

Radar Rainfall Analysis

March 2020 Summary Report



Improving our region's water quality

Prepared for 3 Rivers Wet Weather

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301 David L. Boren Blvd., Suite 3050
Norman, Oklahoma 73072
www.vieuxinc.com

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Glossary

Average Difference (AD) – Average of the absolute percentage differences between the rain gauge data and uncalibrated radar data sampled over the gauges.

Bias Correction Factor – Bias is a systematic error that can be corrected through calibration. The correction factor is the sum of the gauges divided by the sum of the sampled radar values over the gauges.

Calibrated Average Difference (CAD) – Average of the absolute percentage differences between the rain gauges and local bias calibrated radar data sampled over the gauges.

Cumulative Distribution Plot (CDP) – A graph depicting the accumulation of a rain gauge and the unadjusted/adjusted radar over that gauge.

Decibels of Reflectance (dBZ) – The logarithmic scale for measuring radar reflectivity factor or a measure of reflectivity of a radar signal off a remote object.

Gauge Adjusted Radar Rainfall (GARR) – Bias corrected radar rainfall through comparison with rain gauges.

KCCX – Federal Communications Commission (FCC) call sign for the NEXRAD near State College, PA.

KPBZ – Federal Communications Commission (FCC) call sign for the NEXRAD near Pittsburgh, PA.

Level II – The Level II radar products are the highest resolution, and consist of the base data that includes reflectivity measured in decibels of reflectance (dBZ) among Doppler velocity and spectrum width.

Level III – The Level III radar products are derivative products from Level II, and consist of horizontal and vertical reflectivity among other products.

Local Bias (LB) – An approach to adjusting radar rainfall that uses the ratio of gauge to radar accumulations from surrounding gauges, with the closest gauge having the most weight.

Minimum Storm Total Threshold (MSTT) – A check used to remove radar/gauge pairs whose cumulative radar and/or gauge values for a given event period were below 0.05 inches.

Next Generation RADAR (NEXRAD) – A network of S-band (10.5-cm wavelength) radars operated by the National Weather Service.

Radio Detection and Ranging (RADAR) – An electronic instrument used for the detection and ranging of distant objects of such composition that they scatter or reflect radio energy.

Radar-Gauge (RG) – A pair of rainfall accumulations measured by the rain gauge and the radar rainfall accumulation sampled above the gauge.

Z-R relationship – An empirical relationship between radar reflectivity factor Z ($\text{mm}^6 \text{ m}^{-3}$) and rain rate R (mm hr^{-1}). Radar reflectivity factor is dependent on the rain drop size distribution. [$Z = aR^b$, where a and b are empirically derived constants]

- **Convective** – generally used for convective (i.e. thunderstorms) rainfall [$Z = 300R^{1.4}$]
- **Eastern U.S. Cool Stratiform** – generally used for cool season, non-convective rainfall that occurs east of the Continental Divide [$Z = 130R^{2.0}$]

Overview

Vieux & Associates, Inc. (Vieux) processes radar and rain gauge data for 3 Rivers Wet Weather (3RWW). During each month, radar and rain gauge data are segmented into qualified storm event periods and then Quality Controlled (QC). To produce QC gauge-adjusted radar rainfall (GARR), both radar and rain gauge data are reviewed manually to remove inconsistent data. While only qualified rainfall events are included in this report, the RainVieux online database contains continuous data where QC rain gauge and radar data are available during the inter-event periods. QC is performed to remove anomalous radar data and inconsistent rain gauges during both the qualified and inter-event periods.

Radar data used in production of GARR is produced by the National Weather Service (NWS) Next Generation Radar (NEXRAD) system. NEXRAD Level II radar data are often referred to as Base Data and contain the full spatial/temporal/data resolution data from the radar. Level II radar data measures reflectivity in decibels of reflectance (dBZ), and at a spatial resolution of 0.5-degree by 0.25-km every 4 – 10 minutes with a data resolution of 0.5 dBZ amounting to 256 data levels of data. Level III reflectivity radar data have the same data and temporal resolution, but a reduced spatial resolution of 1-degree by 1-km.

The primary radar data source used to process this period was Level II NEXRAD data from KPBZ located near Pittsburgh, PA. The succession of data used gives priority to Level II followed by Level III products. If KPBZ Level II NEXRAD data are unavailable, then KPBZ Level III Q1 is substituted. If no radar data are available from KPBZ, then Level III Q0 NEXRAD data from KCCX (State College, PA) are used. In the event that all radar sources are unavailable or if the radar provides insufficient rainfall information, then a gauge-only product that spatially distributes point rainfall estimates is used. All radar data were processed into five-minute increments.

Because the radar measures reflectivity in polar coordinates centered on the radar installation, the 1-degree azimuth increases in width as range increases from the radar. Range resolution of the Level II radar data is 1-km and is measured out to 230 km from the radar. Due to the proximity of KPBZ to the study area, the polar coordinates defining horizontal resolution over Allegheny County range from 0.1 – 0.9 km, whereas KCCX ranges from 2.5 – 3.6 km. The radar data represented in these polar coordinates are sampled through spatial averaging into a Cartesian grid of uniform resolution, i.e. 1x1 km. An advantage of the Cartesian grid is that one radar can be substituted for the other without changing the grid resolution, as would be necessary if polar coordinates were used for output of rainfall information at 1x1 km spatial resolution. The Cartesian grid used was defined by a 1-km² grid domain shapefile containing 2313 1-km² pixels covering the study area. CDM Smith provided two basin shapefiles consisting of 440 RFM basins and 871 RFM sheds that are located within the 1-km² pixel domain.

Rain gauge data from as many as 37 gauges were used to adjust the radar. 3RWW provided rain data in 5-minute increments for 33 stations. In addition, rain gauge data were obtained from two United States Geological Survey (USGS) stations and two NWS Automated Surface Observing System (ASOS) stations. Figure 1 depicts the spatial distribution of the rain gauge network, KPBZ NEXRAD, RFM basins and 1-km² pixels. For the gauges shown in Figure 1, the ID, name and source of each gauge is listed in Table 1. Radar data review, preparation and sampling the radar over the gauges and 1-km² pixels were achieved using software developed at Vieux.

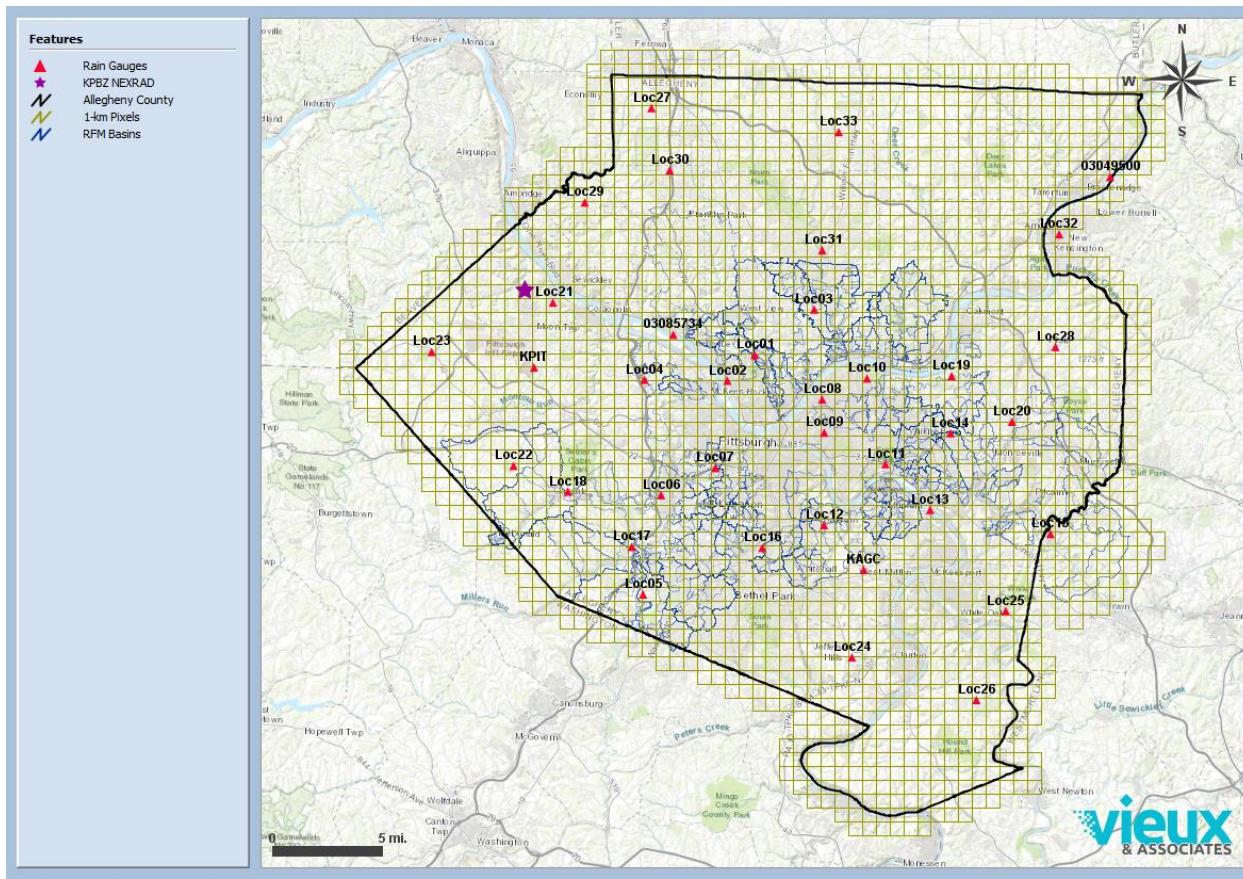


Figure 1. Spatial Distribution of the Rain Gauge Network, KPBZ NEXRAD, RFM Basins and 1-km² Pixels

Table 1. Rain Gauge ID, Name and Source

Gauge ID	Gauge Name	Source
Loc01	PWSA-Montana St.	3RWW
Loc02	ALCOSAN WWTP Lab	3RWW
Loc03	Shaler Munic Bldg	3RWW
Loc04	Kennedy Twp PS	3RWW
Loc05	Upper St. Clair	3RWW
Loc06	Carnegie Transit Time	3RWW
Loc07	Greentree Munic Bldg	3RWW
Loc08	AC Health Dept Bldg	3RWW
Loc09	Univ of Pittsburgh	3RWW
Loc10	PWSA-Highland Park	3RWW
Loc11	M-46 Access Shaft	3RWW
Loc12	Baldwin	3RWW
Loc13	M-59 Access Shaft	3RWW

Gauge ID	Gauge Name	Source
Loc14	Churchill Munic Bldg	3RWW
Loc15	Trafford Maint Bldg	3RWW
Loc16	Castle Shannon	3RWW
Loc17	Chartiers Pump Station	3RWW
Loc18	Oakdale Pump Station	3RWW
Loc19	Sandy Creek Eq Facility	3RWW
Loc20	Gascola Eq Facility	3RWW
Loc21	Moon TWP	3RWW
Loc22	North Fayette TWP	3RWW
Loc23	Clinton Munic Bldg	3RWW
Loc24	Jefferson Hills	3RWW
Loc25	White Oak Public Works Bldg	3RWW
Loc26	Elizabeth TWP Municipal Bldg	3RWW
Loc27	Marshall TWP	3RWW
Loc28	Plum Municipal Bldg	3RWW
Loc29	Bell Acres Munic Bldg	3RWW
Loc30	McCandless Twn Hall	3RWW
Loc31	Hampton Municipal Bldg	3RWW
Loc32	Arnold	3RWW
Loc33	Richland TWP	3RWW
KAGC	Pittsburgh Allegheny Cty	NWS - ASOS
KPIT	Greater Pittsburgh Int'l	NWS - ASOS
03049500	Allegheny River at Natrona	USGS
03085734	Ohio River at Emsworth Dam Lower Pool at Emsworth	USGS

The 37 rain gauges and the two NWS NEXRAD radars are used to produce gauge-adjusted radar rainfall (GARR). The methodology used in production of the GARR and the dataset metadata are described in the following sections.

Methodology

Radar and rain gauge data are segmented into qualified storm event periods and then Quality Controlled (QC). Qualified rainfall events are defined based on the storm event definition where, for any given hour, at least 50% of all working 3RWW gauges have an accumulation of 0.05 inches. Only qualified rainfall events are included in the report, while the RainVieux online database contains continuous data. Both the qualified and inter-event periods receive QC to remove anomalous radar data and inconsistent rain gauges.

Statistical control of the data makes radar rainfall measurements more accurate. By statistical comparison between the radar and rain gauge accumulations during a GARR period, certain gauges may be identified as statistical outliers and excluded for all or part of an event. Radar data

is enhanced by correcting it for systematic errors called bias, which helps improve the accuracy of the rainfall product. The bias correction factors are multiplicative factors applied to the radar that enhances the accuracy of the radar rainfall for any accumulation period. By adjusting the radar data with rain gauge data, better maps of rainfall are produced than either sensor system could produce alone.

In the production of GARR, radar rainfall is bias corrected through comparison with rain gauge accumulations. To the extent possible, individual gauges are combined to cover the target area for use in bias adjustment. The method of adjustment depends on the hydrologic application and the spatial extent of the area of interest. The local bias (LB) approach to adjusting the radar rainfall uses the ratio of gauge to radar accumulations from surrounding gauges with the closest gauge having the most weight. The LB approach distributes the variation of bias over the region, and is computed and applied within each event period.

The LB uses the ratio between the sum of each gauge divided by the sum of the sampled radar values over each gauge. Gauge and radar accumulations were computed for each event period. A minimum storm total threshold (MSTT) check was used to remove radar/gauge (RG) pairs whose R or G cumulative values for a given event period were below a chosen threshold (i.e. 0.05 inches for this study). The remaining RG pairs were then checked for statistical outliers. Those RG pairs with individual bias (G/R) or average difference ($((G-R)/G)$) values greater than three standard deviations from the mean were then excluded from being used to adjust the radar.

After RG pairs have been removed on an event basis by either the MSTT, outlier check or gauge performance review, there must be at least two remaining RG pairs to proceed with gauge-adjustment of the radar. The individual biases of the remaining RG pairs are then distributed spatially over the analysis area using the LB weighted distance method. The resulting LB value over each radar bin is the multiplicative factor that adjusts the radar. For example, a bias of 1.5 can be interpreted as a 33% underestimation by the radar. The statistical measures reported are 1) average difference (AD) and 2) calibrated average difference (CAD). Both of these statistical measures are expressed as an absolute percentage about the mean of G/R accumulations for each event period. GARR is then spatially aggregated from the final adjusted radar bins to the basins and 1-km² pixels using an area-averaged technique.

After bias correction, though generally small, differences between rain gauge and radar rainfall accumulations still exist due to sampling differences or local meteorological conditions among other reasons. A major reason for departures is that radar collects data by averaging reflectivity over a 1-degree by 1-km sample volume, while rain gauges measure at a point. Another source of difference is that radar measures above the ground, while rain gauges measure close to the ground. Further, updrafts and downdrafts during storms can decrease or increase rain rates, respectively. However, radar cannot detect local wind effects, while rain gauges can be affected. Differences between the radar data and the rain gauge data are also affected by precipitation processes associated with the type of storm, which also are affected by the season of the year.

Metadata

Data accompanying this document provides a continuous rainfall record of all 2313 1-km pixels, 440 RFM basins and 871 RFM sheds in 15-minute intervals. The data are provided in CSV format for the period from 2020-03-01 00:00 EST to 2020-04-01 00:00 EDT. Shapefiles of the 1-km pixels, RFM basins and RFM sheds are located in the Shapefiles subfolder.

1-km² Pixel CSV metadata:

- Individual CSV files are provided for each pixel.
- The pixel filenames use a "Ryyymm_" (i.e. R, year, month) prefix in front of the pixel ID.
- The comma-delimited text files contain a header row in the 1st row and time/data values beginning on the 2nd row.
- The time/data columns consist of Month, Day, Year, Hour, Minute, Rainfall and Source, where R represents EOM GARR quality.
- Time stamps are in EST/EDT.
- Data values represent 15-min accumulation (inches) at end of interval.
- The 1-km Pixel ID field that was used from the shapefile DBF is "PIXEL".

Basin CSV metadata:

- Individual CSV files are provided for each RFM Basin and RFM Shed.
- The RFM Basin filenames use a "P-" prefix and a "yyyymmG" (i.e. year, month, G) suffix in front and after the RFM Basin ID.
- The RFM Shed filenames use a "P-" prefix and a "yyyymmN" (i.e. year, month, N) suffix in front and after the RFM Shed ID.
- The comma-delimited text files contain a header row in the 1st row and time/data values beginning on the 2nd row.
- The 1st column contains the date (yyyy/mm/dd hh:mm) and the 2nd column contains the corresponding rainfall value.
- Time stamps are in EST/EDT.
- Data values represent 15-min accumulation (inches) at end of interval.
- The RFM Basin ID field that was used from the shapefile DBF is "DS_METERNA".
- The RFM Shed ID field that was used from the shapefile DBF is "DELINID".

Shapefile metadata:

- NAD 1983, State Plane Pennsylvania South (feet).

Gauge-Adjusted Radar Rainfall (GARR)

Rainfall totals for March 2020 are shown in Figure 2. The rainfall amounts for the 2313 1-km² pixels range from 4.5 to 7.4 inches with a mean of 5.8 inches. The rainfall amounts for the 440 RFM basins range from 4.8 to 6.6 inches with a mean of 5.5 inches. The rainfall amounts for the 871 RFM sheds range from 4.8 to 6.6 inches with a mean of 5.5 inches.

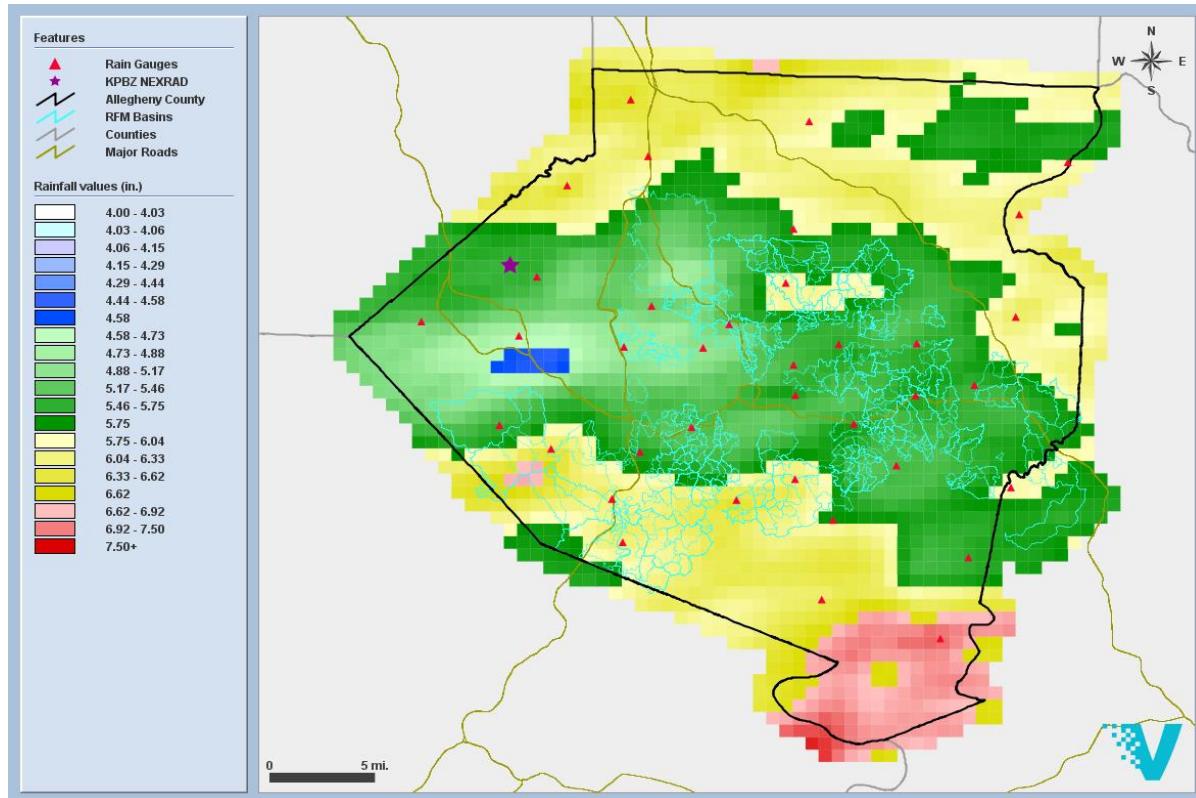


Figure 2. GARR Storm Total for March 2020

GARR was processed continuously at five-minute increments and covers the period from 2020-03-01 00:00 EST to 2020-04-01 00:00 EDT. Nine rainfall events were identified as having met the storm definition during March 2020. The GARR statistics for each event are listed in Table 2. Eight of the events were split into multiple sub-event periods to improve gauge-adjustment of the radar, resulting in a total of forty-one event and sub-event periods. The events that were split into multiple periods are shown in the **Event#** column with the letter "a", "b", "c", etc. appended to the event number (e.g., E1a, E1b, E1c). The **Source** column shows what rainfall source was used to produce GARR for each event or sub-event period. The listed **Event Date** shown in Table 2 corresponds to the day or portion of the day when most of the rainfall occurred for that GARR event period. All nine rainfall events are discussed in more detail in the following Events section.

The **Bias** value shown in Table 2 is the sum of the gauges divided by the sum of the sampled radar values over the gauges. Those rain events with the lowest CAD values shown in Table 2 represent the best agreement between GARR and gauge values for all radar/gauge pairs used to adjust the radar. On average, lower values of CAD imply higher statistical confidence in the reliability of the

dataset. Typically, stratiform rainfall events (i.e., low spatial variability) have lower CAD values than convective rainfall events (i.e., high spatial variability). Based on all forty-one event and sub-event periods, the event CAD averaged 2.7%, indicating that the mean GARR agrees with the mean gauge accumulation to within $\pm 1.3\%$.

Table 2. Storm Events and GARR Statistics

Event #	Source	Event Date	Start Time (EST/EDT)	End Time (EST/EDT)	Gauges Used (37)	Avg. Depth (in)	Bias	AD (%)	CAD (%)
E1	KPBZ LII	2020-03-02	2020-03-02 11:05	2020-03-03 00:00	22	0.096	0.850	26.7	3.1
E2a	KPBZ LII	2020-03-03 AM	2020-03-03 00:05	2020-03-03 07:30	3	0.041	1.124	9.8	0.4
E2b	KPBZ LII	2020-03-03 AM	2020-03-03 07:35	2020-03-03 08:15	27	0.161	0.910	18.1	2.8
E2c	KPBZ LII	2020-03-03 AM	2020-03-03 08:20	2020-03-03 08:45	24	0.078	0.749	37.6	2.7
E2d	KPBZ LII	2020-03-03 AM	2020-03-03 08:50	2020-03-03 14:00	35	0.175	1.200	29.0	1.9
E3a	KPBZ LII	2020-03-03 PM	2020-03-03 14:05	2020-03-03 19:00	22	0.105	0.911	25.2	2.3
E3b	KPBZ LII	2020-03-03 PM	2020-03-03 19:05	2020-03-03 23:00	6	0.044	0.570	61.0	0.0
E4a	KPBZ LII	2020-03-10	2020-03-10 01:05	2020-03-10 08:00	20	0.054	0.646	56.5	3.1
E4b	Gauge Only	2020-03-10	2020-03-10 08:05	2020-03-10 14:15	31	0.025	---	---	---
E4c	KPBZ LII	2020-03-10	2020-03-10 14:20	2020-03-10 18:00	30	0.091	0.902	23.5	5.3
E5a	KPBZ LII	2020-03-18	2020-03-18 14:05	2020-03-18 19:00	30	0.145	1.085	14.9	2.3
E5b	KPBZ LII	2020-03-18	2020-03-18 19:05	2020-03-18 21:15	34	0.273	1.559	35.3	1.8
E5c	KPBZ LII	2020-03-18	2020-03-18 21:20	2020-03-18 23:00	32	0.241	1.747	42.4	2.2
E5d	Gauge Only	2020-03-18	2020-03-18 23:05	2020-03-19 00:45	32	0.056	---	---	---
E5e	KPBZ LII	2020-03-18	2020-03-19 00:50	2020-03-19 02:15	29	0.115	0.920	23.5	2.1
E5f	Gauge Only	2020-03-18	2020-03-19 02:20	2020-03-19 07:00	32	0.037	---	---	---
E6a	KPBZ LII	2020-03-20	2020-03-19 16:05	2020-03-19 20:30	33	0.073	0.823	25.7	3.0

Event #	Source	Event Date	Start Time (EST/EDT)	End Time (EST/EDT)	Gauges Used (37)	Avg. Depth (in)	Bias	AD (%)	CAD (%)
E6b	KPBZ LII	2020-03-20	2020-03-19 20:35	2020-03-19 21:00	27	0.075	0.950	16.2	3.5
E6c	KPBZ LII	2020-03-20	2020-03-19 21:05	2020-03-19 22:00	13	0.043	0.901	29.8	4.5
E6d	KPBZ LII	2020-03-20	2020-03-19 22:05	2020-03-20 03:00	27	0.098	0.649	55.2	4.6
E6e	KPBZ LII	2020-03-20	2020-03-20 03:05	2020-03-20 04:30	27	0.083	0.999	24.6	3.4
E6f	KPBZ LII	2020-03-20	2020-03-20 04:35	2020-03-20 06:00	34	0.276	1.359	27.0	1.1
E6g	KPBZ LII	2020-03-20	2020-03-20 06:05	2020-03-20 07:45	32	0.299	1.270	20.3	1.9
E6h	KPBZ LII	2020-03-20	2020-03-20 07:50	2020-03-20 09:00	33	0.171	1.233	19.4	1.5
E6i	KPBZ LII	2020-03-20	2020-03-20 09:05	2020-03-20 14:00	25	0.107	0.843	26.2	2.6
E6j	KPBZ LII	2020-03-20	2020-03-20 14:05	2020-03-20 20:00	11	0.045	0.966	22.1	4.0
E7a	KPBZ LII	2020-03-23	2020-03-23 01:05	2020-03-23 09:15	13	0.062	0.854	28.8	6.1
E7b	KPBZ LII	2020-03-23	2020-03-23 09:20	2020-03-23 11:00	36	0.193	1.119	14.9	3.8
E7c	KPBZ LII	2020-03-23	2020-03-23 11:05	2020-03-23 13:15	25	0.102	0.960	19.3	1.8
E7d	Gauge Only	2020-03-23	2020-03-23 13:20	2020-03-23 20:00	32	0.035	---	---	---
E8a	KPBZ LII	2020-03-25	2020-03-24 21:05	2020-03-25 04:30	25	0.074	0.749	36.2	3.2
E8b	KPBZ LII	2020-03-25	2020-03-25 04:35	2020-03-25 10:00	30	0.104	0.493	97.6	3.1
E9a	KPBZ LII	2020-03-28	2020-03-27 20:05	2020-03-28 00:00	27	0.063	1.221	17.2	2.0
E9b	KPBZ LII	2020-03-28	2020-03-28 00:05	2020-03-28 04:00	35	0.159	1.214	17.3	1.9
E9c	KPBZ LII	2020-03-28	2020-03-28 04:05	2020-03-28 08:00	35	0.177	1.266	23.4	2.0
E9d	KPBZ LII	2020-03-28	2020-03-28 08:05	2020-03-28 15:30	22	0.091	0.620	90.0	4.5

Event #	Source	Event Date	Start Time (EST/EDT)	End Time (EST/EDT)	Gauges Used (37)	Avg. Depth (in)	Bias	AD (%)	CAD (%)
E9e	KPBZ LII	2020-03-28	2020-03-28 15:35	2020-03-28 17:00	35	0.388	0.900	16.3	2.3
E9f	KPBZ LII	2020-03-28	2020-03-28 17:05	2020-03-28 20:00	36	0.148	1.027	12.1	2.0
E9g	KPBZ LII	2020-03-28	2020-03-28 20:05	2020-03-28 23:00	34	0.160	0.889	15.8	1.8
E9h	KPBZ LII	2020-03-28	2020-03-28 23:05	2020-03-29 03:00	36	0.314	1.101	15.5	2.4
E9i	KPBZ LII	2020-03-28	2020-03-29 03:05	2020-03-29 10:00	7	0.038	0.611	65.5	1.6

Statistical review of the data can provide an indication of data quality. Depending on the quality of the radar and gauge data, CAD values for individual events less than 10% are considered excellent, 10 - 20% are considered good, and 20 - 30% are considered fair. However, CAD may not serve as a reliable indicator of data quality when abrupt changes in bias occur within the analysis period, particularly when compensating over- and under-estimation results due to using an assumed Z-R relationship throughout the period while atmospheric conditions merit different Z-R coefficients. The effects from abrupt changes in Z-R are mitigated by splitting the event periods.

Rain gauges were analyzed to identify those that were not consistent with the radar or surrounding gauges. Cumulative Distribution Plots (CDPs) at each gauge location showing gauge, unadjusted radar and GARR values were produced for each rainfall event and are presented in Appendices C - K. CDPs are useful for visualizing rain gauge performance. Figure 3 shows the rainfall accumulation at the Churchill Munic Bldg (Loc14) gauge during the 2020-03-18 event as measured by the gauge (green), unadjusted radar (blue), and gauge-adjusted radar (red). Rain gauges that are not performing consistently with the radar or surrounding gauges have characteristics such as clogs, synchronization or other mechanical/transmission malfunctions that can be visually identified in the CDP graph.

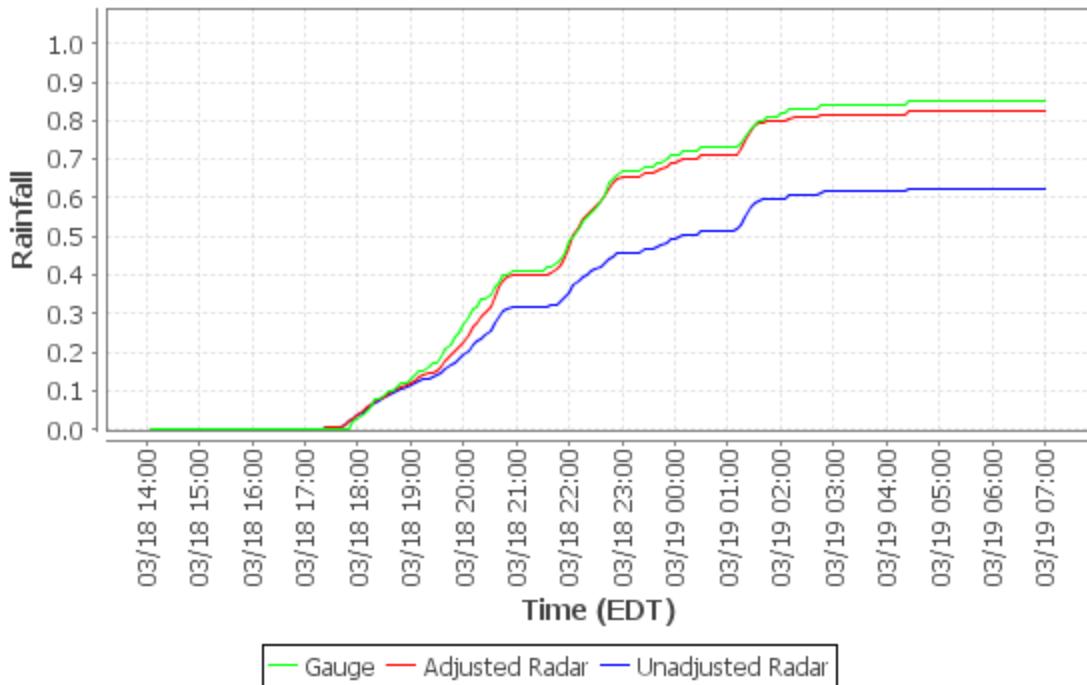


Figure 3. CDP Showing Rain Gauge Versus Unadjusted Radar Versus GARR

Reasons for not using gauges in rainfall analysis include clogs, significant under- or over-reporting of rainfall, gauges that stop reporting during rainfall, or a combination of these reasons. A list of possible reasons for not using a gauge based on CDP analysis is shown in Table 3. Those gauges that were excluded from analysis based on gauge performance are shown in [Appendix A](#). Additional gauges were not used to adjust the radar for a given event or sub-event period if they did not meet the statistical criteria outlined in the Methodology section. A list of reasons for not using a gauge based on statistical criteria is shown in Table 4. The gauges listed in [Appendix B](#) did not meet statistical criteria for gauge-adjustment of the radar and were not used to adjust the radar.

Table 3. Reasons for Gauge Exclusion Based on Performance

Reason	Explanation
Clog (C)	Gauge appeared to be clogged
Zero (Z)	Gauge did not report any rainfall while radar rainfall estimates reported significant rainfall
Stop (S)	Gauge appeared to stop reporting rainfall while radar rainfall estimates reported significant rainfall
Over (O)	Gauge appeared to significantly over-report rainfall as compared to radar rainfall estimates and surrounding gauges (e.g. anomalously high rainfall values caused by field calibration, data transmission error, or switch malfunctions)
Under (U)	Gauge appeared to significantly under-report as compared to radar rainfall estimates and surrounding Gauges (e.g. half-tipper)
Sync (SY)	Gauge appeared to be reporting out-of-sync with the radar rainfall estimates

Reason	Explanation
Frozen/Melt (F/M)	Gauge not reporting properly due to frozen or melting precipitation
Other (T)	Combination of multiple reasons
No Data (ND)	Gauge reported "no data" for a significant amount of time

Table 4. Reasons for Gauge Exclusion Based on Statistical Criteria

Reason	Explanation
Minimum Storm Total Threshold (MSTT)	The radar or gauge cumulative sum during the event or sub-event period was less than MSTT
Outlier Based on Mean Field Bias (OMFB)	The RG pair bias (G/R) was greater than three standard deviations from the mean bias (e.g. G>>R)
Outlier Based on Average Difference (OAD)	The RG pair average difference ((G-R)/G)) was greater than three standard deviations from the mean average difference (e.g. G<<R)

A synopsis for each event is described below in terms of the specific processing protocol applied to each event period as well as specific GARR information.

Events

Event 1: 2020-03-02

The analysis period was from 2020-03-02 11:00 EST to 2020-03-03 00:00 EST.

The gauges listed in [Appendix A](#) were not used to adjust the radar due to inconsistencies between the gauge and the radar or surrounding gauges, or they did not have data available for this event. The gauges listed in [Appendix B](#) were not used to adjust the radar since they did not meet statistical criteria for gauge-adjustment.

