).

Chapter 17-671, F.A.C.: Phosphate Mining Waste Treatment Requirements

Chapter 17-671 establishes effluent guidelines and standards for mining and processing of phosphate. The chapter incorporates "The Effluent Guidelines and Standards for Mineral Mining and Processing," 40 C.F.R. §§436.180, 436.181, and 436.182, as incorporated into Rule 17-660.400(1)(e)32, F.A.C., except where provisions of this rule are more specific.

Chapter 17-701, F.A.C: Solid Waste Facilities

Generally, Chapter 17-701, F.A.C. regulates the permitting, operation and closure of solid waste disposal operations, primarily landfills. The purpose of the rule is to reduce disposal of recyclable material and eliminate adverse environmental effects of improper disposal of solid waste.[151] The rule requires every resource recovery facility or solid waste management facility to obtain a permit from the Florida Department of Environment Regulation (DER).[152] These facilities include landfills, waste transfer stations, land application systems, recycling facilities, and volume reduction facilities.

Operations exempted from permit requirements include normal farming operations and solid waste disposal areas for construction and demolition debris, though construction and demolition debris landfills, solid waste transfer stations and land application of domestic wastewater water sludge receive general permits with minimal conditions.[153] Generally, individuals disposing of solid waste generated from activity on the individual's property are exempt from permit requirements. However, individuals are required to notify DER of their disposal activity unless the waste is solely residential garbage and trash, wastes from normal farming operations, or construction or demolition debris.[154]

Solid waste may only be disposed of by landfilling, incineration, recycling process or other method approved by DER,[155] and may not be disposed of in any of the following locations:

-- any open sink holes or in geologic areas that can not support a landfill;
-- gravel or limestone pit;
-- immediately adjacent to or within 500 feet of an existing or proposed shallow water supply well unless disposal takes place in a sanitary landfill which was originally permitted before the shall water supply well was in existence;
-- in a dewatered pit unless permanent leachate containment and special design techniques are use to ensure the integrity of the landfill liner;
-- in an area subject to frequent and periodic flooding unless DER-approved drainage provisions are installed;
-- within 200 feet of any natural or artificial body of water, except bodies of water contained completely within the land fill site, which do not discharge from the

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[151] Rule 17-701.001, Fla. Admin. Code (1990).

[152] Rule 17-701.030(1), Fla. Admin. Code (1990).

[153] Rule 17-701.030(1)(a), Fla. Admin. Code (1990).

[154] Id.

[155] Rule 17-701.040(1), Fla. Admin. Code (1990).

site.[156]

The DER also prohibits siting of landfill facilities within 3,000 ft of a Class I (potable) surface water.[157] The land disposal site must be sufficient to support the landfill, including total wastes to be disposed of, cover material and structures to be built on the site.[158] The facility must also have a ground water monitoring plan, including a hydrogeological survey to ensure that ground water quality will be protected from waste or leachate.[159]

The type of waste which may be placed in landfills is also regulated. Hazardous waste must be rendered non-hazardous before it is disposed of at a landfill or incinerated.[160] If it can not be rendered non-hazardous, the waste generator must confer with DER on proper storage or disposal.[161] Infectious waste may not be placed in a landfill unless first treated, but may be incinerated or disposed of by an alternate DER-approved method.[162]

Landfills are classified into three categories depending on the amount and type of solid waste received. Class I sanitary landfills receive an average of 20 tons or more of solid waste per day and receive an initial cover at the end of each working day.[163] Class II sanitary landfills receive an average of less than 20 tons per day and must be covered once every four days or more frequently if they receive sewage or industrial sludges, dead animals, or other nuisance wastes.[164] The cover protects against adverse environmental or health effects from blowing litter, odors, flies or rodents. Any pesticides used to control rodents, flies and other insects must be specified by Florida Department of Agriculture and Consumer Services.[165] Class I and Class II landfills must have a liner constructed of materials that have appropriate chemical properties for compatibility with the waste.[166] Class III landfills receive only trash and yard trash, including any combination of vegetative matter from landscaping maintenance or land clearing operation, construction and demolition debris, cardboard, cloth, glass, street sweepings, and vehicle tires. These sites must be covered once every week.[167]

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[156] Rule 17-701.040(2), Fla. Admin. Code (1990).

[157] Rule 17-701.040(7), Fla. Admin. Code (1990).

[158] Rule 17-701.050(2), Fla. Admin. Code (1990).

[159] Id.

[160] Rule 17-701.040(4), Fla. Admin. Code (1990).

[161] Id.

[162] Rule 17-701.040(5), Fla. Admin. Code (1990).

[163] Rule 17-701.050(1)(a), Fla. Admin. Code (1990).

[164] Rule 17-701.050(1)(b), Fla. Admin. Code (1990).

[165] Rule 17-701.050(5)(p), Fla. Admin. Code (1990).

[166] Rule 17-701.050(3), Fla. Admin. Code (1990).

[167] Rule 17-701.050(1)(c), Fla. Admin. Code (1990).

Liner Standards

Liners must be constructed of materials compatible with the waste and leachate and must be of sufficient strength and thickness to prevent failure of the liner due to pressure gradients, climatic conditions, and the stress of installation and operation.[168] Design standards for soil liners require a minimum of three feet of soil (clay) which must meet certain permeability standards. The soil liner can not contain any lenses, cracks, root holes or other structural inconsistencies which could become migration pathways for leachate. Synthetic liners must meet minimum strength requirements of the National Sanitation Foundation and must be protected from physical damage by placement of bedding soil above and below the liner. All field seams of the liner must be visually inspected and pressure or vacuum tested for continuity. Other liner materials may be used, if acceptable to DER.[169] Landfills built after June 1, 1990 must have a composite liner with leachate collection or a double flexible membrane system with leachate detection and collection.

Leachate Control System Standards

Landfills must have a leachate collection and removal system immediately above the liner that is designed, constructed, maintained, and operated to collect and remove leachate from the landfill. The system must be constructed of materials that are chemically resistant to the waste disposed of in the landfill and the leachate expected to be generated. The system must also be of sufficient strength and thickness to prevent collapse under pressures exerted by overlying wastes, cover materials, and by equipment used at the landfill. The system must be designed and operated to function without clogging throughout its active life and closure. The system must also be designed and constructed to provide for removal of leachate within the drainage system to a central collection point for treatment and disposal.[170]

Design standards specify a 12-inch drainage layer above the liner to promote drainage and a collection system to remove leachate. Filter material should be placed around the collection and removal system to prevent clogging of the system by waste infiltration. Methods should be developed to test for clogging and to clean the system in the event of clogging.[171] The current standard requires a leachate collection system to maintain the head over the liner to one foot or less. Landfills built after June 1, 1990 must have systems capable of maintaining the head at no more than one inch over the liner, following a 25-year, 24-hour storm event.

Surface Water Management System Standards

Landfills are required to have surface water management systems designed, constructed, operated, and maintained to prevent surface water flow onto waste-filled areas, and a storm water runoff control system designed, constructed, operated, and maintained to collect and control storm water in accord with Chapter 17-25, F.A.C. and local water management district requirements.[172]

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[168] Rule 17-701.050(3)(b), Fla. Admin. Code (1990).

[169] Rule 17-701.050(4)(d), Fla. Admin. Code (1990).

[170] Rule 17-701.050(4)(e), Fla. Admin. Code (1990).

[171] Rule 17-701.050(4)(f), Fla. Admin. Code (1990).

[172] Rule 17-701.050(4)(g), Fla. Admin. Code (1990).

Design standards specify that storm water controls must be specifically designed with consideration of local drainage patterns, soil permeability, precipitation, area land use and other land characteristics. Retention and detention ponds must be designed, constructed and maintained to meet the requirements of Chapter 17-25 or, if applicable, local water management district requirements. The system should be designed to minimize the possible mixing of storm water and leachate. When storm water mixes with leachate, it becomes classified as leachate and must be treated as such.[173]

Landfill Operation Requirements

The operation of landfills requires monitoring wells to be installed and sampled at appropriate intervals.[174] An operation plan must be developed to document procedures for monitoring, waste loading and unloading, and operation of control systems.[175] The operational design features of the landfill should contain certain minimum features including a barrier to prevent unauthorized entry and dumping into the landfill.[176] Rule 17-701.070 contains the minimum permit application requirements to close a landfill and monitor and maintain the closed facility so that no threat will be posed to human health or the environment. This section applies to virtually all landfills, except sites where an individual disposes of waste resulting from the individual's own activities on the individual's own property; any dredge spoil site, any yard trash composting site; and any construction and demolition debris site.[177]

Closing a landfill requires an approved schedule and closure plan. The closure plan should include a groundwater monitoring plan meeting criteria specified in Rule 17-4.245(6)d,[178] and must identify provisions for long term care, including leachate control, groundwater protection, and storm water control.[179] The plan must also report on the effectiveness of existing landfill design and operation, including effects of the landfill on adjacent ground and surface waters.[180] Chapter 17-701, F.A.C. also briefly addresses design and operation standards for volume reduction facilities[181] and transfer stations[182]; permitting for land application of waste water treatment sludge[183]; and permitting for off-site disposal of construction and demolition debris.[184]

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173 Rule 17-701.050(4)(h), Fla. Admin. Code (1990).

174 Rule 17-701.050(5)(a), Fla. Admin. Code (1990).

175 Rule 17-701.050(5)(b), Fla. Admin. Code (1990).

176 Rule 17-701.050(5)(c), Fla. Admin. Code (1990).

177 Rule 17-701.070(1), Fla. Admin. Code (1990).

178 Rule 17-701.071(3), Fla. Admin. Code (1990).

179 Rule 17-701.073(6), Fla. Admin. Code (1990).

180 Rule 17-701.071(5), Fla. Admin. Code (1990).

181 Rule 17-701.090, Fla. Admin. Code (1990).

182 Rule 17-701.091, Fla. Admin. Code (1990).

183 Rule 17-701.802, Fla. Admin. Code (1990).

Chapter 17-710, F.A.C.: Used Oil Management

Chapter 17-710, F.A.C., covers used oil regulation. The purpose of this chapter is to reduce the dangerous effects of used oil and to promote used oil recycling. This chapter implements the Florida Resource Recovery and Management Act. In order to reduce the dangerous effects of used oil, this chapter prohibits any public endangerment, as well as any discharge of used oil into sewers, drainage systems, or waters. Used oil cannot be used for road oiling, dust control, or weed abatement in areas where sole source aquifers have been designated.

Chapter 17-711, F.A.C.: Waste Tire Rule

Chapter 17-711, F.A.C., provides for the regulation of waste tire storage, collection, transport, processing and disposal. A waste tire storage facility site must be managed to divert stormwater or flood water around and away from the storage piles. These facilities must maintain compliance with Chapter 17-25, F.A.C., and the water quality requirements of Chapter 17-3, F.A.C. The storage piles must be surrounded by a 50 foot fire lane, and bermed to keep liquid runoff from a potential tire fire from entering surface or ground water.

Chapter 17-730, F.A.C.: Hazardous Waste

Chapter 17-730, F.A.C., implements Part IV of Chapter 403, F.S., establishing a Florida hazardous waste management program which lists currently known hazardous wastes and establishes procedures by which hazardous wastes may be identified. Permits are required for construction, operation, and closure of hazardous waste treatment, storage, or disposal facilities. Under certain circumstances, ocean disposal barges or vessels, publicly owned treatment works, and injection wells are exempt from permit requirements under the rule.

Chapter 17-731, F.A.C.: County and Regional Hazardous Waste Management Programs

The purpose of Chapter 17-731, F.A.C. is to establish the amounts, types, and sources of hazardous wastes generated in the state, as well as to facilitate proper storage, transportation, treatment, disposal, reduction, and resource recovery methods. Each county must conduct a hazardous waste management assessment to identify hazardous waste problems.

The assessments are performed according to "Guidelines to Conduct County and Regional Hazardous Waste Assessments - January 1985," available from the DER. Additionally, each county is required to identify areas where a hazardous waste facility could be located. Each regional planning council must select one or more regional storage or treatment facility sites. Under this rule each county must participate in the "small quantity generator notification program."

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[184](...continued)

[184] Rule 17-701.803, Fla. Admin. Code (1990).

Chapter 17-761, F.A.C.: Underground Storage Tank Systems

Chapter 17-761, F.A.C. provides standards for the construction, registration, removal and disposal of underground storage tank systems, including their on-site integral piping and associated release detection systems. The rule became effective December 10, 1990, and its requirements supercede those of Rule 17-61, F.A.C. ("Stationary Tanks"). It is preemptive with respect to most local programs. The Department of Environmental Regulation is the implementing agency, but may contract with capable local governments for administration of its responsibilities under the rule.[185] Final agency action for any of these responsibilities performed by a locally administered program must be taken by the DER. This section of the rule does not apply to local governments with approved local programs authorized under Section 376.317, Florida Statutes, except to the extent that the local government has contracted with the DER for specific duties related to the rule.[186]

The chapter applies to systems which have individual tank capacities over 110 gallons, storing "regulated substances." These include two general categories of substances: 1.) "pollutants," defined as any commodity made from oil or gas, or their derivatives, as well as pesticides, ammonia, chlorine and their derivatives, but not liquefied petroleum gas;[187] and 2.) any substance defined in section 101(14) of the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) of 1980 (not including hazardous wastes regulated under Subtitle C of the Resource Conservation and Recovery Act) that is liquid at standard temperature and pressure.[188]

Exemptions

Many types of systems are exempt from the requirements of the chapter.[189] These include:

1. Underground tank systems holding hazardous wastes regulated under Title C of RCRA,

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[185] Rule 17-761.840, Fla. Admin. Code (1990). Section 376.3073, Fla. Stat., requires DER, to the greatest extent possible, to contract with local governments for administration of its responsibilities under Sections 376.3071(4)(a)-(e),(h), 376.3072, and 376.3077, Fla. Stat. These include regulation of aboveground and underground storage tanks, other compliance verification programs, and monitoring, assessment and remediation of petroleum product contamination. Eligible local governments "deemed capable of carrying out such responsibilities" and which contract with DER under this section are entitled to receive sufficient funds to administer the local program. Fla. Stat. § 376.3073 (1989).

[186] Rule 17-761.840(3), Fla. Admin. Code (1990). Fla. Stat. § 376.317 allows county governments to adopt countywide ordinances which are more stringent than state rules on underground storage tanks, if: 1) the ordinance was adopted and in force before September 1, 1984; or 2) the ordinance was adopted and filed with the Secretary of State before July 1, 1987; or 3) the county effectively administers the state rules for two years, then files a petition for approval of the local ordinance. A county which sought approval of its program prior to January 1, 1988 is not required to administer the state program for any minimum period. Fla. Stat. § 376.317 (1989).

[187] See Fla. Stat. §§ 376.301(12), 377.19(11) (1989).

[188] Rule 17-761.200(32), Fla. Admin. Code (1990).

[189] See Rule 17-761.300, Fla. Admin. Code (1990).

or mixtures of such wastes with other regulated substances;

2. Wastewater treatment tank systems which are part of a wastewater treatment facility or an evaporation/degradation system for pesticide equipment rinse water regulated under Rule 17-660, F.A.C.;

3. Equipment or machinery which contains regulated substances for operational purposes, such as hydraulic lift or fluid tank systems and electrical equipment tank systems;

4. Any storage tank system whose individual capacity is 110 gallons or less;

5. Any storage tank system containing small quantities (de minimus, as defined at 40 Code of Federal Regulations (CFR), Sec. 280.12) of regulated substances;

6. Any emergency spill or overflow containment storage tank system that is emptied as soon as possible after use;

7. Any agricultural storage tank system of 550 gallons or less capacity;

8. Any storage tank system used to store heating oil for consumptive use on the premises where stored;

9. Any septic tank system;

10. Any pipeline facility;[190]

11. Any surface impoundment, pit, pond or lagoon;

12. Any stormwater or wastewater collection system;

13. Any flow-through process tank system;[191]

14. Any liquid trap or associated gathering lines directly related to oil or gas production and gathering operations;

15. Any storage tank system situated in an underground area if the storage tank is located on or above the floor;

16. Any residential storage tank system;

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[190] Defined as "new and existing pipe rights-of-way and any associated equipment, gathering lines, facilities, or buildings." Rule 17-761.200(31), Fla. Admin. Code (1990).

[191] Defined as a "tank that forms an integral part of a production process through which there is a steady, variable, recurring, or intermittent flow of materials during the operation of the process. Flow-through process tanks do not include storage tanks used for the storage of regulated substances before their introduction into the production process or for the storage of finished products or by-products from the production process." Rule 17-761.200(13), Fla. Admin. Code (1990).

17. Any facility covered by Section 376.011-376.21, Fla. Stat.,[192] except for marine fueling facilities with underground tank systems where the facility has no individual tank with a capacity greater than 30,000 gallons.

18. Any storage tank system regulated by Chapter 377, Fla. Stat.;[193]

19. Any storage tank system storing solid or gaseous pollutants;

20. Any storage tank system that is part of an emergency generator system at nuclear power generation facilities regulated by the Nuclear Regulatory Commission under 10 CFR Part 50 Appendix A; or

21. Airport hydrant piping systems regulated by Rule 17-762, F.A.C.[194]

Notification and Reporting

The rule requires owners of any in-service, out of service or unmaintained storage tank systems with capacities over 110 gallons to register the system with the Department of Environmental Regulation, at least ten days before the start of any installation. Existing systems not previously required to register must do so within 90 days of the effective date of the rule. There are minimal registration fees, renewal fees, replacement fees and late fees. Registration placards must be prominently displayed.[195] There are also notification requirements and time limits applicable to changes in status for regulated tank systems. These include requirements to notify the DER of the date and method of closure at least 30 days prior to closure, ten days notice of the replacement or upgrading of a system (except for emergency replacements), and 24 hours written or verbal notice before the closure, upgrading or installation of a system.[196]

Any spill, overflow or discharge of "regulated substances" that equals or exceeds reportable quantities under CERCLA (40 CFR Section 302) must be reported within one working day of discovery. The same reporting time limit applies to spills, overflows or discharges of petroleum products which result in a release to the environment of over 25 gallons or that causes a sheen on surface water.[197] Suspected releases, including unusual operating conditions, sudden loss of product, positive monitoring results from release detection systems or closure

[192] Generally addressing spills and discharges of "pollutants," from "terminal facilities" used to drill for, pump, store, handle, transfer, process, or refine such pollutants, in coastal areas.

[193] Generally regulating the exploration for, and drilling of, oil and gas wells.

[194] Rule 17-762, Fla. Admin. Code, is currently undergoing rule adoption, and will regulate stationary aboveground storage tanks and associated piping and release detection systems for storage of pollutants. The proposed rule defines "airport hydrant piping systems" as the "integral pressurized underground piping system, including hydrant pits, associated with aboveground bulk petroleum storage tank systems serving major aiports." Draft Rule 17-762.200(1) (Aug. 1990 draft).

[195] Rules 17-761.400, 17-761.410, Fla. Admin. Code (1990).

[196] Rule 17-761.450, Fla. Admin. Code (1990).

[197] Rule 17-761.460, Fla. Admin. Code (1990).

assessments, and excessive variations in manual tank gauging results must also be reported within one working day of discovery.[198]

Siting and Performance Standards for New Storage Tank Systems

New storage tank systems, including tanks, integral piping and release detection, may not be placed within fifty feet of a potable water supply well. Existing storage tank systems within fifty feet of such a well may be replaced with equivalent or lesser volume systems in the same excavation only if the replacement includes secondary containment. Secondary containment is also required for new, upgraded or replacement tank systems within 300 feet of an existing potable well serving a community or nontransient, noncommunity water system,[199] or within 100 feet of an existing well serving any private, other public or noncommunity water system.[200]

Generally, new storage tanks may be constructed of:

1. Fiberglass reinforced plastic;

2. Cathodically protected coated steel, if the coating is of a suitable dielectric material, any field installed cathodic protection is designed by a corrosion professional, any impressed current system allows for determination of the operating status, and cathodic protection systems are operated and maintained in accord with the requirements of the rule;

3. Steel coated with a fiberglass reinforced plastic composite; or

4. Any other material, design, construction or corrosion protection determined by DER to be sufficient to prevent discharge of regulated substances.[201]

A new tank constructed with previously used or remanufactured components must be certified by a recognized product testing laboratory before being installed. A tank which is excavated and removed during its useful life must be certified as meeting the performance standards for new tanks before being installed. Industry standards for materials, system designs and methods of operation are incorporated by reference in Rule 17-761.210, F.A.C.

New hazardous substance storage tank systems, begun on or after January 1, 1991, must include secondary containment and interstitial monitoring between the walls of a double-walled

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[198] Id.

[199] "Community water system" means a public water system which serves at least 15 service connections used by year-round residents or regularly serves at least 25 year-round residents. "Noncommunity water system" means a public water system providing piped water for human consumption, which serves at least 25 individuals daily at least 60 days a year, but which is not a community water system; a wilderness educational camp water system is a noncommunity water system. Fla. Stat. § 403.852 (1989).

[200] Rule 17-761.500(4), Fla. Admin. Code (1990).

[201] Rule 17-761.500, Fla. Admin. Code (1990). Alternative materials, design, construction or corrosion protection must provide equivalent protection or meet the appropriate performance standards of Chapter 17-761. Rule 17-761.860, Fla. Admin. Code (1990).

tank, or between a single walled tank and its liner.[202] After December 31, 1998, the installation of all other types of new storage tanks must include secondary containment.[203] Release detection is also required for all new petroleum storage tank systems, defined as those for which installation began after the effective date of the rule.[204]

All integral piping in contact with the soil, installed after the effective date of the rule, must include secondary containment and must be constructed of acceptable materials.[205] All storage tank systems installed, upgraded or replaced after the effective date of the rule must include dispenser liners, located directly beneath dispensers at the terminus of the integral piping, to contain discharges resulting from maintenance activity.[206]

Liners used as secondary containment may be of synthetic material conforming to criteria within the rule, or may be constructed of concrete which is "product tight" (undefined), sealed, and of sufficient thickness and strength to prevent a discharge during its operating life. Liners must be designed and installed to direct any discharges from the tank system to a monitored point within the liner.[207] Transfer and filling operations must be monitored, and systems must include spill containment measures to prevent discharges when the transfer hose is detached from a fill pipe. Systems must also include overfill protection to automatically cut off flow when a tank is 95% full or to restrict flow when the tank is more than 90% full.[208] Before any regulated substance may be dispensed from a tank system, the tank and integral piping must pass a tightness test capable of detecting leaks of 0.1 gallon per hour, while accounting for the effects of several variables.[209] It should be noted that the rule allows a system to be filled with product before being tested for tightness, and that tightness tests meeting this standard will fail to detect leaks of up to 2.4 gallons per day.

Siting and Performance Standards for Existing Storage Tank Systems

If located outside the 50-300 foot buffer zones around different categories of potable water wells, replacement storage tanks of equivalent capacity do not require immediate secondary containment, but are subject to the requirements of an upgrade schedule contained in Table I of

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[202] Rules 17-761.550, 17-640(3),(4) Fla. Admin. Code (1990). A "hazardous substance storage tank system" is one which contains a hazardous substance defined in section 101(14) of CERCLA (not including hazardous wastes regulated under Subtitle C of RCRA), ammonia, chlorine, pesticides and their derivatives, or any mixture of such substances and petroleum products, and which is not a petroleum underground storage tank system. Rule 17-761.200(14), Fla. Admin. Code (1990).

[203] Rule 17-761.500(1)(d), Fla. Admin. Code (1990).

[204] See Rules 17-761.600(3), 17-761.200 (23), Fla. Admin. Code (1990).

[205] Rule 17-761.500(2), Fla. Admin. Code (1990).

[206] Rule 17-761.500(6), Fla. Admin. Code (1990).

[207] Rule 17-761.500(7), Fla. Admin. Code (1990).

[208] Rule 17-761.500(5), Fla. Admin. Code (1990).

[209] See Rules 17-761.500(3) and 17-761.680, Fla. Admin. Code (1990).

the rule.[210] The schedule specifies upgrade or replacement dates for unprotected tanks, integral piping, dispenser liners, overfill protection, spill containment and secondary containment, based on the year the system was installed.

Existing vehicular fuel petroleum storage tank systems must include secondary containment by the year 2012, 2015 or 2018, depending on the date of original installation. Prior to those years, such systems may be ugraded with any of several types of internal lining or cathodic protection, provided that the integrity of the tank and piping is ensured, and that periodic tightness tests are performed.[211] There is some question whether state enforcement capacity will be adequate to properly oversee the internal inspections and tightness test schedules called for in the rule. As has been noted, applicable tightness test standards will not detect fairly significant leaks.

Release detection for existing vehicular fuel storage systems over 550 gallons is required on the effective date of the rule,[212] and may include interstitial monitoring, one monitoring well or vapor detector within a liner, a continuously operating release detection system, a network of four monitoring wells, a groundwater monitoring plan, spill prevention or countermeasure plan, or automatic tank gauging with two monitoring wells.[213]

Generally, release detection must be capable of detecting a "significant increase" in contamination levels above background,[214] a relatively low standard of sensitivity. Acceptable methods of release detection include: groundwater monitoring wells, vapor monitoring within the excavation backfill, interstitial monitoring for double walled tanks, interstitial monitoring for tanks with liners,[215] manual tank gauging (tanks of 550 gallons or less), automatic tank gauging, and in line leak detectors.[216] Until secondary containment is required for all storage systems, the rule allows from two to four monitoring wells as acceptable release detection methods, a practice which can fail to detect leaks which do not occur almost directly upgradient of a monitoring well.

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[210] Rule 17-761.500(1)(d), Fla. Admin. Code (1990). See Rule 17-761.510(6) (Table I), Fla. Admin. Code (1990) for upgrade schedule. The schedule requires tanks or integral piping installed before 1976 to be upgraded with secondary containment by the year 2012; systems installed from 1976-1980 must be so upgraded by 2015; systems installed after 1981 are not required to have secondary containment until the year 2018. Other types of upgrading are required in the years before 2012, depending on the year of installation, degree of corrosion protection, spill containment capability, and proximity to potable water supply wells. Rule 17-761.510(6) (Table I), Fla. Admin. Code (1990).

[211] Rule 17-761.510, Fla. Admin. Code (1990).

[212] Rule 17-761.600(3), Fla. Admin. Code (1990).

[213] Rule 17-761.610, Fla. Admin. Code (1990).

[214] Rule 17-761.600(1), Fla. Admin. Code (1990).

[215] Both types of interstitial monitoring require that the system detect breaches of the inner tank wall. For both types of system, but especially double walled tanks, it is advisable to require that monitoring also be capable of detecting a breach of the outer wall.

[216] Rule 17-761.640, Fla. Admin. Code (1990).

Existing regulated substance storage tanks, except for existing vehicular fuel petroleum storage tanks, must be equipped with one or more of several types of monitoring, in accordance with the retrofit schedule in Table II of the rule. The alternatives include:

1.) interstitial monitoring for double walled tanks;
2.) one monitoring well within a liner;
3.) a continuously operating release detection system;
4.) a network of two monitoring wells for single tanks of 2000 gallons or less; four wells for a single tank over 2000 gallons or for two or more tanks;
5.) manual tank gauging (tanks of 550 gallons or less);
6.) automatic tank gauging in conjunction with two monitoring wells; or
7.) any other method capable of detecting a 0.2 gallon per hour leak or a release of 150 gallons within one month.[217]

Existing non-vehicular fuel petroleum storage tanks must either comply with new system standards (Rule 17-761.500, F.A.C.), comply with upgrade requirements (Rule 17-761.510(1)-(5), F.A.C.), or permanently close by December 31, 1998. By December 31, 2018, all such tanks must include secondary containment.[218] Release detection for pressurized piping in such systems is required by December 31, 1990, while release detection for tanks and suction piping is required in 1991, 1992 or 1993, depending on the original date of system installation.[219]

Existing hazardous substance storage tank systems must be upgraded to the standards for new systems by December 31, 1998, and must include secondary containment.[220] Unless upgraded to new system standards, such systems must also include installation of either groundwater monitoring, vapor monitoring, interstitial monitoring, manual tank gauging (tanks of 550 gallons or less), automatic tank gauging, or in line leak detectors, on a schedule contained in the rule.[221]

All integral piping installed after the rule's effective date and which is in contact with soil must include secondary containment and interstitial monitoring.[222] After December 31, 1998, in accordance with Table I,[223] single walled piping must have in line leak detectors. Before those requirements take effect, any of the external methods used for tank release detection may be used for integral piping,[224] and are subject to the same inadequacies noted above.

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[217] Rule 17-761.620, Fla. Admin. Code (1990).

[218] Rule 17-761.520, Fla. Admin. Code (1990).

[219] Rule 17-761.600(3), Fla. Admin. Code (1990).

[220] Rule 17-761.560, Fla. Admin. Code (1990).

[221] See Rules 17-761.560, 17-761.640, Fla. Admin. Code. The compliance schedule for release detection requirements is contained in Rule 17-761.600, (Table II), Fla. Admin. Code (1990).

[222] Rule 17-761.630, Fla. Admin. Code (1990).

[223] See Rule 17-761.510(6), Fla. Admin. Code (1990).

[224] Id.

Chapter 17-761 includes sections which address tightness testing standards,[225] repairs,[226] record keeping,[227] inventory requirements,[228] cathodic protection operating requirements,[229] activities requiring certified contractors,[230] out of service and closure requirements,[231] discharge response,[232] and approval of alternate procedures.[233]

Chapter 17-762, F.A.C.: Aboveground Storage Tank Systems

Chapter 17-762, F.A.C., which supercedes Chapter 17-61, F.A.C., was adopted by the Environmental Regulation Commission in December 1990 and will become effective in late February 1991. It provides standards for the construction, installation, maintenance, registration, removal and disposal of aboveground storage tank systems, including tanks and their on-site integral piping and associated release detection systems. The rule will only apply to systems which have capacities over 550 gallons, storing "pollutants."[234] Aboveground tanks for storage of pollutants which are permitted before the effective date will be required to meet the criteria established in Chapter 17-61, F.A.C., but will be subject to the sections of Chapter 17-762 dealing with existing tanks. The Department of Environmental Regulation is the implementing agency, but may contract with capable local governments for administration of its responsibilities under the rule.[235]

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[225] Rule 17-761.680, Fla. Admin. Code (1990).

[226] Rule 17-761.700, Fla. Admin. Code (1990).

[227] Rule 17-761.710, Fla. Admin. Code (1990).

[228] Rule 17-761.720, Fla. Admin. Code (1990).

[229] Rule 17-761.730, Fla. Admin. Code (1990).

[230] Rule 17-761.740, Fla. Admin. Code (1990).

[231] Rule 17-761.800, Fla. Admin. Code (1990).

[232] Rule 17-761.820, Fla. Admin. Code (1990).

[233] Rule 17-761.850, Fla. Admin. Code (1990).

[234] Defined as any commodity made from oil or gas, or their derivatives, as well as pesticides, ammonia, chlorine and their derivatives, but not liquefied petroleum gas. See Fla. Stat. §§ 376.301(12), 377.19(11) (1989).

[235] Rule 17-762.840, Fla. Admin. Code (1991). The rule does not apply to local governments with approved local programs authorized under Fla. Stat. § 376.317, except to the extent that the local government has contracted with the DER for specific duties. Section 376.3073, Fla. Stat. requires DER, to the greatest extent possible, to contract with local governments for administration of its responsibilities under Sections 376.3071(4)(a)-(e),(h), 376.3072, and 376.3077, Fla. Stat. These include regulation of aboveground and underground storage tanks, other compliance verification programs, and monitoring, assessment and remediation of petroleum product contamination. Eligible local governments "deemed capable of carrying out such responsibilities" and which contract with DER under this section are entitled to receive sufficient funds to administer the local program. Fla. Stat. § 376.3073 (1989).

Exemptions

A large number of exemptions are listed in Section 17-762.300 of the rule. A partial listing of the exemptions includes those such as storage tanks containing LP gas; skid or mobile tanks that are moved to a different location at least every 180 days; any storage tank system containing hazardous wastes defined under Subtitle C of RCRA or any mixture of such wastes with pollutants; any evaporation/degradation system for pesticide equipment rinse water regulated under Rule 17-660, F.A.C.; storage tank systems with a capacity under 30,000 gallons used for storing heating oil for use on the premises; storage tank systems located within an enclosed building or vault, with roof and walls and an impervious floor containing no valves, drains or other such openings; storage tanks used for temporary storage of pesticides and diluents intended for reapplication as pesticides; and storage tank systems which are not in contact with the soil, constructed non-corrosive materials, containing less than 80% fertilizer materials applied on site.[236]

Performance Standards for New Tank Systems

New aboveground storage tank systems with capacities above 550 gallons which contain pollutants must be constructed of or lined with materials which are compatible with the stored pollutants. They must be supported on well drained stable and supportive foundations, and must include secondary containment, overfill protection and product loading area containment. Different types of secondary containment must meet standards for durability and imperviousness. If not protected from accumulations of rainfall, the secondary containment must include leak-free manual pumps or siphons, or a gravity drain pipe with a manually controlled valve to remove stormwater. Cathodic protection must be provided for any portions of tanks which are in contact with the soil. Integral piping which is contact with soil must be secondarily contained.[237]

Performance Standards for Existing Shop-Fabricated Tank Systems

By December 31, 1999, such systems over 550 gallons capacity which contain vehicular fuel must have cathodic protection for tank bottoms in contact with the soil; must be maintained by coating with materials which prevent corrosion and ultraviolet degradation; must include overfill protection and loading area containment; and must install secondary containment for integral piping in contact with soil. Shop-fabricated systems which store or use 1000 gallons per month or less, or 10,000 gallons per year or less of vehicular fuel must additionally meet the requirements for secondary containment, by December 31, 1999. The interior bottom of tanks resting on soil may be lined with an impervious coating, but secondary containment is otherwise required. Integral piping in contact with soil, which is installed onto an existing system after the effective date must include secondary containment and an acceptable form of leak detection.[238]

Performance Standards for Existing Field-Erected Tank Systems

By December 31, 1991, such systems that contain pollutants must meet the requirements of the rule applicable to new systems, concerning cathodic protection for tank bottoms in contact with soil, exterior coatings, overfill protection and secondary containment. When the bottom of such tanks are replaced, secondary containment must be installed beneath the tank. The interior bottom of existing tanks resting on the soil may be lined with an impervious coating, but

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[236] See Rule 17-762.300(2), Fla. Admin. Code (1991).

[237] See Rule 17-762.500, Fla. Admin. Code (1991).

[238] See Rule 17-762.510, Fla. Admin. Code (1991).

secondary containment is otherwise required. Integral piping on such systems, except hydrant piping and bulk product piping must be upgraded with secondary containment by December 31, 1999. Existing hydrant piping and bulk product piping must go through a structural integrity and tightness evaluation by January 1, 1993, and must follow procedures for repair and upgrade if necessary.[239]

Additional sections of Chapter 17-762, F.A.C. address general release detection standards, repairs, operating requirements for cathodic protection systems, out of service and closure requirements, response to discharges, and recordkeeping and inventory requirements.

DEPARTMENT OF HEALTH AND REHABILITATIVE SERVICES

Chapter 10D-6, F.A.C.: Standards for Onsite Sewage Disposal Systems

State regulations on the siting and construction of individual sewage disposal systems are administered by the Department of Health and Rehabilitative Services (HRS) under the authority of Chapter 381, Florida Statutes and Chapter 10D-6, Florida Administrative Code.[240] Onsite sewage disposal systems require a permit from HRS, and local governments may not issue building or plumbing permits for buildings using such a system until the owner has received a construction permit for the system from HRS.[241] Existing, already approved systems are not subject to any additional requirements, so long as they are in satisfactory condition and the buildings they serve are not changed or sewage flows increased.[242] If those conditions are not met, the system must be upgraded to comply with the current rules.[243] County public health units have the discretion to allow minor changes, such as the addition of one bedroom, without upgrading the onsite system.[244] They may also require notification of intent to repair a system, or may require the repairer to obtain prior written approval before making a repair.[245]

A relatively new requirement was enacted by the legislature in 1989. Section 381.272(9), Florida Statutes, specifies that on-site septic systems may not be constructed in any

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239 See Rule 17-762.520, Fla. Admin. Code (1991).

240 Chapter 10D-6, F.A.C. is currently undergoing revision, with an expected adoption date in mid-1991.

241 Rule 10D-6.041(4), (5) Fla. Admin. Code (1989). Treatment and disposal of sewage flow must comply with Florida Department of Environmental Regulation rules when: a.) the volume of domestic sewage exceeds 5000 gallons per day (see Rule 10D-6.048(1) for estimated domestic sewage flows); b.) sewage or wastewater contains industrial or toxic or hazardous chemical waste; c.) the area is zoned for industrial or manufacturing use, or its equivalent, and the system may be used for disposing of other than domestic wastes; or d.) total food establishment wastewater flow exceeds 3000 gallons per day. Rule 10D-6.041(8) Fla. Admin. Code (1989).

