

# Memorandum

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To:	Stephanie Potts, Washington State Department of Ecology
From:	Bridget August and John Monahan (GeoEngineers, Inc.)
Date:	October 18, 2019
File:	00504-161-00
Subject:	WRIA 9 Growth Projections - DRAFT

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#### INTRODUCTION

GeoEngineers, Inc. (GeoEngineers) is providing technical support to the Washington State Department of Ecology (Ecology) and the Watershed Restoration and Enhancement (WRE) Committees for Water Resource Inventory Areas (WRIAs) 7, 8 and 9. This memorandum provides a summary of the deliverable for Work Assignment GEO102, Task 3, WRIA 9 Growth Projections.

### BACKGROUND AND CONTEXT

The Streamflow Restoration Act (SRA, Chapter 90.94 Revised Code of Washington) specifies that by June 30, 2021, Ecology must establish a WRE Committee and adopt a WRE Plan in the Duwamish-Green Watershed (WRIA 9). The WRE Plan needs to address impacts on streamflows from consumptive use caused by new domestic permit-exempt wells anticipated between January 19, 2018 and January 18, 2038.

The WRE Plan must estimate growth projections for the watershed for January 2018 through January 2038 (at a minimum). Based on the projected growth, the plan will estimate the amount of rural growth and associated water use from new permit exempt well connections.

Ultimately, WRE Plan growth projections need to address the following two primary questions:

- 1. How many new permit-exempt domestic well connections (PE wells<sup>1</sup>) could be installed throughout the watershed over the next 20 years?
- 2. Where could the PE sourced growth occur at the subbasin level?

WRIA 9 includes parts of unincorporated King County and 15 incorporated cities. The methods used to estimate the number and location of new wells in unincorporated and incorporated areas in WRIA 9 are summarized below.

#### **GROWTH PROJECTION METHODS**

GeoEngineers worked with the WRIA 9 – Duwamish-Green WRE Committee to define growth projection methods and growth projections for WRIA 9. The WRIA 9 growth projection methods included using King County historical building permit data to predict potential PE well growth over the 20-year planning horizon. This methodology

<sup>&</sup>lt;sup>1</sup> "PE wells" is used to refer to new homes associated with new permit-exempt wells and also new homes added to existing wells, including homes on group systems relying on permit-exempt wells.

assumes that the rate and location of past growth will continue over the 20-year planning horizon. Using past building permits to predict future growth is one of Ecology's recommended methods (Ecology 2019). King County completed the analysis in-house and the methods and assumptions are described in detail in Attachment A and summarized below.

GeoEngineers also completed an analysis of potential PE well growth within the incorporated and unincorporated Urban Growth Areas (UGAs) using Ecology's well log database. The methods and assumptions are also described below and GeoEngineers data tables are included in Attachment B.

In addition, King County also completed a PE Well Potential Assessment which identified potential parcels where growth could occur within rural King County. The PE Well Potential Assessment results were used to assess whether a subbasin (as identified by the WRE Committee) has the capacity to handle the number of PE wells in the 20-year growth projection. In those areas where the number of projected PE wells exceeded the potential parcels available, the wells were reallocated to the nearest subbasin with similar growth patterns and parcel capacity. The King County PE Well Potential methods and assumptions are described in Attachment A and summarized below.

### King County Unincorporated Area Past Trends Analysis

King County elected to complete the WRIA 9 historic growth analysis in-house using 2000 to 2017 building permit data from the King County Assessor's office. The analysis was completed to estimate the number of recently built homes that relied on PE wells as their water source in unincorporated King County, both inside and outside of water service areas. GeoEngineers then used the King County historic growth results to estimate the number of potential new PE wells per subbasin over the 20-year planning horizon. This method is referred to as the King County Past Trends Analysis and the general methodology used was as follows:

### King County:

- Obtain available King County building permit and parcel data (2000 to 2017).
- Use centroid of parcel data to determine location information (e.g. WRIA, inside or outside water district service areas, King County stream basin, WRIA 9 subbasin, etc.).
- Link building permit data and parcel data.
- Use King County building permit parcel attribute data to determine public versus private water source (private water sources are PE wells).
- Determine the number of building permits that are:
  - o Public (pub) water
  - Private (pvt) water (PE wells)
  - o Other (unknown/null)
    - The "other" category includes parcels listing their water source as "unknown" (likely vacant land) and where building permit data and parcel attribute data did not match. King County used the "other" category to calculate an error of 6 percent (of the total number of building permits).
- Calculate the percentage of building permits for each type of water source (pub, pvt or other).

