Lowe, Sorensen GUIDELINES FOR PREPARING HYDROGEOLOGIC AND SOIL REPORTS FOR WASTEWATER DISPOSAL SYSTEMS, WEBER COUNTY, UTAH UGS Circular 102

GUIDELINES FOR PREPARING HYDROGEOLOGIC AND SOIL REPORTS ADDRESSING SUITABILITY FOR ALTERNATIVE WASTEWATER DISPOSAL SYSTEMS IN WEBER COUNTY, UTAH

by
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Utah Water Research Laboratory,
Utah State University

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Cover photographs courtesy of Mary Hazard, Weber-Morgan District Health Department. Recent installation of an alternative wastewater disposal system in Ogden Valley, Weber County, Utah. Top photo shows drain-field distribution pipes; bottom two photos show septic tank.

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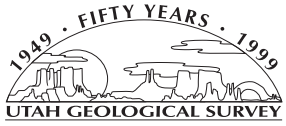

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ABSTRACT

Many lots in Weber County presently cannot be developed because adverse site characteristics (such as soil that percolates outside of acceptable rate ranges or shallow ground water) make them unsuitable for conventional wastewater disposal systems (septic tank soil-absorption systems). The Weber-Morgan District Health Department and the Utah Division of Water Quality have developed designs for alternative wastewater disposal systems that may be used in such areas if hydrogeologic and soil conditions are suitable, ground- and surface-water quality will not be degraded, and humans will not be exposed to wastewater pathogens. To demonstrate conformance with these criteria, hydrogeologic and soil studies of proposed sites will need to be conducted and results submitted to the Weber-Morgan District Health Department. Suitable hydrogeologic conditions include: (1) site slopes no steeper than 4 percent, (2) soil percolation rates between 60 minutes/inch and 1 minute/inch (5 minutes/inch for both Ogden Canyon and Ogden Valley), (3) depth to seasonal shallow ground water at least 2 feet (0.6 m) below the bottom of soil-absorption drain-field trenches or beds and 1 foot (0.3 m) below the original ground surface (location of trenches and beds with respect to original ground surface varies with alternative system type), (4) depth to bedrock or unsuitable soil at least 4 feet (1.2 m) below the bottom of soil-absorption drain-field trenches, (5) topographic and geologic conditions that prevent wastewater from surfacing or reaching surface-water bodies or culinary wells or springs within 250 days ground-water time of travel, (6) ground-water flow available for mixing in the zone of mixing in the aquifer below the site such that average nitrate concentrations will not be increased more than 1 mg/L under the anticipated wastewater loading, and (7) nitrate in high concentration zones (plumes) will not exceed 10 mg/L at any depth or location when it reaches the alternative wastewater disposal system owner's property line, as determined using a defendable solute transport model. Additionally, soil conditions should be such that wastewater will be adequately treated before reaching ground or surface water.

INTRODUCTION

Purpose

Many lots in Weber County (figure 1) presently cannot be developed because adverse site characteristics (such as soil that percolates outside of acceptable rate ranges,

