Draft
Spokane County
Critical Aquifer Recharge Areas Review
Technical Memorandum #1

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Acronyms

BOD	biological oxygen demand
CARA	critical aquifer recharge area
CDEP	Connecticut Department of Environmental Protection
CWA	Clean Water Act
CWPP	Countywide Planning Policies
GIS	geographic information system
GMA	Growth Management Act
gpd	gallons per day
HDR	HDR Engineering, Inc.
MAR	Minnesota Administrative Rules
NRCS	Natural Resources Conservation Service
RAC	rural activity center
RCW	Revised Code of Washington
SCC	Spokane County Code
SRHD	Spokane Regional Health District
SVRP	Spokane Valley Rathdrum Prairie
TN	total nitrogen
TP	total phosphorus
UGA	urban growth area
UMN	University of Minnesota
U.S.C.	United States Code
USEPA	United States Environmental Protection Agency
USGS	United States Geologic Survey
WDOE	Washington Department of Ecology
WAC	Washington Administrative Code
WEF	Water Environment Foundation
WERF	Water Environment Research Foundation

Introduction

Study Objectives and Approach

The objective of this study is to review and, if necessary, recommend updates to the Critical Aquifer Recharge Area (CARA) wastewater disposal standards for non-residential uses and activities outside the Urban Growth Areas (UGA) boundary (Spokane County Code (SCC) 11.20.075). HDR Engineering, Inc. (HDR) is working with Spokane County to review the current standard and to evaluate the need for standard revisions. An important component of this project is stakeholder participation, which includes a series of meetings and document review. Stakeholder engagement is being supported by Sarah Hubbard-Gray of Hubbard Gray Consulting.

This study involves an assessment of non-residential sanitary wastewater loadings to soils (typically through septic system leach fields) that are protective of groundwater in susceptible aquifer areas outside the UGA boundary. Understanding loadings that are protective of groundwater allows for recommendations for revised standards. In addition, surface water protection associated with groundwater-to-surface water discharge will be considered in this analysis. Acceptable constituent loadings to soil that lead to loadings to groundwater are dependent upon several factors, including wastewater constituent type, soil properties, groundwater properties, surface water properties, hydraulic loadings, and attenuation factors.

To meet project objectives, the following tasks will be conducted:

a. Define area of study.
b. Define non-residential uses.
c. Define non-residential sanitary wastewater characteristics.
d. Define environmental/resource properties for the area of study.
e. Define groundwater quality criteria.
f. Analyze the aquifer mixing zone.
g. Determine soil loadings.
h. Determine sanitary wastewater loadings.
i. Develop a predictive model.
j. Recommendations and final report.

Four technical memoranda (drafts and finals) will be developed that describes the above listed tasks and findings, along with supporting documentation:

i. Technical Memorandum # 1 – Introduction of regulations and description of current standards and summary of tasks a through d (listed above).
ii. Technical Memorandum # 2 – Documentation for task e.
iii. Technical Memorandum # 3 – Documentation for tasks f through h.
iv. Technical Memorandum # 4 – Documentation for task i.

In addition, the technical memorandums will be combined into a final document with recommendations.

This document, Technical Memorandum #1, presents the following information:

- Summary of Washington State's Growth Management Act (GMA) and aquifer protection in Spokane County.
- Description of SCC Section 11.20.075 – Critical Aquifer Recharge Areas.
- Review of the current CARA standard relating to non-residential wastewater disposal.
- Definition of the study area, identification of non-residential land uses in the study area, identification of non-residential sanitary wastewater characteristics, and descriptions of available resource databases.

Background

The following sections provide background and context regarding the GMA and aquifer protection in Spokane County.

Growth Management Act (GMA)

Washington State adopted the GMA in 1990 (Chapter 36.70A Revised Code of Washington (RCW)). The GMA requires that state and local governments manage Washington's population growth by identifying and protecting critical areas and natural resource lands, designating UGA, preparing comprehensive plans and implementing them through capital investments and development regulations. The GMA requires that Washington State counties and cities experiencing significant population increases designate and protect critical areas functions and values. The GMA identifies five critical areas for protection:

- Wetlands.
- Areas with a critical recharging effect on aquifers used for potable water.
- Frequently flooded areas.
- Geologically hazardous areas.
- Fish and wildlife habitat conservation areas.

As required by the GMA, each city and County has the responsibility to identify, designate, and protect those critical areas found in their local environment.

Spokane County Aquifer Protection and Implementation of the GMA

As early as the 1970s, Spokane County recognized the importance of protecting the Spokane Valley Rathdrum Prairie (SVRP) aquifer, which underlies much of the urbanized portion of the County. This included the development of a water quality management program that culminated in the 1979 *Spokane Aquifer Water Quality Management Plan (*Spokane County 1979). The plan, which was funded under the federal Clean Water Act (CWA) Section 208 Water Quality Management program, contained recommendations aimed at mitigating specific threats to aquifer quality and mitigating pollutant loads to allow additional development without increasing the total loading of pollutants on the aquifer area.

Also during the 1970s, the federal Sole Source Aquifer Protection Program was authorized by Section 1442(d) of the Safe Drinking Water Act of 1974 (Public Law 93-523, 42 United States Code (U.S.C.) 300 et seq.). The SVRP aquifer was designated as a sole source aquifer (see **Box 1** for definition of sole source aquifer) in February 1978. The 1979 *Spokane Aquifer Water Quality Management Plan* served as the main planning document for aquifer protection in Spokane County until the enactment of the GMA.

Spokane County began planning under the GMA in 1993, after rapid population growth in the late 1980s and early 1990s made it mandatory. The Spokane County Steering Committee of Elected Officials developed the Countywide Planning Policies (CWPPs) using the GMA goals as guidelines. The primary purpose of the CWPPs was to coordinate efforts between the County and the cities within the County as each jurisdiction's comprehensive plan was developed. The Spokane County CWPPs were adopted in December 1994. An outgrowth of the CWPP was the development of the Spokane County *Critical Areas Ordinance for the Protection of Wetlands, Fish and Wildlife Habitats, Geo-hazard Areas and Critical Aquifer Recharge* Areas (implemented by SCC 11.20.010 through 11.20.090). This ordinance was first adopted in March 1996 and amended in 2003 and 2008. Section 11.20.075 – Critical Aquifer Recharge Areas, addresses protecting areas within the unincorporated areas of Spokane County important to maintaining groundwater recharge and quality. Section 11.20.075 is the focus of this current study and is further described below.

Box 1: Sole Source Aquifer - The United States Environmental Protection Agency (USEPA) defines a sole source aquifer as an aquifer that supplies at least 50 percent of the drinking water consumed in the area overlying the aquifer. These areas may have no alternative drinking water source(s) that could physically, legally, and economically supply all those who depend on the aquifer for drinking water.

Critical Aquifer Recharge Areas - SCC 11.20.075

The GMA requires Spokane County to designate areas and adopt development regulations for the purpose of protecting areas within the unincorporated areas of Spokane County critical to maintaining groundwater recharge and quality (see **Box 2** for definition of CARA). SCC 11.20.075 specifies the requirements to be enacted when regulated development within these areas is proposed to occur (see Attachment A for a copy of SCC 11.20.075). CARA goals as defined in the code are:

Box 2: Critical Aquifer Recharge Areas - Areas where there is an aquifer that is a source of drinking water that is vulnerable to contamination that would affect the potability of the water (Washington Administrative Code (WAC) 365-190-030).

1. Prevent degradation of groundwater quality in Spokane County and improve water quality of aquifers that do not meet state standards.
2. Protect groundwater quality from development impacts.
3. Secure adequate water quantity for the residents of Spokane County.
4. Provide public information programs for land users to demonstrate how to protect critical aquifer recharge areas from degradation.
5. Consistently enforce regulations, effectively monitor compliance, and provide incentives to protect critical aquifer recharge areas.
6. Regularly update critical aquifer recharge area protection measures so they are effective, enforceable, and equitable.

SCC 11.20.075 addresses all aquifers in Spokane County, not just the SVRP aquifer. **Table 1** summarizes uses and activities that are regulated under CARA (SCC 11.20.075) and describes restrictions to land uses and activities based on aquifer susceptibility ratings. The aquifer susceptibility ratings presented in **Table 1** are based on an aquifer susceptibility model developed by the County (see Attachment B – Explanation of Aquifer Susceptibility Map for a description of the modeling and the map).

This study is focused on sanitary wastewater disposal from uses and activities outside the UGA. For high and moderate aquifer susceptibility ratings (**Table 1**), there are limitations on land use that include the need to comply with the standards in SCC 11.20.075C, which are described below.

Table 1. Uses and Activities Regulated in CARA (SCC 11.20.075, Table 11.20.075B)

	Aquifer Susceptibility Rating		
Uses and Activities	**High*** **	**Moderate**	**Low**
Biosolids land application	N	L-1	L-1
Critical Material storage, handling, generating or use	L-2, L-3	L-2, L-3	L-2, L-3 **
Cultivation of land (commercial)	L-1	L-1	P
Dairy	L-1*	L-1	L-1
Feed lot	N	L-1	L-1
Feed mill	L-2	L-2	P
Floriculture (flower growing)	L-1	L-1	P
Grazing	L-1	L-1	P
Greenhouse – commercial	L-1	L-1	P
Horse boarding and training	L-1	L-1	P
Horticulture (vegetable growing)	L-1	L-1	P
Landfill, demolition, inert	N	L-6	L-6
Landfills (all others)	N	N	L-6
Large Animal raising and/or keeping	L-1	L-1	P
Mining	L-5	L-5	L-5
Nursery – wholesale	L-1	L-1	P
Orchard	L-1	L-1	P
Poultry-raising, commercial	N	L-1	L-1
Riding stable	L-1	L-1	P
Sanitary waste discharge	L-3	L-3	P
Stormwater disposal systems	L-4	L-4	L-4
Tree farming	L-1	L-1	P
Truck gardening	L-1	L-1	P
Vineyard	L-1	L-1	P

INDEX:
Uses and activities are defined in the Spokane County Zoning Code.
P = Permitted without County Review under this Ordinance
N = Not permitted
L = Limited Uses. These uses are permitted if they comply with the standards in SCC11.20.075 and the corresponding performance standards listed in SCC 11.20.075.C. L-1 = Agriculture; L-2 Critical Materials Storage, L-3 Wastewater Disposal; L-4 Stormwater Disposal; L-5 Mining; L-6 Landfill.
*A hydrogeologic study is required for this use.
**When there are low susceptibility areas hydrologically connected to moderate and high susceptibility areas, the regulations for moderate or high susceptibility areas apply. Hydrologic connection is determined by a hydrogeologic study.
***Designated wellhead protection areas and areas within a one thousand-foot radius of wells without reported plans, are additionally treated as high aquifer susceptibility areas.

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Performance Standards for Wastewater Disposal for High and Moderate CARA

SCC 11.20.075C.L-3.2 addresses sanitary wastewater management outside the UGA boundary:

a. *Nonresidential uses and activities in moderate and high susceptibility areas that produce more than 90 gallons of wastewater per acre, per day, and any Critical Material Use Activity that produces sanitary wastewater discharge, shall have a disposal system that protects the aquifer equal to or greater than one of the following:*

i. Treatment utilizing sealed lagoons;
ii. Treatment utilizing holding tanks with transport and disposal at a site licensed for disposal of the particular effluent;
iii. Treatment in compliance with a valid surface water discharge permit obtained from the Washington State Department of Ecology; or
iv. Treatment in a mechanical wastewater treatment plant that produces less than 3500 gallons per day of effluent which meets the Washington State Drinking Water Standards prior to disposal into the ground using an infiltration system or subsurface disposal system; or
v. Treatment in a mechanical wastewater treatment plant that produces more than 3500 gallons per day of effluent in compliance with a valid state waste discharge permit obtained from the Washington State Department of Ecology and meeting the Ground Water Standards, Chapter 173-200 WAC, or as amended.

b. *The evaluation of any plans submitted under RCW 90.48.110 must include consideration of opportunities for the use of reclaimed water as defined in RCW 90.46.010. Wastewater plans submitted under RCW 90.48.110 must include a statement describing how applicable reclamation and reuse elements will be coordinated as required under RCW 90.46.120(2).*

c. *Nonresidential uses and activities in low susceptibility areas that produce more than 90 gallons of wastewater per acre per day may utilize on-site disposal subject to approval by the Spokane Regional Health District or Washington State Department of Health.*

d. *Nonresidential uses and activities not involving Critical Material Use Activities and which produce less than 90 gallons of wastewater per acre, per day, may utilize on-site disposal subject to approval by the Spokane Regional Health District or Washington State Department of Health.*

e. *Residential uses with lots legally created after March 21, 2000 which requires a new onsite sewage system shall have a minimum lot size of five (5) acres per dwelling unit with the following exceptions:*

i. Lots which are part of an approved Rural Cluster Development.
ii. Non-conforming lots that complied with state and local development regulations at the time the parcel was created.
iii For Rural Activity Centers (RAC).

Current Standard Review

The following information is based on interviews conducted by HDR Engineering of current and past County staff, no written document was found regarding the development of the 90 gallons per acre per day criteria.

Prior to the development of SCC 11.20.075C in 1996, the 1979 *Spokane Aquifer Water Quality Management Plan* served as the framework for groundwater protection in the County. This framework included restricting sanitary wastewater disposal for new development outside the priority sewer service areas (similar to today's UGA boundary) in order to achieve an overall goal of no further aquifer degradation. This framework included not allowing discharge of non-residential wastewater directly to soils (drain fields) in aquifer sensitive areas.