The Eastern U.S. cool season stratiform Z-R relationship was used to convert radar reflectivity to rainfall rates. Table 5 shows the mean bias and average depth of the event along with the AD and CAD, respectively. Table 6 summarizes the results for each RG pair used for final radar adjustment, where G_i is the gauge estimate, R_i is the non-adjusted radar estimate, R_i^* is the GARR estimate, Diff* (in) is the difference in inches between the gauge and GARR estimate, and Diff* (%) is the percent difference between the gauge and GARR estimate. Those gauges not used to adjust the radar are shown at the bottom of the table and are highlighted in red. The specific reason for gauge exclusion is displayed in the Flag column. Figure 4 shows the scatter plot of the RG pairs. Those gauges not used to adjust the radar are shown in red. Figure 5 depicts the GARR storm total over the 1-km² pixels. The GARR amounts for the 2313 1-km² pixels range from 0.0 - 0.3 inches with a mean of 0.1 inches. The GARR amounts for the 440 RFM basins range from 0.0 - 0.1 inches with a mean of 0.1 inches. The GARR amounts for the 871 RFM sheds range from 0.0 - 0.1 inches with a mean of 0.1 inches. Table 7 shows the Depth Duration Frequency (DDF) maximum values for the 1-km² pixels.

Table 5. GARR Statistics for Event 1

Event #	Radar	Event Date	Start Time (EST)	End Time (EST)	Gauges Used (37)	Avg. Depth (in)	Bias	AD (%)	CAD (%)
E1	KPBZ LII	2020-03-02	11:05	2020-03-03 00:00	22	0.096	0.850	26.7	3.1

Table 6. Summary of Individual RG Pairs for Event 1

Gauge ID	Name	G _i (in)	R _i (in)	R _i * (in)	Diff* (in)	Diff* (%)	Flag
Loc09	Univ of Pittsburgh	0.08	0.07	0.09	-0.01	-12.5	
Loc20	Gascola Eq Facility	0.10	0.15	0.11	-0.01	-10.0	
Loc05	Upper St. Clair	0.11	0.12	0.12	-0.01	-9.1	
KAGC	Pittsburgh Allegheny Cty	0.12	0.13	0.12	0.00	0.0	
Loc02	ALCOSAN WWTP Lab	0.05	0.05	0.05	0.00	0.0	
Loc03	Shaler Munic Bldg	0.08	0.08	0.08	0.00	0.0	
Loc04	Kennedy Twp PS	0.06	0.05	0.06	0.00	0.0	
Loc07	Greentree Munic Bldg	0.09	0.06	0.09	0.00	0.0	
Loc11	M-46 Access Shaft	0.10	0.09	0.10	0.00	0.0	
Loc12	Baldwin	0.10	0.09	0.10	0.00	0.0	
Loc14	Churchill Munic Bldg	0.10	0.12	0.10	0.00	0.0	
Loc16	Castle Shannon	0.10	0.10	0.10	0.00	0.0	
Loc19	Sandy Creek Eq Facility	0.09	0.09	0.09	0.00	0.0	
Loc21	Moon TWP	0.07	0.11	0.07	0.00	0.0	
Loc24	Jefferson Hills	0.11	0.15	0.11	0.00	0.0	
Loc25	White Oak Public Works Bldg	0.12	0.27	0.12	0.00	0.0	
Loc27	Marshall TWP	0.06	0.06	0.06	0.00	0.0	
Loc28	Plum Municipal Bldg	0.10	0.15	0.10	0.00	0.0	
Loc31	Hampton Municipal Bldg	0.09	0.10	0.09	0.00	0.0	
Loc32	Arnold	0.11	0.19	0.11	0.00	0.0	
Loc08	AC Health Dept Bldg	0.09	0.06	0.08	0.01	11.1	
Loc17	Chartiers Pump Station	0.09	0.07	0.08	0.01	11.1	
03049500	Allegheny River at Natrona	0.05	---	---	---	---	U
03085734	Ohio River at Emsworth Dam Lower Pool at Emsworth	0.03	---	---	---	---	U
KPIT	Greater Pittsburgh Int'l	0.05	---	---	---	---	MSTT
Loc01	PWSA-Montana St.	0.02	---	---	---	---	U
Loc06	Carnegie Transit Time	0.13	---	---	---	---	O

Gauge ID	Name	G_i (in)	R_i (in)	R_i^* (in)	Diff* (in)	Diff* (%)	Flag
Loc10	PWSA-Highland Park	0.06	---	---	---	---	U
Loc13	M-59 Access Shaft	0.08	---	---	---	---	U
Loc15	Trafford Maint Bldg	0.00	---	---	---	---	ND
Loc18	Oakdale Pump Station	0.06	---	---	---	---	MSTT
Loc22	North Fayette TWP	0.06	---	---	---	---	MSTT
Loc23	Clinton Munic Bldg	ND	---	---	---	---	ND
Loc26	Elizabeth TWP Municipal Bldg	0.14	---	---	---	---	OAD
Loc29	Bell Acres Munic Bldg	0.04	---	---	---	---	MSTT
Loc30	McCandless Twn Hall	0.04	---	---	---	---	MSTT
Loc33	Richland TWP	0.03	---	---	---	---	MSTT

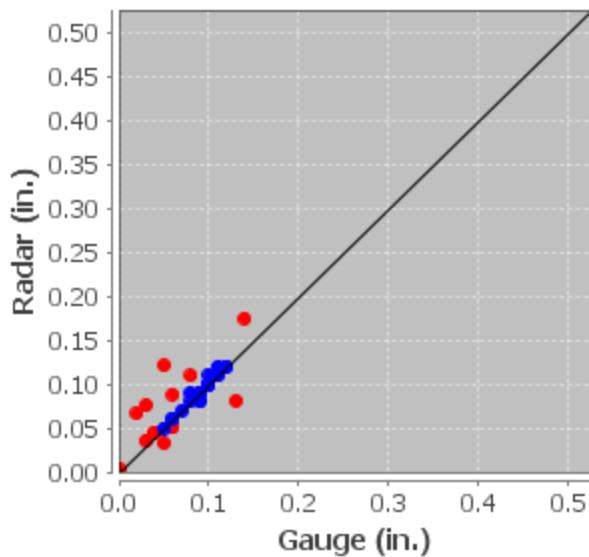


Figure 4. Scatter Plot of RG Pairs for Event 1

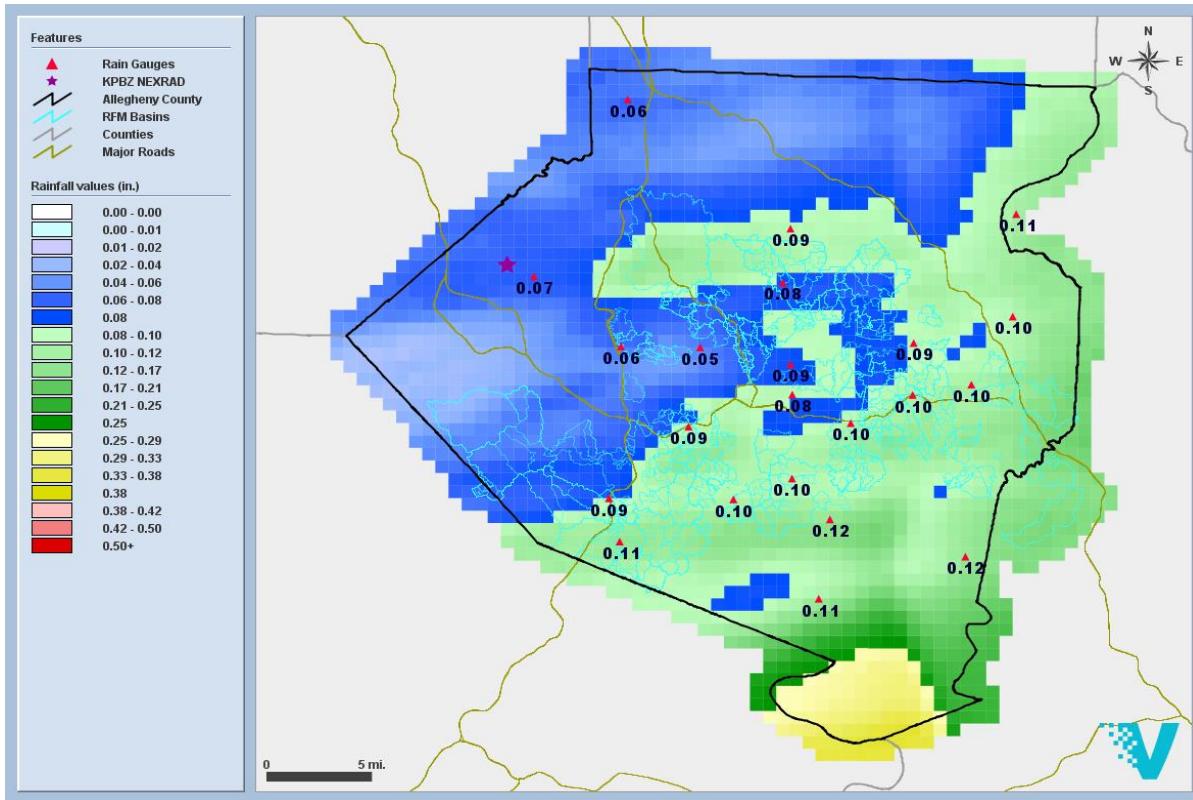


Figure 5. GARR Storm Total for Event 1

Table 7. Depth Duration Frequency Analyses for Event 1

Duration	Depth (in)	Pixel	Time (EST)	Frequency
15 minutes	0.055	147128	2020-03-02 17:30	<1 yr.
30 minutes	0.089	156160	2020-03-02 18:15	<1 yr.
1 hour	0.168	152166	2020-03-02 18:15	<1 yr.
2 hour	0.296	152167	2020-03-02 19:00	<1 yr.
3 hour	0.319	155166	2020-03-02 19:20	<1 yr.
6 hour	0.345	157166	2020-03-02 19:20	<1 yr.
12 hour	0.346	157166	2020-03-02 23:00	<1 yr.

Event 2: 2020-03-03 AM

The analysis period was from 2020-03-03 00:00 EST to 2020-03-03 14:00 EST. The event was then split into four sub-event periods at 2020-03-03 07:30 EST, 2020-03-03 08:15 EST and 2020-03-03 08:45 EST to improve gauge adjustment of the radar.

The gauges listed in [Appendix A](#) were not used to adjust the radar due to inconsistencies between the gauge and the radar or surrounding gauges, or they did not have data available for this event.

The gauges listed in [Appendix B](#) were not used to adjust the radar since they did not meet statistical criteria for gauge-adjustment.

A convective Z-R relationship was used to convert radar reflectivity to rainfall rates. Table 8 shows the mean bias and average depth of the event along with the AD and CAD, respectively. Tables 9 - 12 summarize the results for each RG pair used for final radar adjustment, where G_i is the gauge estimate, R_i is the non-adjusted radar estimate, R_i^* is the GARR estimate, and Diff* (%) is the percent difference between the gauge and GARR estimate. Those gauges not used to adjust the radar are shown at the bottom of the table and are highlighted in red. The specific reason for gauge exclusion is displayed in the Flag column. Figures 6 - 9 show the scatter plots of the gauge-adjusted RG pairs. Those gauges not used to adjust the radar are shown in red. Figure 10 depicts the GARR storm total over the 1-km² pixels. The GARR amounts for the 2313 1-km² pixels range from 0.3 - 0.9 inches with a mean of 0.5 inches. The GARR amounts for the 440 RFM basins range from 0.3 - 0.5 inches with a mean of 0.4 inches. The GARR amounts for the 871 RFM sheds range from 0.3 - 0.5 inches with a mean of 0.4 inches. Table 13 shows the Depth Duration Frequency (DDF) maximum values for the 1-km² pixels.

Table 8. GARR Statistics for Event 2

Event #	Radar	Event Date	Start Time (EST)	End Time (EST)	Gauges Used (37)	Avg. Depth (in)	Bias	AD (%)	CAD (%)
E2a	KPBZ LII	2020-03-03 AM	2020-03-03 00:05	2020-03-03 07:30	3	0.041	1.124	9.8	0.4
E2b	KPBZ LII	2020-03-03 AM	2020-03-03 07:35	2020-03-03 08:15	27	0.161	0.910	18.1	2.8
E2c	KPBZ LII	2020-03-03 AM	2020-03-03 08:20	2020-03-03 08:45	24	0.078	0.749	37.6	2.7
E2d	KPBZ LII	2020-03-03 AM	2020-03-03 08:50	2020-03-03 14:00	35	0.175	1.200	29.0	1.9

Table 9. Summary of Individual RG Pairs for Event 2a

Gauge ID	Name	G_i (in)	R_i (in)	R_i^* (in)	Diff* (in)	Diff* (%)	Flag
Loc21	Moon TWP	0.17	0.15	0.17	0.00	0.0	
Loc29	Bell Acres Munic Bldg	0.40	0.33	0.40	0.00	0.0	
Loc30	McCandless Twn Hall	0.27	0.27	0.27	0.00	0.0	
03049500	Allegheny River at Natrona	0.00	---	---	---	---	MSTT
03085734	Ohio River at Emsworth Dam Lower Pool at Emsworth	0.01	---	---	---	---	MSTT
KAGC	Pittsburgh Allegheny Cty	0.01	---	---	---	---	MSTT
KPIT	Greater Pittsburgh Int'l	0.10	---	---	---	---	U
Loc01	PWSA-Montana St.	0.01	---	---	---	---	MSTT

Gauge ID	Name	G _i (in)	R _i (in)	R _i * (in)	Diff* (in)	Diff* (%)	Flag
Loc02	ALCOSAN WWTP Lab	0.01	---	---	---	---	MSTT
Loc03	Shaler Munic Bldg	0.00	---	---	---	---	MSTT
Loc04	Kennedy Twp PS	0.00	---	---	---	---	MSTT
Loc05	Upper St. Clair	0.00	---	---	---	---	MSTT
Loc06	Carnegie Transit Time	0.00	---	---	---	---	MSTT
Loc07	Greentree Munic Bldg	0.00	---	---	---	---	MSTT
Loc08	AC Health Dept Bldg	0.00	---	---	---	---	MSTT
Loc09	Univ of Pittsburgh	0.00	---	---	---	---	MSTT
Loc10	PWSA-Highland Park	0.00	---	---	---	---	MSTT
Loc11	M-46 Access Shaft	0.00	---	---	---	---	MSTT
Loc12	Baldwin	0.00	---	---	---	---	MSTT
Loc13	M-59 Access Shaft	0.00	---	---	---	---	MSTT
Loc14	Churchill Munic Bldg	0.00	---	---	---	---	MSTT
Loc15	Trafford Maint Bldg	ND	---	---	---	---	ND
Loc16	Castle Shannon	0.01	---	---	---	---	MSTT
Loc17	Chartiers Pump Station	0.00	---	---	---	---	MSTT
Loc18	Oakdale Pump Station	0.02	---	---	---	---	MSTT
Loc19	Sandy Creek Eq Facility	0.00	---	---	---	---	MSTT
Loc20	Gascola Eq Facility	0.00	---	---	---	---	MSTT
Loc22	North Fayette TWP	0.03	---	---	---	---	MSTT
Loc23	Clinton Munic Bldg	ND	---	---	---	---	ND
Loc24	Jefferson Hills	0.01	---	---	---	---	MSTT
Loc25	White Oak Public Works Bldg	0.01	---	---	---	---	MSTT
Loc26	Elizabeth TWP Municipal Bldg	0.01	---	---	---	---	MSTT
Loc27	Marshall TWP	0.40	---	---	---	---	O
Loc28	Plum Municipal Bldg	0.01	---	---	---	---	MSTT
Loc31	Hampton Municipal Bldg	0.00	---	---	---	---	MSTT
Loc32	Arnold	0.00	---	---	---	---	MSTT
Loc33	Richland TWP	0.04	---	---	---	---	MSTT

Table 10. Summary of Individual RG Pairs for Event 2b

Gauge ID	Name	G _i (in)	R _i (in)	R _i * (in)	Diff* (in)	Diff* (%)	Flag
Loc08	AC Health Dept Bldg	0.09	0.09	0.10	-0.01	-11.1	
Loc03	Shaler Munic Bldg	0.20	0.26	0.21	-0.01	-5.0	
Loc06	Carnegie Transit Time	0.22	0.27	0.23	-0.01	-4.5	
Loc22	North Fayette TWP	0.23	0.33	0.24	-0.01	-4.3	
Loc30	McCandless Twn Hall	0.30	0.35	0.31	-0.01	-3.3	
Loc02	ALCOSAN WWTP Lab	0.23	0.29	0.23	0.00	0.0	
Loc04	Kennedy Twp PS	0.19	0.25	0.19	0.00	0.0	
Loc05	Upper St. Clair	0.20	0.23	0.20	0.00	0.0	
Loc07	Greentree Munic Bldg	0.17	0.18	0.17	0.00	0.0	
Loc10	PWSA-Highland Park	0.10	0.09	0.10	0.00	0.0	
Loc11	M-46 Access Shaft	0.15	0.15	0.15	0.00	0.0	
Loc13	M-59 Access Shaft	0.06	0.06	0.06	0.00	0.0	
Loc14	Churchill Munic Bldg	0.09	0.09	0.09	0.00	0.0	
Loc16	Castle Shannon	0.15	0.16	0.15	0.00	0.0	
Loc19	Sandy Creek Eq Facility	0.11	0.10	0.11	0.00	0.0	
Loc20	Gascola Eq Facility	0.05	0.06	0.05	0.00	0.0	
Loc21	Moon TWP	0.26	0.36	0.26	0.00	0.0	
Loc24	Jefferson Hills	0.10	0.07	0.10	0.00	0.0	
Loc28	Plum Municipal Bldg	0.10	0.06	0.10	0.00	0.0	
Loc29	Bell Acres Munic Bldg	0.29	0.34	0.29	0.00	0.0	
Loc31	Hampton Municipal Bldg	0.23	0.28	0.23	0.00	0.0	
Loc32	Arnold	0.08	0.05	0.08	0.00	0.0	
Loc33	Richland TWP	0.29	0.29	0.29	0.00	0.0	
Loc27	Marshall TWP	0.28	0.25	0.27	0.01	3.6	
Loc18	Oakdale Pump Station	0.22	0.24	0.21	0.01	4.5	
Loc12	Baldwin	0.19	0.16	0.18	0.01	5.3	
Loc09	Univ of Pittsburgh	0.14	0.11	0.13	0.01	7.1	
03049500	Allegheny River at Natrona	0.03	---	---	---	---	U
03085734	Ohio River at Emsworth Dam Lower Pool at Emsworth	0.17	---	---	---	---	U
KAGC	Pittsburgh Allegheny Cty	0.06	---	---	---	---	U
KPIT	Greater Pittsburgh Int'l	0.12	---	---	---	---	U
Loc01	PWSA-Montana St.	0.17	---	---	---	---	U
Loc15	Trafford Maint Bldg	ND	---	---	---	---	ND
Loc17	Chartiers Pump Station	0.17	---	---	---	---	U
Loc23	Clinton Munic Bldg	ND	---	---	---	---	ND

Gauge ID	Name	G _i (in)	R _i (in)	R _i * (in)	Diff* (in)	Diff* (%)	Flag
Loc25	White Oak Public Works Bldg	0.04	---	---	---	---	MSTT
Loc26	Elizabeth TWP Municipal Bldg	0.03	---	---	---	---	MSTT

Table 11. Summary of Individual RG Pairs for Event 2c

Gauge ID	Name	G _i (in)	R _i (in)	R _i * (in)	Diff* (in)	Diff* (%)	Flag
KAGC	Pittsburgh Allegheny Cty	0.10	0.14	0.11	-0.01	-10.0	
Loc08	AC Health Dept Bldg	0.11	0.16	0.12	-0.01	-9.1	
Loc01	PWSA-Montana St.	0.05	0.08	0.05	0.00	0.0	
Loc02	ALCOSAN WWTP Lab	0.05	0.06	0.05	0.00	0.0	
Loc03	Shaler Munic Bldg	0.07	0.11	0.07	0.00	0.0	
Loc05	Upper St. Clair	0.10	0.09	0.10	0.00	0.0	
Loc07	Greentree Munic Bldg	0.05	0.09	0.05	0.00	0.0	
Loc09	Univ of Pittsburgh	0.11	0.14	0.11	0.00	0.0	
Loc10	PWSA-Highland Park	0.12	0.15	0.12	0.00	0.0	
Loc11	M-46 Access Shaft	0.13	0.16	0.13	0.00	0.0	
Loc13	M-59 Access Shaft	0.11	0.14	0.11	0.00	0.0	
Loc16	Castle Shannon	0.13	0.12	0.13	0.00	0.0	
Loc17	Chartiers Pump Station	0.05	0.05	0.05	0.00	0.0	
Loc19	Sandy Creek Eq Facility	0.12	0.14	0.12	0.00	0.0	
Loc20	Gascola Eq Facility	0.10	0.12	0.10	0.00	0.0	
Loc24	Jefferson Hills	0.10	0.21	0.10	0.00	0.0	
Loc25	White Oak Public Works Bldg	0.10	0.22	0.10	0.00	0.0	
Loc26	Elizabeth TWP Municipal Bldg	0.12	0.24	0.12	0.00	0.0	
Loc28	Plum Municipal Bldg	0.14	0.15	0.14	0.00	0.0	
Loc31	Hampton Municipal Bldg	0.07	0.09	0.07	0.00	0.0	
Loc32	Arnold	0.15	0.17	0.15	0.00	0.0	
Loc33	Richland TWP	0.08	0.12	0.08	0.00	0.0	
Loc12	Baldwin	0.15	0.16	0.14	0.01	6.7	
Loc14	Churchill Munic Bldg	0.13	0.14	0.12	0.01	7.7	
03049500	Allegheny River at Natrona	0.08	---	---	---	---	U
03085734	Ohio River at Emsworth Dam Lower Pool at Emsworth	0.03	---	---	---	---	MSTT
KPIT	Greater Pittsburgh Int'l	0.06	---	---	---	---	O
Loc04	Kennedy Twp PS	0.02	---	---	---	---	MSTT

Gauge ID	Name	G _i (in)	R _i (in)	R _i * (in)	Diff* (in)	Diff* (%)	Flag
Loc06	Carnegie Transit Time	0.04	---	---	---	---	MSTT
Loc15	Trafford Maint Bldg	ND	---	---	---	---	ND
Loc18	Oakdale Pump Station	0.03	---	---	---	---	MSTT
Loc21	Moon TWP	0.01	---	---	---	---	MSTT
Loc22	North Fayette TWP	0.02	---	---	---	---	MSTT
Loc23	Clinton Munic Bldg	ND	---	---	---	---	ND
Loc27	Marshall TWP	0.03	---	---	---	---	MSTT
Loc29	Bell Acres Munic Bldg	0.03	---	---	---	---	MSTT
Loc30	McCandless Twn Hall	0.04	---	---	---	---	MSTT

Table 12. Summary of Individual RG Pairs for Event 2d

Gauge ID	Name	G _i (in)	R _i (in)	R _i * (in)	Diff* (in)	Diff* (%)	Flag
Loc20	Gascola Eq Facility	0.25	0.27	0.27	-0.02	-8.0	
Loc12	Baldwin	0.20	0.14	0.21	-0.01	-5.0	
Loc11	M-46 Access Shaft	0.21	0.16	0.22	-0.01	-4.8	
03049500	Allegheny River at Natrona	0.22	0.36	0.23	-0.01	-4.5	
03085734	Ohio River at Emsworth Dam Lower Pool at Emsworth	0.11	0.07	0.11	0.00	0.0	
KAGC	Pittsburgh Allegheny Cty	0.20	0.12	0.20	0.00	0.0	
KPIT	Greater Pittsburgh Int'l	0.13	0.08	0.13	0.00	0.0	
Loc01	PWSA-Montana St.	0.18	0.12	0.18	0.00	0.0	
Loc02	ALCOSAN WWTP Lab	0.17	0.12	0.17	0.00	0.0	
Loc03	Shaler Munic Bldg	0.18	0.14	0.18	0.00	0.0	
Loc04	Kennedy Twp PS	0.12	0.08	0.12	0.00	0.0	
Loc05	Upper St. Clair	0.11	0.07	0.11	0.00	0.0	
Loc06	Carnegie Transit Time	0.14	0.09	0.14	0.00	0.0	
Loc07	Greentree Munic Bldg	0.15	0.09	0.15	0.00	0.0	
Loc09	Univ of Pittsburgh	0.16	0.10	0.16	0.00	0.0	
Loc10	PWSA-Highland Park	0.17	0.11	0.17	0.00	0.0	
Loc13	M-59 Access Shaft	0.24	0.19	0.24	0.00	0.0	
Loc16	Castle Shannon	0.18	0.12	0.18	0.00	0.0	
Loc17	Chartiers Pump Station	0.11	0.06	0.11	0.00	0.0	
Loc18	Oakdale Pump Station	0.17	0.10	0.17	0.00	0.0	
Loc19	Sandy Creek Eq Facility	0.19	0.15	0.19	0.00	0.0	

Gauge ID	Name	G_i (in)	R_i (in)	R_i^* (in)	Diff* (in)	Diff* (%)	Flag
Loc21	Moon TWP	0.11	0.09	0.11	0.00	0.0	
Loc22	North Fayette TWP	0.12	0.07	0.12	0.00	0.0	
Loc24	Jefferson Hills	0.16	0.14	0.16	0.00	0.0	
Loc25	White Oak Public Works Bldg	0.21	0.30	0.21	0.00	0.0	
Loc26	Elizabeth TWP Municipal Bldg	0.23	0.32	0.23	0.00	0.0	
Loc27	Marshall TWP	0.13	0.10	0.13	0.00	0.0	
Loc28	Plum Municipal Bldg	0.27	0.25	0.27	0.00	0.0	
Loc29	Bell Acres Munic Bldg	0.10	0.09	0.10	0.00	0.0	
Loc30	McCandless Twn Hall	0.10	0.10	0.10	0.00	0.0	
Loc31	Hampton Municipal Bldg	0.13	0.10	0.13	0.00	0.0	
Loc33	Richland TWP	0.16	0.14	0.16	0.00	0.0	
Loc14	Churchill Munic Bldg	0.25	0.19	0.24	0.01	4.0	
Loc32	Arnold	0.24	0.25	0.23	0.01	4.2	
Loc08	AC Health Dept Bldg	0.18	0.10	0.17	0.01	5.6	
Loc15	Trafford Maint Bldg	ND	---	---	---	---	ND
Loc23	Clinton Munic Bldg	ND	---	---	---	---	ND

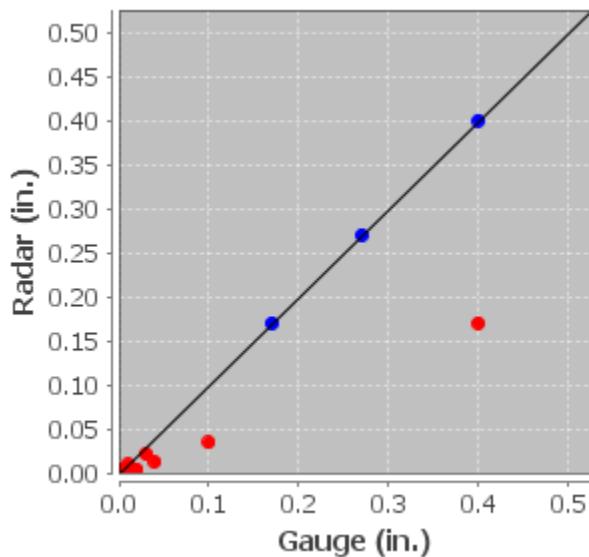


Figure 6. Scatter Plot of RG Pairs for Event 2a

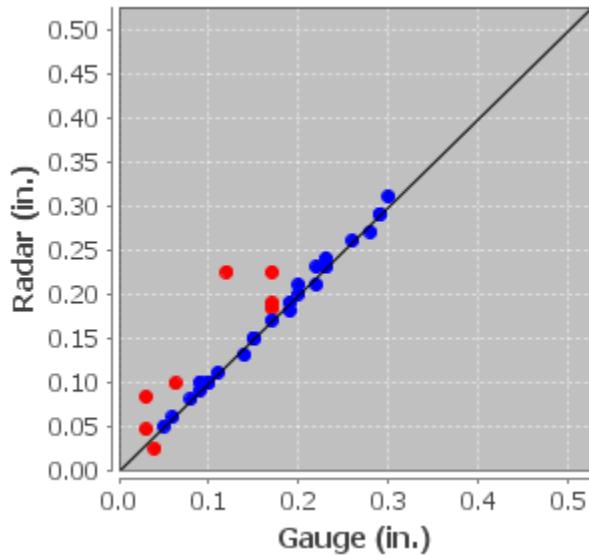


Figure 7. Scatter Plot of RG Pairs for Event 2b

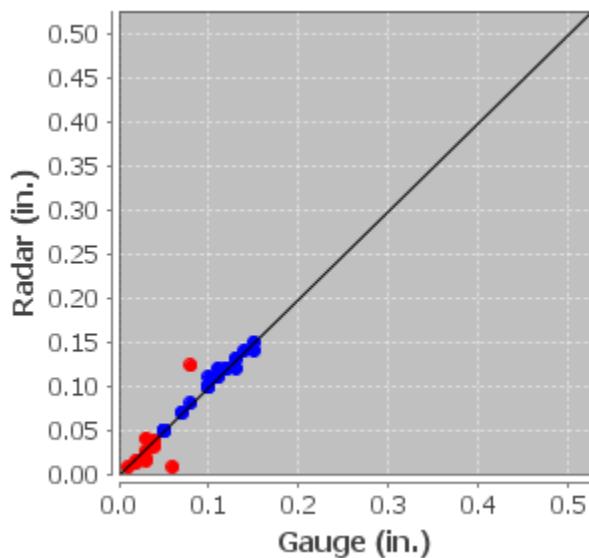


Figure 8. Scatter Plot of RG Pairs for Event 2c

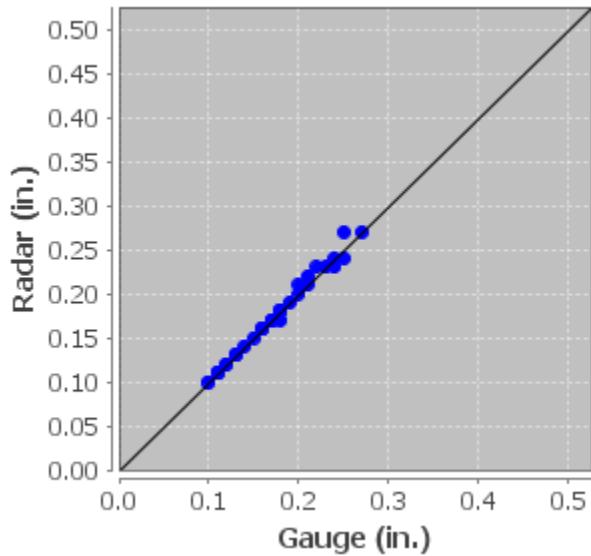


Figure 9. Scatter Plot of RG Pairs for Event 2d

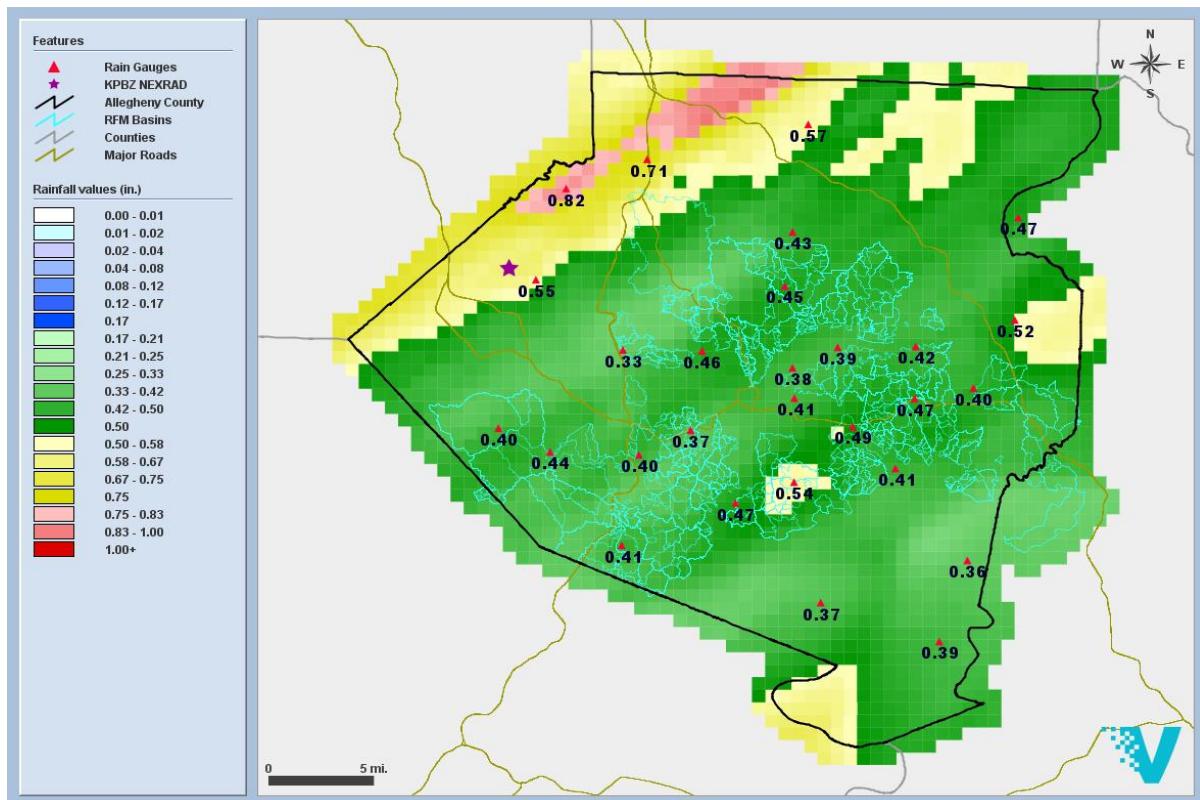


Figure 10. GARR Storm Total for Event 2

Table 13. Depth Duration Frequency Analyses for Event 2

Duration	Depth (in)	Pixel	Time (EST)	Frequency
15 minutes	0.277	149165	2020-03-03 08:15	<1 yr.
30 minutes	0.351	145115	2020-03-03 07:35	<1 yr.
1 hour	0.578	145115	2020-03-03 08:10	<1 yr.
2 hour	0.730	143116	2020-03-03 08:55	<1 yr.
3 hour	0.820	145115	2020-03-03 10:05	<1 yr.
6 hour	0.851	145115	2020-03-03 11:00	<1 yr.
12 hour	0.851	145115	2020-03-03 12:00	<1 yr.

Event 3: 2020-03-03 PM

The analysis period was from 2020-03-03 14:00 EST to 2020-03-03 23:00 EST. The event was then split into two sub-event periods at 2020-03-03 19:00 EST to improve gauge adjustment of the radar.

