INDIANA GEOLOGICAL & WATER SURVEY
INDIANA UNIVERSITY

# Final Technical Report

**Project Title:**

Assimilating groundwater-level trend monitoring by the Indiana Geological Survey into the National Groundwater Monitoring Network (NGWMN)

**Agency Name:**

Indiana Geological Survey

**Award Number:**

G16AC00360

**Award Term:**

September 1, 2016 through August 31, 2018

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## OVERVIEW OF WORK

The Indiana Geological and Water Survey (IGWS) became a new data provider to the USGS National Ground-Water Monitoring Network (NGWMN) with the agreement under the FY2016 NGWMN program announcement with agreement dates from 9/1/2016 to 8/31/2018 (Grant/Cooperative Agreement Number: G16AC00360). Data was compiled and organized into NGWMN formats from a pre-existing micrometeorological and groundwater monitoring network referred to as the Indiana Water Balance Network (IWBN). The IWBN web site is: https://igws.indiana.edu/CGDA/waterBalanceNetwork.cfm. Data contributed from the IWBN to the NGWMN can be found at: https://cida.usgs.gov/ngwmn/.

During the new data provider phase of the two-year project, the well registry was completed for all twelve IGWS NGWMN sites. Subsequently, Web services were developed and posted for water-level, lithology, well casing, and well screen data/metadata for sites where the necessary information was readily available. Field work and data processing protocols were also documented and included herein.

Subsequent work during year-2 of the award period included compiling information missing from Web services (mostly well casing, well screen, and lithology details) for several sites. Additionally, monitoring well maintenance (mostly consisting of well protective cover installation) was conducted at multiple sites and well development was done at all sites except one location where site access was an issue. Persistent data services accomplished during year-2 included updates of water-level Web services with new data that underwent quality assurance protocols.

As a point of clarification, The Indiana Geological Survey's (IGS) name was changed to the Indiana Geological and Water Survey (IGWS) during the project period as a result of Indiana Senate Bill 416 that took effect on July 1, 2017. The name change required minor revisions to the data files submitted to the NGWMN.

## DESCRIPTION OF EXISTING WATER-LEVEL NETWORKS

Several past projects undertaken at the IGWS resulted in the collection of continuous data related to water balance parameters (especially weather/potential evapotranspiration, soil moisture, and groundwater elevation). In lieu of removing sensors following project completion, IGWS researchers developed the Indiana Water Balance Network (IWBN) to monitor long-term trends in water loss and gain for multiple components of the hydrologic budget for 12 sites, which are representative of various hydrogeologic settings and underlying aquifer systems.

Groundwater-elevation data are collected primarily to determine how groundwater levels are changing over time (i.e., trend monitoring described in ACWI, 2013). Data from sites with continuous/high-frequency water-level records are also used to assess groundwater-recharge dynamics for the various hydrogeologic settings.

## DESCRIPTION OF SITE SELECTION CRITERIA AND PROCESS

Twelve groundwater monitoring wells were chosen from 33 wells where the Indiana Geological and Water Survey (IGWS) is actively monitoring groundwater in Indiana as part of the Indiana Water Balance Network (IWBN) (Figure 1 and Table 1). The groundwater monitoring sites were selected based on four primary criteria: their density/spatial distribution throughout Indiana, their depth relative to other wells in the vicinity, their unique representation of regional (IDNR, 2011) and national aquifers (ACWI, 2013), and the availability of minimum data requirements as outlined in the national groundwater monitoring framework document (ACWI, 2013). Multiple wells are present at each site but the deeper well was typically selected for inclusion in the NGWMN because these wells could represent more extensive, regional aquifers.

The focus of the IGWS groundwater monitoring program is to establish baseline conditions and track long-term water-level fluctuation trends. Hence, each of the selected wells are categorized as "trend" monitoring wells, consistent with the NGWMN framework document (ACWI, 2013).