Spokane County and the Spokane Regional Health District (SRHD) were responsible entities for the development of sanitary wastewater disposal requirements in SCC 11.20.075C. In general, the SRHD and Spokane County incorporated the findings and recommendations of the 1979 plan into the standard but included an acceptance for non-residential sanitary wastewater disposal (conventional septic system drain fields) for situations where the pollutant loads were similar to residential discharges and where there was no Critical Material Use Activity (see **Box 3** for definition). To develop a standard for non-residential sanitary discharges, the SRHD and County relied upon available information on sanitary wastewater loading rates to drain fields that were protective of sensitive aquifers. This information included rules developed by the Idaho Panhandle Health District and research studies in Wisconsin (both areas with sandy soils overlying sensitive aquifers). In general, research showed that for sandy soils on top of a sensitive aquifer, a density of one unit (residence with septic drain field) per 5-acres was protective of groundwater quality (nitrate and bacteria were the two main constituents evaluated).

Box 3: Critical Materials Use Activity - An activity or land use which has been determined to use, transport, or store a critical material. A **critical material** is a substance present in sufficient quantity that its accidental or intentional release would result in the impairment of one or more of the beneficial uses of aquifer water.

For the development of the SCC 11.20.075C.L-3.2, the following assumptions were made:

- The sanitary disposal for a non-residential land use that was not a Critical Material Use Activity would be similar to residential wastewater quality and loadings.
- For a residence, it was assumed in 1996 that the average person would use 200 gallons per day (gpd) of water and that 75 percent of that water would enter a drain field as wastewater. Thus, 150 gpd of wastewater per person would be the discharge to an on-site drain field.
- Typical household size in Spokane County in 1996 was three persons, thus the total wastewater loading to a drain field would be 450 gpd.
- Given that a density of one-unit per 5-acres (as described above) is protective of groundwater, it follows that:

$$450 \text{ gpd}/5 \text{ acres} = 90 \text{ gpd per acre.}$$

Thus, 90 gpd per acre is based on the protection of groundwater, based on preventing the overloading of nitrates and bacteria onto sandy or coarse soils, using residential wastewater loading assumptions.

Define Area of Study

One of the listed goals of the CARA standard is to “regularly update the CARA protection measures so they are effective, enforceable, and equitable” (SCC 11.20.075). This study will review and make recommendations for updates, as necessary, of the current CARA wastewater disposal standards for non-residential uses and activities outside the UGS boundary. Thus, the area of study is defined as non-residential areas that are within CARA (low, medium, and high susceptible areas), and outside the UGA boundary. Attachment C presents a study area map that illustrates the CARA, UGA, and Spokane County boundary.

Define Non-residential Uses

The Critical Areas Ordinance does not define "non-residential" nor is there a definition in the Comprehensive Plan. However, the ordinance does define residential development as (SCC 11.20.010):

Only single-family, two-family, multi-family, manufactured and mobile home, community residential facility, community treatment facility, dormitory, fraternity and sorority, as defined in the Spokane County Zoning Code, or as amended.

Thus, non-residential is interpreted to be any land use that does not meet the above definition of residential development. **Table 2** summarizes the types of non-residential land uses identified outside the UGA boundary in Spokane County. Attachment C contains a map that illustrates areas of non-residential land use outside the UGA and also contains a spreadsheet that lists each non-residential land use type, its corresponding CARA susceptibility rating, and number of parcels associated with that rating.

Table 2.Types of Non-residential Land Uses Outside the UGA Boundary

Land Use[1]
Agricultural – commercial
Churches
Commercial
Communication
Education
Hotel/Condo
Manufacturing – chemical
Manufacturing – petroleum
Manufacturing – stone/glass
Manufacturing – others
Mining – sand and gravel
Public assembly
Recreation
Resort camping
Retail – auto
Retail – eating
Retail – food
Retail – general merchandise
Retail – hardware
Retail 0ther
Service – construction
Service – education
Service – finance
Service – governmental
Service – professional
Service – miscellaneous
Service - repair
Timber
Transportation – aircraft
Transportation – motor
Transportation – railroad
Utilities
Wholesale

[1] See Attachment C for spreadsheet listing CARA susceptibility and number of parcels for each non-residential land use type.

Define Non-residential Sanitary Wastewater Characteristics.

To assess potential impacts to groundwater from non-residential sanitary wastewater disposal an understanding of typical non-residential wastewater quantity and biological and chemical characteristics is needed. Much of the available literature about on-site wastewater flow and characteristics is for residential sanitary wastewater (Metcalf and Eddy 2003; Crites and Tchobanoglous 1998; USEPA 1980 and 2002; and, Water Environmental Federation (WEF) Manual of Practice (year unknown); Water Environment Research Foundation (WERF) 2009 and 2008). Identifying the range of non-residential land uses and wastewater quantity and quality for effluent from on-site treatment systems is far more challenging (Seabloom, et.al, 2005).

Furthermore, it is important to distinguish the type of wastewater data available, where *influent* wastewater is sewage that is generated on-site prior to entering the on-site treatment system, *effluent* wastewater is sewage after treatment (e.g. discharge from a septic tank) but prior to entering a drain field, and *leachate* is water that percolates from the drain pipes into the soil (**Figure 1**).

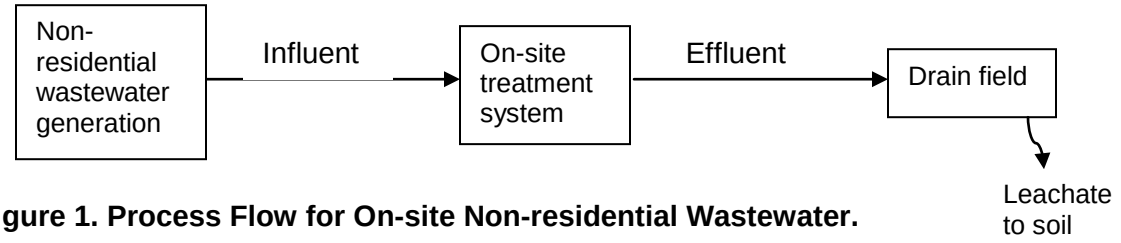

Figure 1. Process Flow for On-site Non-residential Wastewater.

Given the absence of, or incomplete information on non-residential systems, some translations of characteristics from residential systems may be necessary and is reasonable if the similarities between the residential and non-residential usages are understood.

For Spokane County, a wide variety of services (e.g., schools), retail (e.g., restaurants), and manufacturing (e.g., agri-chemical) sites fall into the non-residential wastewater category. Wastewater generating activities in some non-residential establishments are similar to those of residential dwellings. For example, a retail store may have restrooms, a small kitchen, and employee showers and would generate similar wastewater characteristics as a dwelling. A restaurant would generate a waste stream dominated by dishwashing activities and food waste and would have a waste stream of greater volumes and solids loading then a typical single-family dwelling. A church's waste stream would be expected to generate low solids loading (dominated by urine) compared to a typical residential waste stream. In some cases, non-residential wastewater characteristics can lead to higher strength wastewater to the septic systems that are also outside the treatment capacities of conventional on-site systems (Snowden 2012).

Table 2 and Attachment C presents a summary of current non-residential land uses outside the UGA. Common non-residential facilities include office/commercial/service buildings, churches, retail, and restaurants. Some wastewater characteristic data for these types of non-residential

facilities are identified in the literature (Metcalf and Eddy, 2003; MAR, 2012/UMN, 2012; Smith and Loveless, 1962; Goldstein and Moberg, 1973; CDEP 2006) and are summarized in **Tables D-1** through **D-3** in Attachment D. **Table D-1** summarizes sanitary wastewater flow rates (typical, low, and high) for a range of non-residential facilities and **Table D-2** presents a range of Biological Oxygen Demand (BOD) concentrations for such facilities. **Table D-3** presents a range of mass and concentration ranges (low and high) for a number of selected constituents found in sanitary wastewater. The data presented in these three tables are for wastewater generation (influent wastewater).

In addition to these three tables based on a literature search, the Washington State *Criteria for Sewage Works Design* (Orange Book) contains design criteria information that includes wastewater generation for some non-residential uses (WDOE 2008). Table G2-2 of the Orange Book provides information on flow, BOD, suspended solids, and flow duration for a number of non-residential uses. A copy of Table G2-2 is presented in Attachment D. This information is for influent wastewater.

In the document *Guidance for Design of Large-Scale On-Site Wastewater Renovation Systems*, the Connecticut Department of Environmental Protection (CDEP) provides a discussion of commercial and institutional wastewater characteristics and compares the biological strength (measured as BOD) of various non-residential uses compared to residential uses (CDEP 2006). The guidance provides a comprehensive literature review of effluent wastewater characteristics (BOD, total suspended solids, fats-oil-grease, total nitrogen, and total phosphorus) for food processing, food serving establishments, commercial businesses, and institutional facilities. Pertinent summary tables (**Tables D-4** through **D-7**) from the CDEP document are presented in Attachment D. These tables present effluent wastewater data and are based on standard septic tank treatment. Thus, this data is pertinent in assessing wastewater effluent quality entering a drain field.

Table 3 presents an example of effluent wastewater characteristics for BOD, total nitrogen (TN), and total phosphorus (TP) for select residential and selected non-residential land uses (see Attachment D **Tables D-4** through **D-7** for data sources). The data demonstrates that there are differences in effluent wastewater characteristics based on land use. For example, middle and high schools have a higher total nitrogen average concentration (104 mg/L) compared to residential, restaurants, and supermarkets (41 to 88 mg/L). The data in this table also illustrates the high range of values presented in the literature for these constituents and need to review this data (specific literature citations) for applicability to Spokane County.

Table 3. Example of Septic Tank Effluent Concentrations for Residential and Non-Residential Land Uses

	BOD_5, (mg/L)			TN (mg/L)			TP (mg/L)		
Type[1]	**Min.**	**Mean**	**Max.**	**Min.**	**Mean**	**Max.**	**Min.**	**Mean**	**Max.**
Residential	13	184	1,211	10	51	330	3	9	48
Restaurant	53	909	1,216	n/a	41	n/a	n/a	8	n/a
Mid & High Schools	70	179	599	80	104	141	3	12	18
Supermarket	164	500	883	39	88	189	n/a	29	n/a

[1]Source: CDEP 2006 (see Attachment D Tables D-4 through D-7). Data are presented to illustrate the range of values for each land use type and within each type, see Attachment D for details and specific literature citations.

Define Environmental / Resource Properties for Area of Study

The following geographic information system (GIS) database (layers) are available in various, limited areas of the County to support this study:

- Soil series classification, soil texture, soil depth, soil restrictive layer, soil hydrologic group, soil type (as defined by Spokane County Rules and Regulations for On-Site Sewage System), and soil permeability – Source: Natural Resource Conservation Service (NRCS).
- Vadose zone geology based on well logs – Source: Washington Department of Ecology (WDOE).
- Depth to groundwater – Source: WDOE (well logs) and Spokane County GIS
- Aquifer identification – Source: United States Geologic Survey (USGS) and Spokane County.
- Aquifer gradient - Source: USGS and Spokane County.
- Aquifer flow direction – Source: USGS and Spokane County.
- Aquifer thickness – Source: USGS and Spokane County.
- Aquifer hydraulic conductivity – Source: USGS and Spokane County.
- Surface water distance – Source: Spokane County.
- Groundwater quality for key constituents – Source: Spokane County.
- Aquifer/surface water discharge - Source: USGS and Spokane County.

Next Steps

The objective of Technical Memorandum #1 was to introduce the regulatory framework of the Spokane County CARA standard (SCC 11.20.075), including the rationale of the current non-residential wastewater disposal requirements. In addition, information on study area boundaries and non-residential wastewater characteristics were presented. A draft of this technical memorandum will be presented to the CARA Review Committee for input. In addition, the project team will meet with the committee to discuss the technical memorandum and to discuss future study activities. The information presented in this memorandum, as well as input provided by the committee, will be used to support an evaluation of non-residential sanitary wastewater constituent loadings to soils that are protective of groundwater in CARA outside the UGA.

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Attachment A – Spokane County Code 11.20.075 – Critical Aquifer Recharge Areas

Spokane County, Washington

Critical Areas Ordinance

for the Protection of Wetlands, Fish and Wildlife Habitats, Geo-hazard Areas and Critical Aquifer Recharge Areas

Contact Planning by:

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This ordinance may be purchased at the above address for a nominal fee. This ordinance is also available at the above Web Site.

Published June 2008
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SPOKANE COUNTY

Critical Aquifer

Section 11.20.075

11.20.075 - Critical Aquifer Recharge Areas

The Growth Management Act requires Spokane County to designate areas and adopt development regulations for the purpose of protecting areas within the unincorporated areas of Spokane County critical to maintaining ground water recharge and quality. This section specifies the requirements to be enacted when regulated development within these areas is proposed to occur. This section applies to any person, firm, or corporation, which establishes or proposes to establish new, expanded, enlarged or different land use or activity identified in Table 11.20.075B, or a use or activity determined by the Director, in consultation with the Utilities Director or the Hearing Examiner as subject to the intent and purpose of this section, within a designated Critical Aquifer Recharge Area~~s~~ in the unincorporated areas of Spokane County.

The following Critical Aquifer Recharge Area goals are consistent with the Spokane County Comprehensive Plan, Natural Environment Element, or as amended.

Critical Aquifer Recharge Area Goals

1. Prevent degradation of groundwater quality in Spokane County and improve water quality of aquifers that do not meet state standards.

2. Protect groundwater quality from development impacts.

3. Secure adequate water quantity for the residents of Spokane County.

4. Provide public information programs for land users to demonstrate how to protect critical aquifer recharge areas from degradation.

5. Consistently enforce regulations, effectively monitor compliance and provide incentives to protect critical aquifer recharge areas.

6. Regularly update critical aquifer recharge area protection measures so they are effective, enforceable and equitable.

A. Designation and Rating

1. Critical Aquifer Recharge Areas are those areas with a critical recharging effect on aquifers used for potable water as defined by WAC 365-190-030(2). Critical Aquifer Recharge Areas have prevailing geologic conditions associated with infiltration rates that create a high potential for contamination of ground water resources or contribute significantly to the replenishment of ground water.

