Southwest Gravity Program

SGP utilities

User guide
2020

Table of contents

1. Description of scripts

SGP utilities (a.k.a sgp-utils) is a collection of scripts used by the USGS Southwest Gravity Program for parsing, plotting, and post-processing data from Micro-g Lacoste absolute gravity meters. The scripts were developed for the A-10 gravity meter and some may need slight modification to be useful with FG-5 data.

The data source for SGP utilities are the .project.txt files written by 'g' software. These files contain the final gravity value and metadata in a human-readable, free-form format.

A brief summary of each script:

fg5_parse.py - creates a text (Excel) file with relevant information from a specified directory of project.txt files.

fg5_plot.py - creates figures, one per station, showing gravity change over time, using a file created using A10_parse.py.

fg5_SY_plot.py - plots gravity change (converted to feet of free-standing water) vs. groundwater-level change. The slope of this relation is an estimate of specific yield.

fg5_WL_plot.py - plots gravity time series together with groundwater-level time series.

fg5_toExcel.py - converts the text file output by fg5_parse.py into an Excel file (1 sheet per site) and retrieves groundwater-level data from NWIS.

fg5_update.py - applies a laser drift correction and (or) soil moisture correction to the gravity value in a *.project.txt file.

In addition to these scripts, the sgp-utils code repository includes Ingestor, a Gui for copying and archiving field data.

fg5_parse.py

fg5_parse.py parses the project.txt files in a given directory and writes a tab-delimited txt file with gravity values and metadata that can be opened in Excel.

The script can be called two ways:
 - Double-clicking fg5_parse.py in Windows.
 - Right-clicking on a directory and selecting Send to > parse_fg5.cmd in the context menu (requires installing the parse_fg5.cmd)

If double-clicking, a dialog is shown to choose the directory to parse. An output file is written in the sgp-utils/working_dir directory.

If right-clicking, the output file is written to the directory where the directory to be parsed resides.

NOTE: fg5_parse output files are subject to deletion during periodic Gravity Data Archive cleanup. Please move important output files to project-specific directories.

Output format

fg5_parse creates a tab-delimited .txt file that can be opened in Excel (e.g., by drag-and-drop). Four of the columns contain lookup formulas to compare output to reference values; to enable these formulas one must click the "Enable editing" button if shown at the top of the worksheet. The lookup values are:

Polar motion lookup - Polar motion values in the project.txt files are compared to values provided by the International Earth Rotation Service (https://datacenter.iers.org/data/latestVersion/10_FINALS.DATA_IAU2000_V2013_0110.txt). The IERS values are periodically copied to an Excel spreadsheet. The Excel worksheet shows the difference between the values used in the .project.txt file and the IERS value for the project date.

Laser calibration lookup - Laser calibration values in the project.txt files are compared to values recorded in an Excel worksheet. If the correct laser calibration was used, values in this column should be zero.

Clock calibration lookup - Clock calibration values in the project.txt files are compared to values recorded in an Excel worksheet. If the correct clock calibration was used, values in this column should be zero.

Laser and clock calibrations are determined during routine visits to Micro-g Lacoste.