The gauges listed in [Appendix A](#) were not used to adjust the radar due to inconsistencies between the gauge and the radar or surrounding gauges, or they did not have data available for this event. The gauges listed in [Appendix B](#) were not used to adjust the radar since they did not meet statistical criteria for gauge-adjustment.

A convective Z-R relationship was used to convert radar reflectivity to rainfall rates. Table 14 shows the mean bias and average depth of the event along with the AD and CAD, respectively. Tables 15 - 16 summarize the results for each RG pair used for final radar adjustment, where G_i is the gauge estimate, R_i is the non-adjusted radar estimate, R_i^* is the GARR estimate, and Diff* (%) is the percent difference between the gauge and GARR estimate. Those gauges not used to adjust the radar are shown at the bottom of the table and are highlighted in red. The specific reason for gauge exclusion is displayed in the Flag column. Figures 11 - 12 show the scatter plots of the gauge-adjusted RG pairs. Those gauges not used to adjust the radar are shown in red. Figure 13 depicts the GARR storm total over the 1-km² pixels. The GARR amounts for the 2313 1-km² pixels range from 0.1 - 0.3 inches with a mean of 0.1 inches. The GARR amounts for the 440 RFM basins range from 0.1 - 0.2 inches with a mean of 0.1 inches. The GARR amounts for the 871 RFM sheds range from 0.1 - 0.2 inches with a mean of 0.1 inches. Table 17 shows the Depth Duration Frequency (DDF) maximum values for the 1-km² pixels.

Table 14. GARR Statistics for Event 3

Event #	Radar	Event Date	Start Time (EST)	End Time (EST)	Gauges Used (37)	Avg. Depth (in)	Bias	AD (%)	CAD (%)
E3a	KPBZ LII	2020-03-03 PM	2020-03-03 14:05	2020-03-03 19:00	22	0.105	0.911	25.2	2.3
E3b	KPBZ LII	2020-03-03 PM	2020-03-03 19:05	2020-03-03 23:00	6	0.044	0.570	61.0	0.0

Table 15. Summary of Individual RG Pairs for Event 3a

Gauge ID	Name	G _i (in)	R _i (in)	R _i * (in)	Diff* (in)	Diff* (%)	Flag
Loc20	Gascola Eq Facility	0.06	0.12	0.07	-0.01	-16.7	
Loc31	Hampton Municipal Bldg	0.17	0.20	0.18	-0.01	-5.9	
Loc27	Marshall TWP	0.19	0.21	0.20	-0.01	-5.3	
KAGC	Pittsburgh Allegheny Cty	0.05	0.05	0.05	0.00	0.0	
KPIT	Greater Pittsburgh Int'l	0.12	0.15	0.12	0.00	0.0	
Loc02	ALCOSAN WWTP Lab	0.11	0.13	0.11	0.00	0.0	
Loc04	Kennedy Twp PS	0.11	0.12	0.11	0.00	0.0	
Loc07	Greentree Munic Bldg	0.06	0.06	0.06	0.00	0.0	
Loc09	Univ of Pittsburgh	0.07	0.08	0.07	0.00	0.0	
Loc10	PWSA-Highland Park	0.12	0.12	0.12	0.00	0.0	
Loc11	M-46 Access Shaft	0.06	0.07	0.06	0.00	0.0	
Loc13	M-59 Access Shaft	0.05	0.08	0.05	0.00	0.0	
Loc19	Sandy Creek Eq Facility	0.11	0.11	0.11	0.00	0.0	
Loc21	Moon TWP	0.09	0.13	0.09	0.00	0.0	
Loc22	North Fayette TWP	0.10	0.08	0.10	0.00	0.0	
Loc25	White Oak Public Works Bldg	0.05	0.11	0.05	0.00	0.0	
Loc28	Plum Municipal Bldg	0.12	0.13	0.12	0.00	0.0	
Loc29	Bell Acres Munic Bldg	0.19	0.14	0.19	0.00	0.0	
Loc30	McCandless Twn Hall	0.17	0.15	0.17	0.00	0.0	
Loc32	Arnold	0.11	0.14	0.11	0.00	0.0	
Loc33	Richland TWP	0.15	0.14	0.15	0.00	0.0	
Loc03	Shaler Munic Bldg	0.21	0.18	0.20	0.01	4.8	
03049500	Allegheny River at Natrona	0.04	---	---	---	---	U
03085734	Ohio River at Emsworth Dam Lower Pool at Emsworth	0.05	---	---	---	---	U
Loc01	PWSA-Montana St.	0.07	---	---	---	---	U
Loc05	Upper St. Clair	0.02	---	---	---	---	MSTT
Loc06	Carnegie Transit Time	0.01	---	---	---	---	MSTT
Loc08	AC Health Dept Bldg	0.03	---	---	---	---	U
Loc12	Baldwin	0.03	---	---	---	---	MSTT
Loc14	Churchill Munic Bldg	0.03	---	---	---	---	U
Loc15	Trafford Maint Bldg	ND	---	---	---	---	ND
Loc16	Castle Shannon	0.03	---	---	---	---	MSTT
Loc17	Chartiers Pump Station	0.02	---	---	---	---	MSTT

Gauge ID	Name	G _i (in)	R _i (in)	R _i * (in)	Diff* (in)	Diff* (%)	Flag
Loc18	Oakdale Pump Station	0.02	---	---	---	---	MSTT
Loc23	Clinton Munic Bldg	ND	---	---	---	---	ND
Loc24	Jefferson Hills	0.03	---	---	---	---	MSTT
Loc26	Elizabeth TWP Municipal Bldg	0.05	---	---	---	---	OAD

Table 16. Summary of Individual RG Pairs for Event 3b

Gauge ID	Name	G _i (in)	R _i (in)	R _i * (in)	Diff* (in)	Diff* (%)	Flag
KPIT	Greater Pittsburgh Int'l	0.05	0.07	0.05	0.00	0.0	
Loc04	Kennedy Twp PS	0.05	0.05	0.05	0.00	0.0	
Loc14	Churchill Munic Bldg	0.05	0.05	0.05	0.00	0.0	
Loc26	Elizabeth TWP Municipal Bldg	0.05	0.07	0.05	0.00	0.0	
Loc27	Marshall TWP	0.09	0.25	0.09	0.00	0.0	
Loc33	Richland TWP	0.06	0.13	0.06	0.00	0.0	
03049500	Allegheny River at Natrona	0.01	---	---	---	---	MSTT
03085734	Ohio River at Emsworth Dam Lower Pool at Emsworth	0.03	---	---	---	---	MSTT
KAGC	Pittsburgh Allegheny Cty	0.02	---	---	---	---	MSTT
Loc01	PWSA-Montana St.	0.02	---	---	---	---	MSTT
Loc02	ALCOSAN WWTP Lab	0.02	---	---	---	---	MSTT
Loc03	Shaler Munic Bldg	0.00	---	---	---	---	MSTT
Loc05	Upper St. Clair	0.01	---	---	---	---	MSTT
Loc06	Carnegie Transit Time	0.00	---	---	---	---	MSTT
Loc07	Greentree Munic Bldg	0.03	---	---	---	---	MSTT
Loc08	AC Health Dept Bldg	0.02	---	---	---	---	MSTT
Loc09	Univ of Pittsburgh	0.04	---	---	---	---	MSTT
Loc10	PWSA-Highland Park	0.01	---	---	---	---	MSTT
Loc11	M-46 Access Shaft	0.03	---	---	---	---	MSTT
Loc12	Baldwin	0.02	---	---	---	---	MSTT
Loc13	M-59 Access Shaft	0.02	---	---	---	---	MSTT
Loc15	Trafford Maint Bldg	ND	---	---	---	---	ND
Loc16	Castle Shannon	0.02	---	---	---	---	MSTT
Loc17	Chartiers Pump Station	0.02	---	---	---	---	MSTT
Loc18	Oakdale Pump Station	0.00	---	---	---	---	MSTT
Loc19	Sandy Creek Eq Facility	0.02	---	---	---	---	MSTT

Gauge ID	Name	G_i (in)	R_i (in)	R_i^* (in)	Diff* (in)	Diff* (%)	Flag
Loc20	Gascola Eq Facility	0.04	---	---	---	---	MSTT
Loc21	Moon TWP	0.02	---	---	---	---	MSTT
Loc22	North Fayette TWP	0.02	---	---	---	---	MSTT
Loc23	Clinton Munic Bldg	ND	---	---	---	---	ND
Loc24	Jefferson Hills	0.04	---	---	---	---	MSTT
Loc25	White Oak Public Works Bldg	0.00	---	---	---	---	MSTT
Loc28	Plum Municipal Bldg	0.02	---	---	---	---	MSTT
Loc29	Bell Acres Munic Bldg	0.01	---	---	---	---	MSTT
Loc30	McCandless Twn Hall	0.04	---	---	---	---	MSTT
Loc31	Hampton Municipal Bldg	0.02	---	---	---	---	MSTT
Loc32	Arnold	0.01	---	---	---	---	MSTT

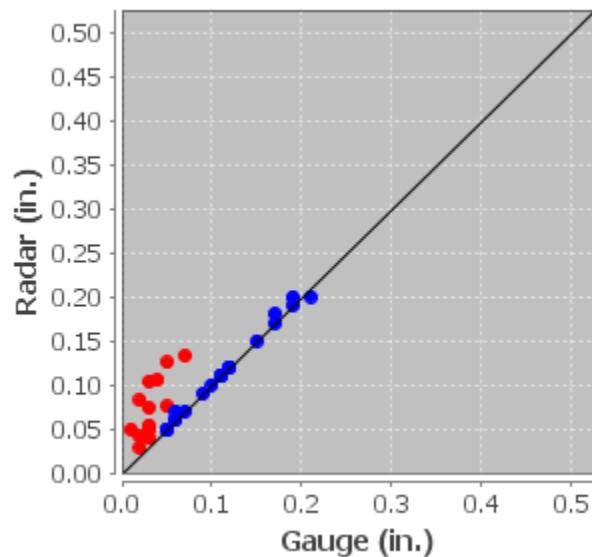


Figure 11. Scatter Plot of RG Pairs for Event 3a

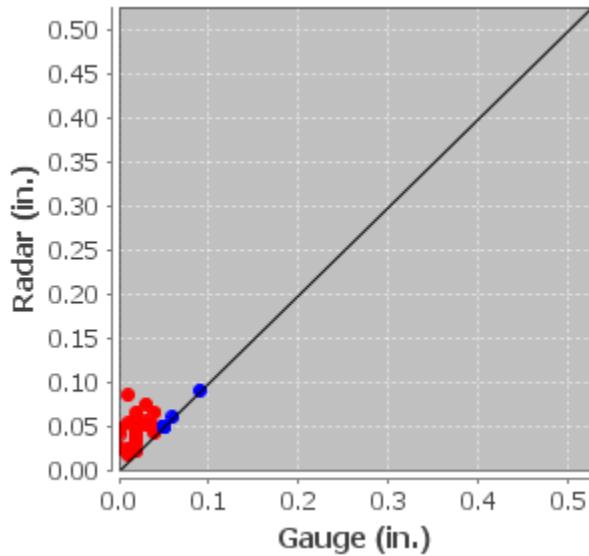


Figure 12. Scatter Plot of RG Pairs for Event 3b

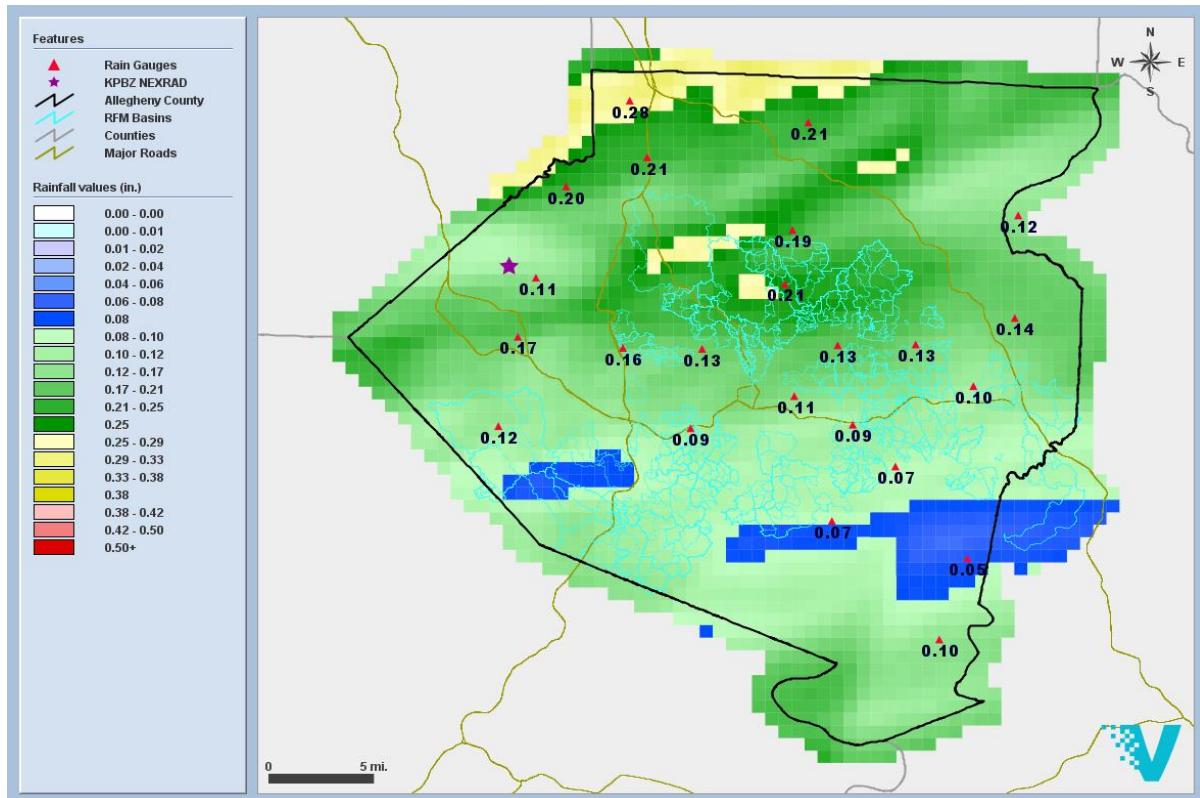


Figure 13. GARR Storm Total for Event 3

Table 17. Depth Duration Frequency Analyses for Event 3

Duration	Depth (in)	Pixel	Time (EST)	Frequency
15 minutes	0.219	130120	2020-03-03 16:15	<1 yr.
30 minutes	0.249	130120	2020-03-03 16:25	<1 yr.
1 hour	0.251	130120	2020-03-03 16:30	<1 yr.
2 hour	0.255	130120	2020-03-03 16:30	<1 yr.
3 hour	0.255	130120	2020-03-03 17:00	<1 yr.
6 hour	0.312	146112	2020-03-03 20:35	<1 yr.

Event 4: 2020-03-10

The analysis period was from 2020-03-10 01:00 EDT to 2020-03-10 18:00 EDT. The event was then split into three sub-event periods at 2020-03-10 08:00 EDT and 2020-03-10 14:15 EDT to improve gauge adjustment of the radar. Gauge Only was used during Event 4b since all radar sources were either unavailable or provided insufficient rainfall information.

The gauges listed in [Appendix A](#) were not used to adjust the radar due to inconsistencies between the gauge and the radar or surrounding gauges, or they did not have data available for this event. The gauges listed in [Appendix B](#) were not used to adjust the radar since they did not meet statistical criteria for gauge-adjustment.

A convective Z-R relationship was used to convert radar reflectivity to rainfall rates. Table 18 shows the mean bias and average depth of the event along with the AD and CAD, respectively. Tables 19 - 21 summarize the results for each RG pair used for final radar adjustment, where G_i is the gauge estimate, R_i is the non-adjusted radar estimate, R_i^* is the GARR estimate, and Diff* (%) is the percent difference between the gauge and GARR estimate. Those gauges not used to adjust the radar are shown at the bottom of the table and are highlighted in red. The specific reason for gauge exclusion is displayed in the Flag column. Figures 14 - 15 show the scatter plots of the gauge-adjusted RG pairs. Those gauges not used to adjust the radar are shown in red. Figure 16 depicts the GARR storm total over the 1-km² pixels. The GARR amounts for the 2313 1-km² pixels range from 0.1 - 0.3 inches with a mean of 0.2 inches. The GARR amounts for the 440 RFM basins range from 0.1 - 0.2 inches with a mean of 0.2 inches. The GARR amounts for the 871 RFM sheds range from 0.1 - 0.2 inches with a mean of 0.2 inches. Table 22 shows the Depth Duration Frequency (DDF) maximum values for the 1-km² pixels.

Table 18. GARR Statistics for Event 4

Event #	Radar	Event Date	Start Time (EDT)	End Time (EDT)	Gauges Used (37)	Avg. Depth (in)	Bias	AD (%)	CAD (%)
E4a	KPBZ LII	2020-03-10	2020-03-10 01:05	2020-03-10 08:00	20	0.054	0.646	56.5	3.1
E4b	Gauge Only	2020-03-10	2020-03-10 08:05	2020-03-10 14:15	31	0.025	---	---	---

Event #	Radar	Event Date	Start Time (EDT)	End Time (EDT)	Gauges Used (37)	Avg. Depth (in)	Bias	AD (%)	CAD (%)
E4c	KPBZ LII	2020-03-10	2020-03-10 14:20	2020-03-10 18:00	30	0.091	0.902	23.5	5.3

Table 19. Summary of Individual RG Pairs for Event 4a

Gauge ID	Name	G _i (in)	R _i (in)	R _i * (in)	Diff* (in)	Diff* (%)	Flag
Loc09	Univ of Pittsburgh	0.05	0.08	0.06	-0.01	-20.0	
Loc03	Shaler Munic Bldg	0.05	0.10	0.05	0.00	0.0	
Loc04	Kennedy Twp PS	0.06	0.09	0.06	0.00	0.0	
Loc06	Carnegie Transit Time	0.05	0.07	0.05	0.00	0.0	
Loc10	PWSA-Highland Park	0.05	0.08	0.05	0.00	0.0	
Loc12	Baldwin	0.05	0.08	0.05	0.00	0.0	
Loc14	Churchill Munic Bldg	0.05	0.07	0.05	0.00	0.0	
Loc17	Chartiers Pump Station	0.05	0.07	0.05	0.00	0.0	
Loc18	Oakdale Pump Station	0.05	0.07	0.05	0.00	0.0	
Loc19	Sandy Creek Eq Facility	0.05	0.09	0.05	0.00	0.0	
Loc21	Moon TWP	0.05	0.10	0.05	0.00	0.0	
Loc22	North Fayette TWP	0.06	0.08	0.06	0.00	0.0	
Loc27	Marshall TWP	0.05	0.08	0.05	0.00	0.0	
Loc28	Plum Municipal Bldg	0.06	0.09	0.06	0.00	0.0	
Loc29	Bell Acres Munic Bldg	0.07	0.09	0.07	0.00	0.0	
Loc30	McCandless Twn Hall	0.05	0.09	0.05	0.00	0.0	
Loc31	Hampton Municipal Bldg	0.06	0.10	0.06	0.00	0.0	
Loc32	Arnold	0.06	0.11	0.06	0.00	0.0	
Loc33	Richland TWP	0.08	0.11	0.08	0.00	0.0	
Loc08	AC Health Dept Bldg	0.07	0.08	0.06	0.01	14.3	
03049500	Allegheny River at Natrona	0.04	---	---	---	---	U
03085734	Ohio River at Emsworth Dam Lower Pool at Emsworth	0.03	---	---	---	---	MSTT
KAGC	Pittsburgh Allegheny Cty	0.04	---	---	---	---	MSTT
KPIT	Greater Pittsburgh Int'l	0.03	---	---	---	---	MSTT
Loc01	PWSA-Montana St.	0.02	---	---	---	---	MSTT
Loc02	ALCOSAN WWTP Lab	0.03	---	---	---	---	MSTT
Loc05	Upper St. Clair	0.04	---	---	---	---	MSTT
Loc07	Greentree Munic Bldg	0.04	---	---	---	---	MSTT

Gauge ID	Name	G _i (in)	R _i (in)	R _i * (in)	Diff* (in)	Diff* (%)	Flag
Loc11	M-46 Access Shaft	0.03	---	---	---	---	MSTT
Loc13	M-59 Access Shaft	0.03	---	---	---	---	MSTT
Loc15	Trafford Maint Bldg	ND	---	---	---	---	ND
Loc16	Castle Shannon	0.04	---	---	---	---	MSTT
Loc20	Gascola Eq Facility	0.02	---	---	---	---	MSTT
Loc23	Clinton Munic Bldg	ND	---	---	---	---	ND
Loc24	Jefferson Hills	0.07	---	---	---	---	O
Loc25	White Oak Public Works Bldg	0.03	---	---	---	---	MSTT
Loc26	Elizabeth TWP Municipal Bldg	0.02	---	---	---	---	MSTT

Table 20. Summary of Individual RG Pairs for Event 4b

Gauge ID	Name	G _i (in)	R _i (in)	R _i * (in)	Diff* (in)	Diff* (%)	Flag
Loc01	PWSA-Montana St.	0.00	---	---	---	---	
Loc10	PWSA-Highland Park	0.00	---	---	---	---	
Loc02	ALCOSAN WWTP Lab	0.01	---	---	---	---	
Loc09	Univ of Pittsburgh	0.01	---	---	---	---	
Loc11	M-46 Access Shaft	0.01	---	---	---	---	
Loc12	Baldwin	0.01	---	---	---	---	
Loc14	Churchill Munic Bldg	0.01	---	---	---	---	
Loc19	Sandy Creek Eq Facility	0.01	---	---	---	---	
Loc20	Gascola Eq Facility	0.01	---	---	---	---	
Loc24	Jefferson Hills	0.01	---	---	---	---	
Loc25	White Oak Public Works Bldg	0.01	---	---	---	---	
Loc03	Shaler Munic Bldg	0.02	---	---	---	---	
Loc04	Kennedy Twp PS	0.02	---	---	---	---	
Loc05	Upper St. Clair	0.02	---	---	---	---	
Loc06	Carnegie Transit Time	0.02	---	---	---	---	
Loc07	Greentree Munic Bldg	0.02	---	---	---	---	
Loc08	AC Health Dept Bldg	0.02	---	---	---	---	
Loc13	M-59 Access Shaft	0.02	---	---	---	---	
Loc16	Castle Shannon	0.02	---	---	---	---	
Loc17	Chartiers Pump Station	0.02	---	---	---	---	
Loc18	Oakdale Pump Station	0.02	---	---	---	---	
Loc22	North Fayette TWP	0.02	---	---	---	---	

Gauge ID	Name	G _i (in)	R _i (in)	R _i * (in)	Diff* (in)	Diff* (%)	Flag
Loc26	Elizabeth TWP Municipal Bldg	0.02	---	---	---	---	
Loc28	Plum Municipal Bldg	0.02	---	---	---	---	
Loc31	Hampton Municipal Bldg	0.03	---	---	---	---	
Loc21	Moon TWP	0.04	---	---	---	---	
Loc32	Arnold	0.04	---	---	---	---	
Loc30	McCandless Twn Hall	0.05	---	---	---	---	
Loc33	Richland TWP	0.05	---	---	---	---	
Loc27	Marshall TWP	0.06	---	---	---	---	
Loc29	Bell Acres Munic Bldg	0.06	---	---	---	---	
03049500	Allegheny River at Natrona	0.00	---	---	---	---	T
03085734	Ohio River at Emsworth Dam Lower Pool at Emsworth	0.01	---	---	---	---	T
KAGC	Pittsburgh Allegheny Cty	0.03	---	---	---	---	T
KPIT	Greater Pittsburgh Int'l	0.03	---	---	---	---	T
Loc15	Trafford Maint Bldg	ND	---	---	---	---	ND
Loc23	Clinton Munic Bldg	ND	---	---	---	---	ND

Table 21. Summary of Individual RG Pairs for Event 4c

Gauge ID	Name	G _i (in)	R _i (in)	R _i * (in)	Diff* (in)	Diff* (%)	Flag
Loc08	AC Health Dept Bldg	0.07	0.12	0.08	-0.01	-14.3	
Loc01	PWSA-Montana St.	0.08	0.12	0.09	-0.01	-12.5	
Loc05	Upper St. Clair	0.08	0.10	0.09	-0.01	-12.5	
03085734	Ohio River at Emsworth Dam Lower Pool at Emsworth	0.09	0.11	0.10	-0.01	-11.1	
Loc06	Carnegie Transit Time	0.10	0.13	0.11	-0.01	-10.0	
Loc20	Gascola Eq Facility	0.11	0.18	0.12	-0.01	-9.1	
KAGC	Pittsburgh Allegheny Cty	0.11	0.10	0.11	0.00	0.0	
Loc03	Shaler Munic Bldg	0.07	0.09	0.07	0.00	0.0	
Loc10	PWSA-Highland Park	0.08	0.11	0.08	0.00	0.0	
Loc12	Baldwin	0.12	0.12	0.12	0.00	0.0	
Loc16	Castle Shannon	0.15	0.17	0.15	0.00	0.0	
Loc18	Oakdale Pump Station	0.09	0.10	0.09	0.00	0.0	
Loc19	Sandy Creek Eq Facility	0.08	0.11	0.08	0.00	0.0	
Loc21	Moon TWP	0.12	0.09	0.12	0.00	0.0	

Gauge ID	Name	G _i (in)	R _i (in)	R _i * (in)	Diff* (in)	Diff* (%)	Flag
Loc22	North Fayette TWP	0.11	0.10	0.11	0.00	0.0	
Loc24	Jefferson Hills	0.08	0.14	0.08	0.00	0.0	
Loc25	White Oak Public Works Bldg	0.10	0.13	0.10	0.00	0.0	
Loc26	Elizabeth TWP Municipal Bldg	0.10	0.10	0.10	0.00	0.0	
Loc27	Marshall TWP	0.06	0.06	0.06	0.00	0.0	
Loc28	Plum Municipal Bldg	0.08	0.06	0.08	0.00	0.0	
Loc29	Bell Acres Munic Bldg	0.08	0.08	0.08	0.00	0.0	
Loc30	McCandless Twn Hall	0.09	0.06	0.09	0.00	0.0	
Loc31	Hampton Municipal Bldg	0.08	0.09	0.08	0.00	0.0	
Loc33	Richland TWP	0.07	0.05	0.07	0.00	0.0	
Loc07	Greentree Munic Bldg	0.15	0.13	0.14	0.01	6.7	
Loc04	Kennedy Twp PS	0.13	0.11	0.12	0.01	7.7	
Loc09	Univ of Pittsburgh	0.12	0.14	0.11	0.01	8.3	
Loc14	Churchill Munic Bldg	0.12	0.15	0.11	0.01	8.3	
Loc17	Chartiers Pump Station	0.11	0.10	0.10	0.01	9.1	
Loc02	ALCOSAN WWTP Lab	0.10	0.10	0.09	0.01	10.0	
03049500	Allegheny River at Natrona	0.05	---	---	---	---	MSTT
KPIT	Greater Pittsburgh Int'l	0.08	---	---	---	---	U
Loc11	M-46 Access Shaft	0.15	---	---	---	---	T
Loc13	M-59 Access Shaft	0.07	---	---	---	---	U
Loc15	Trafford Maint Bldg	ND	---	---	---	---	ND
Loc23	Clinton Munic Bldg	ND	---	---	---	---	ND
Loc32	Arnold	0.05	---	---	---	---	OAD

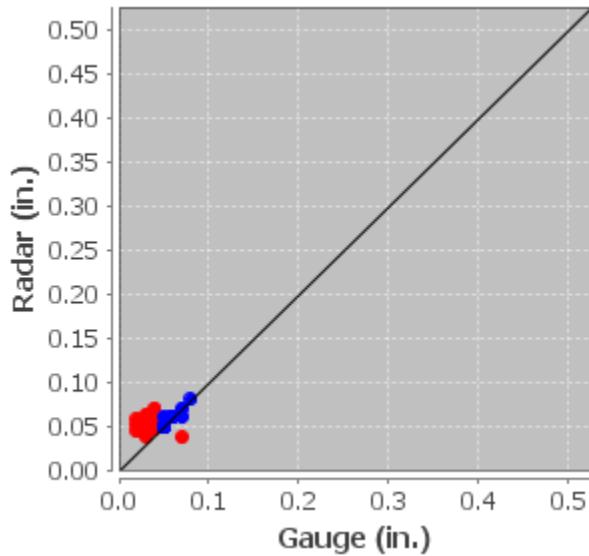


Figure 14. Scatter Plot of RG Pairs for Event 4a

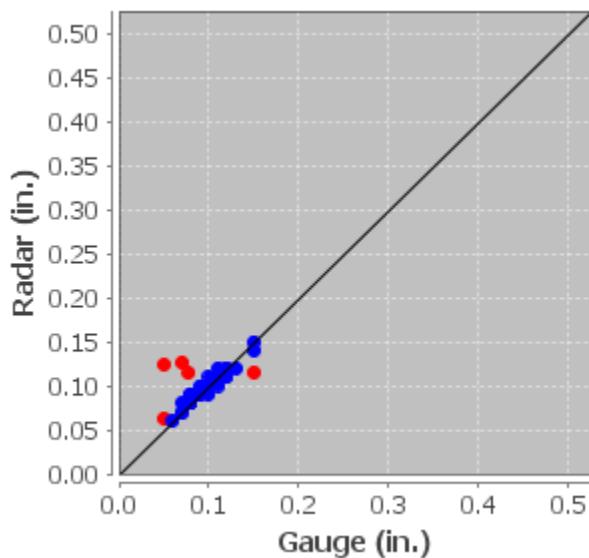


Figure 15. Scatter Plot of RG Pairs for Event 4c

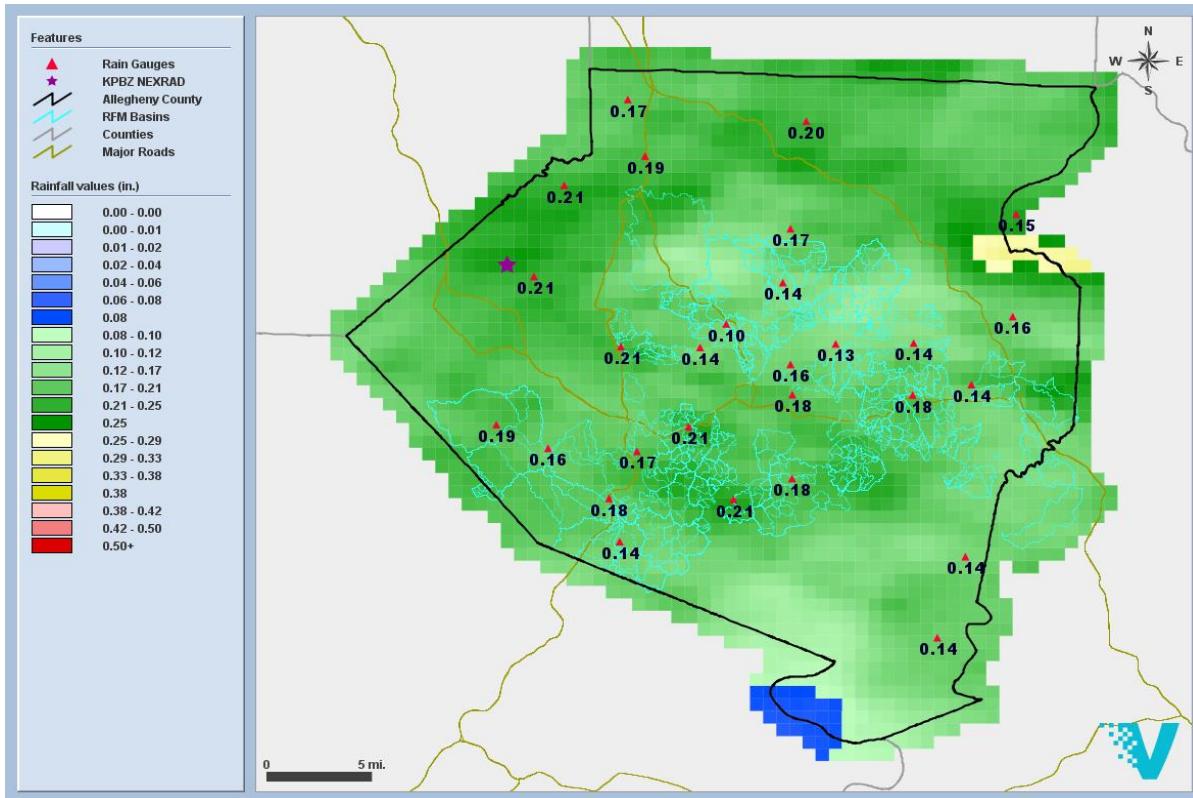


Figure 16. GARR Storm Total for Event 4

Table 22. Depth Duration Frequency Analyses for Event 4

Duration	Depth (in)	Pixel	Time (EDT)	Frequency
15 minutes	0.148	166127	2020-03-10 15:15	<1 yr.
30 minutes	0.160	166127	2020-03-10 15:20	<1 yr.
1 hour	0.190	171128	2020-03-10 16:05	<1 yr.
2 hour	0.194	171128	2020-03-10 16:10	<1 yr.
3 hour	0.199	171128	2020-03-10 16:10	<1 yr.
6 hour	0.228	166127	2020-03-10 16:05	<1 yr.
12 hour	0.282	167127	2020-03-10 16:05	<1 yr.

Event 5: 2020-03-18

The analysis period was from 2020-03-18 14:00 EDT to 2020-03-19 07:00 EDT. The event was then split into six sub-event periods at 2020-03-18 19:00 EDT, 2020-03-18 21:15 EDT, 2020-03-18 23:00 EDT, 2020-03-19 00:45 EDT and 2020-03-19 02:15 EDT to improve gauge adjustment of the radar. Gauge Only was used during Event 5d since all radar sources were either unavailable or provided insufficient rainfall information. Gauge Only was used during Event 5f since all radar sources were either unavailable or provided insufficient rainfall information.

The gauges listed in [Appendix A](#) were not used to adjust the radar due to inconsistencies between the gauge and the radar or surrounding gauges, or they did not have data available for this event. The gauges listed in [Appendix B](#) were not used to adjust the radar since they did not meet statistical criteria for gauge-adjustment.