242 Rule 10D-6.041(6) Fla. Admin. Code (1989).

243 Id.

244 Id.

245 Rule 10D-6.041(7) Fla. Admin. Code (1989).

area zoned or used for industrial or manufacturing purposes, where a publicly-owned or investor-owned sewage treatment system is available, or where a likelihood exists that the system may receive toxic, hazardous or industrial waste. A central sewer system is considered available if it is located within 1/4 mile of the area zoned or used for the indicated purposes, has adequate hydraulic capacity to accept the proposed sewage flow, and is not under moratorium for violation of treatment capability. Existing systems in such areas may be repaired or improved if a central sewer system is not available within 500 feet of the building sewer stub-out, and the system construction and operations standards can be met. Businesses in the applicable zones, which have the capacity to generate toxic, hazardous or industrial wastewater, and which use on-site septic systems installed on or after July 5, 1989 must obtain operating permits from the DER. Occupational licenses are required for owners or tenants of buildings in applicable areas, which are served by on-site systems, contingent on no use of the system for disposal of toxic, hazardous or industrial waste.[246]

Under Ch. 10D-6, F.A.C., a development exceeding 5000 gallons per day sewage flow will normally require a sewer permit from the Department of Environmental Regulation (DER),[247] however when DER determines that it would be "impractical" to sewer a low density development, it may recommend the applicant apply for a variance to allow use of onsite sewage systems. If the variance is granted, the county health unit becomes the permitting authority.[248] State policy is to require every onsite sewage disposal system, except approved greywater systems, to connect to a publicy owned or investor-owned sewerage system within 365 days after notification that such a system is available.[249] Where a system is not available, provision must be made, by inclusion of utility easements and rights-of-way in a subdivision, to assure the eventual construction and utilization of such a system in the subdivision.[250] However, with the approval of HRS, the requirement to connect onsite systems to the sewer may be waived if the owner of the publicly or investor-owned sewerage system determines that the "connection is not required in the public interest due to financial or public health considerations."[251]

Where a central sewerage system is not available, onsite sewage disposal systems are allowed under certain conditions related to the size of lots, use of public water, and projected

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246 Fla. Stat. § 381.272(9) (1989).

247 Rule 10D-6.041(8)(a) Fla. Admin. Code (1989).

248 Rule 10D-6.041(9) Fla. Admin. Code (1989).

249 Fla. Stat. § 381.272(1), Rule 10D-6.041(2) Fla. Admin. Code (1989). A municipal or investor-owned sewerage system is considered "available" when:

a. it is not under DER moratorium;

b. for estimated sewage flows 600 gallons or less per day, the sewer line is in a public easement or right-of-way abutting the property and gravity flow can be maintained from the building to the sewer line;

c. for estimated sewage flows exceeding 600 gallons per day, a sewer line, force main, or lift station exists in a public easement or right-of-way abutting the property or within 100 feet of the property;

d. the sewerage system has adequate hydraulic capacity to accept the quantity to be generated by the proposed use. Rule 10D-6.042(7) Fla. Admin. Code (1989).

250 Id.

251 Id.

daily sewage flows. Onsite sewer systems may be used with private potable wells in subdivisions and lots in which:

1. the lot is at least one-half acre, and has either a minimum dimension of 100 feet or a mean of at least 100 feet of the side bordering the street and the length of a line drawn parallel to the side bordering the street between the two most distant points of the remainder of the lot,

2. projected domestic sewage flows do not exceed 1500 gallons per acre per day,

3. satisfactory drinking water is obtainable, and all setback, soil condition, water table elevation, and other requirements can be met.[252]

In subdivisions and lots using public water systems, onsite sewer systems may be used if there are no more than four lots per acre, average daily sewage flow does not exceed 2500 gallons per acre, and all other setback, soil condition, water table elevation and related requirements are met.[253] If mandatory sewerage system connection has not been waived, the above provisions do not apply to areas where a municipally owned or investor owned and approved public sewer system is available, contiguous to the proposed subdivision or within one-fourth mile with public right-of-way accessibility.[254]

Where a developer or other appropriate entity has made provisions, including financial assurances or other commitments, that a central water system will be installed by a regulated public utility based on a density formula, then private potable wells may be used with onsite sewage systems on an interim basis until the agreed densities are reached. In these subdivisions, average daily sewage flows must not exceed 2500 gallons per acre per day.[255]

Lots platted before 1972 are not subject to minimum lot size requirements, but the daily sewage flows must not exceed an average of 2500 gallons per acre per day for lots served by a public potable water system, and must not exceed 1500 gallons per acre per day for lots served by private potable wells or by certain limited use wells.[256] Lots platted before 1972 which are served by private wells or limited use wells, and are at least 5500 square feet qualify for a single family residence with no more than two bedrooms and no more than 1000 square feet of heated or cooled living area.[257] This provision allows densities of almost eight on-site septic systems per acre.

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[252] Fla. Stat. § 381.272(2); Rule 10D-6.046(7) Fla. Admin. Code (1989).

[253] Rule 10D-6.046(7)(b) Fla. Admin. Code (1989).

[254] Rule 10D-6.046(7)(d) Fla. Admin. Code (1989).

[255] Rule 10D-6.046(7)(c) Fla. Admin. Code (1989).

[256] Rule 10D-6.046(7)(f) Fla. Admin. Code (1989). Rule 10D-6.042(31)(b) defines these limited use wells as public wells serving non-community systems with a projected sewage flow of no more than 2000 gallons per day; or a water system not served by a private well, with less than fifteen service connections used year around, or which serves less than 25 persons daily at least 60 days out of the year, or serves at least 25 persons daily less than 60 days out of the year.

[257] Id.

Tables used to calculate average sewage flows for various residences and residential establishments are contained in the rule. Dwelling units with one bedroom and 600 feet or less of heated or cooled area are assigned an estimated average of 150 gallons of sewage flow per day. Those with two bedrooms and 601-1000 square feet are estimated at 250 gallons per day. Dwelling units with three bedrooms and 1001-2000 square feet are estimated at 350 gallons per day, and those with four or more bedrooms and over 2000 square feet are estimated at 450 gallons per day.[258] For residential uses other than single family, sewage flows are to be estimated at 75 gallons per day per occupant. These and other more detailed estimated daily sewage flows for various commercial, institutional and residential uses are listed in Rule 10D-6.048(1) (Table I), Fla. Admin. Code.

With respect to groundwater, onsite systems must be located downgradient from water supply wells "when practical."[259] They may be placed no closer than 75 feet from a private potable well; 200 feet from a public potable well serving a residential or non-residential establishment with a total sewage flow of over 2000 gallons per day; 100 feet from a public potable well serving a residential or non-residential establishment with 2000 gallons or less of total sewage flow per day; 75 feet from surface waters; or 50 feet from non-potable wells.[260] Systems must not be located under buildings or within five feet of foundations. Drain fields must not be located within ten feet of potable water lines unless the lines are encased in at least six inches of concrete or are placed within a sleeve of similar pipe material to a distance of at least ten feet from the nearest part of the drainfield. Systems must not be located within 75 feet of the mean high water line of tidal waters, or within 75 feet of the ordinary high water line of non-tidal waters.[261] Variances from the setbacks and density limitations can be granted by DHRS if: the hardship was not caused intentionally by the action of the applicant; no reasonable alternative exists for treatment of the sewage; and the discharge from the individual on-site system will not adversely affect the health of the applicant or the public, or significantly degrade ground or surface waters.[262]

Where permitted, onsite systems are subject to the following soils criteria: 1) the effective soil depth throughout the drainfield installation site must extend 42 inches or more below the bottom surface of the drainfield trench or absorption bed; 2) the water table elevation at the wettest season must be at least 24 inches below the bottom surface of the drainfield trench or absorption bed; 3) the setbacks and other requirements stated above must be met; 4) the site and drainfield must not be covered with asphalt or concrete, or be subject to traffic requiring an impervious surface which would impede the operation of the system; 5) the installation site and drainfield must not be subject to saturation from artificial drainage flows; 6) the final lot elevation must not be subject to frequent flooding.[263] Standard onsite systems must not be installed in fill

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[258] Rule 10D-6.047(e)3, Fla. Admin. Code (1989). Where the number of bedrooms on the floor plan and the square footage of heated and cooled area do not coincide, the criterion which results in the greater sewage flow applies. Id.

[259] Rule 10D-6.046(1) Fla. Admin. Code (1989).

[260] Fla. Stat. § 381.272(6); Rule 10D-6.046(1) Fla. Admin. Code (1989).

[261] Rule 10D-6.046(2), (3), Fla. Admin. Code (1990).

[262] Fla. Stat. § 381.272(8) (1989).

[263] Rule 10D-6.047 Fla. Admin. Code (1989).

material unless the fill has settled for six months, or has been compacted to a density comparable to that of the surrounding soil.[264]

Minimum septic tank capacities are based on average sewage flows in gallons per day, ranging from a 750 gallon tank for sewage flows of 0-400 gallons per day, up to a 5800 gallon tank for sewage flows of 4501-5000 gallons per day.[265] The minimum absorption area for standard subsurface drainfield systems and graywater drainfield systems must be based on estimated domestic sewage flows and the table reproduced below, contained in Rule 10D-6.049(5) (Table IV), Fla. Admin. Code. Rule 10D-6.058 describes the major USDA soil texture classifications and gives methods of field classification.

Suitable, unobstructed land must be available for the installation and proper functioning of drainfields, and at least 50 percent of the unobstructed area must meet the minimum setbacks described above. The unobstructed area must be at least three times the required absorption field area. Other relevant sections of Chapter 10D-6, F.A.C. include those detailing design, construction, maintenance and closure standards for on-site septic systems; design requirements for graywater systems; specific provisions for the Florida Keys, and areas of Dade County in which Key Largo Limestone or Miami Limestone exists within 18 inches of the ground surface; and registration requirements for septic tank contractors.

U.S. DEPT. OF AGRICULTURE SOIL TEXTURAL CLASSIF.	PERCOLATION RATE	MAXIMUM SEWAGE LOADING RATE TO TRENCH BOTTOM (GAL./SQ. FT./DAY)
Sand; Loamy Sand	Less than 2 min. per inch	2.0
Sandy Loam	2-4 min. per inch	1.5
Loam; Silt Loam	5-10 min. per inch	1.0
Silt; Sandy Clay Loam	$>$10 min. per inch but $\leq$ 15 min./inch	.75
Clay Loam; Silty Clay Loam; Sandy Clay; Silty Clay	$>$15 min. per inch but $\leq$ 30 min./inch	.50
Clay; Organic Soils; Hardpan; Bedrock	$>$30 min. per inch	Unsatisfactory for std. subsurface system
Very Coarse Sand; Gravel or Fractured Rock	$<$1 min. per inch and water table $<$4 feet below drainfield	Unsatisfactory for std. subsurface system

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264 Rule 10D-6.046(5) Fla. Admin. Code (1990).

265 See Rule 10D-6.048(2) (Table III), Fla. Admin. Code (1990).

Chapter 5E-1, F.A.C.: Fertilizer

Generally, Ch. 5E-1, F.A.C. controls the registration and labeling of commercial fertilizers. Raw animal manures are exempted, as are potting soils, mulch and peat, when no plant nutrient values are claimed or implied. The rule requires listings of the sources and amounts of various primary and secondary plant nutrients. It also provides for the categorization and labeling of fertilizer-pesticide blends. Instructions for the proper application of such blends must be included on the label. Vehicles for transporting fertilizer-pesticide blends must be designed to prevent spills and dusting, and must include caution signs indicating that the vehicle is carrying fertilizers with pesticides. The rule also specifies proper sampling methods for various circumstances, including documentation procedures.

Chapter 5E-2, F.A.C.: Pesticides

State regulations on the registration, use, and application of pesticides are administered by the Department of Agriculture and Consumer Services (DACS) under the authority of Chapter 487, Florida Statutes.[266] This chapter generally requires registration of any substance used for pest control. The law prohibits the distribution or sale of any unregistered, improperly labeled, or unlabeled pesticide. It also prohibits the use or disposal of any pesticide, including a restricted-use pesticide[267] in a manner contrary to the label directions.[268]

Certain distributors and applicators are exempt from compliance with the portions of the Florida Pesticide Law. The penalty for failure to register does not apply to any carrier of pesticides who has permitted DACS to copy all records of movement of the shipment, public officials engaged in the performance of their duties, or to manufacturers or shippers of pesticides for experimental use only. Further, the prohibitions do not apply when the pesticide is intended solely for export to a foreign country when packed according to the specifications of the purchaser. Registration and labeling are not required when the pesticide is only to be shipped from one manufacturer to another within the state, except that poison labels are required for any substance in quantities highly toxic to humans. The chapter also does not apply to pest control operators engaging in mosquito control or in pest control under structures, on lawns or ornamental plants.[269]

Chapter 5E-2 of the Florida Administrative Code further defines the registration and use requirements as stated in Chapter 487, Florida Statutes. Chapter 5E-2 requires distributors to

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[266] Fla. Stat. §487.041 (1987)

[267] A "restricted-use" pesticide is defined as "a pesticide which, when applied in accordance with its directions for use ... may generally cause, without additional regulatory restrictions, unreasonable adverse effects on the environment, or injury to the applicator or other persons, and which has been classified as a restricted-use pesticide by [DACS] or the administrator of the [EPA]." Fla. Stat. §487.021(50) (1987).

[268] Fla. Stat. §487.031(8) (1987).

[269] Fla. Stat. §487.081 (1987)

register pesticides by completing a registration application and submitting data summaries of information sent to EPA in compliance with FIFRA. DACS reviews the data summaries for a number of factors: susceptibility of the pesticide to leaching into groundwater; toxicological impact on non-target organisms such as fish or humans; the environmental fate of the pesticide under Florida hydrogeological conditions; and methods for measuring residue in soil and groundwater.[270]

The chapter also designates restricted-use pesticides and prescribes labeling, sampling, and disposal procedures. Many pesticide labels indicate setbacks required in certain types of geologic areas or in areas with drinking water wells. It is the responsibility of the applicator to ensure these setbacks are followed.[271]

All irrigation systems which apply chemicals or fertilizer must be equipped with antisyphon devices to prevent flowback of chemicals into the water supply. The rule specifies different devices, depending on what type of chemical or fertilizer is being applied.[272] The chemical storage tanks on all irrigation systems must be constructed and maintained to ensure containment of the chemical and prevent contamination.[273] The rule also requires that all check valves, low pressure drains, solenoid valves, pressure switches, system interlocks and vacuum breakers on irrigation systems be kept free of corrosion and must be operative at all times when the irrigation system is in operation.[274]

Disposal of highly toxic waste pesticides is regulated under this section. Waste pesticides must be removed from their container and destroyed according to label directions. The empty containers must be buried, burned, or decontaminated as the label indicates.[275]

Chapter 5E-9, F.A.C.: Pesticide Applicators

Chapter 5E-9 defines the licensing and certification requirements for restricted-use pesticide applicators as authorized under the Florida Pesticide Application Act of 1974 in Chapter 487 of the Florida Statutes. The rule does not apply to pesticide applicators for the control of mosquitos or pests under structures, on lawns or ornamental plants.[276]

Commercial and public applicators must take an examination to demonstrate knowledge of principles of pest control and safe use of pesticides. The environmental aspects of the exam cover the environmental consequences of the use and misuse of pesticides due to weather

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[270] Rule 5E-2.031(3), Fla. Admin. Code (1989).

[271] Rule 5E-2.028(4), Fla. Admin. Code (1989).

[272] Rule 5E-2.030, Fla. Admin. Code (1989).

[273] Rule 5E-2.030(5), Fla. Admin. Code (1989).

[274] Rule 5E-2.030(7), Fla. Admin Code (1989).

[275] Rule 5E-2.018, Fla. Admin. Code (1989).

[276] Rule 5E-9.001, Fla. Admin. Code (1989).

conditions, types of soil or substrate, presence of non-target organisms, and drainage patterns.[277] Private applicators are also tested to demonstrate knowledge of adverse effects of pesticides on humans, animals and the environment.[278]

ST. JOHNS RIVER WATER MANAGEMENT DISTRICT[279]

Chapter 40C-2, F.A.C.: Permitting of Consumptive Uses of Water

The primary goals of this rule are to ensure that water uses are "reasonable beneficial," that they do not impact existing users and that they are in the public interest. Criteria which are applied in evaluating permit applications include avoiding impacts to the saltwater interface, preventing adverse drawdowns in the water table or potentiometric surface, and avoiding adverse impacts to fish and wildlife or the public health and safety. Maintenance of recharge is not a specific criterion within the rule.

Chapters 40C-3, 40C-4, 40C-5, F.A.C.

Beyond the level of protection offered within the consumptive use rule, other protection measures are contained in the rules relating to the management and storage of surface waters (MSSW), well construction standards and artificial recharge, Rules 40C-4, 40C-3, and 40C-5, respectively. Usually considered within the context of flood control and water quality and wetlands protection, the MSSW permitting program actually results in substantial protection of recharge functions and groundwater. Permits are required to provide reasonable assurances that the surface water management system will not result in, among other things, inducement of saltwater intrusion, groundwater pollution, or reduction of natural water storage areas.

By requiring that water be retained or detained on-site, excessive drainage is avoided and maintenance of recharge is promoted. Where discharge requirements are expressed in terms of volumetric standards as opposed to peak rate of discharge standards, recharge is preserved. This volumetric standard is applied only within specific, critical areas of the district such as discharges to land-locked lakes and where basin specific criteria have been adopted. Within the Wekiva River Basin, specific, quantitative recharge requirements are included within the MSSW rule. For projects within the "most effective recharge areas," recharge in the post-development condition is required to be at least equal to the pre-development condition.

For projects involving the artificial recharge of water, the district participates in the DER Underground Injection Control permitting program. For artificial recharge of water containing sewage wastes, the district requires a separate permit. Applicants must investigate alternative methods of wastewater disposal such as reuse to ensure that the injection will not adversely affect the public interest.

The final permitting program affording significant groundwater protection is the water well construction program. By regulating the location, construction, repair and abandonment of water

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277 Rule 5E-9.007, Fla. Admin. Code (1989).

278 Rule 5E-9.006, Fla. Admin. Code (1989).

279 Summaries provided by St. Johns River Water Management District staff.

wells and requiring the licensing of water well contractors, adverse impacts to water quality related to improperly constructed or abandoned wells are minimized.

SOUTHWEST FLORIDA WATER MANAGEMENT DISTRICT[280]

Chapter 40D-4, F.A.C.: Management and Storage of Surface Waters

The principal method by which the SWFWMD protects recharge areas is through the Management and Storage of Surface Waters permitting function. Chapter 40D-4, F.A.C. regulates the management of all surface waters within the District by means of a surface water management permit system. Through requirements to maintain pre-development discharge conditions on development sites in the post-development condition, significant recharge protection occurs. In addition, Rule 40D-4.301(1)(d), F.A.C. requires that a surface water management system not cause adverse impacts on surface and groundwater levels as a condition for the issuance of a permit.

Chapter 40D-5, F.A.C.: Artificial Recharge

Chapter 40D-5, F.A.C. regulates the construction of projects involving artificial recharge or the intentional introduction of water into underground formations. Rule 40D-5.041(1), F.A.C. requires that any project involving artificial recharge or the intentional introduction of water into any underground formation shall obtain a permit from the District.

Chapter 40D-6, F.A.C.: Works of the District

The purpose of Chapter 40D-6, F.A.C. is to implement the declared water policy of the SWFWMD and the State of Florida as it relates to the works of the District. This Rule is aimed at protecting the works of the District. Rule 40D-6.301(2)(a), F.A.C. requires the denial of a permit for any activity that will place fill material, or a non-water use related structure within the mean annual floodplain of a lake or other impoundment, or of a stream or other watercourse.

Chapter 40D-21, F.A.C.: Water Shortage Plan

Chapter 40D-21, F.A.C. comprises the SWFWMD water shortage plan. The purpose of the plan is to protect the water resources of the District from harm and assure equitable distribution of the resource during times of shortage. Rule 40D-21.221(2)(c), F.A.C. requires a periodic determination of potential impacts on the water resource. These impacts include the occurrence of or potential for ground water contamination or significant lowering of the water table. Rule 40D-21.401(3), F.A.C. provides for monitoring and data collection. This includes information on water quality and levels of surface and ground waters.

Chapter 40D-40, F.A.C.: General Surface Water Management Permits

Chapter 40D-40, F.A.C. grants general permits for certain specified surface water management systems that are not harmful to the water resources of the District, and are

[280] Summaries provided by Southwest Florida Water Management District staff.

consistent with the objectives of the District. Those systems not qualifying for a general permit are required to obtain an individual permit through Chapter 40D-4, F.A.C. Rule 40D-40.301, F.A.C. ensures that discharges from stormwater management systems will meet state water quality standards and have acceptable or insignificant impact on water resources.

Chapter 40D-45, F.A.C.: Surface Water Management for Mining Materials Other Than Phosphate

Chapter 40D-45, F.A.C. governs surface water management during mining of materials other than phosphate. This rule protects water resources, including wetlands and other natural resources, both during mining operations and following the completion of mining activities. Rule 40D-45, F.A.C. ensures that surface water management systems will not cause adverse impacts on surface or ground water levels and flows as a condition for the issuance of a permit.

LOCAL GOVERNMENT COMPREHENSIVE PLANNING AND LAND DEVELOPMENT REGULATION ACT

Local Government Comprehensive Plans

The Local Government Comprehensive Planning and Land Development Regulation Act (Growth Management Act) requires that local governments devise comprehensive plans to guide and control future development.[1] Comprehensive plans are long range policy documents which provide guidance for local government regulatory activities. Local governments must implement and enforce the objectives of the comprehensive plan through land development regulations.[2] The Act requires that land development regulations and development orders must be consistent with the validly adopted local government comprehensive plan.[3]

The Department of Community Affairs (DCA) and the appropriate Regional Planning Council[4] review and assist in development of local government plans and regulations. DCA is responsible for insuring that local governments comply with the Act, and has adopted Rule 9J-5, F.A.C., which establishes minimum criteria for review and determination of compliance of comprehensive plans. As part of the review, DCA evaluates the consistency of the comprehensive plan elements with each other, the state comprehensive plan, and the appropriate regional policy plan.[5] A variety of sanctions are available to encourage local governments to comply with the requirements of the Act.[6]

Local governments are required to evaluate, appraise, and update the local comprehensive plan at least once every five years, in a report to DCA.[7] DCA's rules establishing minimum criteria

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[1] Fla. Stat. §§ 163.3161 - 163.3243 (1989). Most local governments are currently using growth management plans developed to satisfy the Local Government Comprehensive Planning Act of 1975. These local governments are developing new comprehensive plans to satisfy the more stringent requirements of Chapter 163, Florida Statutes. Local government comprehensive plans which must include a coastal management element are due between July 1, 1988 and July 1, 1990. All other local government comprehensive plan elements are due between July 1, 1989 and July 1, 1991. Id. § 163.3167(2)(a),(b). Due dates for specific local governments are contained in Rule 9J-12.007, Fla. Admin. Code (Aug.,1988).

[2] Fla. Stat. § 163.3202 (1989). Local governments must adopt land development regulations within one year after submission of a comprehensive plan for review. Id. § 163.3202(1).

[3] Fla. Stat. § 163.3194 (1989). Rule 9J-24.008, Fla. Admin. Code (July, 1989), provides criteria for determining consistency of land development regulations with the comprehensive plan.

[4] Florida is divided geographically into eleven Regional Planning Councils. Chapter 29, Fla. Admin. Code.

[5] Fla. Stat. § 163.3177(9)(b),(c) (1989). Criteria for determining the consistency of local government comprehensive plans with comprehensive regional policy plans and with the state comprehensive plan are contained in Rule 9J-5.021, Fla. Admin. Code (Dec., 1989).

[6] Fla. Stat. §§ 163.3167(3), 163.3184(11) (1989).

[7] Fla. Stat. § 163.3191 (1989).

for the review of local plans emphasize that the Act establishes minimum thresholds for acceptance of a local plan. As long as a plan is found to be in compliance with the Act and DCA's rules, it may be as broad, specific, detailed, or strict as the local government wishes.

State Comprehensive Plan

The state comprehensive plan, codified at Chapter 187, F.S., contains broad goals and policies which provide guidance for local government comprehensive plans and land development regulations.[8] Local government comprehensive plan elements must be consistent with the state comprehensive plan. The state comprehensive plan goal for water resources is to "assure the availability of an adequate supply of water for all competing uses ... and maintain the functions of natural systems and the overall present level of surface and ground water quality."[9] The plan contains the following policies relating directly to groundwater protection: 1) ensure the safety and quality of drinking water supplies; 2) identify and protect the functions of water recharge areas and provide incentives for their conservation; 3) ensure that new development is compatible with existing water supplies; 4) protect aquifers from depletion and contamination; and 5) protect surface and groundwater quality and quantity in the state.[10] The plan also contains other goals and policies which relate to groundwater protection.

Comprehensive Plan Elements Relating to Groundwater Protection

The Act requires that local government comprehensive plans include the following elements relating to groundwater protection: 1) capital improvements element; 2) future land use element; 3) general sanitary sewer, solid waste, drainage, potable water, and natural groundwater aquifer recharge element; and 4) conservation element. Rule 9J-5, F.A.C., the state comprehensive plan, and regional policy plans[11] provide additional guidance and criteria for development of the comprehensive plan elements. Rule 9J-5 provides minimum criteria for development and review of local government comprehensive plans. The state comprehensive plan, discussed above, provides broad policy guidelines for water resources, natural systems, and land use. Regional policy plans provide detailed goals, objectives, and policies pertaining to each of the required comprehensive plan elements.[12]

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[8] Fla. Stat. ch. 187 (1989).

[9] Fla. Stat. § 187.201(8)(a) (1989).

[10] Id. § 187.201(8)(b).

[11] Each Regional Planning Council must create a regional policy plan and is responsible for assisting in development and review of local government comprehensive plans and land development regulations. Fla. Stat. §§ 186.507, 186.508, 186.505 (1989). Regional planning councils also assist in review of certain large scale developments (Developments of Regional Impact). Fla. Stat. § 186.507(9) (1989).

[12] Regional Planning Council comprehensive plans are incorporated by reference in the Florida Administrative Code as follows: West Florida Regional Planning Council (Chapter 29-A2); North Central Florida Regional Planning Council (Chapter 29C-7); Northeast Florida Regional Planning Council (Chapter 29D-4); Withlacoochee Regional Planning Council (Chapter 29E-11); East Central Florida Regional Planning Council (Chapter 29F-19); Central Florida Regional Planning Council (Chapter 29G-2); Tampa Bay Regional Planning Council (Chapter 29H-9.002); Southwest Florida Regional Planning Council (Chapter 29I-6); South Florida Regional Planning Council (Chapter 29J-2.007); Treasure Coast Regional Planning Council (Chapter 29K-5); Apalachee Regional Planning

Rule 9J-5 requires that comprehensive plan elements be based on an inventory and analysis of specific factors identified in the rule.[13] Local governments must use these inventories and analyses to set long term goals, specific objectives, and policies, including regulatory or management techniques for implementing the plan.[14] While a discussion of all of the specific requirements of Rule 9J-5 is beyond the scope of this report, the most important requirements pertaining to protection of groundwater are identified below.

1. Capital Improvements Element

The capital improvements element must "consider the need for and the location of public facilities," such as potable water wellfields, "in order to encourage the efficient utilization of such facilities."[15] The element must outline principles for construction, extension, or increase in capacity of public facilities, and must ensure the availability of those facilities at acceptable levels of service.[16] Local governments must adopt levels of service for potable water,[17] which establish minimum design flow, storage capacity, and pressure for potable water facilities.[18] Local governments may not issue development orders which would result in reduction of levels of service below the levels provided for in the comprehensive plan.[19]

2. Future Land Use Plan Element

The future land use element must designate the future distribution, location, and extent of private and public land uses, including uses for conservation and public facilities.[20] The element must include standards to control the distribution of population densities and building and

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Council (Chapter 29L-5).

[13] Data and analysis requirements for comprehensive plan elements relating to groundwater protection are found at: 1) Rule 9J-5.016(1),(2), F.A.C (capital improvements element); 2) Rule 9J-5.006(1),(2), F.A.C. (future land use element); 3) Rule 9J-5.011(1), F.A.C. (general sanitary sewer, solid waste, drainage, potable water, and natural groundwater aquifer recharge element); and 4) Rule 9J-5.013(1), F.A.C. (conservation element).

[14] Requirements for goals, objectives, and policies for comprehensive plan elements relating to groundwater protection are found at: 1) Rule 9J-5.016(3), F.A.C (capital improvements element); 2) Rule 9J-5.006(3), F.A.C. (future land use element); 3) Rule 9J-5.011(2), F.A.C. (general sanitary sewer, solid waste, drainage, potable water, and natural groundwater aquifer recharge element); and 4) Rule 9J-5.013(2), F.A.C. (conservation element).

[15] Fla. Stat. § 163.3177(3)(a) (1989).

[16] Id.

[17] Rule 9J-5.0055(1)(a)5, Fla. Admin. Code (Feb., 1990).

[18] Id. Rule 9J-5.011(2)(c)2.d. (March, 1990).

[19] Fla. Stat. § 163.3202(2)(g) (1989). Local governments may condition development permits or orders on the availability of public facilities and services necessary to serve the proposed development. Id.

[20] Fla. Stat. § 163.3177(6)(a) (1989).

structure intensities.[21] In addition, the element must include existing land use maps which show generalized land uses and natural resources, including existing and planned waterwells and cones of influence.[22]

The future land use plan must be based on surveys, studies, and data which evaluate the amount of land required to accommodate anticipated growth, the projected population of the area, the character and magnitude of undeveloped land, and the availability of public services.[23] The analysis must include consideration of whether the availability of public facilities and services as identified in the sanitary sewer, solid waste, drainage, potable water, and natural groundwater aquifer recharge element is adequate to serve existing land uses and approved developments.[24]

The element must be supplemented with goals, policies, and measurable objectives[25] which ensure: 1) protection of natural resources; 2) development approval is conditioned upon the availability of adequate levels of service; and 3) protection of potable water wellfields and environmentally sensitive lands.[26] The element must also include a future land use map depicting natural resources, including existing and planned waterwells and cones of influence, and the proposed distribution, extent, and location of generalized land uses.[27]

3. General Sanitary Sewer, Solid Waste, Drainage, Potable Water, and Natural Groundwater Aquifer Recharge Element

This element must identify ways to provide for future potable water, drainage, sanitary sewer, solid waste, and aquifer recharge protection requirements which are projected in the future land use element.[28] The element must identify existing and projected problems and needs and describe the general facilities which will be required to solve the problems and needs.[29] The element must include a topographic map depicting any areas designated as prime groundwater recharge areas by the regional water management district.[30] Prime recharge areas must be given special consideration when local governments consider zoning or land uses for these areas.[31]

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[21] Id.

[22] Rule 9J-5.006(1)(b), Fla. Admin. Code (May, 1990).

[23] Fla. Stat. § 163.3177(6)(a) (1989).

[24] Rule 9J-5.006(2)(a), Fla. Admin. Code (May, 1990).

[25] Fla. Stat. § 163.3177(6)(a) (1989).

[26] Rule 9J-5.006(3)(b),(c), Fla. Admin. Code (May, 1990).

[27] Id. Rule 9J-5.006(4) (March, 1990).

[28] Fla. Stat. § 163.3177(6)(c) (1989); Rule 9J-5.011, Fla. Admin. Code (March, 1990).

[29] Fla. Stat. § 163.3177(6)(c) (1989).

[30] Rule 9J-5.011(1)(g), Fla. Admin. Code (March, 1990).

[31] Fla. Stat. § 163.3177(6)(c) (1989).

Local governments must assess the strengths and weaknesses of existing regulations and programs in maintaining the functions of natural drainage features and groundwater recharge areas.[32] In areas where septic tanks are allowed, local governments must provide soil surveys indicating the suitability of soils for septic tanks.[33] In addition, the element must contain objectives and policies which address: 1) conserving potable water resources, 2) protecting the functions of natural groundwater and natural drainage features, 3) establishing minimum design flow, storage capacity, and pressure for potable water facilities, 4) establishing and utilizing potable water conservation strategies and techniques, and 5) regulating land use and development to protect functions of natural drainage features and groundwater recharge areas.[34]

4. **Conservation Element**

The conservation element must provide for conservation, use, and protection of natural resources, including water, water recharge areas, and waterwells.[35] Local governments must assess their current water needs and sources for a ten year period, based on the demands for industrial, agricultural, and potable water use.[36] The quality and quantity of water available to meet these demands must also be analyzed.[37] The element must contain policies which protect water quality by restricting activities which "adversely affect the quality and quantity of identified water sources including existing cones of influence, water recharge areas, and waterwells."[38] The element must also include policies providing for emergency conservation of water resources in accordance with water management district plans.[39] In addition, the land use map contained in the future land use plan element must depict "existing and planned waterwells and cones of influence."[40]

Local Government Land Development Regulations

Local governments must implement and enforce the objectives of the comprehensive plan through land development regulations.[41] The Act states that local government land development regulations must provide for protection of potable water wellfields.[42] Land development regulations must also regulate the use of land and water for land use categories included in the

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[32] Rule 9J-5.011(1)(h), Fla. Admin. Code (March, 1990).

[33] Id. Rule 9J-5.011(1)(f)4; Fla. Stat. § 163.3177(6)(c) (1989).

[34] Rule 9J-5.011(2)(b),(c), Fla. Admin. Code (March, 1990).

[35] Fla. Stat. § 163.3177(6)(d) (1989).

[36] Rule 9J-5.013(1)(c), Fla. Admin. Code (Dec., 1989).

[37] Id.

[38] Id. Rule 9J-5.013(2)(c)1.

[39] Id. Rule 9J-5.013(2)(c)4.

[40] Fla. Stat. § 163.3177(6)(d) (1989).

[41] Fla. Stat. § 163.3202 (1989).

[42] Id. § 163.3202(2)(c).

land use element, ensure the compatibility of adjacent uses, and ensure the protection of environmentally sensitive lands as designated in the comprehensive plan.[43]

Procedures and criteria for review of local government land development regulations are contained in Chapter 9J-24, Florida Administrative Code.[44] In determining whether a local government has adopted the required land development regulations, DCA must determine whether the regulation provides for the "control of land uses and activities within identified cones of influence for potable water wells and wellfields, in order to protect the potable water supply."[45] Also, DCA must determine whether the regulations provide for protection of environmentally sensitive lands, including protection of groundwater.[46] A local government may adopt existing regulations applied within its jurisdiction by other agencies, if the local government determines that the regulations satisfy the requirements of the Act and DCA's rules.[47]

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43 Id. § 163.3202(2)(b),(e).

44 Chapter 9J-24, Fla. Admin. Code (July, 1989).

45 Id. Rule 9J-24.003(1)(c).

46 Id. Rule 9J-24.003(1)(f).

47 Id. Rule 9J-24.003(3).

Chapter III Review of Aquifer Protection Tools

REVIEW OF AQUIFER PROTECTION TOOLS

Once data has been collected and protection zones established, an aquifer protection program can be developed which addresses applicable conditions. The content and structure of the program will depend on several factors, among them: the hydrogeologic characteristics of presently used aquifers and those designated for future use; the nature, number and location of potential contamination threats; the nature and location of existing development in the area; and the administrative and financial resources of the local government.

A complete aquifer protection program will normally consist of both regulatory and non-regulatory approaches. Regulatory components include techniques such as zoning ordinances, subdivision controls, and health regulations. Non-regulatory approaches may include land acquisition, rights of first refusal, conservation easements, hazardous waste collection (amnesty days), contingency plans, and public education.

This section of the manual addresses several types of options and tools available to local governments, and provides summaries of their content and potential application in aquifer protection programs. The section is intended to provide a general understanding of methods that might be used in an aquifer protection program. The meshing of these techniques into an effective program will require analysis and creativity. Several different types of suggested regulatory approaches applicable to different threats are presented in Chapter IV of this volume.

ORDINANCE STRUCTURE

The structure of local regulatory approaches to potential groundwater threats will depend on the type of threat and the level of control imposed, but several basic elements will clarify the intent and rationale of an ordinance, and create a logical approach to the requirements it imposes. For any ordinance with effects on land use, it is important to include a series of ***specific findings of fact*** that identify the basic problems to which the ordinance is addressed, and that justify the requirements imposed by the ordinance. This should include explanation of the functions and benefits of the resource, the known adverse effects of its pollution, and the level of threat posed by the land use being regulated.

An ***objectives and purposes*** section should clearly explain the function of and need for the ordinance, based on the information put forth in the findings of fact. This section is meant to serve as a clear explanation of the intent of the ordinance. Controls on land uses affecting groundwater are an essential exercise of the police power, basic to protection of the public health, safety and welfare. The sections on findings of fact and objectives and purposes should create a careful and comprehensive justification of the particular ordinance.