fg5_parse.ini

Parameters that control output written by fg5_parse.py are stored in fg5_parse.ini:
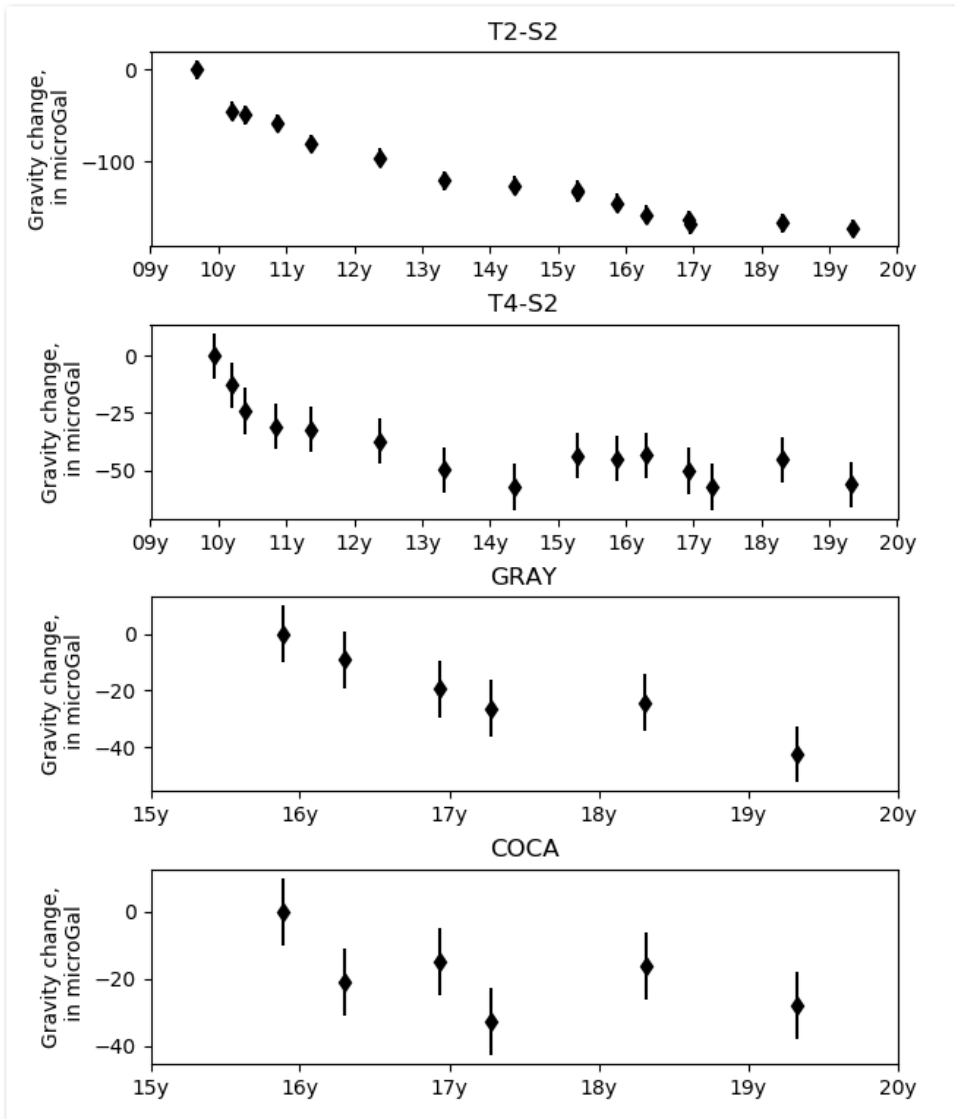
```
[Parameters]
```
SKIP_UNPUBLISHED = `true`
If true, Files with the string 'unpublished' in the path will be ignored.

fg5_plot.py

fg5_plot.py takes the output file written by fg5_parse.py and produces plots of gravity change. Double-clicking fg5_plot.py opens a Windows open dialog. Select a .txt file written by fg5_parse.py.

fg5_plot.ini

Parameters that control output written by fg5_parse.py are stored in fg5_plot.ini:

```
YAXIS_LIMITS_TIGHT = True
```

If true, tight bounds are enforced on the y axis

YAXIS_FT_OF_WATER = False
If true, gravity change is converted to ft of water using the Bouguer slab approximation (12.77 uGal/ft). Otherwise plots are in microGal.

ERROR_BAR = 10.0
+/- Error bars, in microGal

SET_XLIM = False
```
XLEFT = parser.parse('2018-02-01')
XRIGHT = parser.parse('2018-05-25')
ALTFMT = mdates.DateFormatter('%yyyy')
```
If SET_XLIM is False, the x-axis for each plot is scaled automatically. If SET_XLIM is true, the other three values are read and the x-axes in all plots formatted consistently.