2. Aquifer recharge areas are rated as having a high, moderate, or low susceptibility based on a scientific analysis of soils, hydraulic conductivity (the ease with which water moves between the surface and aquifers), annual rainfall, the depth to aquifers, the importance of the material between soils and aquifers (Vadose zone), and wellhead protection information. See Appendix N for an explanation of the Aquifer Susceptibility Map.

3. If a parcel lies within two or more susceptibility rating designations, the higher susceptibility rating designation shall apply to the whole parcel.

4. Designated wellhead protection areas~~,~~ and areas within a 1,000-foot radius of wells without reported plans, are additionally treated as high-susceptibility areas. As wellhead protection

plans are completed for wells, the 1,000–foot radius placeholder will be replaced by the Washington State Department of Health-certified wellhead protection area.

B. Uses and Activities Regulated in Critical Aquifer Recharge Areas

Table 11.20.075B establishes the following uses and activities regulated by the requirements of this section. The Director, in consultation with the Utilities Director or the Hearing Examiner may determine that other uses or activities are also subject to the intent and purpose of this section. This table should be interpreted with the corresponding performance standards set forth in section 11.20.075C.

TABLE 11.20.075B

Uses and Activities regulated in Critical Aquifer Recharge Areas	**Aquifer Susceptibility Rating** (See Aquifer Susceptibility Map)		
	High* **	**Moderate**	**Low**
Biosolids land application	**N**	**L-1**	**L-1**
Critical Material storage, handling, generating or use	**L-2, L-3**	**L-2, L-3**	**L-2, L-3 ** **
Cultivation of land (commercial)	**L-1**	**L-1**	**P**
Dairy	**L-1***	**L-1**	**L-1**
Feed lot	**N**	**L-1**	**L-1**
Feed mill	**L-2**	**L-2**	**P**
Floriculture (flower growing)	**L-1**	**L-1**	**P**
Grazing	**L-1**	**L-1**	**P**
Greenhouse - commercial	**L-1**	**L-1**	**P**
Horse boarding and training	**L-1**	**L-1**	**P**
Horticulture (vegetable growing)	**L-1**	**L-1**	**P**
Landfill, demolition, inert	**N**	**L-6**	**L-6**
Landfills (all others)	**N**	**N**	**L-6**
Large Animal raising and/or keeping	**L-1**	**L-1**	**P**
Mining	**L-5**	**L-5**	**L-5**
Nursery - wholesale	**L-1**	**L-1**	**P**
Orchard	**L-1**	**L-1**	**P**
Poultry-raising, commercial	**N**	**L-1**	**L-1**
Riding stable	**L-1**	**L-1**	**P**
Sanitary waste discharge	**L-3**	**L-3**	**P**
Stormwater disposal systems	**L-4**	**L-4**	**L-4**
Tree farming	**L-1**	**L-1**	**P**
Truck gardening	**L-1**	**L-1**	**P**
Vineyard	**L-1**	**L-1**	**P**

INDEX:
Uses and activities are defined in the Spokane County Zoning Code**.**
P = Permitted without County Review under this Ordinance
N = Not permitted
L = Limited Uses. These uses are permitted if they comply with the standards of this Ordinance and the corresponding performance standards listed in section 11.20.075C.
*A hydrogeologic study is required for this use.
**When there are low susceptibility areas hydrologically connected to moderate and high susceptibility areas, the regulations for moderate or high susceptibility areas apply. Hydrologic connection is determined by a hydrogeologic study.
***Designated wellhead protection areas and areas within a 1,000-foot radius of wells without reported plans, are additionally treated as high aquifer susceptibility areas.

C. Performance Standards for Uses and Activities in Critical Aquifer Recharge Areas

The following are the performance standards applicable to the uses and activities listed in Table 11.20.075B, or a use or activity determined by the Director, in consultation with the Utilities Director

or the Hearing Examiner as subject to the intent and purpose of this section. The uses and activities are defined in the Spokane County Zoning Code.

L-1 Agriculture:

1. Agricultural practices that impact critical aquifer recharge areas shall be mitigated by having a conservation plan prepared and the subject property shall be required to comply with approved land management and/or conservation practices that protect groundwater, as set forth in the United States Department of Agriculture Natural Resource Conservation Service (NRCS) Technical Guides, and all local, state and federal regulations and their amendments governing agricultural practices. The NRCS Technical Guide is available at the local field office of the Natural Resource Conservation Service.

2. Agricultural practices that are accessory to a primary residential use, including animal raising and/or keeping, and that exist for the personal enjoyment of the property resident, shall be exempt, and this subsection shall be advisory only as to those accessory agricultural practices.

L-2 Critical Materials Storage, Handling, Generating or Use:

Critical materials subject to the following performance standards are set forth in the Critical Materials List adopted and amended pursuant to Chapter 3.15, or as amended, of the Spokane County Code.

1. All facilities related to the use of critical materials shall be designed so that:

   a. Any spilled or leaked critical materials are contained on site;

   b. Any spilled or leaked critical materials cannot infiltrate into the ground; and

   c. No disposal of any waste containing critical materials shall be allowed on site.

2. Stormwater draining facilities in areas where critical material spills could occur shall be designed so that:

   a. Mingling of stormwater and spilled critical materials is prevented; and

   b. Spill cleanup procedures are enhanced.

3. Underground storage tanks used for containing critical material shall be installed and maintained according to the provisions in Chapter 3.15 of the Spokane County Code.

a. Surface or subsurface disposal of a critical material is prohibited.

L-3 Wastewater Disposal shall be consistent with the Spokane County Comprehensive Plan, Capital Facilities and Utilities Element goals and policies for sanitary sewer systems together with the following standards:

1. Performance standards applicable to all unincorporated areas.

Critical Material Use Activities that produce a process waste instead of or in addition to sanitary waste shall utilize one of the following methods for waste management and disposal:

a. Separate waste disposal systems shall be provided so those sanitary and process wastes are handled separately. The process waste shall be disposed of by collection in sealed holding tanks and shall be transported and disposed of at a site licensed for disposal of this effluent. An agreement to dispose of process waste under this section shall be recorded in the Spokane County Auditor's office and shall not be removed without approval by Spokane County.

b. Sanitary and/or process waste waters shall be managed in compliance with a valid authorization from a Publicly Owned Treatment Works (POTW), which shall include any required pretreatment or monitoring;

c. Sanitary and/or process wastewaters shall be managed in compliance with a valid surface water discharge permit, which is obtained from the Washington State Department of Ecology.

2. Performance standards for new development located outside of the Urban Growth Area Boundary.

a. Nonresidential uses and activities in moderate and high susceptibility areas that produce more than 90 gallons of wastewater per acre~~,~~ per day, and any Critical Material Use Activity that produces sanitary wastewater discharge, shall have a disposal system that protects the aquifer equal to or greater than one of the following:

i. Treatment utilizing sealed lagoons;
ii. Treatment utilizing holding tanks with transport and disposal at a site licensed for disposal of the particular effluent;
iii. Treatment in compliance with a valid surface water discharge permit obtained from the Washington State Department of Ecology; or
iv. Treatment in a mechanical wastewater treatment plant that produces less than 3500 gallons per day of effluent which meets the Washington State Drinking Water Standards prior to disposal into the ground using an infiltration system or subsurface disposal system; or
v. Treatment in a mechanical wastewater treatment plant that produces more than 3500 gallons per day of effluent in compliance with a valid state waste discharge permit obtained from the Washington State Department of Ecology and meeting the Ground Water Standards, Chapter 173-200 WAC, or as amended.

b. The evaluation of any plans submitted under RCW 90.48.110 must include consideration of opportunities for the use of reclaimed water as defined in RCW 90.46.010. Wastewater plans submitted under RCW 90.48.110 must include a statement describing how applicable reclamation and reuse elements will be coordinated as required under RCW 90.46.120(2).

c. Nonresidential uses and activities in low susceptibility areas that produce more than 90 gallons of wastewater per acre per day may utilize on-site disposal subject to approval by the Spokane Regional Health District or Washington State Department of Health.

d. Nonresidential uses and activities not involving Critical Material Use Activities and which produce less than 90 gallons of wastewater per acre~~,~~ per day, may utilize on-site disposal subject to approval by the Spokane Regional Health District or Washington State Department of Health.

e. Residential uses with lots legally created after March 21, 2000 which requires a new on-site sewage system shall have a minimum lot size of five (5) acres per dwelling unit with the following exceptions.

i. Lots which are part of an approved Rural Cluster Development.
ii. Non-conforming lots that complied with state and local development regulations at the time the parcel was created.
iii. For Rural Activity Centers (RAC).

3. Performance standards for new development located inside of the Urban Growth Area Boundary.

a. Public sewer services consistent with the adopted Levels of Service and concurrency requirements set forth in the Spokane County Comprehensive Plan and the Spokane County Zoning Code, or as amended, are required for all new residential and nonresidential uses.

L-4 Stormwater disposal shall be consistent with the Spokane County Comprehensive Plan, Capital Facilities and Utilities Element goals and policies for stormwater together with the following standards:

1. Within the unincorporated areas of the Liberty Lake Sewer District, stormwater management policies of Spokane County and the Liberty Lake Sewer District shall apply.

2. Development shall provide for the treatment of stormwater run-off from impervious surfaces in a manner consistent with Chapter 9.14 of the Spokane County Code, or as amended, and adopted Stormwater Control Ordinances, or as amended.

3. Direct injection wells without an associated drainage swale or drainage swale system for stormwater disposal within special protection zones of wellhead protections areas are prohibited.

L-5 Mining

Mining shall be subject to the standards of the Mining Zone (M), Chapter 14.636 of the Spokane County Zoning Code, or as amended. For subsequent uses of mining sites, the performance

standards for the next-higher category of aquifer susceptibility shall apply using the site's pre-mining susceptibility rating as the base standard

L-6 Landfill

All landfills shall comply with Chapters 173-350 and 173-351 WAC and shall be approved by the Spokane Regional Health District and the Washington State Department of Ecology.

D. Procedures for Hydrogeologic Report/ Study

When a use or activity identified in Table 11.20.075B is proposed, or a use or activity determined by the Director in consultation with the Utilities Director or the Hearing Examiner as subject to the intent and purpose of this section, it shall be subject to the following:

1. The property shall be reviewed for susceptibility of the aquifer and whether mitigation measures for ground water protection are required. The Aquifer Susceptibility Map serves as the first level for review. Section 11.20.075C establishes the minimum mitigation required.

2. The Utilities Director or the Hearing Examiner may require an applicant to submit a Hydrogeologic Report if:

a. There is insufficient groundwater information to perform an adequate review to assure aquifer protection; or

b. There is evidence of groundwater degradation, or known groundwater contamination in the vicinity of a proposed project, and the project could influence or be influenced by the water quality degradation (for example, the identified quality degradation may render the proposed water source unusable or the proposed project may add to existing quality degradation and may render some other users' water source unusable).

An applicant may also voluntarily submit a site-specific Hydrogeologic Report to evaluate the aquifer susceptibility to contamination from a project site.

3. The Utilities Director, in consultation with agencies of expertise, shall review and accept or reject the Hydrogeologic Report.

4. The Utilities Director or Hearing Examiner may approve or deny a proposed project based on the information in the Hydrogeologic Report, or the Utilities Director may adjust the aquifer susceptibility rating of the site and apply appropriate mitigation measures provided for in section 11.20.075C.

5. A Hydrogeologic Report may recommend alternative mitigation measures that the Utilities Director or Hearing Examiner may approve, provided the measures give equal or greater protection to the aquifer.

6. A qualified geologist, as defined in this Ordinance, shall prepare the Hydrogeologic Report. The report shall include, but is not limited to, the following information.

a. A site location map that depicts the site and land parcels within 1,000 feet of the site. The map shall include roads, topography, existing and proposed structures and shall identify land uses within 1,000 feet of the boundaries of the site.

b. Geologic setting, including well logs and other well information for wells within 1,000 feet of the boundaries of the site.

c. Any current available data on any springs or seeps within 1,000 feet of the boundaries of the site.

d. Background water quality data.

e. Water source/supply to facility.

f. Any sampling schedules necessary.

g. Depth/location of any perched water tables or geological features that could form perched water tables if recharge is increased.

h. Groundwater flow direction and gradient.

i. An analysis of aquifer susceptibility to include:

- **i.** Soil types (from the Natural Resources Conservation Service Soil Survey of Spokane County;
- **ii.** Hydraulic conductivity;
- **iii.** Annual recharge (based on estimate of monthly precipitation at the site and an appropriate recharge model).
- **iv.** Depth to water (the depth to the water-bearing zone, not the potentiometric surface);
- **v.** Importance of the Vadose Zone based on the geology above the aquifer;
- **vi.** Discussion of the effects of the proposed project on groundwater resources;
- **vii.** Discussion of potential mitigation measures if the proposed project should have an adverse impact on groundwater resources; and
- **viii.** Other information as required by the Utilities Director or Hearing Examiner in consultation with other agencies of expertise.

7. An applicant may elect to meet the appropriate performance standards in lieu of preparing a Hydrogeologic Report if the Utilities Director or Hearing Examiner finds the performance standards provide adequate aquifer protection.

E. Monitoring and Reporting

1. The Utilities Director, Building and Planning Director, or the Hearing Examiner may require a monitoring program as a condition of approval to document compliance with permit conditions and to determine whether the project contributes to water quality degradation.

2. Monitoring shall be by a qualified individual as determined by the County, and shall be paid for by the applicant.

3. The Building and Planning Department shall periodically review monitoring programs to determine compliance with conditions of approval in cooperation with the Division of Utilities, Spokane Regional Health District, Spokane Aquifer Joint Board and other agencies responsible for aquifer protection.

4. For critical material users, the Hearing Examiner or the Building and Planning Director shall establish a periodic inspection program to determine compliance with permit requirements and the provisions of this section.