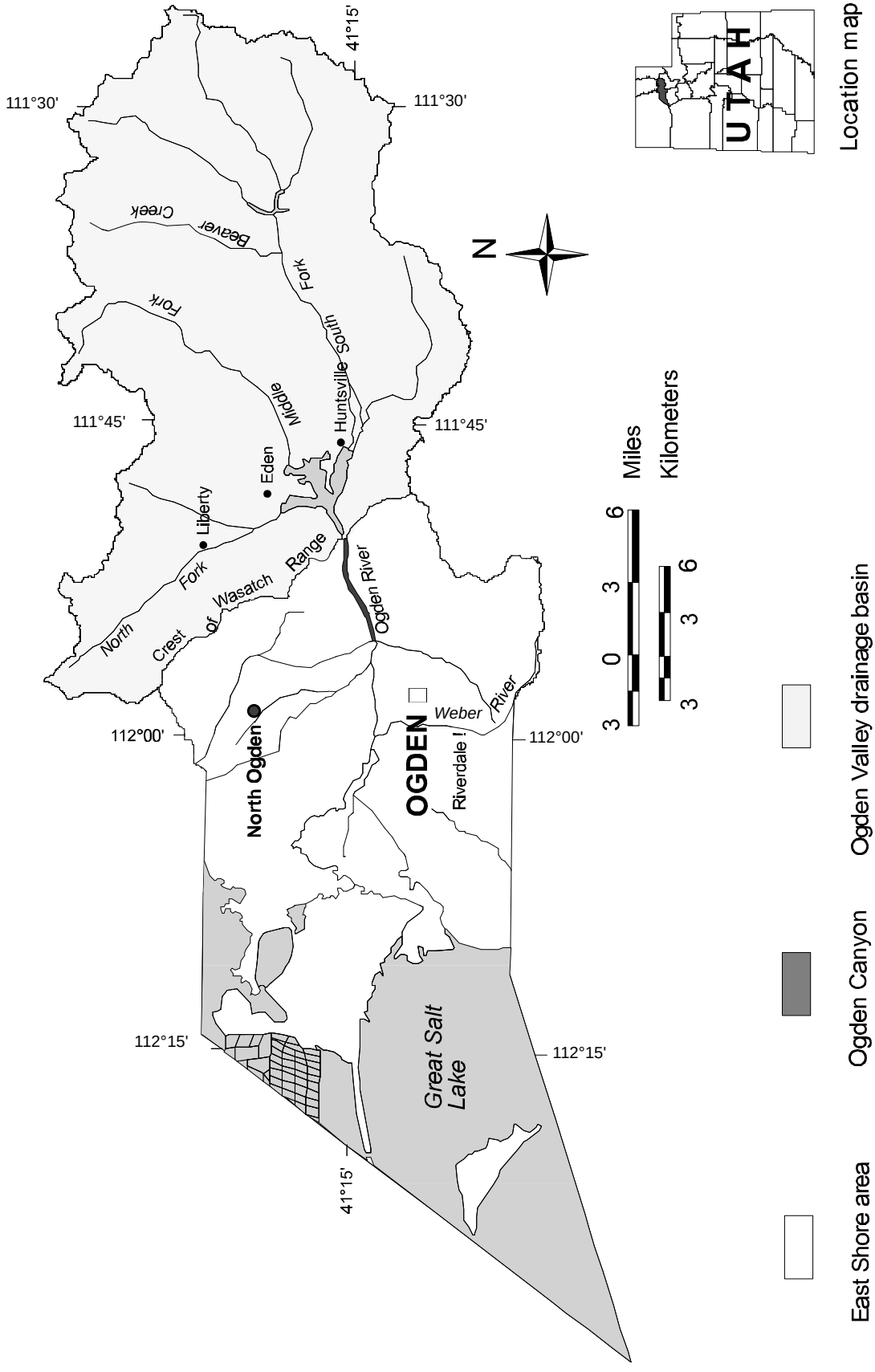

***Figure 1**. Location map of East Shore area, Ogden Canyon, and the Ogden Valley drainage basin, Weber County, Utah.*

or shallow ground water) make them unsuitable for conventional wastewater disposal systems (septic tank soil-absorption systems). The Weber-Morgan District Health Department and the Utah Division of Water Quality have developed designs for alternative wastewater disposal systems that may be used if hydrogeologic and soil conditions are suitable, ground- and surface-water quality will not be degraded, and humans will not be exposed to wastewater pathogens (Utah Administrative Code, R317-502-20; R317-507-7 to 9). To demonstrate conformance with these criteria, hydrogeologic and soil studies of proposed sites will need to be conducted and results submitted to the Weber-Morgan District Health Department.

The purpose of this circular, prepared at the request of the Weber-Morgan District Health Department, is to provide guidelines for: (1) geologists preparing hydrogeologic reports pertinent to the suitability of sites for alternative wastewater disposal systems, (2) soil scientists preparing soil evaluation reports pertinent to the suitability of sites for alternative wastewater disposal systems, and (3) geologists, soil scientists, and Weber-Morgan District Health Department officials reviewing these reports. These guidelines are applicable to other areas of Utah where alternative wastewater disposal systems are used or are being considered to be used.

These guidelines do not include systematic descriptions of all available techniques, and do not imply that all techniques be used on every project. Variations in site conditions or projected wastewater loadings may require more or permit less effort than is outlined here. Many sections of these guidelines have been modified from Utah Geological and Mineral Survey Miscellaneous Publication M, "Guidelines for preparing engineering geologic reports in Utah" (Utah Section of the Association of Engineering Geologists, 1986).