A convective Z-R relationship was used to convert radar reflectivity to rainfall rates. Table 23 shows the mean bias and average depth of the event along with the AD and CAD, respectively. Tables 24 - 29 summarize the results for each RG pair used for final radar adjustment, where G_i is the gauge estimate, R_i is the non-adjusted radar estimate, R_i^* is the GARR estimate, and Diff* (%) is the percent difference between the gauge and GARR estimate. Those gauges not used to adjust the radar are shown at the bottom of the table and are highlighted in red. The specific reason for gauge exclusion is displayed in the Flag column. Figures 17 - 20 show the scatter plots of the gauge-adjusted RG pairs. Those gauges not used to adjust the radar are shown in red. Figure 21 depicts the GARR storm total over the 1-km² pixels. The GARR amounts for the 2313 1-km² pixels range from 0.6 - 1.1 inches with a mean of 0.9 inches. The GARR amounts for the 440 RFM basins range from 0.6 - 1.0 inches with a mean of 0.8 inches. The GARR amounts for the 871 RFM sheds range from 0.6 - 1.0 inches with a mean of 0.8 inches. Table 30 shows the Depth Duration Frequency (DDF) maximum values for the 1-km² pixels.

Table 23. GARR Statistics for Event 5

Event #	Radar	Event Date	Start Time (EDT)	End Time (EDT)	Gauges Used (37)	Avg. Depth (in)	Bias	AD (%)	CAD (%)
E5a	KPBZ LII	2020-03-18	2020-03-18 14:05	2020-03-18 19:00	30	0.145	1.085	14.9	2.3
E5b	KPBZ LII	2020-03-18	2020-03-18 19:05	2020-03-18 21:15	34	0.273	1.559	35.3	1.8
E5c	KPBZ LII	2020-03-18	2020-03-18 21:20	2020-03-18 23:00	32	0.241	1.747	42.4	2.2
E5d	Gauge Only	2020-03-18	2020-03-18 23:05	2020-03-19 00:45	32	0.056	---	---	---
E5e	KPBZ LII	2020-03-18	2020-03-19 00:50	2020-03-19 02:15	29	0.115	0.920	23.5	2.1
E5f	Gauge Only	2020-03-18	2020-03-19 02:20	2020-03-19 07:00	32	0.037	---	---	---

Table 24. Summary of Individual RG Pairs for Event 5a

Gauge ID	Name	G_i (in)	R_i (in)	R_i^* (in)	Diff* (in)	Diff* (%)	Flag
KAGC	Pittsburgh Allegheny Cty	0.07	0.09	0.08	-0.01	-14.3	
Loc20	Gascola Eq Facility	0.07	0.10	0.08	-0.01	-14.3	
Loc11	M-46 Access Shaft	0.10	0.12	0.11	-0.01	-10.0	
KPIT	Greater Pittsburgh Int'l	0.18	0.18	0.18	0.00	0.0	

Gauge ID	Name	G _i (in)	R _i (in)	R _i * (in)	Diff* (in)	Diff* (%)	Flag
Loc01	PWSA-Montana St.	0.20	0.18	0.20	0.00	0.0	
Loc03	Shaler Munic Bldg	0.21	0.18	0.21	0.00	0.0	
Loc04	Kennedy Twp PS	0.18	0.16	0.18	0.00	0.0	
Loc05	Upper St. Clair	0.13	0.12	0.13	0.00	0.0	
Loc06	Carnegie Transit Time	0.13	0.13	0.13	0.00	0.0	
Loc07	Greentree Munic Bldg	0.14	0.14	0.14	0.00	0.0	
Loc08	AC Health Dept Bldg	0.15	0.15	0.15	0.00	0.0	
Loc09	Univ of Pittsburgh	0.14	0.14	0.14	0.00	0.0	
Loc12	Baldwin	0.12	0.11	0.12	0.00	0.0	
Loc13	M-59 Access Shaft	0.07	0.10	0.07	0.00	0.0	
Loc15	Trafford Maint Bldg	0.06	0.07	0.06	0.00	0.0	
Loc16	Castle Shannon	0.14	0.11	0.14	0.00	0.0	
Loc17	Chartiers Pump Station	0.13	0.11	0.13	0.00	0.0	
Loc18	Oakdale Pump Station	0.18	0.14	0.18	0.00	0.0	
Loc19	Sandy Creek Eq Facility	0.11	0.10	0.11	0.00	0.0	
Loc21	Moon TWP	0.21	0.22	0.21	0.00	0.0	
Loc25	White Oak Public Works Bldg	0.05	0.06	0.05	0.00	0.0	
Loc26	Elizabeth TWP Municipal Bldg	0.06	0.06	0.06	0.00	0.0	
Loc27	Marshall TWP	0.28	0.20	0.28	0.00	0.0	
Loc28	Plum Municipal Bldg	0.08	0.07	0.08	0.00	0.0	
Loc29	Bell Acres Munic Bldg	0.27	0.22	0.27	0.00	0.0	
Loc31	Hampton Municipal Bldg	0.22	0.17	0.22	0.00	0.0	
Loc32	Arnold	0.11	0.10	0.11	0.00	0.0	
Loc33	Richland TWP	0.19	0.16	0.19	0.00	0.0	
Loc10	PWSA-Highland Park	0.16	0.14	0.15	0.01	6.3	
Loc14	Churchill Munic Bldg	0.13	0.11	0.12	0.01	7.7	
03049500	Allegheny River at Natrona	0.08	---	---	---	---	U
03085734	Ohio River at Emsworth Dam Lower Pool at Emsworth	0.16	---	---	---	---	U
Loc02	ALCOSAN WWTP Lab	0.12	---	---	---	---	U
Loc22	North Fayette TWP	0.22	---	---	---	---	O
Loc23	Clinton Munic Bldg	ND	---	---	---	---	ND
Loc24	Jefferson Hills	0.04	---	---	---	---	MSTT
Loc30	McCandless Twn Hall	0.20	---	---	---	---	U

Table 25. Summary of Individual RG Pairs for Event 5b

Gauge ID	Name	G _i (in)	R _i (in)	R _i * (in)	Diff* (in)	Diff* (%)	Flag
Loc09	Univ of Pittsburgh	0.28	0.21	0.30	-0.02	-7.1	
Loc11	M-46 Access Shaft	0.28	0.21	0.30	-0.02	-7.1	
Loc22	North Fayette TWP	0.21	0.16	0.22	-0.01	-4.8	
Loc02	ALCOSAN WWTP Lab	0.27	0.18	0.28	-0.01	-3.7	
Loc17	Chartiers Pump Station	0.27	0.18	0.28	-0.01	-3.7	
Loc07	Greentree Munic Bldg	0.32	0.19	0.33	-0.01	-3.1	
KPIT	Greater Pittsburgh Int'l	0.29	0.18	0.29	0.00	0.0	
Loc03	Shaler Munic Bldg	0.29	0.17	0.29	0.00	0.0	
Loc04	Kennedy Twp PS	0.24	0.15	0.24	0.00	0.0	
Loc05	Upper St. Clair	0.27	0.19	0.27	0.00	0.0	
Loc08	AC Health Dept Bldg	0.28	0.19	0.28	0.00	0.0	
Loc12	Baldwin	0.31	0.20	0.31	0.00	0.0	
Loc14	Churchill Munic Bldg	0.28	0.20	0.28	0.00	0.0	
Loc15	Trafford Maint Bldg	0.21	0.15	0.21	0.00	0.0	
Loc16	Castle Shannon	0.30	0.20	0.30	0.00	0.0	
Loc19	Sandy Creek Eq Facility	0.26	0.19	0.26	0.00	0.0	
Loc20	Gascola Eq Facility	0.23	0.17	0.23	0.00	0.0	
Loc21	Moon TWP	0.35	0.23	0.35	0.00	0.0	
Loc24	Jefferson Hills	0.20	0.14	0.20	0.00	0.0	
Loc25	White Oak Public Works Bldg	0.20	0.12	0.20	0.00	0.0	
Loc26	Elizabeth TWP Municipal Bldg	0.18	0.10	0.18	0.00	0.0	
Loc27	Marshall TWP	0.27	0.18	0.27	0.00	0.0	
Loc28	Plum Municipal Bldg	0.29	0.20	0.29	0.00	0.0	
Loc29	Bell Acres Munic Bldg	0.30	0.21	0.30	0.00	0.0	
Loc30	McCandless Twn Hall	0.28	0.19	0.28	0.00	0.0	
Loc31	Hampton Municipal Bldg	0.28	0.17	0.28	0.00	0.0	
Loc32	Arnold	0.31	0.16	0.31	0.00	0.0	
Loc33	Richland TWP	0.33	0.19	0.33	0.00	0.0	
Loc13	M-59 Access Shaft	0.33	0.19	0.32	0.01	3.0	
KAGC	Pittsburgh Allegheny Cty	0.31	0.18	0.30	0.01	3.2	
Loc01	PWSA-Montana St.	0.29	0.18	0.28	0.01	3.4	
Loc06	Carnegie Transit Time	0.36	0.19	0.34	0.02	5.6	
Loc10	PWSA-Highland Park	0.36	0.21	0.34	0.02	5.6	
Loc18	Oakdale Pump Station	0.34	0.19	0.32	0.02	5.9	
03049500	Allegheny River at Natrona	0.28	---	---	---	---	U

Gauge ID	Name	G _i (in)	R _i (in)	R _i * (in)	Diff* (in)	Diff* (%)	Flag
03085734	Ohio River at Emsworth Dam Lower Pool at Emsworth	0.20	---	---	---	---	U
Loc23	Clinton Munic Bldg	ND	---	---	---	---	ND

Table 26. Summary of Individual RG Pairs for Event 5c

Gauge ID	Name	G _i (in)	R _i (in)	R _i * (in)	Diff* (in)	Diff* (%)	Flag
Loc08	AC Health Dept Bldg	0.21	0.14	0.23	-0.02	-9.5	
Loc11	M-46 Access Shaft	0.21	0.14	0.23	-0.02	-9.5	
Loc22	North Fayette TWP	0.16	0.10	0.17	-0.01	-6.3	
Loc17	Chartiers Pump Station	0.19	0.12	0.20	-0.01	-5.3	
KAGC	Pittsburgh Allegheny Cty	0.20	0.10	0.21	-0.01	-5.0	
03085734	Ohio River at Emsworth Dam Lower Pool at Emsworth	0.21	0.16	0.22	-0.01	-4.8	
Loc19	Sandy Creek Eq Facility	0.22	0.13	0.23	-0.01	-4.5	
03049500	Allegheny River at Natrona	0.39	0.18	0.39	0.00	0.0	
KPIT	Greater Pittsburgh Int'l	0.22	0.15	0.22	0.00	0.0	
Loc01	PWSA-Montana St.	0.21	0.14	0.21	0.00	0.0	
Loc03	Shaler Munic Bldg	0.29	0.17	0.29	0.00	0.0	
Loc04	Kennedy Twp PS	0.19	0.13	0.19	0.00	0.0	
Loc07	Greentree Munic Bldg	0.21	0.13	0.21	0.00	0.0	
Loc15	Trafford Maint Bldg	0.21	0.11	0.21	0.00	0.0	
Loc16	Castle Shannon	0.20	0.11	0.20	0.00	0.0	
Loc21	Moon TWP	0.24	0.19	0.24	0.00	0.0	
Loc24	Jefferson Hills	0.18	0.08	0.18	0.00	0.0	
Loc25	White Oak Public Works Bldg	0.19	0.09	0.19	0.00	0.0	
Loc26	Elizabeth TWP Municipal Bldg	0.22	0.09	0.22	0.00	0.0	
Loc27	Marshall TWP	0.25	0.15	0.25	0.00	0.0	
Loc28	Plum Municipal Bldg	0.28	0.13	0.28	0.00	0.0	
Loc29	Bell Acres Munic Bldg	0.28	0.19	0.28	0.00	0.0	
Loc31	Hampton Municipal Bldg	0.32	0.19	0.32	0.00	0.0	
Loc32	Arnold	0.36	0.18	0.36	0.00	0.0	
Loc33	Richland TWP	0.33	0.20	0.33	0.00	0.0	
Loc14	Churchill Munic Bldg	0.26	0.14	0.25	0.01	3.8	
Loc10	PWSA-Highland Park	0.25	0.14	0.24	0.01	4.0	

Gauge ID	Name	G _i (in)	R _i (in)	R _i * (in)	Diff* (in)	Diff* (%)	Flag
Loc12	Baldwin	0.24	0.11	0.23	0.01	4.2	
Loc13	M-59 Access Shaft	0.23	0.11	0.22	0.01	4.3	
Loc18	Oakdale Pump Station	0.19	0.09	0.18	0.01	5.3	
Loc05	Upper St. Clair	0.18	0.10	0.17	0.01	5.6	
Loc09	Univ of Pittsburgh	0.25	0.13	0.23	0.02	8.0	
Loc02	ALCOSAN WWTP Lab	0.15	---	---	---	---	U
Loc06	Carnegie Transit Time	0.28	---	---	---	---	O
Loc20	Gascola Eq Facility	0.21	---	---	---	---	U
Loc23	Clinton Munic Bldg	ND	---	---	---	---	ND
Loc30	McCandless Twn Hall	0.23	---	---	---	---	U

Table 27. Summary of Individual RG Pairs for Event 5d

Gauge ID	Name	G _i (in)	R _i (in)	R _i * (in)	Diff* (in)	Diff* (%)	Flag
Loc01	PWSA-Montana St.	0.02	---	---	---	---	
Loc02	ALCOSAN WWTP Lab	0.03	---	---	---	---	
Loc15	Trafford Maint Bldg	0.04	---	---	---	---	
Loc17	Chartiers Pump Station	0.04	---	---	---	---	
Loc18	Oakdale Pump Station	0.04	---	---	---	---	
Loc22	North Fayette TWP	0.04	---	---	---	---	
Loc26	Elizabeth TWP Municipal Bldg	0.04	---	---	---	---	
Loc04	Kennedy Twp PS	0.05	---	---	---	---	
Loc07	Greentree Munic Bldg	0.05	---	---	---	---	
Loc08	AC Health Dept Bldg	0.05	---	---	---	---	
Loc09	Univ of Pittsburgh	0.05	---	---	---	---	
Loc10	PWSA-Highland Park	0.05	---	---	---	---	
Loc11	M-46 Access Shaft	0.05	---	---	---	---	
Loc13	M-59 Access Shaft	0.05	---	---	---	---	
Loc16	Castle Shannon	0.05	---	---	---	---	
Loc19	Sandy Creek Eq Facility	0.05	---	---	---	---	
Loc20	Gascola Eq Facility	0.05	---	---	---	---	
Loc21	Moon TWP	0.05	---	---	---	---	
Loc03	Shaler Munic Bldg	0.06	---	---	---	---	
Loc05	Upper St. Clair	0.06	---	---	---	---	
Loc06	Carnegie Transit Time	0.06	---	---	---	---	

Gauge ID	Name	G _i (in)	R _i (in)	R _i * (in)	Diff* (in)	Diff* (%)	Flag
Loc12	Baldwin	0.06	---	---	---	---	
Loc14	Churchill Munic Bldg	0.06	---	---	---	---	
Loc24	Jefferson Hills	0.06	---	---	---	---	
Loc25	White Oak Public Works Bldg	0.06	---	---	---	---	
Loc27	Marshall TWP	0.06	---	---	---	---	
Loc29	Bell Acres Munic Bldg	0.06	---	---	---	---	
Loc30	McCandless Twn Hall	0.06	---	---	---	---	
Loc31	Hampton Municipal Bldg	0.06	---	---	---	---	
Loc28	Plum Municipal Bldg	0.07	---	---	---	---	
Loc33	Richland TWP	0.07	---	---	---	---	
Loc32	Arnold	0.09	---	---	---	---	
03049500	Allegheny River at Natrona	0.14	---	---	---	---	T
03085734	Ohio River at Emsworth Dam Lower Pool at Emsworth	0.03	---	---	---	---	T
KAGC	Pittsburgh Allegheny Cty	0.04	---	---	---	---	T
KPIT	Greater Pittsburgh Int'l	0.06	---	---	---	---	T
Loc23	Clinton Munic Bldg	ND	---	---	---	---	ND

Table 28. Summary of Individual RG Pairs for Event 5e

Gauge ID	Name	G _i (in)	R _i (in)	R _i * (in)	Diff* (in)	Diff* (%)	Flag
Loc20	Gascola Eq Facility	0.09	0.11	0.10	-0.01	-11.1	
Loc08	AC Health Dept Bldg	0.10	0.12	0.11	-0.01	-10.0	
Loc12	Baldwin	0.12	0.12	0.13	-0.01	-8.3	
03085734	Ohio River at Emsworth Dam Lower Pool at Emsworth	0.06	0.08	0.06	0.00	0.0	
KAGC	Pittsburgh Allegheny Cty	0.14	0.12	0.14	0.00	0.0	
KPIT	Greater Pittsburgh Int'l	0.07	0.11	0.07	0.00	0.0	
Loc02	ALCOSAN WWTP Lab	0.08	0.10	0.08	0.00	0.0	
Loc03	Shaler Munic Bldg	0.07	0.08	0.07	0.00	0.0	
Loc04	Kennedy Twp PS	0.08	0.11	0.08	0.00	0.0	
Loc05	Upper St. Clair	0.17	0.14	0.17	0.00	0.0	
Loc07	Greentree Munic Bldg	0.13	0.11	0.13	0.00	0.0	
Loc09	Univ of Pittsburgh	0.10	0.10	0.10	0.00	0.0	
Loc13	M-59 Access Shaft	0.12	0.11	0.12	0.00	0.0	

Gauge ID	Name	G _i (in)	R _i (in)	R _i * (in)	Diff* (in)	Diff* (%)	Flag
Loc14	Churchill Munic Bldg	0.10	0.09	0.10	0.00	0.0	
Loc15	Trafford Maint Bldg	0.13	0.16	0.13	0.00	0.0	
Loc16	Castle Shannon	0.12	0.09	0.12	0.00	0.0	
Loc18	Oakdale Pump Station	0.14	0.11	0.14	0.00	0.0	
Loc19	Sandy Creek Eq Facility	0.10	0.10	0.10	0.00	0.0	
Loc21	Moon TWP	0.05	0.09	0.05	0.00	0.0	
Loc22	North Fayette TWP	0.13	0.12	0.13	0.00	0.0	
Loc24	Jefferson Hills	0.20	0.22	0.20	0.00	0.0	
Loc25	White Oak Public Works Bldg	0.13	0.19	0.13	0.00	0.0	
Loc26	Elizabeth TWP Municipal Bldg	0.29	0.45	0.29	0.00	0.0	
Loc27	Marshall TWP	0.08	0.09	0.08	0.00	0.0	
Loc28	Plum Municipal Bldg	0.09	0.05	0.09	0.00	0.0	
Loc31	Hampton Municipal Bldg	0.05	0.05	0.05	0.00	0.0	
Loc33	Richland TWP	0.06	0.10	0.06	0.00	0.0	
Loc11	M-46 Access Shaft	0.14	0.11	0.13	0.01	7.1	
Loc10	PWSA-Highland Park	0.11	0.10	0.10	0.01	9.1	
03049500	Allegheny River at Natrona	0.02	---	---	---	---	MSTT
Loc01	PWSA-Montana St.	0.05	---	---	---	---	U
Loc06	Carnegie Transit Time	0.19	---	---	---	---	O
Loc17	Chartiers Pump Station	0.09	---	---	---	---	U
Loc23	Clinton Munic Bldg	ND	---	---	---	---	ND
Loc29	Bell Acres Munic Bldg	0.03	---	---	---	---	MSTT
Loc30	McCandless Twn Hall	0.04	---	---	---	---	MSTT
Loc32	Arnold	0.03	---	---	---	---	MSTT

Table 29. Summary of Individual RG Pairs for Event 5f

Gauge ID	Name	G _i (in)	R _i (in)	R _i * (in)	Diff* (in)	Diff* (%)	Flag
Loc01	PWSA-Montana St.	0.00	---	---	---	---	
Loc19	Sandy Creek Eq Facility	0.00	---	---	---	---	
Loc02	ALCOSAN WWTP Lab	0.01	---	---	---	---	
Loc03	Shaler Munic Bldg	0.01	---	---	---	---	
Loc06	Carnegie Transit Time	0.01	---	---	---	---	
Loc07	Greentree Munic Bldg	0.01	---	---	---	---	
Loc08	AC Health Dept Bldg	0.01	---	---	---	---	

Gauge ID	Name	G _i (in)	R _i (in)	R _i * (in)	Diff* (in)	Diff* (%)	Flag
Loc09	Univ of Pittsburgh	0.01	---	---	---	---	
Loc10	PWSA-Highland Park	0.01	---	---	---	---	
Loc11	M-46 Access Shaft	0.01	---	---	---	---	
Loc18	Oakdale Pump Station	0.01	---	---	---	---	
Loc22	North Fayette TWP	0.01	---	---	---	---	
Loc28	Plum Municipal Bldg	0.01	---	---	---	---	
Loc04	Kennedy Twp PS	0.02	---	---	---	---	
Loc12	Baldwin	0.02	---	---	---	---	
Loc13	M-59 Access Shaft	0.02	---	---	---	---	
Loc14	Churchill Munic Bldg	0.02	---	---	---	---	
Loc17	Chartiers Pump Station	0.02	---	---	---	---	
Loc20	Gascola Eq Facility	0.02	---	---	---	---	
Loc21	Moon TWP	0.02	---	---	---	---	
Loc31	Hampton Municipal Bldg	0.02	---	---	---	---	
Loc32	Arnold	0.02	---	---	---	---	
Loc16	Castle Shannon	0.03	---	---	---	---	
Loc30	McCandless Twn Hall	0.03	---	---	---	---	
Loc05	Upper St. Clair	0.04	---	---	---	---	
Loc27	Marshall TWP	0.04	---	---	---	---	
Loc15	Trafford Maint Bldg	0.05	---	---	---	---	
Loc29	Bell Acres Munic Bldg	0.05	---	---	---	---	
Loc33	Richland TWP	0.06	---	---	---	---	
Loc24	Jefferson Hills	0.09	---	---	---	---	
Loc25	White Oak Public Works Bldg	0.09	---	---	---	---	
Loc26	Elizabeth TWP Municipal Bldg	0.16	---	---	---	---	
03049500	Allegheny River at Natrona	0.03	---	---	---	---	T
03085734	Ohio River at Emsworth Dam Lower Pool at Emsworth	0.01	---	---	---	---	T
KAGC	Pittsburgh Allegheny Cty	0.05	---	---	---	---	T
KPIT	Greater Pittsburgh Int'l	0.02	---	---	---	---	T
Loc23	Clinton Munic Bldg	ND	---	---	---	---	ND

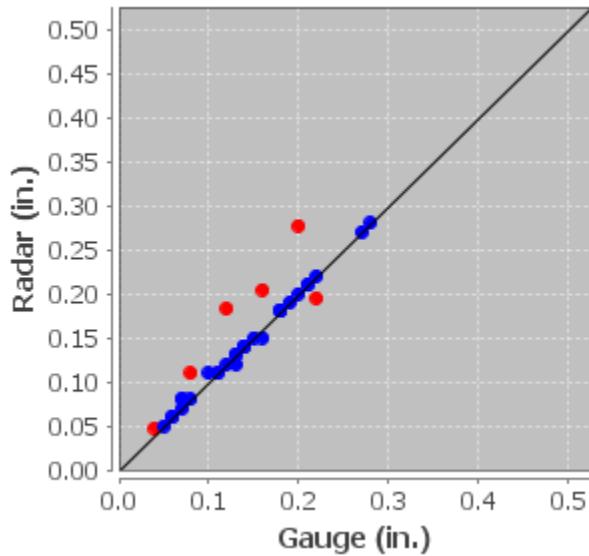


Figure 17. Scatter Plot of RG Pairs for Event 5a

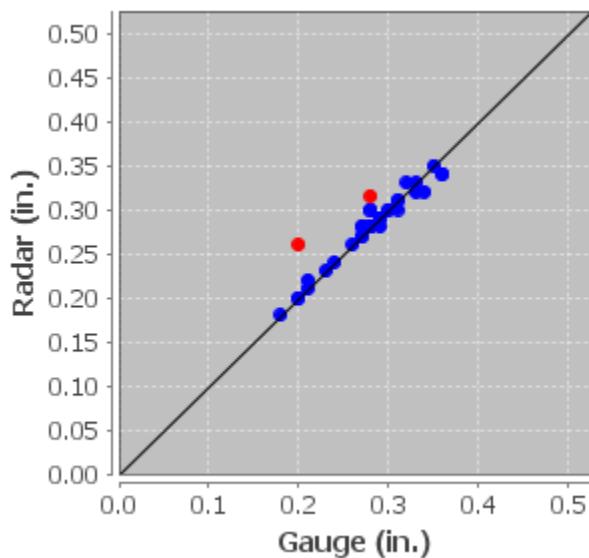


Figure 18. Scatter Plot of RG Pairs for Event 5b

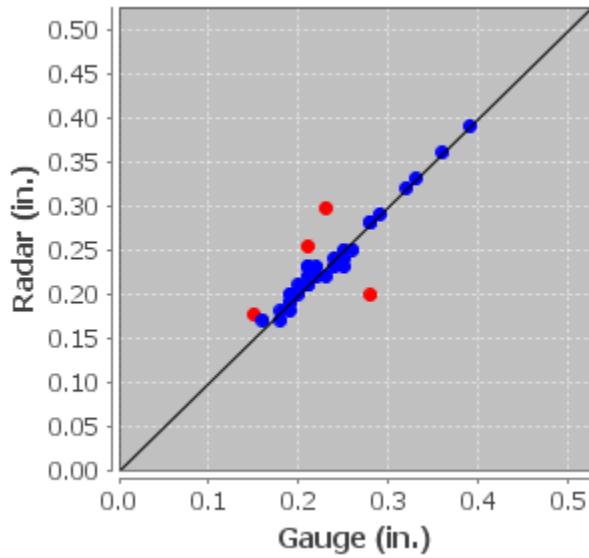


Figure 19. Scatter Plot of RG Pairs for Event 5c

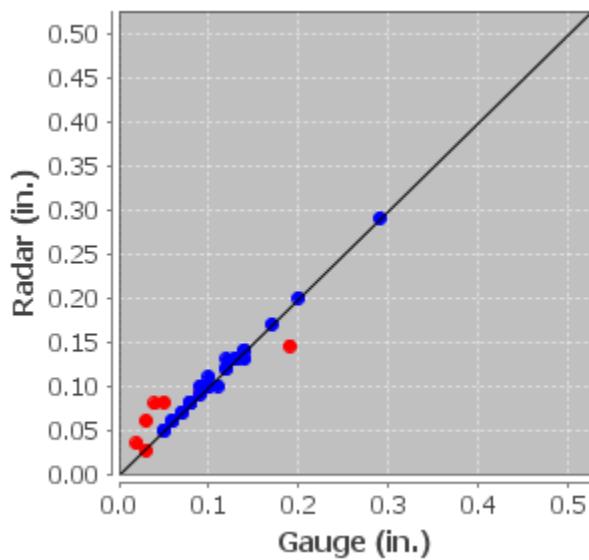


Figure 20. Scatter Plot of RG Pairs for Event 5e

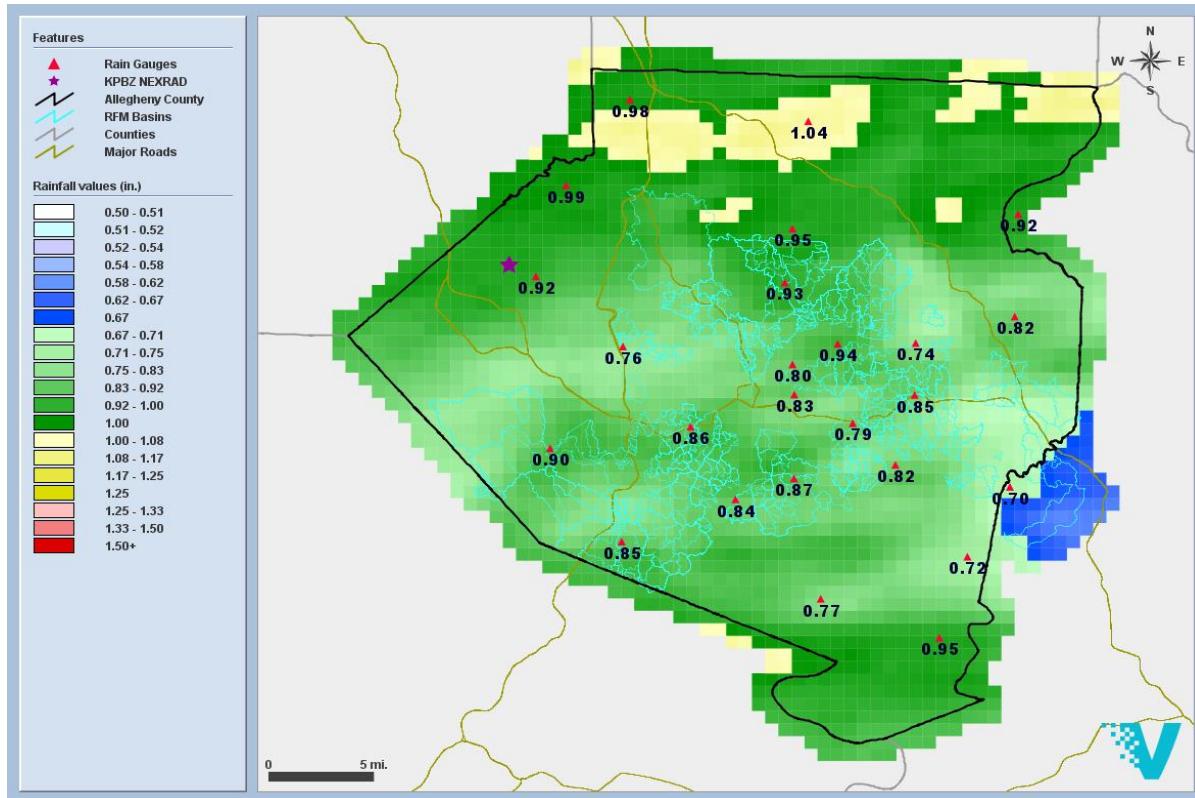


Figure 21. GARR Storm Total for Event 5

Table 30. Depth Duration Frequency Analyses for Event 5

Duration	Depth (in)	Pixel	Time (EDT)	Frequency
15 minutes	0.189	148160	2020-03-19 01:50	<1 yr.
30 minutes	0.268	148161	2020-03-19 01:50	<1 yr.
1 hour	0.469	148161	2020-03-19 01:50	<1 yr.
2 hour	0.552	148160	2020-03-19 02:35	<1 yr.
3 hour	0.612	148160	2020-03-19 02:35	<1 yr.
6 hour	0.933	164112	2020-03-19 00:05	<1 yr.
12 hour	1.071	170114	2020-03-19 03:55	<1 yr.

Event 6: 2020-03-20

The analysis period was from 2020-03-19 16:00 EDT to 2020-03-20 20:00 EDT. The event was then split into ten sub-event periods at 2020-03-19 20:30 EDT, 2020-03-19 21:00 EDT, 2020-03-19 22:00 EDT, 2020-03-20 03:00 EDT, 2020-03-20 04:30 EDT, 2020-03-20 06:00 EDT, 2020-03-20 07:45 EDT, 2020-03-20 09:00 EDT and 2020-03-20 14:00 EDT to improve gauge adjustment of the radar.

The gauges listed in [Appendix A](#) were not used to adjust the radar due to inconsistencies between the gauge and the radar or surrounding gauges, or they did not have data available for this event. The gauges listed in [Appendix B](#) were not used to adjust the radar since they did not meet statistical criteria for gauge-adjustment.

A convective Z-R relationship was used to convert radar reflectivity to rainfall rates. Table 31 shows the mean bias and average depth of the event along with the AD and CAD, respectively. Tables 32 - 41 summarize the results for each RG pair used for final radar adjustment, where G_i is the gauge estimate, R_i is the non-adjusted radar estimate, R_i^* is the GARR estimate, and Diff* (%) is the percent difference between the gauge and GARR estimate. Those gauges not used to adjust the radar are shown at the bottom of the table and are highlighted in red. The specific reason for gauge exclusion is displayed in the Flag column. Figures 22 - 31 show the scatter plots of the gauge-adjusted RG pairs. Those gauges not used to adjust the radar are shown in red. Figure 32 depicts the GARR storm total over the 1-km² pixels. The GARR amounts for the 2313 1-km² pixels range from 0.6 - 1.8 inches with a mean of 1.3 inches. The GARR amounts for the 440 RFM basins range from 1.1 - 1.8 inches with a mean of 1.3 inches. The GARR amounts for the 871 RFM sheds range from 1.1 - 1.8 inches with a mean of 1.3 inches. Table 42 shows the Depth Duration Frequency (DDF) maximum values for the 1-km² pixels.