For most approaches, a section on ***definitions*** serves to identify and define terms used in the ordinance that may not be readily understood, or that may be misinterpreted without clarification. For ordinances addressing groundwater, groundwater threats, and performance and design standards, careful attention to details in this section will serve to identify protection areas and prevent confusion and challenges to the application of the ordinance. Where necessary, maps and other technical documents or standards can be adopted by reference.

For some types of overlay zoning ordinances, a section on ***establishment of the protection zones*** may be necessary to clearly define the extent of the zones, with references to maps, and to allow for interpretation of a zone boundary in ambiguous cases. This information can be incorporated into a section on applicability, that details which parts of the community and which types of land use are subject to the ordinance. For ordinances addressing hazardous materials, the types of substances regulated may be addressed in a subsection, or in a separate section.

Communities with the necessary administrative resources will be able to establish permitting programs, requiring proposed land uses in sensitive zones to apply for and obtain a permit based on the requirements of the ordinance. Generally, a ***permitting section*** states the conditions under which a permit will be required. Subsections may include those for the application process with detailed information requirements, and a listing of non-threatening activities which are exempted so long as they meet the performance standards and intent of the ordinance. An operating permit may be a separate requirement, allowing the local government to review and revise the permit on a regular basis. The term of the permit should also be made clear, as well as provisions for review and renewal. Several types of land uses should include closure permit requirements, which assure that when the activity is concluded, the site will not become a hazard or a source of contamination.

Where flexibility is required, ***special exceptions*** may be included for certain areas, subject to strict review procedures and conditions. Use variances are no longer permitted in Florida. Other types of variances should be granted only when the hardship is clear and unavoidable and granting the variance will not impair the intent or effectiveness of the ordinance in protecting drinking water supplies. Review of any special exception or variance should be strictly judged against the performance standards and objectives of the ordinance. Generally, use of special exceptions is preferred over use of variances, since allowable uses and applicable conditions can be carefully controlled in the case of special exceptions.

The most important sections are those providing various ***standards*** for new and existing activities, and replacement activities subject to the ordinance. Depending on the type and degree of threat posed by an activity, standards can be specified for the siting, location, design, construction, installation, operation, performance, monitoring and closure of an activity. For more complex sets of activities it may be necessary to place the differing types of standards in separate sections. Particularly important are performance and design standards. Performance standards are those that state the acceptable relationship between the activity and the protected resource, usually in terms of water quality, or level of acceptable pollutant discharge. They are more general in nature and allow for flexible, innovative and effective designs. Design standards and the other types of standards are more specific and establish more technical limits and specifications for the way the activity should be designed, constructed and operated. The standards should have sufficient detail to allow clear interpretation and application.

Sections on ***administration and enforcement*** state which departments are responsible for which actions related to implementation of the ordinance, including conditions under which permits may be revoked. Since the implementation of such ordinances often requires significant administrative resources, a section setting the fees for various types of permits may also be necessary.

LEGAL CONSIDERATIONS

Regulation of land use requires the consideration of certain legal principles. Police power obligations require that local regulations protect the public health, safety and welfare, and protection of groundwater sources of drinking water is directly related to these objectives. There is specific state support for local regulation of threats to groundwater, in Florida's Comprehensive

Planning and Land Development Regulation Act (Growth Management Act),[1] which requires local governments to develop and enforce comprehensive land use plans and regulations that protect and conserve natural resources. The effect of this law is that local governments have the backing of the legislature in the effort to protect drinking water aquifers. The state plan elements[2] and applicable regional policy plan elements (prepared by Regional Planning Councils) will provide support for local comprehensive plan objectives and the land development regulations aimed at protecting groundwater sources of drinking water.

Regulations must have a reasonable relationship to a valid government objective. The concept of reasonableness or rationality is central to local land development regulations. The required regulatory approach taken must be a reasonable means of achieving the objectives; if judicially determined to be unreasonable, it may be found legally invalid. There must be a reasonable basis for any classifications of lands and uses subject to the ordinance. Classifying different areas on the basis of their vulnerability to contamination and their importance as aquifer recharge areas falls clearly within this rule, and requires that, using available resources, a local government develop as clear an understanding as possible of the hydrogeology, water use patterns, and potential threats facing the locality. Classifying land uses and activities on the basis of their potential to contaminate groundwater also falls within the rule, and should be supported by a clear understanding of the types, numbers and locations of potential threats within the locality. The information generated by these studies will serve as the basis for all classifications and land use regulations, and should be clearly communicated to the public and stated in the supporting documentation to the ordinance.

One of the axioms of land use law is that regulations which go too far may so severely restrict the use of private property that a "taking" may occur. Takings analysis is performed on a site-specific basis, and a complete explanation is beyond the scope of this manual, but several general principles and considerations should serve to guide the development of a local ordinance.[3] The first of these is that the ordinance should clearly promote the general health, safety, and welfare of the public. This will be a central basis for all local land development regulations protecting groundwater, and includes the requirement that an ordinance have a reasonable relationship to a valid government objective. The second principle relates to the degree of physical invasion resulting from an ordinance. Regulation of private land is more likely to be considered a taking if it results in an actual physical invasion of the property. For example, regulations which restrict the alteration of the natural features of private property would be considered a proper exercise of the police power, while those which as a result, caused flooding of private property would be acts of eminent domain, requiring condemnation of the property and payment of compensation.

Another very important principle has to do with whether the regulation is designed to provide a public good or avoid a public harm. Where regulations are designed to protect groundwater sources of drinking water from pollution by overlying land uses, they should be characterized as preventing a public harm, rather than securing a previously unsecured public good. This principle will help support the imposition of strict regulations of land use where necessary for protection of groundwater. Unless the regulation removes almost all private property rights, it is less likely to be considered a taking.

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[1] Fla. Stat. §§ 163.3161-163.3215 (1989).

[2] Fla. Stat. Ch. 187 (1989).

[3] See, eg., Graham v. Estuary Properties, Inc., 399 So.2d, at 1380-1381 (Fla. 1981).

Regulations may also be judged on whether they prevent all economically reasonable use of property, and the extent to which they curtail reasonable investment backed expectations. The process of planning and developing regulations often requires local governments to balance the rights of landowners to reasonable use of their property and the community's need to protect the health, safety and welfare. It is possible for changes to occur during the planning and implementation process, which may affect a landowner's expectations for use of the property. Local governments must consider the extent of their accountability in regards to compensating certain landowners for the effects of comprehensive plan development and land use regulation implementation. Landowners who have been issued final development orders and who have started and are continuing development in good faith, may have vested rights to continue the development,[4] a factor that would influence a court's decision in whether there were reasonable investment backed expectations for which compensation would be required. One example of the successful implementation of compensation provisions is that of the Palm Beach County wellfield protection ordinance (Sec. 14), which provides for careful, detailed documentation by the applicant and separate types of compensable expenses that may be paid by the county.

Also important in making this determination is the reasonableness, type and extent of the landowner's investments in a particular piece of land. Takings claims rarely succeed when owners buy vacant lands and attempt to argue that they had reasonable expectations of developing the land. Courts often hold that landowners are not necessarily entitled to development expectations which are out of character with the natural suitability of the land. A successful takings claim requires that the investment be made in reliance on some affirmative conduct of the local government, that leads the owner to reasonably believe that the development may continue. Examples include a rezoning approval or preliminary development plan approval.

There are several approaches local governments can take to reduce legal challenges to land development regulations. One is to provide some flexibility in the regulatory process. One of the most commonly used is the special exception, which sets forth a specific list of potential uses in sensitive areas, subject to strict regulatory controls. The standards to which such uses are subject should be tightly controlled. Some ordinances include provisions for a variance, though the conditions under which the variance is granted should be carefully listed in the ordinance, to assure that the decision will be consistent with groundwater protection purposes. Generally, special exceptions are preferable to variances, since the latter allows for occasional abuse of discretion, while allowable uses and applicable conditions can be carefully controlled in the case of special exceptions. There should be clear processes by which the landowner submits additional information, and providing for adequate input on any such proposal. Providing for the possibility of other less threatening land uses in sensitive protection zones will also help reduce takings claims. So long as there is some reasonable use of the land available under a regulatory approach, courts are more likely to rule in favor of protection of the resource.

Generally, development of a successful regulatory process requires a clear statement of the areas of application and the rationale behind a groundwater protection ordinance. For example, protection zones based on speculative notions of the sensitivity of an area will not be acceptable. The data gathering effort should clearly indicate the need for and reasonableness of an aquifer protection ordinance. In situations where local governments are planning for and protecting future wellfield sites, it will be important to allow full public involvement in the decisionmaking process for the location of these areas. For large wells, the land surface area which requires protection can extend quite far. Planning studies, hydrogeological information, water use data and data on existing and future groundwater threats should be used to justify any potential placement of a wellfield, as well as the need for and extent of protection zones, and

[4] Fla. Stat. § 163.3167(8) (1989).

proposed restrictions necessary to protect the wellfield. Several hearings and public workshops should be held, at which planners, engineers, hydrogeologists and officials can present findings and proposals, and at which the public has an opportunity to express concerns. Palm Beach County Ordinance No. 88-7 (Sec. 9) applies the prohibitions and restrictions of the ordinance to sites officially designated as future wellfields, effective upon approval of the zones of influence maps for those sites. All property owners and "discernable operating activities" in the area affected must receive notice at least thirty days prior to the public hearing at which such action is considered.

REGULATORY TECHNIQUES--ZONING

Traditional Zoning

Traditional, or euclidean, zoning is used to divide communities into districts and to apply different use standards to those districts. It was originally developed to prevent conflicts between incompatible land uses and prevent overcrowding of land. Zoning ordinances normally indicate geographic districts on maps, specify the permitted and prohibited uses within particular districts, and establish the minimum standards controlling lot sizes, building heights, setbacks, etc.

In the context of aquifer protection, zoning can be useful for communities with little or no existing development in aquifer protection areas. Using this technique, a local government can zone or rezone important districts within which aquifer protection areas lie, to allow only those land uses which present little or no threat to the underlying aquifer. Depending on the sensitivity of the area, these designations might include conservation, recreation, or open space uses; low-density residential uses; and certain low-impact agricultural uses. Land uses involving large areas of impervious surface, hazardous substances, or dense development patterns would be assigned to areas where the potable aquifer is not threatened.

One significant disadvantage associated with traditional zoning and rezoning efforts concerns protection zones which have already experienced more than minor amounts of development. In these areas, existing uses and interests that are incompatible with the proposed rezoning may make it very difficult to impose more restrictive zoning classifications. Legal challenges based on charges of a "taking" are likely. If rezoning is successful, pre-existing polluting or threatening activities are "grandfathered" in, allowing them to continue operating as nonconforming uses. Other regulatory techniques may be used to mitigate the threat represented by nonconforming uses, but cannot protect a sensitive area as well as prior restrictive zoning.

Nonconforming uses tend not to disappear by attrition. Depending on the level of risk, and the sensitivity of the underlying aquifer, nonconforming uses found to pose significant threats to the public health, safety and welfare may be immediately discontinued, or discontinued after allowing a reasonable period of time for amortization of the investment. Many smaller local governments lacking the resources to implement a comprehensive aquifer protection program may not have experienced incompatible development in their aquifer protection zones. For these governments, traditional zoning, or rezoning, of these areas can be part of a cost-effective protection strategy.

It should be noted that Florida's Local Government Comprehensive Planning and Land Development Regulation Act (LGCPLDRA)[5] does not require a general zoning code, if a local

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[5] Fla. Stat. §§ 163.3167-.3215 (1989).

government's adopted land development regulations[6] contain specific and detailed provisions necessary or desirable to implement the adopted comprehensive plan, and at a minimum:

a. regulate the subdivision of land;

b. regulate the use of land and water for those land use categories included in the land use element and ensure the compatibility of adjacent uses and provide for open space;

c. provide for protection of potable water wellfields;

d. regulate areas subject to seasonal and periodic flooding and provide for drainage and stormwater management;

e. ensure the protection of environmentally sensitive lands designated in the comprehensive plan;

f. regulate signage;

g. provide that public facilities and services meet or exceed the standards established in the capital improvements element, and are available when needed for the development, or that development orders and permits are conditioned on the availability of these public facilities and services;

h. ensure safe and convenient onsite traffic flow, considering needed vehicle parking.[7]

Thus, traditional zoning may not be a necessary or, in many cases, a particularly desirable approach to protecting a local source of potable water. For aquifer protection purposes, the land development regulations referenced in the LGCPLDRA take in the full range of possible regulatory approaches discussed below.

Overlay Zoning

A problem with traditional zoning strategies is that the districts established may or may not correspond to the geographic boundaries of the aquifer sensitive zones needing protection. Another more flexible and effective approach is known as overlay zoning. Overlay zoning is appropriate in protecting environmentally sensitive areas with geographic boundaries that do not coincide with the underlying zoning district. The technique can be readily incorporated into a system of land development regulations applicable to existing and future threats in these areas.

For aquifer protection purposes, an overlay zone is a mapped district, corresponding to the boundaries of an aquifer sensitive area, which sets other requirements, in addition to those of any other underlying district. Once aquifer protection zones are designated, an overlay zoning ordinance can incorporate several different types of land use and land development controls, which will apply to varying degrees in the different zones. In each case, a primary test of reasonableness will require that the level of regulation be based on the applicable contamination

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[6] Defined as "ordinances enacted by governing bodies for the regulation of any aspect of development and includ(ing) any local government zoning, rezoning, subdivision, building construction, or sign regulations or any other regulations controlling the development of land...." Fla. Stat. § 163.3164 (22) (1989).

[7] Fla. Stat. § 163.3202(3) (1989).

threats and the sensitivity of the area. All of the controls discussed in this section are adaptable to use in conjunction with an overlay zoning scheme. Specific application of these types of ordinances within an aquifer protection program is addressed in Chapter IV of this volume.

Based on the sensitivity of the area, such requirements might include prohibition of uses, reduced densities, limits on amounts of impervious surface, strict control of hazardous materials storage and management, and special stormwater and waste disposal provisions, among others. Flexibility can be added by making many of the uses in aquifer protection overlay zones conditional uses, requiring special permitting. For a local government with more than one type of aquifer protection zone, the overlay zoning scheme will recognize the difference in natural conditions within each zone, and contain correspondingly stringent requirements for the types of land uses allowed and the conditions to be applied to permitted uses. Most representative ordinances included in Volume III, Appendix A include different regulatory standards for activities in different protection zones. See for example, the ordinances of Acton, Mass., Broward County, Florida, and Dade County, Florida.

One of the most important requirements for establishing an overlay zoning ordinance is that the zones be based on sound hydrogeological information. If based on purely arbitrary or speculative notions of aquifer sensitivity, the protection zone boundaries will be subject to constitutional attack. Since the approach being taken bases its restrictions on the essential connection between land use practices and groundwater quality, there must first be a substantive showing of the hydrogeologic sensitivity of the area(s) enclosed by the designated boundaries. This does not necessarily require that the boundaries be based on consultant-generated, area-specific hydrogeologic studies, though a local government in position to carry out or contract for an in-depth study will be in a better position to defend its protective zone designations.

The local government must use whatever resources are at its disposal in order to make a reasonable calculation of the boundaries of its aquifer protection areas. Local governments with fewer resources can make use of less expensive, basic studies, as well as information produced by agencies such as the United States Geological Survey, the Florida Geological Survey, the Florida Department of Environmental Regulation, the Soil Conservation Service and the appropriate water management district,[8] among others. The state University System is an invaluable source of reports. Though these studies may produce less specific information on the location of aquifer protection zone boundaries, one approach for a local government operating with limited resources is to require that permit applicants challenging a particular boundary produce more site-specific studies that clearly establish whether the development will be located within an aquifer protection zone. Where the location of zone boundaries are in doubt, the Cortlandville, N.Y. ordinance is one of several which places the burden of proof on the land owner to properly locate the boundaries relative to that property. At the owner's request, the town may engage a hydrogeologist or other qualified person to perform the studies, with costs borne by the land owner.

Once an overlay zone is established, many of the potential zoning related requirements will still encounter the problem associated with existing nonconforming uses. However, especially within its most critical aquifer protection zones, a local government's authority to protect the

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[8] Fla. Stat. § 373.0391 requires that the water management districts assist local governments in the development and revision of comprehensive plans, with preparation and provision of information on groundwater characteristics, including existing and planned wellfield sites, existing and anticipated cones of influence, highly productive groundwater areas, aquifer recharge areas, deep well injection zones, contaminated areas, an assessment of regional water resource needs and sources for the next 20 years, and water quality.

public health and safety provides greater power to remove, amortize or strictly regulate threatening nonconforming uses in sensitive areas, with less concern over "taking" challenges.

Prohibition of Uses

Prohibition of uses is an approach taken directly from one of the functions of traditional zoning, the separation of uses into suitable areas. Depending on the characteristics of a particular aquifer protection zone, prohibition of various land uses which pose high levels of threat is appropriate. Such uses might include landfills, gas stations, injection wells, sewage treatment plants, businesses using or storing hazardous materials, and other land uses which represent significant threats to the community's drinking water aquifer, and for which design, construction and performance standards do not provide adequate groundwater protection. Most of the overlay zoning ordinances in Appendix A of this manual specify several types of prohibited uses.

In most aquifer protection strategies, the zones established closest to a wellhead or wellfield will probably require prohibitions on all but the most necessary and least threatening uses, particularly if the area is also a recharge zone. Within these extremely sensitive zones, existing uses that do not fit the category of accepted uses are candidates for immediate closure or closure after a brief amortization period. To reduce the potential for a "taking" claim, some local ordinances provide compensation for certain categories of expense associated with the removal and/or relocation of threatening uses within sensitive zones. Language to amend a zoning ordinance can include lists of all prohibited uses within each zone, based on the level of threat represented, or in the case of the most sensitive zone, can simply specify which non-threatening uses will be allowed.

Large Lot Zoning

In certain cases, minimum lot sizes may be required within a protection zone, in order to reduce the impacts of residential development by reducing the total number of buildings, amounts of impervious surface, and numbers of septic systems within the zone. See for example, the ordinances of Acton, Mass. (Zoning By-Law, Sec. 4.3) and Holliston, Mass. (Aquifer Protection Overlay Bylaw). The technique involves downzoning an area to increase the minimum acreage required for lots in a development. Large lot zoning serves to disperse sources of potential contamination and usually helps maintain natural vegetation and landscape contours on the property, contributing to the filtration of runoff and recharge water. Paved areas and other impervious surfaces are minimized, increasing recharge rates and reducing stormwater contamination from paved surfaces. Overlay zones corresponding to the boundaries of the aquifer protection areas would be logical candidates for application of this technique. Generally, downzoning is a technique well-suited for use by local governments with rural, undeveloped or sparsely populated aquifer protection areas. Landowner opposition is likely not to be as strong, and there will tend to be fewer nonconforming uses.

Where the aquifer protection area to which downzoning is being applied is already zoned for commercial or industrial uses, changing the zoning to require large-lot residential development may result in a legal challenge based on a "taking." Generally, unless they have acted in reliance on the commercial or industrial zoning, and have acquired vested rights to develop the land according to that classification, developers do not have a right to develop according to what they might consider the most profitable use of the property. Courts are less likely to strike down such an approach when some use is allowed of the land, including its use as a single family residence.

Depending in part on the sensitivity of the area and the pollution potential of allowed industrial or commercial uses, downzoning an aquifer protection zone would be considered a legitimate expression of the police power. The most important factor in imposing such requirements is that they clearly reflect a rational connection between the minimum lot size or other downzoning requirement and the protection goals for the particular zone. One way to help establish this connection is to include in the purposes and goals section of the ordinance language which cites documentation of the groundwater contamination that has resulted from intense development and from industrial/commercial development in aquifer recharge areas, and the advantages to be gained from dispersing septic tanks, reducing impervious surfaces, and eliminating industrial/commercial uses in these areas.

Another potential legal challenge to downzoning an aquifer protection zone is that the large lot requirement is actually an exclusionary zoning, designed to financially exclude low-income housing and other unwanted development. This charge has been brought against attempted downzonings that bore little relation to the sensitivity of the underlying aquifer.[9] Again, in order to reduce the potential for such a challenge, it is important to establish a rational connection between the purposes of the downzoning and the problem being addressed. Information on past aquifer contamination events in this or similar areas, and sound technical studies of the hydrogeologic sensitivity of a well-defined aquifer protection area should provide adequate support for downzoning in that area. If in-depth hydrogeologic studies are beyond the capability of the local government, it should use best available information to establish reasonable boundaries and reasonable evaluations of the sensitivity of a particular zone, then require permit applicants who challenge those findings to produce more site-specific studies on the boundaries and sensitivity of the zone. The appropriate water management district should be able to assist in evaluating these site-specific studies.

Cluster Zoning and PUD Zoning

In an aquifer protection context, cluster and PUD zones are strategies similar to that of large lot zoning, in that they attempt to maintain as much land as possible in a natural, unaffected state. However, they offer the advantage of flexibility in designing and locating a development, especially on larger sites, allowing permitted development to locate in the less sensitive areas of a site. Instead of widely spread development patterns that create large amounts of non-point source pollution, the allowed development is closely sited, allowing for simpler monitoring and regulation of potential contaminant sources. Such approaches have potential application when combined with careful regulation of stormwater systems, use and storage of hazardous materials, sanitary sewers, and other sources of contamination.

Essentially, cluster zoning permits single family, residential development on building lots with reduced dimensions, with the leftover lot area maintained as permanent open space. It is normally used to group houses more tightly on certain portions of a tract, saving the remainder of the tract as common areas and open space. It allows greater freedom for the layout of streets and lots, greater sensitivity to natural features, more usable open space, and more protection of natural resources. Typically, it reduces the length of streets and utilities required, thus reducing construction and maintenance costs.

Generally, clustering must be integrated into the local zoning code, offered as a development option for parcels within identified areas, in this case, overlay zones corresponding to aquifer sensitive areas. In this sense, clustering is closely related to subdivision control, since during the site plan review process, the planning board will be required to look closely at many aspects of how the development is located, designed and engineered. In practice, the cluster development plan which is adopted for a particular tract will be considered the zoning ordinance

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[9] <u>See</u>, <u>e.g.</u>, Southern Burlington County NAACP v. Township of Mount Laurel, 336 A.2d 713 (N.J. 1975).

for that tract. Some of the basic requirements that should be specified in the option include the type of housing permitted; allowable densities; the minimum area of land on which a cluster can be permitted; which types of sensitive areas must be protected, and providing for conveyance and maintenance; buffering zones for the perimeter of the development and between types of use within the area; and the minimum lot size.

Overall densities applicable to the buildable areas within a cluster development can be the same as those allowed in a typical grid development, or can include density bonuses for creative, carefully designed and located development. If the cluster acreage includes sensitive areas, the ordinance may allow the builder to construct on buildable areas the same number of units as would be permitted were the whole acreage buildable, or it may limit the builder to the number possible under a normal subdivision of the buildable areas only.

Since zoning is primarily a legislative function, it is probably best to also have any bonus requirements and conditions (such as increased densities and decreased lot sizes in return for protection of sensitive areas or provision of added amenities) set out in the ordinance itself, rather than leaving the discretion for such decisions with a local permit review board. One approach involves downzoning an area to low density residential uses, and then offering clustering as an option, with bonus density provisions adopted in exchange for design measures which contribute to protection of sensitive areas.

The planned unit development, or PUD, is essentially a pre-planned large-scale development, including several types of uses in one development plan. Though the concept allows for the mix of a wide range of land uses, from single family residential to commercial and industrial, many PUDs are designed to consist of only clustered residences, with multi-family or shopping facilities added. They offer similar advantages to those of clustering, in that uses, densities and design standards can be flexibly adapted to the features of the site, allowing for protection of sensitive areas. In an aquifer protection scheme, the PUD option should include carefully considered lists of acceptable and nonacceptable uses, and regulation of allowable uses for any development affecting an aquifer protection zone.

Cluster and PUD zonings can also exist as "floating zones," districts which are described in the zoning text, but not mapped. The text describes the conditions that must be met to establish the zone, such as allowable uses, required tract size, densities, etc. The district "floats" until a landowner petitions to have it apply to a particular parcel by amendment of the zoning map, and the request is processed as a zoning amendment. Any bonus requirements and conditions should be clearly listed in the ordinance. For aquifer protection purposes, one of the general conditions necessary to the application of the district would be that, if wholly or partially located in an aquifer protection zone, a cluster or PUD development be configured to meet open space and design standards that protect the underlying aquifer, depending on the sensitivity of the area. Other requirements might include any of the health based criteria covered in this section of the manual. An ordinance allowing floating zones must also be in compliance with the local government comprehensive plan, including the conservation element, open space and recreation element, future land use element, and the element concerned with general sanitary, sewer, solid waste, drainage, potable water, and natural groundwater aquifer recharge.[10]

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[10] See, Fla. Stat. § 163.3177 and Fla. Admin. Code § 9J-5 for more specific requirements applicable to these and other required elements of the comprehensive plan.

Special Permitting

Special permitting, also known as conditional use, special use or special exception permitting, provides for administrative relief from the restrictions of a typical zoning scheme. The technique is designed to allow uses under certain specified conditions, which would be inappropriate to a district if permitted without limitation. Thus, the standards and guidelines under which such a permit may be granted must be clearly specified in the ordinance. Florida courts have been strict in their review of the adequacy of such guidelines in the special permitting process.[11] The most important general standards are that the public interest not be adversely affected, and that the special permit be in harmony with the zoning ordinance. Special permits are normally considered first by an appointed board such a planning commission, then by the board of city or county commissioners.

The special permit is not to be confused with a variance. A variance allows for departure from the requirements of the zoning ordinance and is typically considered at the discretion of an appointed board such as a zoning board of appeals or a board of adjustment. Basically, the board may grant a variance to the applicable zoning provisions when application of the zoning code to that particular property would create an unnecessary hardship to the landowner not shared by the rest of the district, and when the variance would not violate the general zoning plan or impair the intent or effectiveness of the ordinance in protecting health and safety. The preferred type of relief mechanism, for groundwater protection purposes, is the special exception, since it may only be granted under certain conditions which can be carefully specified in the ordinance.

Normally, there are two types of variances: use variances, permitting a use other than those prescribed; and bulk or area variances, permitting deviations from requirements such as setbacks, frontage, height, lot coverage, density, etc. Florida no longer allows the granting of use variances. The criteria for a variance should always include specific consideration of the proposed location of the use in relation to an aquifer protection zone. Generally, the hardship that must be clearly shown by a landowner is that under present zoning, no reasonable use can be made of the land. Several types of use other than commercial, industrial or high density residential will allow for reasonable use of the land, while providing more protection for aquifer sensitive areas. Bulk or area variance criteria should be keyed to the need for protection of an underlying aquifer. In cases where the requested variance proposes bulk/area modifications that will negatively impact an important aquifer protection zone, the public interest in maintaining adequate amounts of safe drinking water will tend to override the applicant's desire to make the most profitable use of the land.

For a special permit, the only discretion granted the administrative body is to determine whether the permit applicant qualifies for the legislatively established exception, under the terms of the ordinance. If carefully observed, the special permit process has the potential to be an effective tool in regulating uses and structures that might otherwise threaten an aquifer protection zone. Strict procedural and substantive criteria for the issuance of special permits are written into the ordinance in order to assure that a project goes through full review, and that sensitive areas are adequately protected. Acceptable special uses and conditions applying to those uses are predetermined and must be carefully specified. Failure to do so invites a situation in which the local administrative body might interpret the ordinance as allowing an incompatible use or as not requiring an essential protective condition. See for example, the Acton, Mass. zoning by-law which contains a list of land uses which are either permitted, prohibited or subject to a special

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[11] See, eg., Drexel v. City of Miami Beach, 64 So.2d 317 (Fla. 1953); City of St. Petersburg v. Schweitzer, 297 So.2d 74 (Fla. 2d D.C.A. 1974); City of Naples v. Central Plaza of Naples, 303 So.2d 423 (Fla. 2d D.C.A. 1974).

use permit for each of three aquifer protection zones. The Lee County, Florida wellfield protection ordinance contains detailed sections addressing the application and permitting requirements for special permits.

Transfer of Development Rights (TDR)

Basically, the concept of transferable development rights (TDR) is similar to clustering on noncontiguous sites. The basis for this approach is that land ownership has associated with it a "bundle of rights," such as rights of possession, and water, mineral and air rights. A TDR program allows the owner of a parcel located in a protected "sending area" to separate the development rights permitted by the zoning, and to apply them to a parcel in a designated "receiving area." Essentially, in exchange for protection of the sending area, the owner is granted a density bonus in the receiving area.

Though it requires extensive administrative resources, a local government can implement such a program by preparing a plan designating the "sending areas," from which development rights would be transferred, and the "receiving areas," to which the development rights would apply, thus allowing development at a higher density than that allowed by the underlying zoning classification. For aquifer protection purposes, the sending area would be one important to the protection of the local government's potable aquifer, such as a recharge zone or an area close to a wellfield. The receiving area should be one capable of dealing with the added development density, in terms of its physical suitability for development, and in terms of its compatibility with the comprehensive plan and growth management objectives of the local government.

The local government could establish a special permit bonus in receiving areas, for developers who negotiate permanent conservation restrictions for applicable parcels in the sending area. The sending area may or may not be contiguous to the receiving area, and many or may not be owned by the developer. If the sending area parcels are not owned by the developer, he or she could obtain the necessary conservation restrictions by paying the owner(s) of parcels in the sending area. Another option involves zoning the receiving area for one to several units per acre--one unit as of right, and others depending on the developer's ability to obtain the extra building rights from owners of parcels in sending areas throughout the community.

REGULATORY TECHNIQUES--SUBDIVISION CONTROLS

Subdivision control deals with the division of land into separately owned parcels, usually for residential uses, and is administered by a municipal or county planning board. Basically, subdivision regulations allow the local government to take a closer look at development proposals than do zoning ordinances. The focus is less on land use, and more on engineering concerns such as drainage patterns, street construction, utility placement and traffic patterns of individual subdivisions. Under Florida's Local Government Comprehensive Planning and Land Development Regulation Act,[12] all local governments must regulate the subdivision of land.[13] A proposed subdivision must be consistent with the goals of the future land use element, the traffic circulation element, the sewer, water and drainage element, the housing element, the open space and recreation element, the capital improvements element and the conservation element.[14] The

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[12] Fla. Stat. §§ 163.3167-.3215 (1989).

[13] Fla. Stat. § 163.3202(2)(a) (1989).

[14] Fla. Stat. § 163.3177 (1989).

term "subdivision" refers to the partition of land into three or more parcels,[15] and includes resubdivision, if the change in the map reduces the size of the lots shown on the original map, or if lots have been sold since the map was recorded, or if the change intensifies land uses.[16]

Before receiving subdivision approval, subdividers are required to prepare plat maps of the land proposed to be subdivided. The plat maps must be approved by local regulatory agencies and planning boards before they can be recorded and the lots sold. It is during this site plan review that a development can be examined to ensure the physical suitability of the site for a subdivision; sufficiency of water supply protection and waste disposal systems; proper stormwater management; control of erosion and sedimentation; the adequacy of the street system; proper dimensions and layout of lots; and adequate open space. For groundwater protection purposes, a subdivision control ordinance should address each of these factors with regard to the effect on underlying potable aquifers.

Drainage Requirements

In the aquifer protection context, local subdivision ordinances may contain specific provisions which condition plat approval upon measures which assure protection of aquifer sensitive areas impacted by the subdivision. Some of the more important of these provisions will require careful review of drainage, also known as stormwater management. Criteria for the location, creation, use and maintenance of swales, and retention and detention basins should be specified that allow for optimum treatment of stormwater associated with development. These criteria should include consideration of any underlying karst limestone formations, since serious groundwater contamination can result when retention/detention basins fail in these areas. Criteria for the treatment of stormwater runoff by these types of catch basins should also be specified, and in situations where outfall is into lakes, canals and streams, end-of-the-pipe water quality standards should be stipulated. Generally, disposal by means of drainage wells and underground injection wells is not advisable. Underground stormwater transfer facilities should be designed and constructed to assure minimum leakage.

The Florida Department of Environmental Regulation and four of the five water management districts have promulgated rules dealing with location, design, construction, operation and water quality standards for stormwater systems. These rules and permitting specifications are minimum requirements, and a local government may be delegated the authority to administer them, including those delegated from the DER to the water management districts. The delegation may only be made if the local government program is compatible with or more stringent than the requirements of the DER or the district, provides for enforcement by appropriate administrative and judicial processes, and provides the administrative, financial, staff and other resources necessary for effective enforcement.[17]

Impervious Surface/Road Engineering Requirements

Another area of accepted subdivision control allows a limitation on the percentage of impervious road surface for subdivisions within, or impacting, aquifer protection zones. This type of control fits easily within the category of concerns normally reviewed under subdivision regulations. Since impervious road surfaces are the source of many of the oils, suspended solids,

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[15] See, Fla. Stat. § 380.04(1); Fla. Stat. § 177.031(18) (1989).

[16] Fla. Stat. § 380.04(2) (a), (b) (1989).

[17] Fla. Stat. § 373.103 (8) (1989).

and other pollutants characteristic of development runoff, rules controlling the length, width and engineering design of roads are appropriate to a review of subdivisions within or impacting an aquifer protection zone. The potential for reducing amounts of impervious road surfaces in PUDs and cluster developments should be maximized during any review process. See for example, the ordinances of Acton, Mass. (Zoning By-Law, Sec. 4.3) and Holliston, Mass. (Aquifer Protection Overlay Bylaw).

REGULATORY TECHNIQUES--HEALTH REGULATIONS

For local governments with the necessary resources, health regulations offer the advantages of retroactive application and a clear relation to the health and safety of a community. Adoption of health regulations applying to land use activities may involve an expansion of responsibilities for health departments. Additional staff expertise may be required to accurately and effectively review the information required by health codes. Local governments may require applicants to hire independent engineering consultants to prepare studies showing that the development will meet the standards of the ordinance. Though most of the following techniques may be applied on a county- or city-wide basis if necessary, they may also be applied as part of an overlay zone strategy that relates the stringency of the health measures to the sensitivity of particular aquifer protection zones.

Underground Storage Tanks for Hazardous Substances

Leaking underground storage tanks containing fuel products and other hazardous materials are the most significant source of groundwater contamination in Florida and the nation. The Florida Department of Environmental Regulation has adopted a preemptive rule controlling the design, installation, monitoring and operation of underground storage systems for vehicular fuels,[18] but there are several ways in which local regulations can fill in gaps in the state regulatory program. Among others, these include the regulation of storage systems for hazardous materials other than those regulated by the state, and the regulation of systems under the size thresholds for state regulation.

Local governments may adopt more stringent ordinances regulating underground storage systems for regulated substances, but only after contracting with the DER, and administering the DER rule governing such systems for a period of two years. During the two year period, the local government may research and develop an ordinance meeting the needs of the community, and undergo the necessary local and state review. A well constructed ordinance will address the proper design of storage tanks, integrated piping and fixtures, the transportation and installation of such equipment, the testing and monitoring of the equipment before and during operation, and correct operating and closure procedures. Several ordinances included in Appendix A of this manual address the management and storage of hazardous materials, including Austin, Texas, Broward County, Florida, Dade County, Florida, Lee County, Florida, and Santa Cruz County, California.

Privately-Owned Small-Scale Wastewater Treatment Plants

Small scale sewage treatment plants, also known as package plants, allow some developments to be located in areas that would otherwise be unable to assimilate conventional septic system wastewater loads. However, package plants have greater maintenance requirements, and their rates of failure have been high enough to make them unsuitable for many

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[18] Chapter 17-761, Fla. Admin. Code (1990).

aquifer sensitive areas. The police power gives local governments authority to adopt wide ranging controls on potential health threats such as package plants, including maintenance requirements, maximum loading rates, and prohibitions on such systems in sensitive areas.

On-Site Septic System Regulations

Residential and commercial/industrial development using septic tanks has been associated with many cases of non-point pollution of groundwater. In such systems, bacterial action digests the solid materials and the liquid effluent is discharged to the ground. In theory, filtration by soils provides additional treatment so that the liquid should be relatively clean by the time it reaches groundwater, however many of the pollutants in the effluent are often not attenuated by overlying soils. Excessive nitrates, organic chemicals, detergents, metals, bacteria, and viruses are often leached to groundwater. Halogenated hydrocarbons such as chloroform, carbon tetrachloride and trichloroethylene, among others, are often used in industrial and domestic degreasers and solvents. Home products such as fabric and rug cleaners, workshop chemicals and cleaning solutions are often flushed into septic systems. Many septic tank cleaners are composed of halogenated hydrocarbons.

The Florida Department of Health and Rehabilitative Services has primary authority for state-wide regulation of septic systems, but local governments have authority to incorporate septic tank siting and design controls into any of several types of ordinances. These controls will be more specifically oriented to local conditions, in particular, controlling septic tank densities based on the sensitivity of the applicable aquifer protection zone. See for example, Dade County, Florida (Section 24-13), and Panhandle Health District No. 1 (Rathdrum Prairie Sewage Disposal Regulations).