**Table 1. List of wells from the IWBN selected for NGWMN. Table includes a portion of the data provided in the Well Registry table including field names.**

| SiteName | DecLatVa | DecLongVa | AltVa | AltUnits | WellDepth | WellDepthUnits |
|---|---|---|---|---|---|---|
| Rushville_S | 39.5799721 | -85.4649384 | 287.87 | m | 3.08 | m |
| FortWayne_N1 | 41.2476 | -85.118248 | 266.65 | m | 30.5 | m |
| FortWayne_N2 | 41.2477149 | -85.139121 | 256.05 | m | 22.08 | m |
| Muncie_N | 40.2221534 | -85.4232041 | 285.94 | m | 10.09 | m |
| Martinsville_N | 39.496509 | -86.428606 | 184.58 | m | 3.34 | m |
| Glenwood_N | 39.6383908 | -85.2916502 | 335.14 | m | 4.92 | m |
| Indianapolis_N | 39.818356 | -86.204417 | 215.05 | m | 1.22 | m |
| LakeStation_W | 41.5845385 | -87.2753423 | 179.76 | m | 2.54 | m |
| Brownsburg_N1 | 39.8944763 | -86.3730135 | 278.11 | m | 11.97 | m |
| NewCastle_NE | 40.053383 | -85.314942 | 307.41 | m | 0.86 | m |
| Newburgh_E | 37.9480863 | -87.296249 | 142.95 | m | 27.13 | m |
| Bloomington_N | 39.194058 | -86.512716 | 231 | m | 3.8 | m |

**LIST OF MINIMUM DATA ELEMENTS AND HOW THEY ARE PROVIDED TO DATA PORTAL**

All sites were assigned unique site number identifiers and site names were standardized to include a geographic reference (nearest city and direction of site relative to city). Well construction/completion logs were gathered for groundwater monitoring wells selected for inclusion in the NGWMN. Since the deeper groundwater monitoring wells are often "wells of opportunity" that were not installed by IGWS personnel, the well construction details existed in multiple formats including geotechnical report records, Indiana Department of Natural Resources (IDNR) well driller logs, and geologist field notes. Information related to well screen and well casing characteristics were gleaned from the construction/completion logs and entered into the NGWMN Web service data structures as shown in Tables 2 and 3.

**Table 2. Well casing and well screen web service data elements**

| Well casing web service | Well screen web service |
|---|---|
| Agency code | Agency code |
| Site number | Site number |
| Casing depth from | Screen depth from |
| Casing depth to | Screen depth to |
| Casing depth units | Screen depth units |
| Casing material | Hole size |
| Casing diameter | Hole size units |
| Casing diameter units | Screen material |
| | Screen diameter |
| | Screen diameter units |

Lithologic data included in the NGWMN web service (Table 3) were also obtained from the multiple sources used to extract well construction information (geotechnical logs, driller's logs, and field notes) and additional resources (hydrogeologic reports, master's theses) were used to extract more detailed lithologic information. Lithologic units were standardized based on USGS conventions from the Rock Term Abbreviation table in Section 6.11.1.4 of the User's Manual for the National Water Information System of the U.S. Geological Survey Ground-water Site-Inventory (USGS, 2004). The textural (i.e., grain size) term was chosen that best matched the above lithologic data. Till is listed the USGS table and is a heterogeneous mixture of clay, silt, sand, and gravel but the closest grain size term is "Sand, gravel, and clay." Sand, gravel, and clay was selected for till or diamictons.

Groundwater-level data were compiled for the NGWMN water-level web service for the deepest monitoring wells at each monitoring location. A standardized data-processing routine was developed using spreadsheets wherein data from both barometrically compensated non-vented pressure transducers and vented pressure transducers could be translated into the NGWMN web service format including the data elements listed in Table 3 (see Description of Data Quality and Quality Assurance Processes section for more details).

The NGWMN network requires date and time in an ISO8601 time format. The concatenate function in Excel was used to convert the date and time recorded by the pressure transducer (e.g., 8/28/2012 14:35) into the ISO8601 format (e.g., `2012-08-28T14:35:37-05:00`). The -5.00 value is the difference from Coordinated Universal Time (UTC), also referred to as Greenwich Mean Time. An example concatenate formula is as follows:

=CONCATENATE(TEXT(A8,"yyyy-mm-ddThh:MM:ss"),$J$2)

(cell $J$2 contains the value -5.0)