Table 31. GARR Statistics for Event 6

Event #	Radar	Event Date	Start Time (EDT)	End Time (EDT)	Gauges Used (37)	Avg. Depth (in)	Bias	AD (%)	CAD (%)
E6a	KPBZ LII	2020-03-20	2020-03-19 16:05	2020-03-19 20:30	33	0.073	0.823	25.7	3.0
E6b	KPBZ LII	2020-03-20	2020-03-19 20:35	2020-03-19 21:00	27	0.075	0.950	16.2	3.5
E6c	KPBZ LII	2020-03-20	2020-03-19 21:05	2020-03-19 22:00	13	0.043	0.901	29.8	4.5
E6d	KPBZ LII	2020-03-20	2020-03-19 22:05	2020-03-20 03:00	27	0.098	0.649	55.2	4.6
E6e	KPBZ LII	2020-03-20	2020-03-20 03:05	2020-03-20 04:30	27	0.083	0.999	24.6	3.4
E6f	KPBZ LII	2020-03-20	2020-03-20 04:35	2020-03-20 06:00	34	0.276	1.359	27.0	1.1
E6g	KPBZ LII	2020-03-20	2020-03-20 06:05	2020-03-20 07:45	32	0.299	1.270	20.3	1.9
E6h	KPBZ LII	2020-03-20	2020-03-20 07:50	2020-03-20 09:00	33	0.171	1.233	19.4	1.5
E6i	KPBZ LII	2020-03-20	2020-03-20 09:05	2020-03-20 14:00	25	0.107	0.843	26.2	2.6
E6j	KPBZ LII	2020-03-20	2020-03-20 14:05	2020-03-20 20:00	11	0.045	0.966	22.1	4.0

Table 32. Summary of Individual RG Pairs for Event 6a

Gauge ID	Name	G _i (in)	R _i (in)	R _i * (in)	Diff* (in)	Diff* (%)	Flag
Loc09	Univ of Pittsburgh	0.07	0.09	0.08	-0.01	-14.3	
Loc02	ALCOSAN WWTP Lab	0.08	0.11	0.09	-0.01	-12.5	
Loc05	Upper St. Clair	0.09	0.11	0.10	-0.01	-11.1	
KAGC	Pittsburgh Allegheny Cty	0.07	0.09	0.07	0.00	0.0	
KPIT	Greater Pittsburgh Int'l	0.09	0.13	0.09	0.00	0.0	
Loc01	PWSA-Montana St.	0.09	0.10	0.09	0.00	0.0	
Loc03	Shaler Munic Bldg	0.09	0.08	0.09	0.00	0.0	
Loc04	Kennedy Twp PS	0.09	0.11	0.09	0.00	0.0	
Loc06	Carnegie Transit Time	0.11	0.11	0.11	0.00	0.0	
Loc07	Greentree Munic Bldg	0.12	0.12	0.12	0.00	0.0	
Loc10	PWSA-Highland Park	0.08	0.09	0.08	0.00	0.0	
Loc11	M-46 Access Shaft	0.06	0.07	0.06	0.00	0.0	
Loc12	Baldwin	0.08	0.08	0.08	0.00	0.0	
Loc13	M-59 Access Shaft	0.05	0.08	0.05	0.00	0.0	
Loc14	Churchill Munic Bldg	0.06	0.07	0.06	0.00	0.0	
Loc15	Trafford Maint Bldg	0.05	0.06	0.05	0.00	0.0	
Loc16	Castle Shannon	0.08	0.08	0.08	0.00	0.0	
Loc19	Sandy Creek Eq Facility	0.06	0.08	0.06	0.00	0.0	
Loc20	Gascola Eq Facility	0.05	0.07	0.05	0.00	0.0	
Loc21	Moon TWP	0.08	0.15	0.08	0.00	0.0	
Loc22	North Fayette TWP	0.11	0.12	0.11	0.00	0.0	
Loc24	Jefferson Hills	0.06	0.07	0.06	0.00	0.0	
Loc25	White Oak Public Works Bldg	0.05	0.07	0.05	0.00	0.0	
Loc26	Elizabeth TWP Municipal Bldg	0.05	0.06	0.05	0.00	0.0	
Loc27	Marshall TWP	0.09	0.12	0.09	0.00	0.0	
Loc28	Plum Municipal Bldg	0.06	0.08	0.06	0.00	0.0	
Loc29	Bell Acres Munic Bldg	0.09	0.15	0.09	0.00	0.0	
Loc30	McCandless Twn Hall	0.06	0.11	0.06	0.00	0.0	
Loc31	Hampton Municipal Bldg	0.06	0.06	0.06	0.00	0.0	
Loc32	Arnold	0.05	0.06	0.05	0.00	0.0	
Loc33	Richland TWP	0.08	0.08	0.08	0.00	0.0	
Loc17	Chartiers Pump Station	0.12	0.11	0.11	0.01	8.3	
Loc08	AC Health Dept Bldg	0.09	0.09	0.08	0.01	11.1	
03049500	Allegheny River at Natrona	0.03	---	---	---	---	U
03085734	Ohio River at Emsworth Dam Lower Pool at Emsworth	0.06	---	---	---	---	U

Gauge ID	Name	G _i (in)	R _i (in)	R _i * (in)	Diff* (in)	Diff* (%)	Flag
Loc18	Oakdale Pump Station	0.19	---	---	---	---	O
Loc23	Clinton Munic Bldg	ND	---	---	---	---	ND

Table 33. Summary of Individual RG Pairs for Event 6b

Gauge ID	Name	G _i (in)	R _i (in)	R _i * (in)	Diff* (in)	Diff* (%)	Flag
Loc09	Univ of Pittsburgh	0.09	0.12	0.11	-0.02	-22.2	
Loc18	Oakdale Pump Station	0.07	0.09	0.08	-0.01	-14.3	
Loc19	Sandy Creek Eq Facility	0.10	0.11	0.11	-0.01	-10.0	
Loc01	PWSA-Montana St.	0.08	0.08	0.08	0.00	0.0	
Loc03	Shaler Munic Bldg	0.10	0.10	0.10	0.00	0.0	
Loc04	Kennedy Twp PS	0.07	0.06	0.07	0.00	0.0	
Loc05	Upper St. Clair	0.06	0.07	0.06	0.00	0.0	
Loc06	Carnegie Transit Time	0.09	0.11	0.09	0.00	0.0	
Loc07	Greentree Munic Bldg	0.10	0.12	0.10	0.00	0.0	
Loc11	M-46 Access Shaft	0.07	0.07	0.07	0.00	0.0	
Loc12	Baldwin	0.06	0.07	0.06	0.00	0.0	
Loc13	M-59 Access Shaft	0.06	0.06	0.06	0.00	0.0	
Loc15	Trafford Maint Bldg	0.07	0.05	0.07	0.00	0.0	
Loc16	Castle Shannon	0.05	0.07	0.05	0.00	0.0	
Loc17	Chartiers Pump Station	0.06	0.09	0.06	0.00	0.0	
Loc20	Gascola Eq Facility	0.06	0.07	0.06	0.00	0.0	
Loc24	Jefferson Hills	0.06	0.09	0.06	0.00	0.0	
Loc25	White Oak Public Works Bldg	0.06	0.07	0.06	0.00	0.0	
Loc26	Elizabeth TWP Municipal Bldg	0.14	0.14	0.14	0.00	0.0	
Loc28	Plum Municipal Bldg	0.11	0.11	0.11	0.00	0.0	
Loc31	Hampton Municipal Bldg	0.09	0.09	0.09	0.00	0.0	
Loc32	Arnold	0.11	0.11	0.11	0.00	0.0	
Loc33	Richland TWP	0.08	0.08	0.08	0.00	0.0	
Loc10	PWSA-Highland Park	0.14	0.12	0.13	0.01	7.1	
Loc08	AC Health Dept Bldg	0.12	0.11	0.11	0.01	8.3	
Loc14	Churchill Munic Bldg	0.09	0.08	0.08	0.01	11.1	
Loc22	North Fayette TWP	0.09	0.07	0.08	0.01	11.1	
03049500	Allegheny River at Natrona	0.07	---	---	---	---	U

Gauge ID	Name	G _i (in)	R _i (in)	R _i * (in)	Diff* (in)	Diff* (%)	Flag
03085734	Ohio River at Emsworth Dam Lower Pool at Emsworth	0.05	---	---	---	---	U
KAGC	Pittsburgh Allegheny Cty	0.04	---	---	---	---	U
KPIT	Greater Pittsburgh Int'l	0.04	---	---	---	---	MSTT
Loc02	ALCOSAN WWTP Lab	0.06	---	---	---	---	U
Loc21	Moon TWP	0.03	---	---	---	---	MSTT
Loc23	Clinton Munic Bldg	ND	---	---	---	---	ND
Loc27	Marshall TWP	0.04	---	---	---	---	MSTT
Loc29	Bell Acres Munic Bldg	0.03	---	---	---	---	MSTT
Loc30	McCandless Twn Hall	0.04	---	---	---	---	MSTT

Table 34. Summary of Individual RG Pairs for Event 6c

Gauge ID	Name	G _i (in)	R _i (in)	R _i * (in)	Diff* (in)	Diff* (%)	Flag
Loc04	Kennedy Twp PS	0.08	0.11	0.09	-0.01	-12.5	
03049500	Allegheny River at Natrona	0.13	0.16	0.13	0.00	0.0	
Loc01	PWSA-Montana St.	0.05	0.07	0.05	0.00	0.0	
Loc02	ALCOSAN WWTP Lab	0.05	0.06	0.05	0.00	0.0	
Loc03	Shaler Munic Bldg	0.08	0.08	0.08	0.00	0.0	
Loc09	Univ of Pittsburgh	0.05	0.05	0.05	0.00	0.0	
Loc13	M-59 Access Shaft	0.05	0.08	0.05	0.00	0.0	
Loc14	Churchill Munic Bldg	0.05	0.08	0.05	0.00	0.0	
Loc20	Gascola Eq Facility	0.05	0.10	0.05	0.00	0.0	
Loc28	Plum Municipal Bldg	0.05	0.06	0.05	0.00	0.0	
Loc32	Arnold	0.12	0.13	0.12	0.00	0.0	
Loc31	Hampton Municipal Bldg	0.14	0.11	0.13	0.01	7.1	
03085734	Ohio River at Emsworth Dam Lower Pool at Emsworth	0.21	0.16	0.18	0.03	14.3	
KAGC	Pittsburgh Allegheny Cty	0.03	---	---	---	---	MSTT
KPIT	Greater Pittsburgh Int'l	0.03	---	---	---	---	MSTT
Loc05	Upper St. Clair	0.01	---	---	---	---	MSTT
Loc06	Carnegie Transit Time	0.03	---	---	---	---	MSTT
Loc07	Greentree Munic Bldg	0.04	---	---	---	---	MSTT
Loc08	AC Health Dept Bldg	0.02	---	---	---	---	MSTT
Loc10	PWSA-Highland Park	0.03	---	---	---	---	MSTT

Gauge ID	Name	G _i (in)	R _i (in)	R _i * (in)	Diff* (in)	Diff* (%)	Flag
Loc11	M-46 Access Shaft	0.04	---	---	---	---	MSTT
Loc12	Baldwin	0.04	---	---	---	---	MSTT
Loc15	Trafford Maint Bldg	0.03	---	---	---	---	MSTT
Loc16	Castle Shannon	0.03	---	---	---	---	MSTT
Loc17	Chartiers Pump Station	0.02	---	---	---	---	MSTT
Loc18	Oakdale Pump Station	0.02	---	---	---	---	MSTT
Loc19	Sandy Creek Eq Facility	0.04	---	---	---	---	MSTT
Loc21	Moon TWP	0.01	---	---	---	---	MSTT
Loc22	North Fayette TWP	0.02	---	---	---	---	MSTT
Loc23	Clinton Munic Bldg	ND	---	---	---	---	ND
Loc24	Jefferson Hills	0.01	---	---	---	---	MSTT
Loc25	White Oak Public Works Bldg	0.04	---	---	---	---	MSTT
Loc26	Elizabeth TWP Municipal Bldg	0.00	---	---	---	---	MSTT
Loc27	Marshall TWP	0.03	---	---	---	---	MSTT
Loc29	Bell Acres Munic Bldg	0.01	---	---	---	---	MSTT
Loc30	McCandless Twn Hall	0.01	---	---	---	---	MSTT
Loc33	Richland TWP	0.01	---	---	---	---	MSTT

Table 35. Summary of Individual RG Pairs for Event 6d

Gauge ID	Name	G _i (in)	R _i (in)	R _i * (in)	Diff* (in)	Diff* (%)	Flag
Loc17	Chartiers Pump Station	0.06	0.12	0.07	-0.01	-16.7	
Loc11	M-46 Access Shaft	0.08	0.16	0.09	-0.01	-12.5	
Loc20	Gascola Eq Facility	0.08	0.15	0.09	-0.01	-12.5	
Loc07	Greentree Munic Bldg	0.12	0.19	0.13	-0.01	-8.3	
Loc09	Univ of Pittsburgh	0.12	0.20	0.13	-0.01	-8.3	
03085734	Ohio River at Emsworth Dam Lower Pool at Emsworth	0.13	0.24	0.14	-0.01	-7.7	
Loc03	Shaler Munic Bldg	0.13	0.23	0.14	-0.01	-7.7	
KPIT	Greater Pittsburgh Int'l	0.17	0.29	0.17	0.00	0.0	
Loc02	ALCOSAN WWTP Lab	0.12	0.18	0.12	0.00	0.0	
Loc04	Kennedy Twp PS	0.13	0.20	0.13	0.00	0.0	
Loc05	Upper St. Clair	0.05	0.06	0.05	0.00	0.0	
Loc10	PWSA-Highland Park	0.13	0.17	0.13	0.00	0.0	
Loc18	Oakdale Pump Station	0.16	0.23	0.16	0.00	0.0	

Gauge ID	Name	G _i (in)	R _i (in)	R _i * (in)	Diff* (in)	Diff* (%)	Flag
Loc19	Sandy Creek Eq Facility	0.13	0.21	0.13	0.00	0.0	
Loc21	Moon TWP	0.15	0.28	0.15	0.00	0.0	
Loc22	North Fayette TWP	0.18	0.26	0.18	0.00	0.0	
Loc26	Elizabeth TWP Municipal Bldg	0.05	0.06	0.05	0.00	0.0	
Loc27	Marshall TWP	0.09	0.13	0.09	0.00	0.0	
Loc28	Plum Municipal Bldg	0.18	0.23	0.18	0.00	0.0	
Loc29	Bell Acres Munic Bldg	0.13	0.19	0.13	0.00	0.0	
Loc30	McCandless Twn Hall	0.09	0.15	0.09	0.00	0.0	
Loc31	Hampton Municipal Bldg	0.16	0.24	0.16	0.00	0.0	
Loc32	Arnold	0.13	0.21	0.13	0.00	0.0	
Loc33	Richland TWP	0.09	0.13	0.09	0.00	0.0	
Loc08	AC Health Dept Bldg	0.15	0.19	0.14	0.01	6.7	
Loc14	Churchill Munic Bldg	0.12	0.17	0.11	0.01	8.3	
Loc06	Carnegie Transit Time	0.16	0.17	0.14	0.02	12.5	
03049500	Allegheny River at Natrona	0.10	---	---	---	---	U
KAGC	Pittsburgh Allegheny Cty	0.03	---	---	---	---	MSTT
Loc01	PWSA-Montana St.	0.09	---	---	---	---	U
Loc12	Baldwin	0.04	---	---	---	---	MSTT
Loc13	M-59 Access Shaft	0.03	---	---	---	---	MSTT
Loc15	Trafford Maint Bldg	0.05	---	---	---	---	MSTT
Loc16	Castle Shannon	0.04	---	---	---	---	MSTT
Loc23	Clinton Munic Bldg	ND	---	---	---	---	ND
Loc24	Jefferson Hills	0.01	---	---	---	---	MSTT
Loc25	White Oak Public Works Bldg	0.02	---	---	---	---	MSTT

Table 36. Summary of Individual RG Pairs for Event 6e

Gauge ID	Name	G _i (in)	R _i (in)	R _i * (in)	Diff* (in)	Diff* (%)	Flag
Loc09	Univ of Pittsburgh	0.05	0.08	0.06	-0.01	-20.0	
Loc17	Chartiers Pump Station	0.14	0.12	0.15	-0.01	-7.1	
03085734	Ohio River at Emsworth Dam Lower Pool at Emsworth	0.06	0.09	0.06	0.00	0.0	
KAGC	Pittsburgh Allegheny Cty	0.15	0.10	0.15	0.00	0.0	
Loc02	ALCOSAN WWTP Lab	0.06	0.09	0.06	0.00	0.0	
Loc03	Shaler Munic Bldg	0.08	0.10	0.08	0.00	0.0	

Gauge ID	Name	G _i (in)	R _i (in)	R _i * (in)	Diff* (in)	Diff* (%)	Flag
Loc06	Carnegie Transit Time	0.12	0.11	0.12	0.00	0.0	
Loc07	Greentree Munic Bldg	0.11	0.10	0.11	0.00	0.0	
Loc10	PWSA-Highland Park	0.07	0.08	0.07	0.00	0.0	
Loc12	Baldwin	0.11	0.07	0.11	0.00	0.0	
Loc13	M-59 Access Shaft	0.05	0.06	0.05	0.00	0.0	
Loc15	Trafford Maint Bldg	0.11	0.08	0.11	0.00	0.0	
Loc16	Castle Shannon	0.15	0.10	0.15	0.00	0.0	
Loc18	Oakdale Pump Station	0.13	0.12	0.13	0.00	0.0	
Loc19	Sandy Creek Eq Facility	0.07	0.07	0.07	0.00	0.0	
Loc21	Moon TWP	0.07	0.12	0.07	0.00	0.0	
Loc22	North Fayette TWP	0.11	0.10	0.11	0.00	0.0	
Loc27	Marshall TWP	0.11	0.13	0.11	0.00	0.0	
Loc28	Plum Municipal Bldg	0.05	0.06	0.05	0.00	0.0	
Loc29	Bell Acres Munic Bldg	0.13	0.16	0.13	0.00	0.0	
Loc31	Hampton Municipal Bldg	0.07	0.08	0.07	0.00	0.0	
Loc32	Arnold	0.06	0.08	0.06	0.00	0.0	
Loc33	Richland TWP	0.09	0.11	0.09	0.00	0.0	
Loc05	Upper St. Clair	0.18	0.12	0.17	0.01	5.6	
Loc04	Kennedy Twp PS	0.09	0.09	0.08	0.01	11.1	
Loc08	AC Health Dept Bldg	0.08	0.09	0.07	0.01	12.5	
Loc11	M-46 Access Shaft	0.07	0.06	0.06	0.01	14.3	
03049500	Allegheny River at Natrona	0.04	---	---	---	---	U
KPIT	Greater Pittsburgh Int'l	0.05	---	---	---	---	MSTT
Loc01	PWSA-Montana St.	0.05	---	---	---	---	U
Loc14	Churchill Munic Bldg	0.04	---	---	---	---	MSTT
Loc20	Gascola Eq Facility	0.03	---	---	---	---	MSTT
Loc23	Clinton Munic Bldg	ND	---	---	---	---	ND
Loc24	Jefferson Hills	0.04	---	---	---	---	MSTT
Loc25	White Oak Public Works Bldg	0.03	---	---	---	---	MSTT
Loc26	Elizabeth TWP Municipal Bldg	0.04	---	---	---	---	MSTT
Loc30	McCandless Twn Hall	0.08	---	---	---	---	U

Table 37. Summary of Individual RG Pairs for Event 6f

Gauge ID	Name	G _i (in)	R _i (in)	R _i * (in)	Diff* (in)	Diff* (%)	Flag
Loc31	Hampton Municipal Bldg	0.21	0.18	0.22	-0.01	-4.8	
Loc07	Greentree Munic Bldg	0.23	0.17	0.24	-0.01	-4.3	
Loc22	North Fayette TWP	0.29	0.20	0.30	-0.01	-3.4	
03085734	Ohio River at Emsworth Dam Lower Pool at Emsworth	0.17	0.14	0.17	0.00	0.0	
KAGC	Pittsburgh Allegheny Cty	0.43	0.27	0.43	0.00	0.0	
Loc02	ALCOSAN WWTP Lab	0.27	0.22	0.27	0.00	0.0	
Loc04	Kennedy Twp PS	0.17	0.13	0.17	0.00	0.0	
Loc05	Upper St. Clair	0.40	0.22	0.40	0.00	0.0	
Loc06	Carnegie Transit Time	0.25	0.16	0.25	0.00	0.0	
Loc08	AC Health Dept Bldg	0.23	0.18	0.23	0.00	0.0	
Loc09	Univ of Pittsburgh	0.22	0.16	0.22	0.00	0.0	
Loc10	PWSA-Highland Park	0.21	0.16	0.21	0.00	0.0	
Loc12	Baldwin	0.46	0.30	0.46	0.00	0.0	
Loc13	M-59 Access Shaft	0.49	0.32	0.49	0.00	0.0	
Loc14	Churchill Munic Bldg	0.29	0.20	0.29	0.00	0.0	
Loc15	Trafford Maint Bldg	0.66	0.48	0.66	0.00	0.0	
Loc16	Castle Shannon	0.46	0.29	0.46	0.00	0.0	
Loc18	Oakdale Pump Station	0.30	0.18	0.30	0.00	0.0	
Loc19	Sandy Creek Eq Facility	0.20	0.14	0.20	0.00	0.0	
Loc20	Gascola Eq Facility	0.28	0.18	0.28	0.00	0.0	
Loc21	Moon TWP	0.19	0.21	0.19	0.00	0.0	
Loc24	Jefferson Hills	0.51	0.30	0.51	0.00	0.0	
Loc25	White Oak Public Works Bldg	0.41	0.32	0.41	0.00	0.0	
Loc26	Elizabeth TWP Municipal Bldg	0.33	0.26	0.33	0.00	0.0	
Loc27	Marshall TWP	0.23	0.27	0.23	0.00	0.0	
Loc28	Plum Municipal Bldg	0.25	0.16	0.25	0.00	0.0	
Loc29	Bell Acres Munic Bldg	0.21	0.23	0.21	0.00	0.0	
Loc30	McCandless Twn Hall	0.17	0.23	0.17	0.00	0.0	
Loc32	Arnold	0.21	0.16	0.21	0.00	0.0	
Loc33	Richland TWP	0.21	0.20	0.21	0.00	0.0	
Loc11	M-46 Access Shaft	0.36	0.23	0.35	0.01	2.8	
Loc17	Chartiers Pump Station	0.31	0.17	0.30	0.01	3.2	
Loc03	Shaler Munic Bldg	0.21	0.15	0.20	0.01	4.8	
KPIT	Greater Pittsburgh Int'l	0.17	0.15	0.16	0.01	5.9	
03049500	Allegheny River at Natrona	0.12	---	---	---	---	U

Gauge ID	Name	G _i (in)	R _i (in)	R _i * (in)	Diff* (in)	Diff* (%)	Flag
Loc01	PWSA-Montana St.	0.16	---	---	---	---	U
Loc23	Clinton Munic Bldg	ND	---	---	---	---	ND

Table 38. Summary of Individual RG Pairs for Event 6g

Gauge ID	Name	G _i (in)	R _i (in)	R _i * (in)	Diff* (in)	Diff* (%)	Flag
Loc09	Univ of Pittsburgh	0.35	0.32	0.38	-0.03	-8.6	
Loc01	PWSA-Montana St.	0.26	0.24	0.28	-0.02	-7.7	
Loc19	Sandy Creek Eq Facility	0.38	0.33	0.40	-0.02	-5.3	
Loc30	McCandless Twn Hall	0.24	0.23	0.25	-0.01	-4.2	
Loc11	M-46 Access Shaft	0.41	0.35	0.42	-0.01	-2.4	
Loc18	Oakdale Pump Station	0.42	0.33	0.43	-0.01	-2.4	
03085734	Ohio River at Emsworth Dam Lower Pool at Emsworth	0.26	0.21	0.26	0.00	0.0	
Loc04	Kennedy Twp PS	0.30	0.23	0.30	0.00	0.0	
Loc06	Carnegie Transit Time	0.38	0.27	0.38	0.00	0.0	
Loc10	PWSA-Highland Park	0.34	0.28	0.34	0.00	0.0	
Loc16	Castle Shannon	0.51	0.41	0.51	0.00	0.0	
Loc17	Chartiers Pump Station	0.47	0.33	0.47	0.00	0.0	
Loc20	Gascola Eq Facility	0.36	0.27	0.36	0.00	0.0	
Loc21	Moon TWP	0.31	0.28	0.31	0.00	0.0	
Loc22	North Fayette TWP	0.29	0.21	0.29	0.00	0.0	
Loc24	Jefferson Hills	0.27	0.19	0.27	0.00	0.0	
Loc25	White Oak Public Works Bldg	0.23	0.23	0.23	0.00	0.0	
Loc26	Elizabeth TWP Municipal Bldg	0.08	0.09	0.08	0.00	0.0	
Loc28	Plum Municipal Bldg	0.49	0.36	0.49	0.00	0.0	
Loc29	Bell Acres Munic Bldg	0.25	0.22	0.25	0.00	0.0	
Loc31	Hampton Municipal Bldg	0.27	0.22	0.27	0.00	0.0	
Loc32	Arnold	0.32	0.24	0.32	0.00	0.0	
Loc33	Richland TWP	0.27	0.22	0.27	0.00	0.0	
Loc15	Trafford Maint Bldg	0.55	0.37	0.54	0.01	1.8	
Loc12	Baldwin	0.53	0.40	0.52	0.01	1.9	
Loc13	M-59 Access Shaft	0.42	0.31	0.41	0.01	2.4	
Loc03	Shaler Munic Bldg	0.37	0.28	0.36	0.01	2.7	
Loc14	Churchill Munic Bldg	0.37	0.28	0.36	0.01	2.7	

Gauge ID	Name	G _i (in)	R _i (in)	R _i * (in)	Diff* (in)	Diff* (%)	Flag
Loc07	Greentree Munic Bldg	0.35	0.23	0.34	0.01	2.9	
Loc02	ALCOSAN WWTP Lab	0.29	0.23	0.28	0.01	3.4	
Loc27	Marshall TWP	0.27	0.20	0.26	0.01	3.7	
Loc08	AC Health Dept Bldg	0.38	0.29	0.36	0.02	5.3	
03049500	Allegheny River at Natrona	0.18	---	---	---	---	U
KAGC	Pittsburgh Allegheny Cty	0.31	---	---	---	---	U
KPIT	Greater Pittsburgh Int'l	0.28	---	---	---	---	U
Loc05	Upper St. Clair	0.43	---	---	---	---	U
Loc23	Clinton Munic Bldg	ND	---	---	---	---	ND

Table 39. Summary of Individual RG Pairs for Event 6h

Gauge ID	Name	G _i (in)	R _i (in)	R _i * (in)	Diff* (in)	Diff* (%)	Flag
Loc13	M-59 Access Shaft	0.15	0.17	0.16	-0.01	-6.7	
Loc05	Upper St. Clair	0.17	0.17	0.18	-0.01	-5.9	
Loc11	M-46 Access Shaft	0.23	0.22	0.24	-0.01	-4.3	
KAGC	Pittsburgh Allegheny Cty	0.14	0.11	0.14	0.00	0.0	
Loc02	ALCOSAN WWTP Lab	0.16	0.15	0.16	0.00	0.0	
Loc03	Shaler Munic Bldg	0.20	0.15	0.20	0.00	0.0	
Loc04	Kennedy Twp PS	0.18	0.15	0.18	0.00	0.0	
Loc06	Carnegie Transit Time	0.18	0.13	0.18	0.00	0.0	
Loc07	Greentree Munic Bldg	0.16	0.13	0.16	0.00	0.0	
Loc08	AC Health Dept Bldg	0.20	0.15	0.20	0.00	0.0	
Loc09	Univ of Pittsburgh	0.21	0.17	0.21	0.00	0.0	
Loc10	PWSA-Highland Park	0.20	0.15	0.20	0.00	0.0	
Loc12	Baldwin	0.19	0.15	0.19	0.00	0.0	
Loc15	Trafford Maint Bldg	0.16	0.11	0.16	0.00	0.0	
Loc16	Castle Shannon	0.20	0.16	0.20	0.00	0.0	
Loc17	Chartiers Pump Station	0.13	0.10	0.13	0.00	0.0	
Loc18	Oakdale Pump Station	0.23	0.15	0.23	0.00	0.0	
Loc19	Sandy Creek Eq Facility	0.21	0.16	0.21	0.00	0.0	
Loc20	Gascola Eq Facility	0.24	0.19	0.24	0.00	0.0	
Loc21	Moon TWP	0.14	0.17	0.14	0.00	0.0	
Loc22	North Fayette TWP	0.26	0.17	0.26	0.00	0.0	
Loc24	Jefferson Hills	0.09	0.09	0.09	0.00	0.0	

Gauge ID	Name	G _i (in)	R _i (in)	R _i * (in)	Diff* (in)	Diff* (%)	Flag
Loc25	White Oak Public Works Bldg	0.14	0.10	0.14	0.00	0.0	
Loc26	Elizabeth TWP Municipal Bldg	0.13	0.10	0.13	0.00	0.0	
Loc27	Marshall TWP	0.10	0.10	0.10	0.00	0.0	
Loc28	Plum Municipal Bldg	0.26	0.20	0.26	0.00	0.0	
Loc29	Bell Acres Munic Bldg	0.14	0.14	0.14	0.00	0.0	
Loc30	McCandless Twn Hall	0.17	0.14	0.17	0.00	0.0	
Loc31	Hampton Municipal Bldg	0.21	0.16	0.21	0.00	0.0	
Loc32	Arnold	0.22	0.14	0.22	0.00	0.0	
Loc33	Richland TWP	0.14	0.14	0.14	0.00	0.0	
Loc14	Churchill Munic Bldg	0.27	0.21	0.26	0.01	3.7	
03085734	Ohio River at Emsworth Dam Lower Pool at Emsworth	0.19	0.14	0.18	0.01	5.3	
03049500	Allegheny River at Natrona	0.17	---	---	---	---	U
KPIT	Greater Pittsburgh Int'l	0.29	---	---	---	---	O
Loc01	PWSA-Montana St.	0.11	---	---	---	---	U
Loc23	Clinton Munic Bldg	ND	---	---	---	---	ND

Table 40. Summary of Individual RG Pairs for Event 6i

Gauge ID	Name	G _i (in)	R _i (in)	R _i * (in)	Diff* (in)	Diff* (%)	Flag
Loc11	M-46 Access Shaft	0.07	0.11	0.08	-0.01	-14.3	
Loc14	Churchill Munic Bldg	0.11	0.17	0.12	-0.01	-9.1	
03049500	Allegheny River at Natrona	0.07	0.11	0.07	0.00	0.0	
KPIT	Greater Pittsburgh Int'l	0.06	0.07	0.06	0.00	0.0	
Loc06	Carnegie Transit Time	0.09	0.12	0.09	0.00	0.0	
Loc07	Greentree Munic Bldg	0.12	0.17	0.12	0.00	0.0	
Loc08	AC Health Dept Bldg	0.10	0.08	0.10	0.00	0.0	
Loc10	PWSA-Highland Park	0.07	0.06	0.07	0.00	0.0	
Loc15	Trafford Maint Bldg	0.05	0.05	0.05	0.00	0.0	
Loc17	Chartiers Pump Station	0.05	0.05	0.05	0.00	0.0	
Loc19	Sandy Creek Eq Facility	0.06	0.09	0.06	0.00	0.0	
Loc20	Gascola Eq Facility	0.12	0.15	0.12	0.00	0.0	
Loc21	Moon TWP	0.07	0.13	0.07	0.00	0.0	
Loc22	North Fayette TWP	0.07	0.09	0.07	0.00	0.0	
Loc24	Jefferson Hills	0.14	0.14	0.14	0.00	0.0	

Gauge ID	Name	G _i (in)	R _i (in)	R _i * (in)	Diff* (in)	Diff* (%)	Flag
Loc25	White Oak Public Works Bldg	0.13	0.12	0.13	0.00	0.0	
Loc26	Elizabeth TWP Municipal Bldg	0.20	0.30	0.20	0.00	0.0	
Loc27	Marshall TWP	0.24	0.32	0.24	0.00	0.0	
Loc28	Plum Municipal Bldg	0.06	0.07	0.06	0.00	0.0	
Loc29	Bell Acres Munic Bldg	0.30	0.29	0.30	0.00	0.0	
Loc30	McCandless Twn Hall	0.18	0.21	0.18	0.00	0.0	
Loc31	Hampton Municipal Bldg	0.08	0.10	0.08	0.00	0.0	
Loc33	Richland TWP	0.16	0.18	0.16	0.00	0.0	
Loc09	Univ of Pittsburgh	0.22	0.19	0.21	0.01	4.5	
Loc18	Oakdale Pump Station	0.15	0.14	0.14	0.01	6.7	
03085734	Ohio River at Emsworth Dam Lower Pool at Emsworth	0.03	---	---	---	---	MSTT
KAGC	Pittsburgh Allegheny Cty	0.05	---	---	---	---	MSTT
Loc01	PWSA-Montana St.	0.02	---	---	---	---	MSTT
Loc02	ALCOSAN WWTP Lab	0.03	---	---	---	---	MSTT
Loc03	Shaler Munic Bldg	0.04	---	---	---	---	MSTT
Loc04	Kennedy Twp PS	0.04	---	---	---	---	MSTT
Loc05	Upper St. Clair	0.02	---	---	---	---	MSTT
Loc12	Baldwin	0.04	---	---	---	---	MSTT
Loc13	M-59 Access Shaft	0.03	---	---	---	---	MSTT
Loc16	Castle Shannon	0.04	---	---	---	---	MSTT
Loc23	Clinton Munic Bldg	ND	---	---	---	---	ND
Loc32	Arnold	0.04	---	---	---	---	MSTT

Table 41. Summary of Individual RG Pairs for Event 6j

Gauge ID	Name	G _i (in)	R _i (in)	R _i * (in)	Diff* (in)	Diff* (%)	Flag
Loc02	ALCOSAN WWTP Lab	0.05	0.07	0.06	-0.01	-20.0	
Loc27	Marshall TWP	0.09	0.12	0.10	-0.01	-11.1	
KPIT	Greater Pittsburgh Int'l	0.06	0.07	0.06	0.00	0.0	
Loc03	Shaler Munic Bldg	0.06	0.08	0.06	0.00	0.0	
Loc04	Kennedy Twp PS	0.06	0.07	0.06	0.00	0.0	
Loc21	Moon TWP	0.06	0.07	0.06	0.00	0.0	
Loc22	North Fayette TWP	0.06	0.05	0.06	0.00	0.0	
Loc29	Bell Acres Munic Bldg	0.08	0.07	0.08	0.00	0.0	

Gauge ID	Name	G _i (in)	R _i (in)	R _i * (in)	Diff* (in)	Diff* (%)	Flag
Loc30	McCandless Twn Hall	0.09	0.08	0.09	0.00	0.0	
Loc33	Richland TWP	0.14	0.09	0.14	0.00	0.0	
Loc01	PWSA-Montana St.	0.09	0.08	0.08	0.01	11.1	
03049500	Allegheny River at Natrona	0.03	---	---	---	---	U
03085734	Ohio River at Emsworth Dam Lower Pool at Emsworth	0.02	---	---	---	---	U
KAGC	Pittsburgh Allegheny Cty	0.00	---	---	---	---	MSTT
Loc05	Upper St. Clair	0.00	---	---	---	---	MSTT
Loc06	Carnegie Transit Time	0.00	---	---	---	---	MSTT
Loc07	Greentree Munic Bldg	0.01	---	---	---	---	MSTT
Loc08	AC Health Dept Bldg	0.03	---	---	---	---	MSTT
Loc09	Univ of Pittsburgh	0.01	---	---	---	---	MSTT
Loc10	PWSA-Highland Park	0.04	---	---	---	---	MSTT
Loc11	M-46 Access Shaft	0.02	---	---	---	---	MSTT
Loc12	Baldwin	0.02	---	---	---	---	MSTT
Loc13	M-59 Access Shaft	0.00	---	---	---	---	MSTT
Loc14	Churchill Munic Bldg	0.01	---	---	---	---	MSTT
Loc15	Trafford Maint Bldg	0.00	---	---	---	---	MSTT
Loc16	Castle Shannon	0.02	---	---	---	---	MSTT
Loc17	Chartiers Pump Station	0.02	---	---	---	---	MSTT
Loc18	Oakdale Pump Station	0.02	---	---	---	---	MSTT
Loc19	Sandy Creek Eq Facility	0.04	---	---	---	---	MSTT
Loc20	Gascola Eq Facility	0.02	---	---	---	---	MSTT
Loc23	Clinton Munic Bldg	ND	---	---	---	---	ND
Loc24	Jefferson Hills	0.00	---	---	---	---	MSTT
Loc25	White Oak Public Works Bldg	0.00	---	---	---	---	MSTT
Loc26	Elizabeth TWP Municipal Bldg	0.00	---	---	---	---	MSTT
Loc28	Plum Municipal Bldg	0.03	---	---	---	---	MSTT
Loc31	Hampton Municipal Bldg	0.04	---	---	---	---	MSTT
Loc32	Arnold	0.03	---	---	---	---	MSTT