NON-REGULATORY TOOLS

Nonregulatory programs encourage voluntary action to protect ground water quality. These programs supplement regulatory approaches, adding flexibility to the groundwater protection strategy, and providing less coercive protection to groundwater resources in areas with more natural protective features. Typical nonregulatory approaches include land acquisition, public education, hazardous waste collection, contingency planning, capital improvements planning, and monitoring. The success of these approaches depends on community acceptance, understanding of the necessity and mechanics of the approach by those who are expected to use it, and an incentive program.

Land Acquisition

A municipality may purchase land overlying sensitive aquifers from willing landowners. It may also be possible for a local government to obtain private land by exercising eminent domain. High priority areas would include wellhead protection zones and recharge areas. The outright sale can take several forms including fair market value sale, installment sale, or sale with a reserved life estate. In a fair market value sale, the full purchase price is paid and transfer is immediate. With an installment sale, the purchase of the property occurs over a period of years allowing the municipality to spread out the acquisition cost and the seller to defer income tax on the full value of the land. Landowners who wish to retain use of their property, but are inclined to transfer it to a local government to further groundwater protection, may make a sale with a reserved life estate. This type of sale gives a property interest to the community, but allows the landowner use of property for the lifetime of the landowner, and if so designated, for the lifetime of immediate family members.

Many municipalities may have limited financial resources for outright land purchases, therefore careful planning is required to ensure that important areas are targeted and adequate protection is obtained. Local governments using the outright purchase approach are urged to develop a strategy which prioritizes lands to be purchased and defines the interests to be purchased. Lands considered for acquisition should be evaluated based on the sensitivity of the underlying aquifers, the existing and potential future land uses, soil conditions, and the effectiveness of land use regulations in providing protection. For example, in certain areas, pre-existing zoning regulations may adequately protect groundwater without the need for community ownership. An intermediate approach to land acquisition might target lands within for example the ten year travel time zone of larger public wells.

Rather than purchasing the property in fee simple, a municipality may opt to purchase only a partial interest, since partial interests are typically less expensive than fee simple purchases. With only partial interest, a local government may not exercise full control over the property, but may restrict certain activities or land uses. Additional advantages to partial interest purchase are that generally the local government is not required to maintain the property and the property taxes are still collected from the landowner. Conservation easements and restrictive covenants are two types of partial interests. A conservation easement prohibits certain land uses by the present and subsequent owners for the entire term of the easement which may be a few years or forever. A restrictive covenant, likewise, prohibits certain land uses by present and subsequent owners. The difference between an easement and a covenant is who may enforce the interest. An easement is enforced by the easement holder, while a covenant is enforced by other landowners who have similar restrictions.

Municipalities financially unable to purchase land outright may also seek donations of land from local landowners. Community-minded landowners may be inclined to donate land or agree to a "bargain sale" where land is purchased at less than full value. In addition to contributing to protection of the community drinking water supply, the landowner benefits from these charitable transfers by elimination of real estate taxes, insurance and maintenance costs as well as estate or capital gains taxes. Moreover, with a donative transfer, the value of the property can be deducted over time from federal income tax. A municipality with few resources and critical acquisition needs may consider raising money through a number of methods. These include raising property taxes and transfer fees; raising water and sewer rates, or by issuing municipal bonds. A local government should coordinate with state and district agencies, which are currently buying lands for resource maintenance purposes, by making recommendations for acquisition which further the local government's aquifer protection goals.

Public Education

Public education can be an inexpensive, but important approach to involving the community in ground water protection. Informed citizens who understand how and when ground water may become contaminated, how to have water sampled and tested, and who to contact if they suspect contamination, will be more supportive of an aquifer protection program and can assist in enforcement.

A public education program can take many forms including in-school programs, workshops, slide or video presentations, and handbooks or pamphlets. Workshops or seminars can be targeted to specific groups whose activities threaten groundwater such as farmers or homeowners with septic tank systems. Workshops may also focused on specific topics such as hazardous household waste disposal or septic tank maintenance. Many civic groups have developed slide or video presentations related to ground water protection. Public support can also be gained by including brochures on groundwater threats and protective measures in utility bill mailouts.

Hazardous Waste Collection

Toxic household wastes such as cleaning products, pesticides, paints, pool chemicals, and solvents are often disposed with other household trash, increasing the risk of groundwater contamination at municipal landfills. Wastes discharged into sewer or septic systems may also jeopardize groundwater quality. To deal with this problem, many local governments may choose to designate a safe collection site for these wastes. Typically, a local government will contract with a hazardous waste management company to transport and dispose the waste.

The Florida Department of Environmental Regulation (DER) recently awarded grants to nine counties for the construction of local hazardous waste collection centers for the disposal of hazardous household waste. The counties are: Clay, Dade, DeSoto, Duval, Lee, Leon, Martin, Pasco, and St. Lucie. Eighteen Florida counties have constructed permanent collection centers. A list of collection center grant project managers for the various counties can be obtained from DER's Bureau of Waste Planning and Regulation, Hazardous Waste Management Section in Tallahassee. Under DER's Cooperative Collection Center Arrangement Grant, neighboring counties can enter into agreements with grant counties that have permanent collection centers to assist in a hazardous waste collection program.

Municipalities without financial resources to construct a permanent center may also consider periodic collection events and make arrangements with a hazardous waste management firm to handle the collection. Advertisements and public service announcements can advise citizens of designated dates and locations for collection of hazardous household wastes. The events serve as reminders to the public of the risks of improper disposal, and encourage citizens to support ground water protection.

In planning collection events, several important factors may determine the success of the programs. The cost of publicity, staffing, and waste disposal must be considered. Publicity must be widespread through as many media as possible -- public service announcements on radio and television, newspaper advertisements, announcements at local civic groups, postings in public buildings. The information about the events must be thorough including the date, location, purpose of the event, and identification of the types of waste materials that will and will not be accepted. In selecting the location for the event, consideration should be given to general accessibility and adequate parking. Another consideration is disposal; a hazardous waste management firm should be contacted to collect, transport and dispose the waste.

Contingency Planning

A contingency plan identifies how a municipality will deal with water supply disruption and contamination events. In developing a contingency plan, potential threats to ground water should be identified along with appropriate response and remediation actions. Individuals responsible for coordinating and taking response actions should be identified by name and how they may be reached. Plans for obtaining replacement water sources should be determined as well as how response to such events will be funded. A contingency plan should also address prevention methods and mitigation measures to avert threatening events.

Capital Improvements Planning

Capital improvements planning is an important component of a complete aquifer protection approach, given the role that local government infrastructure plays in fostering development. The Local Government Comprehensive Planning and Land Development Regulation Act requires local governments to develop a comprehensive plan that considers the need for and the location of public facilities such as potable wellfields. In planning areas for future development, local governments must ensure that these areas will have adequate potable water supplies. To protect potable water supplies, development areas should be planned and permitted only for less sensitive zones.

Monitoring

A municipality may initiate its own groundwater monitoring program, in order to evaluate and if necessary, modify its aquifer protection program. Implementation of a monitoring program requires documented sampling procedures and certified laboratory analyses. To minimize sampling and analysis costs, priorities should be established. For example, as a top priority, samples may only be collected from existing public drinking water supplies and the analysis may be limited to parameters listed as federal Safe Drinking Water Act standards. The local government should coordinate its monitoring efforts with those of the U.S. Geological Survey, the Florida Department of Environmental Regulation and the Florida Department of Health and Rehabilitative Services.

For newly developed areas, monitoring may be appropriate to determine if the new uses are impacting groundwater. In areas of existing development, samples may be collected to determine if adequate protective measures are being used.

Chapter IV Suggested Regulatory Strategies

INTRODUCTION

As discussed in Volume I, the creation of effective aquifer protection programs may require development of local ordinances addressing conditions and groundwater threats in the area. The following sections present high stringency permitting approaches with potential application to land uses occurring in highly sensitive areas. Methods by which these requirements can be moderated are also discussed. For most groundwater threats, a low stringency approach to local regulation involves the general requirement that any form of development approval be conditioned on proof that all relevant state and federal permits have been acquired. High stringency approaches range from land use prohibitions to strict controls on the location, siting, density, design, construction, operation, monitoring and closure of permitted facilities.

REGULATION OF ON-SITE SEWAGE DISPOSAL

INTRODUCTION

Individual on-site sewage disposal facilities normally include septic tanks and drainfields. The effluent that is discharged from such facilities contains high levels of nitrates, phosphorus, bacteria and often viruses, and has the potential to contaminate groundwater under several conditions. Most of the problems have to do with improper site characteristics, system design, improper installation practices, and improper use and maintenance of a system. Soils which are too impermeable can clog a drainfield, while those which are too permeable will not offer sufficient treatment to sewage effluent. Groundwater levels which are too high do not allow sufficient unsaturated soil to attenuate the effluent before it reaches the water table. Inadequate drainage, and flooding, may flush untreated sewage into surface and ground waters. The densities at which on-site septic systems are installed, or the total allowable sewage flows from septic systems in an area may be more than natural biological and chemical processes can assimilate. Systems installed too close to wells, surface waters and ground waters may cause contamination. Allowing organic chemicals into a system, such as those found in many septic tank cleaners, or allowing septic systems to be used by facilities with industrial processes, can result in hazardous materials being leached directly into potable groundwater. Inadequate maintenance of on-site systems can lead also to discharge of untreated sewage solids into the subsurface environment.

BASELINE APPROACHES

Basic state regulations on the siting and construction of individual sewage disposal systems are administered by the Department of Health and Rehabilitative Services (HRS) under the authority of Chapter 381, Florida Statutes and Chapter 10D-6, Florida Administrative Code. On-site sewage disposal systems require a permit from HRS, and local governments may not issue building or plumbing permits for buildings using such a system until the owner has received a construction permit for the system from HRS.[1] Under state rules, existing, already approved

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[1] Rule 10D-6.041(4), (5) Fla. Admin. Code (1989). Treatment and disposal of sewage flow must comply with Florida Department of Environmental Regulation rules when: a) the volume of domestic sewage exceeds 5000 gallons per day (see Rule 10D-6.048(1) for estimated domestic sewage flows); b) sewage or wastewater contains industrial or toxic or hazardous chemical waste; c) the area is zoned for industrial or manufacturing use, or its equivalent, and the system (continued...)

systems are not subject to any additional requirements, so long as they are in satisfactory condition and the buildings they serve are not changed or sewage flows increased.[2] If those conditions are not met, the system must be upgraded to comply with the newer rules.[3] County public health units have the discretion to allow minor changes, such as the addition of one bedroom, without upgrading the on-site system.[4] They may also require notification of intent to repair a system, or may require the repairer to obtain prior written approval before making a repair.[5]

A development exceeding 5000 gallons per day sewage flow will normally require a sewer permit from the Department of Environmental Regulation (DER),[6] however when DER determines that it would be "impractical" to sewer a low density development, it may recommend the applicant apply for a variance to allow use of on-site sewage systems. If the variance is granted, the county health unit becomes the permitting authority.[7] A local government ordinance may include additional requirements to those of Chapter 10D-6, F.A.C. The requirements of Chapter 10D-6 are summarized in Chapter II of this volume.

LOCAL ORDINANCE: HIGH LEVEL OF STRINGENCY

Many contamination problems associated with on-site wastewater disposal systems can be mitigated with proper siting, density control, design, and construction standards. However, some sensitive areas may require prohibition of on-site systems. An important concern is determining whether the ordinance criteria should apply throughout the jurisdiction or within specified protection zones. Jurisdictions with wide use of septic tanks and private wells, little natural protection for potable aquifers, and little or no potential for sewering should apply the criteria over broader areas. Siting and design standards should be more stringent in sensitive aquifer protection zones. A second concern is determining what densities should be allowed in particular protection zones and what criteria will apply for determining proper use and location of septic systems relative to potable wells. A well-written septic system ordinance will also include sections detailing under what conditions existing systems will be required to connect to a central sewer system, and how on-site systems are to be maintained.

The following provisions address these and other problems arising from attempts to place on-site septic systems in sensitive areas. Some segments are from ordinances which have been adopted by local governments in Florida and other states, while others are derived from model ordinances. See Appendix A for copies of local ordinances which address the regulation of on-site septic systems, including those of Dade County, Florida (Sections 24-12.1 and 24-13), Panhandle

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[1](...continued)
may be used for disposing of other than domestic wastes; d) total food establishment wastewater flow exceeds 3000 gallons per day. Rule 10D-6.041(8) Fla. Admin. Code (1989).

[2] Rule 10D-6.041(6) Fla. Admin. Code (1989).

[3] Id.

[4] Id.

[5] Rule 10D-6.041(7) Fla. Admin. Code (1989).

[6] Rule 10D-6.041(8)(a) Fla. Admin. Code (1989).

[7] Rule 10D-6.041(9) Fla. Admin. Code (1989).

Health District No. 1. Several ordinances regulate whether and at what density septic systems are allowed in wellfield protection zones, including those of Dade County (Sections 24-12.1 and 24-13), Acton, Mass., Holliston, Mass., and Temple Terrace, Florida.

1. General Requirements

a. All individual sewage disposal facilities within the jurisdiction of (local unit) must be installed, modified, and maintained in accordance with the provisions of the ordinance. Where provisions of the ordinance are more stringent than comparable provisions in Chapter 10D-6, F.A.C. the provisions of the ordinance will apply.

b. New buildings in which plumbing fixtures are installed must be connected to a municipal or investor-owned sewerage system if:

1.) such a system is available within [one-half] mile of the property; or

2.) such a system is under construction and will be available within [one-half] mile of the property; and

3.) the additional wastewater to be added to the sewerage system by connecting the building will not cause the total waste load entering the system to exceed the maximum waste load for which it was designed.

For groundwater quality protection purposes in sensitive aquifer protection zones, and in densely developed areas, it is normally advisable to have buildings discharging to the central sewer system, since the leakage from sewer lines represents less sewage loading than that generated by on-site septic systems. A carefully structured approach should also specify low leakage rates for central sewer piping. Florida's Growth Management Act requires the infrastructure serving a development to be in place concurrent with the development, thus in most cases, new development should not be permitted so far from urban service areas that the above standards cannot be met.

For estimated sewage flows of 600 gallons per day or less, Chapter 10D-6, F.A.C. generally defines a sewer system as being "available" if a sewer line abuts the property, and gravity flow can be maintained. For sewage flows over 600 gallons per day, the system is considered available if a sewer line, force main or lift station is within 100 feet of the property. Especially within sensitive groundwater protection areas, the local government may increase the stringency of its ordinance by increasing these distances, requiring buildings to connect to a central sewer system though it may be farther away, and by requiring connection if the distance standard is met, without regard to gravity flow. Another stringent alternative is to require connection if such an approach is "feasible," allowing the local authority the discretion to take into account factors other than distance.

In some areas, effluent discharge from on-site septic systems has a role in groundwater recharge. Where this is the case, though it may be necessary to allow individual septic systems, strict design, siting and density criteria will reduce the potential for groundwater contamination.

c. When connection to a sewage collection system is not required by the above section, and until a sewage collection system is available, wastewater must be discharged into an individual sewage disposal facility pursuant to the provisions of the ordinance.

d. No person may obtain a building or plumbing permit from (local authority) unless that person obtains a sewage disposal permit.

e. Issuance of the sewage disposal permit must be based on satisfaction of all requirements of the ordinance. The permit is issued only to the person named in the permit, and should include the date of issuance and expiration, and state that the permit is non-transferable.

The permit should be issued only if, after evaluating the application, the (local authority) is assured that with reasonable maintenance the individual sewage disposal system will function in a sanitary manner, not create a nuisance or health hazard, or contribute to the pollution of surface or groundwaters.

f. Organic chemical solvents or additives may not be advertised, sold or used to promote cleaning, deodorizing, percolation or degreasing of individual sewage disposal systems.

g. Any property used for industrial or manufacturing processes, or zoned for such use, or with the potential to generate toxic, hazardous, or industrial wastewater is not eligible for a sewage disposal permit for an individual sewage disposal facility.

h. Existing property used for industrial or manufacturing processes, or zoned for such use, or with the potential to generate toxic, hazardous, or industrial wastewater, and which uses an individual sewage disposal facility, must immediately close that facility and connect to a municipal or investor-owned sewage treatment system if such a system is available within [one-half] mile of the property. If a municipal or investor-owned treatment facility is not immediately available, such properties must submit and implement hazardous materials management plans, which insure that hazardous materials will not be introduced into an individual sewage disposal facility, and must regularly test the septic system for the presence of hazardous materials.

The connection requirement for such facilities should be based on distance alone, without regard to maintenance of gravity flow. The property owner should be required to construct any lift station or pumps necessary to assure that the effluent can be delivered to a central sewer line within one-half mile as suggested.

2. Permit Application Requirements

a. Application for a sewage disposal permit must be made to the (local authority) on forms supplied by that office. Applications should include:

1.) the property owner's name and address;

2.) the location of the property;

3.) the existing or proposed location and size of the individual waste disposal facility;

4.) a diagram drawn to scale which clearly indicates:

a.) the location of the proposed or existing individual waste disposal facility, property lines, structures and adjacent bodies of water.

b.) the location of any public or private water well inlets or water pipelines on the property described in the application or within [#] feet thereof.

c.) the groundwater level, represented by contour lines, for the wettest portion of the year.

d.) ground surface contours and slopes, showing direction and grade of all slopes.

e.) a soil profile identifying soil types to a depth of six (6) feet or the wet season water table, whichever is less, within any proposed absorption field(s) and extending [50] feet in all directions from the edges of the absorption area(s).

f.) subsurface geologic features such as karst formations.

g.) any proposed or existing drainage features affecting the property described in the application, including offsite areas.

h.) any areas containing fill or covered with any impervious material and areas where fill or impervious surfacing is proposed.

5.) A description of all existing or proposed sources of wastewater to be treated by the individual sewage disposal system(s) described in the application, including:

a.) sinks;
b.) toilets;
c.) tubs and/or showers;
d.) automatic dish or clothes washers; and
e.) garbage grinders and disposals.

6.) Any percolation test results.

7.) An application fee.

b. The permit application must include the results of tests and investigations by a registered engineer which indicate the suitability of the land or building for the use of an individual sewage treatment facility.

Permit applications should require all of the data necessary to truly evaluate the application. Application fees help offset the administration of the permitting program.

3. Design and Siting Standards

a. An individual sewage disposal facility may not be installed in [applicable aquifer protection zone] where the waste load to be discharged by that facility exceeds [0 to 750, based on sensitivity of applicable zone] gallons per acre, per day.

-and/or-

An individual sewage disposal facility may not be installed in [applicable aquifer protection zone] on lots less than [one to five, based on sensitivity of applicable zone] acres in size.

The suggested provisions represent two complementary approaches to stringent siting requirements. It is not possible to project a stringent density or sewage loading standard for all localities and zones, since this is dependent on soil and subsurface conditions, but the bracketed numbers reflect stringent approaches adopted in other jurisdictions. Studies have indicated that generally, proper attenuation of effluent from one single family septic tank requires lots of at least one-half acre, but the analysis depends on several variables. A stringent approach should err on the side of protecting the public health and safety.

Allowable densities and loading rates will require careful analysis of the proximity to a potable well, the type of land use, densities of private wells, the size of the lot, its location with respect to aquifer protection areas, and the types of soils and geology on the property. In very permeable aquifer protection zones, or those closest to an unprotected public well, or in areas with existing problems related to excessive sewage loads, it may be necessary to prohibit any additional septic sewage loading. For groundwater quality protection purposes, the sensitivity of soils and groundwater, and the total septic sewage load in an area are the critical factors. Thus, although some local governments allow higher sewage loading rates for lots using public water, if an area is within the zone of contribution of a public water supply well, the fact that public water is being used by residences should not affect the need to restrict septic sewage loads in that area. The presence and densities of private wells in an area should always be considered in setting allowable densities and loading rates for onsite septic systems.

The town of Holliston, Mass. delineates three areas of aquifer protection: Area 1 (cones of depression, and respective areas of influence and recharge generated by municipal wells); Area 2 (the four principal aquifers within the town and their primary recharge areas); and Area 3 (land contiguous to Area 2 underlain by deposits in which groundwater flows toward Area 2, and contiguous wetlands, waterbodies and streams contributing surface water flow to Area 2). In Area 1, only single family residential and non-hazardous commercial development is permitted, on lots of at least 80,000 sq. ft., with on-site domestic sewage disposal limited to 55 gallons/10,000 sq. ft./day (approximately 240 gallons per acre per day). In Area 2, the same types of development are permitted and must be located on lots of at least 40,000 sq. ft., with on-site domestic sewage disposal limited to 110 gallons/10,000 sq. ft./day (approximately 480 gallons per acre per day). In Area 2, any use other than a single family dwelling with sewage flow over 110 gallons/10,000 sq. ft./day or exceeding 15,000 gallons/day regardless of lot area, is only permitted under the terms of a special use permit.

Dade County dictates allowable loading rates based on the distance from the property to the nearest public potable water well, the presence or absence of indigenous sandy substrata, whether the land use is residential or nonresidential, and whether the property is served by public water supply. Allowable discharges from residential septic systems range from zero in aquifer protection zones nearest public wells, to 1500 gallons per acre per day for residential uses other than single family or duplex, in zones farthest away from public wells. Nonresidential septic systems not using hazardous materials have separate but similar loading rates.

Outside of aquifer protection zones, Dade County requires residential septic systems to be located on lots of certain minimum sizes with maximum loading rates. Where public water is used, the lots sizes are 15,000 sq. ft. for a single family residence, and 20,000 sq. ft. for a duplex. All other residential uses in these areas must contribute no more than 1500 gallons per unsubmerged acre per day of sewage loading. Where private wells are used, the lot sizes are 20,328 sq. ft. for a single family residence, and 29,040 sq. ft. for duplexes. All other residential uses in these areas must contribute no more than 750 gallons per unsubmerged acre per day.

b. Surface and stormwaters shall not be discharged into an individual sewage disposal facility nor in any manner which could interfere with the functioning of the facility.

Discharge of stormwater into an individual sewage disposal facility is likely to exceed its design capacity and contribute to the malfunctioning of the system.

c. Individual sewage disposal facilities must not be located [in this section, bracketed numbers indicate what is currently required by Chapter 10D-6, F.A.C.]:

1.) within [75] feet of any private potable well;

2.) within [200] feet of any public potable well serving a residential or nonresidential establishment with a total sewage flow of over 2000 gallons per day;

3.) within [100] feet of any public potable well serving a residential or nonresidential establishment with 2000 gallons or less of total sewage flow per day;

It is not possible to project appropriately stringent setbacks for all conditions. The setbacks in subsections 1.) through 3.) should be based on consideration of soils, well depth, groundwater height, degree of natural protective features, and total sewage flows from septic systems. Where projected densities and sewage flows might threaten an unprotected well, the setbacks should be increased. Studies have revealed well contamination from nitrates, phosphorus, viruses and bacteria at setback distances much greater than those required by the state rule.

4.) upgradient of any water supply well;

5.) within [50] feet of any non-potable well;

6.) under or within [5] feet of any building;

7.) within [10] feet of potable water lines unless the lines are encased in six inches of concrete or placed within a sleeve of similar pipe material;

8.) within [5] feet of any property line;

9.) within [75] feet of the mean high water line of tidal waters, or the ordinary high water line of non-tidal waters;

This setback should be based on consideration of soils, topography, groundwater height, degree of natural protective features, and total sewage flows from the septic system. Where projected densities and sewage flows might threaten surface waters the setbacks should be increased. Studies have indicated that in most cases, the figure should be closer to 150 feet, to prevent surface water contamination.

10.) in areas where satisfactory soil types do not extend at least [42] inches below the bottom of the drainfield trench or absorption bed;

11.) in areas where the water table in the wettest season rises or is likely to rise to within [24] inches of the bottom of the drainfield trench or absorption bed;

Studies have indicated that effluent should move through at least 36 to 48 inches of unsaturated soil, to prevent contamination of groundwater and surface water. Flow of effluent through unsaturated soil increases travel time for contaminants, results in better effluent/soil contact for physical, chemical and biological attenuation, and improved effluent treatment by the soil.

12.) in areas subject to natural flooding or to saturation from artificial drainage flows.

13.) within filled areas, unless the fill has been allowed to settle for at least [6] months, or has been compacted to a density comparable to surrounding natural soils.

These provisions are similar to those of Rule 10D-6.046, F.A.C. Bracketed numbers indicate current rule standards. More stringent setbacks and standards will probably be necessary in many cases, depending on the sensitivity or permeability of the applicable aquifer protection zone, the extent of existing contamination from septic systems, and natural aquifer protection features.

d. Septic tanks must be sized so that wastewater entering the tank will be detained for at least [48] hours to insure sufficient anaerobic digestion and sedimentation of organic material.

e. The minimum acceptable size of any septic tank must be determined based upon the estimated peak waste load which will enter the septic tank. Factors to be considered in calculating the peak waste load should include:

1.) The number of persons to inhabit the dwelling described in the application;

2.) the number of bedrooms;

3.) the number, and operation specifications of wastewater-producing appliances and other wastewater sources described in the application, including:

a.) toilets and sinks,
b.) tubs and/or showers,
c.) automatic dish and cloths washers,
d.) garbage grinders and disposals.

4.) In no instance should the minimum septic tank volume be less than [750] gallons.

5.) If it is determined that one septic tank will not be adequate to insure sufficient anaerobic digestion and sedimentation of organic material, based on the number and types of wastewater-producing appliances in the dwelling, the (local authority) should require the installation of two separate tanks.
When two septic tanks are utilized, wastewater sources can be connected in a manner which facilitates effective anaerobic digestion. Kitchen and clothes washer effluent, for example, can be routed to one tank and sanitary waste to another.

f. Absorption fields should be sized so that wastewater entering the field will receive the degree of waste stabilization and attenuation necessary to insure it will be rendered harmless to human health and safety, not create a nuisance, and not contribute to the pollution of surface or groundwaters.

1.) The minimum acceptable size of any absorption field should be based on the following factors:

a.) the number of persons to inhabit the dwelling described in the application;

b.) the number of bedrooms;

c.) the number, and operation specifications of wastewater-producing appliances and other wastewater sources described in the application;

d.) soil characteristics of the area designated in the permit application, including:

(1) soil types;
(2) percolation rate;
(3) ground slope degree & direction.

2.) In no instance shall the minimum absorption field be less than [#] square feet.

Chapter 10D-6 bases minimum absorption areas for standard subsurface drainfield systems on estimated domestic sewage flows and a table in the rule indicating maximum sewage loading rates for various types of soils. For a single family residence with two bedrooms and an estimated 300 gallons per day of sewage, the required absorption field in an area with the least acceptable percolating soils would have to be 600 square feet.

3.) Automatic dosing devices shall be installed in absorption fields which exceed 1000 square feet in area, such that septic tank effluent is delivered in a uniform manner over the entire absorption field in a pulse as opposed to a continuous flow.

Dosing devices significantly enhance the effectiveness and operational life of the facility by avoiding overloading near the discharge point and thus make better use of the entire absorption field.

4. **Existing Facilities**

a. Where existing individual sewage disposal facilities are on lots under [one] acre, or where estimated sewage flows are greater than [1000] gallons per acre per day, existing individual sewage disposal facilities are required to connect to a municipal or investor-owned central sewer facility within [6] months of the date that the sewer facility becomes available within [one-half] mile.

The suggested threshold acreage is based on studies showing that generally, adequate dilution and attenuation of residential septic tank effluent requires lots of at least one-half acre. Applicable standards must be related to the severity of the threat to groundwater in the area. The total sewage flow into an area is the most important criterion for determining potential effects on an aquifer. Conditions within certain aquifer protection zones may require that the threshold acreage be increased or the threshold sewage flow rate be decreased. It may also be necessary to modify the thresholds in areas with higher densities of private wells, in order to decrease the potential for well contamination.

b. The owner of any property with an existing individual sewage disposal facility, as of the effective date of the ordinance, is required to make application for a sewage disposal permit within [60] days from the date of notification by the (local unit) that a permit is required for the continued operation of the facility.

1.) Notification must be made by registered mail and should include an explanatory letter and a sewage disposal permit application form.

2.) An application for a sewage disposal permit for the existing facility shall be made in accordance with the requirements of the ordinance.

c. Within [60] days of receiving an application for a sewage disposal permit personnel approved by (local authority) shall conduct a physical inspection of the individual sewage disposal facility described in the application.

d. A sewage disposal permit shall not be issued for an existing facility without an inspection certificate described below.

Unlike the inspection which must be made in conjunction with a proposed facility, this inspection is to determine whether the existing system is functioning properly under actual user conditions.

It may not be practicable to make all existing individual sewage disposal facilities immediately subject to the ordinance. An alternative is to determine which areas are in greatest need of immediate regulation to prevent groundwater contamination and danger to the public health. The requirements of the ordinance can then be implemented on a pre-determined schedule until all individual sewage disposal facilities have met the proper standards. Aquifer protection areas closest to public wells, or in areas with high concentrations of private wells, or in zones with existing problems from septic tanks would receive priority on the schedule.

5. Permit Validity

a. A sewage disposal permit issued pursuant to this ordinance is valid for a period of [2] years from the date of issuance, except that all permits are revocable by the (local authority) upon reasonable notice to the holder and opportunity to be heard. A permit may be revoked only when the individual sewage disposal system no longer meets the minimum standards contained in this ordinance.

An expiration date allows for re-inspection of the system before it is likely to begin malfunctioning. Chapter 10D-6, F.A.C. provides no oversight or other control after installation. The applicable permit period can be increased in areas with less susceptibility to contamination from septic tank effluent.

b. When property with an individual sewage treatment facility is sold, devised, conveyed or title is otherwise transferred, the new owner must notify the (local authority) within [60] days of the date of transfer and such notification must include the information required above for septic tank sizing.

c. If, based on the application information, no alteration of the existing facility is required to ensure its proper functioning, a sewage disposal permit should be issued to the new owner for the duration of the period for which the previous permit was issued.

d. If an alteration of the existing facility may be required due to increased peak loads, an inspection should be conducted to ascertain what alterations are required before a sewage disposal permit will be issued.

e. A sewage disposal permit must not be issued without the inspection certificate described below.

These provisions allow for consideration of possible changes in the waste stream as a result of new ownership. The new land use may be larger or use more wastewater-producing appliances or processes. Under such conditions, it may be necessary to alter the sewage disposal facility to prevent malfunctioning. The owner should be responsible for the disposal facility, therefore new owners must receive a sewage disposal permit in their own names.

6. Inspection Certification

a. An inspection certificate is required before issuance of a sewage disposal permit when:

1.) An individual sewage disposal facility exists on the effective date of the ordinance and a sewage disposal permit is required as an existing facility;

2.) the previous sewage disposal permit has expired; or

3.) title to the property on which the individual sewage disposal facility is located has been transferred and changes in the waste stream require that the facility be modified.

b. The property owner is required to provide reasonable access to the facility so that an inspection may be performed. Failure to provide reasonable access will constitute grounds for issuance of a deficiency notice, as explained below.

c. The inspection certification should be signed by an approved inspector, and should provide information that:

1.) The sludge and surface scum was pumped out of the tank into a licensed haul truck; or that the volume of sludge and scum was such that pumping was not necessary.

2.) The absorption field is functioning well.

3.) All other components are adequately maintained and functioning properly, and there is no recognizable present or potential danger to human health or the environment.

4.) Other information detailing any deficiencies, and corrective measures taken to bring the facility into compliance with the requirements of the ordinance.

Periodic inspections reduce the potential for groundwater contamination from inadequately treated sewage. Malfunctions due to overloading, breakage, or any number of other possible circumstances can be greatly reduced. The certificate insures that the inspector understands his responsibility and provides for a description of the action taken by him and the owner.

7. Deficiency Notice and Response

a. If an inspection certificate cannot be issued, the (local authority) will issue a written deficiency notice to the applicant.

1.) The notice should describe the deficiencies, state that a sewage disposal permit will not be issued until the deficiencies are corrected, and state what remedial action must be taken before a permit will be issued.

2.) Applicants should be given the opportunity for a hearing before the (local authority) for reconsideration of the matter. If the (local authority) decides that a deficiency notice is warranted with or without modifications, a new deficiency notice will be issued stating that the applicant must apply for reinspection, as below.

b. Within [60] days of receiving a deficiency notice, the applicant must apply to the (local authority) for reinspection of the facility, to certify that the deficiencies have been corrected.

c. If reapplication has not been made within [60] days, the facility should be declared a public nuisance and a public health hazard.

When it makes the declaration, in order to protect the public health, safety and welfare, the (local authority) should either perform necessary corrective measures at cost to the applicant, or assure that the deficient system receives zero waste load, either by condemnation of the premises as a threat to public health or by assuring that all wastewater sources formerly connected to the deficient system have been disconnected and connected to a separate, approved, and properly functioning waste collection and treatment system.

8. Variance Standards

a. Variances from the requirements of the ordinance should not be allowed in more highly permeable or more sensitive aquifer protection zones, and should not be based on economic difficulties arising from the ordinance requirements.

b. The application for a variance must include:

1.) name, address and phone number of the developer and owner;

2.) description and drawing of the property and buildings;

3.) location of the property with respect to aquifer protection zones and existing or planned central sewer systems;

4.) detailed description of the reasons why the property owner is unable to meet the requirements of the ordinance.

5.) detailed description of the proposed alternative approach.

c. A copy of the variance application should be transmitted to each local government department with the expertise to comment on the simplicity, reliability and feasibility of the proposed variance, and the degree of threat to groundwater quality which would result if the proposed measures failed. Reviewing departments include: the health department, engineering, building inspector, environmental department, planning department, and utilities department. Comments should be required within a specified period of time.

d. Variances from the requirements of the ordinance, except the requirements for uses in [applicable aquifer protection zones], may be granted by the (governing authority) if it makes a positive finding, based on substantial competent evidence, for each of the following:

1.) There are special practical difficulties in strictly conforming to the ordinance requirements, not shared by the other uses regulated under the applicable standards.

2.) The granting of the variance will not [appreciably] contribute to the degradation of surface or ground water, or otherwise impair attainment of the objectives of the ordinance.

3.) The granting of the variance is consistent with the purpose and intent of the ordinance, in light of existing and probable future development of surrounding areas.

4.) The proposed variance will not adversely affect an existing or planned water supply.

In areas identified as being sensitive to contamination from sewage disposal, variances should not be granted, unless the proposed alternative can be shown to offer protection equivalent to the use of a central sewer system. Use of qualifying terms such as "appreciably" reduces the stringency of the variance section, but may increase its practical applicability. Other approaches are possible, but the important point is to insure that the decisions of the reviewing body will be consistent with the objectives of the ordinance.

e. The (governing authority) shall not consider as grounds for the granting of variances:

1.) That the implementation of these requirements would impose an economic hardship on the cost of the development.

2.) That other adjacent lands, structures or buildings not in conformance with these requirements provide a rationale for relaxing their application to this development.

Depending on the size and structure of the local government, the "governing authority" to which the suggested provisions refer can be a local governing board, a zoning board, or an "environmental quality control board."

LOCAL ORDINANCE: MODERATE LEVEL OF STRINGENCY

As with other types of local regulation of potential threats, creating a moderate approach generally involves either upgrading the baseline regulations or moderating the requirements of the more stringent approaches. A moderate approach must maintain a reasonable relationship between technical studies showing the vulnerability of the aquifer and any contamination threats, the goals of the ordinance and the regulatory structure created to address those goals. Where available information and studies indicate that on-site sewage disposal of certain types or in certain areas poses a threat to a potable aquifer which has been targeted for protection, the strategy for regulating on-site sewage disposal must adequately address the threats.

1. Upgrading Baseline Regulations

The principal areas in which state baseline rules may be upgraded are those related to densities, requirements for existing on-site systems, and setbacks and other siting standards. Where private wells are used, Ch. 10D-6, F.A.C. allows on-site septic systems on half acre lots, as long as sewage flows are less than 1500 gallons per acre per day. Where public water is used, the rule allows four on-site systems per acre and sewage flows of up to 2500 gallons per acre per day. Particularly in sensitive aquifer protection areas, these densities and allowable flows can be made more stringent. In areas where the wet season water table elevation is only 24 inches below the drainfield, as is allowed by the state rule, serious consideration should be given to decreasing the allowable densities and sewage flows.

Ch. 10D-6, F.A.C. also allows developers to make provisions to connect subdivisions to central sewer systems when formula-based densities are reached. Until that time, such subdivisions may use on-site systems on an interim basis, as long as total sewage flows are under 2500 gallons per acre per day. A local ordinance can upgrade the state rule by specifying that such arrangements are not permitted at all, or are not permitted in aquifer protection zones. The state rule also includes a policy statement that all on-site systems connect to a central sewer system within one year of its availability. However, the rule allows existing approved on-site systems to continue in use without being upgraded, so long as they are in satisfactory condition, and the quantity or character of sewage flows does not increase. In some cases, existing sewage flows, even from systems which are operating satisfactorily, may be contributing to the contamination of an aquifer. Local ordinances can take a more stringent approach by requiring existing systems, especially those above certain densities or above certain sewage flows or within sensitive aquifer zones, to connect to a central sewer system within a short time after it becomes available.