Groundwater-level data are typically logged on hourly time intervals using nonvented pressure transducers and downloaded to a laptop computer during site visits. Two sites have vented pressure transducers connected to a datalogger, which can be downloaded either directly using a laptop computer or remotely via a modem. Manual depth-to-water measurements are also collected during site visits. Example field forms for the site visit are included in Appendix A. The manual depth-to-water measurements are converted to a groundwater elevation value by subtracting the depth-to-water and well riser stickup from the GPS-surveyed reference elevation at ground surface. Nonvented pressure transducer groundwater-level data are barometrically compensated using site-specific barometric pressure data that are also logged using hourly time intervals. The pressure transducer data are converted from water-column depth measurements (i.e., height of water above the pressure transducer) to groundwater elevations based on a linear relationship established using matched pairs of manual-measured groundwater elevations and compensated pressure transducer water-column data. The daily groundwater elevation data are compiled and stored in spreadsheets, and hydrographs are plotted along with hand-measured groundwater elevations for QA/QC purposes. The depth-to-water below grade is calculated by subtracting the pressure transducer groundwater elevation from the ground surface elevation.

Accuracy values for pressure transducer measurements were obtained from the transducer manufacturer's technical specification sheets. The accuracy value is a percentage of the full scale (FS) of the pressure transducer. The accuracy value multiplied by the FS is the value populated into the ObservationAccuracy field in the WATERLEVEL file.

**Table 3. Lithology and water-level Web service data elements**

| Lithology web service | Water-level web service |
|---|---|
| Agency code | Agency code |
| Site number | Site number |
| Lithology ID | Time (ISO 8601) |
| Observation method | Original parameter |
| Lithology depth from | Original unit |
| Lithology depth to | Original value |
| Lithology depth units | Depth to water below land surface |
| | Observation method |
| | Data provided by |
| | Observation accuracy |
| | Accuracy unit |