Wastewater Disposal Systems

Wastewater is disposed of in several different ways in Weber County, including public sewer systems/wastewater treatment plants in the East Shore area (locally known as lower Ogden Valley), total-containment sewage lagoons in Ogden Valley (locally known as upper Ogden Valley) and various types of subsurface disposal systems in the western part of the East Shore area and in the Ogden Valley drainage basin. The guidelines presented herein apply to both community and individual alternative on-site subsurface disposal systems.

Subsurface wastewater disposal systems generally consist of a building sewer(s), septic tank(s), and a soil-absorption drain-field system (figure 2). The septic tank provides primary treatment of wastewater. The volume of solids is reduced in the septic tank, with nonfloatable solids removed from the wastewater producing a somewhat clarified effluent that is then distributed to the soil-absorption drain-field system.

Alternative wastewater disposal systems differ from conventional wastewater disposal systems (septic tank soil-absorption systems [figure 2]) primarily in the placement of the soil-absorption drain fields (either trench or bed design). The drain fields of alternative wastewater disposal systems are generally placed at or above the original ground surface. Current alternative wastewater disposal system types include Low Pressure Pipe, At-Grade, Earth Fill, and Mound systems. New permits for Low Pressure Pipe systems that distribute effluent to a soil-absorption drain field in sandy fill above the original ground surface using a “demand-dosed” pump mechanism, are no longer issued in Weber County and thus are not discussed further. At-Grade systems, like conventional wastewater disposal systems, generally do not utilize dosing chambers and pumps to