#### **GeoEngineers:**

- Use the annual average number of permits per year multiplied by the past percentage of growth per subbasin and percentage of building permits using a private water source (well) per subbasin to determine a projected number of PE wells per year for each subbasin.
- Multiply the number of PE wells per year per subbasin by 20 to calculate the estimated total of PE wells projected over the 20-year planning horizon for each subbasin.
- Add 6 percent error to 20-year growth projections per subbasin (error is based on the "other/null" category as described above).
- Tabulate the total growth projected over the 20-year planning horizon, including the 6% error, for each subbasin and sum to get the total of PE wells projected over the 20-year planning horizon in rural unincorporated King County

King County historic growth projection data tables are provided in Attachment A for reference. King County used the time period 2000 through 2017 because those data were available. The building permit data for 2000-2017 includes both periods of high growth and periods of low growth. King County compared this data with information from Vision 2040 and population data and is confident in using the average of this time period to project into the future. This methodology assumes that the rate and location of past growth will continue over the 20-year planning horizon.

### **GeoEngineers UGA Well Log Spot Check**

As described above, the King County Past Trends Analysis focused on the potential for PE wells to be installed within rural, unincorporated King County. The King County method does not account for potential PE wells in cities or UGAs. However, early in the growth projection planning process, the WRIA 9 WRE Committee recommended looking at potential growth within UGAs. GeoEngineers completed an analysis of potential PE well growth within the incorporated and unincorporated UGAs using Ecology's Washington State Well Report Viewer database. The general methodology used was as follows:

- Obtain tabular and spatial data from Ecology's Washington State Well Report Viewer database (1998 through 2018). Ecology's complete Well Report Viewer database was filtered for water wells greater than 30 feet deep and 6- to 8-inch-diameter, which are typical depths and dimensions for domestic wells. Ecology does not have the ability to filter for permit-exempt domestic wells. Information in the database is based on records submitted by the well driller.
- Filter database for wells located within UGAs. Note that well locations were estimated to the nearest <sup>1</sup>/<sub>4</sub>-<sup>1</sup>/<sub>4</sub> section.
- Review randomly selected water well reports and note the well type (e.g. domestic, industrial, municipal, irrigation, test well, or other), and well location (physical address and/or parcel number).
- Determine the number of wells that were:
  - Domestic (assumed to be PE Wells)
  - o Irrigation
  - Other (test, municipal, dewatering, industrial, mitigation, UIC, deepened or refurbished wells)

- o Incorrect (location, date, etc.)
- Calculate the percentage of each type of well (domestic, irrigation, other and incorrect).
- Multiply the percentage of domestic wells by the total number of wells located within UGAs to estimate the number of domestic wells installed over the past 20-year period.
- Cross-check the physical address of the wells with the UGA boundary to determine which subbasin the domestic wells were located in.
- Multiply the total number of domestic wells per subbasin by 20 to calculate the estimated number of PE wells located within the UGA projected over a 20-year period for each WRIA 9 subbasin.

UGA well log spot check data tables are included in Attachment B.

#### **King County PE Well Potential Assessment**

King County also completed a PE Well Potential Assessment which evaluated the parcels available for future growth in unincorporated King County. The purpose of the PE Well Potential Assessment was to determine if there would be enough parcels to accommodate the 20-year growth projection at the WRIA and subbasin level. In those areas where the number of projected PE wells exceeded the potential parcels available, GeoEngineers reallocated those wells to the nearest subbasin with similar growth patterns and parcel capacity. The general methodology used was as follows:

#### King County:

- Use assumptions and screening criteria to identify parcels with potential for future growth by subbasin.
  A table of assumptions made by King County are provided in Attachment A.
- Use centroid of parcel data to determine location information (e.g. WRIA, inside or outside water district service areas, WRIA 9 subbasin, etc.).
- Use King County parcel attribute data to determine total number of parcels and dwelling units per subbasin. A dwelling unit (DU) is a rough estimate of subdivision potential based on parcel size and zoning (e.g. a 22-acre parcel zoned RA-5 is assumed to have 4 dwelling units).
- Determine the number of parcels and dwelling units that would be inside or outside water district service boundaries.
- Calculate water use projections for public connections and PE sourced parcels:
  - Public connection parcels would be those located within water district service boundaries and were calculated based on historic rates of connection to public water within each subbasin.
  - The remaining number of parcels located within water district service boundaries that exceeded the historic rate of public water connection were assigned to be PE sourced (e.g. served by a PE well).
  - PE sourced parcels were calculated based on the number of parcels located outside water district service boundaries plus the remaining parcels from "inside" water district boundaries, as described above.