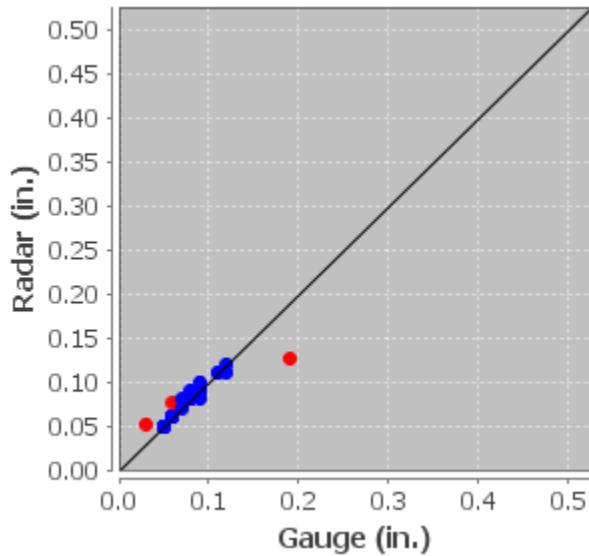


Figure 22. Scatter Plot of RG Pairs for Event 6a

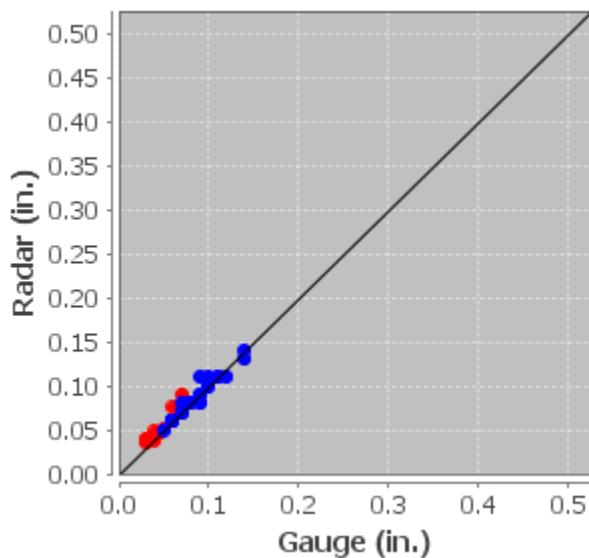


Figure 23. Scatter Plot of RG Pairs for Event 6b

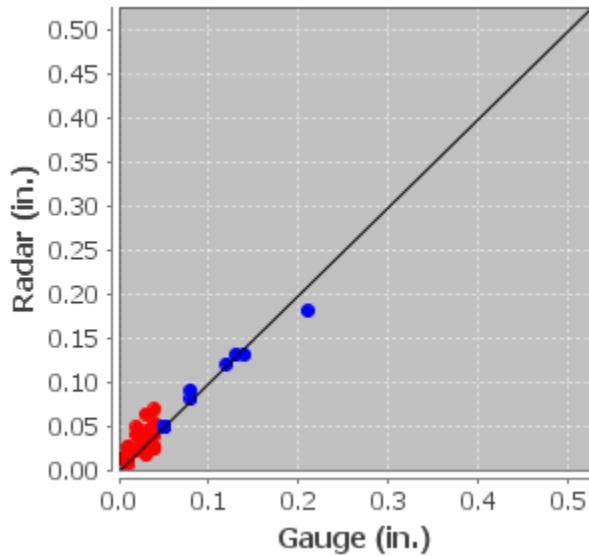


Figure 24. Scatter Plot of RG Pairs for Event 6c

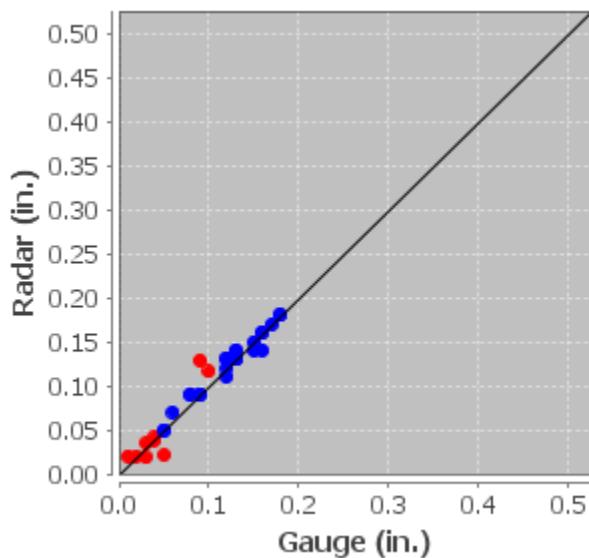


Figure 25. Scatter Plot of RG Pairs for Event 6d

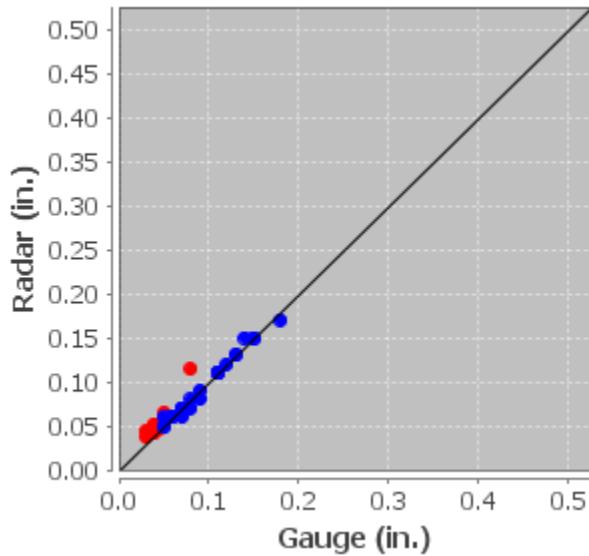


Figure 26. Scatter Plot of RG Pairs for Event 6e

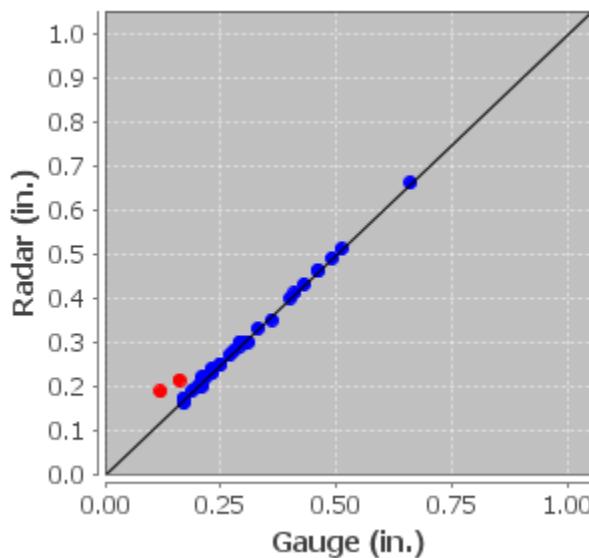


Figure 27. Scatter Plot of RG Pairs for Event 6f

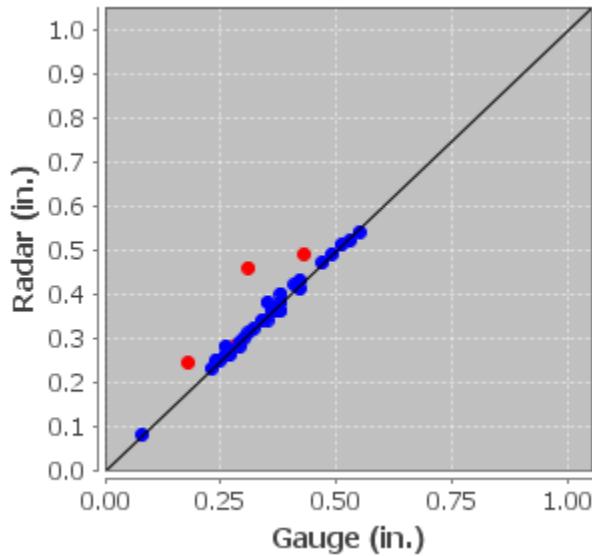


Figure 28. Scatter Plot of RG Pairs for Event 6g

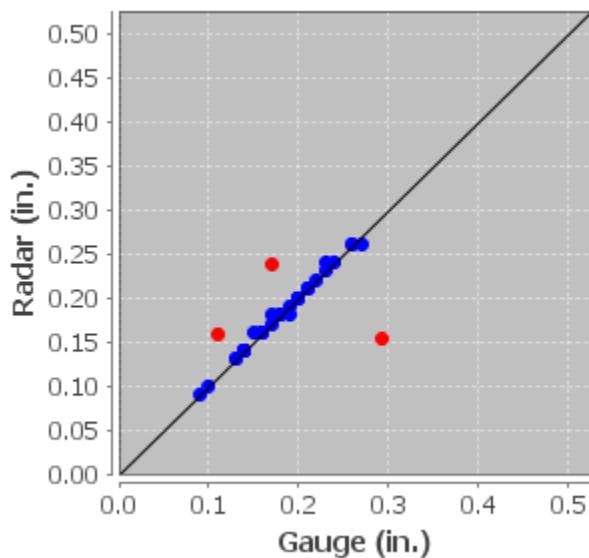


Figure 29. Scatter Plot of RG Pairs for Event 6h

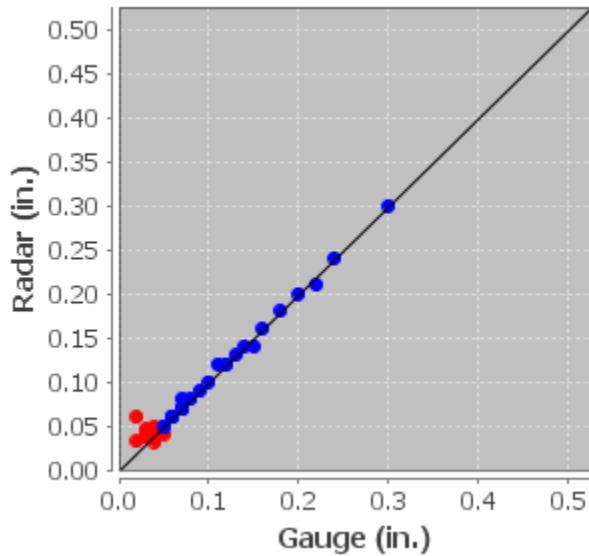


Figure 30. Scatter Plot of RG Pairs for Event 6i

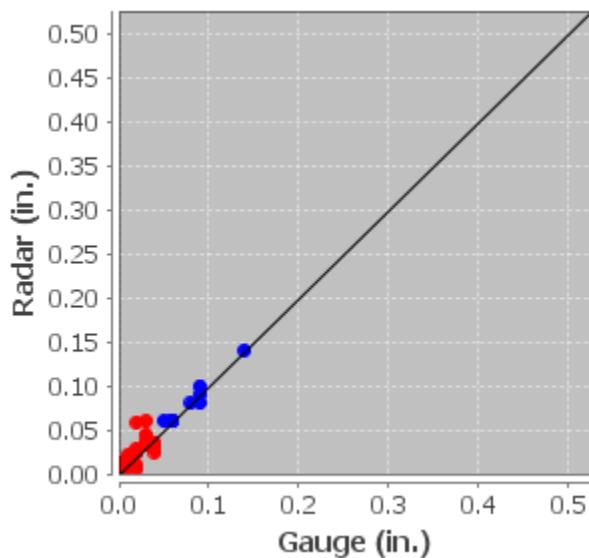


Figure 31. Scatter Plot of RG Pairs for Event 6j

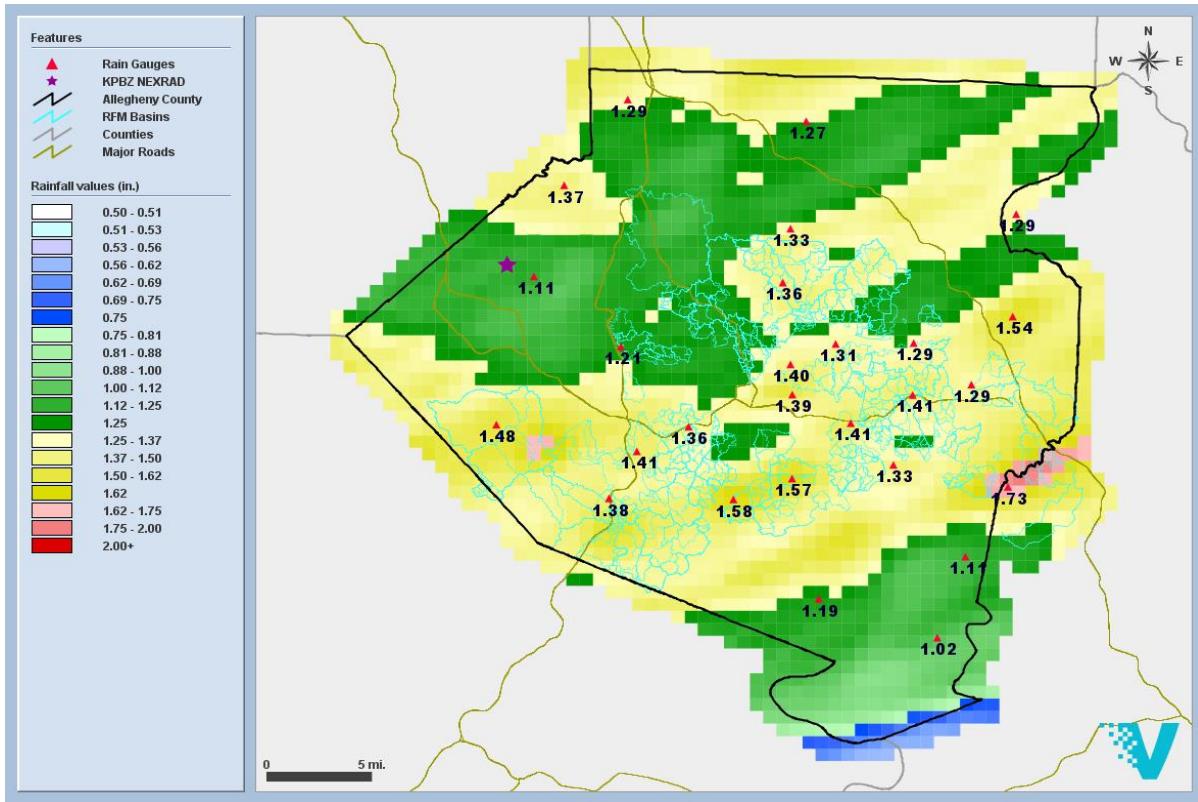


Figure 32. GARR Storm Total for Event 6

Table 42. Depth Duration Frequency Analyses for Event 6

Duration	Depth (in)	Pixel	Time (EDT)	Frequency
15 minutes	0.295	139155	2020-03-20 05:15	<1 yr.
30 minutes	0.374	167142	2020-03-20 07:05	<1 yr.
1 hour	0.573	167145	2020-03-20 05:30	<1 yr.
2 hour	0.794	154151	2020-03-20 07:05	<1 yr.
3 hour	1.221	167145	2020-03-20 07:20	1 yr.
6 hour	1.531	167145	2020-03-20 09:50	1 yr.
12 hour	1.635	167145	2020-03-20 08:40	<1 yr.
24 hour	1.754	167145	2020-03-20 17:00	<1 yr.

Event 7: 2020-03-23

The analysis period was from 2020-03-23 01:00 EDT to 2020-03-23 20:00 EDT. The event was then split into four sub-event periods at 2020-03-23 09:15 EDT, 2020-03-23 11:00 EDT and 2020-03-23 13:15 EDT to improve gauge adjustment of the radar. Gauge Only was used during Event 7d since all radar sources were either unavailable or provided insufficient rainfall information.

The gauges listed in [Appendix A](#) were not used to adjust the radar due to inconsistencies between the gauge and the radar or surrounding gauges, or they did not have data available for this event. The gauges listed in [Appendix B](#) were not used to adjust the radar since they did not meet statistical criteria for gauge-adjustment.

The Eastern U.S. cool season stratiform Z-R relationship was used to convert radar reflectivity to rainfall rates. Table 43 shows the mean bias and average depth of the event along with the AD and CAD, respectively. Tables 44 - 47 summarize the results for each RG pair used for final radar adjustment, where G_i is the gauge estimate, R_i is the non-adjusted radar estimate, R_i^* is the GARR estimate, and Diff* (%) is the percent difference between the gauge and GARR estimate. Those gauges not used to adjust the radar are shown at the bottom of the table and are highlighted in red. The specific reason for gauge exclusion is displayed in the Flag column. Figures 33 - 35 show the scatter plots of the gauge-adjusted RG pairs. Those gauges not used to adjust the radar are shown in red. Figure 36 depicts the GARR storm total over the 1-km² pixels. The GARR amounts for the 2313 1-km² pixels range from 0.2 - 0.7 inches with a mean of 0.4 inches. The GARR amounts for the 440 RFM basins range from 0.2 - 0.6 inches with a mean of 0.4 inches. The GARR amounts for the 871 RFM sheds range from 0.2 - 0.6 inches with a mean of 0.4 inches. Table 48 shows the Depth Duration Frequency (DDF) maximum values for the 1-km² pixels.

Table 43. GARR Statistics for Event 7

Event #	Radar	Event Date	Start Time (EDT)	End Time (EDT)	Gauges Used (37)	Avg. Depth (in)	Bias	AD (%)	CAD (%)
E7a	KPBZ LII	2020-03-23	2020-03-23 01:05	2020-03-23 09:15	13	0.062	0.854	28.8	6.1
E7b	KPBZ LII	2020-03-23	2020-03-23 09:20	2020-03-23 11:00	36	0.193	1.119	14.9	3.8
E7c	KPBZ LII	2020-03-23	2020-03-23 11:05	2020-03-23 13:15	25	0.102	0.960	19.3	1.8
E7d	Gauge Only	2020-03-23	2020-03-23 13:20	2020-03-23 20:00	32	0.035	---	---	---

Table 44. Summary of Individual RG Pairs for Event 7a

Gauge ID	Name	G_i (in)	R_i (in)	R_i^* (in)	Diff* (in)	Diff* (%)	Flag
Loc11	M-46 Access Shaft	0.05	0.09	0.06	-0.01	-20.0	
Loc12	Baldwin	0.05	0.08	0.06	-0.01	-20.0	
03049500	Allegheny River at Natrona	0.08	0.13	0.08	0.00	0.0	
Loc08	AC Health Dept Bldg	0.06	0.06	0.06	0.00	0.0	
Loc09	Univ of Pittsburgh	0.06	0.07	0.06	0.00	0.0	
Loc13	M-59 Access Shaft	0.05	0.07	0.05	0.00	0.0	
Loc14	Churchill Munic Bldg	0.07	0.09	0.07	0.00	0.0	

Gauge ID	Name	G _i (in)	R _i (in)	R _i * (in)	Diff* (in)	Diff* (%)	Flag
Loc16	Castle Shannon	0.07	0.06	0.07	0.00	0.0	
Loc19	Sandy Creek Eq Facility	0.10	0.09	0.10	0.00	0.0	
Loc32	Arnold	0.10	0.11	0.10	0.00	0.0	
Loc33	Richland TWP	0.07	0.10	0.07	0.00	0.0	
Loc10	PWSA-Highland Park	0.09	0.08	0.08	0.01	11.1	
KAGC	Pittsburgh Allegheny Cty	0.07	0.05	0.06	0.01	14.3	
03085734	Ohio River at Emsworth Dam Lower Pool at Emsworth	0.01	---	---	---	---	MSTT
KPIT	Greater Pittsburgh Int'l	0.02	---	---	---	---	MSTT
Loc01	PWSA-Montana St.	0.02	---	---	---	---	MSTT
Loc02	ALCOSAN WWTP Lab	0.00	---	---	---	---	MSTT
Loc03	Shaler Munic Bldg	0.04	---	---	---	---	MSTT
Loc04	Kennedy Twp PS	0.02	---	---	---	---	MSTT
Loc05	Upper St. Clair	0.02	---	---	---	---	MSTT
Loc06	Carnegie Transit Time	0.03	---	---	---	---	MSTT
Loc07	Greentree Munic Bldg	0.02	---	---	---	---	MSTT
Loc15	Trafford Maint Bldg	0.04	---	---	---	---	MSTT
Loc17	Chartiers Pump Station	0.01	---	---	---	---	MSTT
Loc18	Oakdale Pump Station	0.01	---	---	---	---	MSTT
Loc20	Gascola Eq Facility	0.03	---	---	---	---	MSTT
Loc21	Moon TWP	0.04	---	---	---	---	MSTT
Loc22	North Fayette TWP	0.00	---	---	---	---	MSTT
Loc23	Clinton Munic Bldg	ND	---	---	---	---	ND
Loc24	Jefferson Hills	0.03	---	---	---	---	MSTT
Loc25	White Oak Public Works Bldg	0.03	---	---	---	---	MSTT
Loc26	Elizabeth TWP Municipal Bldg	0.04	---	---	---	---	MSTT
Loc27	Marshall TWP	0.02	---	---	---	---	MSTT
Loc28	Plum Municipal Bldg	0.04	---	---	---	---	MSTT
Loc29	Bell Acres Munic Bldg	0.03	---	---	---	---	MSTT
Loc30	McCandless Twn Hall	0.03	---	---	---	---	MSTT
Loc31	Hampton Municipal Bldg	0.04	---	---	---	---	MSTT

Table 45. Summary of Individual RG Pairs for Event 7b

Gauge ID	Name	G _i (in)	R _i (in)	R _i * (in)	Diff* (in)	Diff* (%)	Flag
KAGC	Pittsburgh Allegheny Cty	0.14	0.16	0.16	-0.02	-14.3	
Loc19	Sandy Creek Eq Facility	0.16	0.19	0.18	-0.02	-12.5	
Loc08	AC Health Dept Bldg	0.17	0.19	0.19	-0.02	-11.8	
Loc06	Carnegie Transit Time	0.11	0.15	0.12	-0.01	-9.1	
03085734	Ohio River at Emsworth Dam Lower Pool at Emsworth	0.15	0.16	0.16	-0.01	-6.7	
Loc13	M-59 Access Shaft	0.15	0.16	0.16	-0.01	-6.7	
Loc22	North Fayette TWP	0.17	0.17	0.18	-0.01	-5.9	
03049500	Allegheny River at Natrona	0.29	0.22	0.29	0.00	0.0	
KPIT	Greater Pittsburgh Int'l	0.14	0.14	0.14	0.00	0.0	
Loc02	ALCOSAN WWTP Lab	0.29	0.24	0.29	0.00	0.0	
Loc05	Upper St. Clair	0.14	0.11	0.14	0.00	0.0	
Loc07	Greentree Munic Bldg	0.14	0.17	0.14	0.00	0.0	
Loc10	PWSA-Highland Park	0.20	0.20	0.20	0.00	0.0	
Loc15	Trafford Maint Bldg	0.19	0.17	0.19	0.00	0.0	
Loc16	Castle Shannon	0.16	0.12	0.16	0.00	0.0	
Loc20	Gascola Eq Facility	0.17	0.16	0.17	0.00	0.0	
Loc21	Moon TWP	0.18	0.17	0.18	0.00	0.0	
Loc24	Jefferson Hills	0.20	0.21	0.20	0.00	0.0	
Loc25	White Oak Public Works Bldg	0.20	0.18	0.20	0.00	0.0	
Loc26	Elizabeth TWP Municipal Bldg	0.25	0.23	0.25	0.00	0.0	
Loc27	Marshall TWP	0.21	0.17	0.21	0.00	0.0	
Loc28	Plum Municipal Bldg	0.17	0.16	0.17	0.00	0.0	
Loc29	Bell Acres Munic Bldg	0.15	0.14	0.15	0.00	0.0	
Loc30	McCandless Twn Hall	0.17	0.16	0.17	0.00	0.0	
Loc31	Hampton Municipal Bldg	0.23	0.19	0.23	0.00	0.0	
Loc32	Arnold	0.28	0.26	0.28	0.00	0.0	
Loc33	Richland TWP	0.19	0.17	0.19	0.00	0.0	
Loc03	Shaler Munic Bldg	0.26	0.20	0.25	0.01	3.8	
Loc18	Oakdale Pump Station	0.42	0.32	0.40	0.02	4.8	
Loc04	Kennedy Twp PS	0.20	0.17	0.19	0.01	5.0	
Loc11	M-46 Access Shaft	0.18	0.12	0.17	0.01	5.6	
Loc12	Baldwin	0.18	0.13	0.17	0.01	5.6	
Loc01	PWSA-Montana St.	0.32	0.24	0.30	0.02	6.3	
Loc09	Univ of Pittsburgh	0.16	0.14	0.15	0.01	6.3	
Loc17	Chartiers Pump Station	0.13	0.11	0.12	0.01	7.7	

Gauge ID	Name	G _i (in)	R _i (in)	R _i * (in)	Diff* (in)	Diff* (%)	Flag
Loc14	Churchill Munic Bldg	0.22	0.16	0.20	0.02	9.1	
Loc23	Clinton Munic Bldg	ND	---	---	---	---	ND

Table 46. Summary of Individual RG Pairs for Event 7c

Gauge ID	Name	G _i (in)	R _i (in)	R _i * (in)	Diff* (in)	Diff* (%)	Flag
Loc13	M-59 Access Shaft	0.16	0.18	0.17	-0.01	-6.3	
KAGC	Pittsburgh Allegheny Cty	0.19	0.16	0.19	0.00	0.0	
Loc01	PWSA-Montana St.	0.06	0.09	0.06	0.00	0.0	
Loc02	ALCOSAN WWTP Lab	0.05	0.08	0.05	0.00	0.0	
Loc03	Shaler Munic Bldg	0.07	0.09	0.07	0.00	0.0	
Loc04	Kennedy Twp PS	0.05	0.06	0.05	0.00	0.0	
Loc05	Upper St. Clair	0.13	0.10	0.13	0.00	0.0	
Loc06	Carnegie Transit Time	0.05	0.05	0.05	0.00	0.0	
Loc08	AC Health Dept Bldg	0.06	0.09	0.06	0.00	0.0	
Loc09	Univ of Pittsburgh	0.05	0.07	0.05	0.00	0.0	
Loc10	PWSA-Highland Park	0.07	0.10	0.07	0.00	0.0	
Loc11	M-46 Access Shaft	0.12	0.12	0.12	0.00	0.0	
Loc12	Baldwin	0.17	0.15	0.17	0.00	0.0	
Loc15	Trafford Maint Bldg	0.22	0.25	0.22	0.00	0.0	
Loc16	Castle Shannon	0.13	0.13	0.13	0.00	0.0	
Loc18	Oakdale Pump Station	0.06	0.06	0.06	0.00	0.0	
Loc19	Sandy Creek Eq Facility	0.09	0.08	0.09	0.00	0.0	
Loc20	Gascola Eq Facility	0.16	0.15	0.16	0.00	0.0	
Loc24	Jefferson Hills	0.21	0.20	0.21	0.00	0.0	
Loc25	White Oak Public Works Bldg	0.20	0.26	0.20	0.00	0.0	
Loc26	Elizabeth TWP Municipal Bldg	0.21	0.23	0.21	0.00	0.0	
Loc28	Plum Municipal Bldg	0.13	0.13	0.13	0.00	0.0	
Loc31	Hampton Municipal Bldg	0.07	0.06	0.07	0.00	0.0	
Loc32	Arnold	0.11	0.09	0.11	0.00	0.0	
Loc14	Churchill Munic Bldg	0.16	0.13	0.15	0.01	6.3	
03049500	Allegheny River at Natrona	0.09	---	---	---	---	U
03085734	Ohio River at Emsworth Dam Lower Pool at Emsworth	0.04	---	---	---	---	MSTT
KPIT	Greater Pittsburgh Int'l	0.04	---	---	---	---	MSTT

Gauge ID	Name	G _i (in)	R _i (in)	R _i * (in)	Diff* (in)	Diff* (%)	Flag
Loc07	Greentree Munic Bldg	0.04	---	---	---	---	MSTT
Loc17	Chartiers Pump Station	0.04	---	---	---	---	MSTT
Loc21	Moon TWP	0.02	---	---	---	---	MSTT
Loc22	North Fayette TWP	0.02	---	---	---	---	MSTT
Loc23	Clinton Munic Bldg	ND	---	---	---	---	ND
Loc27	Marshall TWP	0.05	---	---	---	---	MSTT
Loc29	Bell Acres Munic Bldg	0.03	---	---	---	---	MSTT
Loc30	McCandless Twn Hall	0.01	---	---	---	---	MSTT
Loc33	Richland TWP	0.03	---	---	---	---	MSTT

Table 47. Summary of Individual RG Pairs for Event 7d

Gauge ID	Name	G _i (in)	R _i (in)	R _i * (in)	Diff* (in)	Diff* (%)	Flag
Loc26	Elizabeth TWP Municipal Bldg	0.00	---	---	---	---	
Loc02	ALCOSAN WWTP Lab	0.02	---	---	---	---	
Loc11	M-46 Access Shaft	0.02	---	---	---	---	
Loc12	Baldwin	0.02	---	---	---	---	
Loc13	M-59 Access Shaft	0.02	---	---	---	---	
Loc14	Churchill Munic Bldg	0.02	---	---	---	---	
Loc15	Trafford Maint Bldg	0.02	---	---	---	---	
Loc16	Castle Shannon	0.02	---	---	---	---	
Loc24	Jefferson Hills	0.02	---	---	---	---	
Loc25	White Oak Public Works Bldg	0.02	---	---	---	---	
Loc01	PWSA-Montana St.	0.03	---	---	---	---	
Loc06	Carnegie Transit Time	0.03	---	---	---	---	
Loc07	Greentree Munic Bldg	0.03	---	---	---	---	
Loc10	PWSA-Highland Park	0.03	---	---	---	---	
Loc17	Chartiers Pump Station	0.03	---	---	---	---	
Loc20	Gascola Eq Facility	0.03	---	---	---	---	
Loc03	Shaler Munic Bldg	0.04	---	---	---	---	
Loc04	Kennedy Twp PS	0.04	---	---	---	---	
Loc05	Upper St. Clair	0.04	---	---	---	---	
Loc08	AC Health Dept Bldg	0.04	---	---	---	---	
Loc09	Univ of Pittsburgh	0.04	---	---	---	---	
Loc18	Oakdale Pump Station	0.04	---	---	---	---	

Gauge ID	Name	G_i (in)	R_i (in)	R_i^* (in)	Diff* (in)	Diff* (%)	Flag
Loc19	Sandy Creek Eq Facility	0.04	---	---	---	---	
Loc22	North Fayette TWP	0.04	---	---	---	---	
Loc29	Bell Acres Munic Bldg	0.04	---	---	---	---	
Loc21	Moon TWP	0.05	---	---	---	---	
Loc27	Marshall TWP	0.05	---	---	---	---	
Loc30	McCandless Twn Hall	0.05	---	---	---	---	
Loc31	Hampton Municipal Bldg	0.05	---	---	---	---	
Loc32	Arnold	0.05	---	---	---	---	
Loc33	Richland TWP	0.05	---	---	---	---	
Loc28	Plum Municipal Bldg	0.06	---	---	---	---	
03049500	Allegheny River at Natrona	0.03	---	---	---	---	T
03085734	Ohio River at Emsworth Dam Lower Pool at Emsworth	0.02	---	---	---	---	T
KAGC	Pittsburgh Allegheny Cty	0.02	---	---	---	---	T
KPIT	Greater Pittsburgh Int'l	0.03	---	---	---	---	T
Loc23	Clinton Munic Bldg	ND	---	---	---	---	ND

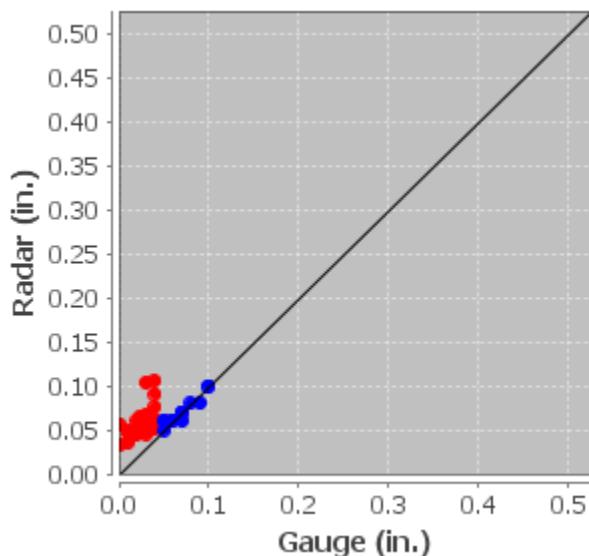


Figure 33. Scatter Plot of RG Pairs for Event 7a

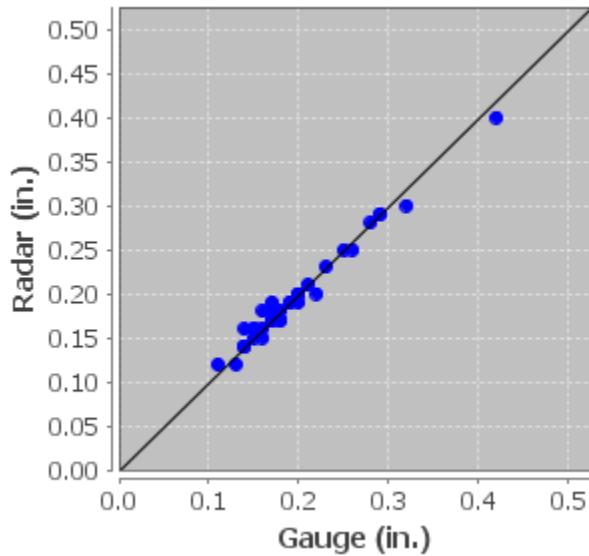


Figure 34. Scatter Plot of RG Pairs for Event 7b

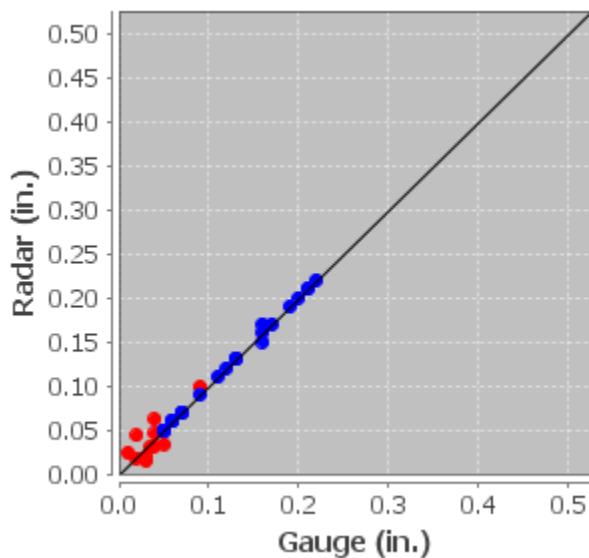


Figure 35. Scatter Plot of RG Pairs for Event 7c

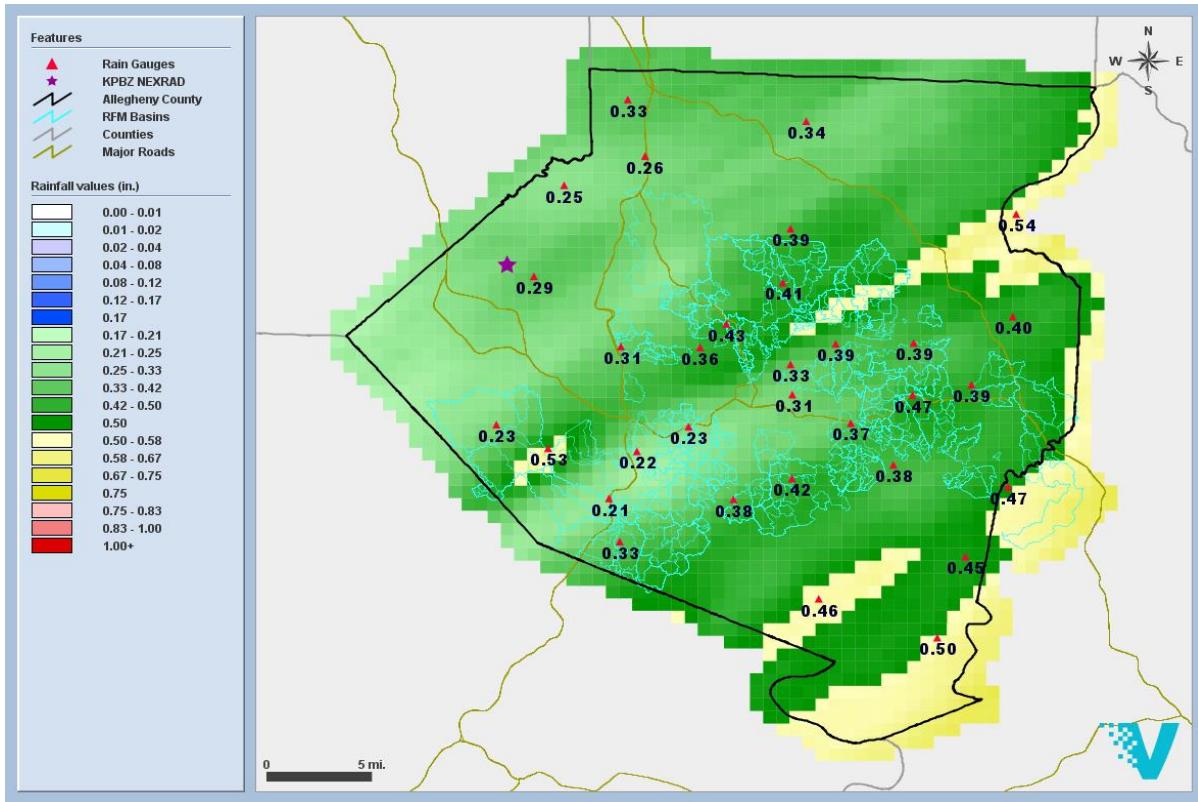


Figure 36. GARR Storm Total for Event 7

Table 48. Depth Duration Frequency Analyses for Event 7

Duration	Depth (in)	Pixel	Time (EDT)	Frequency
15 minutes	0.153	163126	2020-03-23 10:15	<1 yr.
30 minutes	0.239	163126	2020-03-23 10:30	<1 yr.
1 hour	0.392	174146	2020-03-23 11:40	<1 yr.
2 hour	0.501	174146	2020-03-23 12:00	<1 yr.
3 hour	0.577	174146	2020-03-23 13:00	<1 yr.
6 hour	0.610	165162	2020-03-23 13:10	<1 yr.
12 hour	0.656	165162	2020-03-23 13:10	<1 yr.

