Washington State Department of Ecology

Principal Aquifer Water Level Monitoring Network: Final Report

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Introduction

The National Groundwater Monitoring Network (NGWMN) is a United States Geological Survey (USGS) program established to provide national long-term groundwater quantity and quality data for principal aquifers by using existing federal, state, and local groundwater monitoring programs. In 2016, the Washington State Department of Ecology (Ecology) became a data provider to the NGWMN through a two-year cooperative agreement with USGS (G16AC00365).

Ecology became a data provider because it routinely collects groundwater level measurements from a series of well networks that are used to support water use permitting activities and planning related to ambient groundwater level status and trends.

Under the original two-year agreement (G16AC00365), Ecology established the well registry; water-level, construction, and lithology web services; and submitted data for 61 groundwater monitoring wells.

In October 2018, Ecology entered into a second two-year cooperative agreement (G18AC00067) with USGS. During this agreement, Ecology established the water quality web services, added additional wells to the water level and water quality database, installed 11 new monitoring wells, surveyed well sites, and tested aquifer connectivity.

In September 2020, Ecology began work on a third two-year cooperative agreement (G20AC00191) to continue maintaining the web services, add additional wells to the NGWMN list, and fill spatial gaps in the groundwater monitoring network.

Ecology's Groundwater Monitoring Program

Ecology collects groundwater level information from a state-level network of domestic, irrigation, and purpose-built monitoring wells to support water use permitting activities. Ecology uses these data for long-term planning related to groundwater depletion, drought, and the evaluation of ambient groundwater level status and trends. Ecology also conducts groundwater quality monitoring throughout the state for a wide range of projects.

Washington States' annual groundwater water-level monitoring network is operated and maintained by Ecology's Water Resources Program (WRP). All data generated are entered and retained in Ecology's Environmental Information Management (EIM) database from which the data are then accessed through the NGWMN portal. The procedure that describes how the program will conduct groundwater monitoring and adhere to quality assurance requirements is provided in the *Integrated Statewide Groundwater Monitoring Strategy* (Culhane, 2017).

There are 2,350 wells considered "candidate monitoring wells" in EIM's WRP groundwater monitoring database . Figure 1 shows a breakdown of the type and quantity of wells in this database.