Calculate the shortfall or surplus of available parcels to be sourced by PE wells by taking the total PE sourced DUs minus the 20-year growth projection from the King County past trends analysis.

#### **GeoEngineers:**

If the projected PE well growth exceeds the total number of available PE sourced parcels, reallocate shortfall to adjacent subbasin with similar growth patterns and parcel capacity.

King County used historic rates of connection to water service because the County does not have county-wide information on the location of water lines. King County PE well potential data tables are included in Attachment A.

### **GROWTH PROJECTON RESULTS**

The King County Past Trends Analysis and GeoEngineers UGA Well Log Spot Check results were combined to determine the total number of projected PE wells per subbasin within WRIA 9. Using the King County PE Well Potential Assessment, total growth was reallocated to adjacent subbasins where potential growth in the unincorporated area exceeded the total number of PE sourced parcels. The results are summarized in Table 1 and shown on Figure 1. GeoEngineers estimates 632 new permit-exempt domestic well connections in WRIA 9 over the 20-year planning horizon. The following is a brief summary of the calculations used to complete the WRIA 9 growth projection analysis:

- King County used the average number of building permits per year (79) for the 18-year period from 2000 to 2017, multiplied by the historic percentage of homes using PE wells (36.4 percent) to determine a projected number of new PE wells per year (29) in the WRIA 9 portion of rural unincorporated King County. The number of PE wells per year (29) was then multiplied by 20 to determine the estimated total of PE wells projected over the 20-year planning horizon (578) for rural unincorporated King County. (Note that due to rounding, the total number is 578 vs. 580).
- To estimate the 20-year PE well projection per subbasin, GeoEngineers used the average number of building permits per year (79), multiplied by the historic distribution of growth per subbasin. The average building permits per subbasin was then multiplied by the historic percentage of homes using PE wells to estimate the average number of PE wells per year per subbasin. The number of PE wells per year per subbasin was then multiplied by 20 to calculate the estimated total of PE wells over a 20-year period per subbasin. A 6 percent error was then added to each subbasin total. The total number of estimated PE wells, including the 6 percent error, is 612. See Attachment A for detailed results.
- GeoEngineers also completed a UGA Well Spot Check for wells from the Ecology Well Report Viewer database that plot within the Urban Growth Area. When wells were plotted in WRIA 9, 93 wells were located within the UGA for 1998 through 2018. GeoEngineers checked about 70 percent of the wells by looking at the well logs and noting whether the wells were identified as being for domestic, irrigation, or other purposes (e.g. test, industrial, errors, etc.). About 23 percent of the wells were for domestic use.
- GeoEngineers took the number and distribution of wells from the 1998-2018 data and projected the same rate and distribution per subbasin for the 20-year planning horizon. The estimated number of PE wells within the UGA over the 20-year period is 20. See Attachment B for detailed results.

- King County also completed a PE Well Potential Assessment to determine whether a subbasin has capacity for the number of wells in our 20-year projection.
- The PE Well Potential Assessment shows a capacity shortfall of 20 wells in the Newaukum subbasin. Those 20 wells were reallocated to the Middle Middle Green subbasin because it is adjacent and has similar growth patterns.

# TABLE 1. GROWTH PROJECTIONS FOR NEW PE WELLS IN WRIA 9 - DUWAMISH-GREEN2018 TO 2038

Subbasins <sup>1</sup>	King County Past Trends <sup>2</sup>	UGA Well Log Spot Check <sup>3</sup>	Total PE Wells <sup>4</sup> per Subbasin <sup>5</sup>
Central Puget Sound	0	0	0
Duwamish	0	0	0
Lower Green	0	4	4
Soos Creek	72	11	83
Jenkins Creek	44	1	45
Covington Creek	41	0	41
Lower Middle Green	81	3	84
Middle Middle Green	100	0	100
Newaukum	102 1		103
Upper Middle Green	110	0	110
Coal Deep	62	0	62
Upper Green	0	0	0
Totals	612	20	632

Notes:

1 = Subbasins from proposal approved at July 23, 2019 WRE Committee meeting.