The setbacks and other site evaluation criteria of the state rule may also be examined and made more stringent if warranted. The height of water table elevation which is considered acceptable is an important area in which state rules may be upgraded, by requiring that the wet season water table be at least 36-48 inches below the drainfield. Serious consideration should be given to increasing applicable setbacks from private and public wells, depending on the permeability of soils in the area. The state standards should be considered absolutely minimum criteria. The same concern applies to setbacks from surface waters.

2. Moderating Stringent Approaches

The stringent approach suggested in this section requires that new buildings, and existing systems exceeding certain thresholds, must connect to a central sewer system when available within one-half mile. The distance threshold might be moderated to reflect conditions in less threatened or less sensitive areas. Any reduction of the distance threshold for facilities zoned or used for industrial processes, or with the potential to generate hazardous wastewater, should be very carefully evaluated, since such facilities can easily introduce toxic chemicals into groundwater. Consideration might be given to basing the connection requirement on the maintenance of proper gravity flow, instead of on distance alone, in effect deleting the requirement that an owner construct necessary pumps and lift stations.

The design, siting and installation standards of the stringent approach are eligible for moderation, if conditions warrant a less strict approach. In appropriate areas, allowable densities or sewage loading rates might be slightly increased. A stringent approach will require greater well setbacks and surface water setbacks than those of the state rule, based on the sensitivity of the applicable aquifer protection zone. As with other standards, in less sensitive areas, consideration might be given to moderating the stringent setbacks. Local conditions might also warrant a slight reduction in the depth of unsaturated soil required beneath the bottom of an absorption field under the suggested stringent approach.

Existing facilities over certain thresholds must connect to central sewer within six months of the availability of such a system, under the suggested stringent approach. Depending on the sensitivity of the applicable area, it may be considered acceptable to moderate the threshold values, or to extend the deadline for the required connection. Consideration can also be given to easing a stringent schedule for upgrading or connecting existing on-site systems. Permits might also be granted for slightly longer periods.

REFERENCES

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REGULATION OF HAZARDOUS MATERIALS STORAGE AND HAZARDOUS MATERIALS MANAGEMENT

INTRODUCTION

One of the most important components of an effective aquifer protection program involves careful regulation of storage tanks for hazardous materials which are liquid at standard temperature and pressure. Aboveground storage systems may include unprotected tanks and piping subject to weathering, or may involve storage of materials without properly diked containment and transfer areas. Underground tanks pose special problems, because leaks may go unnoticed for long periods of time and potential contaminants may be discharged much closer to groundwater, below the biologically active soil layer where attenuation of contaminants can occur. Today, the average capacity of service station tanks is about 10,000 gallons per tank. The generally accepted estimate is that one gallon of gasoline is capable of contaminating one million gallons of potable water.

Urban areas normally include many types of facilities which use, store, handle, or process hazardous materials. With growing public concern over the siting of such facilities, rural and semi-rural locations are likely to become more popular. In either location, such facilities may be subject to chronic or sudden loss of hazardous materials to the outside environment, with potential damage to groundwater resources. Local governments often have little information on the types of materials and processes being used at a facility, while the facility itself may not have fully evaluated its use, handling or contingency procedures.

BASELINE APPROACHES

1. Underground Storage Tanks

In Florida, the basic regulatory approach to underground storage of hazardous materials, not including hazardous wastes, is represented by Chapter 17-761, Florida Administrative Code (F.A.C.), entitled "Underground Storage Tank Systems." It provides standards for the construction, registration, removal and disposal of underground storage tank systems, including their on-site integral piping and associated release detection systems. It applies to systems which have individual tank capacities over 110 gallons, storing "regulated substances."[1]

The rule was adopted by the Environmental Regulation Commission in June of 1990, and by the Governor and Cabinet in October, 1990. The requirements of the rule supercede those of Chapter 17-61, F.A.C. ("Stationary Tanks"). The requirements of Chapter 17-761 are summarized and explained in Chapter II of this volume.

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[1] The definition includes two general categories of substances: 1.) "pollutants," defined as any commodity made from oil or gas, or their derivatives, as well as pesticides, ammonia, chlorine and their derivatives, but not liquefied petroleum gas; and 2.) any substance defined in section 101(14) of the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) of 1980 (not including hazardous wastes regulated under Subtitle C of the Resource Conservation and Recovery Act) that is liquid at standard temperature and pressure. Rule 17-761.200(32), Fla. Admin. Code (1990). See Fla. Stat. §§ 376.301(12), 377.19(11) (1989).

The requirements of Chapter 17-761 are preemptive with regard to most local programs. The Department of Environmental Regulation is the implementing agency, but may contract with capable local governments for administration of certain of its responsibilities under the rule.[2] Final agency action for any of these responsibilities performed by a locally administered program must be taken by the DER. This section of the rule does not apply to local governments with approved local programs authorized under Section 376.317, Florida Statutes, except to the extent that the local government has contracted with the DER for specific duties related to the rule.[3]

Section 376.317, Florida Statutes allows county governments to adopt countywide ordinances which are more stringent than state rules on underground storage tanks, if: 1) the ordinance was adopted and in force before September 1, 1984; or 2) the ordinance was adopted and filed with the Secretary of State before July 1, 1987; or 3) the county effectively administers the state rules for two years, then files a petition for approval of the local ordinance. A county which sought approval of its program prior to January 1, 1988 is not required to administer the state program for any minimum period before filing for approval of its own ordinance.[4]

Thus, most local governments which did not adopt ordinances addressing this topic before the applicable dates, and which wish to adopt a more stringent ordinance must contract with the Department of Environmental Regulation to administer Chapter 17-761, F.A.C. for two years before being eligible to adopt the more stringent approach. Contracting local governments will be able to research and develop more stringent ordinances during the two-year period, allowing them to immediately begin the petition process for approval at the end of that period. Whether or not a local government chooses to develop a more stringent ordinance, it should take every opportunity to contract with DER to administer the requirements of Chapter 17-761. The rule represents a minimum level of regulation for a range of potentially drastic threats to an essential resource, and local government oversight of facilities within its jurisdiction is likely to be greater than that of the DER.

2. Aboveground Storage Tanks

The basic regulatory approach to aboveground storage of certain hazardous materials is represented by Chapter 17-762, F.A.C., entitled "Aboveground Storage Tank Systems." The rule was adopted by the Environmental Regulation Commission in December of 1990, and will become effective in late February 1991. It provides standards for the design, construction, installation, maintenance, registration, closure, removal and disposal of aboveground storage tank systems, including tanks and their on-site integral piping and associated release detection systems. The

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[2] Rule 17-761.840, Fla. Admin. Code (1990). Section 376.3073, Fla. Stat., requires DER, to the greatest extent possible, to contract with local governments for administration of its responsibilities under Sections 376.3071(4)(a)-(e),(h), 376.3072, and 376.3077, Fla. Stat. These include regulation of aboveground and underground storage tanks, other compliance verification programs, and monitoring, assessment and remediation of petroleum product contamination. Eligible local governments "deemed capable of carrying out such responsibilities" and which contract with DER under this section are entitled to receive sufficient funds to administer the local program. Fla. Stat. § 376.3073 (1989).

[3] Rule 17-761.840(3), Fla. Admin. Code (1990).

[4] Fla. Stat. § 376.317 (1989).

rule will apply to systems which have capacities over 550 gallons, storing "pollutants."[5] For systems permitted prior to the effective date of Chapter 17-762, F.A.C., the basic permitting approach to aboveground tanks will be that of Chapter 17-61, F.A.C., though previously permitted systems will become subject to the requirements of Rule 17-762 regarding existing systems.

The requirements of Chapter 17-762 will not preempt those of local governments. As with Chapter 17-761, the Department of Environmental Regulation may also contract with capable local governments for administration of certain of its responsibilities under the rule.[6] Final agency action for any of DER's responsibilities performed by a local program under these contracts must be taken by the DER. This section of the rule will not apply to local governments with approved local programs authorized under Section 376.317, Florida Statutes, except to the extent that the local government has contracted with the DER for specific duties related to the rule. The independent local programs will have independent authority to take final action related to their ordinances.[7]

3. Hazardous Materials Management Plan

The baseline approach to hazardous materials management is represented by the federal Emergency Planning and Community Right-To-Know Act (EPCRA),[8] which imposes non-emergency reporting requirements on industry, including material safety data sheets (chemical information), emergency and hazardous chemical inventory forms (amounts of certain hazardous chemicals), and toxic substance release forms (amounts of emissions). The reports must be submitted to a local emergency planning committee, state emergency response committee, and local fire department, or to the federal EPA and state designated official in the case of toxic substances. Releases of reportable quantities of extremely hazardous chemicals must be reported to the community's emergency coordinator. The Act also requires local emergency planning committees to develop emergency plans dealing with preparation for, and response to releases of hazardous materials from covered facilities. Nothing in EPCRA preempts local efforts to develop hazardous material disclosure or management ordinances.

Provisions requiring a hazardous materials management plan (HMMP) can serve as strong preventive tools for local governments. Basically, the HMMP is a document submitted by the applicant to the local government which details the planning and procedures applicable to the

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[5] Defined as any commodity made from oil or gas, or their derivatives, as well as pesticides, ammonia, chlorine and their derivatives, but not liquefied petroleum gas. See Fla. Stat. §§ 376.301(12), 377.19(11) (1989).

[6] Rule 17-761.840, Fla. Admin. Code (1991). Section 376.3073, Fla. Stat., requires DER, to the greatest extent possible, to contract with local governments for administration of its responsibilities under Sections 376.3071(4)(a)-(e),(h), 376.3072, and 376.3077, Fla. Stat. These include regulation of aboveground and underground storage tanks, other compliance verification programs, and monitoring, assessment and remediation of petroleum product contamination. Eligible local governments "deemed capable of carrying out such responsibilities" and which contract with DER under this section are entitled to receive sufficient funds to administer the local program. Fla. Stat. § 376.3073 (1989).

[7] Rule 17-762.840(3), Fla. Admin. Code (1991).

[8] 42 U.S.C. § 11001 et seq. (1989). See also, 40 C.F.R. Part 355, Appendices A and B; 40 C.F.R. Part 370; 40 C.F.R. Part 372 (1989).

facility's use of hazardous materials. It is used to require industries to disclose descriptions of their chemical handling process, demonstrate adequate procedures for preventing and responding to toxic releases, examine the effectiveness of pollution control technologies and management practices, and implement programs which reduce the possibility of routine or accidental chemical releases.[9]

A local government may use HMMP information to review, inspect, set conditions for and approve hazardous materials operations within its jurisdiction. For new facilities, the HMMP should be part of the permitting process, with local governments using the information to determine appropriate siting and permit conditions. Existing facilities which handle hazardous materials should also be required to formulate HMMPs, in order to educate the facility on its own use of hazardous materials, provide more oversight for local government, and provide information for the revision of existing permits.

LOCAL ORDINANCE: HIGH LEVEL OF STRINGENCY

Since most local governments in Florida will be required to administer the state rules regulating underground storage tanks for two years before being eligible to adopt a more stringent ordinance, the following provisions should be considered in the process of developing the more stringent approach. The state rule addressing aboveground storage tanks (Chapter 17-762, F.A.C.) is not preemptive and will only regulate the storage of "pollutants" (any commodity made from oil or gas, or their derivatives, as well as pesticides, ammonia, chlorine and their derivatives, but not liquefied petroleum gas), leaving local governments free to more carefully regulate the aboveground storage of many types of hazardous materials. There are no preemptive regulations addressing hazardous materials management, leaving local governments free to develop and adopt such ordinances which address local needs.

There are several topics that should be addressed in a hazardous materials storage ordinance, including siting considerations, forms of primary and secondary containment for tanks, forms of primary and secondary containment for integral piping, containment for loading and transfer areas, containment of areas around dispensers and fill lines, monitoring of tanks and piping with automatic leak alarms, proper installation procedures, overfill containment with automatic alarms, regular inspection and reporting, contingency plans, closure and retrofit schedules, and proper closure procedures.

Complete hazardous materials management plans should include provisions for hazardous materials disclosure inventory, throughput information (total estimated amounts of hazardous materials handled in a certain period of time), process descriptions, source reduction, recycling/recovery and treatment technologies for each material, emergency prevention and preparedness, self-monitoring plan, contingency plan, closure plan, and facility security. Hazardous materials management plans can be required under a freestanding ordinance, or made part of a more comprehensive storage and management ordinance. The advantage to combining HMMP and storage system requirements in the same ordinance is that the information required by HMMPs can be helpful in establishing proper storage and monitoring techniques.

The following provisions represent measures necessary to a comprehensive and effective hazardous materials storage and management ordinance. The basic thrust of the underground storage tank provisions is to have all tanks and piping used to store liquid hazardous materials

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[9] See Sherry, S., High Tech and Toxics: A Guide for Local Communities, 256, Conference on Alternative State and Local Policies, Washington, D.C. (1985).

include secondary containment and continuous interstitial monitoring as soon as is reasonably possible. For aboveground tanks and piping, external secondary containment and weather protection are some of the most important provisions, and should include internal lining for those tanks which are in contact with the soil and which cannot be raised to allow full secondary containment. The HMMP requirements aim at providing essential information on materials management, and requiring facilities to plan for the careful use of hazardous materials. See Appendix A for copies of several local ordinances which address the storage and management of hazardous materials, including those of Austin, Texas, Broward County, Florida, Dayton, Ohio and Santa Cruz County, California.

1. General Requirements for All Storage Facilities

a. A permit to store hazardous materials must be obtained. The permit should be conditional upon satisfactory completion of all provisions below, with a compliance inspection required.

For local governments with the capability of administering a permit program, the advantages include careful review of all aspects of the design, installation and operation of a facility. A separate permit is required for each geographic location. Permits should not be transferable between old and new owners of a facility. An operating permit may also be required, with annual or biannual renewal based on satisfactory compliance with all operating requirements. See the hazardous materials storage ordinance of Austin, Tex. for detailed permitting requirements.

b. All storage areas within any one facility must be registered with appropriate state and local agencies.

c. All hazardous materials to be stored at a facility must be identified as part of a materials inventory.

This should include a description of the type, location and quantity of hazardous materials and detailed information on their storage methods. (Where the local government has a geographic information system (GIS), this type of information can be entered into the system, to aid in effective and safe emergency response.)

d. Adequate security measures for the storage facility must be provided.

e. Incompatible materials must be stored in separate areas of the storage facility.

These include any materials which in combination may cause a fire or explosion, or the production of a flammable, toxic or poisonous gas, or the deterioration of a primary or secondary container.

f. All primary storage tanks and piping must be product-tight and impervious to any material which may be released into them. To be product tight, tanks and piping must not be subject to physical or chemical deterioration by the substances they contain, over their useful life.

g. All secondary containment must be product-tight and impervious to any material which may be released into it.

h. All storage tanks for hazardous substances which are liquid at standard temperature and pressure (STP) must be equipped with continuous electrical or mechanical monitoring systems connected to warning devices to detect leakage of materials out of the primary container. Where possible, monitoring should also include direct visual observation of all sides of storage containers.

i. Storage systems must be pressure tested, at the owner's expense, after installation but prior to being buried or put into service.

Tanks should be tested by air pressure at not less than 3 psi or more than 5 psi. Piping should be tested either: hydrostatically to 150% of the maximum anticipated pressure, or pneumatically, joints coated with a soap solution, to 100% of the maximum anticipated pressure of the system, but not less than 50 psi at the highest point of the system.

j. Overfill protection must be provided for all storage containers. This can include audible and/or visual alarms that are activated when a tank is 90% full, devices to stop the transfer of product when a tank is for instance, 95% full, product-tight catchment devices and vent line check valves.

k. Equipment must be available for removing released materials collected by secondary containment systems. Alternatively, a discharge response contractor must be identified and must be capable of responding to a release within a specified period of time.

l. Proper labeling must be provided for all storage containers, storage areas, piping and transfer areas. Labeling should include, at a minimum, the chemical name, concentration and hazard class of the hazardous material.

m. Routine recordkeeping of maintenance, testing, inspection and monitoring must be conducted for all storage facilities and available to local authorities upon request.

n. All storage areas should be given suitable protection from the environment, including hurricane impacts. Indoor storage and aboveground storage areas should include hurricane proof roofing, and reasonable protection to storage tanks, piping and barrels from flood damage and flying debris. Underground storage systems should include adequate anchoring to prevent floating during flood events and high groundwater.

o. Any leaking storage container must be immediately emptied of its contents and reported to local authorities. The emptied product must be transferred to approved product-tight holding tanks.

p. New storage facilities are subject to the provisions of the ordinance immediately upon adoption of the ordinance. Existing storage facilities are subject to mandatory retrofitting, to the standards applicable to new systems, within a period of time which assures that previously installed tanks and piping do not develop leaks.

The retrofit schedule will require consideration of the age of the storage system, its location relative to aquifer protection zones, the materials and technologies used by the system, and the corrosivity of the subsurface environment. In the interim period before retrofit, existing facilities should be required to provide the results of a precision tank tightness test, less than six months old, capable of detecting the loss of 0.05 gallons per hour, indicating that a facility is not leaking. Existing facilities should also be required to install monitoring and demonstrate financial responsibility. The wellfield protection ordinance of Palm Beach County (Ordinance 88-7) requires existing nonresidential uses within thirty days' travel time of public wells to close existing storage facilities within one year of ordinance adoption.

2. **Underground and Aboveground Storage Tanks**

a. All storage tanks must be provided with impervious secondary containment.

Laminated, coated or clad tanks are considered single-walled and do not fulfill the requirement for secondary containment. When double-walled tanks with continuous interstitial monitoring are used to satisfy this requirement, the next two requirements do not apply.

b. Secondary containment systems must be capable of holding at least 110% of the volume of a single tank, or for multiple tank containment systems, 150% of the volume of the largest tank, or 50% of the aggregate volume of all tanks within the containment system, whichever is greater.

Broward County Code (Chapter 27-12) requires complete containment of <u>any</u> spill of hazardous material from a new or existing facility within thirty days' travel time of a public well, the county's second most sensitive overlay zone.

c. Containment systems must be sheltered so that intrusion of precipitation is effectively prevented. Alternatively, where storage tanks are exposed to rainfall or runoff infiltration, the secondary containment must be capable of holding the contents of a 24-hour (100 year history) storm in addition to the requirement in the preceding section, and must include a means of removing the water without allowing its contact with stormwater or sanitary sewer drains or the ground.

d. Incompatible materials must be separated in both the primary and secondary containment so as to avoid intermixing in the event of a container rupture.

e. Records of deliveries and consumption should be reconciled to detect hazardous material loss in underground storage facilities.

f. Existing aboveground tank systems in contact with the soil must be tested for structural integrity. If judged to be sound, such systems must be internally lined with an impervious coating which seals those portions of the tank in contact with the soil. Secondary containment must be adequately sized and sealed to the side of the tank(s). Such tanks which are capable of being lifted should be subject to a retrofit schedule requiring them to be lifted and provided with adequate secondary containment.

3. **Indoor Storage Facilities**

a. Indoor storage facilities must be provided with impervious secondary containment that meets the same standards as aboveground and underground facilities. The containment must be capable of holding at least 110% of the volume of the tank in a single containment system, or for multiple tank containment systems, 150% of the volume of the largest tank, or 50% of the aggregate volume of all tanks within the containment system, whichever is greater. This can include impervious curbed areas, and rooms with impervious floors, curbs and walls providing the required containment volumes.

b. Aisles must be provided so that all containers are accessible.

c. Indoor tanks and containers must be provided with automatic covers.

d. Portable indoor containers should not be stacked more than two high without an approved rack and must be visible from all sides (including the bottom).

e. Incompatible materials must be separated in both the primary and secondary containment so as to avoid intermixing in the event of a container rupture.

f. Floor drains to sanitary sewers or septic tanks must be sealed.

4. Piping, Fittings and Connections

Most leaks occur in piping, fittings and connections, especially in underground applications where direct observation is not possible.

a. All piping, fittings and connections must be corrosion resistant and compatible with the hazardous materials for which they are used. They must be designed for the working pressures and structural stresses to which they may be subject.

b. All piping must be provided with secondary containment: either double-walled pipes, or single-walled pipes located within other types of secondary containment, draining to a monitored point in the containment.

c. Piping must be clearly labeled for easy materials identification.

d. Where applicable, piping must be designed to provide access points for tightness testing.

e. Piping systems must be provided with emergency shut-off valves, monitoring devices and warning alarms.

5. Areas for Loading, Unloading and Transfer

These types of areas are subject to both chronic and sudden releases of materials, related to small spills, neglected transfer lines which overflow, and uncontained transfer areas. The suggested provisions require proper containment and monitoring, overfill alarms and catchments, and vent line check valves.

a. Transfer areas must be provided with secondary containment and/or paved and curbed with an impervious material.

b. Transfer containment areas must be drained to an adequately sized and sealed holding tank or containment sump with a roof.

c. Transfer facilities must be equipped with a monitoring system and warning devices. All possible overflow points should be visible from loading locations.

d. Vent lines must use check valves to avoid spills.

e. Transfer facilities must be equipped with emergency shut-off valves, high product level alarms and mechanical catchment devices to protect against the overfilling of tanks and other containers.

6. Comprehensive Hazardous Materials Management Plan

Hazardous materials management plans should be required of all new and existing facilities using or storing hazardous materials. See the hazardous materials storage ordinances of Austin, Tex., Broward County (Chapter 27-12) and Santa Cruz County, Calif. for examples of strict application and permit requirements for HMMPs. An ordinance incorporating such plans initially requires consideration of which hazardous materials and volumes should be regulated by the ordinance. The four general parts of an HMMP ordinance include: environmental audit; emergency prevention and preparedness; continuous protection measures; and permit requirements. Many types of information in the HMMP can be entered into a geographic information system (GIS) to aid in effective and safe emergency response.

a. Environmental Audit

1.) Facility description.

Provides standard information on the firm, including: name, address, business phone number, emergency contact, emergency phone number, name of chief officer/manager, number of employees, hours of operation, principal business activity.

2.) Hazardous materials disclosure inventory.

A list of all hazardous materials handled, used, stored, released or disposed of by the firm. For non-waste materials, this should include both the chemical and common name, and a Material Safety Data Sheet (MSDS), which is provided by chemical manufacturers and summarizes most of the health, safety, chemical property and emergency response information on a particular chemical. The hazard class should also be provided, the estimated maximum amount of each material handled at any point in time, and the estimated total amount of each material handled over a designated time period.

3.) Process description(s).

An explanation of the all production processes and the flow of hazardous materials through each process.

4.) Description of operational procedures for routine handling of hazardous materials, including delivery and pickup procedures.

5.) List of current source reduction, recycling/recovery and treatment technologies employed per waste stream.

Subsections 5.) through 11.) are designed to allow evaluation of a processing firm's plans to minimize generation of hazardous wastes. The provisions are less applicable to storage facilities such as gasoline stations.

6.) Materials balance (mass) analysis per chemical.

Estimate of how much of each chemical is emitted into the air, discharge into sewer/surface water, disposed, recycled and/or becomes part of the end-product. Involves a full accounting of all hazardous materials used and generated by the facility. Used to determine how much of each chemical is brought into the facility, and in what form and quantity the chemical leaves.

Includes: inventorying the incoming mass of each hazardous material; full monitoring of air, wastewater, workplace and liquid/solid wastes for all hazardous materials; estimating mass of each material which leaves the plant as product, recycled material, air emission, wastewater, onsite leakage and hazardous waste disposal.

7.) Identification of portion of materials whose fate cannot be determined through the materials balance analysis.

8.) Identification and description of waste reduction technologies/practices to reduce the use, generation, or release of hazardous materials, based on results of materials balance analysis.

9.) Economic assessment of current and proposed pollution control/waste reduction methods.

In addition to reducing contamination potential, waste reduction technologies and practices may be economically beneficial by decreasing use of raw material, reducing potential liability or by producing reusable resources.

10.) Required or recommended goals, set by a facility, for reducing hazardous waste emissions.

The process described in subsections 5.) through 10.) can provide an industrial facility with strong incentives to include efficient technologies/practices designed to reduce loss of hazardous materials and production of wastes.

11.) Listing of offsite hazardous waste hauler.

12.) Listing of onsite and offsite recycling, treatment and land disposal facilities used.

13.) Listing of contract labs used for environmental analyses.

14.) Listing of current environmental permits and their status.

15.) Assessment of current compliance with relevant hazardous materials laws at the local/state/federal levels.

b. Emergency Prevention and Preparedness

Important provisions applying to any firm using hazardous materials. If not included in an HMMP ordinance, the requirements should be made a part of the local fire code. All emergency response personnel should have the information before responding to an emergency.

1.) Site description and facility map.

Site descriptions should include locations of wells, floodplains, waterways, sinkholes and aquifers on the property, as well as drainage patterns, subsurface geologic conditions and land uses within one mile of the facility's boundaries.

Facility maps should include locations of all buildings and structures, permanent access roads, parking lots, internal roads, chemical loading and transfer areas, equipment cleaning areas, and storm and sanitary sewer drains.

2.) Detailed description of types and locations of hazardous materials and their storage methods; demonstration of proper labeling, storage and separation of materials; demonstration of compliance with storage ordinance requirements.

Storage descriptions should include the location of all interior, exterior and underground/aboveground storage areas, access to such facilities, types of storage methods used, and the nature and amount of materials stored.

Standards for labeling and materials separation should be contained in the hazardous materials storage ordinance (or local fire code). The HMMP should describe how the firm's labeling and storage practices are in compliance.

3.) Pre-fire and spill contingency plan.

Plans detailing emergency response procedures for fires, leaks, explosions or spills. A minimal approach should include lists of emergency equipment and personnel, an evacuation plan, and methods of distributing copies of emergency procedures to employees and posting copies in conspicuous locations.

4.) Spills notification agreement with local authorities.

Signed by the firm, outlining and acknowledging legal responsibility to promptly report unauthorized releases of hazardous materials (both threatened and actual) to appropriate authorities. Should include suspected losses of material indicated by mass balance discrepancies or onsite monitoring results.

5.) Provisions for adequate emergency equipment.

Description of available equipment, its location in the facility, and provisions for its testing and maintenance. (See for example, Lee County Ordinance 89-30, Sec. 6.02). An alternative approach for smaller facilities would require listing of the emergency response contractor capable of responding to an emergency within a short period of time.

6.) Description of hazardous materials training for plant personnel.

Plan for instructing employees in the routine handling and storage of hazardous materials, as well as procedures to be followed in emergencies.

c. **Continuous Protection Measures**

1.) Comprehensive plan for ongoing self-monitoring and reporting.

Includes a thorough explanation of the onsite monitoring program and its adequacy as an early warning system. Should address groundwater and nearby wells, soils, wastewater discharges and all storage facilities. Establishes background levels of contamination. Includes requirement that any problems revealed by monitoring data be reported to local officials.

2.) Schedule for routine self-inspections, recordkeeping and maintenance.

Schedules and procedures for the firm's inspection of its facilities and processes using hazardous materials, regularly recorded and available to local officials on request.

3.) Closure plan, including provisions for financial coverage in the event of post-closure releases.

The plan should describe procedures for terminating the facility without need for further maintenance. Should describe control measures which will minimize the threat to public health or the environment from residual materials. Should demonstrate the firm's ability to pay for closure after it has ceased operations.

4.) Demonstration of financial coverage for both sudden spills, slow leaks and third party liability, including cost recovery for local government.

Should be sufficient coverage to provide cost recovery to the community in case third-party cleanup is necessary, and to compensate for any bodily injury or property damage caused by an incident.

5.) Description of facility security precautions, to prevent unauthorized entry by persons or animals into areas of hazardous materials storage or handling.

d. **Permit**

The advantage of a permit system is that before engaging in any use of hazardous materials, the facility must demonstrate to authorities that it has met all requirements. In securing the permit, the firm is informed of requirements, and in signing the permit, it agrees to abide by applicable regulations. A permit can also be revoked for non-compliance.

1.) Mandatory for all industrial and commercial facilities which handle hazardous materials (possibly above an established volume threshold).

2.) Separate permit required for each facility or geographic site.

3.) Annual or biannual renewal, conditional upon satisfactory completion of and compliance with HMMP elements.

4.) Compliance inspections part of ordinance (possible use of permit fees to cover costs of reviews and inspections).

LOCAL ORDINANCE: MODERATE LEVEL OF STRINGENCY

Several methods may be used to structure a moderately stringent ordinance. Generally, these involve either upgrading the baseline approaches or moderating the requirements of the more stringent approaches. The most important consideration in creating a moderate approach is to maintain a reasonable relationship between applicable conditions, the goals of the ordinance and the regulatory structure created to address those goals. Where studies and available information indicate that a certain level of threat is posed by hazardous materials in sensitive groundwater areas, the strategy for regulating their storage and management must adequately address applicable conditions and assure protection of public health and safety.

1. Upgrading Baseline Regulations

A local government may choose to adopt the state-level baseline regulations, with modifications and upgrades, in structuring what would be considered a moderate approach to hazardous materials storage. Refer to the requirements of Chapter 17-761, F.A.C. and Chapter 17-762 for the DER's baseline approach. One of the most effective upgrading techniques involves decreasing the number of exemptions. Thus, for example, underground systems holding hazardous wastes, or agricultural storage tank systems holding less than 550 gallons, or other appropriate types of systems may be required to meet the requirements of the rule.

A second very important way in which state regulations may be upgraded is by increasing the setbacks from potable water wells, for any use or storage of hazardous materials. If made a part of an overlay zoning approach, the containment, spill protection and release detection standards can be based on the sensitivity of the zone to which they apply. In very sensitive areas, it may be necessary to prohibit any use or storage of hazardous materials, including use or storage by existing systems.

Shortening the period of time allowed before retrofit and secondary containment of tanks and piping is required will also strengthen the state storage tank rules. As adopted, the rules for underground storage tanks require secondary containment for underground "hazardous substance storage tank systems," excluding those for petroleum, after January 1, 1991. However, petroleum storage tanks represent the far greater threat of contamination, and the rule does not require secondary containment for new systems until January 1, 1998. Existing systems storing petroleum fuel products are required to upgrade various parts of the system on a schedule in the rule, but full secondary containment for such systems installed before 1970 is not required until the year 2012. Considering the sensitivity of the area, it may be necessary to shorten the schedule for upgrading existing systems and requiring secondary containment. Similar analysis of the aboveground storage tank rule, when adopted, will likely indicate other areas which can be upgraded at the local level.

Release detection is an area which should be considered for upgrading. The state rule generally allows several types of release detection, but the least costly will most likely be the most often used. For existing vehicular fuel storage facilities over 550 gallons without secondary containment, a "groundwater monitoring plan, spill prevention control and countermeasure plan" is acceptable if it can be demonstrated that it will detect leaks of 0.2 gallons per hour or a release of 150 gallons per month. The acceptable leak sensitivity standard fails to detect leaks of up to 4.8 gallons per <u>day</u>, and the rule allows non-continuous, non-automatic monitoring to be checked as infrequently as every 30 days. Existing facilities without secondary containment should have release detection methods which are more sensitive than those applicable to facilities with secondary containment. If not required to be automatic and continuous, monitoring systems should be checked as often as reasonably possible. Careful study of the underground and aboveground rules will suggest other ways in which the requirements can be upgraded at the local level.

2. Moderating Stringent Approaches

Moderation of stringent provisions should be based on findings that the relaxation is appropriate to the level of threat posed by the storage and use of hazardous materials in particular areas. As with moderate approaches discussed in other sections of this manual, one strategy is to reduce the stringency of the performance and design standards which storage systems must meet. It may be possible to allow tanks with corrosion protection but without secondary containment in appropriate areas which have high levels of natural aquifer protection. This approach would only be feasible where private wells tapping the water table aquifer would not be threatened by potential leaks. Since piping is more prone to leakage, approaches which permit anything other than secondarily contained piping systems should be carefully studied. Moderating the many performance and design standards applicable to hazardous materials storage can be difficult, since even small leaks of such materials may have drastic impacts on potable water, and the cumulative effects of many small leaks or spills can be so easily overlooked. Any modifications should remain sensitive to conditions in an area, and should reflect a reasonable approach to regulation of applicable hazards.

Another way in which stringent approaches may be moderated is by increasing the volume thresholds for systems required to meet the standards of the ordinance. Rather than attempting to regulate all storage tanks, a moderate approach may set volume thresholds for different types of tanks, with different levels of leak protection, or for tanks of different ages, using an approach that recognizes that older tanks are likely to be more leak-prone than newer tanks.

Retrofit schedules for upgrading and secondarily containing existing hazardous materials storage facilities may be modified to reflect the level of threat posed by such facilities, considering the age of the facility, its current level of leak protection, and the sensitivity of the area. Though it may be necessary to close older unprotected facilities in very sensitive areas, a retrofit schedule may also, for example, allow a system with cathodic protection located in a naturally protected aquifer protection zone to operate slightly longer before requiring secondary containment.

Monitoring requirements should be carefully studied before consideration is given to moderating a stringent approach. In addition to the security provided by secondary containment, a hazardous materials ordinance is highly dependent on accurate, timely data as to the integrity of tank systems. Refer to the high stringency ordinance provisions presented in this section of the manual, for a regulatory approach which might be modified to create a moderate approach.

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REGULATION OF STORMWATER RUNOFF

INTRODUCTION

Stormwater runoff has the potential to contaminate aquifers if the discharge has not been adequately treated, or if it is injected directly into aquifers via sinkholes or drainage wells. Approaches to properly dealing with stormwater runoff will depend on whether the source is residential or nonresidential, and on whether the local government chooses to focus on sensitive area controls or on broader areas. Residential stormwater pollutants tend to be less toxic than certain types of nonresidential stormwater, but will normally be distributed over larger areas and may be greater in total mass. Thus, residential and many nonresidential stormwater discharges might be regulated at a certain level of stringency outside of sensitive areas, and at higher levels within sensitive areas. High risk nonresidential uses will require more careful approaches to stormwater management. It may be necessary to disallow certain nonresidential uses in a wellfield protection area, based on the potential threat posed by stormwater discharges. This, and other aspects of stormwater control for facilities using or storing hazardous materials, are addressed in the chapter section addressing hazardous materials storage and management.

Proper strategies for managing stormwater quality depend on conditions specific to the areas being regulated, including types of soils, topography, average rainfall, and underlying geological formations. It may also be appropriate to apply more generalized requirements outside of wellfield protection zones, while inside the zones, more restrictive approaches to treatment systems and dispersal mechanisms might be specified. Generally, the most effective and practical approach to urban stormwater management involves combining several techniques into what have been termed "treatment trains."[1] The approach allows the linked systems to work in tandem, each reducing one or more aspects of stormwater pollution, producing the most efficient overall attenuation. The most effective of these techniques include:

1. Using source controls to reduce the types and quantities of pollutants on a site, before they can be picked up and transported by stormwater.

2. Routing on-site stormwater through turfed areas and vegetated swales to allow infiltration, settling of suspended solids and some attenuation of other pollutants by adsorption and biological uptake.

3. Using proper erosion and sediment controls to minimize erosion and maintain sediment on-site. Using settling ponds, or sedimentation basins, to allow for suspended solids to settle out before routing the stormwater on to other treatment facilities.

4. Treating the "first flush" of stormwater runoff by appropriate management practices. Wherever soil and water table conditions allow, sodded off-line retention areas that are integrated into a site's landscaping should be used. The first inch of runoff from impervious surfaces has been calculated to contain approximately 90% of the pollutants in stormwater. Though applicable water management district regulations might not require treatment of the first inch of runoff, local conditions and adopted levels of service may warrant stricter standards. (It is important to recognize that DER and water management district regulations are statewide or regional in scope

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[1] See The Florida Development Manual: A Guide to Sound Land and Water Management, Nonpoint Source Management Section, Florida Department of Environmental Regulation (June 1988).

and may not be adequate to achieve desired local objectives.) Percolation, evaporation and evapotranspiration allow for slow recovery of the basin volume necessary to treat stormwater from the next storm event. If conditions will not allow the use of off-line retention areas, then wet detention systems should be used. However, the treatment volume should be one inch, or 2.5 times the percent of imperviousness, whichever is greater, and pretreatment practices such as swale conveyances, placing storm sewers inlets in grassed areas, or landscape retention should be used in combination with the wet detention system.

5. Directing stormwater volumes beyond the first flush of runoff into detention basins, which act primarily to reduce immediate rates of runoff from a storm event, slowly releasing the water through positive outfall to downstream waters, through natural percolation, or through underground perforated piping systems which act as underdrains to percolate the excess water back to groundwater. Detention systems also contribute to attenuation of sediment loads in stormwater.

6. As a last resort, and only in situations where the local government assumes operation and maintenance responsibility, using different types of filtration to assure that sediments and other pollutants will be captured before contact with surface waters or groundwaters. The simplest forms of filtration, basins with sidewalls of sand and gravel, and underdrain piping with filter cloth, are often used in conjunction with detention systems, primarily to capture sediments and suspended solids. More expensive and maintenance-intensive filtration systems include granular activated carbon filters and resin filters, both of which have the capacity to absorb toxic organic contaminants such as solvents, pesticides and hydrocarbons.