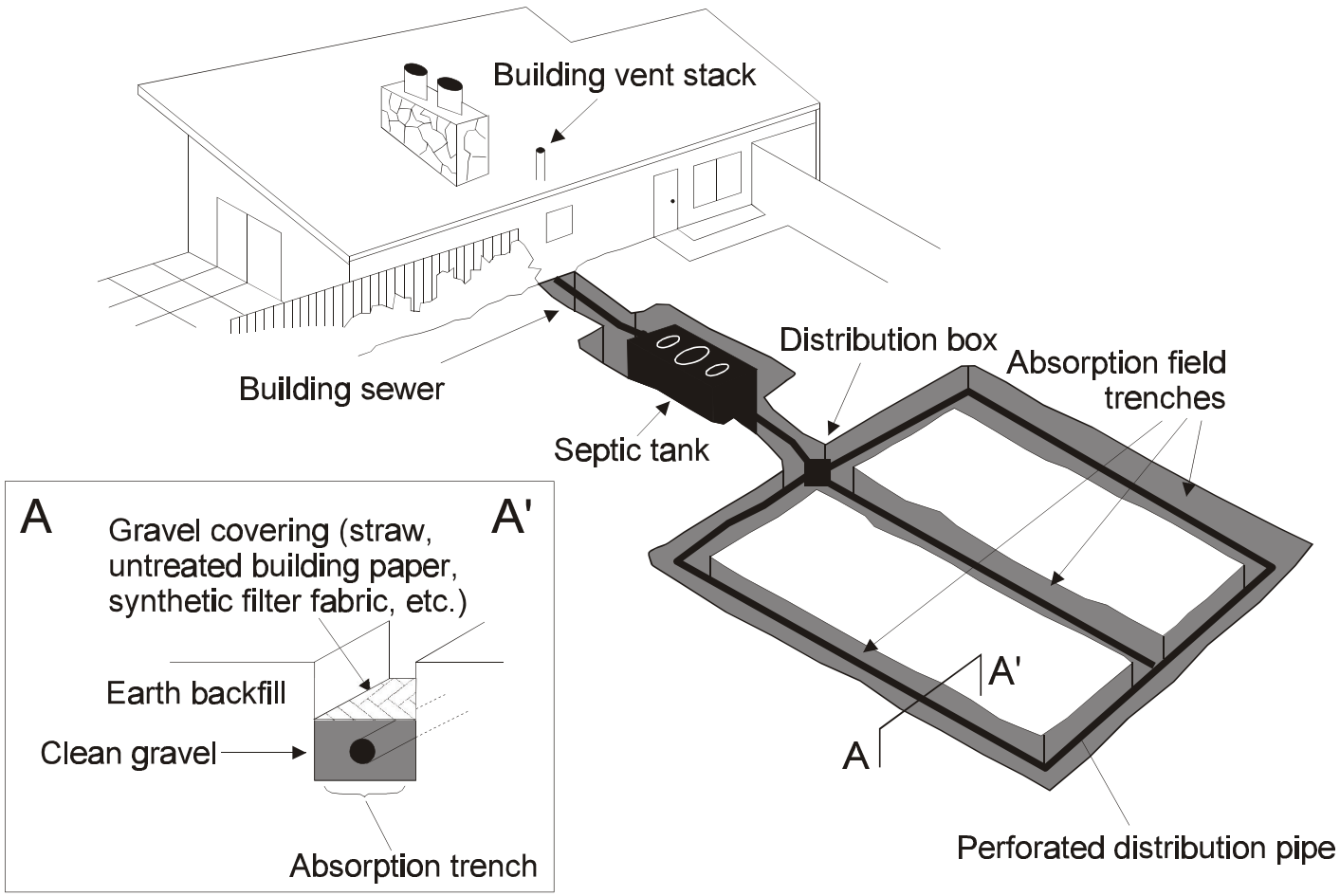

***Figure 2**. Conventional wastewater disposal system (from R317-501 through 513, Utah Administrative Code).*

distribute effluent. Soil-absorption drain fields for At-Grade systems consist of a series of trenches, having the bottoms of the trenches located at the original ground surface (figure 3). For Earth Fill (figure 4) systems, distribution pipes are placed at some distance above the original ground surface in engineered fill with a stabilized percolation rate between 15 and 45 minutes/inch after one year; these systems generally rely on gravity flow and do not utilize dosing chambers and pumps to distribute effluent. Mound systems (figure 5) use a “time-dosed” pump mechanism to distribute effluent from a dosing chamber to soil-absorption drain-field distribution laterals placed on sand fill (meeting American Society for Testing and Materials C33 specifications) at some distance above the original ground surface and covered with fabric and soil. Slopes at At-Grade, Earth Fill, and Mound system sites may not exceed 4 percent.

For all types of soil-absorption systems, the soil characteristics and percolation rates at the soil-absorption drain-field location must fall within acceptable ranges; the acceptable ranges of percolation rates are more conservative (protective) in Ogden Valley (locally known as upper Ogden Valley) and Ogden Canyon because the aquifers are generally more vulnerable to contamination than in the East Shore area (Anderson and others, 1994; Snyder and Lowe, 1998). For the East Shore area (figure 1), percolation rates must be between 1 and 60 minutes/inch for a depth of at least 4 feet (1.2 m) below the soil-absorption drain field. For Ogden Valley