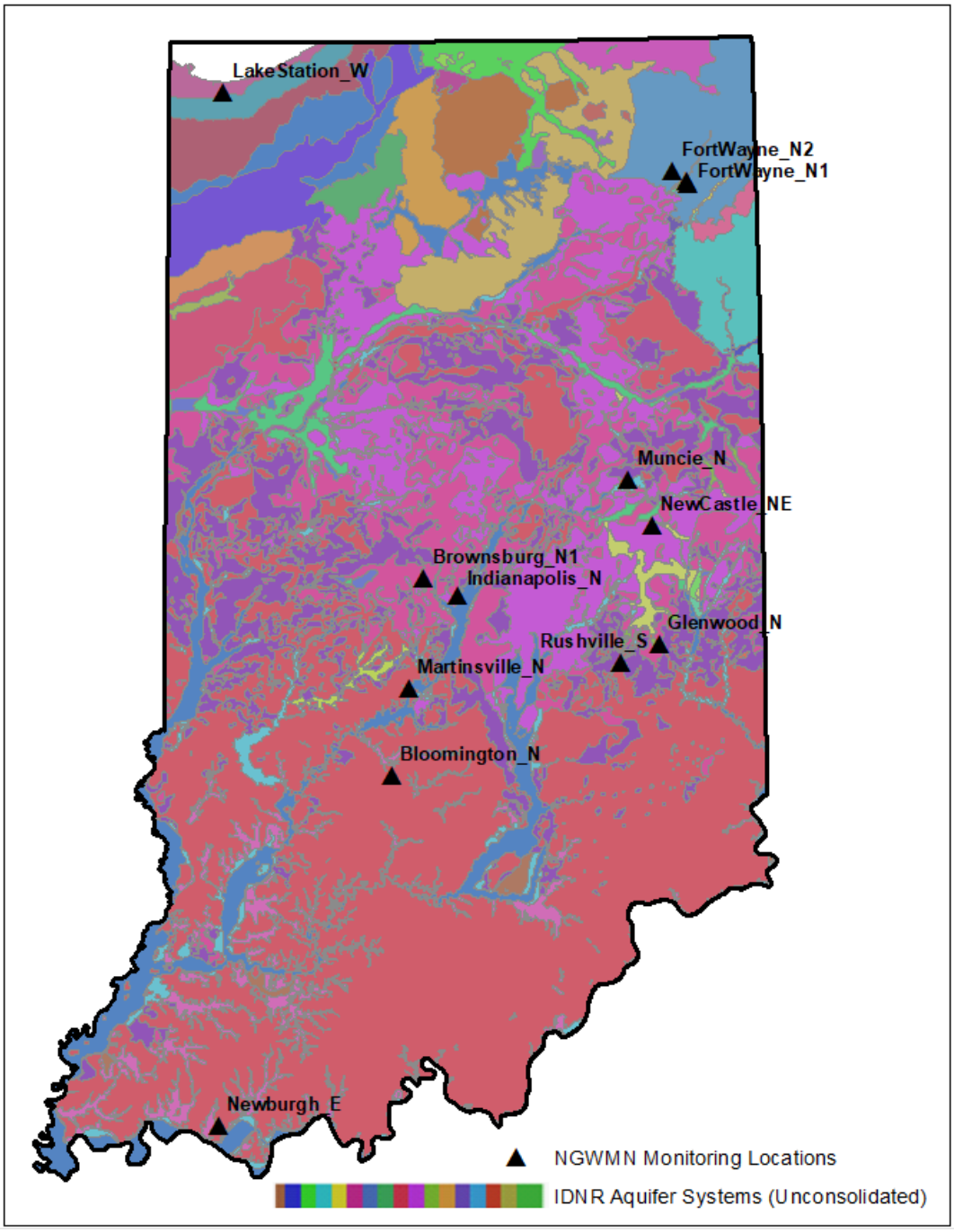
**NOTES ON ANY SITES THAT HAVE MISSING REQUIRED DATA ELEMENTS**

Many missing data components were located and compiled during year-2 of the project, but some sites continue to lack required elements. After searching through existing files and inquiring with previous monitoring coordinators, lithology logs are not currently available for the NewCastle_N1 and Bloomington_N (see Figure 1 for locations) sites. We plan to visit these sites during the 2019 spring/summer field season to obtain geophysical logs or cores if funds and site access (for coring) are available. Well screen details are also missing for sites NewCastle_N1 and Brownsburg_N1 and we plan to request funds as part of the next NGWMN funding cycle to conduct downhole camera surveys to identify screened intervals at these locations. Attempts were made to view the screened interval with an inexpensive downhole camera but were unsuccessful.

**SITES THAT DO NOT MEET FRAMEWORK DOCUMENT REQUIREMENTS**

As noted in the project proposal, re-instating site access for the Newburgh_E monitoring location was contingent upon successful communication with the landowner. Unfortunately, email attempts have thus far been unsuccessful in establishing renewed correspondence with property owners. The existing continuous monitoring record spans from 2007 to 2012, but without site access we are unable to meet minimum water-level measurement frequencies outlined in Table 4.5.1.1 of the NGWMN framework document (ACWI, 2013). We plan to continue attempts to contact the property owners, but can remove the Newburgh_E monitoring site from the NGWMN site list in the meantime, if necessary.

**Figure 1. Map of Indiana showing IGWS groundwater monitoring sites that are included in the NGWMN. Indiana Dept. of Natural Resources (unconsolidated aquifer boundaries (IDNR, 2011) are shown to demonstrate the complexity of glacial aquifer systems in Indiana. The IDNR aquifer types are used for local aquifer names in the "Site Info" NGWMN tables.**




## WEB SERVICES USED OR INSTALLED FOR THIS PROJECT

The IGWS maintains groundwater data that have undergone QA/QC steps (described later in this report) in comma-separated value (CSV) files, while the Web API for the NGWMN uses a SQL database. After newly acquired water-level data are finished with quality assurance procedures and ready for uploading to the NGWMN web service, CSV files are manually added to the SQL database by an IGWS Information Services staff member.

**FIELD TECHNIQUES FOR WATER-LEVEL MEASUREMENT**

## *Manual water-level measurements*

Indiana Water Balance Network (IWBN) sites are routinely visited on average every 12 weeks to conduct maintenance and collect both manual and automated water-level data. Manual measurements of groundwater level and total well depth are made from the well reference point, typically the top of well casing marked by an indelible marker, using a Geotech ET electronic-tape meter (accuracy = $\pm$0.01 ft). The measurement, date, and time are recorded on field sheets (Appendix A) and well sediment accumulation is noted, if present. Measurements are transferred to a well metadata spreadsheets when field personnel return to the office. Field sheets are scanned into a pdf format and saved to a network directory to provide both paper and electronic versions of field notes.