7. Avoiding any use of drainage wells, sinkholes or other form of direct injection of stormwater into underlying aquifer formations. Whenever possible, the existing use of these types of drainage should be discontinued, or stormwater pretreatment retrofitting performed to treat water before it is discharged into drainage wells or sinkholes.

8. Carefully siting, designing and constructing retention and detention basins in areas of karst geology. If the solution pipes often present in these areas are not avoided or properly sealed during the construction of a basin, it may fail, causing rapid loss of stormwater pollutants and basin sediments into underlying aquifer formations. The proper design and maintenance of stormwater basins in such areas is addressed in a document entitled, "Applicant's Handbook: Karst Sensitive Areas," published by the St. Johns River Water Management District.

BASELINE APPROACHES

Pursuant to authority granted by Florida's Growth Management Act of 1985, the Department of Community Affairs promulgated Rule 9J-24, Florida Administrative Code (F.A.C.), establishing the procedures and criteria for review of local government land development regulations. The rules require land development regulations to include "specific programs, activities, standards, actions or prohibitions which regulate or govern the ... provision of adequate drainage facilities to control the individual and cumulative impacts of flooding and non-point source pollution in drainage basins existing wholly or in part within the jurisdiction."[2]

Rule 9J-24, F.A.C. permits the incorporation by reference of federal, state or regional regulatory requirements, but only if the resulting program effectively implements the standards of the locally adopted comprehensive plan. A local government which chooses to take a baseline

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[2] Rule 9J-24.033, Fla. Admin. Code (1990).

approach to stormwater regulation might simply include in its land development code a requirement that the applicant supply copies of all appropriate DER or water management district stormwater permits, with accompanying support documentation, before a development order can be issued. This approach assumes however, that the levels of service for stormwater quantity and quality, which the local government has adopted in its comprehensive plan, are met by the regulatory requirements of the DER and water management district. If this is not the case, additional standards will be necessary.

The basic regulatory approach to stormwater management for groundwater quality purposes is represented by Chapter 17-25, Florida Administrative Code, promulgated by the Department of Environmental Regulation (DER). The requirements of Chapter 17-25, F.A.C. are addressed in Chapter II of this volume. As explained below, four of the five water management districts have been delegated stormwater permitting authority by DER. In addition to Chapter 17-25, the DER regulates discharges to groundwater under Chapter 17-28, Parts VII and VIII and Chapter 17-3, Parts IV and V, which permit certain activities using site-specific "zones of discharge" for installations discharging to groundwater of different classes.[3] The applicable requirements of Chapter 17-28 and Chapter 17-3 are addressed in Chapter II of this volume.

Rule 17-25.050, F.A.C., allows for delegation of authority to a local government or water management district to issue or deny permits, initiate enforcement actions, and monitor for compliance. Delegation does not include authority for a local government or water management district to issue or deny permits for its own activities, except for replacement or maintenance of existing facilities. Once delegation is authorized, the requirements of a water management district which have been approved by the Environmental Regulation Commission will apply in lieu of the provisions of Chapter 17-25, F.A.C. A local government to which authority has been delegated may also establish alternative requirements to those in Chapter 17-25, provided the DER determines that the alternative requirements are compatible with, or more stringent than those of Chapter 17-25.[4]

As of May 1990, the Southwest Florida Water Management District, St. Johns River Water Management District, South Florida Water Management District and Suwannee River Water Management District had been delegated certain levels of authority under the rule.[5] The applicable Southwest Florida district rules are published as Chapters 40D-4 and 40D-40, F.A.C., and incorporate by reference the district publication entitled, "Management and Storage of Surface Waters: Permit Information Manual (Volume I)" (March 1988). The applicable St. Johns River district rules are contained in Chapter 40C-42, F.A.C., and incorporate by reference the district publication entitled, "Applicant's Handbook: Management and Storage of Surface Waters" (1988).

The applicable South Florida district rules are codified in Chapter 40E-4, F.A.C., and incorporate by reference the district publication entitled, "Management and Storage of Surface Waters: Permit Information Manual (Volume IV)" (June 1987). The applicable Suwannee River district rules are published as Chapter 40B-4, F.A.C. As of May, 1990, the Northwest Florida

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[3] See Rules 17-3.401--17-3.503, F.A.C., for classification of groundwater and water quality standards applicable to each class; see Rules 17-28.700--17-28.822, F.A.C., for permitting and monitoring requirements for installations discharging to specific classes of groundwater.

[4] Rule 17-25.050, Fla. Admin. Code (1990).

[5] Rule 17-25.090, Fla. Admin. Code (1990).

Water Management District had not been delegated authority to regulate stormwater discharges under the rule.

LOCAL ORDINANCE: HIGH LEVEL OF STRINGENCY

There are several ways a stormwater management ordinance can be organized. The following suggested provisions represent a comprehensive and effective approach to stormwater management. The approach should not be considered a model ordinance in itself, but it does include suggested ordinance sections addressing important aspects of a stringent approach. Refer to Appendix A for copies of other ordinances with potential application, including those of Broward County (Chapter 27-14.06), Dade County (Section 24-12.1) and Winter Park, Florida. Several ordinances regulate stormwater siting with regard to aquifer protection zones, including Acton, Mass., Holliston, Mass., Dade County (Section 24-12.1) and Pinellas County, Florida.

1. Findings of Fact

These provisions should specify the threat posed by stormwater runoff generally, and any hazardous conditions or threats identified as being specific to the locality or to aquifer protection zones. Police power regulations must be reasonably related to protection of the public health, safety or welfare. Findings of fact identify the problems which the ordinance is intended to address. A court or an affected citizen should be able to read the findings of fact and understand the reasons for the ordinance's requirements.

2. Purposes and Objectives

The purposes and objectives should specify the connections between the findings of fact and the intent of the ordinance. The section helps define the direction and scope of the regulatory approach taken, and promotes public and judicial understanding of the stormwater management program. The following is a suggested set of purposes and objectives, with particular reference to stormwater impacts on groundwater:

a. To protect, restore, and maintain the chemical, physical and biological integrity of potable aquifers for the city/county;

b. To prevent individuals, business organizations and governments from causing harm to the city/county by activities which adversely affect potable water resources;

c. To encourage the construction of drainage systems which aesthetically and functionally approximate natural systems;

d. To minimize the transport of pollutants to city/county surface waters and potable aquifers;

e. To maintain or restore groundwater levels;

f. To minimize erosion and sedimentation.

3. Definitions

A listing of definitions serves to clarify terms and phrases that might otherwise be misinterpreted. In ordinances regulating various sources of groundwater pollution, careful attention should be given to defining terms that might be unfamiliar to the public or development community. The particular regulatory approach taken in a locality will dictate required definitions.

4. Relationship to Other Requirements

The suggested provision makes clear that other requirements may be applicable, and that the stormwater management system must comply with the most stringent of those requirements:

> a. In addition to the requirements of the ordinance, the design and performance of all stormwater management systems shall comply with applicable state regulations (Chapter 17-25, F.A.C.) or rules of the ____ Water Management District. In all cases, the strictest of the applicable standards will apply.

As explained in the introduction to this Section, stormwater regulation is addressed by the Florida Department of Environmental Regulation in Chapter 17-25, F.A.C. Delegation of stormwater permitting authority has been accepted by all water management districts except for the Northwest Florida district.[6] Applicable Suwannee River district rules are published as Chapter 40B-4, F.A.C. The Southwest Florida district rules are published as Chapters 40D-4 and 40D-40, F.A.C. The St. Johns River district rules are contained in Chapter 40C-42, F.A.C. The South Florida district rules are codified in Chapters 40E-4 and 40E-40, F.A.C. The rules of the last three districts listed incorporate by reference manuals with specific requirements for the management and storage of surface waters.

5. Applicability

This section of the ordinance specifies which activities and which areas of the locality will be regulated by the ordinance. It includes subsections covering exemptions and variances. A stringent approach allows fewer exemptions and establishes strict, distinct criteria for granting variances. A recommended approach is to require non-exempt development to prepare and submit a stormwater management plan incorporating the performance and design standards of the ordinance, as explained in a manual of stormwater management practices, prepared by the local government.

> a. Unless exempt or granted a variance, all new development must submit a "stormwater management plan" demonstrating compliance with the performance standards and the design standards of the ordinance: 1.) before a plat is recorded or land is subdivided; 2.) before any existing drainage system is altered, rerouted, deepened, widened, enlarged, or obstructed; 3.) before any development is commenced.
>
> b. The requirements of this subsection also apply to all building projects whose construction value exceeds [twenty-five percent] of the assessed value of the improvements detailed on the current property tax assessment role.

Building renovations phased over a two year period should be combined to

[6] See Rule 17-25.090, Fla. Admin. Code (1990).

determine applicability of the twenty-five percent threshold. Twenty-five percent is a suggested threshold figure for redevelopment requirements; local circumstances may dictate a different approach.

c. The following development activities are suggested exemptions from the requirements of this ordinance, except that Soil Conservation Service best management practices to control erosion and sedimentation must be followed for all development:

1.) The construction of one single family or duplex residential dwelling unit on a single parcel of land, so long as it is not part of a larger development.

2.) Maintenance activity that does not affect the quality, rate, or location of stormwater flows within the site, or stormwater discharge from the site.

3.) Development within a subdivision where the following conditions are met:

a.) Stormwater management provisions have been previously approved, and remain valid as part of a final plat or development plan; and
b.) The development is conducted and completed in accord with the previously approved stormwater management provisions.

4.) Emergency action taken to prevent imminent harm or danger to persons, or to protect property, provided a report of the emergency action taken shall be made to the local agency as soon as practicable.

d. An application for a variance must be submitted to the governing authority, and shall contain:

1.) The name, address and telephone number of the developer and owner.

2.) A description and a drawing of the proposed development.

3.) The location of the development.

4.) Any other information requested by the governing authority that is reasonably necessary to evaluate the proposed development.

e. The governing authority may grant a variance from any requirement of this ordinance if it makes a positive finding, based on substantial competent evidence, for each of the following:

1.) There are special practical or economic difficulties in strictly conforming to the regulatory requirements, not shared by other uses regulated under the applicable standards.

2.) The granting of the variance will not:

a.) [appreciably] increase or decrease the required rate or volume of runoff;
b.) have an adverse impact on a wetland, watercourse, waterbody or on potable groundwater;
c.) [appreciably] contribute to the degradation of surface or ground water quality;
d.) otherwise impair attainment of the objectives of this ordinance.

Use of qualifying terms like "appreciably" or "significantly" should be considered a moderation of the high stringency approach. Other approaches are possible and may be explored, but the important point is to insure that the decisions of the reviewing body will be consistent with the objectives of the ordinance.

3.) The governing authority shall not consider as grounds for the granting of variances:

a.) That the implementation of these requirements would impose an economic hardship on the cost of the development.

b.) That these requirements impose a hardship by decreasing the maximum density of a property in terms of the number of units, square footage, etc.

c.) That other adjacent lands, structures or buildings not in conformance with these requirements provide a rationale for relaxing their application to this development project.

4.) The governing authority shall have the power to prescribe reasonable conditions and safeguards on the approval of any variance that furthers the interest of these regulations or which promotes the public's health, safety and general welfare.

5.) Variances granted by the governing authority are approved for a specific property and a specific development plan, and are not transferable to other development plans significantly different from that originally approved.

Depending on the size and structure of the local government, the "governing authority" to which the suggested ordinance sections refer might be a local governing board, an "environmental quality control board," or where adopted, a "stormwater board of appeals," as explained later in this Section.

6. Procedures and Fees

It is important to clearly state the process which an applicant must follow in obtaining permission from the local government to construct a stormwater management system. The suggested provisions require a proposed development to either be exempt, apply for and receive a variance, or submit a "stormwater management plan" which meets the performance and design criteria. The proposed plan is reviewed on a schedule, and may be rejected, or approved with or without modifications. Inspections of each step in the design and construction process help assure that the project is adequately planned, and constructed to specification. An appeal process is included to allow review of permitting and enforcement decisions.

a. Any person planning a development as defined in this ordinance must submit a "stormwater management plan" to the local agency, unless exempted or granted a variance.

b. Within [thirty] days after submission of the completed stormwater management plan, the local agency should approve, with or without specified conditions or modifications, or reject the plan and should notify the applicant accordingly. If the local agency has not rendered a decision within [thirty] days after plan submission, it shall inform the applicant of the status of the review process and the anticipated completion date. If the plan is rejected or modified, the local agency should state its reasons.

c. The stormwater management plan must clearly indicate that the proposed development will meet the performance standards and design standards of the ordinance.

d. Inspections. Stormwater management plans should not be approved without adequate provision for inspection of the property before development starts. The applicant shall arrange with the local agency for scheduling the following inspections:

1.) Initial Inspection: prior to approval of the Stormwater Management Plan;

2.) Erosion Control Inspection: as necessary to ensure effective control of erosion and sedimentation;

3.) Bury Inspection: prior to burial of any underground drainage structure;

4.) Finish Inspection: when all work including installation of all drainage facilities has been completed. The local agency shall inspect the work and shall either approve it or notify the applicant in writing in what respects there has been a failure to comply with the requirements of the approved "stormwater management plan."

Any portion of the work which does not comply must be immediately corrected by the applicant or the applicant will be subject to an administrative penalty as determined under local code provisions.

e. Permit Fee. A permit fee should be collected at the time the "stormwater management plan," or variance application is submitted and should reflect the cost of administration and management of the permitting process. The governing authority should establish, by resolution, a prorated fee schedule based upon the relative complexity of projects.

f. Appeals. Grievances and appeals of the decision of any official charged with the enforcement of the ordinance, should have the right to appeal the action to the governing board. The appeal must be filed in writing within [twenty] days of the date of official transmittal of the final decision or determination to the applicant, must state clearly the grounds on which the appeal is based, and must be processed in the manner prescribed for hearing administrative appeals under local or state code provisions.

As discussed above, it may also be acceptable for a "stormwater board of appeals" or "environmental quality control board" to take the place of a local governing board in hearing such appeals. The appeals procedure may require modification or inclusion of detail, and should be drafted to conform to any existing procedure for hearing appeals from building permit denials.

7. Stormwater Management Requirements

This section of an ordinance contains the criteria by which a proposed stormwater management system will be evaluated. It should reflect careful consideration of the quality and quantity of the stormwater which the proposed system will receive, and the ability of the system to attenuate those loads. As suggested here, one approach is to require non-exempt development to prepare and submit a stormwater management plan incorporating the performance and design standards of the ordinance, as explained in a manual of stormwater management practices, prepared by the local government. The "stormwater management plan" requires a developer to collect and organize detailed information on existing physical conditions, and the specifications of the proposed system. It allows staff to make an in-depth analysis of the proposed system, compare it to the performance and design standards of the ordinance, and respond to any anticipated problems.

a. Stormwater Management Plan. All non-exempt development must prepare and submit a stormwater management plan, incorporating the information requirements, and the performance and design standards of the ordinance.

It is the responsibility of an applicant to include in the stormwater management plan sufficient information for the local agency to evaluate the environmental characteristics of the affected areas, the potential and predicted impacts of the proposed activity on surface water and ground waters, and the effectiveness and acceptability of those measures proposed by the applicant for reducing adverse impacts. The plan should contain maps, charts, graphs, tables, photographs, narrative descriptions and explanations and citations to supporting references, as appropriate to communicate the information required by this section.

b. The stormwater management plan must contain the name, address and telephone number of the owner and the developer, the legal description of the property, and maps showing its location with reference to any wellfield protection zones, major waterbodies, adjoining roads, railroads, subdivisions, and rights-of-way.

c. The existing environmental and hydrologic conditions of the site and of receiving waters and wetlands must be described in detail, including the following:

1.) the direction, flow rate, and volume of stormwater runoff under existing conditions and, to the extent practicable, predevelopment conditions;

2.) the location of areas on the site where stormwater collects or percolates into the ground, including sinkholes and drainage wells;

3.) the location and description of all watercourses, waterbodies and wetlands on or adjacent to the site or into which stormwater flows. Information regarding their water quality and the current water quality classification, if any, given them by the Florida Department of Environmental Regulation or ____ Water Management District shall be included;

4.) information such as groundwater levels, including seasonal fluctuations; location of flood plains; vegetation; topography; soils.

d. Proposed alterations of the site must be described in detail, including:

1.) changes in topography;
2.) areas where vegetation will be cleared or otherwise killed;
3.) areas that will be covered with an impervious surface and a description of the surfacing material;
4.) the size and location of any buildings or other structures.
5.) the locations of all active and inactive water wells. The stormwater

management plan must include provisions for the proper closure of existing unused wells.

e. Predicted impacts of the proposed development on existing conditions must be described in detail, including:

1.) changes in surface water and groundwater quality;
2.) changes in groundwater levels;
3.) changes in the incidence and duration of flooding on the site and upstream and downstream from it;
4.) impacts on wetlands; and
5.) impacts on vegetation.

f. All components of the drainage system and any measures for the detention, retention, or infiltration of water or for the protection of water quality must be described in detail, including:

1.) the channel, direction, flow rate, volume and quality of stormwater that will be conveyed from the site, with a comparison to natural or existing conditions;

2.) detention and retention areas, including plans for the discharge of contained waters, maintenance plans, and predictions of surface water quality in those areas;

3.) areas of the site to be used or reserved for percolation including an assessment of the impact on groundwater quality;

4.) location of off-site water resource facilities such as works, surface water management systems, wells, or well fields, that will be incorporated into or used by the proposed project, showing the names and addresses of the owners of the facilities;

5.) a plan for the control of erosion and sedimentation which describes the type and location of control measures, the stage of development at which they will be put into place or used, and maintenance provisions;

6.) linkages with existing or planned stormwater management systems;

7.) on- and off-site right-of-ways and easements for the system including locations and a statement of the nature of the reservation of all areas to be reserved as part of the stormwater management system;

8.) the entity or agency responsible for the operation and maintenance of the stormwater management system;

9.) any other information which the developer or the local agency believes is reasonably necessary for an evaluation of the development.

g. Performance Standards. Stormwater management plans must demonstrate the proposed development or activity has been planned and designed and will be constructed and maintained to meet each of the following standards:

1.) Stormwater management systems must approximate the rate, volume, quality and timing, both during and after construction, of stormwater that occurred under the site's natural unimproved or existing state.

2.) Not allow stormwater discharge to violate water quality standards set forth in Chapter 17-3, Florida Administrative Code.

3.) Maintain the natural hydrodynamic characteristics of the watershed;

4.) Protect or restore the quality of ground and surface waters;

5.) Ensure that erosion during and after development is minimized;

6.) Protect groundwater levels;

7.) Protect the beneficial functioning of wetlands as areas for the natural storage of surface waters and the chemical reduction and assimilation of pollutants:

8.) Prevent increased flooding and damage that results from improper location, construction and design of structures in areas which are presently subject to an unacceptable danger of flooding;

h. Design Standards. To ensure attainment of the objectives of the ordinance and to ensure that the performance standards will be met, the design, construction and maintenance of drainage systems must be consistent with the following standards, and must be certified as such by a professional engineer registered in the state of Florida:

1.) Channeling runoff directly into surface waters or ground water is prohibited. Runoff must be routed through vegetated swales and other systems designed to increase time of concentration, decrease velocity, increase infiltration, allow suspended solids to settle, and remove pollutants.

2.) No surface water or stormwater management system discharge may be channelled or directed into a sanitary sewer, sinkhole or drainage well which recharges a potable water aquifer. Where development is proposed in areas with existing drainage wells, these shall be properly abandoned, including adequate closure. (See for example, the requirements of the Manatee County, Groundwater/ Wellhead Protection ordinance).

3.) Dredging, clearing of vegetation, deepening, widening, straightening, stabilizing or otherwise altering natural surface waters must be prohibited [minimized].

4.) No grading, cutting or filling should be started until erosion and sedimentation control devices have been installed between the disturbed area and waterbodies, watercourses, wetlands, sinkholes or other direct pathways to groundwater. Whenever possible, natural vegetation should be retained and protected.

5.) Land which has been cleared for development and on which construction has not started must be protected from erosion by Soil Conservation Service best management practices, and by appropriate techniques designed to revegetate the area.

Retention and detention areas must be preliminarily "roughed out" prior to any other clearing or construction activity. Where necessary, after other construction activity is complete, sediment from these preliminary retention/detention areas should be removed before they are completed.

The Florida Development Manual: A Guide to Sound Land and Water Management, published by the Stormwater Management Section, Florida Department of Environmental Regulation (June 1988) contains sections explaining erosion and sediment control techniques.

6.) Sediment must be retained on the site of the development. Where necessary, sedimentation basins must be provided to reduce suspended solids before stormwater is routed to retention or detention basins.

7.) Natural surface waters, and natural or manmade wetlands must not be used as sediment traps during or after development. No site alteration should cause sedimentation of wetlands, pollution of downstream wetlands, or reduce the natural retention or filtering capabilities of wetlands.

8.) Natural wetlands must not be damaged by the construction of a stormwater management system. Although the use of wetlands for storing and purifying water is encouraged, care must be taken not to overload their capacity, thereby harming the wetlands and transitional vegetation.

9.) Vegetated buffer strips should be created or, where practical, retained in their natural state along the banks of all natural or manmade watercourses, waterbodies or wetlands.

The width of the buffer must be sufficient to prevent erosion, trap the sediment in overland runoff, provide access to the waterbody and allow for periodic flooding without damage to structures.

10.) Intermittent watercourses, such as swales, must be vegetated.

11.) Artificial watercourses and waterbodies must be designed, considering soil type, so that the velocity of flow is low enough to prevent erosion, and so that aeration and circulation are optimized.

12.) Retention and detention basins must be used to retain and detain the stormwater runoff which the development generates, as well as stormwater that flows onto or across the development from adjacent lands.

13.) Where soil, subsurface and water table conditions are appropriate, the first [one inch] of runoff from impervious surfaces shall be routed to retention basins on the site of the development, and discharged through percolation and evapotranspiration processes. (See for example, Broward County Code, Chapter 27-14.06).

Where soil, subsurface and water table conditions allow, appropriately sized dry, grassed retention basins, used in combination with other approaches are the preferred techniques for attenuating stormwater pollutants. For retention facilities dependent entirely on percolation for volume recovery, the minimum depth to the seasonally high groundwater level should be at least two feet. The suggested retention volume is based on estimates that 90% of the pollutants from impervious surfaces are contained in the first one inch of runoff. Other figures may be appropriate, depending on the type of development and the location with respect to wellfield sensitive areas. Proper natural filtering of percolating water requires that the water table be sufficiently far below the bottom of the retention basin. Filtering devices can be effective in attenuating residual pollutants, however they require special provisions to assure proper operation and maintenance.

14.) Stormwater runoff volumes beyond the first [one inch] of runoff must be routed to on-site wet, vegetated detention basins. Detention basins must be designed for a [24-hour, 50-year] storm event. (See for example, Pinellas County Ordinance No. 88-7).

Water should be discharged from detention ponds at a rate and in a manner approximating the natural flow which would have occurred before development. Care should be required in the design and construction of wet detention basins. Research has shown that if the discharge structure for these types of systems is set at an elevation lower than the seasonal high water table, the total pollutant load leaving the system will be greater than the load entering the system. The suggested design storm is an average-to-high standard.

15.) Detention and retention areas must be designed so that shorelines are sinuous rather than straight and so that the length of shoreline is maximized, thus offering more space for the growth of littoral vegetation, increasing aesthetic appeal, shoreline habitat and pollutant attenuation.

Research has suggested that retention systems, which hold more of the "first flush" contaminants, should not be planted with extensive littoral vegetation, since the nutrients in stormwater may artificially stimulate plant growth and create maintenance problems. Though research is not conclusive, it may also be that the more highly toxic contaminants in retention ponds can be taken up at lower levels of the food chain, posing a threat to wildlife that would be attracted to extensive littoral plantings.

16.) The banks of detention and retention areas should slope at a gentle grade into the water to reduce safety hazards, to encourage the growth of littoral vegetation and to allow the alternate flooding and exposure of areas along the shore as water levels periodically rise and fall. Littoral areas should be planted with appropriate vegetation.

Chapter 17-25, F.A.C., requires stormwater wet retention and wet detention basins to be fenced if side slopes are any steeper than 4 to 1 to a depth two feet below the control elevation. To encourage littoral vegetation and to avoid the negative aesthetics of fencing, gentler slopes should be required.

17.) Retention and detention basins, except natural water bodies used for this purpose, should be accessible for maintenance from street or public rights-of-way.

18.) Runoff from parking lots should be treated to remove oil, grease and sediment before it enters receiving waters.

19.) The stormwater management system for each stage of a phased development must be capable of functioning independently and in compliance with the ordinance.

20.) The stormwater management system must be designed to function properly for a minimum twenty year life.

21.) The use of drainage facilities and vegetated buffer zones as open space, recreation and conservation areas should be encouraged.

22.) To the maximum extent practicable, water reuse and conservation should be enhanced by incorporating stormwater management systems into irrigation systems serving the development.

The suggested performance and design criteria of the foregoing section are general standards. Another approach to careful stormwater management might provide separate standards for different types of development in different areas. Within particular areas, certain types of activities, types of stormwater management systems, or types of dispersal mechanisms may be differentially regulated. The overall structure of the ordinance can take this approach, defining the permitted activities and types of stormwater management systems allowed in each zone, based on the characteristics of the activity and the sensitivity of the wellfield protection zone.

The Winter Park, Fla. stormwater management ordinance contains separate sections, specifying different requirements for several types of stormwater management systems, based on the location of the system, whether the development is single family, multi-family or non-residential, whether it is a new system or the retrofit of an existing system, and whether it is a surface system or an underground seepage system. The Acton, Mass. aquifer protection ordinance requires 90% of every lot in its most critical protection zone to remain open space, with 50% as undisturbed open space, and no more than 10% of the lot covered by impervious surfaces. In the next most critical protection zone, 70% of every lot must remain open space, with 40% as undisturbed open space, and no more than 30% of the lot covered by impervious surfaces.

One part of the Dade County, Fla. approach to stormwater regulation specifies allowable disposal mechanisms for stormwater systems, based on the travel time or distance from the closest point of the property to the nearest public potable well. Within 100 feet, no stormwater disposal is allowed. From 100 feet to the 10 day travel time contour, infiltration only is allowed. From the 10 day to the 30 day travel time contours, only infiltration or seepage are allowed, and from the 30 day to the 210 day travel time contours, only infiltration, seepage or overflow outfalls are allowed. (See Dade County Code, Sec. 24-12.1(4)). The aquifer protection ordinance of Acton, Mass. requires an average of three days retention for stormwater runoff from impervious surfaces in all three of the town's aquifer protection zones.

8. Manual of Stormwater Management Practices

It is normally not feasible to establish specific stormwater management criteria within an ordinance which assure that groundwater quality will be protected for every potential combination of factors on a site. There are many techniques and approaches which could satisfy the performance and design standards in an environmentally acceptable manner. The local government can help developers and local staff by compiling a manual of techniques appropriate to meeting the requirements of the ordinance. The Florida Development Manual: A Guide to Sound Land and Water Management, published by the Stormwater Management Section, Florida Department of Environmental Regulation (June 1988) contains a wealth of information on stormwater management techniques, their applicability and effectiveness, and design and construction considerations.[7] Other sources of information are listed in the references to this chapter.

a. The city/county should compile a stormwater management manual for the guidance of persons seeking approval of a stormwater management plan under the ordinance. The manual should be updated periodically to reflect the most current and effective practices, and be readily available to the public.

b. The manual should include:

1.) Guidance and specifications for the design of stormwater management systems consistent with the performance standards and design standards of the ordinance, and acceptable techniques for obtaining, calculating and presenting the information required by the stormwater management plan.

2.) Guidance in the selection of environmentally sound practices for the management of stormwater and the control of erosion and sediment. Specific techniques and practices should be described in detail with particular attention given to the development and use of techniques that emphasize the use of natural systems.

3.) Minimum construction specifications for stormwater management facilities in accordance with good engineering practices.

Several local governments include guidance manuals, adopted by reference, as part of their regulatory structures. The large manual created for the city of Orlando includes two volumes. Volume I and Phase I of the Orlando Urban Storm Water Management Manual (OUSWWM) contain information on water quality, drainage basin maps, flood prone areas, rainfall data, runoff, and metropolitan stormwater characteristics and basin analysis. Volume II contains the minimum standards, guidelines and criteria for the design, rehabilitation and review of existing and/or proposed stormwater management systems within Orlando.[8] Though not as in-depth as the Orlando manual, the Land Development Code of Seminole County includes an appendix containing several types of criteria and standards, including those for the design of surface water management systems, material specifications, and erosion and sediment control.[9]

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[7] See also, Stormwater Management Procedures and Methods: A Manual of Best Management Practices, Snohomish County, King County, City of Everett, Washington (Sept. 1977); Tourbier and Westmacott, Water Resources Protection Technology: A Handbook of Measures to Protect Water Resources in Land Development, Urban Land Institute, Washington, D.C. (1981).

[8] See Orlando Urban Storm Water Management Manual, Vol. II (Design Criteria), Department of Planning and Development, City of Orlando, Fl. (prepared by Dyer, Riddle, Mills & Precourt, Inc.).

[9] See The Land Development Code of Seminole County, Florida, Appendix B, Department of Land Management, Sanford, Fl. (1989).

9. **Cash in Lieu of Onsite Treatment**

One of the ways certain local governments may improve the treatment of stormwater within drainage basins is to allow payment of cash in lieu of providing on-site stormwater management systems. The suggested ordinance section can be adopted by those local governments which have approved and functioning regional stormwater management facilities available to the development.

a. Payment of cash in lieu of providing on-site treatment of stormwater may be accepted by the city/county, on the condition that:

1.) The development project is within the area covered by a functioning regional stormwater management facility permitted by the Department of Environmental Regulation or __ Water Management District; and

2.) The local agency , after consultation with the city/county engineer, determines that the regional stormwater management facility is of sufficient size and capacity to adequately attenuate the water quantity and water quality impacts of the additional stormwater runoff without impairing its ability to attenuate these impacts from other areas served by the regional facility.

b. If accepted by the city/county, cash in lieu shall be made according to the following:

1.) The applicant shall provide calculations, certified by a professional engineer registered in the state of Florida, of anticipated additional post-development stormwater runoff.

2.) A payment of $____ per cubic foot/second (C.F.S.) of additional stormwater runoff shall be paid by the applicant to the city/county upon final approval of the development plan.

3.) The amount of the payment shall only be utilized by the city/county for land acquisition and/or capital improvements for stormwater management purposes, within the drainage basin of the project for which it was collected.

c. The governing authority shall act to resolve any conflicts or disputes regarding the appropriate cash in lieu payment.

Depending on the size and structure of the local government, the "governing authority" to which the suggested ordinance sections refer might be a local governing board, an "environmental quality control board," or where adopted, a "stormwater board of appeals," as explained below.

10. **Stormwater Board of Appeals**

The suggested provision establishes a board for the review and resolution of conflicts under the ordinance. Smaller local governments may not find such a board to be necessary, though in larger jurisdictions, the approach can work to increase efficiency and reduce administrative workloads for the local governing body. As an intermediate approach, some jurisdictions might consider creating an "environmental quality control board," which would serve to review all environmentally related aspects of development, including stormwater management systems. See for example, Winter Park, Florida (Chapter 23A).

a. Establishment and Procedures. A stormwater board of appeals should consist of [five] members appointed by the city/county. All members should be residents of the city/county. The city/county commission should select the members from the current membership of [appropriate pre-existing committees].

The members of the board should be appointed for terms of two (2) years. At first, [two] members could be appointed for one year and [three] members for two years. Thereafter, all members would be appointed for two years. Vacancies should be filled by appointment for the unexpired term only. Members of the board may be removed for cause by a majority vote of the city/county commission.

The board should annually select a chairman and vice-chairman from among its members. The [public works director] or designee should serve as secretary to the board. This person should not be entitled to vote, but should be empowered to present staff recommendations on each variance, interpretation or appeal.

The board should adopt rules for the governance of its proceedings and keep a record of attendance at meetings, resolutions, transactions, findings and determinations showing the vote of each member. The records of the board must be considered public record and should be retained by the city/county clerk.

b. The board should have the power to authorize variances from the ordinance which will not be contrary to the public interest, in accordance with specific procedures and standards.

Suggested approaches to the granting of variances are presented above in this section (Applicability). Localities which choose not to establish a stormwater board of appeals or an environmental quality control board may process variance applications through the planning department and building department, to be decided by the local governing board.

c. The board is authorized to make recommendations to the city/county commission on amendments to this code or other codes of the city/county which will further the purposes of the regulations, or improve the administrative enforcement of the ordinance.

d. The board can make recommendations on questions of interpretation of the meaning, intent or application of the ordinance. Such recommendations should be transmitted to the city/county commission for final decision at a public hearing.

e. The board can also act to resolve any conflicts or disputes regarding the appropriate cash in lieu payment of providing on-site treatment of stormwater.

11. Dedication or Maintenance of Stormwater Management Systems

One of the recurrent problems hindering good stormwater management is that facilities often do not receive adequate long-term maintenance. The suggested provisions ensure that either the local government or another responsible entity will provide for maintenance of the stormwater management system.

a. When a stormwater management system approved under the ordinance will function as an integral part of the city/county maintained regional system, as determined by the city/county engineer, the facilities should be dedicated to the city/county.

b. All stormwater management systems that are not dedicated to the city/county must be operated and maintained by one of the following entities:

1.) A local governmental unit including a county, municipality, or Municipal Service Taxing Unit, special district or other governmental unit.

2.) An active water control district created pursuant to Chapter 298 Florida Statutes or drainage district created by special act, or Community Development District created pursuant to Chapter 190 Florida Statutes, or Special Assessment District created pursuant to Chapter 170 Florida Statutes.

3.) A state or federal agency.

4.) An officially franchised, licensed or approved communication, water, sewer, electrical or other public utility.

5.) The property owner or developer if:

a.) Written proof is submitted in the appropriate form by either letter or resolution, that a governmental entity or such other acceptable entity as set forth in subparagraphs 1-4 above, will accept the operation and maintenance of the stormwater management and discharge facility at a time certain in the future.

b.) A bond or other assurance of continued financial capacity to operate and maintain the system is submitted.

6.) For-profit or non-profit corporations including homeowners associations, property owners associations, condominium owners associations or master associations if:

a.) The owner or developer submits documents constituting legal capacity and a binding legal obligation between the entity and the city/county affirmatively taking responsibility for the operation and maintenance of the stormwater management facility.

b.) The association has sufficient powers reflected in its organizational or operational documents to:

(1) Operate and maintain the stormwater management system as permitted by the city/county.
(2) Establish rules and regulations.
(3) Assess members.
(4) Contract for services.
(5) Exist perpetually, with the articles of incorporation providing that if the association is dissolved, the stormwater management system will be maintained by an acceptable entity as described above.

c. If a project is to be constructed in phases, and subsequent phases will use the same stormwater management facilities as the initial phase or phases, the operation/ maintenance entity must have the ability to accept responsibility for the operation and maintenance of the stormwater management systems of future phases of the project.

d. In phased developments that have an integrated stormwater management system, but employ independent operation/maintenance entities for different phases, the operation/maintenance entities, either separately or collectively, must have the responsibility and authority to operate and maintain the stormwater management system for the entire project. That authority shall include cross easements for stormwater management and the authority and ability of each entity to enter and maintain all facilities, should any entity fail to maintain a portion of the stormwater management system within the project.

e. The applicant must be an acceptable entity and must be responsible for the operation and maintenance of the stormwater management system from the time construction begins until the stormwater management system is dedicated to and accepted by another acceptable entity.

f. The systems maintained by an acceptable entity must have adequate easements to permit the local agency to inspect and, if necessary, to take corrective action should the entity fail to properly maintain the system. Before taking corrective action, the local agency should give the responsible entity written notice of the nature of the existing defects. If the entity fails within [thirty] days from the date of notice to begin corrective action or to appeal the matter to the governing authority, the local agency may take necessary corrective action, the cost of which should become a lien on the real property until paid.

12. Retrofitting and Redevelopment Compliance

In areas where pre-existing stormwater management systems and discharges represent a significant threat to groundwater quality, there may be the need to work towards retrofitting systems to reflect appropriate performance and design criteria. The stringent approach suggested requires alterations and redevelopments which exceed a twenty-five percent of property value threshold to meet the performance and design criteria of the ordinance.

