NEON USER GUIDE TO GAUGE HEIGHT (NEON.DP1.20267)

PREPARED BY	ORGANIZATION	DATE
Kaelin M. Cawley	AQU	12/15/2017
Keli Goodman	AQU	12/15/2017
Stephanie Parker	AQU	12/15/2017

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1 DESCRIPTION

1.1 Purpose

This document provides an overview of the data included in this NEON Level 1 data product, the quality controlled product generated from raw Level 0 data, and associated metadata. In the NEON data products framework, the raw data collected in the field, for example, staff gauge height are considered the lowest level (Level 0). Raw data that have been quality checked via the steps detailed herein, as well as simple metrics that emerge from the raw data are considered Level 1 data products.

The text herein provides a discussion of measurement theory and implementation, data product provenance, quality assurance and control methods used, and approximations and/or assumptions made during L1 data creation.

1.2 Scope

This document describes the steps needed to generate the L1 data product Gauge Height - the water level read from a staff gauge pre- and post- data collected for all aquatic protocols - and associated metadata from input data. This document also provides details relevant to the publication of the data products via the NEON data portal, with additional detail available in the file, Gauge Height Publication Workbook (AD[05]), provided in the download package for this data product.

This document describes the process for ingesting and performing automated quality assurance and control procedures on the data collected in the field pertaining to Gauge Height and Field Metadata collected alongside all AOS protocols. The raw data that are processed in this document are detailed in the file, NEON Raw Data Validation for Gauge Height (AD[04]), provided in the download package for this data product. Please note that raw data products (denoted by 'DP0') may not always have the same numbers (e.g., '10033') as the corresponding L1 data product.

2 RELATED DOCUMENTS AND ACRONYMS

2.1 Associated Documents

AD[01]	NEON.DOC.000001	NEON Observatory Design (NOD) Requirements
AD[02]	NEON.DOC.000913	TOS Science Design for Spatial Sampling
AD[03]	NEON.DOC.002652	NEON Level 1, Level 2 and Level 3 Data Products Catalog
AD[04]	NEON.DP0.20267.001_dataValidation.csv	NEON Raw Data Validation for Gauge Height
AD[05]	NEON.DP1.20267.001_variables.csv	Gauge Height Publication Workbook
AD[06]	NEON.DOC.001152	Aquatic Sampling Strategy
AD[07]	NEON.DOC.001085	AOS Protocol and Procedure: Stream Discharge
AD[08]	NEON.DOC.001646	General AQU Field Metadata Sheet
AD[09]	NEON.DOC.000008	NEON Acronym List
AD[10]	NEON.DOC.000243	NEON Glossary of Terms
AD[11]	OS_Generic_Transitions .pdf	NEON Algorithm Theoretical Basis Document: OS Generic Transitions
AD[12]		NEON's Ingest Conversion Language (NICL) specifications

2.2 Acronyms

Acronym	Definition
AOS	Aquatic Observation System

3 DATA PRODUCT DESCRIPTION

Gauge height is a ubiquitous measurement collected at many aquatic water bodies because it is a rapid quantitative assessment of the physical hydrology of a system. For example, the U.S. geological survey operates over 7,000 gauges across the United States (waterdata.usgs.gov/nwis). At all NEON aquatic sites gauge height is based on readings made from a fixed staff gauge with 1 cm resolution. This reading can be used to determine the water depth at the staff gauge location and over time can be used to monitor fluctuations in water level.

NEON aquatic general field metadata will facilitate data sharing, analysis, and interpretation of unfamiliar research data. Furthermore, the NEON aquatic field metadata will be important to maintaining long-term data sets, such as documenting changes in qualitative site characteristics over time.

Physical characteristics of a water body, e.g., flow data in streams and water level in lakes, are critical to interpreting chemical and biological measurements. Gauge height is a rapid assessment of water level. By collecting multiple measurements of discharge, channel area, and stream stage (i.e., gauge height) over a range of discharge levels, a stage-discharge rating curve can be developed for a specific cross section. This cross section location will remain fixed so that the stage-discharge relationship can be checked and revised regularly, when necessary (e.g., following major disturbance events), for the duration of NEON Operations. Water level will be tracked with gauge height in addition to using pressure transducer sensors at identified inflow and outflow locations at lakes, nearshore stations at rivers and sensor sets #1 and #2 in streams.