2 = Based on 20-year estimate of potential new PE wells in unincorporated King County, plus 6% error.

3 = Based on spot-check of Ecology Well Report Viewer database. Accounts for potential wells within the incorporated and

unincorporated Urban Growth Areas (UGAs) over the 20-year planning period.

4 = "PE Wells" is used to refer to new homes associated with new permit-exempt wells and also new homes added to existing wells on group systems relying on permit-exempt wells.

5 = Includes redistribution of 20 wells from Newaukum subbasin to Middle Middle Green subbasin.

### **NEXT STEPS**

- The WRIA 9 WRE Committee agreed to move forward with the WRIA planning process using 632 as the WRIA 9 20-year PE well growth projection without holding a formal vote. The Committee can revisit the growth projections later in the planning process, if needed.
- The Committee can also decide to apply an additional "safety factor" after estimating consumptive use.

### REFERENCES

Department of Ecology, 2019. Final Guidance for Determining Net Ecological Benefit, GUID-2094 Water Resources Program Guidance. Washington State, Department of Ecology, Publication 19-11-079, p. 131.

Attachments:

Figure 1. WRIA 9 Distribution of Projected Permit-Exempt Wells 2019-2038

Attachment A. King County Growth Projections and Permit Exempt Well Potential Memo, Data Tables and Assumptions Attachment B. GeoEngineers UGA Well Log Spot Check Data Tables



### Legend

WRIA 9 Boundary WRIA 9 Subbasins

#### Projected Permit-Exempt Wells 2018-2038



## Projected WRIA 9 PE Well Total = 632



 The locations of all features shown are approximate.
 This drawing is for information purposes. It is intended to assist in showing features discussed in an attached document. GeoEngineers, Inc. cannot guarantee the accuracy and content of electronic files. The master file is stored by GeoEngineers, Inc. and will serve as the official record of this communication.

Data Source: ESRI Topographic Map Base

Projection: NAD 1983 StatePlane Washington North FIPS 4601 Feet



Miles

### WRIA 9 Distribution of Projected Permit-Exempt Wells 2018-2038

Watershed Restoration and Enhancement Plan King County, Washington

GEOENGINEERS

Figure 1

# **ATTACHMENT A**

King County Growth Projections and Permit Exempt Well Potential Memo and Data Tables

# WRIA 9 - Green-Duwamish Draft 9/23/19

	(KC building permi	ting data)		permits									
WRIA (Ecology Coverage)	2000-2009	2010-2017	total	per year	% of county	-wide total		WRIA 9	PE/yr	20 yr estimate	Historic	pub	0.576
9	1152	278	1430	79	249	6		Future PE wells	29	578	Percentages	pvt	0.364
							_						
District info	2000-2009	2010-2017	total	APD	permits	% of WRIA total							
total	1152	278	1430	WRIA 9	125	9%							
wtr dst (inside water district)	831	219	1050										
no dst (outside water district)	321	59	380	FPD	permits	% of WRIA total							
				WRIA 9	43	3%							
Water service info	(derived from KC p	parcel attribute data)											
pub (water service)	708	115	823	Existing									
pvt (well)	436	84	520	PE wells	436	84	520						
other	8	79	87										
total	1152	278	1430	error	1%	28%	6%	]					
	•	• •			•	•	•	-					