## *Automated water-level measurements*

Continuous groundwater-level data are collected using both vented (e.g., Druck PDCR series sensors) and unvented (e.g., In-Situ Rugged Troll 100 and Solinst 3000 series sensors) pressure transducers. The IGWS is currently working to move toward vented instruments as the standard automated measurement approach that would also facilitate real-time data service, but the transition is constrained due to budget limitations including the need for multiplexers to expand to the required number of IWBN site datalogger terminals.

Monitoring wells instrumented with unvented (i.e., absolute) pressure transducers with internal memory are downloaded during routine site visits immediately following manual water-level measurement. Barometric pressure sensors located at the site are also downloaded and raw water-level data are compensated for barometric effects using sensor manufacturer software. The uncorrected water-level, barometric and compensated water-level data are stored on a field laptop hard drive and then transferred to a network directory upon field personnel's return to the office.

## *Site latitude, longitude, and elevation (GPS positions)*

Well locations are established using a differentially corrected Real Time Kinematic (RTK) global positioning system (GPS) unit. A Leica Viva GNSS GS12 receiver and Leica controller capable of 8mm horizontal and 15mm vertical baseline accuracy are used to establish horizontal and vertical positions. The controller is set to record positions after a 4-cm three-dimensional (3D) accuracy tolerance is met to ensure a minimum accuracy is obtained and 3D coordinate quality (3D CQ) values are commonly in the range of 0.3 – 3 cm.

Locations are determined for the top of the well casing (TOC), the ground surface immediately adjacent to the well and the top of the protective well cover (if present). GPS location data are stored in the Leica controller and the following information are transferred to a well metadata spreadsheet when field personnel's return to the office:

- Point ID
- Northing
- Easting
- Elevation
- Accuracy (3D CQ)
- Notes

**DESCRIPTION OF DATA QUALITY AND QUALITY ASSURANCE PROCESSES**

*Converting compensated water column thickness measurements to water level depth and elevation*

In accordance with the NGWMN framework report (ACWI, 2013), continuous water-level data are calibrated against manual water-level determinations. Compensated water-level data, reported as water-column depth, are entered into an Excel worksheet along with manual measurements that are temporally coincident to the nearest hour. The manual depth-to-water measurements are converted to groundwater elevation by subtracting depth-to-water measurements and well casing riser heights from the RTK GPS determined ground elevation (meters) at the well. Compensated water column measurements are plotted on the x-axis of an XY scatter plot and manually-determined groundwater elevations are expressed on the y-axis (Figure 2). A linear trendline is fit through the data to establish the linear relationship between the variables and a regression coefficient of determination ($R^2$) greater than 0.85 is used to ensure a consistent relationship. If the pressure transducer is replaced or moved within the well column, a new regression equation is generated to update the calibration.

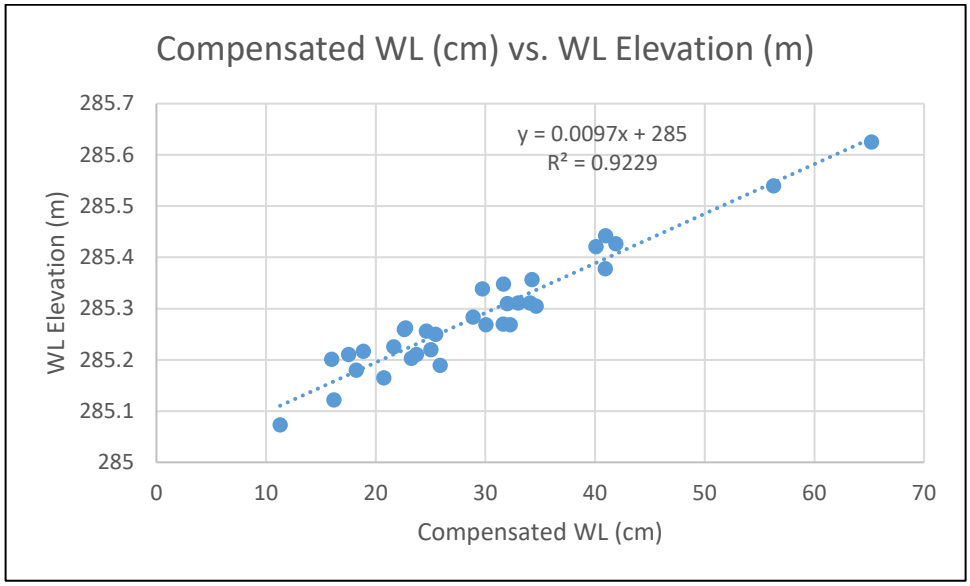



**Figure 2. XY scatter plot showing compensated pressure transducer water column readings versus manual groundwater elevation measurements and linear trendline.**