The provisions suggested here recognize that redevelopment permits, even if conditioned on retrofitting of stormwater management systems, will require about twenty years to upgrade all systems currently out of compliance. If a potable aquifer or sensitive areas are regarded as threatened by the current state of stormwater management in an area, it should be considered reasonable to require existing systems in that area to begin the process of compliance within a certain period of time. The technique is particularly applicable within sensitive aquifer protection areas which are experiencing non-point source pollution of groundwater as a result of inadequate stormwater management systems. (See for example, Winter Park Land Development Regulations (Chapter 23A)).

a. Stormwater management retrofitting requirements. (suggested ordinance language):

1.) In order to achieve the benefits of stormwater management in a substantially developed area such as city/county, there is a public need for a compliance program for stormwater management that does not utilize building permits as the mechanism for achieving compliance with these stormwater management regulations. Since building permits for the redevelopment of properties are estimated to take some twenty years to achieve compliance, the present condition and water quality of city/county lakes and receiving waters and groundwaters dictate an accelerated program of compliance and retrofitting of private and public properties.

> If necessary, this section might also make specific reference to the groundwater contamination caused by pre-existing systems which do not provide adequate attentuation of stormwater pollutants.

2.) All non-residentially zoned properties within the city/county and all residentially zoned properties greater than one-half acre in size shall come into compliance with the stormwater management requirements of this chapter within [five] years of the effective date of the ordinance.

3.) As part of this program for compliance with stormwater management requirements, the city/county shall require all non-residentially zoned properties within the city/county, and all residentially zoned properties greater than one-half acre in size that are not in compliance, to provide a plan and work schedule for such compliance, within four (4) years of the effective date of this ordinance.

> The time frames and lot size thresholds for achieving the requirements of this subsection are those set forth in the city of Winter Park stormwater management ordinance. In other localities, it may be necessary to modify the figures to reflect the level of threat posed by existing stormwater management systems, and the sensitivity of the protection zone(s) to which the requirements apply.

LOCAL ORDINANCE: MODERATE LEVEL OF STRINGENCY

Several methods may be used to structure a moderately stringent ordinance. Generally, these involve either upgrading the baseline approaches or moderating the requirements of the more stringent approaches. The most important consideration in creating a moderate approach is to maintain a reasonable relationship between the goals of the ordinance and the regulatory structure created to address those goals. Local conditions will dictate what should be considered a stringent, moderate or baseline approach. Where studies and available information indicate that a certain level of threat is posed by stormwater of certain types or in certain areas, the strategy for regulating stormwater management must adequately address applicable threats and conditions.

1. Upgrading Baseline Regulations

There are several ways that a local government may adopt the baseline regulations of the DER or applicable water management district, but with modifications that supply more control over stormwater management systems. These include:

a. Restricting the types of projects which receive exemptions and general permits;

b. Reducing the thresholds at which projects must be reviewed under the ordinance;

c. Requiring more evaluation at the local level for proper siting considerations, especially those relevant to hazardous materials, and existing and future wellfields;

d. Requiring more detailed information on site conditions;

e. Upgrading or adding performance and design criteria; and

f. Increasing the design storm specification which a system must be capable of attenuating.

Performance and design criteria upgrades are particularly important for increasing the ability of a permitted system to attenuate pollution loads. The "treatment train" concept explained at the beginning of this section of the manual should be promoted. It may also be possible to require retrofitting of existing facilities in critical areas, using standards in the baseline approaches. Refer to the requirements of Chapter 17-25, F.A.C., summarized in Chapter II of this volume, or to the requirements of the applicable water management district.

Another important way in which local governments can upgrade state or water management district regulations is to take on a continuing oversight role, by requiring operating permits for stormwater management facilities. These types of permits should be based on evidence of adequate maintenance equipment and procedures, and be reviewed on a regular basis. Problems with the particular system, or evidence of inadequate equipment or procedures would be grounds for revision of the permit, or imposition of fines. A certain level of administrative and enforcement capability is required for successful application of this approach.

2. Moderating Stringent Approaches

Moderating a stringent ordinance generally will involve working to appropriately relax the thresholds and standards applicable to stormwater management systems under a high stringency approach. One strategy is to research and compile what would be considered the most rigorous standards for stormwater management systems, and reduce the performance or design standards which such a system must meet. These types of modifications should remain sensitive to conditions in an area, and should reflect a reasonable approach to regulation of applicable hazards. It may also be possible to increase the types of facilities which receive exemptions, or which are eligible for special exceptions in certain less sensitive protection areas, so long as clear criteria are established which assure that the allowed uses will not degrade groundwater quality. Another approach would be to make the criteria for granting variances slightly less stringent in less sensitive areas.

Thresholds for review and regulation of facilities may be increased in certain areas, or for certain types of development which pose less threat of stormwater pollution. The design storm specification may be decreased for facilities in less critical areas, or where regional facilities have the potential to absorb the impacts of storms which exceed the design storm. A slight reduction in the type of treatment required may also be appropriate, for example requiring treatment of only the first one-half inch of runoff, instead of the first full inch. Refer to the high stringency approach presented in this section of the manual, for one example of a structure which could be modified to create a moderate approach to stormwater management.

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REGULATION OF AGRICULTURAL ACTIVITIES

INTRODUCTION

Agricultural activities can cause groundwater contamination through the improper storage, mixing and disposal of chemicals, excessive or inappropriate application of chemicals, and poor management of intensified animal waste collection systems. Primary agricultural threats to groundwater are the various types of organophosphorus pesticides and chlorinated hydrocarbon pesticides, and the nitrates found in fertilizers and manures.

Whether a pesticide will infiltrate to groundwater depends on several interactions between the soil, soil moisture, and the pesticide. The pesticide's survival time in soil (persistence) and its movement (mobility) are determined by several factors, including: water solubility, volatility, soil sorption, and degradation (related to its reactions to light, water, and microorganisms). Local conditions such as soil pH and organic matter, temperature, moisture, precipitation, and groundwater flow patterns will also affect persistence and mobility. Chemigation locations and mixing and application techniques must be carefully controlled to prevent backflows into wells and rapid leaching of chemicals to groundwater.

Nitrates from manures and fertilizers are soluble and do not interact with soils, making them particularly mobile in the subsurface environment and in groundwater.[1] Animal feedlots, dairies and the unlined waste lagoons they often utilize can easily contaminate groundwater, as can use of fertilizers when the method, timing or rate of application exceed the needs of crops. The phosphorus and potassium found in fertilizers are readily sorbed onto soil particles and are less likely to create a groundwater contamination threat, unless they are washed into sinkholes or drainage wells.

In addition to traditional farm use of agricultural chemicals, there are approximately 630 active 18-hole golf courses in Florida, totalling about 79,000 acres, which use large amounts of fertilizers and pesticides. The care and maintenance of home lawns and highway rights of way also contribute a share of agricultural chemicals to groundwater. Particularly in areas with surficial aquifers, coarse soils with little organic matter, karstic limestone subsurface, or few natural confining layers to protect drinking water supplies, the types of chemical and waste pollutants associated with farms and several other land uses can quickly infiltrate potable aquifers.

BASELINE APPROACHES

1. Pesticide and Fertilizer Regulations

Since many farms utilize chemigation, introducing fertilizers and pesticides into irrigation water, there is considerable potential for these systems to impact groundwater. Under DER's rules for discharges to groundwater,[2] in G-II and G-III areas, agricultural fields, ditches and canals normally do not go through a permitting procedure, but receive a zone of discharge of 100 feet from the site or to the installation property boundary, whichever is less.[3] The rule also provides

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[1] Blodgett and Clark, Fertilizers, Nitrates and Groundwater: An Overview, National Research Council and The Conservation Foundation, Washington, D.C. (1985).

[2] See summary of Ch.17-3, Part IV and Ch.17-28, Part VII, Fla. Admin. Code (1990).

[3] Rule 17-28.700(4)(c), Fla. Admin. Code (1990).

that, if the discharge from such facilities threatens to violate groundwater standards at the boundary of the zone, or otherwise threatens to impair the designated use of contiguous waters (G-II areas are potable drinking water), the DER must require the owner to apply for a permit, define a zone of discharge and institute appropriate monitoring.[4] However, the DER has not utilized this provision to regulate farms, since agricultural fields, ditches and canals are normally exempt from monitoring, thereby making it difficult to determine when and where they may be threatening drinking water supplies.

Additionally, under its permitting of discharges to groundwater, the DER does not allow zones of discharge for any discharge through natural or man-made wells or sinkholes that allow direct contact with Class G-I or G-II groundwater. Though this can be interpreted as prohibiting agricultural chemical application or waste management practices that might result in such discharges, the DER has not applied the provision for those purposes.

The state's five water management districts are responsible for the regulation of farming and forestry agricultural water management systems, including those for irrigation and stormwater management. The effects of agricultural activities and water management systems on groundwater are also regulated by the water management districts.[5] All water management districts' applicable rules recognize the statutory exemption for those engaged in agriculture, silviculture, floriculture and horticulture to alter the topography of land consistent with accepted practices, as long as the alteration is not for the predominant purpose of impounding or obstructing surface waters.[6] An agricultural project such as an irrigation or surface water management system which is for the purpose of impounding water, may also be exempted if it falls under certain volume or size thresholds established by the districts. Though the districts' rules generally require that discharges from permitted surface water management systems meet applicable state water quality standards, until recently, the impacts of such systems on groundwater have received less strict review.

The St. Johns River Water Management District is currently conducting workshops and hearings on a draft of proposed Chapter 40C-44, F.A.C. (Agricultural Discharge Rule), which will require permits for agricultural operations. The draft rule imposes a general performance standard requiring that new agricultural stormwater management systems, and existing systems which do not comply with state water quality standards at the point of discharge, must implement levels of treatment and pollutant reduction such that pollutant loads they discharge to surface waters of the state are 80% less than those of a similar operation which did not incorporate treatment systems and water quality practices. Under the draft rule, all systems, unless exempted, must implement the following measures to meet the performance standards:

1. reduce volume of stormwater and associated wastewater discharged to waters of the state, by maximizing on-site recycling for irrigation, freeze protection and nematode control, and implementing Soil Conservation Service BMPs to reduce volumes of water discharged off-site.

2. implement and maintain a Conservation Plan, which includes a Nutrient Management Plan and Pesticide Plan.

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[4] Id.

[5] Fla. Stat. § 403.927 (1989).

[6] See Fla. Stat. § 373.406 (1989).

3. for existing stormwater management systems with detention ponds, alter and operate the systems so that: a.) there is treatment volume for the first inch of runoff; b.) the permanent pool volume provides 21 days average residence during the wet season (June to October); c.) no more than half the treatment volume is drawn down in the first 60 hours after a storm, and all treatment volume is drawn down within 168 hours; d.) pond depths should not exceed five feet over 70% of the pond area; and e.) diversion structures are added, if needed to prevent short-circuiting of flow paths.

4. for new stormwater management systems with detention ponds, the requirements are the same, except that pond depths should not exceed four feet or a maximum of 10 feet, unless the applicant can show no anaerobic conditions will result. Additionally, such ponds must: be designed to include littoral zones (6:1 or flatter); with elevations controlled so as not to drown littoral vegetation, which should be concentrated at inflow and outfall areas; must optimize flow paths; include permanent access for maintenance; and have bleed-down orifices at or above the estimated wet season water table elevation.

5. stormwater management systems may incorporate overland flow, vegetative filters and detention in isolated wetlands as water quality practices, if reasonable assurances are provided that the general performance standards will be met.

6. alternative treatment methodologies may be sought, through the individual permit process.

The draft rule also specifies size thresholds for operations required to apply for general and individual permits, exemptions, and strict monitoring plans, which allow for modifications of parameters and frequency after five years, if the data indicate steady state conditions.[7] The new rule will be presented to the district governing board for adoption early in 1991.

State regulations on the registration, use, and application of pesticides are administered by the Department of Agriculture and Consumer Services (DACS) under the authority of Chapter 487, Florida Statutes. This chapter generally requires registration of any substance used for pest control and prohibits the distribution or sale of any unregistered, improperly labeled, or unlabeled pesticide. It also prohibits the use or disposal of any pesticide, including a restricted-use pesticide[8] in a manner contrary to the label directions.[9]

There are several types of exemptions to the registration and labeling requirements of the law, though only a few are directly applicable to agricultural uses at the local level. Registration and labeling are not required when a pesticide is only to be shipped from one manufacturer to another within the state, except that "poison" labels are required for any substance in quantities

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[7] St. Johns River Water Management District, Draft Rule Chapter 40C-44, F.A.C. ("Regulation of Agricultural Discharge"), Palatka, Fl. (September 20, 1990).

[8] A "restricted-use" pesticide is defined as "a pesticide which, when applied in accordance with its directions for use ... may generally cause, without additional regulatory restrictions, unreasonable adverse effects on the environment, or injury to the applicator or other persons, and which has been classified as a restricted-use pesticide by [DACS] or the administrator of the [EPA]." Fla. Stat. §487.021(50) (1987).

[9] Fla. Stat. §487.031(8) (1987).

highly toxic to humans. The chapter does not apply to pest control operators engaging in mosquito control or in pest control under structures, on lawns or ornamental plants.[10]

Chapter 5E-2, F.A.C. elaborates on the registration and use requirements. The rule requires distributors to register pesticides by completing a registration application and submitting data summaries of information sent to EPA in compliance with FIFRA. DACS reviews the data summaries for a number of factors: susceptibility of the pesticide to leaching into groundwater; toxicological impact on non-target organisms such as fish or humans; the environmental fate of the pesticide under Florida hydrogeological conditions; and methods for measuring residue in soil and groundwater.[11] The rule also designates restricted-use pesticides and prescribes labeling, sampling, and disposal procedures. Many pesticide labels indicate setbacks required in certain types of geologic areas or in areas with drinking water wells. The rule requires the pesticide applicator to ensure these setbacks are followed.

All irrigation systems which apply chemicals or fertilizer must be equipped with antisyphon devices to prevent flowback of chemicals into the water supply. The rule specifies different devices for these purposes, depending on the type of chemical or fertilizer being applied. Chemical storage tanks on all irrigation systems must be constructed and maintained to ensure containment of the chemical and to prevent contamination.[12] All check valves, low pressure drains, solenoid valves, pressure switches, system interlocks and vacuum breakers on irrigation systems be kept free of corrosion and must be operative at all times when the irrigation system is in operation. Disposal of highly toxic waste pesticides is also regulated under this section. Waste pesticides must be removed from their container and destroyed according to label directions. Empty containers must be buried, burned, or decontaminated as the label indicates.[13]

Chapter 5E-9, F.A.C. specifies the licensing and certification requirements for restricted-use pesticide applicators. The rule does not apply to pesticide applicators for the control of mosquitos or pests under structures, on lawns or ornamental plants.[14] Commercial and public applicators must take an examination to demonstrate knowledge of principles of pest control and safe use of pesticides. The environmental aspects of the exam cover the consequences of the use and misuse of pesticides due to weather conditions, types of soil or substrate, presence of non-target organisms, and drainage patterns.[15] Private applicators are also tested to demonstrate knowledge of adverse effects of pesticides on humans, animals and the environment.[16]

The DER grants general permits for the construction and operation of pesticide waste degradation systems which have been designed and will be operated in accordance with the provisions of Rule 17-660.802, F.A.C. These are systems designed for the evaporation and degradation of pesticide rinse water generated in the cleaning of pesticide application equipment.

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[10] Fla. Stat. §487.081 (1987)

[11] Rule 5E-2.031(3), Fla. Admin. Code (1989).

[12] Rule 5E-2.030(5), Fla. Admin. Code (1989).

[13] Rule 5E-2.018, Fla. Admin. Code (1989).

[14] Rule 5E-9.001, Fla. Admin. Code (1989).

[15] Rule 5E-9.007, Fla. Admin. Code (1989).

[16] Rule 5E-9.006, Fla. Admin. Code (1989).

The rule requires that there be no discharge of water or pesticide from the system to the surface or groundwater, or to the soil outside of the tank. The owner of the system must notify the appropriate DER district office within two working days if a leak or spill exceeds 25 gallons. The permittee must either own the land or have an agreement from the owner that the land owner will be responsible for the operation of the system.[17] The general permit is also subject to the general conditions of Rule 17-4.540, F.A.C. which include a permit term of five years, and specify that the permit may be modified or revoked under several circumstances, including any violations of water quality standards.

Specifically, pesticide waste degradation systems must not be placed in the 100-year floodplain of a river; within 100 feet of a lake, pond, wetland system or flowing stream; within 75 feet of a drinking water well; or within 25 feet of a property boundary. Among other design specifications, the wash down slab must be concrete with a 6-mil or thicker plastic underliner; the evaporation tank must not be constructed of earthern material; an automatic alarm or pump cut-off switch must activate when the evaporation tank overfills; an in-ground tank must have a second larger tank completely enclosing it, equipped with continuously operating leak detection (checked on a weekly basis) and an automatically activated pump to transfer leakage back to the primary tank; aboveground tanks must be underlain by a concrete slab with 6-mil underlining and a slab or plastic-lined gravel berm extending one foot high completely surrounding the tank and slab.[18] Recommended construction and operation details are contained in Institute of Food and Agricultural Sciences Bulletin No. 242, University of Florida.

2. Regulation of Animal Feedlot Operations

"Concentrated animal feeding operations" around the state, and "dairy farms" in the Lake Okeechobee Drainage Basin[19] are regulated under the provisions of Chapter 17-670, F.A.C., establishing fairly strict standards for the management and disposal of animal wastes. Rule 17-660.400(e) adopts EPA effluent limitation standards for concentrated animal feedlots (40 C.F.R. 412). Rule 17-670 applies them, statewide, to "concentrated animal feeding operations" which confine different types of farm animals above certain threshold numbers.[20] Chapter 17-670 also regulates "dairy farms" of any size within the Lake Okeechobee Drainage Basin. The DER may propose additional regulation of dairies in other drainage basins if it determines that the

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[17] Rule 17-660.802(1), Fla. Admin. Code (1990).

[18] Rule 17-660.800(2)-(6), Fla. Admin. Code (1990).

[19] The drainage basin includes the following sub-drainage basins:
1.) lower Kissimmee River basin below structure S-65;
2.) Taylor Creek--Nubbin Slough basin;
3.) Fish Eating Creek basin;
4.) Indian Prairie and Harney Pond basins;
5.) C-41A basin;
6.) Nicodemus Slough basin; and
7.) drainage areas tributary to the South Florida Water Management District Pump Stations designated as S-127, S-129, S-131, S-133, S-135, S-2, S-3, and S-4.
See South Florida Water Management District, Technical Publication 81-2 (May, 1981) for the geographical boundaries of these sub-basins.

[20] For example, the threshold is 1000 animals for slaughter and feeder cattle, and 700 for mature dairy cattle, except within the Lake Okeechobee Drainage Basin, where no threshold applies.

regulations are required to meet or maintain water quality standards. Feedlot operations which do not meet the thresholds for "concentrated feedlots" may be deemed subject to the standards based on consideration of their location relative to waters of the state, the amount of wastes reaching waters of the state, and other factors indicating the significance of the pollution problem. Permitting requirements may include groundwater considerations, however, to be regulated under this category, facilities must be discharging pollutants either directly to state waters which are passing through the operation, or discharging through a man-made ditch or flushing device.[21]

Rule 17-28.700(4)(c) requires smaller livestock waste lagoons discharging to Class II (potable) or Class III (nonpotable, unconfined) groundwater to: obtain a groundwater permit if not already granted, define or modify an appropriate zone of discharge, and institute monitoring if the discharge from the installation threatens to violate groundwater standards at the boundary of the zone of discharge, or otherwise threatens to impair the designated uses of contiguous waters, including drinking water aquifers. This category of regulated smaller feedlots falls within groundwater permitting requirements regardless of impacts on surface waters of the state.

On the basis of groundwater testing done by the DER and HRS, dairies in the Suwannee River Basin are now being required to apply for permits under these rule sections, with no exemptions permitted. Until studies have been completed, and an appropriate rule developed, new dairies in that region must develop waste management plans incorporating pollution prevention practices, and they must institute groundwater monitoring. Existing dairies are encouraged to install proven pollution prevention waste management practices, and to have drinking water and production wells regularly tested for nitrate contamination. If the results of additional DER and HRS testing indicate the need, existing dairies may be subject to additional regulations. The pollution prevention best management practices being suggested include:

1. Lining of waste lagoons.
2. Irrigation of wastewater and application of manure solids based on sound agronomic practices.
3. Minimizing or eliminating run-off or seepage from high-intensity use areas.
4. Locating waste disposal areas (lagoons, spray irrigation fields, manure storage and disposal areas) away from surface waters, sinkholes, and property boundaries.
5. Installation of monitoring wells.[22]

Additional best management practices are being developed by researchers at the Institute of Food and Agricultural Sciences, to address the groundwater-related problems of feedlot and dairy operations in the Suwannee River Basin. The DER may begin rule-making to address dairies and feedlots statewide by mid-1991.

LOCAL ORDINANCE: HIGH LEVEL OF STRINGENCY

Local regulation of agricultural activities must be based on research data and monitoring studies which indicate a strong potential groundwater pollution problem resulting from categories of agrichemically active land uses, or from specific local uses of agrichemicals. The DER, HRS, USGS and Soil Conservation Service are sources of groundwater monitoring, geological and soils

[21] Rule 17-670.400(3), Fla. Admin. Code (1990).

[22] Twachtmann, "Memorandum to Howard Rhodes and Ernest Frey, Re: Regulation of Dairies in Suwannee River Basin," Department of Environmental Regulation, Tallahassee, Fl. (Sept. 5, 1990).

data for identification of agrichemical threats to groundwater. The Department of Agriculture and Consumer Services, university cooperative extension services, Institute of Food and Agricultural Sciences and the U.S. EPA are starting points for information on agrichemicals, practices and equipment which are likely to pose threats.

There is deep commitment in this country to the concept of private ownership of land, including the attitude that owners should be granted wide latitude in the management of the property. Farming enjoys more of this sentiment, perhaps, than most other potentially polluting land uses, because of its place in American history and the important role it plays in feeding the country. Additionally, in many areas, a lack of data and a lack of identifiable point sources of pollution complicate the effort to impose restrictions on agricultural uses, which may have significant potential to contaminate groundwater. However, the right of private land management can and should be limited in cases of readily apparent hazards to human health and the environment, as is clear in the regulation of industrial pollution, utilities, and waste processing plants, among others. Where statistically, certain types or densities of operations have been associated with contamination, or where planning/monitoring data indicate a significant threat to drinking water supplies, unlimited private development rights must give way to regulatory measures designed to protect the public health and safety.

1. General Considerations

Siting Considerations

The prospective locations of activities such as farming should be carefully addressed in the local comprehensive plan, and in land use regulations which implement the plan, to avoid critical recharge areas and protection zones for existing and future public wells, and areas of existing and anticipated high density use of private wells. Local regulations should require the review of prospective agricultural operations which involve use of agrichemicals or the potential production of significant amounts of animal waste. The local health department, environmental department, planning department and utilities department should be given opportunity to comment on the prospective threat to groundwater.

Local governments with potential land uses that include the significant use of agrichemicals or the confinement of any more than small numbers of farm animals should consider prohibiting those uses within significant recharge areas or aquifer protection zones if the soil and subsurface conditions in those areas will allow rapid infiltration to drinking water supplies. Determining where prohibitions are needed and where best management practices or other permitting requirements are adequate will require analysis of the sensitivity of soils and aquifers, the solubility, mobility, persistence and quantities of the agrichemicals used, and the numbers and types of animals to be confined. Planning data from priority ranking systems such as the comparable potential risk index system of Rock County, Wis. will be important in making such determinations. The location of such land uses relative to nearby concentrations of shallow private drinking water wells should also be considered.

Monitoring Requirements

In sensitive areas, particularly, one of the most important, feasible requirements that local governments should impose on new and existing farming operations, and other facilities using significant amounts of agricultural chemicals, is that monitoring plans be developed and implemented, in order to determine if and where groundwater contamination is occurring. Facilities with fewer inherently hazardous facilities, chemicals or uses might be required to install fewer wells, if groundwater quality is not otherwise threatened. Wells should be placed to evaluate unaffected background water quality values upgradient of the facility, in areas just downgradient of the most likely points of discharge, and at the downgradient property boundary, to determine if the quality of contiguous groundwater is being jeopardized. Groundwater samples should be taken and tested quarterly, until consistent results over time, and planned levels of operation indicate that less frequent analyses are appropriate.

Permit Application Information

In areas where agricultural operations are an allowed use, permits should be conditioned on a demonstration that the criteria below are satisfied. To aid in evaluating the permit and attaching appropriate conditions, the application should include information indicating the location of agrichemical mixing, application and/or irrigation areas, animal feedlots and manure storage areas and wastewater lagoons, and the surrounding area within one-half mile of the site. The map should show general topography, survey boundaries and dimensions of the areas of animal confinement, agrichemical mixing application, irrigation, or waste storage. The map should also indicate sinkholes, other karstic surface features, springs, wetlands, streams, drainage wells, water wells, monitoring wells, quarries, excavations, and any other features with potential to allow groundwater impacts. The application should include data on the general geologic and hydrologic description of the site, and the location of the site relative to public water supply wells, designated areas with higher densities of private wells, and designated recharge protection areas and other protection zones. See for example, the Model Local Groundwater Protection Ordinance (Title 5: Livestock Waste).

2. **Pesticide and Fertilizer Use**

In addition to prohibiting use of petrochemical fertilizers and pesticides in very sensitive areas and overlay protection zones, and monitoring for potential contaminants, certain permitting requirements will reduce the potential for groundwater contamination in protection zones. The basic objectives of these mitigation measures are to: a.) reduce the quantity of pesticides and other agrichemicals used, b.) use types and amounts of agrichemicals with less potential to leach, c.) avoid agrichemical application when conditions are most likely to promote leaching, d.) prevent spills and eliminate pathways for entry of agrichemicals to groundwater.[23]

Locally, in areas where a use of agricultural chemicals is considered potentially acceptable, the activity can be designated as a conditional use, requiring review and a permit. Such reviews should be required for the use of "significant" quantities of agrichemicals, above certain threshold amounts. These thresholds should be set at levels that will include the amounts used by most farm and golf course operations, or any other significant local use of agrichemicals for which studies indicate a potential threat to drinking water supplies. The permit applicant should be required to develop and implement a "groundwater protection agrichemical management plan," which includes at a minimum:

1. for agricultural crops, measures showing maximum use of integrated pest management techniques;

One of the most useful practices to promote is integrated pest management (IPM), which uses a variety of pest control techniques, singly or in combination, to develop more protective and cost effective approaches to management of pests. The practice of IPM promotes use of nonchemical pest control and improves efficiency by improving the timing

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[23] See generally, U.S. Environmental Protection Agency, Office of Ground-Water Protection, Protecting Ground Water: Pesticides and Agricultural Practices, U.S. Environmental Protection Agency, Washington, D.C. (1988).

and placement of applications. Among the many techniques possible are included: minimization of pesticide usage, by carefully adjusting the timing of application relative to climate and pest cycles; eliminating persistent and recurring insects and weeds by crop rotation; using pest resistant varieties of crops; properly maintaining and calibrating application equipment; and using mechanical cultivation to cultivate weeds when possible. The Cooperative Extension Service at the Institute of Food and Agricultural Sciences, University of Florida, should be contacted for additional information on IPM practices for particular areas and particular crops. Local county extension services can also be consulted for IPM information.

2. listing of the types, amounts, and relative toxicities of all agrichemicals to be utilized;

3. information on leaching characteristics, including persistence, solubility and mobility of all agrichemicals to be utilized;[24]

4. information on the soil series type and properties, such as hydraulic permeability, organic matter, and slope, for areas of application for all agrichemicals;

5. delineation of steps in the process from purchase to storage, handling and application, demonstrating that agrichemicals will not be accidentally spilled or leaked to the soil or groundwater;

6. use of agrichemicals with lower leaching potential;[25]

7. identification of mixing areas, operating procedures and lists of all equipment to be used, showing:

a. adequate buffers between mixing areas and sensitive areas such as wells and sinkholes,
b. adequate containment of mixing areas and potential spills,
c. secondary containment of underground storage tanks and integral piping above 550 gallons, and secondary containment of aboveground agrichemical tanks and

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[24] The Cooperative Extension Service, Institute of Food and Agricultural Sciences at the University of Florida, has published a series of circulars and fact sheets which allow determinations of the proper pesticides to use for approximately 30-40 agricultural commodities, in order to minimize groundwater contamination from leaching, and surface water contamination from runoff. The series, **"Managing Pesticides for Crop Production and Water Quality Protection,"** utilizes Soil Conservation Service soil survey maps that are available for most of Florida's counties. The system assigns either high, medium or low ratings for both leaching and runoff characteristics to the soil names and map unit identifiers within each county. These ratings tables, available for the soils in most counties at a fairly detailed level, will aid in determining where leaching of pesticides (herbicides, insecticides, nematicides and fungicides) registered for crops is more likely to occur. Other tables yield a "relative leaching potential index" and "relative runoff potential index" for each of the registered pesticides for each crop, as well as the HALEQ (Lifetime Health Advisory Level or Equivalent) value, and aquatic toxicity value for each pesticide. Worksheets and pesticide selection criteria are supplied, to allow evaluation of soil and pesticide characteristics, and selection of the pesticide with least impact on health and groundwater for a particular crop, in a particular location.

[25] See id.

integral piping, above 25 gallons,[26] with protection from weather,
d. failsafe equipment to prevent backflow and backsiphoning into wells from irrigation pumps,[27]
e. pressure relief valves and other safety equipment to assure safe operation of pressurized systems (certified by licensed engineer),[28]
f. triple-rinsing, puncturing and proper disposal of containers after emptying, with return of rinse water to spray or mixing tanks for reuse,

8. procedures to be followed in the case of a spill, including the prior instruction of all agricultural workers with responsibility for mixing or application of agrichemicals;

9. information showing that irrigation wells are properly constructed, grouted and sealed and that all unused or abandoned irrigation wells will be capped (see Chapter 17-532, F.A.C. or the well construction rule of the applicable water management district for construction requirements; see Chapter 17-531, F.A.C. for licensing requirements for water well contractors);

10. maps of application areas for all agrichemicals to be used in the operation, showing that sensitive areas (wells, drainage wells, sinkholes, coarse sandy soils) will be avoided, and that the use and size of buffer zones around sensitive areas will be maximized, to minimize infiltration and to allow adequate space and time for dilution, dispersion or degradation of the agrichemical before it reaches groundwater;

Where necessary to avoid likely or continuing contamination of drinking water supplies, farm drainage wells should be capped and sealed. Specification of stringent buffer zone distances will require consideration of several factors, including the varying types of agrichemicals, and their rates and degrees of degradation in groundwater, the topography of the area, hydrogeological conditions and the sensitivity of the aquifer.

11. nutrient analysis of crops and inputs, showing that amounts and rates of fertilization application will not be greater than are needed or than can be effectively utilized by

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[26] Ch. 17-761, Fla. Admin. Code, which preempts local regulations, does not cover underground storage tanks of 110 gallons or less, or underground agricultural storage tanks of 550 gallons or less. Local governments may implement Ch. 17-761 for two years, then adopt more stringent standards. Ch. 17-762, Fla. Admin. Code regulates aboveground storage tanks systems, and does not preempt more stringent local regulations. The rule becomes effective in late February 1991.

[27] See Smajstrla, Harrison, Becker, Zazueta & Haman, "Backflow Prevention Requirements for Florida Irrigation Systems," Bulletin 217, Florida Cooperative Extension Service, University of Florida, Gainesville, Fl. (1988); Smajstrla, Zazueta & Haman, "Potential Impacts of Improper Irrigation System Design," Agricultural Fact Sheet AE 73, Florida Cooperative Extension Service, University of Florida, Gainesville, Fl. (1989).

[28] See Smajstrla, Harrison & Becker, "Chemigation Safety," Agricultural Engineering Fact Sheet AE-58, Florida Cooperative Extension Service, University of Florida, Gainesville, Fl. (1986).

crops;[29]

Fertilizers should be used only in quantities and at rates of application which are absolutely essential; the analysis should include consideration of animal wastewater nutrient applications. For example, the Broward County Code (Chapter 27-12) restricts use of nitrate fertilizers in all three of the county's wellfield protection zones, with conditions applying to both recreational and agricultural uses.

12. careful timing of agrichemical applications relative to meteorological conditions and irrigation schedules to reduce applications at times which are most likely to promote leaching; demonstrate through irrigation and pesticide application schedules that irrigation is delayed as long as possible following pesticide applications;

13. minimum use of flood or furrow irrigation and sprinkle irrigation, which both promote leaching, and maximum use of trickle or drip irrigation; chemigation should be practiced only with trickle or drip irrigation.

In addition to a "groundwater protection agrichemical management plan," the permit requirements should include an approved plan of BMPs established by the Cooperative Extension Service and Soil Conservation Service. Additional BMPs and their possible use in groundwater protection plans are listed in Table 1 and Glossary, adapted from an IFAS Cooperative Extension Service publication.[30] The guide lists four columns: agricultural systems, affected waters, potential pollutants and BMPs. The first column lists many crops and soil types typically found in Florida, though the guide can be useful for related conditions. Types of affected waters and potential pollutants for each farming operation are also listed in order of general importance, but the guide warns that many exceptions exist, requiring care in the final selection. Local Cooperative Extension Service offices, the Soil Conservation Service and the Soil and Water Conservation District offices can be contacted for expert advice.

A program of BMPs should only be adopted after careful analysis that considers specific impacts on groundwater quality. Prevention of soil erosion and sediment are important considerations, but in some cases, BMPs for their control may not be consistent with groundwater protection from other potentially serious pollution sources. In karst areas, and certain sensitive areas, such as drainage wells, sinkholes, poorly constructed water wells, and other points of direct contact with groundwater, the sediment control BMPs will also protect groundwater quality by preventing phosphorus and potassium, which tend to bind to soil particles, from being washed into groundwaters. It should be noted that certain of the BMPs such as "Conservation Tillage" or "Subsurface Drain" may promote other conservation goals while tending to exacerbate potential groundwater pollution problems.

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[29] See Hochmuth, G. (ed.), Nitrogen Management in Vegetable Production for Groundwater and Health Protection, Special Series Report SSVEC 940, Florida Cooperative Extension Service, Institute of Food and Agricultural Sciences, University of Florida, Gainesville, Fl. (1990); Graetz, D., "Crop Fertilization and Its Relation to Ground Water Quality in Florida," Soil Fact Sheet 7, Florida Cooperative Extension Service, University of Florida, Gainesville, Fl. (1975).

[30] Bottcher and Baldwin, "BMP Selector: General Guide for Selecting Agricultural Water Quality Practices," Florida Cooperative Extension Service, Institute of Food and Agricultural Sciences, University of Florida, Gainesville, Fl. (1987).

Though many of the BMPs in Table 1 are designed to control soil erosion and sediment, several have specific application to groundwater pollution problems from agrichemicals and should be required for "groundwater conservation plans" in most areas. Others might be considered optional for groundwater protection purposes. Required BMPs for agrichemical management should include:

4. Biological Control of Pests
9. Correct Application of Pesticides
10. Correct Pesticide Container Disposal
13. Cultural Control of Pests
18. Field Border
23. Grassed Waterway or Outlet
24. Irrigation Water Conveyance
25. Irrigation Water Management
26. Land Absorption Areas and Use of Natural Wetland Systems
32. Pesticide Selection
37. Regulated Runoff Impoundment
38. Resistant Crop Yields
40. Slow Release Fertilizers
41. Soil Testing and Plant Analysis
45. Timing and Placement of Fertilizers

Other sources of BMPs include those in: "A Manual of Reference Management Practices for Agricultural Activities," (November 1978), and "Silviculture Best Management Practices Manual," (1979), both available from the Florida Department of Environmental Regulation, Tallahassee, Fl.