Saving plots

Plots created by fg5_plot are not automatically saved. To do so, click the save button on the toolbar of each plot. Saving them as .svg files will allow further editing in Illustrator.

fg5_SY_plot.py

fg5_SY_plot.py creates specific yield plots of gravity change and water-level change. Data are retrieved from NWISweb using the USGS siteID(s) for the gravity station, as read from siteIDcrossref.csv.
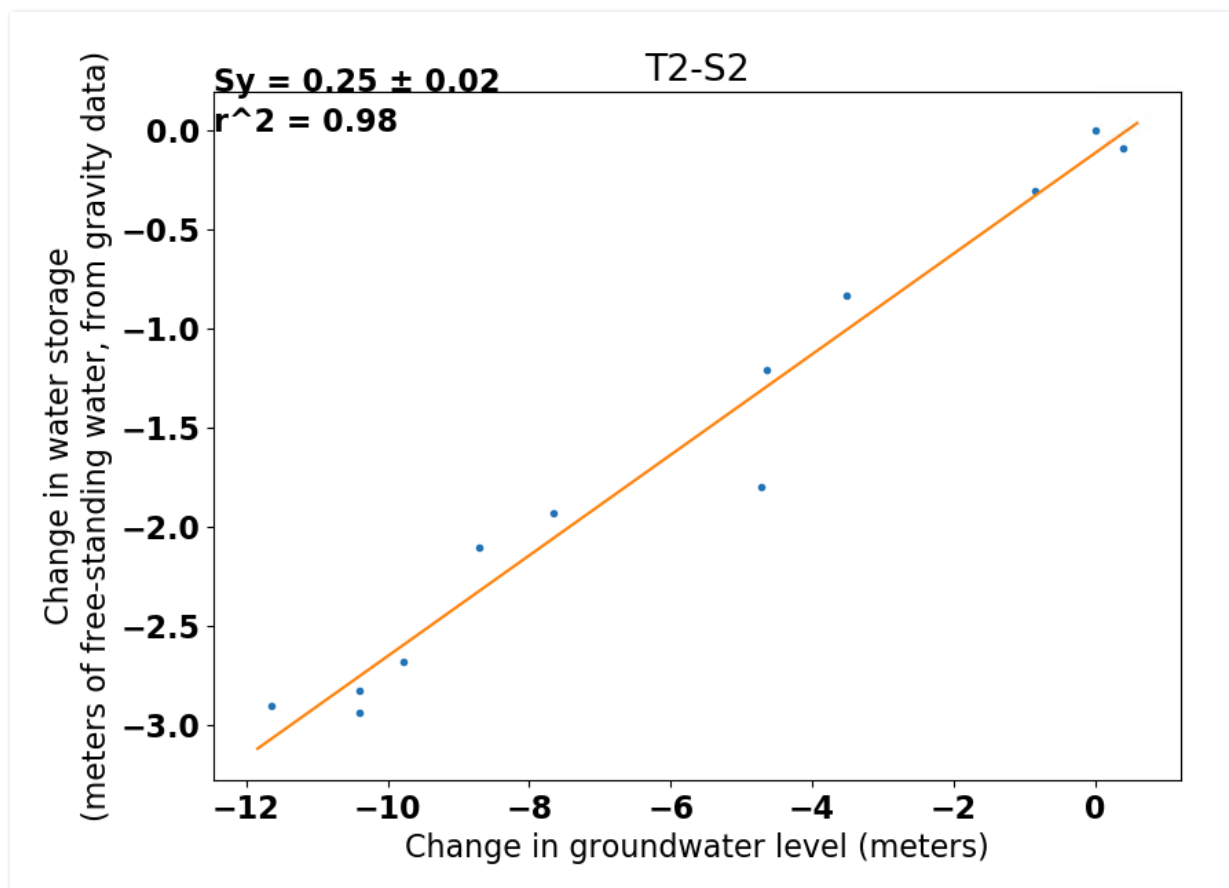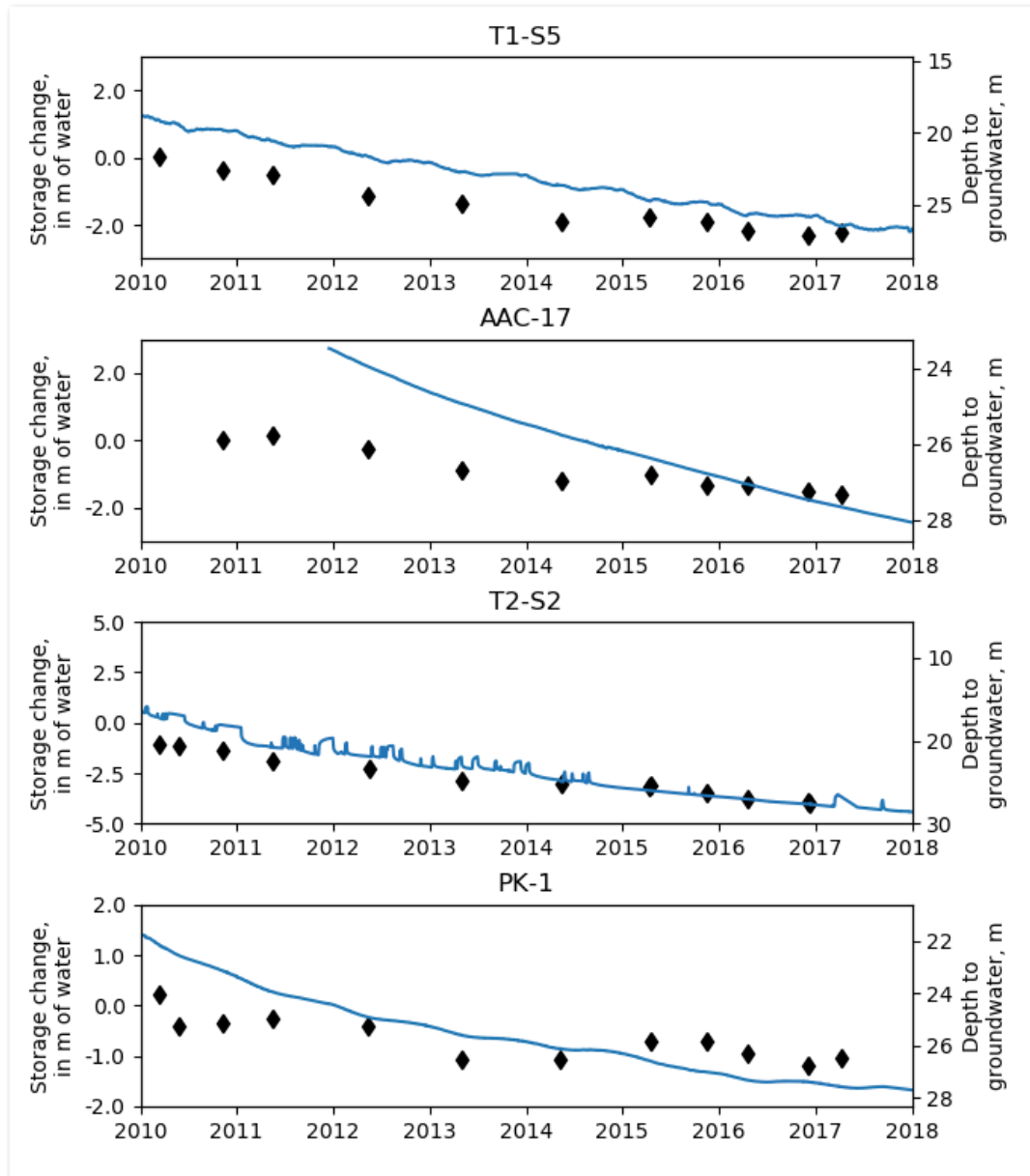

Saving plots

Plots created by fg5_plot are not automatically saved. To do so, click the save button on the toolbar of each plot. Saving them as .svg files will allow further editing in Illustrator.

fg5_WL_plot.py

fg5_WL_plot.py creates time-series plots of gravity change and water-level change. Data are retrieved from NWISweb using the USGS siteID(s) for the gravity station, as read from siteIDcrossref.csv.