The resulting linear transform equation is used to convert hourly compensated water-column depth readings to groundwater elevations relative to the ground surface in a separate worksheet. Data are plotted to show the groundwater hydrograph for the entire monitoring period and a visual QA/QC check is done to verify that the periodic manual measurements correspond well with the continuous record.

*Posting data to NGWMN Web services following initial processing and QA/QC*

Once hourly water-level data have completed the initial processing and QA/QC steps in a spreadsheet, data samples are pulled from each day at approximately 11pm to establish a daily value. The daily values for depth-to-water below ground surface are then transferred to a CSV tabular data format along with dates and

times that are converted from serial to ISO 8601 formats for the date/time field. The remaining data elements for water-level Web services are also added for each record. Finally, the data are transferred to IGWS database and Web development personnel to update the active Web services linked to the NGWMN portal.

**ANAYLTE LIST USED FOR SAMPLE NETWORKS / LABORATORIES**

The analyte list is currently limited to water level data. IGWS staff conduct all water-level measurements and compile data; therefore, no outside laboratory is used.

**WORK DONE TO SUPPORT THE NGWMN AS A DATA PROVIDER**

*Well maintenance*

Well maintenance tasks entailed developing each of the IGWS NGWMN monitoring wells. Wells were pumped or bailed to remove sediment and clear the well screened interval (Figure 3). In most cases, decreased groundwater turbidity was achieved. Development methods, total well depth changes, groundwater removal volumes, and other details were documented for each site using standardized well development forms (Appendix B).

**Figure 3. Image showing IGWS personnel developing a monitoring well at the FortWayne_N1 site.**

Monitoring well steel protective covers were also installed at several sites (Figure 4). The protective covers that stick up above grade also have a locking cover for additional security. Flush mount protective covers were installed where mower or vehicle traffic is anticipated (Figure 5). Flexible conduit was installed within the protective cover to allow a cable to route from the vented pressure transducer in the monitoring well to the datalogger in a nearby weather-resistant enclosure (Figure 5).

**Figure 4. Image showing IGWS personnel installing a protective well cover at the Rushville_S monitoring site.**

**Figure 5. Image showing IGWS personnel installing a flush-mount protective well cover at the Muncie_N monitoring site.**

*Supporting persistent data services*

Maintaining web services during year-2 of the project entailed QA/QC of continuous water-level data prior to posting data to the NGWMN Portal. Additional tasks completed under this objective included: maintaining the list of sites in the NGWMN Well Registry and updating site information, making routine updates to metadata, and updating web services following database changes. A groundwater hydrograph for one of the monitoring sites is shown in Figure 6 as an example of data provided by the IGWS.