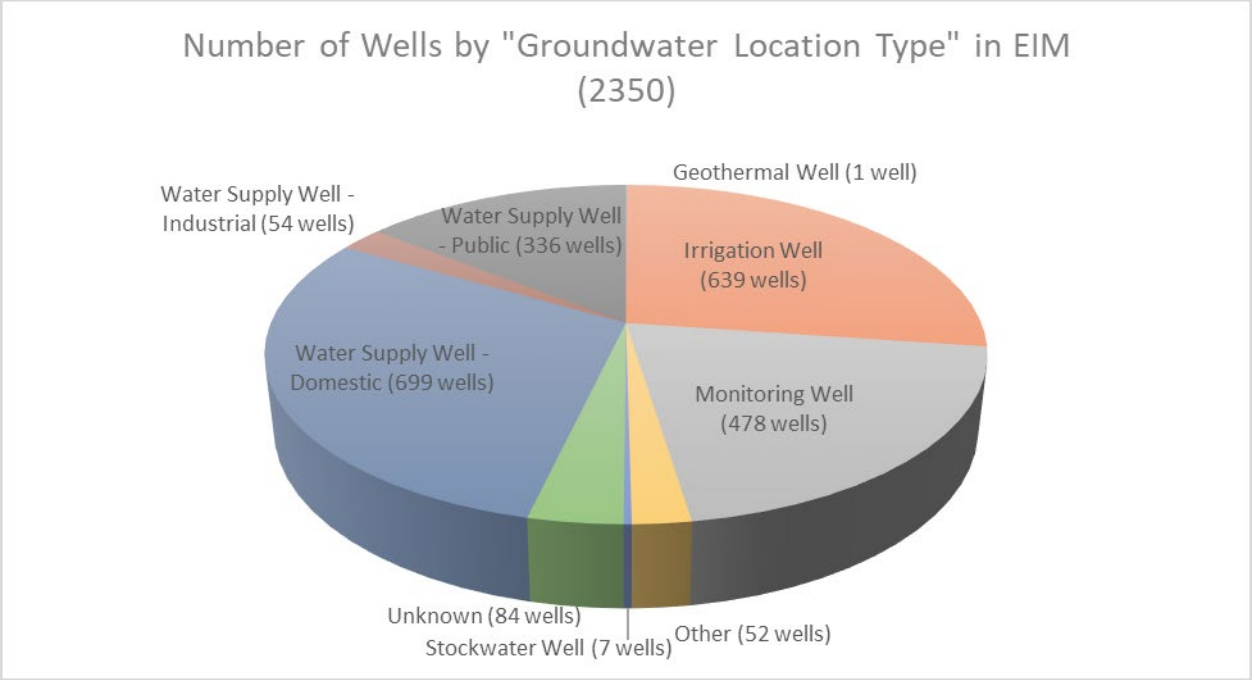

Figure 1. Distribution of wells in Ecology's Water Resources Program (WRP) Environmental Information Management (EIM) groundwater monitoring database.

During Ecology's groundwater monitoring activities during any given year, about 200 wells are monitored throughout the State. For the years 2019, 2020, and 2021, water-level measurements were collected at 321 monitoring wells. Of the 321 water-level wells, 45 well locations had transducer data uploaded to the EIM database. Figure 2 below is a map of Washington State showing the locations of the 321 wells (yellow triangles).

In the "Statewide Groundwater Assessment: 2017", groundwater monitoring schedules, important features that affect groundwater supply, and long-range trends in water-levels for the State are discussed. The information in this document highlights where groundwater supply issues exist and shows the distribution of monitoring wells throughout the State, with an emphasis on geographic regions.

Grant Activities

Cooperative Agreement G20AC00191 provided funds to maintain web services, keep the well registry current, and add wells to the NGWMN portal. Activities for this grant included (1) selection of new well sites to fill in spatial gaps in the groundwater monitoring network and (2) removal of wells from the network that are no longer actively monitored.

There were some challenges during the 2020 to 2022 grant cycle. Covid restrictions resulted in displacement of partner staff from the normal office environment. Partner staff are staff from other agencies who were collecting groundwater data and providing information to Ecology. Consequently, it became difficult to contact some partner staff or they were unresponsive to messages. During 2021, Covid restrictions were lifted to some extent; however, partner staff didn't necessarily return to offices and were still difficult to contact at times. Through 2022 Covid restrictions were largely lifted, but the partner staff work environment continued to be fluid while contact and interaction was sometimes intermittent.

Ecology completed the tasks listed below, with a brief summary of progress to date.

Task 2A: Maintain web services and keep registry updated

The EIM-NGWMN web service continues to be checked and maintained. The connection between Ecology and NGWMN is currently functional and serving data.

The web service continues to provide both discrete (manual) groundwater level measurements and daily average (transducer) measurements. All water level results are normalized to a consistent datum (NGVD88) and reported as depths to groundwater in feet below land surface.

There have been some issues with connectivity while transferring Ecology groundwater data. This resulted in repeated cycling of the NGWMN files request that appeared to result from a prolonged connection and subsequent disconnection during transmittal. The issue was identified by Ecology IT staff and reported to the NGWMN IT support staff.

A second issue resulted when Ecology deleted 41 well sites from the NGWMN registry due to prolonged well monitoring inactivity. Even though the wells are no longer in the registry, they still appear on the NGWMN map page, and the associated data are still present. Ecology has attempted to disconnect each web service (water level, construction, and lithology), but this has not resolved the issue. The protocol for removing the wells from the registry should be revisited , perhaps starting by activating the "do not show" option in the registry.

Data submitted to the NGWMN for the actively monitored wells continue to be updated as the information becomes available and has met quality assurance standards.