Attachment B – Explanation of Aquifer Susceptibility Map

11.20.090N

APPENDIX N

Explanation of
Aquifer Susceptibility Map

A method for assessing ground water susceptibility in Spokane County

A. Introduction

In the language of water resources management the term vulnerability describes the potential risk for the contamination of an aquifer. Vulnerability depends on two factors: aquifer susceptibility (the level of ground water protection provided by the natural environment) and the pollution potential (land use activities above the aquifer). This document describes the development and application of a susceptibility model for Spokane County.

The SHADI ground water susceptibility model is based on the same general approach as the DRASTIC model. DRASTIC is a model developed by the National Water Well Association in cooperation with the U.S. EPA (Aller, L., *et al*, 1987). DRASTIC has been used in its original and modified form in most areas of the United States (Swanson, R., 1994; Palmquist, R., 1991). The SHADI modification developed for use in Spokane County uses the following five environmental characteristics to assess susceptibility:

Soil Media
Hydraulic Conductivity
Annual Recharge
Depth to Ground Water
Importance of the Vadose Zone

To use the SHADI model data, each of the five characteristics must be mapped at a common level of resolution. Collecting the required data is a time consuming process if summary data in map or tabular form is not available for the characteristics. For the Spokane County simplifying the model to five elements greatly reduces the work required to develop the model without losing the ability to resolve differences in susceptibility. These five characteristics reflect essentially the same range of variability that the seven DRASTIC characters would reflect when applied to Spokane County.

The result of applying the SHADI model is a set of "susceptibility ratings," usually presented in map form, for discrete geographic units in the study area. The following relationship is used to calculate the final susceptibility value:

Aquifer Susceptibility = $(S \times W_s) + (H \times W_h) + (A \times W_a) + (D \times I)$

Where S, H, A, D, and I are described above and W_s, W_h, and W_a are weighting factors to bring the relative importance of soil, hydraulic conductivity and annual recharge into balance with the depth to water – vadose zone term. Both the ranking values and weighting values used in SHADI are consistent with those used in DRASTIC.

Aquifer susceptibility using methods like SHADI can be applied "manually" by mapping the various characteristics on tissue paper, overlaying the maps of the characteristics, tracing the boundaries of areas with a unique set of characteristics and manually totaling the ratings for each area. However, this process is easily accomplished using Geographic Information System computer software. The

SHADI data sets for Spokane County will be developed in a format that will allow the automated delineation of "unique area" boundaries and the totaling of the final susceptibility rating for those areas. Like DRASTIC, SHADI is intended to establish the relative risk to contamination that exists for aquifers examined using a consistent database. The model results from one "study" should not be compared with those from another. Similarly, once a study area has been defined it should be treated as a whole. Breaking a study area into subsets requires a reassessment of the ratings applied.

B. Explanation of Ratings shown on SHADI Map Layers

1. **Soil Media.** For most purposes, soil is considered to be that part of the earth's surface in which plants grow. The soil layer extends from the land surfaces to the bottom of the root zone – the depth to which plant roots extend. The soil zone is characterized by high biological activity. In a semi-arid climate like that around Spokane a root zone of 5 to 6 feet is common.

   For most contaminant discharges within an aquifer recharge area the soil is the first line of defense against contamination. Many of the biochemical actions that take place in the soil can destroy potentially harmful wastes, result in their removal by plants or lead to their being bound up as part of the soil matrix. Most of these processes depend on the amount of clay, silt and organic material in the soil. High levels of one or more of these components lead to better ground water protection.

   Table 1 provides a summary of the SHADI ratings for the soil types common in Spokane County.

Table 1. SHADI Ratings for Soil Type	
Soil Type	SHADI Rating
Silty Loam	3
Sandy	6
Rocky/Gravelly	9
Weighting factor: 2	

2. **Hydraulic Conductivity.** Hydraulic conductivity refers to the ease with which water moves through the aquifer media. This is dependent on the amount of interconnected void space in the aquifer. Loose sand and gravel or highly fractured rock have the highest hydraulic conductivity.
   Aquifers with high hydraulic conductivity more easily disperse contaminants away from the point where they enter the ground water.

   Table 2 provides a summary of the SHADI ratings for the hydraulic conductivity of the common aquifer types found in Spokane County.

Table 2. SHADI Ratings for Hydraulic Conductivity	
Hydraulic Conductivity - feet/sec	SHADI Rating
High > 0.025	10
Medium High 0.001 - 0.025	8
Medium 0.00025 - 0.001	6
Medium Low 0.00001 - 0.00025	4
Low < 0.00001	2
Weighting factor: 6	

3. **Annual Recharge.** The amount of water recharged to an aquifer is an important element in assessing ground water susceptibility because it is the recharge water that carries contaminants to the ground water. In general, the greater the amount of recharge, the greater the potential impact. Because precipitation, as with all climatic characteristics, varies greatly from year to year, annual recharge also varies greatly. For long term planning purposes using "average" values for precipitation to calculate recharge should produce good results for tracking potential ground water impacts and estimating the amount of water available for use. However, recharge levels at both extremes can skew the overall impact. Extremely high recharge may dilute the concentration of contaminants to below the background levels in ground water. Conversely, extremely low recharge over a period of time may result in the accumulation of contaminants in the soil. A normal or above normal recharge period could then flush these contaminants into ground water in a short period of time.

   The susceptibility rating values associated with various levels of recharge found in Spokane County are summarized in Table 3.

Table 3. SHADI Ratings for Annual Recharge	
Annual Recharge - inches	SHADI Rating
2-4	3
4-7	6
7-10	8
10 +	8
Weighting factor: 4	

4. **Depth to Water.** Depth to water is important in establishing the susceptibility of an aquifer because it determines the thickness of the material through which contaminated water must travel before it reaches ground water. In general the more material contaminated water moves through the greater the probability that some or all of the contaminants will be removed. A number of physical (e.g. filtration of suspended solids), chemical (e.g. precipitation of phosphorus) and biological (bacterial break down of organic chemicals into CO_2 and water) may affect the contaminants in recharge water. In addition to the amount of material that the water must pass, deeper water tables usually mean longer travel times. The longer the travel time, the greater the opportunity for contaminant removal.

   Table 4 provides a summary of the SHADI ratings for the several depth to water ranges found in Spokane County.

Table 4. SHADI Ratings for Depth to Water	
Depth to Water - feet	SHADI Rating
0 - 15	10
15 - 50	8
50 - 100	6
100 +	4
Weighting factor: *Importance of the Vadose Zone*	

5. **Importance of the Vadose Zone.** The vadose zone is the unsaturated zone between the bottom of the root zone and the water table. As a rule the vadose zone is composed of material similar to that found in the soil or that which contains the aquifer. Because it is below the root zone there is

little biological activity under ordinary conditions, so while the vadose zone is important for some of the same reasons a soil is likely to be less effective than soil. As indicated above, the finer the material the better the vadose zone is at removing contaminants. Where the vadose zone is composed of "solid" rock, the size of cracks and fractures and the complexity of the fracture zone determine the contaminant removal ability.

The main difference between SHADI and DRASTIC lies in how the nature of the material in the vadose zone is accounted for in the model. Not all materials have the same ability to retain contaminants or facilitate their decomposition; silty materials will retain more water and hold it longer than coarse gravel. The larger surface area exposed by finer materials usually increases the amount of contaminants that can be removed. In SHADI the Importance of the Vadose Zone is used as a "weighting factor" for Depth to Water. Under this scheme a thick layer of coarse material may be a poorer buffer to contamination than a thin layer of finer soil

Where there are "confining layers" between the land surface and the water table these zones increase the removal of contaminants by providing longer travel times and providing a zone of fine material that increases contaminant removal.

Table 5 provides a summary of the SHADI ratings for the vadose zone materials common in Spokane County.

Table 5. SHADI Ratings for Importance of the Vadose Zone

Material	SHADI Rating*
Clay and Metasedimentary rock	2
Silt and Crystalline rock	4
Weathered basalt	6
Sand	8
Flood gravels	10
Weighting factor: *Depth to Water*	

**Subtract 1 for each confining layer up to 2.*

C. Results from the application of SHADI

The product of the analysis of ground water susceptibility using SHADI is a set of six maps. Maps one through five depict the characteristics of the environment considered by SHADI. Map six is the susceptibility rating itself. Maps one through five are based on 1) existing mapped data, 2) interpretation of well drillers' logs and 3) a combination of the above.

Soil and Annual Recharge are taken from the mapping contained in the Spokane County Soil Survey (Donaldson and Giese, 1968) and annual precipitation maps prepared by the National Weather Service (NOAA, 1990). These maps probably represent the range of resolution for the mapping. The Soil Survey maps show variations in soil type for parcels as small as five acres. Annual precipitation at any given point in Spokane County varies greatly from year to year. The precipitation map, and therefore the annual recharge map, cannot show this variation. The areas of equal annual recharge can move a mile to the east or west from year to year. The resolution of the annual recharge map is good in the center of the ranges and poor at the edges. This means that the resolution of this factor ranges from 640 acres to 2560 acres.

Hydraulic Conductivity is derived from tests on individual wells penetrating the various ground water bearing formations. The distribution of Hydraulic Conductivity in the various ground water units is based on both the individual well information and the existing geology maps, which delineate the areas in which aquifers with similar characteristics might be found. Given the level of detail in the geology maps, the amount of individual well data used and the range of values for hydraulic conductivity employed in SHADI the resolution of this mapping is estimated to be about 160 acres.

Depth to Water for most of the urbanizing area of the county is derived from special studies that show considerable detail. The resolution of this characteristic for these areas is about 40 acres. For the rest of the county the information for Depth to Water was derived in the same manner as Hydraulic Conductivity and thus has a resolution of about 160 acres.

Importance of the Vadose Zone is based on a recently completed geologic map of Spokane County (Johnson, 1997). The resolution of this map is about 40 acres.

The Geographic Information System (GIS) used a GRID process to calculate the susceptibility rating. The grid process divides the 5 source maps into squares that are the same size and positions throughout the whole county. The values (rate times weight) of the stacked squares in all 5 layers are added together for the final susceptibility rating. The GRID process was programmed to use squares 300 feet on a side (2.1 acres). SHADI rating areas less than 40 acres in size were combined with adjacent areas to create the final SHADI rating map.

D. SHADI Rating Map revised to create Aquifer Susceptibility Map

The SHADI rating map was revised to create the Aquifer Susceptibility Map by adding additional areas to coordinate wellhead protection throughout Spokane County. The Washington State Department of Health provided the data for wellhead protection coordination based on site specific (well specific) determination of susceptibility of contamination to wells. The data includes designated wellhead protection areas and areas within 1000-foot radius of Group A community and Group A community transient wells without reported plans. As wellhead protection plans are completed for wells, the 1,000-foot radius placeholder will be replaced by the Washington Department of Health-certified wellhead protection area. These areas are treated as high aquifer susceptibility areas. It is the intent of the Aquifer Susceptibility Map to coordinate the wellhead protection program with protection of critical aquifer recharge areas. Uses and activities within designated wellhead protection areas subject to critical aquifer recharge area regulations are required to meet the standards for high aquifer susceptibility. However, applicants have the opportunity to provide evidence to support a low or medium aquifer susceptibility rating by means of a hydrogeologic report. The Spokane County Director of Utilities, in consultation with agencies of expertise, shall review and accept or reject the hydrogeologic report.

The Aquifer Susceptibility Map will be revised as required to display updated date on wellhead protection areas received from the Washington State Department of Health. The Aquifer Susceptibility Map is available from the Spokane County Building and Planning and the Spokane County Division of Utilities.