# WRIA 9 - Green-Duwamish - Historic Growth and Water Use by Subbasin

									Added by Geot	ingineers:		20 year
NRIA 9 WREC agreed to 12 subba	asins								permits/year	79		building perr
			Water use by I	basin				_			-	
Sub-basin w/ permits	Number of permits	Distribution of growth	pub	pvt	oth	%pub	%pvt		Average bldg. permits per year	Average wells per year (pvt)	Total wells in 20 years	6% error of wells
Central Puget Sound	Urban	0%	0	0	0	0%	0%		0.0	0.0	0.0	0.0
Duwamish	Urban	0%	0	0	0	0%	0%		0.0	0.0	0.0	0.0
Lower Green	3	0%	3	0	0	100%	0%		0.2	0.0	0.0	0.0
Soos subbasin	167	12%	96	61	10	57%	37%		9.3	3.4	67.8	4.1
Jenkins subbasin	154	11%	109	37	8	71%	24%		8.6	2.1	41.1	2.5
Covington subbasin	235	16%	189	35	11	80%	15%		13.1	1.9	38.9	2.3
Lower Middle Green	250	17%	168	69	13	67%	28%		13.9	3.8	76.7	4.6
Middle Middle Green	256	18%	157	68	31	61%	27%		14.2	3.8	75.6	4.5
Newaukum subbasin	172	12%	60	104	8	35%	60%		9.6	5.8	115.5	6.9
Upper Middle Green	121	8%	26	93	2	21%	77%		6.7	5.2	103.3	6.2
CoalDeep	72	5%	15	53	4	21%	74%		4.0	2.9	58.9	3.5
Upper Green Subbasin	0	0%	0	0	0	0%	0%		0.0	0.0	0.0	0.0
total	1430	100%	823	520	87	total	1430	totals	79.4	28.9	577.7	34.7

# WRIA 9 - 20 year PE Well Projection by Subbasin

nits	1589
total	20 year well total
	+ 6% (rounded)
	0
	0
	0
	72
	44
	41
	81
	80
	122
	110
	62
	0
	612

# WRIA 9 - Permit-Exempt Well Potential Assessment

Assessment of potential parcels for future growth			V	Water district boundaries				Water Use Projection						
	Insid	e	Out	side		public co	onnection			PE sourced				
Sub-basins	Number of parcels	Number of Dwelling Units (DU)	parcels	DU	parcels	DU	subbasin	parcels	DU	parcels	DU	20 year well projection (incl error)	Shortfall ( <i>red if</i> <i>present</i> ) in 20 year well projection	Redistribution - 20 year well projection
Central Puget Sound	Urban	Urban	0	0	0	0	Central Puget Sound	0	0	0	0	0	0	0
Duwamish	Urban	Urban	0	0	0	0	Duwamish	0	0	0	0	0	0	0
Lower Green	3	3	3	3	0	0	Lower Green	3	3	0	0	0	0	0
Soos subbasin	197	232	196	231	1	1	Soos subbasin	113	133	84	99	72	27	72
Jenkins subbasin	176	234	175	233	1	1	Jenkins subbasin	124	165	52	69	44	26	44
Covington subbasin	207	316	207	316	0	0	Covington subbasin	166	254	41	62	41	21	41
Lower Middle Green	152	237	127	210	25	27	Lower Middle Green	85	141	67	96	81	15	81
Middle Middle Green	212	451	130	294	82	157	Middle Middle Green	80	180	132	271	80	191	100
Newaukum subbasin	106	123	53	60	53	63	Newaukum subbasin	18	21	88	102	122	-20	102
Upper Middle Green	161	208	0	0	161	208	Upper Middle Green	0	0	161	208	110	98	110
CoalDeep	122	170	0	0	122	170	CoalDeep	0	0	122	170	62	108	62
Upper Green Subbasin	0	0	0	0	0	0	Upper Green Subbasin	0	0	0	0	0	0	0
total	1336	1974	891	1347	445	627		590	897	746	1077	612		612
			total parcels	1336	total parcels	1974		total parcels	1336	total parcels	1974		20 year Perm	it Exempt well total 612

#### DRAFT Permit-Exempt Well Potential Assessment - Assumptions Matrix

Based on parcel-scale GIS identification and classification of lands with potential for development of homes that will rely on a permit-exempt well. Requires a number of assumptions regarding how specific land categories are treated.