Saving plots

Plots created by fg5_plot are not automatically saved. To do so, click the save button on the toolbar of each plot. Saving them as .svg files will allow further editing in Illustrator.

fg5_toExcel.py

fg5_toExcel converts the text file generated by fg5_parse to an Excel file, with one station per sheet. In addition, it downloads groundwater-level data from NWIS. This Excel file is useful for further analysis.

Plots of time-series gravity change and specific yield are generated automatically. Groundwater-level measurements in the specific yield calculation are taken from the discrete measurements in NWIS using Excel's VLOOKUP function. If discrete measurements weren't taken on the same day as gravity, and(or) daily values from NWISweb are needed, the formula will need to be edited appropriately.

Note that column F, relative GWL, is intentionally blank. This column needs to be populated manually as the groundwater-level lookup is often incomplete and the user needs to select a valid cell to be the reference value.
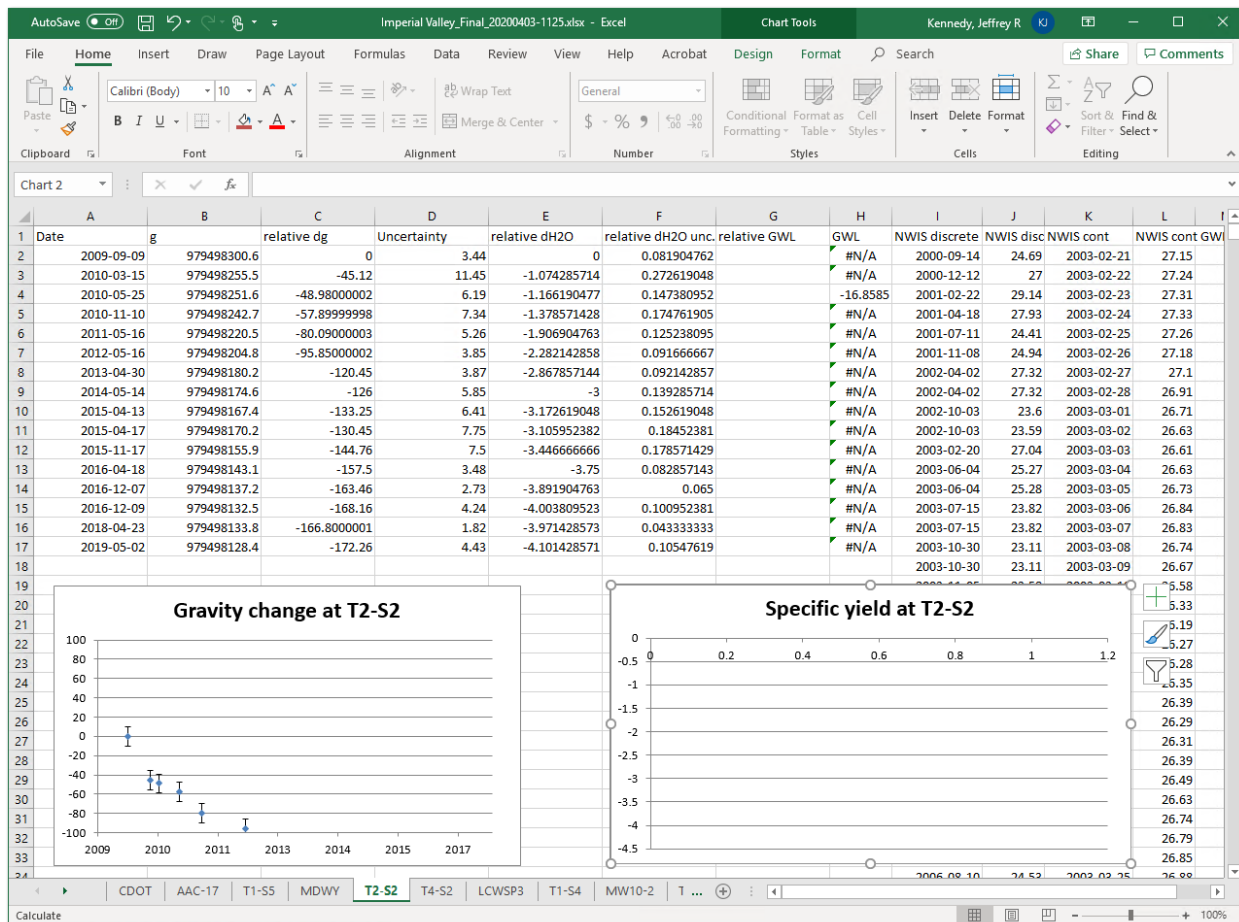
fg5_update.py