Event 8: 2020-03-25

The analysis period was from 2020-03-24 21:00 EDT to 2020-03-25 10:00 EDT. The event was then split into two sub-event periods at 2020-03-25 04:30 EDT to improve gauge adjustment of the radar.

The gauges listed in [Appendix A](#) were not used to adjust the radar due to inconsistencies between the gauge and the radar or surrounding gauges, or they did not have data available for this event.

The gauges listed in [Appendix B](#) were not used to adjust the radar since they did not meet statistical criteria for gauge-adjustment.

The Eastern U.S. cool season stratiform Z-R relationship was used to convert radar reflectivity to rainfall rates. Table 49 shows the mean bias and average depth of the event along with the AD and CAD, respectively. Tables 50 - 51 summarize the results for each RG pair used for final radar adjustment, where G_i is the gauge estimate, R_i is the non-adjusted radar estimate, R_i^* is the GARR estimate, and Diff* (%) is the percent difference between the gauge and GARR estimate. Those gauges not used to adjust the radar are shown at the bottom of the table and are highlighted in red. The specific reason for gauge exclusion is displayed in the Flag column. Figures 37 - 38 show the scatter plots of the gauge-adjusted RG pairs. Those gauges not used to adjust the radar are shown in red. Figure 39 depicts the GARR storm total over the 1-km² pixels. The GARR amounts for the 2313 1-km² pixels range from 0.1 - 0.3 inches with a mean of 0.2 inches. The GARR amounts for the 440 RFM basins range from 0.1 - 0.3 inches with a mean of 0.2 inches. The GARR amounts for the 871 RFM sheds range from 0.1 - 0.3 inches with a mean of 0.2 inches. Table 52 shows the Depth Duration Frequency (DDF) maximum values for the 1-km² pixels.

Table 49. GARR Statistics for Event 8

Event #	Radar	Event Date	Start Time (EDT)	End Time (EDT)	Gauges Used (37)	Avg. Depth (in)	Bias	AD (%)	CAD (%)
E8a	KPBZ LII	2020-03-25	2020-03-24 21:05	2020-03-25 04:30	25	0.074	0.749	36.2	3.2
E8b	KPBZ LII	2020-03-25	2020-03-25 04:35	2020-03-25 10:00	30	0.104	0.493	97.6	3.1

Table 50. Summary of Individual RG Pairs for Event 8a

Gauge ID	Name	G_i (in)	R_i (in)	R_i^* (in)	Diff* (in)	Diff* (%)	Flag
KAGC	Pittsburgh Allegheny Cty	0.05	0.06	0.06	-0.01	-20.0	
Loc05	Upper St. Clair	0.05	0.07	0.06	-0.01	-20.0	
03085734	Ohio River at Emsworth Dam Lower Pool at Emsworth	0.09	0.12	0.10	-0.01	-11.1	
03049500	Allegheny River at Natrona	0.08	0.19	0.08	0.00	0.0	
KPIT	Greater Pittsburgh Int'l	0.13	0.14	0.13	0.00	0.0	
Loc01	PWSA-Montana St.	0.09	0.10	0.09	0.00	0.0	
Loc02	ALCOSAN WWTP Lab	0.09	0.10	0.09	0.00	0.0	
Loc03	Shaler Munic Bldg	0.05	0.07	0.05	0.00	0.0	
Loc04	Kennedy Twp PS	0.11	0.12	0.11	0.00	0.0	
Loc06	Carnegie Transit Time	0.05	0.06	0.05	0.00	0.0	
Loc07	Greentree Munic Bldg	0.06	0.07	0.06	0.00	0.0	
Loc08	AC Health Dept Bldg	0.05	0.07	0.05	0.00	0.0	

Gauge ID	Name	G _i (in)	R _i (in)	R _i * (in)	Diff* (in)	Diff* (%)	Flag
Loc10	PWSA-Highland Park	0.05	0.06	0.05	0.00	0.0	
Loc12	Baldwin	0.06	0.05	0.06	0.00	0.0	
Loc18	Oakdale Pump Station	0.06	0.07	0.06	0.00	0.0	
Loc19	Sandy Creek Eq Facility	0.05	0.07	0.05	0.00	0.0	
Loc21	Moon TWP	0.10	0.16	0.10	0.00	0.0	
Loc24	Jefferson Hills	0.06	0.09	0.06	0.00	0.0	
Loc27	Marshall TWP	0.06	0.08	0.06	0.00	0.0	
Loc28	Plum Municipal Bldg	0.05	0.12	0.05	0.00	0.0	
Loc29	Bell Acres Munic Bldg	0.08	0.12	0.08	0.00	0.0	
Loc30	McCandless Twn Hall	0.06	0.10	0.06	0.00	0.0	
Loc31	Hampton Municipal Bldg	0.07	0.08	0.07	0.00	0.0	
Loc33	Richland TWP	0.06	0.07	0.06	0.00	0.0	
Loc17	Chartiers Pump Station	0.06	0.06	0.05	0.01	16.7	
Loc09	Univ of Pittsburgh	0.04	---	---	---	---	MSTT
Loc11	M-46 Access Shaft	0.02	---	---	---	---	MSTT
Loc13	M-59 Access Shaft	0.04	---	---	---	---	MSTT
Loc14	Churchill Munic Bldg	0.03	---	---	---	---	MSTT
Loc15	Trafford Maint Bldg	0.04	---	---	---	---	MSTT
Loc16	Castle Shannon	0.04	---	---	---	---	MSTT
Loc20	Gascola Eq Facility	0.04	---	---	---	---	MSTT
Loc22	North Fayette TWP	0.04	---	---	---	---	MSTT
Loc23	Clinton Munic Bldg	ND	---	---	---	---	ND
Loc25	White Oak Public Works Bldg	0.03	---	---	---	---	MSTT
Loc26	Elizabeth TWP Municipal Bldg	0.03	---	---	---	---	MSTT
Loc32	Arnold	0.05	---	---	---	---	OAD

Table 51. Summary of Individual RG Pairs for Event 8b

Gauge ID	Name	G _i (in)	R _i (in)	R _i * (in)	Diff* (in)	Diff* (%)	Flag
Loc32	Arnold	0.08	0.15	0.09	-0.01	-12.5	
Loc05	Upper St. Clair	0.13	0.24	0.14	-0.01	-7.7	
Loc07	Greentree Munic Bldg	0.14	0.24	0.15	-0.01	-7.1	
03049500	Allegheny River at Natrona	0.13	0.11	0.13	0.00	0.0	
KAGC	Pittsburgh Allegheny Cty	0.18	0.38	0.18	0.00	0.0	
Loc01	PWSA-Montana St.	0.08	0.11	0.08	0.00	0.0	

Gauge ID	Name	G _i (in)	R _i (in)	R _i * (in)	Diff* (in)	Diff* (%)	Flag
Loc02	ALCOSAN WWTP Lab	0.08	0.12	0.08	0.00	0.0	
Loc03	Shaler Munic Bldg	0.06	0.09	0.06	0.00	0.0	
Loc04	Kennedy Twp PS	0.08	0.10	0.08	0.00	0.0	
Loc08	AC Health Dept Bldg	0.16	0.28	0.16	0.00	0.0	
Loc09	Univ of Pittsburgh	0.17	0.31	0.17	0.00	0.0	
Loc10	PWSA-Highland Park	0.15	0.29	0.15	0.00	0.0	
Loc11	M-46 Access Shaft	0.15	0.36	0.15	0.00	0.0	
Loc12	Baldwin	0.14	0.33	0.14	0.00	0.0	
Loc13	M-59 Access Shaft	0.16	0.41	0.16	0.00	0.0	
Loc14	Churchill Munic Bldg	0.16	0.40	0.16	0.00	0.0	
Loc15	Trafford Maint Bldg	0.14	0.50	0.14	0.00	0.0	
Loc16	Castle Shannon	0.11	0.31	0.11	0.00	0.0	
Loc20	Gascola Eq Facility	0.16	0.43	0.16	0.00	0.0	
Loc22	North Fayette TWP	0.09	0.14	0.09	0.00	0.0	
Loc25	White Oak Public Works Bldg	0.12	0.50	0.12	0.00	0.0	
Loc26	Elizabeth TWP Municipal Bldg	0.13	0.34	0.13	0.00	0.0	
Loc27	Marshall TWP	0.08	0.07	0.08	0.00	0.0	
Loc28	Plum Municipal Bldg	0.12	0.36	0.12	0.00	0.0	
Loc31	Hampton Municipal Bldg	0.07	0.07	0.07	0.00	0.0	
Loc33	Richland TWP	0.06	0.05	0.06	0.00	0.0	
Loc19	Sandy Creek Eq Facility	0.17	0.36	0.16	0.01	5.9	
Loc17	Chartiers Pump Station	0.16	0.22	0.15	0.01	6.3	
Loc06	Carnegie Transit Time	0.15	0.20	0.14	0.01	6.7	
Loc18	Oakdale Pump Station	0.15	0.18	0.14	0.01	6.7	
03085734	Ohio River at Emsworth Dam Lower Pool at Emsworth	0.05	---	---	---	---	MSTT
KPIT	Greater Pittsburgh Int'l	0.06	---	---	---	---	MSTT
Loc21	Moon TWP	0.03	---	---	---	---	MSTT
Loc23	Clinton Munic Bldg	ND	---	---	---	---	ND
Loc24	Jefferson Hills	0.09	---	---	---	---	U
Loc29	Bell Acres Munic Bldg	0.03	---	---	---	---	MSTT
Loc30	McCandless Twn Hall	0.03	---	---	---	---	MSTT

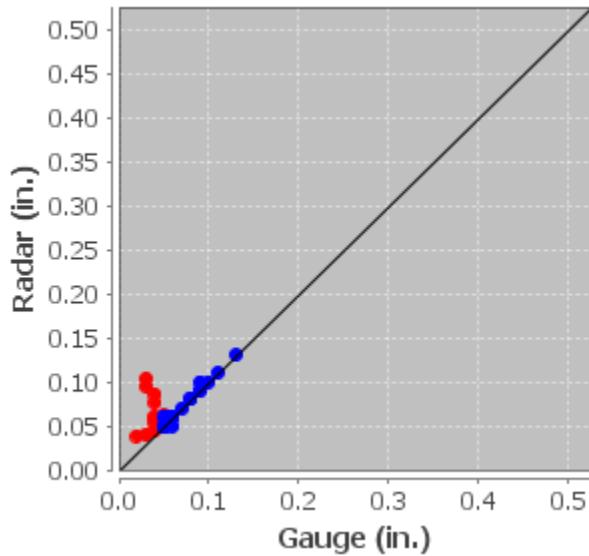


Figure 37. Scatter Plot of RG Pairs for Event 8a

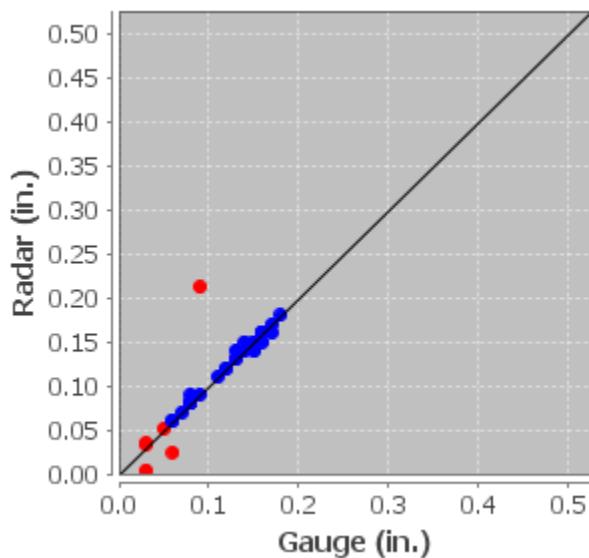


Figure 38. Scatter Plot of RG Pairs for Event 8b

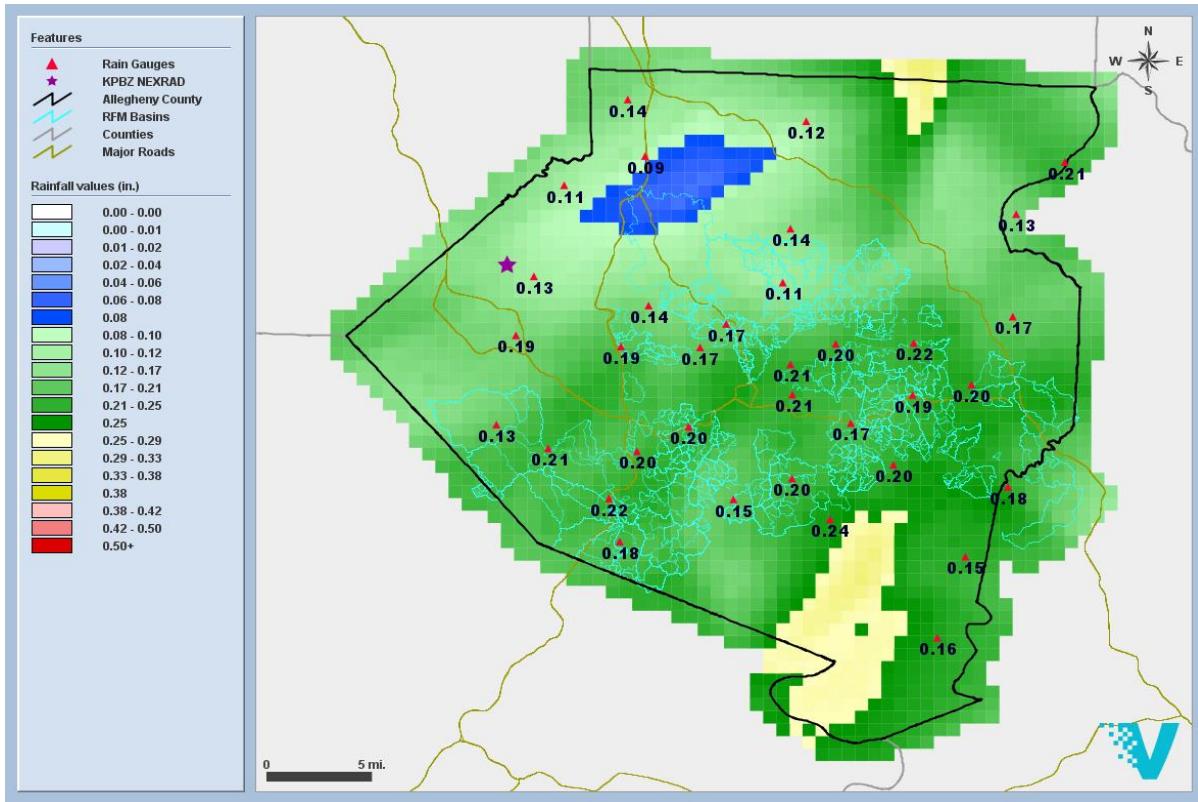


Figure 39. GARR Storm Total for Event 8

Table 52. Depth Duration Frequency Analyses for Event 8

Duration	Depth (in)	Pixel	Time (EDT)	Frequency
15 minutes	0.057	132141	2020-03-25 06:10	<1 yr.
30 minutes	0.097	138145	2020-03-25 06:20	<1 yr.
1 hour	0.150	138155	2020-03-25 06:20	<1 yr.
2 hour	0.215	155153	2020-03-25 06:55	<1 yr.
3 hour	0.231	155153	2020-03-25 07:10	<1 yr.
6 hour	0.296	156151	2020-03-25 07:15	<1 yr.
12 hour	0.301	160112	2020-03-25 09:00	<1 yr.

Event 9: 2020-03-28

The analysis period was from 2020-03-27 20:00 EDT to 2020-03-29 10:00 EDT. The event was then split into nine sub-event periods at 2020-03-28 00:00 EDT, 2020-03-28 04:00 EDT, 2020-03-28 08:00 EDT, 2020-03-28 15:30 EDT, 2020-03-28 17:00 EDT, 2020-03-28 20:00 EDT, 2020-03-28 23:00 EDT and 2020-03-29 03:00 EDT to improve gauge adjustment of the radar.

The gauges listed in [Appendix A](#) were not used to adjust the radar due to inconsistencies between the gauge and the radar or surrounding gauges, or they did not have data available for this event.

The gauges listed in [Appendix B](#) were not used to adjust the radar since they did not meet statistical criteria for gauge-adjustment.

A convective Z-R relationship was used to convert radar reflectivity to rainfall rates. Table 53 shows the mean bias and average depth of the event along with the AD and CAD, respectively. Tables 54 - 62 summarize the results for each RG pair used for final radar adjustment, where G_i is the gauge estimate, R_i is the non-adjusted radar estimate, R_i^* is the GARR estimate, and $\text{Diff}^* (\%)$ is the percent difference between the gauge and GARR estimate. Those gauges not used to adjust the radar are shown at the bottom of the table and are highlighted in red. The specific reason for gauge exclusion is displayed in the Flag column. Figures 40 - 48 show the scatter plots of the gauge-adjusted RG pairs. Those gauges not used to adjust the radar are shown in red. Figure 49 depicts the GARR storm total over the 1-km² pixels. The GARR amounts for the 2313 1-km² pixels range from 0.9 - 2.8 inches with a mean of 1.5 inches. The GARR amounts for the 440 RFM basins range from 1.0 - 2.5 inches with a mean of 1.4 inches. The GARR amounts for the 871 RFM sheds range from 1.0 - 2.5 inches with a mean of 1.3 inches. Table 63 shows the Depth Duration Frequency (DDF) maximum values for the 1-km² pixels.

Table 53. GARR Statistics for Event 9

Event #	Radar	Event Date	Start Time (EDT)	End Time (EDT)	Gauges Used (37)	Avg. Depth (in)	Bias	AD (%)	CAD (%)
E9a	KPBZ LII	2020-03-28	2020-03-27 20:05	2020-03-28 00:00	27	0.063	1.221	17.2	2.0
E9b	KPBZ LII	2020-03-28	2020-03-28 00:05	2020-03-28 04:00	35	0.159	1.214	17.3	1.9
E9c	KPBZ LII	2020-03-28	2020-03-28 04:05	2020-03-28 08:00	35	0.177	1.266	23.4	2.0
E9d	KPBZ LII	2020-03-28	2020-03-28 08:05	2020-03-28 15:30	22	0.091	0.620	90.0	4.5
E9e	KPBZ LII	2020-03-28	2020-03-28 15:35	2020-03-28 17:00	35	0.388	0.900	16.3	2.3
E9f	KPBZ LII	2020-03-28	2020-03-28 17:05	2020-03-28 20:00	36	0.148	1.027	12.1	2.0
E9g	KPBZ LII	2020-03-28	2020-03-28 20:05	2020-03-28 23:00	34	0.160	0.889	15.8	1.8
E9h	KPBZ LII	2020-03-28	2020-03-28 23:05	2020-03-29 03:00	36	0.314	1.101	15.5	2.4
E9i	KPBZ LII	2020-03-28	2020-03-29 03:05	2020-03-29 10:00	7	0.038	0.611	65.5	1.6

Table 54. Summary of Individual RG Pairs for Event 9a

Gauge ID	Name	G _i (in)	R _i (in)	R _i * (in)	Diff* (in)	Diff* (%)	Flag
Loc06	Carnegie Transit Time	0.07	0.06	0.08	-0.01	-14.3	
KAGC	Pittsburgh Allegheny Cty	0.10	0.07	0.10	0.00	0.0	
KPIT	Greater Pittsburgh Int'l	0.08	0.08	0.08	0.00	0.0	
Loc01	PWSA-Montana St.	0.08	0.07	0.08	0.00	0.0	
Loc02	ALCOSAN WWTP Lab	0.10	0.08	0.10	0.00	0.0	
Loc03	Shaler Munic Bldg	0.06	0.05	0.06	0.00	0.0	
Loc04	Kennedy Twp PS	0.10	0.09	0.10	0.00	0.0	
Loc05	Upper St. Clair	0.11	0.08	0.11	0.00	0.0	
Loc07	Greentree Munic Bldg	0.09	0.07	0.09	0.00	0.0	
Loc08	AC Health Dept Bldg	0.08	0.07	0.08	0.00	0.0	
Loc09	Univ of Pittsburgh	0.09	0.09	0.09	0.00	0.0	
Loc10	PWSA-Highland Park	0.07	0.06	0.07	0.00	0.0	
Loc11	M-46 Access Shaft	0.08	0.08	0.08	0.00	0.0	
Loc12	Baldwin	0.09	0.07	0.09	0.00	0.0	
Loc13	M-59 Access Shaft	0.07	0.07	0.07	0.00	0.0	
Loc15	Trafford Maint Bldg	0.07	0.07	0.07	0.00	0.0	
Loc16	Castle Shannon	0.10	0.07	0.10	0.00	0.0	
Loc18	Oakdale Pump Station	0.10	0.06	0.10	0.00	0.0	
Loc19	Sandy Creek Eq Facility	0.06	0.05	0.06	0.00	0.0	
Loc20	Gascola Eq Facility	0.06	0.06	0.06	0.00	0.0	
Loc21	Moon TWP	0.09	0.08	0.09	0.00	0.0	
Loc22	North Fayette TWP	0.09	0.06	0.09	0.00	0.0	
Loc24	Jefferson Hills	0.12	0.08	0.12	0.00	0.0	
Loc25	White Oak Public Works Bldg	0.07	0.06	0.07	0.00	0.0	
Loc26	Elizabeth TWP Municipal Bldg	0.11	0.08	0.11	0.00	0.0	
Loc17	Chartiers Pump Station	0.11	0.07	0.10	0.01	9.1	
Loc14	Churchill Munic Bldg	0.09	0.07	0.08	0.01	11.1	
03049500	Allegheny River at Natrona	0.00	---	---	---	---	MSTT
03085734	Ohio River at Emsworth Dam Lower Pool at Emsworth	0.05	---	---	---	---	MSTT
Loc23	Clinton Munic Bldg	ND	---	---	---	---	ND
Loc27	Marshall TWP	0.00	---	---	---	---	MSTT
Loc28	Plum Municipal Bldg	0.03	---	---	---	---	MSTT
Loc29	Bell Acres Munic Bldg	0.04	---	---	---	---	MSTT
Loc30	McCandless Twn Hall	0.01	---	---	---	---	MSTT
Loc31	Hampton Municipal Bldg	0.02	---	---	---	---	MSTT

Gauge ID	Name	G _i (in)	R _i (in)	R _i * (in)	Diff* (in)	Diff* (%)	Flag
Loc32	Arnold	0.00	---	---	---	---	MSTT
Loc33	Richland TWP	0.00	---	---	---	---	MSTT

Table 55. Summary of Individual RG Pairs for Event 9b

Gauge ID	Name	G _i (in)	R _i (in)	R _i * (in)	Diff* (in)	Diff* (%)	Flag
Loc13	M-59 Access Shaft	0.12	0.12	0.13	-0.01	-8.3	
03085734	Ohio River at Emsworth Dam Lower Pool at Emsworth	0.13	0.12	0.14	-0.01	-7.7	
Loc09	Univ of Pittsburgh	0.14	0.12	0.15	-0.01	-7.1	
Loc14	Churchill Munic Bldg	0.16	0.13	0.17	-0.01	-6.3	
KAGC	Pittsburgh Allegheny Cty	0.07	0.06	0.07	0.00	0.0	
KPIT	Greater Pittsburgh Int'l	0.12	0.11	0.12	0.00	0.0	
Loc01	PWSA-Montana St.	0.17	0.14	0.17	0.00	0.0	
Loc02	ALCOSAN WWTP Lab	0.14	0.11	0.14	0.00	0.0	
Loc03	Shaler Munic Bldg	0.16	0.13	0.16	0.00	0.0	
Loc04	Kennedy Twp PS	0.13	0.10	0.13	0.00	0.0	
Loc05	Upper St. Clair	0.06	0.05	0.06	0.00	0.0	
Loc06	Carnegie Transit Time	0.15	0.13	0.15	0.00	0.0	
Loc07	Greentree Munic Bldg	0.12	0.10	0.12	0.00	0.0	
Loc08	AC Health Dept Bldg	0.16	0.12	0.16	0.00	0.0	
Loc12	Baldwin	0.11	0.09	0.11	0.00	0.0	
Loc15	Trafford Maint Bldg	0.14	0.12	0.14	0.00	0.0	
Loc16	Castle Shannon	0.09	0.08	0.09	0.00	0.0	
Loc17	Chartiers Pump Station	0.10	0.09	0.10	0.00	0.0	
Loc20	Gascola Eq Facility	0.16	0.13	0.16	0.00	0.0	
Loc21	Moon TWP	0.15	0.14	0.15	0.00	0.0	
Loc22	North Fayette TWP	0.10	0.08	0.10	0.00	0.0	
Loc24	Jefferson Hills	0.07	0.08	0.07	0.00	0.0	
Loc25	White Oak Public Works Bldg	0.11	0.08	0.11	0.00	0.0	
Loc26	Elizabeth TWP Municipal Bldg	0.14	0.14	0.14	0.00	0.0	
Loc27	Marshall TWP	0.24	0.21	0.24	0.00	0.0	
Loc28	Plum Municipal Bldg	0.21	0.15	0.21	0.00	0.0	
Loc29	Bell Acres Munic Bldg	0.22	0.16	0.22	0.00	0.0	
Loc30	McCandless Twn Hall	0.17	0.16	0.17	0.00	0.0	

Gauge ID	Name	G _i (in)	R _i (in)	R _i * (in)	Diff* (in)	Diff* (%)	Flag
Loc32	Arnold	0.25	0.20	0.25	0.00	0.0	
Loc33	Richland TWP	0.19	0.18	0.19	0.00	0.0	
Loc31	Hampton Municipal Bldg	0.24	0.17	0.23	0.01	4.2	
Loc19	Sandy Creek Eq Facility	0.20	0.14	0.19	0.01	5.0	
Loc11	M-46 Access Shaft	0.19	0.14	0.18	0.01	5.3	
Loc10	PWSA-Highland Park	0.18	0.12	0.17	0.01	5.6	
Loc18	Oakdale Pump Station	0.16	0.11	0.15	0.01	6.3	
03049500	Allegheny River at Natrona	0.18	---	---	---	---	U
Loc23	Clinton Munic Bldg	ND	---	---	---	---	ND

Table 56. Summary of Individual RG Pairs for Event 9c

Gauge ID	Name	G _i (in)	R _i (in)	R _i * (in)	Diff* (in)	Diff* (%)	Flag
Loc08	AC Health Dept Bldg	0.23	0.20	0.25	-0.02	-8.7	
Loc17	Chartiers Pump Station	0.13	0.16	0.14	-0.01	-7.7	
Loc25	White Oak Public Works Bldg	0.13	0.17	0.14	-0.01	-7.7	
KAGC	Pittsburgh Allegheny Cty	0.18	0.16	0.19	-0.01	-5.6	
Loc19	Sandy Creek Eq Facility	0.19	0.16	0.20	-0.01	-5.3	
03049500	Allegheny River at Natrona	0.24	0.16	0.24	0.00	0.0	
03085734	Ohio River at Emsworth Dam Lower Pool at Emsworth	0.15	0.10	0.15	0.00	0.0	
KPIT	Greater Pittsburgh Int'l	0.17	0.11	0.17	0.00	0.0	
Loc02	ALCOSAN WWTP Lab	0.17	0.13	0.17	0.00	0.0	
Loc04	Kennedy Twp PS	0.17	0.12	0.17	0.00	0.0	
Loc05	Upper St. Clair	0.12	0.14	0.12	0.00	0.0	
Loc06	Carnegie Transit Time	0.14	0.13	0.14	0.00	0.0	
Loc07	Greentree Munic Bldg	0.16	0.14	0.16	0.00	0.0	
Loc09	Univ of Pittsburgh	0.20	0.16	0.20	0.00	0.0	
Loc11	M-46 Access Shaft	0.18	0.16	0.18	0.00	0.0	
Loc13	M-59 Access Shaft	0.17	0.16	0.17	0.00	0.0	
Loc15	Trafford Maint Bldg	0.21	0.14	0.21	0.00	0.0	
Loc16	Castle Shannon	0.24	0.20	0.24	0.00	0.0	
Loc18	Oakdale Pump Station	0.23	0.19	0.23	0.00	0.0	
Loc21	Moon TWP	0.28	0.18	0.28	0.00	0.0	
Loc22	North Fayette TWP	0.20	0.17	0.20	0.00	0.0	

Gauge ID	Name	G _i (in)	R _i (in)	R _i * (in)	Diff* (in)	Diff* (%)	Flag
Loc24	Jefferson Hills	0.06	0.07	0.06	0.00	0.0	
Loc26	Elizabeth TWP Municipal Bldg	0.07	0.05	0.07	0.00	0.0	
Loc27	Marshall TWP	0.15	0.11	0.15	0.00	0.0	
Loc28	Plum Municipal Bldg	0.21	0.17	0.21	0.00	0.0	
Loc29	Bell Acres Munic Bldg	0.37	0.27	0.37	0.00	0.0	
Loc30	McCandless Twn Hall	0.22	0.15	0.22	0.00	0.0	
Loc31	Hampton Municipal Bldg	0.24	0.18	0.24	0.00	0.0	
Loc32	Arnold	0.25	0.18	0.25	0.00	0.0	
Loc33	Richland TWP	0.14	0.11	0.14	0.00	0.0	
Loc14	Churchill Munic Bldg	0.26	0.19	0.25	0.01	3.8	
Loc10	PWSA-Highland Park	0.23	0.16	0.22	0.01	4.3	
Loc12	Baldwin	0.23	0.16	0.22	0.01	4.3	
Loc03	Shaler Munic Bldg	0.22	0.15	0.21	0.01	4.5	
Loc20	Gascola Eq Facility	0.21	0.14	0.20	0.01	4.8	
Loc01	PWSA-Montana St.	0.12	---	---	---	---	U
Loc23	Clinton Munic Bldg	ND	---	---	---	---	ND

Table 57. Summary of Individual RG Pairs for Event 9d

Gauge ID	Name	G _i (in)	R _i (in)	R _i * (in)	Diff* (in)	Diff* (%)	Flag
Loc01	PWSA-Montana St.	0.09	0.31	0.11	-0.02	-22.2	
Loc10	PWSA-Highland Park	0.07	0.17	0.08	-0.01	-14.3	
Loc32	Arnold	0.10	0.31	0.11	-0.01	-10.0	
03049500	Allegheny River at Natrona	0.14	0.22	0.14	0.00	0.0	
KPIT	Greater Pittsburgh Int'l	0.07	0.10	0.07	0.00	0.0	
Loc04	Kennedy Twp PS	0.07	0.10	0.07	0.00	0.0	
Loc08	AC Health Dept Bldg	0.07	0.12	0.07	0.00	0.0	
Loc14	Churchill Munic Bldg	0.11	0.25	0.11	0.00	0.0	
Loc19	Sandy Creek Eq Facility	0.06	0.17	0.06	0.00	0.0	
Loc20	Gascola Eq Facility	0.14	0.32	0.14	0.00	0.0	
Loc21	Moon TWP	0.13	0.18	0.13	0.00	0.0	
Loc24	Jefferson Hills	0.29	0.26	0.29	0.00	0.0	
Loc25	White Oak Public Works Bldg	0.06	0.23	0.06	0.00	0.0	
Loc27	Marshall TWP	0.05	0.06	0.05	0.00	0.0	
Loc28	Plum Municipal Bldg	0.13	0.33	0.13	0.00	0.0	