Screening Category	King County	lustification
servering entegory	PE Well Potential Assessment	Justineation
Current on-site	< 10k appraised improvements <sup>1</sup>	Used as a proxy for vacant land that is unlikely
development	<\$10k appraised improvements	to have an existing home or well
Current zoning	no exclusions	
Growth area	outside LIGAs (inclusitios)	Counties have jurisdiction for permitting in
Glowthalea	outside boas (inci cities)	unincorporated areas.
		King County does not have county-wide data
		on water system infrastructure. They will look
Water convice	$0$ ( with in such as a single set of the last set of $x^2$	at historic rates of connection to water systems
water service	% within water service area likely to connect	within water service areas in order to come up
		with a likelihood of connection for future
		development.
Public ownership	not owned by public agencies	
		King county has purchased development rights
Family Invite		in many of the forest production districts.
Forest lands	outside forest production districts	Zoning in those areas is very low density (80
		acres).
	outside agricultural production districts; not	
Agricultural lands	enrolled in Farmland Preservation Program	
Cuitical aveca	≥1 ac of parcel area outside floodway and	Based on parcel size assumption and
Critical areas	severe channel migration hazard areas	restrictions on building in critical areas.
Easements		
	"Parcel" PE well potential based on one unit	
Subdivision/zoning	per parcel. "Dwelling Unit" PE well potential	
changes	based on subdividing to maximum density	
	allowed by current zoning.	
		Based on assumption from water availability
Deveel size		study, that it would be difficult to site a home,
Parcel size	no parceis <1 acre	septic system, and well on a lot less than 1
		acre.

<sup>1</sup> Information from County Assessor data.

<sup>2</sup> King County reviewed historic building permits and assessors data to estimate % of homes likely to connect to water service within water service areas. Parcels withoutside water service areas are projected to rely on a well.

DRAFT - Updated 9/23/19

Prepared by GeoEngineers from technical workgroup meeting notes. DRAFT - for internal use by WRIA 7, 8, & 9 WRECs and technical workgroups.

# ATTACHMENT B GeoEngineers UGA Well Log Spot Check Data Tables

# **GeoEngineers - WRIA 9 UGA Well Log Spot Check**

Draft 8/21/19

GeoEngineers - UGA Well Log Spot Check											
Period	Total Wells	Total Wells Spot Checked	Domestic wells (includes Group B wells)	Irrigation wells	Other (Test, Municipal, Dewatering, Industrial, Mitigation, UIC, Deepened or Refurbished)	Incorrect (Location, Date, etc.)					
1998-2007	58	41	7	19	11	4					
2008-2018	35	24	8	10	1	5					
Totals	93	65	15	29	12	9					
Percent of Total		70%	23%	45%	18%	14%					
Potential number of new wells	Potential number of new wells based on percentage of past 20 year total (93)										
WRIA 9			21	41	17	13					

Notes:

Total domestic well numbers have been revised after cross-checking well address with the UGA boundary.

Wells located outside of the UGA have been removed from the domestic well total.

The remaining domestic wells that have been spot checked are located in the following UGAs: King County (2), Kent (3), Auburn (5), Covington (3), Maple Valley (1) and Enumclaw (1).

Service Area/City Policy Notes:

Covington WD - incentivizes hookups, only 1 PE well in last 4 years in service area

Tacoma Water (Cumberland) - allows wells until service reaches new homes

Auburn - Allows PE wells until water service reaches new homes. Short plats must hookup.

only 1 new well in last 5 years

Tukwila - PE wells not allowed. No known wells in use.

GeoEngineers - WRIA 9 UGA Well Log Spot Check Growth Projections										
Subbasins	Spot Checked 1998-2007	Spot Checked 2008-2018	Total	Total Potential Wells in UGA in 20 years	Total Rounded	City UGA				
Central Puget Sound	0	0	0	0.00	0					
Duwamish		0	0	0.00	0					
Lower Green	1	2	3	4.20	4	King Co, Kent and Auburn UGAs				
Soos subbasin	5	3	8	11.20	11	Kent, Covington, King				
Jenkins subbasin	0	1	1	1.40	1	Maple Valley UGA				
Covington subbasin	0	0	0	0.00	0	, ,				
Lower Middle Green	1	1	2	2.80	3	Auburn UGA				
Middle Middle Green	0	0	0	0.00	0					
Newaukum subbasin	0	1	1	1.40	1	Enumclaw UGA				
Upper Middle Green	0	0	0	0.00	0					
Coal Deep	0	0	0	0.00	0					
Upper Green Subbasin	0	0	0	0.00	0					
Totals	7	8	15	21.00	20					

Note: This tables includes data for wells in Ecology's Well Report database, filtered for a depth greater than 30 feet and diameter 6-8 inches. Ecology does not have the ability to filter for permit-exempt domestic wells. Information in the database is based on records submitted by the driller. Well Report Data and Images released from the Department of Ecology are provided on an "AS IS" basis, without warranty of any kind.