11.20.090O

Appendix O

Critical Areas Ordinance MAPS,
or as amended

Wetlands Map

Fish and Wildlife Habitat Map

Geo-hazard Map

Critical Aquifer Recharge Areas Map

DNR Water Types Map

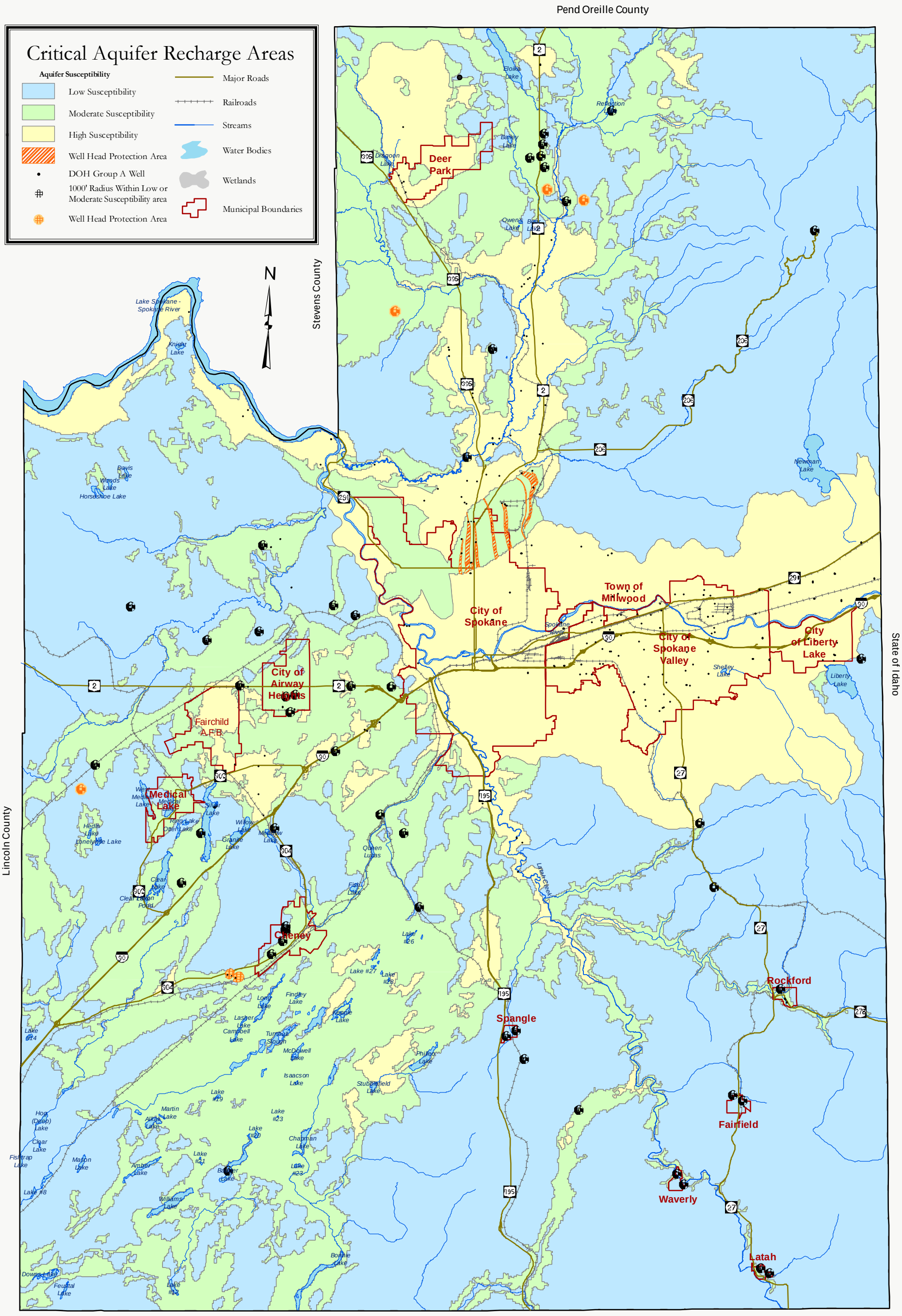
Flood Hazard Map

Shoreline Map

Critical Aquifer Recharge Areas

Aquifer Susceptibility

- Low Susceptibility
- Moderate Susceptibility
- High Susceptibility
- Well Head Protection Area
- DOH Group A Well
- 1000' Radius Within Low or Moderate Susceptibility area
- Well Head Protection Area
- Major Roads
- Railroads
- Streams
- Water Bodies
- Wetlands
- Municipal Boundaries



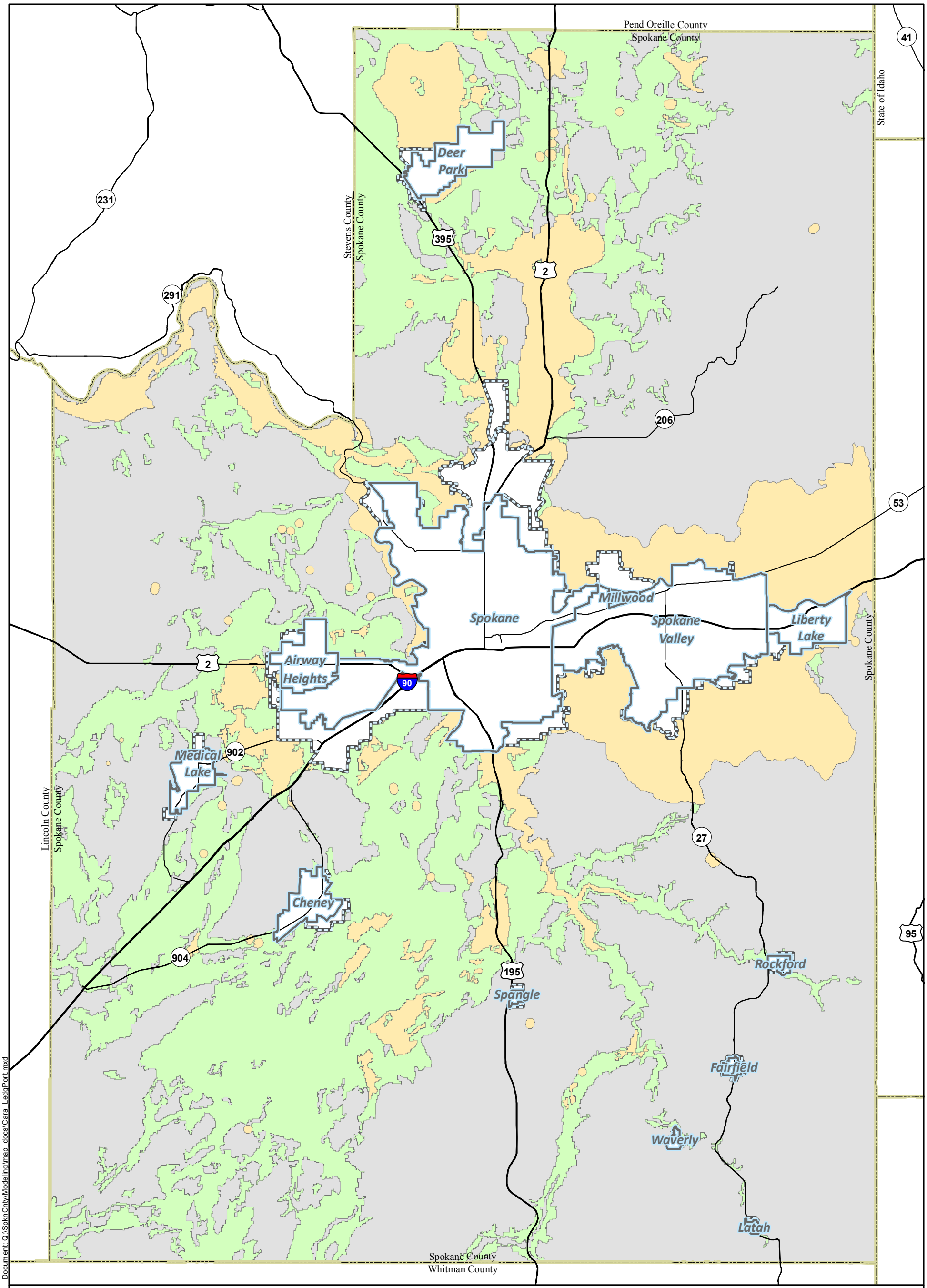
This map is compiled from various sources subject to constant revision. While every effort is made to ensure the accuracy of this information, this is not a survey and there is no warranty made as to the accuracy of this map.

Spokane County

0 1 2 4 6 Miles

Map Produced April 2007 - Spokane County ISD-GIS

Attachment C – Study Area Map and Non-Residential Land Use



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Critical Aquifer Recharge Areas (CARA)

Spokane County CARA Review

Legend

Critical Aquifer Recharge Areas (CARA)

Aquifer Susceptibility

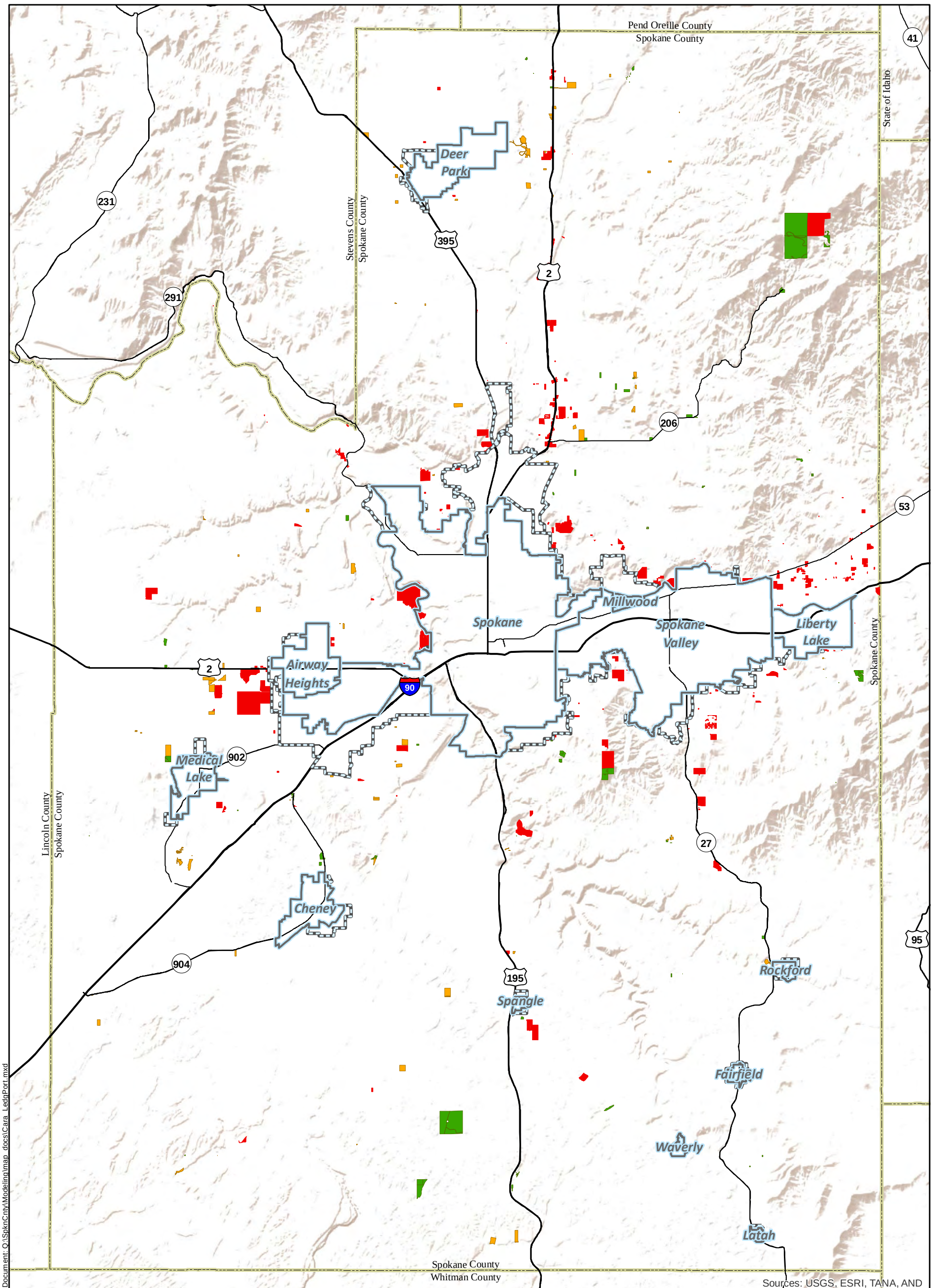
- High Susceptibility
- Moderate Susceptibility
- Low Susceptibility

- Municipalities
- Urban Growth Area
- County Boundary

0 6 12
Miles

Map Production Date: 10/19/2012

Data Sources: Spokane County; USGS; US Census Bureau, ESRI



Non-Residential Parcels Outside Urban Growth Areas by Critical Aquifer Recharge Area (CARA)

Spokane County CARA Review

Legend

Municipalities

Urban Growth Area

County Boundary

Non-Residential Parcels Outside of Urban Growth Area

Aquifer Susceptibility

High

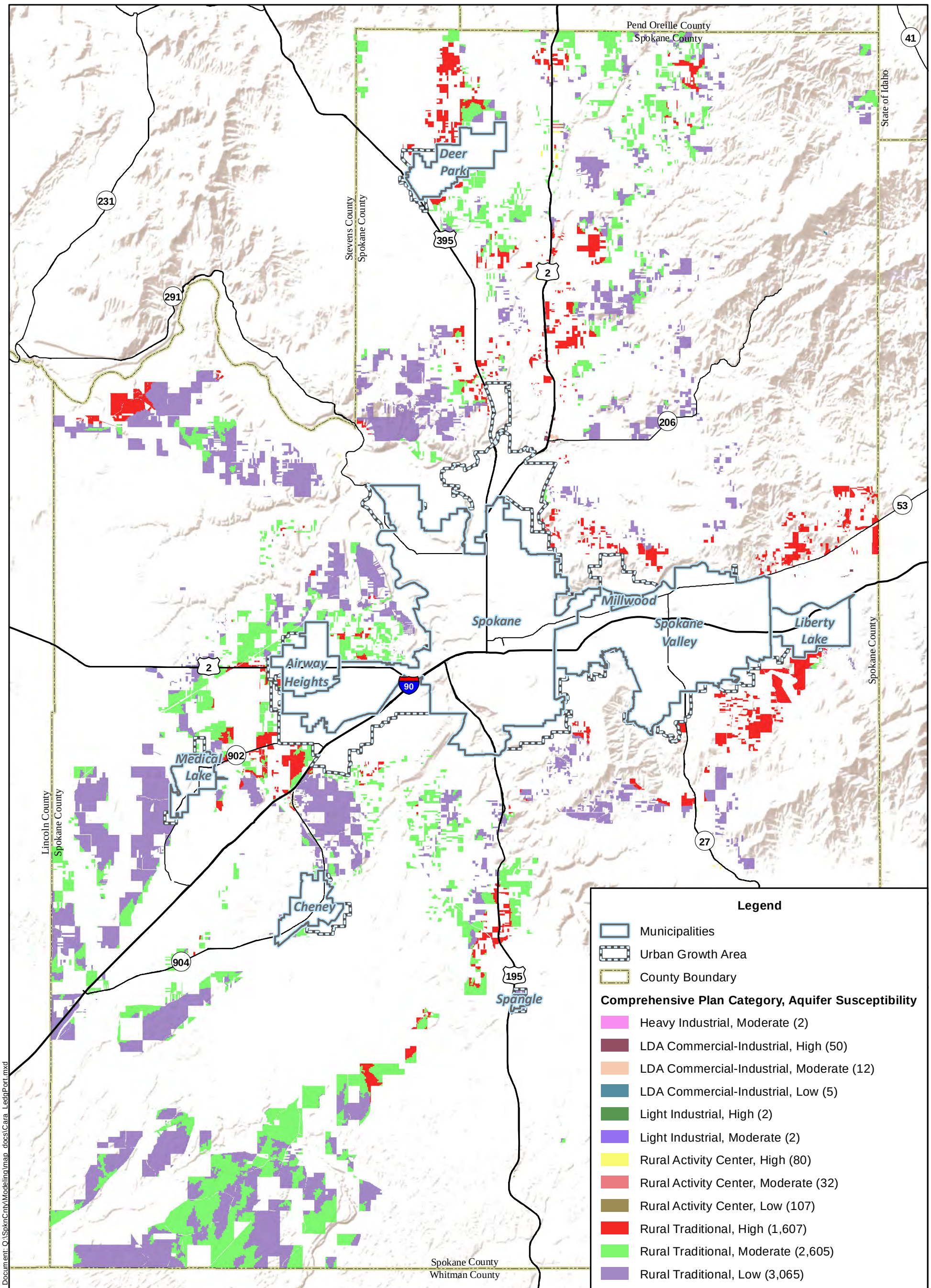
Moderate

Low

0 6 12
Miles

Map Production Date: 10/17/2012

Data Sources: Spokane County; USGS; US Census Bureau, ESRI



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Parcels Currently Vacant Outside Urban Growth Areas
With Comprehensive Plan DesignationsAllowing Non-Residential Development
by Critical Aquifer Recharge Area (CARA)
Spokane County CARA Review