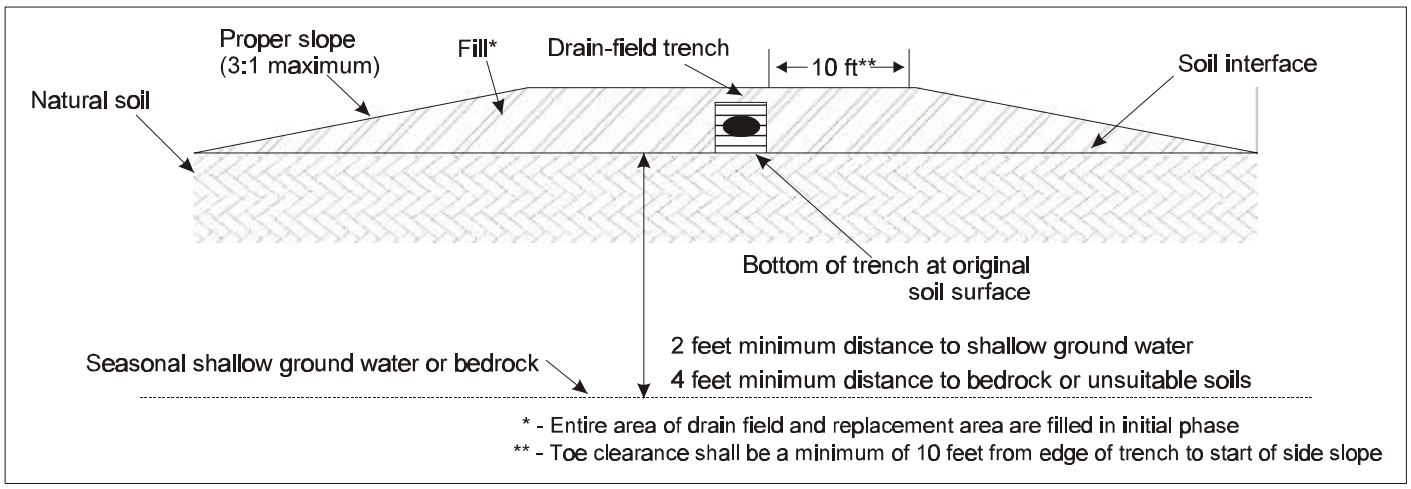

Figure 3. *Schematic diagram of an At-Grade system (from R317-501 through 513, Utah Administrative Code).*

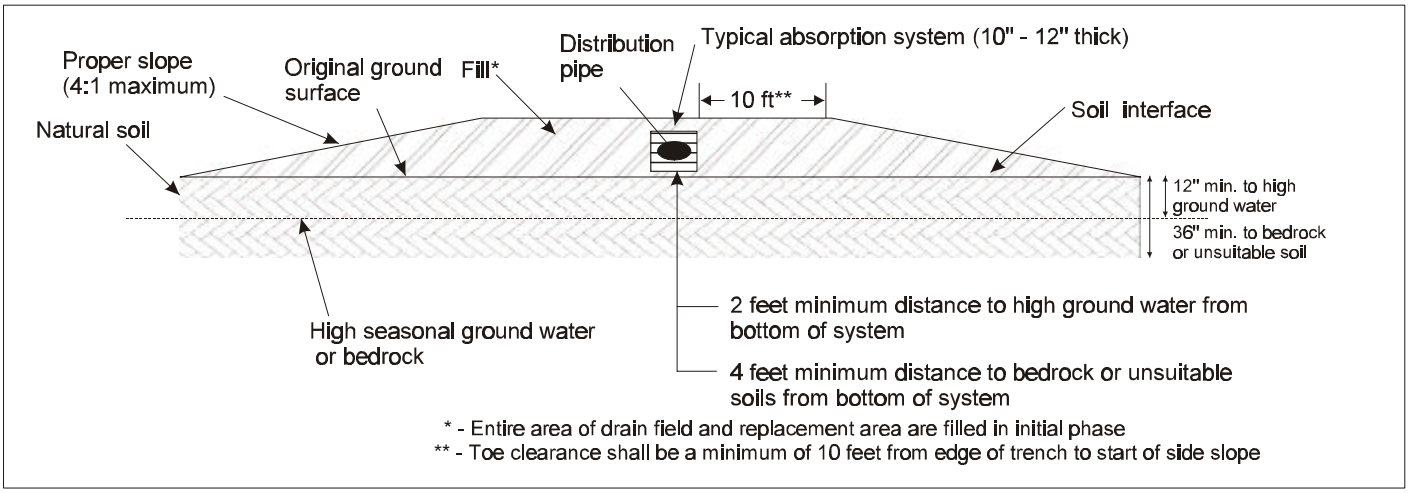

Figure 4. *Schematic diagram of a typical Earth Fill system (from R317-501 through 513, Utah Administrative Code).*