During all field sampling and measurement collection events, AQU field technicians also record gauge height read from a staff gauge (Figure 1). The procedure for reading the staff gauge is in SOP A.6 of AD[07]. In addition to recording staff gauge height at the beginning and ending of a field day, technicians also record general field metadata according to AD[08]. This metadata includes qualitative assessments of temperature, wind speed, cloud cover, human impacts (e.g. trash), and riparian vegetation phenology. The AQU general field metadata is designed to apply to all aquatic data collected via any field protocol on any one date. These assessments are limited to a controlled list of ranges that enable programatic interpretation of the recorded data. There is also a free-form remarks field where technicians can record any additional notes about the field sampling day.

3.1 Spatial Sampling Design

Gauge Height is recorded at all 34 NEON aquatic sites, which include wadeable streams, lakes, and large rivers. The staff gauge is in a pool at streams and near the shore below the ordinary low water mark at lakes and rivers.

3.2 Temporal Sampling Design

Gauge height will be measured whenever field technicians are collecting measurements or samples at an aquatic site. This is at least bi-weekly for stream sites and monthly for lake and river sites.

Figure 1: Example of staff gauge installed in a pool

3.3 Variables Reported

All variables reported from the field or laboratory technician (L0 data) are listed in the file, NEON Raw Data Validation for Gauge Height (AD[04]). All variables reported in the published data (L1 data) are also provided separately in the file, Gauge Height Publication Workbook (AD[05]).

Field names have been standardized with Darwin Core terms (http://rs.tdwg.org/dwc/; accessed 16 February 2014), the Global Biodiversity Information Facility vocabularies (http://rs.gbif.org/vocabulary/gbif/; accessed 16 February 2014), the VegCore data dictionary (https://projects.nceas.ucsb.edu/nceas/projects/bien/wiki/VegCore; accessed 16 February 2014), where applicable. NEON TOS spatial data employs the World Geodetic System 1984 (WGS84) for its fundamental reference datum and Earth Gravitational Model 96 (EGM96) for its reference gravitational ellipsoid. Latitudes and longitudes are denoted in decimal notation to six decimal places, with longitudes indicated as negative west of the Greenwich meridian.

Some variables described in this document may be for NEON internal use only and will not appear in downloaded data.

3.4 Spatial Resolution and Extent

One staff gauge is installed at every NEON aquatic site. The gauge height reported for this dataproduct will be recorded at this location only. All AQU general metadata will be representative of the site level. Overall, this re-

sults in a spatial hierarchy of:

spatial hierarchy = **siteID** (ID of NEON site) -> **domainID** (ID of a NEON domain)

If data are still provisional, the location that comes with the data download may be subject to change. If an event occurs that requires the staff gauge to be moved, it is likely that data may be published on the portal prior to updates to location information being updated in the database.

1. Use the def.extr.geo.os.R function from the geoNEON package, available here: https://github.com/NEONScience/NEON-geolocation
2. Or use the NEON API (http://data.neonscience.org/api; e.g., http://data.neonscience.org/api/v0/locations/LEWI.AOS.gauge) to access the most up-to-date location information.

3.5 Temporal Resolution and Extent

The finest temporal resolution that gauge height will be tracked is per sampling day. Sampling days are dictated by other AQU protocols and occur at least every two weeks at stream sites and at least once per month at lake and river sites. There are periods of time where gauge height may be measured for a few consecutive days during spring, summer, and fall sampling campaigns that involve biological sampling, riparian assessment, and sediment sampling. However, at other times of the year, gauge height may be reported much less frequently, e.g. during bi-weekly water chemistry sampling at stream sites.

3.6 Associated Data Streams

Since gauge height and associated field metadata are recorded during all trips to an aquatic site to collect samples or measurements, the metadata apply to all other aquatic data products.

The gauge height measurements are used as an input to the level 4 Stream discharge rating curve (NEON.DP4.00133) and continuous stream discharge (NEON.DP4.00130) data products. Stream discharge field collection (NEON.DP1.20048) and Elevation of surface water (NEON.DP1.20016) and also used as inputs to the level 4 discharge data products.

3.7 Product Instances

Gauge height is measured bi-weekly or more frequently at wadeable stream sites and monthly or more frequently at lake and large river sites depending on the time of year and frequency of all aquatic protocols.

3.8 Data Relationships

Data can be linked to other aquatic data products based on a combination of **siteID** or **locationID** and **collectDate**. One record, containing a gauge height at the start of the field day and second gauge height measurement made at the end of the field day, will be taken each day that an aquatic protocol is executed at a site.