Tasks 2B: Support Additional Work – Expand Number of Sites in NGWMN

Under the initial agreement (G16AC00365) which ended in 2018, Ecology submitted 61 wells to the NGWMN. These wells were selected from Ecology's existing groundwater monitoring network.

Ecology submitted an additional 80 wells under the second agreement (G18AC00067). To select these wells, Ecology reached out to municipality and county organizations for potential candidate wells that could be added to the NGWMN.

A total of 25 wells were added to the network during the current grant (G20AC00191). The selected wells fill data gaps for the water level or water quality well networks for regions of the State.

Table 1 lists the principal aquifers in Washington State. The table also lists the aquifer code, aquifer location, and the number of wells in each principal aquifer for all wells submitted to the NGWMN by Ecology.

Table 1. List of principal aquifers, locations, and all wells submitted through 2022.

Principal Aquifer Name	Aquifer Code	Description	Location	Number of Wells
Columbia Plateau basaltic-rock aquifer	N600CMBPLV	Basaltic volcanic rocks	Eastern Washington	50
Columbia Plateau basin-fill aquifer	N100CMBPLB	Unconsolidated to semi-consolidated sand and gravel	Eastern Washington	20
Northern Rocky Mountains Intermontane aquifer system	S100NRMTIB	Unconsolidated to semi-consolidated sand and gravel	Eastern Washington	
Pacific Northwest basin-fill aquifer	S100NRMTIB	Unconsolidated to semi-consolidated sand and gravel	Statewide	19
Pacific Northwest volcanic-rock aquifer	N100PCFNWV	Basaltic volcanic rocks	Western Washington	
Puget Sound aquifer system	S100PGTSND	Unconsolidated to semi-consolidated sand and gravel	Western Washington	40
Willamette Lowlands aquifer system	N100WLMLWD	Unconsolidated to semi-consolidated sand and gravel	Southwest Washington	
Other rocks	N9999OTHER	Sedimentary, volcanic, metamorphic	Statewide	

Figure 2 shows wells submitted to the network under the first two grants (orange circles), wells added during this funding cycle (green circles), as well as the USGS Climate Monitoring Network wells (blue squares).