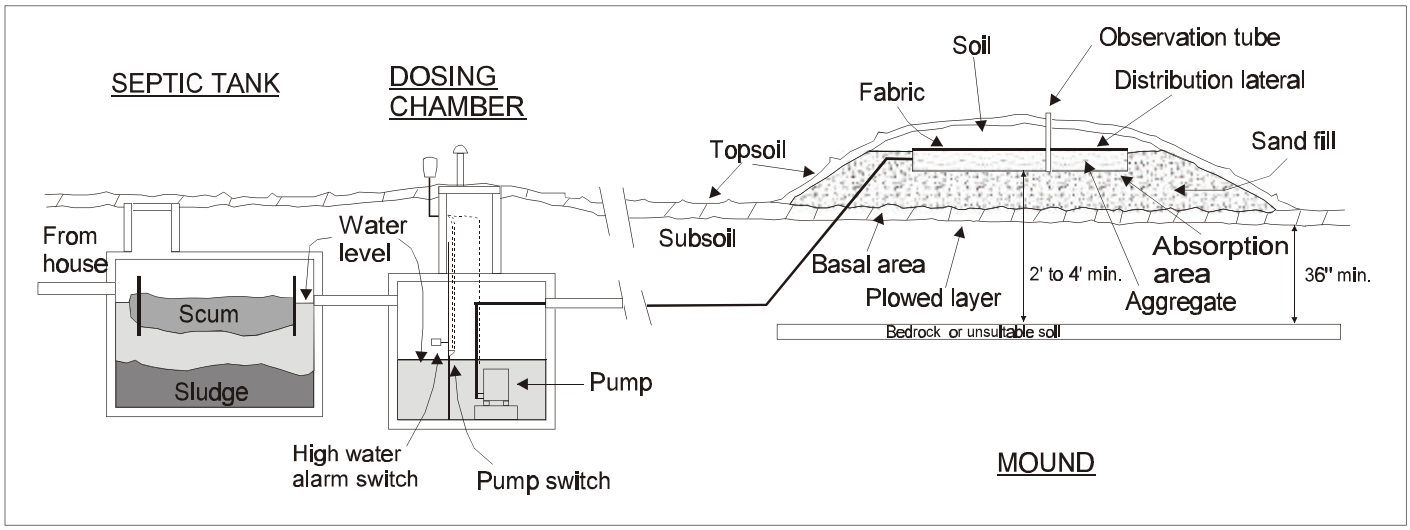

Figure 5. *Schematic diagram of a Mound system (from R317-501 through 513, Utah Administrative Code).*

and Ogden Canyon (figure 1), percolation rates must be between 5 and 60 minutes/inch for a depth of 4 feet (1.2 m) below the soil-absorption drain field. Additionally, the seasonal shallow ground-water table cannot rise to a level of less than 2 feet (0.6 m) below the soil-absorption drain field or 1 foot (0.3 m) below the original ground surface, and there must be sufficient suitable soils at the site for proper treatment of wastewater (table 1).

GUIDELINES FOR PREPARING HYDROGEOLOGIC AND SOIL REPORTS

The purpose of the hydrogeologic and soil reports is to show that conditions are suitable for an alternative wastewater disposal system. Suitable hydrogeologic conditions include:

(1) Site slopes no steeper than 4 percent.

(2) Soil percolation rates between 60 minutes/inch and 1 minute/inch (5 minutes/inch for Ogden Canyon and Ogden Valley) (figure 1).

(3) Depth to seasonal shallow ground water at least 2 feet (0.6 m) below the bottom of soil-absorption drain-field trenches and 1 foot (0.3 m) below the original ground surface.

(4) Depth to bedrock or unsuitable soil at least 4 feet (1.2 m) below the bottom of soil-absorption drain-field trenches.

(5) Topographic and geologic conditions that prevent wastewater from surfacing or reaching surface-water bodies or culinary wells or springs within 250 days ground-water time of travel.

(6) Ground-water flow available for mixing in the zone of mixing in the aquifer below the site such that average nitrate concentrations will not be increased more than 1 mg/L under the anticipated wastewater loading.

(7) Nitrate in high concentration zones (plumes) does not exceed 10 mg/L model (the ground-water-quality [health] standard) at any depth or location when it reaches the alternative wastewater disposal system owner's property line. Nitrate concentrations at the property line are to be determined using a defendable solute transport model.

Table 1. *Suitable soil thickness and separation from seasonal shallow ground-water requirements for conventional (septic tank soil-absorption), At-Grade, Mound, and Earth Fill wastewater disposal systems in Weber County, Utah.*

	CONVEN-TIONAL	AT-GRADE	MOUND AND EARTH FILL
MINIMUM THICKNESS OF SUITABLE SOILS (NOT INCLUDING FILL)	60 inches (150 cm)	48 inches (120 cm)	36 inches (90 cm)
MINIMUM DEPTH TO MAXIMUM SHALLOW GROUND-WATER TABLE BELOW ORIGINAL GROUND SURFACE	36 inches (90 cm)	24 inches (60 cm)	12 inches (30 cm)

Site Description and General Information

The report should describe the general site setting. The following items should be addressed:

(1) Site location, size, and general setting with respect to major or regional geographic and geologic features. A site-location map should be provided on a topographic base at a scale of 1:24,000 or larger. Subdivision site plans, if already prepared, should also be provided.