Use with caution.

fg5_update updates the gravity value in the .project.txt file by applying a pro-rated correction based on the laser calibration. Laser calibrations (performed at Micro-g Lacoste) are stored in a workbook in the Gravity Data Archive/Absolute Data/A-10/Instrument Mainenance directory.

fg5_update creates a copy of the .project.txt file with _original appended to the name. The original .project.txt file is overwritten with the updated gravity value and a comment added indicating the magnitude of the correction and other details.

2. Helper functions

fg5_parse.cmd - add a shortcut to fg5_parse to the right-click context menu.

siteIDcrossref.csv - cross-reference between gravity station names and USGS site IDS of collocated monitoring wells.

nwis_get_data.py - retrieves groundwater-level data for a USGS site from the National Water Information System (NWIS).

fg5.py - given a project.txt file, returns a python object with relevant fields. Primarily for use in other scripts.

fg5_parse.cmd

fg5_parse.cmd is a windows command script that allows fg_parse.py to be run by right-clicking a folder and selecting "fg5_parse.cmd" from the Send to > menu from the popup context menu (screenshot below)

The file fg5_parse.cmd needs to be copied to a user's "Send to" directory in their profile (for each user on a machine). To open the "Send to" directory, open a Windows Explorer window and type shell:sendto in the address bar. This takes you to the "Send to" items for your profile. Copy the fg5_parse.cmd file here.

The fg5_parse Windows script calls fg5_parse.py, passing the name of the selected directory as a parameter.