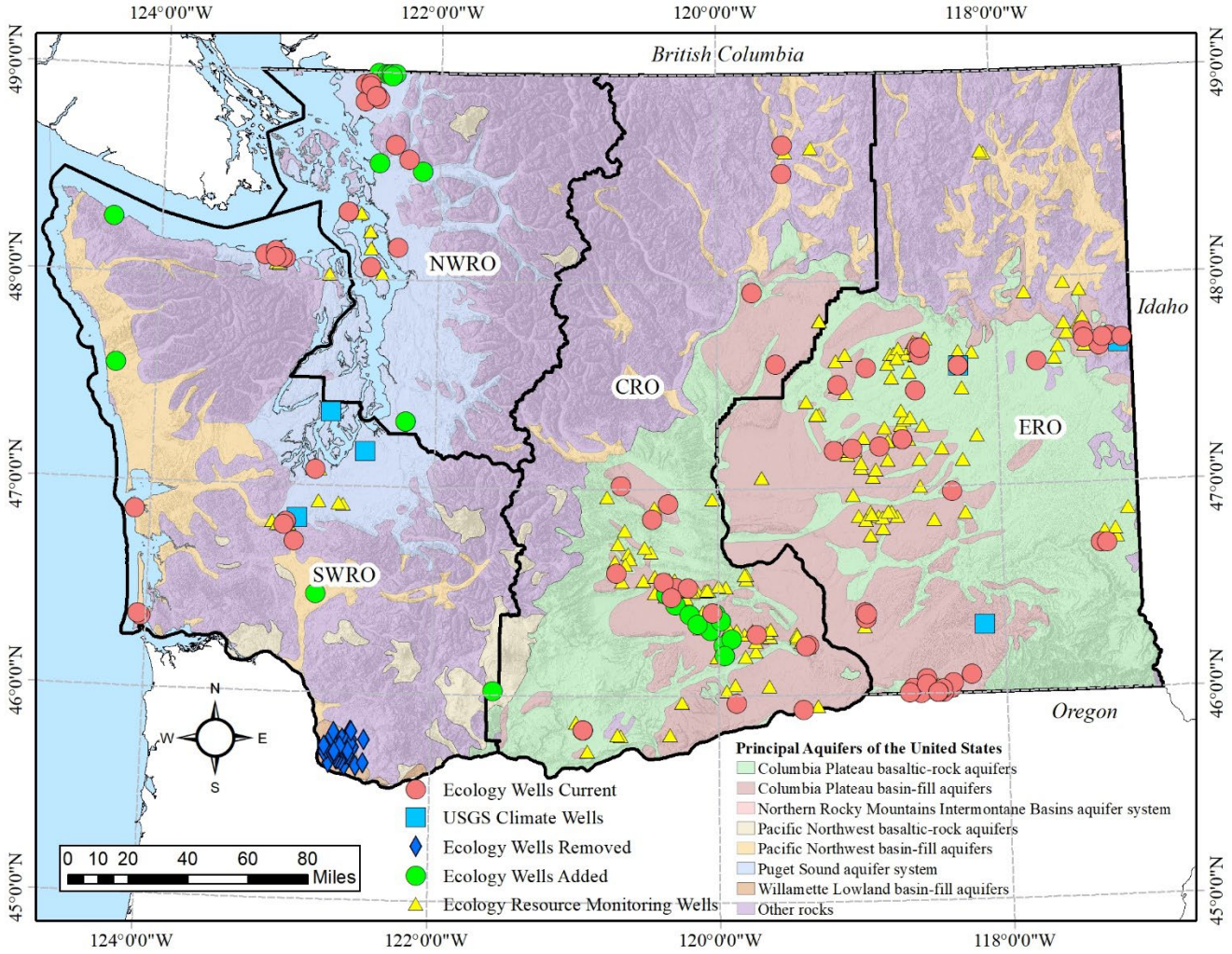

Figure 2. Ecology groundwater monitoring well water-levels measured during 2019-2021, Ecology wells in the NGWMN, USGS climate network wells, Ecology statewide resource monitoring wells, wells added during the current grant, and wells removed during the current grant.

While updating the well registry, it was discovered that not all wells submitted by non-State agencies met the NGWMN selection criteria (ACWI, 2013). Wells were either not being monitored continuously or monitoring had ended when external funding ended.

A group of wells that did not meet the NGWMN selection criteria are located in southwest Washington. Prior to Covid, the Clark County Public Utility District (PUD) had submitted groundwater level data for 41 wells throughout the Vancouver, Washington area. Upon further review of the well submissions, it was observed that the dates of the measurements were not current and did not appear to be updated. After further discussion with the PUD, it was determined that water level data collection from these wells had ceased. The 41 wells have been removed from Ecology's rolls. See Table 2 and Figure 2 (blue diamonds). The removal of the

Clark County PUD wells has created a spatial data gap in this area of the network. Ecology is in the process of determining if there are other wells in the region that would meet the NGWMN selection criteria that could be added to provide some coverage of this groundwater resource.

Table 2. List of wells removed from the NGWMN.