(2) Topography and drainage within or affecting the site.

(3) General description of site geology, emphasizing the characteristics of the uppermost aquifer (including a water-table or potentiometric-surface map and one or more hydrogeologic cross sections).

(4) Location(s) and description(s) of proposed alternative wastewater disposal system(s) and any surface-water bodies and/or culinary springs or water wells in the general area or having the potential of being affected.

(5) List of references used and names(s), affiliations, and certifications of professionals performing the study.

Investigation

Geologic mapping of the site should be on a topographic base, at a scale preferably 1:24,000 or larger, that shows sufficient detail to adequately define the geologic conditions present. Available geologic maps generally must be supplemented with site-specific observations. It may be necessary to study the geology in adjacent areas to aid in defining geologic conditions affecting the siting of alternative wastewater disposal systems.

The report should include descriptions of the types of rock and surficial materials, geologic structures, and show the three-dimensional relationships on one or more appropriately scaled cross sections or fence or block diagrams. The locations of test holes (drill holes, test pits, and trenches) should be shown on maps and cross sections. Logs of test holes should be included in the report to permit technical reviewers to make their own interpretations.

The following checklist is useful as a general, though not necessarily complete, guide for geologic descriptions.

1. Geologic Conditions

A. Rock types (such as granite, silty sandstone, shale, schist) in the area should be described, including age and, where possible, formation name (such as Wasatch Formation and Tintic Quartzite). Descriptions should include: (1) pertinent physical characteristics and variability of rock units (such as color, grain size, voids, thickness, and stratification), (2) dip of beds and description of folds shown on map and in cross sections, and (3) occurrence, distribution, dimensions, aperture, infilling, orientation, and variability of faults and joints; and influence of clay seams, fault gouge, and other infillings on hydrologic conditions.

B. Unconsolidated deposits at proposed sites should be described, including depositional environment (alluvial, colluvial, eolian, glacial, lacustrine, residual, mass movement, volcanic [such as cinders and ash], and fill), grain size, stratification, sorting, compactness, cementation, relative age, distribution, and thickness. Cross sections should be included showing the above information including, where possible, depth to bedrock.

2. Hydrologic Conditions

A. Locations of water bodies such as rivers, streams, canals, land drains, ponds, swamps, springs, and seeps should be clearly delineated on maps.

B. Aquifers should be identified and their properties characterized, including: depth to ground water; seasonal fluctuations; type (confined or unconfined); potential for local perched aquifers above regional aquifers; aquifer characteristics

(permeability, hydraulic conductivity, and transmissivity); water quality; ground-water-flow direction, gradient, and velocity; zone of mixing (nature and thickness); and recharge and discharge areas.

C. Topographic and geologic controls on the ground-water system should be described.

3. Soil Conditions

A. Soil suitability, as described in Utah Administrative Code R317-503-1, should be characterized. The soil texture, structure, and depth of each soil horizon should be logged (by depth and thickness) as described in Utah Administrative Code R317-503-3.

B. Soil horizon boundaries should be described.

C. Moist soil consistency in each horizon should be described.

D. Mottling should be identified and described.

Assessment Of Site Suitability

To show that a site is suitable for alternative wastewater disposal systems, the study must first demonstrate that conventional wastewater disposal systems cannot be used and all of the conditions listed below are met. We recommend that conditions be addressed in the order listed, and that the site be considered unsuitable and the study terminated at any point where a condition is not met.

(1) Slopes at the alternative wastewater disposal systems are less than 4 percent.

(2) There is no evidence of periodic surface-water flooding of the site. Federal Emergency Management Agency (FEMA) floodplain maps are available for some drainages. For surface-water courses shown on Federal Emergency Management Agency floodplain maps, the site must be more than 100 feet (30 m) from the stream channel and more than 25 feet (7.6 m) from any surface water within the floodway and floodway fringe.

(3) There is no evidence of seasonal shallow ground water within 2 feet (0.6 m) of the anticipated bottom of soil-absorption drain-field trenches and 1 foot (0.3 m) below the original ground surface (if the anticipated depth to ground water is 34 inches (86 cm) or less, regular measurements of water levels in a monitoring well over a 1-year period, or for the period of maximum ground-water levels as determined by the Weber-Morgan District Health Department, will be required).