The fg5_parse.py output file is written in the current directory. Copy needed output files somewhere else; files in the gravity archive are subject to deletion during periodic cleanup.
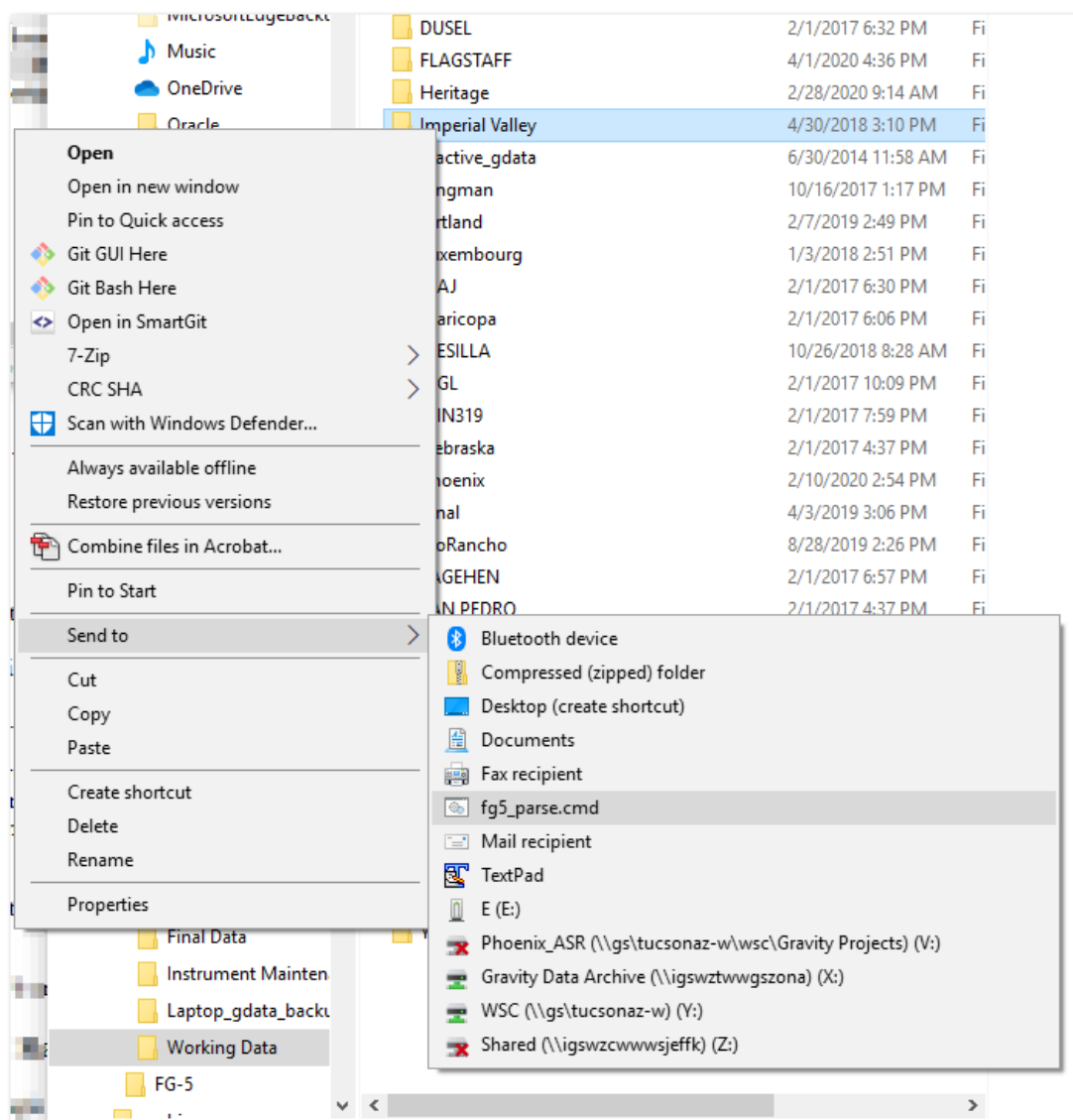
siteIDcrossref.csv

This file provides the relation between gravity station ID and USGS site ID for stations with collocated monitoring wells. Used to retrieve groundwater-level data from NWIS. One gravity station can have multiple collocated monitoring wells. One master file is used for all projects.

Example:

```
AAC-17,324303114480501
PK-1,324325114461001
T3-S2,324426114530901
T2-S2,324410114533801
T1-S5,324226114554901
T1-S1,324252114555801
JCLI,350545106335901
JCLI,350545106335902
JCLI,350545106335903
SOUT,350359106333901
SOUT,350359106333902
SOUT,350359106333903
SOUT,350359106333904
SOUT,350359106333905
SOUT,350359106333906
SOUT,350359106333907
SOUT,350359106333908
...
```

nwis_get_data.py

nwis_get_data retrieves groundwater-level data from NWIS. USGS site ID for a given gravity station is retrieved from siteIDcrossref.csv.

fg5.py

fg5.py is a python function that, given the path to a project.txt file, returns an fg5 object with fields corresponding to the items in the project.txt file.

TODO list

There are many ways these scripts can be improved and many might make good tasks for someone wanting to learn more python.

A current list is here:
https://github.com/jkennedy-usgs/sgp-utils/issues