NGWMN ID	Location ID	Latitude	Longitude	Subnetwork	Category	Principal Aquifer
33490	AAB755	45.64641	-122.50680	Background	Surveillance	N100WLMLWD
1033490	AAB756	45.66123	-122.69621	Background	Surveillance	N100WLMLWD
5133490	AAB770	45.66242	-122.45613	Background	Surveillance	N100WLMLWD
3153490	AAD458	45.67852	-122.64150	Background	Surveillance	N100WLMLWD
4153490	AAD459	45.67865	-122.64150	Background	Surveillance	N100WLMLWD
1253490	AAD466	45.71454	-122.65460	Background	Surveillance	N100WLMLWD
2253490	AAD467	45.70611	-122.65684	Background	Surveillance	N100WLMLWD
2353490	AAD488	45.68566	-122.60761	Background	Surveillance	N100WLMLWD
3353490	AAD490	45.67122	-122.61037	Background	Surveillance	N100WLMLWD
4353490	AAD492	45.70706	-122.64815	Background	Surveillance	N100WLMLWD
4173490	AAF401	45.81747	-122.55052	Background	Surveillance	N100WLMLWD
3273490	AAF411	45.73678	-122.52676	Background	Surveillance	N100WLMLWD
3473490	AAF444	45.71242	-122.72351	Background	Surveillance	N100WLMLWD
8473490	AAF449	45.74052	-122.65411	Background	Surveillance	N100WLMLWD
1573490	AAF452	45.64810	-122.58512	Background	Surveillance	N100WLMLWD
6573490	AAF456	45.69994	-122.55515	Background	Surveillance	N100WLMLWD
7573490	AAF457	45.69994	-122.57522	Background	Surveillance	N100WLMLWD
83490	AAF460	45.72722	-122.70436	Background	Surveillance	N100WLMLWD
1083490	AAF461	45.74340	-122.72663	Background	Surveillance	N100WLMLWD
4083490	AAF464	45.70649	-122.61917	Background	Surveillance	N100WLMLWD
6083490	AAF468	45.73122	-122.60704	Background	Surveillance	N100WLMLWD
9083490	AAF471	45.75148	-122.63058	Background	Surveillance	N100WLMLWD
1183490	AAF473	45.77662	-122.60025	Background	Surveillance	N100WLMLWD
6183490	AAF483	45.78849	-122.67592	Background	Surveillance	N100WLMLWD
283490	AAF487	45.77428	-122.54065	Background	Surveillance	N100WLMLWD
1283490	AAF490	45.77567	-122.45259	Background	Surveillance	N100WLMLWD
2283490	AAF491	45.75534	-122.56870	Background	Surveillance	N100WLMLWD
3283490	AAF492	45.75400	-122.54065	Background	Surveillance	N100WLMLWD
4283490	AAF493	45.75409	-122.54060	Background	Surveillance	N100WLMLWD
9283490	AAF502	45.67133	-122.61080	Background	Surveillance	N100WLMLWD
1383490	AAF506	45.71680	-122.55881	Background	Surveillance	N100WLMLWD
8383490	AAF529	45.80907	-122.66229	Background	Surveillance	N100WLMLWD
9383490	AAF530	45.67746	-122.62917	Background	Surveillance	N100WLMLWD
483490	AAF539	45.74196	-122.61786	Background	Surveillance	N100WLMLWD

NGWMN ID	Location ID	Latitude	Longitude	Subnetwork	Category	Principal Aquifer
583490	AAF551	45.81517	-122.53997	Background	Surveillance	N100WLMLWD
5153490	AAD460	45.68340	-122.64660	Background	Surveillance	N100WLMLWD
6153490	AAD461	45.68340	-122.64660	Background	Surveillance	N100WLMLWD
7153490	AAD462	45.70287	-122.66690	Background	Surveillance	N100WLMLWD
8153490	AAD463	45.70287	-122.66690	Background	Surveillance	N100WLMLWD
9153490	AAD464	45.70260	-122.65177	Background	Surveillance	N100WLMLWD
253490	AAD465	45.71454	-122.65460	Background	Surveillance	N100WLMLWD

There is also a set of groundwater wells located in the city of Walla Walla: 10 city wells and four multilevel nested piezometers. Table 3 lists these wells and piezometers.

The 10 city wells were monitored under an Ecology water resources contract to evaluate water levels during operation of a Managed Aquifer Recharge (MAR) project. The contract ended in 2019 after which most of the wells were dropped from the annual monitoring program. Ecology is in talks with Walla Walla to continue submitting information to the Ecology database for the remaining wells.

The piezometer nest is operated by Ecology. The piezometers were last visited in 2017. The intent going forward is to reactivate one or more of the piezometers and assess the need to rehabilitate the nest if necessary..