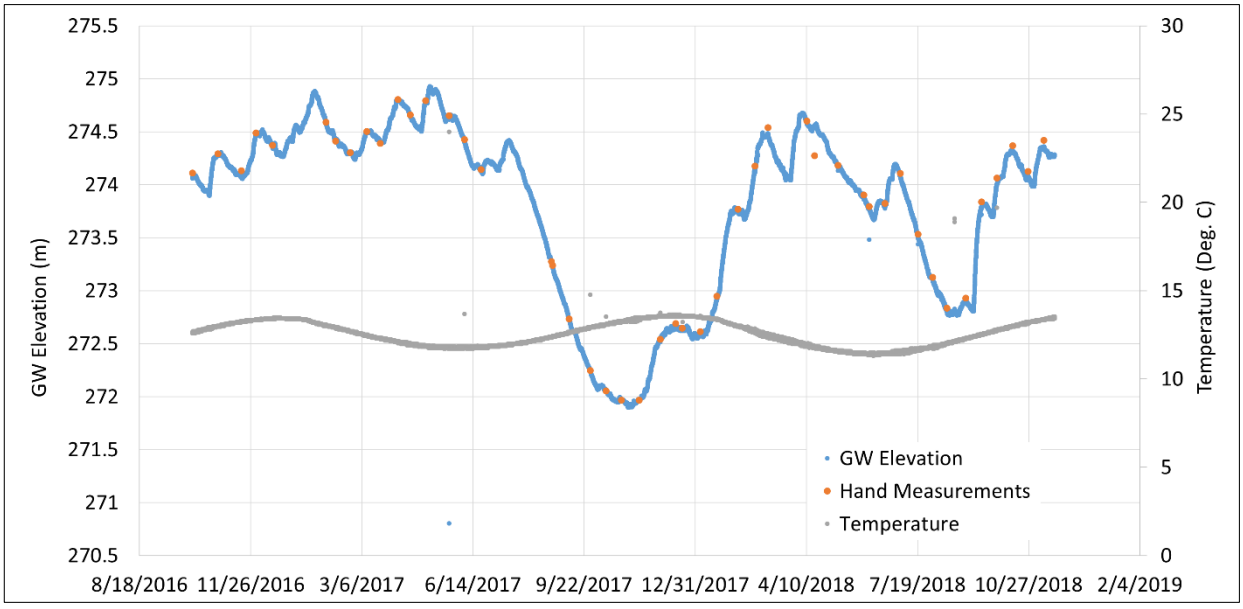



**Figure 6. Groundwater hydrograph and temperature data for the Brownsburg_N2 monitoring site.**

**References**


Advisory Committee on Water Information (ACWI), 2013, A national framework for ground-water monitoring in the United States: U.S. National Ground-Water Monitoring Network Report, 170 p.

Indiana Department of Natural Resources (IDNR), 2011, Unconsolidated aquifer systems of Indiana, Geographic Information Systems polygon shapefile available at: https://maps.indiana.edu/layerGallery.html?category=Aquifers.

US Geological Survey (USGS), 2004, Ground-water Site-inventory System, National Water Information System, Open-File Report 2004-1238 v.4.3, available at: https://pubs.usgs.gov/of/2004/1238/.

**Appendix A**

**Example Field Forms**

**CGDA IWBN Site Check**
**Field Checklist**
**v20170822**

(Pre-field work instructions:

1. Check connection/data graphs on the IWBN web site: https://igs.indiana.edu/CGDA/waterBalanceNetwork.cfm
2. Check Task list with RJA,
3. Check previous Field Checklist for other information.)

Site name: _____
Staff: _____
Weather: cloudy – partly sunny; _____mph _____; _____°F

Weather station:

Anemometer
Spinning? Y / N / NA / _____
Level? Y / N / NA / _____
Pyranometer
Level? Y / N / NA / _____
Clear? Y / N / NA / _____
Net Radiometer
Level? Y / N / NA / _____
Clear? Y / N / NA / _____
Rain gauge
Level? Y / N / NA / _____
Funnel clear? Y / N / NA / _____
Strong box
Moisture? Y / N / NA / _____
Wires taunt? Y / N / NA / _____
Replace desiccant pads –desiccant syringes
Vegetation
Type of crop? _____
Height of crop? _____(ft) _____(inches).

Monitoring well(s):

Name of well: _Weather station / Riparian / Stilling well / _____
Depth to water (from top of PVC): _____(ft)
Total Depth (from top of PVC): _____(ft)
Time of measurement: _____(24 hours)

Name of well: _Weather station / Riparian / Stilling well / _____
Depth to water (from top of PVC): _____(ft)
Total Depth (from top of PVC): _____(ft)
Time of measurement: _____(24 hours)

Name of well: _Weather station / Riparian / Stilling well / _____
Depth to water (from top of PVC): _____(ft)
Total Depth (from top of PVC): _____(ft)
Time of measurement: _____(24 hours)

Weir:

Name of weir: _____

Depth of water (above weir): _____(ft / cm)

Time of measurement: _____(24 hours)

Download pressure transducers (ptrans):

Weather station: S/N _____

Riparian: S/N _____

Stilling well: S/N _____

Baro logger: S/N _____

(On-site instructions: Barometrically compensate ptrans data while on site. Note file name and folder of compensated file.)