Map Production Date: 10/17/2012

Data Sources: Spokane County; USGS;
US Census Bureau, ESRI

0 6 12
Miles

Non-Residential Land Use Outside UGA Boundary

Property Use	CARA Susceptibility	Number of Parcels	Acres
Agricultural	Low	11	28
Agricultural	Moderate	4	26
Churches	High	46	432
Churches	Low	12	96
Churches	Moderate	11	50
Commercial	High	1	0
Communication	High	17	320
Communication	Low	7	128
Communication	Moderate	3	2
Cultural Activity	High	3	140
Cur - Use - Ag	High	5	447
Cur - Use - Ag	Low	3	40
Cur - Use - Ag	Moderate	8	149
Cur - Use - Open	High	2	38
Cur - Use - Timber	High	1	10
Designated Forest Lnd	Low	2	37
Designated Forest Lnd	Moderate	1	5
Education	High	1	11
Hotel/Condo	High	38	73
Hotel/Condo	Low	10	56
Hotel/Condo	Moderate	92	117
Industrial	High	2	3
Manf - Chemical	Low	1	6
Manf - Other	High	2	15
Manf - Petroleum	Moderate	2	40
Manf - Printing	High	1	1
Manf - Stone/Glass	High	2	83
Manf - Stone/Glass	Moderate	1	10
Mining	High	1	27
Mining	Moderate	3	77
Other Cultural	High	1	2
Other Cultural	Low	1	36
Other Cultural	Moderate	1	79
Park	High	11	558
Park	Low	1	627
Park	Moderate	1	11
Public Assembly	High	6	513
Public Assembly	Low	6	27
Public Assembly	Moderate	8	9
Recreational	High	5	302
Recreational	Low	1	21
Recreational	Moderate	4	105
Resort - Camping	High	2	53
Resort - Camping	Low	2	13
Resort - Camping	ModerateE	1	3
Retail - Auto	High	3	10
Retail - Auto	Low	2	7
Retail - Auto	Moderate	3	18

Non-Residential Land Use Outside UGA Boundary

Property Use	CARA Susceptibility	Number of Parcels	Acres
Retail - Eating	High	13	102
Retail - Eating	Low	2	5
Retail - Eating	Moderate	3	6
Retail - Food	High	7	28
Retail - Food	Moderate	1	16
Retail - General Mrchds	High	13	31
Retail - General Mrchds	Low	4	1
Retail - General Mrchds	Moderate	3	21
Retail - Hardware	High	8	103
Retail - Hardware	Low	6	9
Retail - Hardware	Moderate	3	32
Retail - Other	High	3	3
Retail - Other	Moderate	1	0
Service	High	1	4
Service - Construction	High	1	1
Service - Education	High	40	938
Service - Education	Low	7	148
Service - Education	Moderate	4	134
Service - Finance	High	9	130
Service - Finance	Low	1	613
Service - Finance	Moderate	3	28
Service - Governmental	High	42	1,408
Service - Governmental	Low	13	70
Service - Governmental	Moderate	15	116
Service - Miscellaneous	High	4	6
Service - Miscellaneous	Low	1	591
Service - Miscelleneous	High	1	2
Service - Other	High	7	17
Service - Professional	High	12	111
Service - Professional	Low	3	33
Service - Repair	High	19	141
Service - Repair	Low	5	21
Service - Repair	Moderate	7	84
Trans - Motor	High	22	98
Trans - Motor	Low	5	23
Trans - Motor	Moderate	8	114
Trans - Parking	High	3	7
Trans - Railroad	High	1	1
Utilities	High	27	119
Utilities	Low	6	9
Utilities	Moderate	7	67
Wholesale	High	9	64
Wholesale	Moderate	3	7

Attachment D – Non-Residential Wastewater Characteristics

Most frequently found information in the literature regarding wastewater from non-residential facilities is estimates of the wastewater flow rate from the facility (Table D-1).

Table D-1. Influent Wastewater Flow Rate from Non-Residential Facilities

Establishment	Unit	Flow Rate (gal/unit-day)			Footnote
		typical	low	high	
Residential - 1 person	people	97	75	130	a
Residential - 2 person	people	76	63	81	a
Residential - 3 person	people	66	54	70	a
Residential - 4 person	people	53	41	71	a
Residential - 5 person	people	51	40	68	a
Residential - 6 person	people	50	39	67	a
Residential - 7 person	people	48	37	64	a
Residential - 8 person	people	46	36	62	a
Airport	passenger	4	3	5	a
	passenger	15	--	--	e
Apartment	bedroom	120	100	150	a
Assembly Hall	guest	4	3	5	a
	seat	4	--	--	d
Automobile Service Station	vehicle	10	8	15	a
	employee	13	9	15	a
Bar/Cocktail Lounge	seat	20	12	25	a
	employee	13	10	16	a
	employee	15	--	--	e
Barber Shop	chair	68	--	--	d
Beauty Salon	station	285	--	--	d
Boarding House	person	45	25	65	a
Bowling Alley	alley	185	--	--	d
Church	seat	4	--	--	d
Coffee Shop	customer	7	--	--	d
Conference Center	person	8	6	10	a
Daycare (no meals)	child	19	--	--	d
Daycare (with meals)	child	23	--	--	d
Department Store	toilet room	400	350	600	a
	employee	10	8	15	a
Gas Station/Convenience Store	customer	3.5	--	--	d
Gas Station/Service Station	customer	--	11	250	d
Health Club/Gym	member	35	--	--	d
Hotel	guest	70	65	75	a
	employee	10	8	18	a

Establishment	Unit	Flow Rate (gal/unit-day)			Footnote
	guest	55	--	--	d
	square foot	0.28	--	--	d
Hospital	bed	250	175	400	a
	bed	220	--	--	d
	bed	--	150	300	e
	bed	200	--	--	f
Institutions other than hospitals	bed	100	75	125	a
	employee	10	5	15	a
Industrial Building	employee	20	15	35	a
	employee	17.5	--	--	d
	employee w/shower	25	--	--	d
Laundry (self-service)	machine	450	400	550	a
	customer	50	45	55	a
Laundromat	machine	635	--	--	d
	load	52.5	--	--	d
	square foot	2.6	--	--	d
Medical Office	square foot	1.1	--	--	d
	practioner	275	--	--	d
	patient	8	--	--	d
Mobile Home Park	unit	140	125	150	a
Motel (w/ kitchen)	guest	60	55	90	a
Motel (w/o kitchen)	guest	55	50	75	a
Motel	guest	38	--	--	d
	square foot	0.33	--	--	d
	guest	50	--	--	e
	guest	50	--	--	f
Nursing Home	resident	125	--	--	d
Office	employee	13	7	16	a
	employee	18	--	--	d
	square foot	0.18	--	--	d
	employee	15	--	--	e
Prison	inmate	120	80	150	a
	employee	5	15	10	a
Public Lavatory	user	4	3	5	a
	user	5	--	--	d
Restaurant (conventional)	customer	8	7	10	a
	customer	15	--	--	e
	customer	5	--	--	f
Restaurant (no bar or lounge)	customer	--	3.5	50	d

Establishment	Unit	Flow Rate (gal/unit-day)			Footnote
Restaurant (w/ bar/cocktail lounge)	customer	10	9	12	a
Restaurant (short order)	customer	7	--	--	d
Restaurant (drive-in)	car space	30	--	--	d
Retail Store	square foot	0.13	--	--	d
	customer	3.8	--	--	d
	toilet	590	--	--	d
School, day	student	20	10	30	a
	student	--	15	20	e
School, boarding	student	85	75	100	a
Shopping Center	employee	10	7	13	a
	parking space	2	1	3	a
	employee	11.5	--	--	d
	square foot	0.15	--	--	d
	parking space	2.5	--	--	d
Theater (indoor)	seat	3	2	4	a
	seat	4.5	--	--	d
	seat	5	--	--	e
Footnotes:					
*for all d references add	employee	15	--	--	d

a Metcalf & Eddy
b EPA Septic Manual
c McCray et.al.
d MN Rules Chapter 7081.0130
e Smith and Loveless
f Goldstein and Moberg

Less information in the literature is available regarding wastewater characteristics from non-residential facilities. Information is mostly estimates of the wastewater BOD from the facility (Table D-2).

Table D-2. Influent Wastewater BOD Concentrations from Non-Residential Facilities

Establishment	Unit	5-day Biochemical Oxygen Demand (grams/unit-day)	Footnote
Airport	passenger	9.1	d
	passenger	22.7	e
Apartment	bedroom	79.4	d
Bar/Cocktail Lounge	employee	22.7	e
Boarding House	person	63.5	d
Bowling Alley	alley	68.0	d
Church	seat	9.1	d
Gas Station/Service Station	customer	9.5	d
Hotel	guest	283.5	d
Hospital	bed	235.0	d
	bed	136.0	e
	bed	159.0	f
Industrial Building	employee	33.1	d
	employee w/shower	37.6	d
Mobile Home Park	unit	127.0	d
Motel	guest	63.5	d
	guest	68.0	e
	guest	90.7	f
Nursing Home	resident	117.9	d
Office	employee	22.7	d
	employee	22.7	e
Restaurant (conventional)	customer	40.8	e
	customer	27.2	f
Restaurant (no bar or lounge)	customer	16.3	d
Restaurant (w/ bar/cocktail lounge)	customer	20.9	d
Retail Store	toilet	377.4	d
School, day	student	24.0	d
	student	22.7	e
School, boarding	student	94.3	d
Shopping Center	employee	22.7	d
Theater (indoor)	seat	4.5	d
	seat	9.1	e
Footnotes:			
*for all d references add	employee	18.1	d

Establishment	Unit	5-day Biochemical Oxygen Demand (grams/unit-day)	Footnote
a Metcalf & Eddy b EPA Septic Manual c McCray et.al. d MN Rules Chapter 7081.0130 e Smith and Loveless f Goldstein and Moberg			

Information in the literature is available for other wastewater characteristics from residents and from the septic tank (Table D-3). This information could potentially be used for estimates of concentrations from non-residential facilities.

Table D-3. Influent Wastewater Concentrations from Single Residents

Constituent	Mass (grams/person/day)		Concentration (mg/L)		Footnote
	low	high	low	high	
Total Solids	115	200	500	800	b
Volatile Solids	65	85	280	375	b
Total Suspended Solids	35	75	155	330	b
Volatile Suspended Solids	25	60	110	265	b
5-day Biochemical Oxygen Demand	35	36	155	286	b
Chemical Oxygen Demand	115	150	500	600	b
Total Nitrogen	6	7	26	75	b
From STE	--	--	12	453	c
Ammonia	1	3	4	13	b
From STE	--	--	17	178	c
Nitrates and Nitrites	1	--	1	--	b
From STE	--	--	0	1.94	c
Organic N	--	--	--	--	b
From STE	--	--	9.4	15	c
Total Phosphorus	1	2	6	12	b
Phosphate	--	--	--	--	b
From STE	--	--	1.2	21.8	c
Fats, Oils, and Grease	12	18	70	105	b
Volatile Organic Compounds (VOCs)	0.02	0.07	0.1	0.3	b
Surfactants	2	4	9	18	b
Total Coliforms	--	--	1E+9	1E+11	b
Fecal Coliforms	--	--	1E+7	1E+9	b

Footnotes:
a Metcalf & Eddy
b EPA Septic Manual
c McCray et.al.
d MN Rules Chapter 7081.0130
e Smith and Loveless
f Goldstein and Moberg

CONNECTICUT DEPARTMENT OF ENVIRONMENTAL PROTECTION

BUREAU OF MATERIALS MANAGEMENT AND COMPLIANCE ASSURANCE

GUIDANCE FOR DESIGN OF LARGE-SCALE ON-SITE WASTEWATER RENOVATION SYSTEMS

February 2006

Funded in part by the CT DEP through a US EPA Nonpoint Source Grant under § 319 Clean Water Act

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Consulting Civil and Environmental Engineers
86 Main Street, P.O. Box 337
Chester, Connecticut 06412-0337

TABLE D-4.