Table 3. Walla Walla wells

NGWMN ID	Location ID	Latitude	Longitude	Subnetwork	Category	Principal Aquifer
3117850	APC072	46.07206	-118.54951	Suspected/Anticipated Changes	Trend	N100CMBPLB
100030334	BBH630	46.00115	-118.59133	Suspected/Anticipated Changes	Trend	N100CMBPLB
100030336	BBH628	46.02753	-118.64839	Suspected/Anticipated Changes	Trend	N100CMBPLB
100030342	BBH623	46.02129	-118.38319	Suspected/Anticipated Changes	Trend	N100CMBPLB
43503419	APK305	46.00290	-118.43590	Suspected/Anticipated Changes	Trend	N100CMBPLB
27171105	APC069	46.04925	-118.36633	Suspected/Anticipated Changes	Trend	N100CMBPLB
100030346	BCE309	46.00618	-118.67111	Suspected/Anticipated Changes	Trend	N100CMBPLB
100030322	AKT213	46.08812	-118.23721	Suspected/Anticipated Changes	Trend	N100CMBPLB
56964007	APK307	46.04305	-118.55189	Suspected/Anticipated Changes	Trend	N100CMBPLB
18846824	APC070	46.01909	-118.44122	Suspected/Anticipated Changes	Trend	N100CMBPLB
26030163	GWDB_ERO643	46.00381	-118.47281	Background	Surveillance	N600CMBPLV
37197693	GWDB_ERO644	46.00381	-118.47281	Background	Surveillance	N600CMBPLV
96523367	GWDB_ERO645	46.00381	-118.47281	Background	Surveillance	N600CMBPLV
50131278	GWDB_ERO646	46.00381	-118.47281	Background	Surveillance	N600CMBPLV

Table 4 lists the 25 new wells added to the network during the 2020 through 2022 contract. The highlighted wells are the new water quality wells. The 11 wells drilled during the previous NGWMN contract are among those added. Data loggers have been installed in all 11 wells and are recording water levels on a four-hour interval. Six of the 11 wells, located in Whatcom County in Ecology's Northwest Regional Office (NWRO) area (Figure 2), are also being used to provide water quality data. Ten wells located in the Lower Yakima Valley, the new wells in the Central Regional Office (CRO) area (Figure 2), are also providing both water level and water quality data. These wells are manually measured and sampled on a quarterly schedule. The remaining four wells are equipped with data loggers and are providing water level data only.

Water quality data submitted for the 16 wells mentioned above bring the total number of wells in the water quality network to 26.

Table 4. Wells added during the 2022 to 2022 grant cycle. *Locations in blue text are water quality wells.*