Photograph:

Obtain photos from at least 2 sides of weather station

Obtain photo of crop with water level meter for scale

Notes: _____

_____

_____

_____

_____

_____

_____

_____

Additional tasks required: _____

_____

_____

Signature: _____

Date: _____

(Post-field work instructions:

1. Complete and scan form into pdf document. Save pdf document to following folder: P:\GeoThermal\Monitoring_network\Data\Field_Notes. Include site name and date in pdf file name (e.g., IWBN_Site_Check_Bradford-Woods_20160522.pdf).
2. File paper copy in 3-ring binder in Room S425.)
3. Download raw and compensated ptrans file(s) to P:\GeoThermal\Monitoring_network\Data\well_data > Downloads > “site name” > create folder with date in folder name (e.g., 20160509_ptrans-download))

**Appendix B**

**Example Well Development Form**

Indiana Geological and
Water Survey

# MONITORING WELL DEVELOPMENT

| Project Name | County | Well Name |
|---|---|---|
| Monitoring Site | Unique Well Number ___ | IGS Well ID ___ |

1. Can this well be purged dry? ☐ Yes ☐ No

2. Well development method
   - surged with bailer and bailed ☐
   - surged with bailer and pumped ☐
   - surged with block and bailed ☐
   - surged with block and pumped ☐
   - surged with block, bailed and pumped ☐
   - compressed air ☐
   - bailed only ☐
   - pumped only ☐
   - pumped slowly ☐
   - Other _____

3. Time spent developing well ____ min.

4. Depth of well (from top of well casisng) ____.__ ft.

5. Inside diameter of well ____.__ in.

6. Volume of water in filter pack and well casing (if known) ____.__ gal.

7. Volume of water removed from well (if known) ____.__ gal.

8. Volume of water added (if any) ____.__ gal.

9. Source of water added _____

10. Analysis performed on water added? ☐ Yes ☐ No
(If yes, attach results)

| | Before Development | After Development |
|---|---|---|
| 11. Depth to Water (from top of well casing) | a. ____.__ ft. | ____.__ ft. |
| Date | b. mm/dd/yyyy | mm/dd/yyyy |
| Time | c. __:__ ☐ a.m. ☐ p.m. | __:__ ☐ a.m. ☐ p.m. |
| 12. Total well depth | ____.__ feet | ____.__ feet |
| 13. Sediment thickness | ____.__ feet | |
| 14. Water clarity | Clear ☐ Turbid ☐ | Clear ☐ Turbid ☐ |
| | (Describe) _____ | (Describe) _____ |
| Fill in if drilling fluids were used and well is at solid waste facility: | | |
| 14. Total suspended solids | ____.__ mg/l | ____.__ mg/l |
| 15. COD | ____.__ mg/l | ____.__ mg/l |

16. Well developed by: Name (first, last) and Firm
First Name: Last Name:

17. Additional comments on development:

I hereby certify that the above information is true and correct to the best of my knowledge.

Signature: _____

Print Name: _____

Firm: _____

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| FortWayne_N2 | 41.2477149 | -85.139121 | 256.05 | m | 22.08 | m | 8-9-2017 |
| Muncie_N | 40.2221534 | -85.4232041 | 285.94 | m | 10.09 | m | 3-29-2016 |
| Martinsville_N | 39.496509 | -86.428606 | 184.58 | m | 3.34 | m | 5-22-2017 |
| Glenwood_N | 39.6383908 | -85.2916502 | 335.14 | m | 4.92 | m | 2-18-2017 |
| Indianapolis_N | 39.818356 | -86.204417 | 215.05 | m | 1.22 | m | 3-15-2016 |
| LakeStation_W | 41.5845385 | -87.2753423 | 179.76 | m | 2.54 | m | 10-9-2018 |
| Brownsburg_N1 | 39.8944763 | -86.3730135 | 278.11 | m | 11.97 | m | 3-23-2017 |
| NewCastle_NE | 40.053383 | -85.314942 | 307.41 | m | 0.86 | m | 5-9-2013 |
| Newburgh_E | 37.9480863 | -87.296249 | 142.95 | m | 27.13 | m | NA |
| Bloomington_N | 39.194058 | -86.512716 | 231 | m | 3.8 | m | 1-10-2018 |