EFFLUENT REVIEW OF CURRENT LITERATURE ON CONCENTRATIONS OF BOD5 AND TSS IN RESIDENTIAL SEPTIC TANK EFFLUENT

CDEP Guidance for Design of Large-Scale On-Site Wastewater Renovation Systems

Reference	BOD_5, (mg/L)						TSS, (mg/L)					
	No. of Samples	Median	Mean	Standard Deviation	Min.	Max.	No. of Samples	Median	Mean	Standard Deviation	Min.	Max.
Hargett, Tyler & Siegrist-1981 ASAE	10		153			92-225	10		44		22	45
Oregon DEQ Study-1982	70		217				70		146			
Hampton & Jones -1984 ASAE		185	164					26	47			
Siegrist, et al -1984 ASAE												
Multiple Home Developments												
Westboro, WI	15		168				15		85			
Bend, OR	4		157				4		36			
Glide, OR	4		118				4		52			
Manila, CA	4		189				4		75			
Washington State	7		129				7		47			
Converse et al. 1991 ASAE	25		150	54	47	239	30		99	102	44	572
Sherman & Anderson 1991 ASAE	36		141		111	181	36		161		64	594
Viraraghavan & Rana 1991 ASAE	44		222	63.4	141	421	44		134	62.6	51	290
Bruen & Piluk 1994 ASAE												
Site A			300						77			
Site B			202						123			
Site C			135						141			
Cagle & Johnson 1994 ASAE												
Placer County Study	15		160				15		73			
Osesek, et al. 1994 ASAE												
Site #1			271									
Site#2			126									
Rubin, et al. - 1995 NW												
1 residential site	10		169		158	178						
Stuth & Garrison-1995 NW												
1 residential site			183		102	264			57		18	80
1 residential site	16	255	243	59.5	165	347	16	57	59	15.7	30	80
Bounds - 1997 NW			156						84			
Loudon, et al. -1997 NW												
Normal Ranges					100	250					30	150
Converse & Converse - 1998 ASAE												
(20 septic tks w/screened vaults)	69	186	215	95	36	548	24	51	61	35	11	135
Jantrania, et al. 1998 ASAE												
Site #1	17		314	250	165	1211	17		81	63	37	285
Site #2	15		143	141	22	530	16		48	36	15	139
Site #3	15		270	119	99	570	16		60	21	37	16
Site #4	15		248	151	102	720	16		592**	2067	29	8597
Site #5	10		155	58	120	224	11		53	23	26	108
Site #6	11		89	80	16	305	11		58	33	12	111
Site #7	11		264	64	164	409	11		72	32	16	120

TABLE D-4.

EFFLUENT REVIEW OF CURRENT LITERATURE ON CONCENTRATIONS OF BOD5 AND TSS IN RESIDENTIAL SEPTIC TANK EFFLUENT

CDEP Guidance for Design of Large-Scale On-Site Wastewater Renovation Systems

O'Driscoll, et al. 1998 ASAE												
Baldwin County, 10 Residences(93-94)	120		132				120		200			
Tuscaloosa County			331						58			
Roy, et al. 1998 ASAE												
2 Family Home	18		162						92			
Sievers 1998 ASAE			297						44			
Thom, et al. 1998 ASAE												
Paris Site			192	44.1					32	10.5		
Scott Co. Site			193	56.5					68	83.4		
Anderson County			224	58.5					154	147.9		
Stuth - 1999 NW												
21 residential sites (unponded)			141		26	216						
8 residential sites (ponded)			247		150	416						
Henneck, et al. 2001 ASAE												
10 home cluster system (G. Lake)			184	43					27	8		
20 home cluster system (Lake Wash.)			63	31					64	62		
Lindbo & MacConnell 2001 ASAE												
Residential Site #2			114						143			
Residential Site #1			172						80			
Siegrist -2001 ASAE					140	200					50	100
Christopherson, et al. 2001 ASAE												
Winter	96		175	119			96		115	59		
Summer	92		120	88			92		72	65		
Watson and Choate-2001ASAE												
Terrell Site	25		147		13	261	25		255		20	2000
Gray Site	24		103		13	240	24		191		20	1150
Jones Site	17		203		34	382	18		910**		31	4800
Mean of Means (unweighted)	183 mg/L*						90 mg/L*					

MANUALS & TEXTBOOKS

Reference	BOD_5, (mg/L)						TSS, (mg/L)					
	No. of Samples	Median	Mean	Standard Deviation	Min.	Max.	No. of Samples	Median	Mean	Standard Deviation	Min.	Max.
USEPA Manual - 1980, Table 6-1			142		7	480			76		10	485
Cantor and Knox -1985			140						75			
Crites & Tchobanoglous- 1998												
Without Effluent Filter or Garb. Gri.			180		150	250			80		40	140
Without Effluent Filter, w/ Garb. G.			190						85			
With Effluent Filter, w/o Garb. Gri.			130		100	140			30		20	55
With Effluent Filter & Garb. Gri,			140						30			

NOTES:

1.) ASAE = Proceedings of ASAE International Symposiums on Individual and Small community Sewage Systems in year shown.

2.) NW = Proceedings of the Northwest On-Site Wastewater Treatment Short Course and Equipment Exhibitions in year shown.

3.) Crites and Tchobanoglous (1998): with Effluent Screens, the BOD5 and TSS would be reduced by 28% and 62% respectively.

4.) * Excluding values when septic tank effluent filters were known to be present.

5.) ** Excluding values when septic tank effluent filters were known to be present, and outliers of 592 and 910 mg/L.

TABLE D-5.

EFFLUENT REVIEW OF CURRENT LITERATURE ON CONCENTRATIONS OF TOTAL NITROGEN AND PHOSPHORUS IN RESIDENTIAL SEPTIC TANK EFFLUENT

CDEP Guidance for Design of Large-Scale On-Site Wastewater Renovation Systems

Reference	TN, (mg/L)						TP, (mg/L)					
	No. of Samples	Median	Mean	Standard Deviation	Min.	Max.	No. of Samples	Median	Mean	Standard Deviation	Min.	Max.
Hargett, Tyler & Siegrist-1981 ASAE	9*		41		32.8	64.8	11		18.4		8.5	27
Ronayne, et al .Oregon DEQ Study-1982	54		57.5									
Hampton & Jones -1984 ASAE			57*									
Siegrist, et al -1984 ASAE												
Multiple Home Developments												
Westboro, WI	15		57				15		8.1			
Bend, OR	4		41									
Glide, OR	4		50									
Manila, CA												
Washington State	7		34				7		11.4			
Converse et al. 1991 ASAE	30		59		24	132	25		5		3	7
Sherman & Anderson 1991 ASAE	36		36		33	54	36		11		7	15
Viraraghavan & Rana 1991 ASAE	44		46.8	8.8	34	81	44		10.9	2.8	5.2	17.1
Bruen & Piluk 1994 ASAE												
Site A			41.7						7			
Site B			46.9						5.1			
Site C			30.2						13.9			
Cagle & Johnson 1994 ASAE												
Placer County Study	15		61.8									
Osesek, et al. 1994 ASAE												
Site #1			76.6						9			
Site#2			28.7						4			
Rubin, et al. - 1995 NW												
1 residential site	10		48.6		39.8	65.5	10		6.5		5.9	7.7
Loudon, et al. -1997 NW												
Normal Ranges					25	70					5	15
Converse & Converse - 1998 ASAE												
(20 septic tks w/screened vaults)	70	55	58	23	9.7	144						
***Ammonia-Nitrogen only.**												
Jantrania, et al. 1998 ASAE												
Site #1	16		95.6	60.3	52	316	16		8.7	6.6	4.8	33
Site #2	16		39.3	30.7	14	114	16		7.5	4.7	3	24
Site #3	16		153.3++	59.8	33	328	16		16.7	7.1	7.4	30
Site #4	16		78.4	73.9	35	330.4	16		10	11	3.5	48
Site #5	11		78.1	9	59	106	11		7.8	1.2	5.2	9.5
Site #6	11		32.1	11.2	13.1	65	11		6.5	1.7	4.9	11
Site #7	11		76.2	12.9	61	97.5	11		11.4	1.9	8.5	15
O'Driscoll, et al. 1998 ASAE												
Baldwin County, 10 Residences(93-94)	120		50									
Roy, et al. 1998 ASAE												
2 Family Home	18		42									
Thom, et al. 1998 ASAE												
Paris Site	>72		46.2	10.9			>72		7.9	5		
Scott Co. Site	>72		70.3	15.8			>72		9.3	3.3		
Anderson County	>24		49.9	17.3			>24		7.4	3.5		
Henneck, et al. 2001 ASAE												
10 home cluster system (G. Lake)	81		59	12			81		7.9	1.4		
20 home cluster system (Lake Wash.)	50		33	11			50		5.4	1.5		
Lindbo & MacConnell 2001 ASAE												
Residential Site #1			27.4						1.9++			
Residential Sites #2,3,& 4			29.2						4.4			
Christopherson, et al. 2001 ASAE												
Winter	96	51		43			96	9		24		
Summer	92	47		36			91	8		5		
Siegrist -2001 ASAE					46	100					5	15
Mean of Means (unweighted)	50.9						8.8					

TABLE D-5.

EFFLUENT REVIEW OF CURRENT LITERATURE ON CONCENTRATIONS OF TOTAL NITROGEN AND PHOSPHORUS IN RESIDENTIAL SEPTIC TANK EFFLUENT

CDEP Guidance for Design of Large-Scale On-Site Wastewater Renovation Systems

MANUALS & TEXTBOOKS

Reference	TN, (mg/L)						TP, (mg/L)					
	No. of Samples	Median	Mean	Standard Deviation	Min.	Max.	No. of Samples	Median	Mean	Standard Deviation	Min.	Max.
USEPA Manual - 1980, Table 6-1	150		42		9	125						
Cantor and Knox -1985			40						15			
Crites & Tchobanoglous- 1998												
Without Effluent Filter or Garb. Gri.			68		50	90			16		12	20
Without Effluent Filter, w/ Garb. G.			75		50	90			16		12	20
With Effluent Filter, w/o Garb. Gri.			68		50	90			16		12	20
With Effluent Filter & Garb. Gri,			75		50	90			16		12	20

NOTES:

1.) ASAE = Proceedings of ASAE International Symposiums on Individual and Small community Sewage Systems in year shown.

2.) NW = Proceedings of the Northwest On-Site Wastewater Treatment Short Course and Equipment Exhibitions in year shown.

3.) ++ Excluding outliers of 153.3 for TN and 1.9 for TP.

TABLE D-6

Effluent Wastewater Characteristics of Food Processing and Serving Establishments

CDEP Guidance for Design of Large-Scale On-Site Wastewater Renovation Systems

Ref. No.	Facility Type	BOD_5, (mg/L)						TSS, (mg/L)					FOG, (mg/L)					Mean TKN/TN mg/L	Mean TP mg/L
		No. of Samples	Sample Type	Mean	Std. Dev.	Min.	Max.	No. of Samples	Mean	Std. Dev.	Min.	Max.	No. of Samples	Mean	Std. Dev.	Min.	Max.		
	Restaurants																		
R-1a	2 Restaurants in Honolulo, HI	10	R,C	640		525	759	10	500		202	800							
R-1b	5 Restaurants in Greensboro, NC	15	R,C	546		390	737	15	257		48	402							
R-1c	5 Restaurants in Philadelphia, PA	10	R,C	655		280	960	10	1,030		172	1,985							
R-2	12 Restaurants in Wisconsin																		
R-2a	Restaurants only	37	STE,G	506		245	880	36	177		28	962	32	83		26	256		
R-2b	Restaurants w/other Facilities	25	STE,G	196		101	333	25	73		9	176	25	39	39	3	96		
R-3	Restaurants in Oregon																		
R3-a	Full Service Restaurant		STE,G	1,074					289										
R3-b	Full Service Restaurant		STE,G	1,301					350										
R3-c	Fast Food Restaurant		STE,G	1,917					624										
R3-d	Fast Food Restaurant		STE,G	1,716					358										
R-4a	Full Service Restaurant		GTE,G	1,657					382										
R-4b	Full Service Restaurant		STE,G	1,377					120										
R-5	Student Cafeteria, Univ. in Texas																		
R5-1	Summer Session	15	R,G	576				15	460										
R5-2	Beginning of Fall Semester	25	R,G	992				25	620										
R5-3	During Fall Semester	13	R,G	1,628				13	992										
R-6	Restaurants in Oregon																		
R6-1	Full Service Restaurant	22	GTE,G	913			1,800	23	185			774	22	207			378		
R6-2	Fast Food Restaurant	7	STE,G	985			1,216	7	143			195	7	138					
R-7	Restaurant Kitchen Greywater																		
R7-1	Full Service, American Cusine	2	GTE,G										2	2487		1,424	3,550		
R7-2	National Fast Food Franchise	2	GTE,G										2	1,270		297	2,242		
R7-3	Full Service, American Cusine	2	GTE,G										2	193		152	234		
R7-4	International Fast Food Franchise	2	GTE,G																
R7-4a	First Grease Trap Effluent	2	GTE,G										2	712		692	732		
R7-4b	Second Grease Trap Effluent	2	GTE,G										2	323		306	340		
R7-5	Full Service, American Cusine	2	GTE,G										2	12,802		10,646	14,958		
R-8	Restaurants in Hong Kong																		
8-1	Chinese Restaurant	10	R,U			58	1,430	10			13	246				120	712		
R8-2	Western Cusine Restaurant	10	R,U			489	1,410	10			152	545				53	2,100		
R8-3	American Fast Food Restaurant	11	R,U			405	2,240	11			68	345				158	799		
R8-4	Student Canteen	14	R,U			900	3,250	14			124	1,320				415	1,970		
R8-5	Bistro	3	R,U			1,500	1,760	3			359	567				140	410		

TABLE D-6

Effluent Wastewater Characteristics of Food Processing and Serving Establishments