Table 1
BMP Selector Guide*

Agricultural System	Affected Waters (in order of importance)	Potential Pollutants	BMPs (see Glossary for description)** Generally Best	Also Consider
<u>Row Crops (corn, soybeans, etc.)</u>				
well drained sloping loaming soils	surface water more than groundwater	suspended solids	7, 8, 16, 28, 43	1, 3, 6, 11, 12, 14, 18, 19, 21, 22, 23, 24, 25, 27, 29, 37, 42
		nutrients	7, 8, 40, 41, 45	2, 18, 23, 25, 26, 28, 37
		pesticides	4, 9, 10, 32, 38	7, 8, 13, 16, 18, 23, 25, 43
well drained sloping sandy soils	groundwater and surface water	nutrients	7, 25, 40, 41, 45	2, 26, 37
		suspended solids	1, 7, 8, 16, 28	3, 6, 11, 12, 14, 18, 21, 22, 23, 24, 27, 37, 42, 43
		pesticides	4, 9, 10, 32, 38	13, 25, 37
well drained level soils	groundwater more than surface water	nutrients	25, 40, 41, 45	7
		pesticides	4, 9, 10, 32, 38	13, 25
poorly drained soils	surface water more than groundwater	nutrients	25, 37, 40, 41, 45	2, 7, 26, 37
		pesticides	4, 9, 10, 32, 38	13, 37, 44
<u>Groves (citrus)</u>		suspended solids	18, 23, 28, 44	1, 6, 7, 12, 14, 21, 24
well drained soils	groundwater more than surface water	pesticides	25, 40, 41, 45	2, 26, 37
		suspended solids	4, 9, 10, 32, 38	13, 25
			1, 11, 18, 23	24, 25, 37
poorly drained soils	surface water more than groundwater	nutrients	25, 37, 40, 41, 45	2, 23, 26, 44
		pesticides	4, 9, 10, 32, 38	13, 37, 44
		suspended solids	18, 23, 44	1, 6, 21, 24
<u>Sugar Cane</u>				
organic soils	surface water	nutrients, organics	20, 37, 48, 49	2, 25, 26

Vegetable Crops				
well drained soils	groundwater and surface water	nutrients	25, 29, 40, 41, 45	2, 7, 26, 37
		pesticides	4, 9, 10, 32, 38	13, 25
		suspended solids	1, 7, 18, 23, 29	24, 25
poorly drained soils	surface water more than groundwater	nutrients	25, 29, 40, 41, 45	2, 7, 18, 23, 26, 37, 44
		pesticides	4, 9, 10, 32, 38	13, 37, 44
		suspended solids	7, 18, 23, 44	1, 6, 12, 21, 24, 29
organic soils	surface water	nutrients, organics	20, 37, 48, 49	2, 19, 25, 26, 41, 45
		pesticides	4, 9, 10, 32, 38	13, 37
Improved Pasture and Hayland				
well drained soils	groundwater and surface water	animal wastes	17, 26, 33, 37, 50	2, 15, 23, 35, 39
		nutrients	26, 37, 41, 45	2, 30, 40, 47
		sediment	15, 30, 31, 33, 35	3, 17, 23
poorly drained soils	surface water more than groundwater	animal wastes	17, 26, 33, 37, 50	2, 15, 35, 39
		nutrients	26, 37, 41, 45	2, 30, 40, 47
High Density Livestock* **	surface water more than groundwater	animal wastes	17, 37, 39, 46, 50	2, 14, 30, 35, 47
Rangeland & Unimproved Pasture** **	surface water more than groundwater	animal wastes	5, 26, 35, 36, 50	15, 17, 34
Forestry** **	surface water	nutrients, organics	26, 41, 45	37, 51
		sediment	1, 5, 11, 23, 51	3, 22

1. Access Road
2. Aquatic Filter Ponds
3. Artificial Barriers
4. Biological Control
5. Brush Management
6. Chiseling & Subsoiling
7. Conservation Cropping System
8. Contour Farming
9. Correct Application/Pesticides
10. Correct Container Disposal
11. Critical Area Planting
12. Crop Residue Use
13. Cultural Control of Pests
14. Debris Basin
15. Deferred Grazing
16. Diversion and Terraces
17. Fencing
18. Field Border
19. Field Windbreak
20. Flooding During Nonuse
21. Floodwater Reduction Sturcture
22. Grade Stabilization Structure
23. Grassed Waterway or Outlet
24. Irrigation Water Conveyande
25. Irrigation Water Management
26. Land Absorption Areas, Use of Wetland Systems
27. Lined Water way or Outlet
28. Minimum Tillage
29. Mulching
30. Pasture and Hayland Management
31. Pasture and Hayland Planting
32. Pesticide Selection
33. Planned Grazing Systems
34. Prescribed Burning
35. Proper Grazing Use
36. Range Seeding
37. Regulated Runoff Impoundment
38. Resistant Crop Varieties
39. Shade AReas
40. Slow Release Fertilizer
41. Soil Testing & Plant Analysis
42. Streambank Protection
43. Stripcropping
44. Subsurface Drain
45. Timing & Placement of Fertilizer
46. Waste Management System
47. Waste Utilization
48. Water Table Management
49. Water Tolerant Crops
50. Water/Geeder Location
51. Woodland Site Management

* Modified from **Guide for Determining Agricultural Best Management Practices**, U.S. Department of Agriculture, Soil Conservation Service, Gainesville, FL June 1977.
** This column may contain the *most* effective BMPs for some sites and conditions.
*** More than 1,000 lbs. live weight per acre
**** Impact on water quality is minimal

Source: Bottcher and Baldwin, "BMP Selector: General Guide for Selecting Agricultural Water Quality Practices," Florida Cooperative Extension Service, Institute of Food and Agricultural Sciences, University of Florida, Gainesville, Florida (1987).

Table 1 (continued)
BMP Selector Guide
Glossary

Following is a brief description of Best Management Practices listed in the guide. Many practices are also designated "Conservation Practices" by the Soil Conservation Service and are detailed in the SCS Field Office Technical Guide.

1. **Access Road** - A road located and constructed to avoid soil erosion caused by haphazard traffic patterns, yet still provide needed access.

2. **Aquatic Filter Ponds** - Utilization of ponds, basins, or channels containing aquatic vegetation in order to filter or assimilate nutrients from drainage water.

3. **Artificial Barriers** - Fencing, boardwalks, earthen banks, and similar facilities that provide protection for highly erodible areas.

4. **Biological Control of Pests** - Use of natural enemies as part of an integrated pest management (IPM) program which can reduce the use of pesticides.

5. **Brush Management** - Management and manipulation of brush to improve or restore a quality plant cover in order to reduce soil erosion.

6. **Chiseling & Subsoiling** - Loosening the soil to shatter compacted and restrictive layers thereby improving water and root penetration and reducing surface runoff.

7. **Conservation Cropping System** - Growing crops in combination with needed cultural and management measures to improve the soil and protect it during periods when erosion occurs. Includes cover cropping and crop rotation. Such practices provide vegetative cover between crop seasons.

8. **Contour Farming** - Farming sloped land on the contour in order to reduce erosion, control water flow, and increase infiltration.

9. **Correct Application of Pesticides** - Spraying when conditions for drift are minimal. Mixing properly with soil when specified. Avoiding application when heavy rain is forecast.

10. **Correct Pesticide Container Disposal** - Following accepted methods for pesticide container disposal.

11. **Critical Area Planting** - Planting vegetation to stabilize the soil and reduce erosion and runoff.

12 **Crop Residue Use** - Using plant residues to protect cultivated areas during critical erosion periods.

13. **Cultural Control of Pests** - Using cultural practices, such as elimination of host sites and adjustment of planting schedules, to partly substitute for pesticides.

14. **Debris Basin** - A barrier or berm constructed across a water course or at other suitable locations to form a silt or sediment basin.

15. **Deferred Grazing** - Postponing grazing for a prescribed period to improve vegetative conditions and reduce soil loss.

16. **Diversion and Terraces** - Channels with a mound or ridge along the lower side, constructed across a slope to divert runoff water and help control soil erosion. Grassed or lined waterways and subsurface pipes are used to handle water from terrace systems.

17. **Fencing** - Enclosing a sensitive area of land or water with fencing to exclude or control livestock.

18. **Field Border** - A border or strip of permanent vegetation established at field edges to control soil erosion and filter nutrients.

19. **Field Windbreak** - A strip or belt of trees established to reduce wind erosion.

20. **Flooding During Nonuse** - Flooding organic soils when no crops exist to reduce oxidation and the release of nutrients to drainage water.

21. **Floodwater Reduction Structure** - A structure providing temporary storage of stormwater for its controlled release to reduce flooding, streambed erosion, and sedimentation.

22. **Grade Stabilization Structure** - A structure to stabilize the streambed or to control erosion in natural or constructed channels.

23. **Grassed Waterway or Outlet** - A natural or constructed waterway or outlet maintained with vegetative cover in order to prevent soil erosion and filter nutrients.

24. **Irrigation Water Conveyance** - A pipeline or lined waterway constructed to prevent erosion and loss of water quality and quantity.

25. **Irrigation Water Management** - Determining and controlling the rate, amount, and timing of irrigation water application in order to minimize soil erosion, runoff, and fertilizer and pesticide movement.

26. **Land Absorption Areas and Use of Natural Wetland Systems** - Providing an adequate land absorption area downstream from tilled or grazed areas so that soil and plants absorb nutrients and animal wastes.

27. **Lined Waterway or Outlet** - A runoff water channel or outlet with an erosion resistant lining to prevent erosion. Applicable to situations where unlined or grassed waterways would be inadequate.

28. **Conservation Tillage** - Limiting the number of cultural operations needed to produce a crop in order to reduce soil erosion, soil compaction, and energy use. Usually involves increased use of herbicides.

29. **Mulching** - Applying plant residues or other suitable materials to the soil surface in order to reduce water runoff and soil erosion. Plastic mulch can increase runoff but will reduce nutrient leaching.

30. **Pasture and Hayland Management** - Proper treatment and use of pastureland or hayland to protect the soil and reduce water loss.

31. **Pasture and Hayland Planting** - Establishing forage plants on erodible soils to reduce runoff and erosion.

32. **Pesticide Selection** - Selecting pesticides which are less toxic, persistent, soluble and volatile, whenever feasible.

33. **Planned Grazing Systems** - A system in which two or more grazing units are alternately rested from grazing in a planned sequence to improve forage production, maintain vegetative cover, and retain animal wastes.

34. **Prescribed Burning** - Using fire, under conditions where the intensity of the fire is controlled, to improve plant cover so that runoff and erosion are reduced.

35. **Proper Grazing Use** - Grazing areas at an intensity which will maintain enough vegetation cover to reduce soil erosion.

36. **Range Seeding** - Establishing adapted plants on rangeland to reduce soil and water loss and to produce more forage.

37. **Regulated Runoff Impoundment** - Retention, or detention with filtration prior to discharge, to reduce runoff quantity and nutrient and pesticide discharge.

38. **Resistant Crop Varieties** - use of plant varieties that are resistant to insects, nematodes, diseases, etc., in order to reduce pesticide use.

39. **Shade Areas** - Lessening the need for animals to enter water for relief from heat by using trees or artificial shelters to provide shade at selected locations.

40. **Slow Release Fertilizer** - Applying slow release fertilizers to minimize nitrogen losses from soils prone to leaching.

41. **Soil Testing and Plant Analysis** - Testing to avoid overfertilization and subsequent losses of nutrients in runoff water.

42. **Streambank Protection** - Stabilizing and protecting banks of streams, lakes, estuaries, or excavated channels against scour and erosion with vegetative or structural means.

43. **Stripcropping** - Growing crops in a systematic arrangement of strips or bands to reduce water and wind erosion.

44. **Subsurface Drain** - A conduit, such as tile, installed beneath the ground surface to control the water level for increased production. Net runoff and leaching is reduced, but nitrate concentrations may increase.

45. **Timing and Placement of Fertilizers** - Timing and placement of fertilizers for maximum utilization by plants and minimum leaching or movement by surface runoff.

46. **Waste Management System** - A planned system to manage wastes from animal concentrations in a manner which does not degrade air, soil or water resources. Often wastes are collected in storage or treatment impoundments such as ponds or lagoons.

47. **Waste Utilization** - Using wastes for fertilizer in a manner which improves the soil and protects water resources. May also include recycling of waste solids for animal feed supplement.

48. **Water Table Management** - Control of the water table at the highest level consistent with the crop's needs. Reduces oxidation of organic soils and the release of nutrients to drainage water.

49. **Water Tolerant Crops** - Selection of water-tolerant crops for organic soils so higher water tables can be maintained to reduce oxidation and release of nutrients to drainage water.

50. **Water/Feeder Location** - Locating feeders and watering facilities a reasonable distance from streams and water courses, and dispersing them to reduce livestock concentrations, particularly near streams, and to encourage more uniform grazing.

51. **Woodland Site Management** - Managing soils and vegetation to encourage rapid growth of desirable trees in order to reduce soil erosion and runoff.

2. Animal Feedlots and Dairies

As with regulation of agrichemical use, local government ordinances should require review of all proposed animal confinement, feedlot, and dairy operations, particularly in recharge zones and wellfield protection zones. In karst areas, serious consideration should be given to disallowing confinement of animals above very low thresholds. Conditional use review should be required for all operations above certain thresholds of animals. Where planned operations cannot be designed to adequately protect critical areas, the proposed use can be disallowed, or can be required to scale down, to allow for adequate control and attenuation of animal waste pollutants. Monitoring requirements should also be imposed for areas of confinement, areas which normally include higher densities of animals, and waste lagoon and runoff areas.

The siting review process should include consideration of location, water contamination potential, and waste disposal processes. See for example, Crawford County, Wisconsin (Animal Waste Management Ordinance) and Title 5 of the Model Local Groundwater Protection Ordinance (Livestock Waste). The proposed use should not conflict with existing or planned land uses in the area, and the site should not be within a critical aquifer protection zone. Where siting is appropriate, structures, facilities and processes should be designed and constructed to prevent wastes from entering or infiltrating surface and subsurface waters. Operations should include the means to adequately collect, dispose of or recycle a volume of wastes greater than that anticipated from the operation. Planning information, soils and hydrogeological information, and analyses which rank areas for agricultural pollution risks should be utilized to determine areas appropriate for certain densities of animal confinement.

In areas considered acceptable for uses involving the management of animal wastes, permitting requirements should include a "groundwater protection animal waste management plan":

1. wastes and flushings from milking barns and runoff from high intensity use areas will be centrally collected for storage and disposal, using adequate treatment or appropriate land disposal;

2. designs and management practices will function to minimize the areal extent of high-intensity use areas;

   Appropriate designs and management practices can be researched with the aid of U.S.D.A. Soil Conservation Service Field Service Technical Guides, and the help of local service representatives.

3. waste lagoons will have impervious linings of concrete, capable of holding one year's production of manure, and the volume of the 50-year, 24-hour design storm;

4. minimization or elimination of run-off or seepage from high-intensity use areas, including diverting paving and roof runoff away from feeding and confinement areas;

5. irrigation of wastewater and application of manure solids based on sound agronomic practices, and designed so as to maximize plant uptake of nutrients, and minimize impacts on groundwater;

   These include careful timing of applications from a crop nutrient perspective and from a rainfall perspective. Nutrient content of wastes should be analyzed quarterly, before spreading. Analysis of nutrients should show that all sources of nutrients applied are no greater than the annual nutrient requirements of the vegetation being grown in that area.[31] Applications from all sources, should not overwhelm the capacities of the crop to utilize the nutrients.[32] To the degree possible, applications should be timed to allow adequate uptake and attenuation before heavy rainfall events. Applications should only be made when the local water table is at least 18 inches below the surface. If nutrient analyses are consistent, the frequency of analysis may be reduced.

6. location of waste disposal areas (lagoons, spray irrigation fields, manure storage and disposal areas) away from surface waters, sinkholes, drainage wells and property boundaries;

7. exclusion of livestock from sensitive areas near sinkholes and drainage wells, with buffer areas that take into account the topography of the area, the amounts of likely wastewater, the hydrogeological sensitivity of the underlying aquifer, and the proximity of drinking water wells;

8. storage and treatment facilities, and high intensity areas should be located at least 300 feet from drinking water wells, 200 feet from natural watercourses, and 100 feet from drainage ditches; land application areas should be located at least 200 feet from drinking water wells, 50 feet from natural watercourses, and 50 feet from drainage ditches;

These setbacks are those of Rule 17-670, F.A.C. and may require modification, based on local topography and hydrogeological considerations. Title 5 of the Model Local Groundwater Protection Ordinance includes setbacks and other siting requirements for application of manures.

9. installation of monitoring wells, and testing of on-site and nearby off-site drinking water wells; groundwater monitoring wells should be located at the downgradient edge of storage and application areas, and at the property boundary downgradient, as well as upgradient to determine background water quality levels; quarterly monitoring should be required.

In addition to the "groundwater protection animal waste management plan," permits should require an approved plan of BMPs established by the Cooperative Extension Service and Soil Conservation Service. Most of the applicable BMPs listed in Table 1 address the same concerns and approaches as those listed above for a groundwater conservation plan. There are many BMPs developed for conservation purposes in Florida. For groundwater protection purposes these include, but are not limited to:

17. Fencing
18. Field Border

[31] See Hochmuth and Hanlon, "Commercial Vegetable Crop Nutrient Requirements," Florida Cooperative Extension Service, Circular 806, Institute of Food and Agricultural Sciences, University of Florida, Gainesville, Fl. (1989); see also, Hochmuth, G., "Commercial Vegetable Fertilization Guide," Florida Cooperative Extension, Circular 225 C, Institute of Food and Agricultural Sciences, University of Florida, Gainesville, Fl. (1988).

[32] See Hochmuth, G. (ed.), "Nitrogen Management in Vegetable Production for Groundwater and Health Protection," Florida Cooperative Extension Service, Special Series Report SSVEC 940, Institute of Food and Agricultural Sciences, University of Florida, Gainesville, Fl. (undated).

23. Grassed Waterway or Outlet
26. Land Absorption Areas and Use of Natural Wetland Systems
46. Waste Management System
50. Water/Feeder Location

Additional BMPs addressing the groundwater protection problems of dairies and feedlot operations in the Suwannee River Basin are being researched at IFAS, and should be available from DER in 1991.

LOCAL ORDINANCE: MODERATE LEVEL OF STRINGENCY

All moderate approaches should include careful consideration of planning data supporting the less stringent requirements. Areas and operations warranting a more moderate approach will depend on site-specific conditions and the resources of the local government. Moderate levels of regulation may be appropriate where 1.) proposed locations of agricultural operations are not likely to affect important recharge areas for existing or future public wells, or other designated protection zones, or higher concentrations of shallow private drinking water wells; 2.) the types, characteristics or amounts of agrichemicals to be used will not threaten the designated zones or other sensitive areas related to public or private drinking water supplies; 3.) the numbers of animals and the densities at which they will be confined will not threaten protection zones or other sensitive areas. If applied within an overlay zoning scheme, prohibitions may likely apply within close, critical zones, with moderating provisions applicable in less sensitive areas.

Generally, as with other approaches to creating a moderately stringent ordinance, the requirements of state rules may be tightened or adopted with provisions for operating permits to be reviewed by the local government. In areas where the type of operation or degree of hydrogeological sensitivity allows a moderate approach, agricultural operations and land uses of agrichemicals can be required to develop programs of BMPs, without reference to the required provisions of the stringent approach suggested in this section. If a slightly higher degree of control is necessary, it may also be appropriate to loosen slightly the requirements of more stringent approaches. Among the many standards which may be modified are those for: any of the large number of applicable setbacks; required containment volumes for waste management systems; lagoon liner standards; storage tank containment standards; required depths and volumes for agricultural stormwater management systems; monitoring requirements and frequencies; and the level of detail for "groundwater protection plans," or other required programs of BMPs.

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REGULATION OF UNDERGROUND INJECTION WELLS AND DRAINAGE WELLS

INTRODUCTION

The primary pollutants introduced into deep underground injection wells are those associated with industrial wastes, organic chemicals, acids, oil field brines, and sewage. Drainage wells in urban and rural areas are used primarily for disposal of stormwater and irrigation return flows, and controlling lake levels. Most of the potential problems for such wells have to do with improper siting and improper construction. The complexity of Florida's hydrogeology makes it difficult to predict, with a high degree of confidence, that hazardous fluids injected into certain subsurface formations will not eventually influence the quality of water in other formations. Thus, siting considerations are probably the highest for any injection well for the disposal of more toxic materials. Many injection well operations pump the fluids into deep geologic formations under pressure, and the failure of well casings can also cause contamination by allowing wastes to infiltrate into overlying aquifer formations. Improperly sealed and grouted wells can allow migration of wastes past the confining geologic layers protecting one aquifer from another.

Important controls on injection wells involve careful siting considerations and choice of receiving formations, strict well construction standards, and control of well operations. Important physical, chemical and biological parameters should be monitored, including the injection rate, fluid quality, surrounding water quality, well integrity status and movement of injected materials, to assure that such wells do not threaten other groundwater resources.

Estimates are that there are over 1000 stormwater and street runoff drainage wells in Florida, draining into shallow subsurface formations, often directly into shallow potable aquifers. Broward and Dade Counties contain over 80% of the such wells permitted statewide. Orange County has been identified as having a small number of permitted drainage wells, and over 180 non-permitted wells.[1] In 1981, the Florida Department of Transportation was reported to have 81 drainage wells, including 32 in Orange County and 26 in Dade County.[2] Pollutants in roadway runoff and stormwater runoff from developed areas include sediment, heavy metals, nitrogen and phosphorus, biological oxygen demand and the organics associated with petroleum by-products. Drainage wells are also used for irrigation return flow disposal, introducing many of the potentially toxic pollutants associated with chemigation used in agricultural settings.

Though there has been little research in the area, and few documented contamination events, the large numbers of such drainage wells in certain areas and the potential toxicity of the drainage flows, suggest that, without additional controls, the use of such wells in recharge areas and critical protection zones can become chronic sources of contamination for shallow aquifers used for drinking water supplies. The most effective approach to controlling and mitigating the effects of drainage wells involves prohibiting their construction in critical areas, and developing a program to cap existing wells. When located in less sensitive areas or under conditions which do not allow their closure, such wells should be carefully buffered with vegetated areas and adequate stormwater retention, to allow maximum attenuation of pollutants before drainage. In developed areas, the approach can also include regular vacuuming and cleaning of streets and other areas

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[1] Subcommittee on Oversight, Committee on Natural Resources, "A Review of Florida's Underground Injection Control Program," 18, Florida House of Representatives, Tallahassee, Fl. (1983).

[2] Id.

which collect volatile organic pollutants and sediments, and filtration of runoff prior to drainage. In agricultural settings, maximum reuse of irrigation return flows should be required, and pretreatment with adequate wet retention times prior to injection.

BASELINE APPROACHES

Under the provisions of the federal Safe Drinking Water Act, Florida received delegation of the Underground Injection Control Program from EPA in 1983. The DER now regulates the siting, design, construction, hydrogeologic, operating, monitoring, and abandonment criteria applicable to underground injection wells under Chapter 17-28, F.A.C. The rule establishes five general classes of such wells, four of which are addressed by the DER.

Class I wells include those by hazardous waste generators or owners or operators of hazardous waste facilities to inject hazardous waste beneath the lowest formation containing an underground drinking water source within one quarter mile of the well bore. Also included under this class are other industrial and municipal disposal wells injecting fluids beneath the lowest formation containing an underground source of drinking water within one quarter mile of the well bore. Hazardous waste injection wells under Class I are prohibited. Other wells in the class must meet stringent standards for siting, design, construction and monitoring.

Class II wells are used to inject fluids: (a) which are brought to the surface during petroleum or natural gas production, and may be commingled with waste water from gas plants, unless those fluids are hazardous wastes at the time of injection; (b) for enhanced recovery of petroleum and gas; and (c) for storage of hydrocarbons which are liquid at standard temperature and pressure. These wells are regulated by the Department of Natural Resources under the requirements of Chapter 16C-2, F.A.C.

Class III wells inject for extraction of minerals and are also subject to strict regulatory standards though there is very little use of this type of well in Florida. There are stringent siting, design, construction and monitoring criteria for Class III permits. The evaluation of potential impacts from Class I and Class III wells must include an "area of review" which includes all land within the "zone of endangering influence" of the wells or wellfield. The area of review must be based on consideration of several factors, including the characteristics of the injection fluids, hydrogeology, models for computing anticipated changes in the injection zone, population, and groundwater use and dependence. The minimum area of review is a circle with a radius of one mile from the well.

Class IV wells are used by hazardous or radioactive waste generators, owners, or operators to dispose of hazardous or radioactive wastes into or above a formation which, within one quarter mile of the well, contains either an underground source of drinking water or an exempted aquifer. These types of wells are also prohibited in Florida.

Class V wells inject non-hazardous fluids into or above formations that contain underground sources of drinking water, defined to include aquifer segments that supply drinking water for consumption or which are classified as G-I or G-II.[3] The Class V designation includes five groups, which DER regulates on a case by case basis. Group 1 consists of air

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[3] Such an aquifer can be exempted if it does not currently serve as a source of drinking water, and cannot serve as drinking water now or in the future, because of its depth, contamination, potential for mineral or hydrocarbon production, or location over mining areas subject to collapse. Rule 17-28.130(3), Fla. Admin. Code (1990).

condition return flow wells and cooling water return flow wells. Group 2 includes aquifer recharge wells, salt water intrusion barrier wells, subsidence control wells, and connector wells used to connect two aquifers. Group 3 consists of wells which are a part of domestic waste water treatment, swimming pool drainage wells, wells used to return water removed for the extraction of salts, and injection wells used in experimental technologies. Group 4 consists of dry wells used for the injection of wastes, sand backfill wells, wells other than Class IV wells used to inject radioactive wastes of concentrations within drinking water standards, and injection wells used in borehole slurry mining. Group 5 wells are drainage wells used to drain surface fluids, primarily for stormwater runoff or lake level control, into a subsurface formation by gravity flow. Group 6 wells are injection wells associated with the recovery of geothermal energy, and other wells.[4] There are approximately 7000 Class V wells in Florida.

The rule requires that Class V wells must not present a hazard to the existing or future use of an underground source of drinking water, and must not cause or allow movement of fluid containing a contaminant into underground sources of drinking water which might cause a violation of any primary drinking water standard.[5] If an existing Class V well may cause a violation of a primary drinking water standard, the DER must: require a permit for the well; order the injector to take action necessary to prevent the violation, including closure of the well; require monitoring; or take enforcement action. The DER may also take any action necessary to prevent a Class V well from adversely affecting human health.[6]

Construction permits for Class V wells require information such as name, address and license number of the water well contractor; well location and depth, casing diameter and depth for all onsite water supply wells, and locations of all water supply wells of public record within 1000 feet of the proposed well; description and proposed use the system, including quantities, chemical and bacteriological analyses and any pretreatment. The DER may also request additional information on inspection reports by local programs and water management districts, and bacteriological analysis of the proposed injection fluid, onsite monitoring wells, and the nearest downgradient domestic or public water supply well within a 1000 foot radius, if drilled to same formation as the proposed injection well.[7] Except for Groups 1, 2 and 5, most other groups and categories are required to obtain operating permits, with five-year durations. The owner or operator of Class V wells must apply for plugging and abandonment permits, to be carried out by licensed water well contractors, when the wells are no longer used or usable for intended purposes or other purposes approved by DER.[8]

LOCAL ORDINANCE: HIGH LEVEL OF STRINGENCY

The technical expertise necessary to administer and oversee a stringent permitting program for underground injection of toxics may be beyond the resources of most local governments. For Class I, Class III and major Class V wells, the design, construction, monitoring and abandonment

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[4] Rule 17-28.130, Fla. Admin. Code (1990).

[5] Rule 17-28.610(2), Fla. Admin. Code (1990); see Rule 17-550, Fla. Admin. Code (1990) for listings of primary drinking water standards.

[6] Rule 17-28.610(2), (3), Fla. Admin. Code (1990).

[7] Rule 17-28.620, Fla. Admin. Code (1990).

[8] Rule 17-28.640, Fla. Admin. Code (1990).

criteria of Ch. 17-28, F.A.C. are very restrictive, while the DER probably is in better position to review and evaluate such operations. The Technical Advisory Committees which meet to evaluate permit applications also include representatives of the local county pollution control office, allowing a local government the opportunity to comment on siting considerations.

Given the lack of certainty associated with long-term containment of injected fluids and the possibility that leakage can occur from well casings as they age, the most stringent approach local governments may take to Class I, Class III and major Class V wells is to prohibit their placement in recharge zones and within substantial distances of public drinking water wells and higher concentrations of private wells. An overlay zone approach would simply include language prohibiting the drilling or use of any well for such purposes within applicable zones. The Cortlandville, N.Y. aquifer protection ordinance (Article VIII-A) prohibits any form of underground injection of hazardous materials or toxic substances. Within any of its three protection zones, the Holliston, Mass. aquifer protection overlay bylaw prohibits any use which involves as a principal activity the manufacture, storage, use transportation or disposal of toxic or hazardous materials.

Class V, Group 5 wells for stormwater and irrigation drainage should be prohibited in critical overlay zones and should be carefully evaluated in less sensitive zones. Their use in or near areas with higher concentrations of shallow wells, including private, community and non-community wells, may pose a threat to those sources of drinking water. Existing drainage wells in critical protection zones that cannot be immediately capped should be required to meet retrofit standards, including approaches such as monitoring, increasing the size of the "treatment trains" used to increase uptake of sediments and other pollutants, expanding retention volumes, increasing retention times prior to discharge to wells, and incorporating enhanced filtration methods into the system prior to discharge. Existing facilities discharging to wells in less sensitive protection areas can be required to create and implement plans that will lead to the capping of drainage wells and use of other types of discharge, such as infiltration, within, for example, five years.

REGULATION OF LANDFILLS

INTRODUCTION

The primary means of solid waste disposal in this country is by deposit to landfills. Florida has one of the fastest population growth rates in the nation, and generates over 42,000 tons of waste each day, 75% of which goes to landfills, yet also has some of the more vulnerable potable groundwater in the country. Until fairly recently, landfills were sited and constructed with very little concern for groundwater pollution problems. The situation has been improved in recent years, with the DER imposing fairly strict siting, design, construction, operation, monitoring and closure requirements on most landfills.

BASELINE APPROACHES

A baseline approach to landfill permitting will involve requiring a valid DER permit as a condition to receiving local government approval. Generally, DER regulates landfills under the provisions of Chapter 17-701, F.A.C., which addresses the permitting, operation and closure of solid waste disposal operations. These facilities include landfills, waste transfer stations, land application systems, recycling facilities, and volume reduction facilities. Landfills are classified into three categories depending on the amount and type of solid waste received. Class I landfills are those that accept municipal solid waste and receive an average of 20 tons or more per day.[1] Class II sanitary landfills receive an average of less than 20 tons per day and must be covered once every four days, or more frequently if they receive sewage or industrial sludges, dead animals, or other nuisance wastes.[2] Class I and Class II landfills must also have a liner constructed of materials that are compatible with the projected wastes.[3] Class III landfills receive only trash and yard trash, including any combination of vegetative matter from landscaping maintenance or land clearing operation, construction and demolition debris, cardboard, cloth, glass, street sweepings, and vehicle tires. These sites generally do not require liners and must be covered once every week.[4]

Normal farming operations and solid waste disposal areas for construction and demolition debris are exempted from individual permit requirements, though construction and demolition debris landfills, solid waste transfer stations and land application of domestic wastewater sludge receive general permits with minimal conditions.[5] A disposal site must be have sufficient geological integrity to support the landfill, including total wastes to be disposed of, cover material and structures to be built on the site.[6] The facility must also have a ground water monitoring

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[1] Rule 17-701.050(1)(a), Fla. Admin. Code (1990).

[2] Rule 17-701.050(1)(b), Fla. Admin. Code (1990).

[3] Rule 17-701.050(3), Fla. Admin. Code (1990).

[4] Rule 17-701.050(1)(c), Fla. Admin. Code (1990).

[5] Rules 17-701.030(1)(a), 17-701.801--.803, Fla. Admin. Code (1990).

[6] Rule 17-701.050(2), Fla. Admin. Code (1990).

plan, including a hydrogeological survey to ensure that ground water quality will be protected from waste or leachate.[7]

Solid waste may not be disposed of in any of a number of locations, including: a.) open sink holes or geologic areas that cannot support a landfill; b.) gravel or limestone pits; c.) immediately adjacent to or within 500 feet of an existing or proposed shallow water supply well except for deposits in preexisting sanitary landfills; d.) in a dewatered pit without permanent leachate containment and special design techniques; e.) in an area subject to frequent and periodic flooding unless approved drainage provisions are installed; f.) within 200 feet of any natural or artificial body of water, except self-contained landfill waterbodies that do not discharge offsite;[8] g.) within 3,000 ft of a Class I (potable) surface water.[9]

Liners must be constructed of materials compatible with the waste and leachate and must be of sufficient strength and thickness to prevent failure of the liner due to pressure gradients, climatic conditions, and the stress of installation and operation.[10] Soil liners require a minimum of three feet of soil which must meet certain standards of impermeability. The liner must not contain any structural inconsistencies or vegetation through which leachate could migrate. Synthetic liners must meet minimum strength requirements and must be protected from physical damage by bedding soil above and below the liner. Landfills built after June 1, 1990 must have a composite liner (soil liner overlain by synthetic liner) with leachate collection, or a double flexible membrane system with leachate detection and collection. All field seams of a liner must be visually inspected and pressure or vacuum tested for continuity.

A leachate collection system is required, and must be designed and constructed to provide for removal of leachate within the drainage system to a central collection point for treatment and disposal.[11] The collection and removal system must be located immediately above the liner, and designed, constructed, maintained, and operated to collect and remove leachate from the landfill. The system must be constructed of materials that are chemically resistant to the expected waste and leachate. It must also have sufficient strength and thickness to prevent collapse under pressures exerted by overlying wastes, cover and equipment, and must be designed and operated to function without clogging throughout its active life and closure. The rule requires a 12-inch drainage layer above the liner to promote drainage and a collection system to remove leachate. The current standard requires a leachate collection system to maintain the head over the liner to one foot or less. Landfills built after June 1, 1990 must have systems capable of maintaining the head at no more than one inch over the liner, following a 25-year, 24-hour storm event.

Surface water management systems are required, and must be designed, constructed, operated, and maintained to prevent surface water flow onto waste-filled areas. A stormwater runoff control system must also be designed, constructed, operated, and maintained to collect and control stormwater in accord with Chapter 17-25, F.A.C. and local water management district

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[7] Id.

[8] Rule 17-701.040(2), Fla. Admin. Code (1990).

[9] Rule 17-701.040(7), Fla. Admin. Code (1990).

[10] Rule 17-701.050(3)(b), Fla. Admin. Code (1990).

[11] Rule 17-701.050(4)(e), Fla. Admin. Code (1990).

requirements.[12] Retention and detention ponds must also be designed, constructed and maintained to meet such requirements. The system should be designed to minimize the possible mixing of stormwater and leachate. When stormwater mixes with leachate, it becomes classified as leachate and must be treated as such.[13]

The rule requires an operation plan to be developed to document procedures for monitoring, waste loading and unloading, and operation of control systems.[14] Monitoring wells must be installed and sampled at appropriate intervals.[15] The landfill should include certain minimum design features, including a barrier to prevent unauthorized entry and dumping into the landfill.[16] Minimum permit application requirements include those for landfill closure, monitoring and maintenance to prevent any threat to human health or the environment. Virtually all landfills are subject to the requirement, except sites where an individual disposes of waste resulting from the individual's own activities on the individual's own property; any dredge spoil site, any yard trash composting site; and any construction and demolition debris site.[17]

Landfill permits require an approved operation life schedule and closure plan. The closure plan should include a groundwater monitoring plan and must identify provisions for long term care, including leachate control, groundwater protection, and storm water control.[18] The plan must report on the effectiveness of existing landfill design and operation, including effects of the landfill on adjacent ground and surface waters.[19]

LOCAL ORDINANCE: HIGH LEVEL OF STRINGENCY

The most important high stringency regulatory approach for local governments is to carefully review and site landfills. For groundwater protection purposes, the suggested approach would prohibit landfills in any designated aquifer protection zone, recharge area, in karst areas, and near areas with higher densities of private shallow wells. Several ordinances included in Appendix A of this manual prohibit landfills in aquifer protection zones. See for example, the Acton, Mass. ordinance (Zoning By-Law, Sec. 4.3) which prohibits any sanitary landfill, solid waste disposal site, refuse treatment or disposal site within any of its three aquifer protection zones. The technology by which landfills are being made safer is not failure-proof, and given the amounts of leachate produced, once leakage begins, even with early detection, the process of groundwater contamination is virtually unstoppable. The EPA has documented several cases in which ten years' of groundwater pumping was unable to restore potable aquifers contaminated by

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[12] Rule 17-701.050(4)(g), Fla. Admin. Code (1990).

[13] Rule 17-701.050(4)(h), Fla. Admin. Code (1990).

[14] Rule 17-701.050(5)(b), Fla. Admin. Code (1990).

[15] Rule 17-701.050(5)(a), Fla. Admin. Code (1990). Ch. 17-703, Fla. Admin. Code requires landfill operators to fulfill certain training requirements before being permitted to operate a landfill.

[16] Rule 17-701.050(5)(c), Fla. Admin. Code (1990).

[17] Rule 17-701.070(1), Fla. Admin. Code (1990).

[18] Rule 17-701.073(6), Fla. Admin. Code (1990).

[19] Rule 17-701.071(5), Fla. Admin. Code (1990).

toxic materials. The review process should assure that landfills are sited in areas where groundwater levels are low, in order to decrease stress on liners, and reduce the failure rate of leachate collection systems. Any area in which a landfill is permitted should have high levels of natural aquifer protection.

Landfills which might be depositories for more threatening wastes should have composite or double synthetic liners, wherever they may be sited. Synthetic geomembrane liners must be compatible with any materials to be deposited, thick enough and strong enough to resist puncture from movement of deposited materials, and carefully installed to insure that they are properly supported, that seams are properly sealed and that holes are not accidentally caused. Landfills with less hazardous deposits might be considered for location in areas with high amounts of natural protection in the form of clays and other confining layers. For less hazardous landfills, soil liners, normally composed of clay, should be sufficiently thick and impermeable to prevent leachate leakage.

Leachate collection and containment systems should be required, at levels of construction standards that assure the quality and longevity of such systems. Quality control and quality assurance plans should be required, including provisions for full time inspection.

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