NGWMN ID	Location ID	Latitude	Longitude	Subnetwork	Category	Principal Aquifer
100121445	*BKB737*	*46.49207*	*-120.36081*	*Suspected/Anticipated Changes*	*Surveillance*	*N100CMBPLB*
100121447	*BKB738*	*46.44030*	*-120.29880*	*Suspected/Anticipated Changes*	*Surveillance*	*N100CMBPLB*
100121458	*BKB725*	*46.31459*	*-120.05163*	*Suspected/Anticipated Changes*	*Surveillance*	*N100CMBPLB*
100121452	*BKB732*	*46.39270*	*-120.19932*	*Suspected/Anticipated Changes*	*Surveillance*	*N100CMBPLB*
100121460	*BKB734*	*46.39660*	*-120.02058*	*Suspected/Anticipated Changes*	*Surveillance*	*N100CMBPLB*
100121466	*BKB735*	*46.24377*	*-119.96281*	*Suspected/Anticipated Changes*	*Surveillance*	*N100CMBPLB*
100121454	*BKB740*	*46.34638*	*-120.14129*	*Suspected/Anticipated Changes*	*Surveillance*	*N100CMBPLB*
100121472	*BKB741*	*46.27468*	*-119.90532*	*Suspected/Anticipated Changes*	*Surveillance*	*N100CMBPLB*
100121468	*BKB743*	*46.19263*	*-119.95379*	*Suspected/Anticipated Changes*	*Surveillance*	*N100CMBPLB*
100121461	*BKB744*	*46.36052*	*-119.97900*	*Suspected/Anticipated Changes*	*Surveillance*	*N100CMBPLB*
100115907	BMP064	47.55970	-124.28500	Background	Trend	N100PCFNWB
100115908	BMP065	48.26381	-124.34792	Background	Trend	N100PCFNWB
100115909	BMP066	48.09611	-123.16910	Known Changes	Trend	N100PCFNWB
100115910	*BMP060*	*48.99684*	*-122.45614*	*Known Changes*	*Trend*	*S100PGTSND*
100119302	*BNN012*	*48.99330*	*-122.39918*	*Known Changes*	*Trend*	*S100PGTSND*
100119303	*BNN013*	*48.99333*	*-122.37842*	*Known Changes*	*Trend*	*S100PGTSND*
100119304	*BNN014*	*48.99337*	*-122.36460*	*Known Changes*	*Trend*	*S100PGTSND*
100119305	*BNN015*	*48.99326*	*-122.33265*	*Known Changes*	*Trend*	*S100PGTSND*
100119306	*BNN016*	*48.98195*	*-122.35692*	*Known Changes*	*Trend*	*S100PGTSND*
100115911	BNN010	46.47730	-122.81569	Background	Trend	N100PCFNWB
100119301	BNN055	46.01949	-121.56859	Background	Trend	N100CMBPLB
100013644	AHT089	48.56163	-122.43611	Suspected/Anticipated Changes	Trend	S100PGTSND
100092119	Auburn_6D	47.31514	-122.20967	Known Changes	Trend	S100PGTSND
100092118	Auburn_6S	47.31514	-122.20967	Known Changes	Trend	S100PGTSND
100092120	Skagit_Mink_MW1	48.52560	-122.12049	Known Changes	Trend	S100PGTSND

The NGWMN wells comprise a network structure consisting of three subnetworks. The wells added for this grant are partitioned into the subnetworks of 48 known change wells, 59 suspected change wells, and 22 background wells. Within each subnetwork, there are three monitoring categories. The categories for the 129 wells consist of 45 trend wells and 84 surveillance wells.

Summary

The objective of the NGWMN is the implementation of a long-term national groundwater quantity and quality monitoring network (ACWI, 2013).

This is achieved by engaging other organizations who collect groundwater data and establishing a cooperative agreement with them. These data are shared through a web service that transfers the organization data to a common data portal. The cumulative data from all contributors is made available through a map-based interface. Ecology requests a defined set of data elements from each of the contributors so that the ensemble product shows a consistent and uniform output from all contributors.

Ecology entered into a cooperative two-year agreement to provide groundwater level data to enhance the NGWMN starting in 2020 and ending in 2022. Ecology completed the following tasks:

- Continued to maintain web services between the Environmental Information Management system and the NGWMN portal.
- Added 25 new wells and removed 41 existing wells in the NGWMN well registry.
- Completed and submitted the final status report.

Ecology is currently providing data for 129 groundwater wells throughout Washington State. Of the 129 wells, 103 wells provide water level data only, 16 wells provide both water level and water quality data, and 10 wells provide water quality data only.

Tasks that are currently underway to improve and refine the NGWMN submissions include:

- Identify and remove existing wells submitted to the NGWMN that are no longer supporting groundwater monitoring activities or have been found not to satisfy the NGWMN criteria.
- Identify and add new water-level and water quality wells to the network that meet the NGWMN criteria.
- Continue to identify and fill spatial gaps in the State-wide groundwater monitoring network that may be potentially part of the NGWMN.

Ecology prepared and submitted this report in keeping with the four required elements as outlined in section 5.(b)(1)[1] of the NGWMN Terms and Conditions.

[1] 1) A comparison of actual accomplishments to the objectives of the agreement established for the budget period and overall progress in response to the performance metrics.
2) The reasons that established goals were not met, if appropriate.
3) Additional pertinent information including, when appropriate, analysis and explanation of cost overruns or high unit costs.
4) An outline of anticipated activities and adjustments to the program during the next budget period.

References

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