CDEP Guidance for Design of Large-Scale On-Site Wastewater Renovation Systems

R-9	Restaurants in Florida																		
R9-1	Restaurants operating <16 hrs/d	U	STE,G	761	266				226	19				83	75				
R9-2	Single Serv. Rest. Oper <16 hrs/d	U	STE,G	602	313				123	125				33	35				
R9-3	Single Serv. Rest. Oper>16 hrs/d	U	STE,G	548	290				141	158				80	94				
R9-4	Bars and Cocktail Lounges	U	STE,G	451	71				79	38				24					
R9-5	Drive-in Restaurants	U	STE,G	1,920	1,273				454	269				78	67				
R9-6	Convenience Stores	U	STE,G	441	237				43	20				18	18				
R10	15 Restaurants in Florida	109	STE,C	374	255	53	1009	128	77	49	9	268	122	36	33	5	196		
R11	Full Service Restaurant in CT	39	STE,G	362	149	97	729	39	192	141	18	670							
R12a	Kitchen in Full Service Restaurant in CT	1	STE,C	960				1	240										
R12b	Kitchen in Full Service Restaurant in CT	1	STE,G	878				1	116										
R13	Full Service Restaurant in CT																		
	Kitchen Graywater(Same Day)	4	GTE,G	925		790	1000	4	118		87	136	4	30		<3	60		
	Graywater and Blackwater(Same Day)	4	STI,G	700		520	800	4	93		64	117							
R14	Full Service Restaurant in Baltimore	7	R,G	1320		704	1679	7	490		223	722	7	328		96	469		
R15	Full Service Restaurant in Baltimore	10	GTE,G										7	187	128	85	510		
R16	Fast Food Restaurant in CT	1	STE,C	430				1	40									41	8.4
R17	Oriental Restaurant in CT	1	GTE,G	1380				2	106									52	13.2
R18	Fast Food Restaurant in Michigan																		
R18-a	Kitchen Graywater	6	R,G	3960				6	2090				6	460					3.4
R18-b	Washing Machine Effluent	6	R,G	2525				6	806				6	461					2.7

* R=Raw; GTE = Grease Trap Effluent; STI = Septic Tank Influent; STE = Septic Tank Effluent; C = Composite; G=Grab, U = Unknown

Ref No. Reference (See Bibliography)

R-1 U.S.EPA (1978)
R-2 Siegrist, et al. (1984)
R-3 Stuth and Guichard (1989)
R-4 Stuth and Guichard (1989)
R-5 Lowery (1994)
R-6 Stuth and Garrison (1995)
R-7 Stuth and Wecker (1997)
R-8 Chen et al. (2000)
R-9 Matejcek et al. (2000)
R-10 Matejcek et al. (2000)
R-11 CT DEP Files
R-12 CT DEP Files
R-13 CT DEP Files
R-14 Unpublished (2002)
R-15 Unpublished (2002)
R-16 Unpublished (2002)
R-17 Unpublished (2002)
R-18 Unpublished (2002)

TABLE D-7

Effluent Wastewater Characteristics of Commercial and Institutional Facilities

CDEP Guidance for Design of Large-Scale On-Site Wastewater Renovation Systems

Ref. No.	Facility Type	BOD_5, (mg/L)						TSS, (mg/L)					FOG, (mg/L)					Mean TKN/TN mg/L	Mean TP mg/L
		No. of Samples	Sample Type	Mean	Std. Dev.	Min.	Max.	No. of Samples	Mean	Std. Dev.	Min.	Max.	No. of Samples	Mean	Std. Dev.	Min.	Max.		
HC-1	Skilled Nursing Facility	17	STE,G	171	114	64	271	17	100	99	14	426	17	13	9.6	2	37	35	N.A.
HC-2	Life Care Facility	26	R,G	154	62	41	272	26	159	58	74	288						34	N.A.
HC-3	Health Care Facility																		
	Facility No. 1	2	R,C	218				2	84				2					32	2.6
	Facility No. 2	1	R,C	276				1	199				1	10				43	9.5
	Facility No. 3	2	R,C	197				2	134				2					26	6.6
	Facility No. 4	1	R,C	159				1	72									28	8.3
	Facility No. 5	2	R,G	151				2	374									31	1.9
	Facility No. 6	2	R,G	432				2	638									38	7.6
I/ R-1	Inn & Resort w/Full Service Restaurant	20	R,G	195	147	41	726	20	249	303	20	1,200						62	11.8
I/ R-2	Inn w/Full Service Restaurant	10	STE,G	194	104	86	433	10	93	151	26	520						41	6.9
I/R-3	Inn w/no Restaurant		R,G	221		130	340		154		<5	274						33	N.A.
O-1	15,000 SF Office Building		R,C	240					96									97	10
	15,000 SF Office Building		STE,C	150					30									112	11.8
SM-1	Supermarkets in CT, MA, RI																		
SM1-a	Supermarket in CT	8	STE,G	479				8	156					64				39	N.A.
SM1-b	Supermarket in CT		STE,G	576															
SM1-c	Supermarket in CT		STE,G	164					66									55	N.A.
SM1-d	Supermarket in CT	17	STE,G	646				17	162									81	N.A.
SM1-e	Supermarket in MA	9	STE,G	250				9	132									69	N.A.
SM1-f	Supermarket in MA	8	STE,G	426				8	104									53	N.A.
SM1-g	Supermarket in MA	8	STE,G	215				8	86									69	N.A.
SM1-h	Supermarket in MA		STE,G	433															
SM1-I	Supermarket in RI		STE,G	720															
SM-2	Supermarket in CT																		
SM2-a	Influent to ST #1	3	R,G	838				3	172									85	29.5
SM2-b	Effluent from ST#2	3	STE,G	712				3	98									148	29.4
SM-3	Supermarket in CT																		
SM-3a		19	R,G	1132	650	149	2,571	20	313	255	25	1,075						245	N.A.
SM-3b		22	STE,G	883	338	582	2,166	24	178		13	480						189	N.A.

TABLE D-7

Effluent Wastewater Characteristics of Commercial and Institutional Facilities

CDEP Guidance for Design of Large-Scale On-Site Wastewater Renovation Systems

SHPG-1	Shopping Center in CT	46	STE,G	442	219	150	1,260	46	157	99	40	460						51	7.3
SHPG-2	Factory Outlet Complex in CT	4	R,G	118	17	108	143	4	99	55	49	175						117	38.9
SHPG-3	Factory Outlet Complex in CT	23	R,G	409	172	172	795	23	470	556	47	2,480						173	36.9
TC/TT-1	Travel Center in CT	3	R,G	>593				3	374									87	10
TC/TT-2	Express Delivery Truck Terminal	13	R,G	257		70	572	13	350		60	980						68	9.3
TC/TT-3	Travel Centers in TX, CT,TN, AZ																		
TC/TT-3a	Travel Center in Texas	1	U	240				1	120									39	4.1
TC/TT-3b	Travel Center in CT	1	R,C	332				1	294									59	7.9
TC/TT-3c	Travel Center in Tennessee	27	R,U	469				27	346									N.A.	N.A.
TC/TT-3ad	Travel Center in Arizona	7	R,C	349				7	215									40.3	N.A.
SCH-1	Middle School and High School in CT																		
SCH-1a	Middle School		STE,G	215					40									88	17.9
SCH-1b	Middle School		STE,G	115					110									133	3.1
SCH-1b	High School		STE,G	225		70												80	15.4
SCH-2	High School																		
	Septic Tank #1	2	STE,G	220		170	270	2	30		14	46	1	11				84	N.A.
	Septic Tank #2	1	STE,G	90					24									110	N.A.
	Septic Tank #3	2	STE,G	175		130	220	2	33				2	9				86	N.A.
SCH-3	Consolidated School																		
	Septic Tank #1	2	STE,G	146		126	165												
	Septic Tank #2	2	STE,G	117		105	128	2	59		38	80						108	N.A.
SCH-4	Middle School in CT	23	STE,G	304		92	599	24	135		19	1,960						141	N.A.
SCH-5	Boarding School in CT	8	R,G	329	184	510		8	177		121	240							
SCH-6	Schools in Vermont																		
	2 Elem., 2 High and 1 Private																	83	7.5
PP-1	Electrical Generating Facility, CT	12	R,G	324				12	305									136	N.A.
CMP-1	Summer Camp Dining Hall	3	R,G	1,633		1,500	1,800	3	465		74	1,200	2	106		41	170	79	14
	Summer Camp Dining Hall	3	STE,G	1,256		1,070	1400	3	70		33	100	2	17		17	34	76	18
CMP-2	Campground Holding Tank Pumpouts	3	STE,G	717		377	1117						3	91		8	240	650	74
MARINA	Marinas (2), Pump-out only	2	STE,G	648		395	901						2	65		40	91	610	66
	Marinas (4), Pump-out & Rest Rooms	4	STE,G	336		118	644						4	71		6	130	250	27
RRA-1	Interstate Roadside Rest Area, CT	2	STE,G	235		190	280	2	88		86	90	1	15				100	8.7
SKI-1	Ski Resorts																		
SKI-1a	Ski Resort in Oregon	U	R,U	395				U	321									77	12.7
SKI-1b	Ski Resort in Washington	U	R,U	382				U	372									80	13.2
SKI-2	Ski Resort in Vermont	14	R,U	242	53	151	347	14	196	81	68	330							

* R=Raw; GTE = Grease Trap Effluent; STE = Septic Tank Effluent; C = Composite; G=Grab, U = Unknown

Ref No. Reference (See Bibliography)

HC-1 CT DEP Files
HC-2 CT DEP Files
HC-3 Unpublished (2002)
I/R-1 CT DEP Files
I/R-2 CT DEP Files
I/R-3 CT DEP Files
O-1 Unpublished (2002)
SM-1a to 1i CT DEP Files
SM-2 CT DEP Files
SM-3 Unpublished (2002)
SHPG-1 CT DEP Files
SHPG-2 CT DEP Files
SHPG-3 CT DEP Files
TC/TT-1 CT DEP Files
TC/TT-2 CT DEP Files
TC/TT-3 Unpublished (2002)

Ref. No. Reference (See Bibliography)

SCH-1 CT DEP Files
SCH-2 CT DEP Files
SCH-3 CT DEP Files
SCH-4 CT DEP Files
SCH-5 CT DEP Files
SCH-6 Unpublished (2002)
PP-1 Unpublished (2002)
CMP-1 Unpublished (2002)
CMP-2 Matassa, McEntyre and Watson
MARINA Matassa, McEntyre and Watson
RRA-1 Unpublished (2002)
SKI-1 Clark (1969)
SKI-2 Unpublished (2002)

WASHINGTON STATE
DEPARTMENT OF
ECOLOGY

Criteria for Sewage Works Design

Water Quality Program

Revised August 2008
Publication No. 98-37 WQ

State of Washington
Department of Ecology
Olympia, Washington 98504

The hydraulic capacity of the treatment works should be based on the maximum expected flow. The process design of treatment units should be based on either the average design flow or the peak design flow, whichever is controlling. The following items should be determined from the observed rate of flow during the significant period of discharge. Items to be considered in determining design flows are as follows:

- Peak flow rates continuing over a length of time sufficient to adversely affect the detention time of treatment units or the flow characteristics in conduits.
- Applicable data from similar municipalities.
- Wet weather flows.
- Recirculation and inplant recycle flows.

The design organic loading should be computed in the same manner used in determining design flow.

G2-1.2.3 Existing Systems

Treatment plants designed to serve existing sewerage systems should be designed on the basis of characteristics of sewage obtained from the operating records of the treatment works.

The design engineer or owner shall provide a plan acceptable to Ecology for eliminating or handling excessive inflow/infiltration (I/I) so that there will be no discharge of inadequately treated wastewaters or impairment of the treatment process.

G2-1.2.4 New Systems

Sewage treatment plants to serve new sewerage systems should be designed on the basis of information in Table G2- 2. Numbers of persons per dwelling should be based on planning projections derived from an official source. Any deviations should be based on sound engineering judgment substantiated in the engineering report.

Table G2- 2. Design Basis for New Sewage Works

Discharge Facility	Design Units	Flow* (gpd)	BOD (lb/day)	SS (lb/day)	Flow Duration (hr)
Dwellings	per person	100	0.2	0.2	24
Schools with showers and cafeteria	per person	16	.04	.04	8
Schools without showers and with cafeteria	per person	10	.025	.025	8
Boarding schools	per person	75	0.2	0.2	16
Motels at 65 gal/person (rooms only)	per room	130	0.26	0.26	24
Trailer courts at 3 persons/trailer	per trailer	300	0.6	0.6	24
Restaurants	per seat	50	0.2	0.2	16

Discharge Facility	Design Units	Flow* (gpd)	BOD (lb/day)	SS (lb/day)	Flow Duration (hr)
Interstate or through-highway restaurants	per seat	180	0.7	0.7	16
Interstate rest areas	per person	5	0.01	0.01	24
Service stations	per vehicle serviced	10	0.01	0.01	16
Factories	per person per 8-hr shift	15-35	0.03-0.07	0.03-0.07	Operating period
Shopping centers	per 1,000 sq ft of ultimate floor space	200-300	0.01	0.01	12
Hospitals	per bed	300	0.6	0.6	24
Nursing homes	per bed	200	0.3	0.3	24
Homes for the aged	per bed	100	0.2	0.2	24
Doctor's office in medical center	per 1,000 sq ft	500	0.1	0.1	12
Laundromats, 9 to 12 machines	per machine	500	0.3	0.3	16
Community colleges	per student and faculty	15	0.03	0.03	12
Swimming pools	per swimmer	10	0.001	0.001	12
Theaters, drive-in type	per car	5	0.01	0.01	4
Theaters, auditorium type	per seat	5	0.01	0.01	12
Picnic areas	per person	5	0.01	0.01	12
Resort camps, day and night, with limited plumbing	per campsite	50	0.05	0.05	24
Luxury camps with flush toilets	per campsite	100	0.1	0.1	24

*Includes normal infiltration

G2-1.3 In-Plant Piping and Channels

All piping and channels should be designed to carry the maximum expected flows. The incoming sewer should be designed for free discharge. Bottom corners of the channels should be filleted and pockets and corners where solids can accumulate should be eliminated. Isolation gates should be placed in channels to seal off unused sections where sewage solids might accumulate.

G2-1.4 Design Flows, Collection Systems

See C1-3 and Table G2- 2.

G2-1.5 Plant Location

G2-1.5.1 General

Treatment plant sites should be located as far as practicable from any existing commercial or residential area or any area that will probably be developed within the plant's design life. The plant site should be separated from adjacent