4 DATA QUALITY

4.1 Data Entry Constraint and Validation

Many quality control measures are implemented at the point of data entry within a mobile data entry application or web user interface (UI). For example, data formats are constrained and data values controlled through the provision of dropdown options, which reduces the number of processing steps necessary to prepare the raw data for publication. An additional set of constraints are implemented during the process of ingest into the NEON database. The product-specific data constraint and validation requirements built into data entry applications and database ingest are described in the document NEON Raw Data Validation for Gauge Height, provided with every download of this data product. Contained within this file is a field named 'entryValidationRulesForm', which describes syntactically the validation rules for each field built into the data entry application. Data entry constraints are described in Nicl syntax in the validation file provided with every data download, and the Nicl language is described in NEON's Ingest Conversion Language (NICL) specifications ([AD[12]).

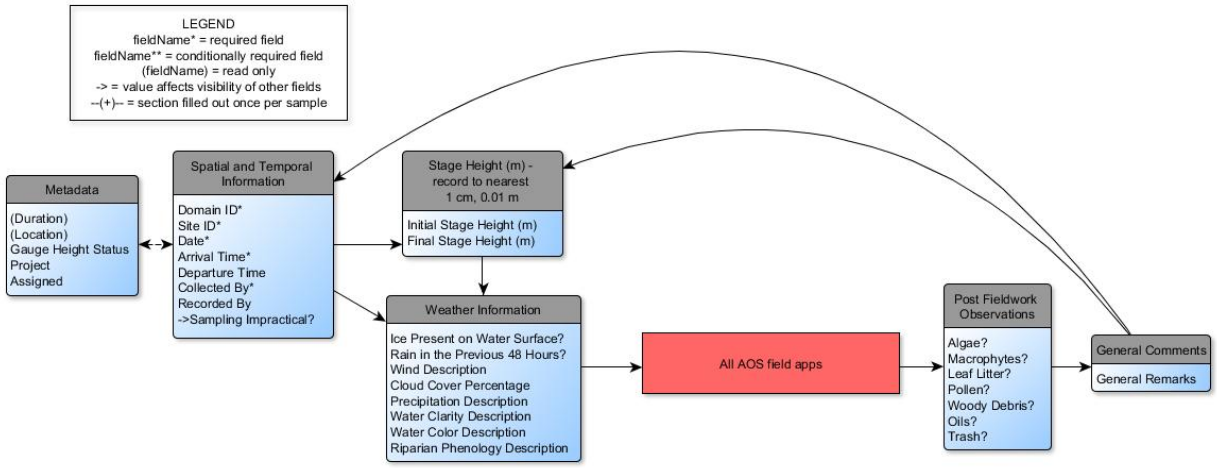

Figure 2: Schematic of the applications used by field technicians to enter gauge height and field metadata

1. The Gauge Height app uses a "status" field to warn data entry technicians when both an initial and/or final guage height has not been entered. The data will show a yellow bar and display the text "Gauge Height Missing".
2. The app has a minimum of 0 and maximum of 40 for the gauge height to accomodate deep lake sites.
3. **samplingImpractical** captures scenarios where attempts at measurements and/or sample collection were made. **initialStageHeight**, **finalStageHeight**, **waterColorDescrip**, and **waterClarityDescrip** will not be recorded if a value is entered for **samplingImpractical**. It is possible that meteorological or other qualitative descriptors of the site will be entered is a value is entered for **samplingImpractical**. If **samplingImpractical** is set to "other" additional **remarks** are required.
4. The app sets the departure time to the arrival time if no departure time is entered.
5. The app checks that departure time is later or equal to arrival time prior to record submission. A record cannot be saved with a departure time earlier than the arrival time.

4.2 Automated Data Processing Steps

Following data entry into a mobile application or web user interface, the steps used to process the data through to publication on the NEON Data Portal are detailed in the NEON Algorithm Theoretical Basis Document: OS Generic Transitions (AD[11]).

4.3 Data Revision

All data are provisional until a numbered version is released; the first release of a static version of NEON data, annotated with a globally unique identifier, is planned to take place in 2020. During the provisional period, QA/QC is an active process, as opposed to a discrete activity performed once, and records are updated on a rolling basis as a result of scheduled tests or feedback from data users. The Change Log section of the data product readme, provided with every data download, contains a history of major known errors and revisions.

4.4 Quality Flagging

The **dataQF** field in each data record is a quality flag for known errors applying to the record. Please see the *Special Considerations* section of this document for a list of known errors that may be present in the data, and below for an explanation of **dataQF** codes specific to this product.

fieldName	value	definition
dataQF	legacyData	Data recorded using a paper-based workflow that did not implement the full suite of quality control features associated with the interactive digital workflow

5 Communicated Precision

The staff gauge is marked to the nearest centimeter and technicians round up to the nearest centimeter. Thus, readings should be interpreted as +/- 1 centimeter.

6 REFERENCES