(4) There is no evidence of bedrock or unsuitable soil within 4 feet (1.2 m) of the anticipated bottom of soil-absorption drain-field trenches.

(5) Moist soil consistency of any horizon is firm or stronger than firm, but the horizon is not cemented.

(6) Soil horizon texture contains a sufficiently high clay content to assure proper treatment of effluent, and the soil structure is massive or weak.

(7) Soil percolation rates are between 60 minutes/inch and 1 minute/inch (5 minutes/inch for both Ogden Canyon and Ogden Valley).

(8) Wastewater from alternative wastewater disposal systems cannot

surface or reach culinary wells or springs within 250 days ground-water time of travel based on conservative (protective) estimates of aquifer properties and ground-water flow paths.

(9) Ground-water flow available for mixing in the zone of mixing in the aquifer below the site is of sufficient quantity to prevent average nitrate concentrations from increasing more than 1 mg/L under the anticipated wastewater loading. The projected average nitrate concentration should be determined using the methods outlined in Wallace and Lowe (1998).

(10) A defendable solute transport model indicates nitrate in high-concentration zones (plumes) will not exceed 10 mg/L at any depth or location when it reaches the alternative wastewater disposal system owner's property line.

If information, such as seasonal shallow ground-water depth or aquifer transmissivity, is not available, the information must be collected or the site will be considered unsuitable. Explanations and supporting evidence from references and field observations should be provided to allow technical reviewers to evaluate reliability of data, interpretations, and conclusions.

Darcy's Law and measured or conservative (protective) estimates of aquifer properties and ground-water flow paths can be used to estimate the distance and direction wastewater could travel in 250 days. Most pathogens found in wastewater die within 250 days. The equation for ground-water seepage velocity (Fetter, 1980), assuming laminar flow, is as follows:

$$v_s = (K/n_e)(I)$$

where:

v_s = seepage velocity (length/time),
K = hydraulic conductivity (length/time),
n_e = effective porosity (dimensionless),
I = hydraulic gradient (dh/dl = length/length = dimensionless).

Measured aquifer properties should be used when possible. If not available, ranges of values for hydraulic conductivity and effective porosity are published in hydrogeology textbooks and journals, and appropriate values may be used to calculate ground-water velocity where site-specific values are unavailable. As a conservative approach, we recommend assuming an instantaneous travel time downward to the regional water table, and then using the hydraulic gradient of the aquifer for the time-of-travel calculation. Hydraulic gradients may be estimated from water levels in wells completed in the aquifer.

Similarly, ground-water flow available for mixing (not including water in effluent) can be calculated using the following equation:

$$Q=TLI$$

where:

Q= volume of water in aquifer below subdivision available for mixing (in mixing zone),
T= transmissivity (length^2/time),
L= length of flow through aquifer parallel to hydraulic gradient, and
I= hydraulic gradient (dimensionless).

REVIEW OF REPORTS

Reports that conclude a site is suitable for alternative wastewater disposal systems should undergo a technical review by a hydrogeologist and soil expert to determine if the scope of work was sufficient and if the conclusions and recommendations are valid. Prior to a technical review, the Weber-Morgan District Heath Department will perform

independent soil studies and shallow ground-water-level monitoring. Prior to technical review by a hydrogeologist and soil expert, Weber-Morgan District Health Department officials should also perform a preliminary administrative compliance review to determine if the report is complete and a technical review is necessary. The preliminary administrative compliance review should determine that the report:

(1) concludes the site is suitable;

(2) documents percolation between 1 and 60 minutes/inch (5 and 60 minutes/inch for Ogden Canyon and Ogden Valley);

(3) contains a site-location map on a topographic base at a scale of 1:24,000 or larger showing water wells, if any, in the area;

(4) contains a site map or maps on a topographic base at an appropriate scale showing the location(s) of the proposed alternative wastewater disposal system(s) and percolation-rate test pit(s);

(5) describes site geology and includes a geologic map;

(6) describes hydrologic conditions of the site; and

(7) identifies the professionals(s) performing the evaluation.

The technical review of the report will be conducted by a hydrogeologist and soil expert who are members of the Weber County Wastewater Advisory Committee.

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