Gauge ID	Name	G _i (in)	R _i (in)	R _i * (in)	Diff* (in)	Diff* (%)	Flag
Loc29	Bell Acres Munic Bldg	0.22	0.19	0.22	0.00	0.0	
Loc30	McCandless Twn Hall	0.09	0.11	0.09	0.00	0.0	
Loc31	Hampton Municipal Bldg	0.05	0.09	0.05	0.00	0.0	
Loc33	Richland TWP	0.16	0.15	0.16	0.00	0.0	
03085734	Ohio River at Emsworth Dam Lower Pool at Emsworth	0.40	0.48	0.38	0.02	5.0	
Loc09	Univ of Pittsburgh	0.19	0.28	0.18	0.01	5.3	
Loc03	Shaler Munic Bldg	0.30	0.38	0.27	0.03	10.0	
KAGC	Pittsburgh Allegheny Cty	0.01	---	---	---	---	MSTT
Loc02	ALCOSAN WWTP Lab	0.03	---	---	---	---	MSTT
Loc05	Upper St. Clair	0.00	---	---	---	---	MSTT
Loc06	Carnegie Transit Time	0.00	---	---	---	---	MSTT
Loc07	Greentree Munic Bldg	0.01	---	---	---	---	MSTT
Loc11	M-46 Access Shaft	0.00	---	---	---	---	MSTT
Loc12	Baldwin	0.00	---	---	---	---	MSTT
Loc13	M-59 Access Shaft	0.01	---	---	---	---	MSTT
Loc15	Trafford Maint Bldg	0.00	---	---	---	---	MSTT
Loc16	Castle Shannon	0.00	---	---	---	---	MSTT
Loc17	Chartiers Pump Station	0.00	---	---	---	---	MSTT
Loc18	Oakdale Pump Station	0.00	---	---	---	---	MSTT
Loc22	North Fayette TWP	0.00	---	---	---	---	MSTT
Loc23	Clinton Munic Bldg	ND	---	---	---	---	ND
Loc26	Elizabeth TWP Municipal Bldg	0.00	---	---	---	---	MSTT

Table 58. Summary of Individual RG Pairs for Event 9e

Gauge ID	Name	G _i (in)	R _i (in)	R _i * (in)	Diff* (in)	Diff* (%)	Flag
Loc13	M-59 Access Shaft	0.19	0.25	0.21	-0.02	-10.5	
03085734	Ohio River at Emsworth Dam Lower Pool at Emsworth	0.10	0.11	0.11	-0.01	-10.0	
Loc05	Upper St. Clair	0.58	0.85	0.61	-0.03	-5.2	
Loc16	Castle Shannon	0.67	0.91	0.69	-0.02	-3.0	
Loc28	Plum Municipal Bldg	0.33	0.44	0.34	-0.01	-3.0	
Loc19	Sandy Creek Eq Facility	0.34	0.31	0.35	-0.01	-2.9	
Loc31	Hampton Municipal Bldg	0.39	0.36	0.40	-0.01	-2.6	

Gauge ID	Name	G _i (in)	R _i (in)	R _i * (in)	Diff* (in)	Diff* (%)	Flag
KAGC	Pittsburgh Allegheny Cty	0.50	0.62	0.51	-0.01	-2.0	
Loc27	Marshall TWP	0.94	1.01	0.95	-0.01	-1.1	
03049500	Allegheny River at Natrona	0.25	0.21	0.25	0.00	0.0	
KPIT	Greater Pittsburgh Int'l	0.10	0.11	0.10	0.00	0.0	
Loc02	ALCOSAN WWTP Lab	0.13	0.11	0.13	0.00	0.0	
Loc04	Kennedy Twp PS	0.10	0.09	0.10	0.00	0.0	
Loc07	Greentree Munic Bldg	0.17	0.21	0.17	0.00	0.0	
Loc08	AC Health Dept Bldg	0.13	0.12	0.13	0.00	0.0	
Loc09	Univ of Pittsburgh	0.11	0.10	0.11	0.00	0.0	
Loc10	PWSA-Highland Park	0.25	0.23	0.25	0.00	0.0	
Loc14	Churchill Munic Bldg	0.11	0.09	0.11	0.00	0.0	
Loc15	Trafford Maint Bldg	0.26	0.30	0.26	0.00	0.0	
Loc18	Oakdale Pump Station	0.53	0.60	0.53	0.00	0.0	
Loc20	Gascola Eq Facility	0.27	0.24	0.27	0.00	0.0	
Loc21	Moon TWP	0.19	0.17	0.19	0.00	0.0	
Loc22	North Fayette TWP	0.38	0.40	0.38	0.00	0.0	
Loc24	Jefferson Hills	0.64	0.81	0.64	0.00	0.0	
Loc26	Elizabeth TWP Municipal Bldg	1.10	1.34	1.10	0.00	0.0	
Loc29	Bell Acres Munic Bldg	0.46	0.43	0.46	0.00	0.0	
Loc30	McCandless Twn Hall	0.79	0.80	0.79	0.00	0.0	
Loc32	Arnold	0.48	0.47	0.48	0.00	0.0	
Loc33	Richland TWP	0.47	0.52	0.47	0.00	0.0	
Loc12	Baldwin	0.44	0.51	0.43	0.01	2.3	
Loc06	Carnegie Transit Time	0.40	0.47	0.39	0.01	2.5	
Loc17	Chartiers Pump Station	1.10	1.33	1.07	0.03	2.7	
Loc03	Shaler Munic Bldg	0.28	0.21	0.27	0.01	3.6	
Loc11	M-46 Access Shaft	0.18	0.15	0.17	0.01	5.6	
Loc01	PWSA-Montana St.	0.13	0.10	0.12	0.01	7.7	
Loc23	Clinton Munic Bldg	ND	---	---	---	---	ND
Loc25	White Oak Public Works Bldg	0.34	---	---	---	---	OAD

Table 59. Summary of Individual RG Pairs for Event 9f

Gauge ID	Name	G _i (in)	R _i (in)	R _i * (in)	Diff* (in)	Diff* (%)	Flag
Loc21	Moon TWP	0.10	0.13	0.11	-0.01	-10.0	
Loc01	PWSA-Montana St.	0.13	0.15	0.14	-0.01	-7.7	
Loc27	Marshall TWP	0.29	0.23	0.30	-0.01	-3.4	
03049500	Allegheny River at Natrona	0.15	0.16	0.15	0.00	0.0	
03085734	Ohio River at Emsworth Dam Lower Pool at Emsworth	0.15	0.14	0.15	0.00	0.0	
KAGC	Pittsburgh Allegheny Cty	0.09	0.09	0.09	0.00	0.0	
Loc02	ALCOSAN WWTP Lab	0.11	0.11	0.11	0.00	0.0	
Loc03	Shaler Munic Bldg	0.18	0.17	0.18	0.00	0.0	
Loc04	Kennedy Twp PS	0.12	0.11	0.12	0.00	0.0	
Loc05	Upper St. Clair	0.06	0.06	0.06	0.00	0.0	
Loc06	Carnegie Transit Time	0.08	0.08	0.08	0.00	0.0	
Loc07	Greentree Munic Bldg	0.09	0.09	0.09	0.00	0.0	
Loc08	AC Health Dept Bldg	0.11	0.13	0.11	0.00	0.0	
Loc09	Univ of Pittsburgh	0.10	0.12	0.10	0.00	0.0	
Loc11	M-46 Access Shaft	0.10	0.11	0.10	0.00	0.0	
Loc12	Baldwin	0.08	0.08	0.08	0.00	0.0	
Loc13	M-59 Access Shaft	0.11	0.10	0.11	0.00	0.0	
Loc14	Churchill Munic Bldg	0.13	0.14	0.13	0.00	0.0	
Loc15	Trafford Maint Bldg	0.11	0.12	0.11	0.00	0.0	
Loc16	Castle Shannon	0.06	0.07	0.06	0.00	0.0	
Loc17	Chartiers Pump Station	0.05	0.06	0.05	0.00	0.0	
Loc18	Oakdale Pump Station	0.08	0.08	0.08	0.00	0.0	
Loc19	Sandy Creek Eq Facility	0.14	0.15	0.14	0.00	0.0	
Loc20	Gascola Eq Facility	0.12	0.15	0.12	0.00	0.0	
Loc22	North Fayette TWP	0.09	0.08	0.09	0.00	0.0	
Loc24	Jefferson Hills	0.14	0.13	0.14	0.00	0.0	
Loc25	White Oak Public Works Bldg	0.13	0.15	0.13	0.00	0.0	
Loc26	Elizabeth TWP Municipal Bldg	0.18	0.19	0.18	0.00	0.0	
Loc28	Plum Municipal Bldg	0.17	0.18	0.17	0.00	0.0	
Loc29	Bell Acres Munic Bldg	0.17	0.14	0.17	0.00	0.0	
Loc31	Hampton Municipal Bldg	0.16	0.14	0.16	0.00	0.0	
Loc32	Arnold	0.16	0.15	0.16	0.00	0.0	
Loc33	Richland TWP	0.22	0.15	0.22	0.00	0.0	
Loc30	McCandless Twn Hall	0.23	0.16	0.22	0.01	4.3	
KPIT	Greater Pittsburgh Int'l	0.15	0.11	0.14	0.01	6.7	

Gauge ID	Name	G _i (in)	R _i (in)	R _i * (in)	Diff* (in)	Diff* (%)	Flag
Loc10	PWSA-Highland Park	0.14	0.14	0.13	0.01	7.1	
Loc23	Clinton Munic Bldg	ND	---	---	---	---	ND

Table 60. Summary of Individual RG Pairs for Event 9g

Gauge ID	Name	G _i (in)	R _i (in)	R _i * (in)	Diff* (in)	Diff* (%)	Flag
Loc20	Gascola Eq Facility	0.12	0.17	0.13	-0.01	-8.3	
Loc22	North Fayette TWP	0.12	0.14	0.13	-0.01	-8.3	
03085734	Ohio River at Emsworth Dam Lower Pool at Emsworth	0.10	0.13	0.10	0.00	0.0	
KAGC	Pittsburgh Allegheny Cty	0.11	0.12	0.11	0.00	0.0	
KPIT	Greater Pittsburgh Int'l	0.09	0.11	0.09	0.00	0.0	
Loc01	PWSA-Montana St.	0.14	0.20	0.14	0.00	0.0	
Loc02	ALCOSAN WWTP Lab	0.13	0.19	0.13	0.00	0.0	
Loc03	Shaler Munic Bldg	0.15	0.16	0.15	0.00	0.0	
Loc05	Upper St. Clair	0.12	0.12	0.12	0.00	0.0	
Loc07	Greentree Munic Bldg	0.16	0.17	0.16	0.00	0.0	
Loc08	AC Health Dept Bldg	0.18	0.19	0.18	0.00	0.0	
Loc09	Univ of Pittsburgh	0.18	0.19	0.18	0.00	0.0	
Loc10	PWSA-Highland Park	0.17	0.19	0.17	0.00	0.0	
Loc11	M-46 Access Shaft	0.13	0.16	0.13	0.00	0.0	
Loc12	Baldwin	0.12	0.12	0.12	0.00	0.0	
Loc13	M-59 Access Shaft	0.12	0.14	0.12	0.00	0.0	
Loc14	Churchill Munic Bldg	0.14	0.17	0.14	0.00	0.0	
Loc15	Trafford Maint Bldg	0.10	0.11	0.10	0.00	0.0	
Loc16	Castle Shannon	0.10	0.11	0.10	0.00	0.0	
Loc17	Chartiers Pump Station	0.15	0.15	0.15	0.00	0.0	
Loc19	Sandy Creek Eq Facility	0.16	0.19	0.16	0.00	0.0	
Loc21	Moon TWP	0.06	0.08	0.06	0.00	0.0	
Loc24	Jefferson Hills	0.10	0.10	0.10	0.00	0.0	
Loc25	White Oak Public Works Bldg	0.08	0.08	0.08	0.00	0.0	
Loc26	Elizabeth TWP Municipal Bldg	0.25	0.32	0.25	0.00	0.0	
Loc27	Marshall TWP	0.06	0.05	0.06	0.00	0.0	
Loc28	Plum Municipal Bldg	0.20	0.22	0.20	0.00	0.0	
Loc29	Bell Acres Munic Bldg	0.06	0.07	0.06	0.00	0.0	

Gauge ID	Name	G _i (in)	R _i (in)	R _i * (in)	Diff* (in)	Diff* (%)	Flag
Loc31	Hampton Municipal Bldg	0.10	0.12	0.10	0.00	0.0	
Loc32	Arnold	0.15	0.20	0.15	0.00	0.0	
Loc33	Richland TWP	0.06	0.05	0.06	0.00	0.0	
Loc06	Carnegie Transit Time	0.18	0.16	0.17	0.01	5.6	
Loc18	Oakdale Pump Station	0.18	0.16	0.17	0.01	5.6	
Loc04	Kennedy Twp PS	0.15	0.17	0.14	0.01	6.7	
03049500	Allegheny River at Natrona	0.08	---	---	---	---	U
Loc23	Clinton Munic Bldg	ND	---	---	---	---	ND
Loc30	McCandless Twn Hall	0.04	---	---	---	---	MSTT

Table 61. Summary of Individual RG Pairs for Event 9h

Gauge ID	Name	G _i (in)	R _i (in)	R _i * (in)	Diff* (in)	Diff* (%)	Flag
03085734	Ohio River at Emsworth Dam Lower Pool at Emsworth	0.14	0.14	0.15	-0.01	-7.1	
KAGC	Pittsburgh Allegheny Cty	0.34	0.34	0.36	-0.02	-5.9	
Loc10	PWSA-Highland Park	0.20	0.17	0.21	-0.01	-5.0	
Loc19	Sandy Creek Eq Facility	0.20	0.17	0.21	-0.01	-5.0	
Loc31	Hampton Municipal Bldg	0.22	0.28	0.23	-0.01	-4.5	
Loc21	Moon TWP	0.24	0.23	0.25	-0.01	-4.2	
Loc09	Univ of Pittsburgh	0.27	0.22	0.28	-0.01	-3.7	
Loc16	Castle Shannon	0.44	0.36	0.45	-0.01	-2.3	
Loc17	Chartiers Pump Station	0.43	0.39	0.44	-0.01	-2.3	
Loc05	Upper St. Clair	0.54	0.52	0.55	-0.01	-1.9	
03049500	Allegheny River at Natrona	0.32	0.44	0.32	0.00	0.0	
KPIT	Greater Pittsburgh Int'l	0.16	0.11	0.16	0.00	0.0	
Loc01	PWSA-Montana St.	0.18	0.15	0.18	0.00	0.0	
Loc02	ALCOSAN WWTP Lab	0.15	0.14	0.15	0.00	0.0	
Loc07	Greentree Munic Bldg	0.30	0.25	0.30	0.00	0.0	
Loc11	M-46 Access Shaft	0.34	0.26	0.34	0.00	0.0	
Loc13	M-59 Access Shaft	0.31	0.25	0.31	0.00	0.0	
Loc15	Trafford Maint Bldg	0.39	0.35	0.39	0.00	0.0	
Loc18	Oakdale Pump Station	0.34	0.25	0.34	0.00	0.0	
Loc20	Gascola Eq Facility	0.27	0.20	0.27	0.00	0.0	
Loc22	North Fayette TWP	0.28	0.21	0.28	0.00	0.0	

Gauge ID	Name	G _i (in)	R _i (in)	R _i * (in)	Diff* (in)	Diff* (%)	Flag
Loc24	Jefferson Hills	0.42	0.41	0.42	0.00	0.0	
Loc25	White Oak Public Works Bldg	0.44	0.41	0.44	0.00	0.0	
Loc26	Elizabeth TWP Municipal Bldg	0.65	0.64	0.65	0.00	0.0	
Loc27	Marshall TWP	0.20	0.22	0.20	0.00	0.0	
Loc28	Plum Municipal Bldg	0.23	0.21	0.23	0.00	0.0	
Loc29	Bell Acres Munic Bldg	0.27	0.28	0.27	0.00	0.0	
Loc30	McCandless Twn Hall	0.29	0.31	0.29	0.00	0.0	
Loc32	Arnold	0.30	0.34	0.30	0.00	0.0	
Loc33	Richland TWP	0.34	0.38	0.34	0.00	0.0	
Loc06	Carnegie Transit Time	0.36	0.28	0.35	0.01	2.8	
Loc14	Churchill Munic Bldg	0.31	0.22	0.30	0.01	3.2	
Loc03	Shaler Munic Bldg	0.23	0.20	0.22	0.01	4.3	
Loc08	AC Health Dept Bldg	0.23	0.17	0.22	0.01	4.3	
Loc12	Baldwin	0.38	0.27	0.36	0.02	5.3	
Loc04	Kennedy Twp PS	0.16	0.11	0.15	0.01	6.3	
Loc23	Clinton Munic Bldg	ND	---	---	---	---	ND

Table 62. Summary of Individual RG Pairs for Event 9i

Gauge ID	Name	G _i (in)	R _i (in)	R _i * (in)	Diff* (in)	Diff* (%)	Flag
Loc01	PWSA-Montana St.	0.05	0.11	0.05	0.00	0.0	
Loc02	ALCOSAN WWTP Lab	0.05	0.11	0.05	0.00	0.0	
Loc03	Shaler Munic Bldg	0.05	0.08	0.05	0.00	0.0	
Loc18	Oakdale Pump Station	0.05	0.07	0.05	0.00	0.0	
Loc21	Moon TWP	0.05	0.10	0.05	0.00	0.0	
Loc29	Bell Acres Munic Bldg	0.06	0.06	0.06	0.00	0.0	
Loc31	Hampton Municipal Bldg	0.05	0.06	0.05	0.00	0.0	
03049500	Allegheny River at Natrona	0.01	---	---	---	---	MSTT
03085734	Ohio River at Emsworth Dam Lower Pool at Emsworth	0.04	---	---	---	---	MSTT
KAGC	Pittsburgh Allegheny Cty	0.02	---	---	---	---	MSTT
KPIT	Greater Pittsburgh Int'l	0.05	---	---	---	---	MSTT
Loc04	Kennedy Twp PS	0.04	---	---	---	---	MSTT
Loc05	Upper St. Clair	0.02	---	---	---	---	MSTT
Loc06	Carnegie Transit Time	0.04	---	---	---	---	MSTT

Gauge ID	Name	G _i (in)	R _i (in)	R _i * (in)	Diff* (in)	Diff* (%)	Flag
Loc07	Greentree Munic Bldg	0.02	---	---	---	---	MSTT
Loc08	AC Health Dept Bldg	0.03	---	---	---	---	MSTT
Loc09	Univ of Pittsburgh	0.02	---	---	---	---	MSTT
Loc10	PWSA-Highland Park	0.04	---	---	---	---	MSTT
Loc11	M-46 Access Shaft	0.04	---	---	---	---	MSTT
Loc12	Baldwin	0.01	---	---	---	---	MSTT
Loc13	M-59 Access Shaft	0.01	---	---	---	---	MSTT
Loc14	Churchill Munic Bldg	0.02	---	---	---	---	MSTT
Loc15	Trafford Maint Bldg	0.01	---	---	---	---	MSTT
Loc16	Castle Shannon	0.03	---	---	---	---	MSTT
Loc17	Chartiers Pump Station	0.02	---	---	---	---	MSTT
Loc19	Sandy Creek Eq Facility	0.03	---	---	---	---	MSTT
Loc20	Gascola Eq Facility	0.02	---	---	---	---	MSTT
Loc22	North Fayette TWP	0.03	---	---	---	---	MSTT
Loc23	Clinton Munic Bldg	ND	---	---	---	---	ND
Loc24	Jefferson Hills	0.01	---	---	---	---	MSTT
Loc25	White Oak Public Works Bldg	0.02	---	---	---	---	MSTT
Loc26	Elizabeth TWP Municipal Bldg	0.00	---	---	---	---	MSTT
Loc27	Marshall TWP	0.03	---	---	---	---	MSTT
Loc28	Plum Municipal Bldg	0.04	---	---	---	---	MSTT
Loc30	McCandless Twn Hall	0.03	---	---	---	---	MSTT
Loc32	Arnold	0.02	---	---	---	---	MSTT
Loc33	Richland TWP	0.03	---	---	---	---	MSTT

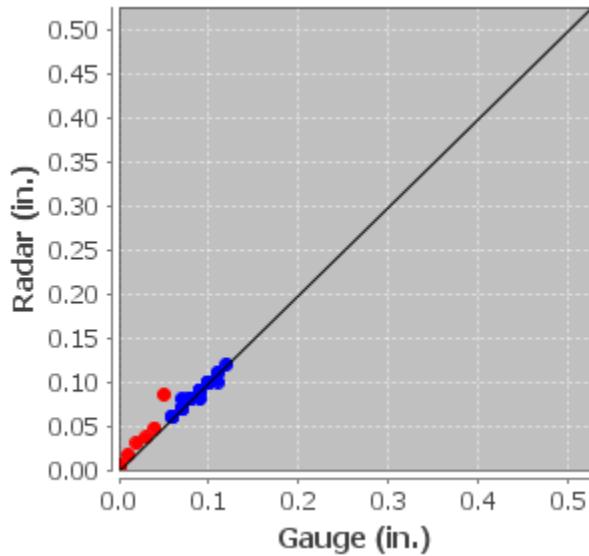


Figure 40. Scatter Plot of RG Pairs for Event 9a

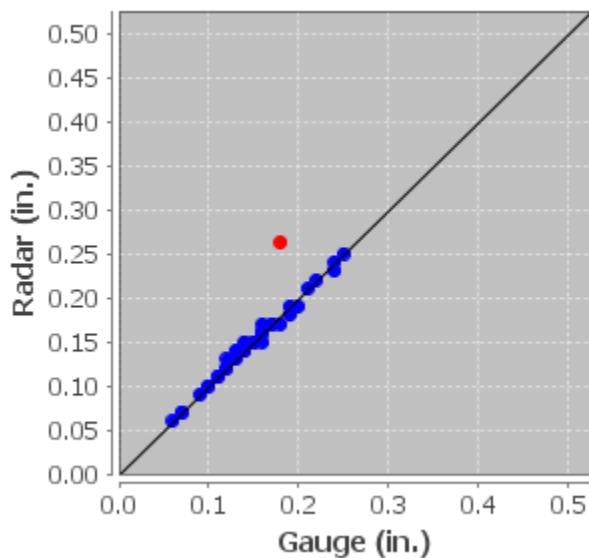


Figure 41. Scatter Plot of RG Pairs for Event 9b

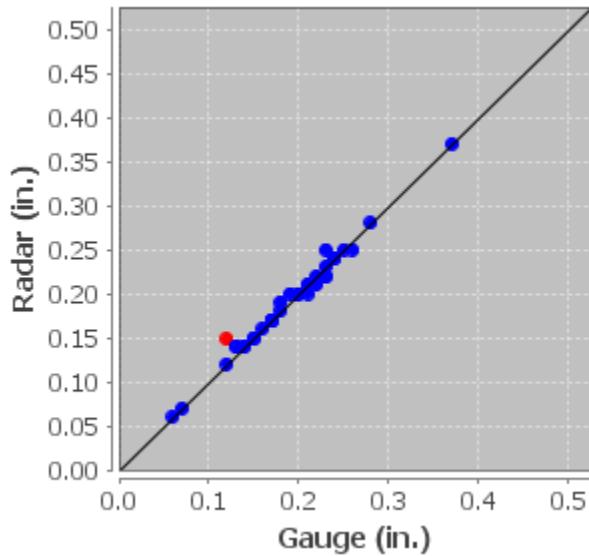


Figure 42. Scatter Plot of RG Pairs for Event 9c

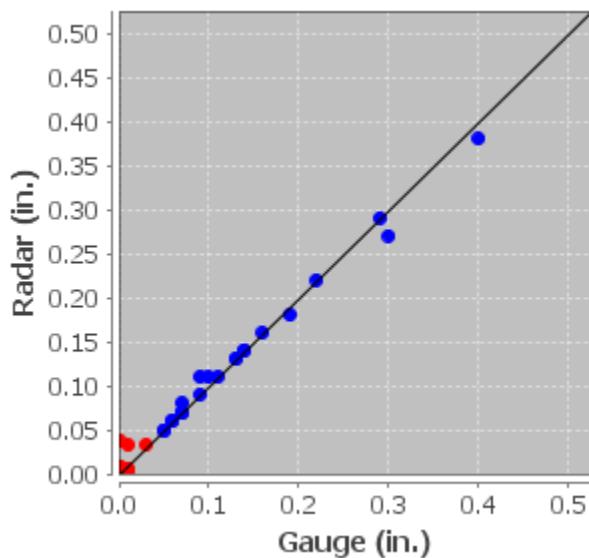


Figure 43. Scatter Plot of RG Pairs for Event 9d

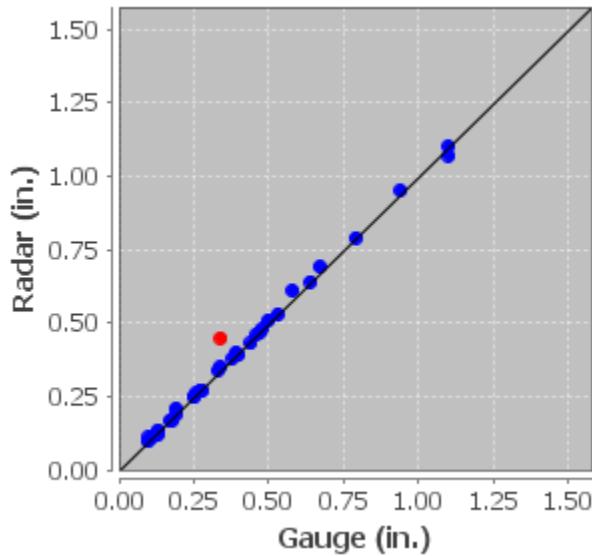


Figure 44. Scatter Plot of RG Pairs for Event 9e

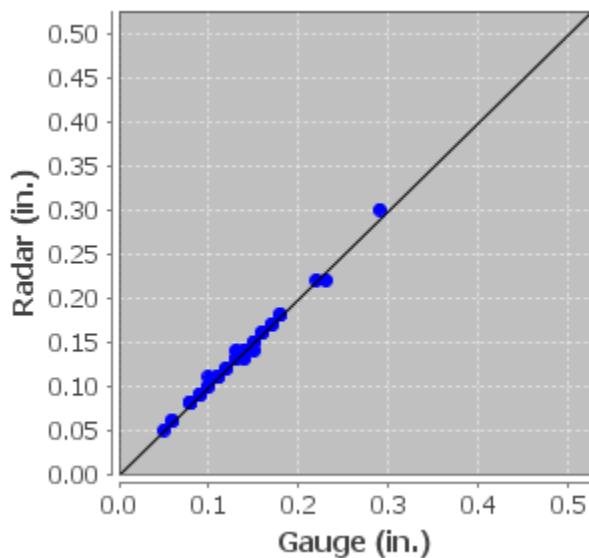


Figure 45. Scatter Plot of RG Pairs for Event 9f

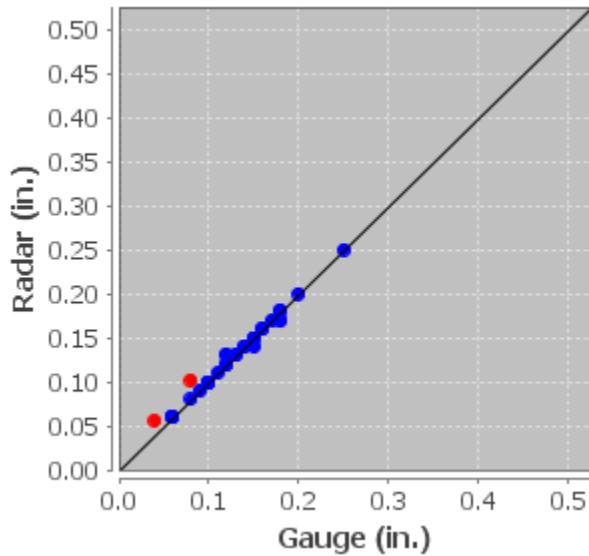


Figure 46. Scatter Plot of RG Pairs for Event 9g

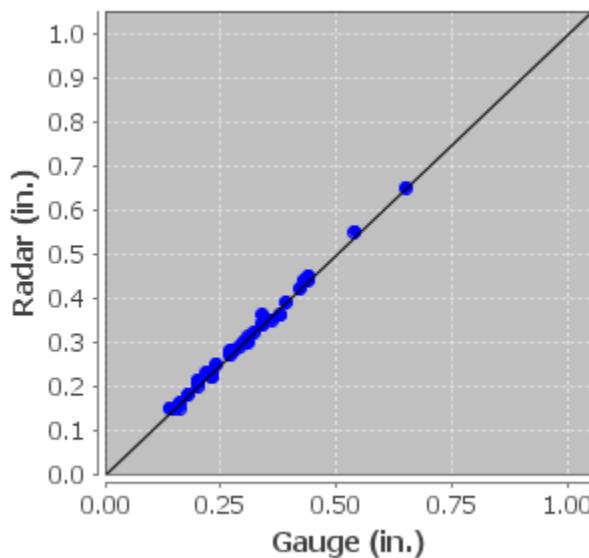


Figure 47. Scatter Plot of RG Pairs for Event 9h

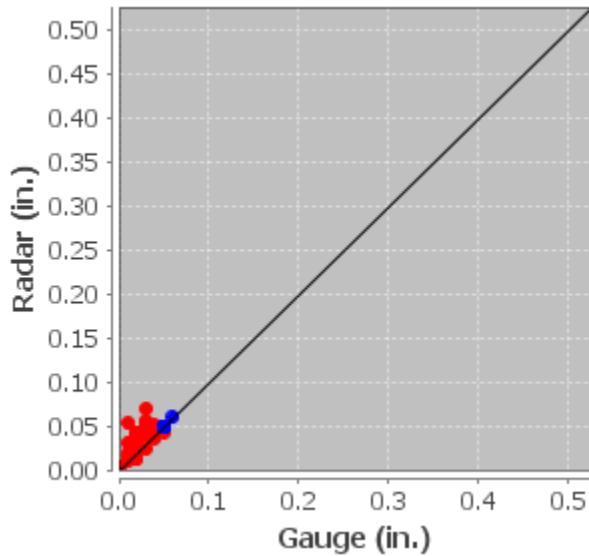


Figure 48. Scatter Plot of RG Pairs for Event 9i

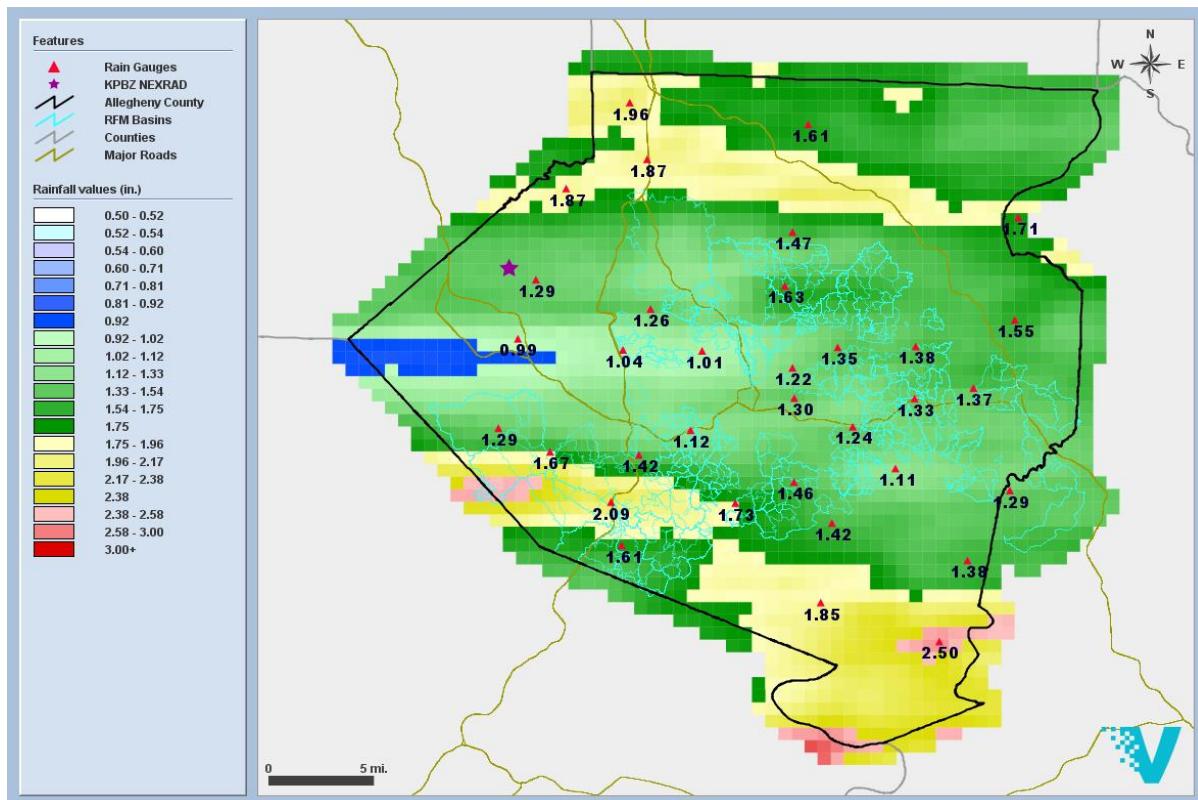


Figure 49. GARR Storm Total for Event 9

Table 63. Depth Duration Frequency Analyses for Event 9

Duration	Depth (in)	Pixel	Time (EDT)	Frequency
15 minutes	0.970	125146	2020-03-28 16:20	5 yr.
30 minutes	1.311	125146	2020-03-28 16:25	5 yr.
1 hour	1.584	151166	2020-03-28 22:20	5 yr.
2 hour	1.832	151166	2020-03-28 22:35	5 yr.
3 hour	2.132	151166	2020-03-29 00:05	10 yr.
6 hour	2.235	151166	2020-03-29 00:20	5 yr.
12 hour	2.561	151166	2020-03-29 00:25	5 yr.
24 hour	2.704	151166	2020-03-29 00:25	2 yr.

Appendices

- [Appendix A](#) - Gauge Performance Exclusion Table
- [Appendix B](#) - Gauge Statistical Criteria Exclusion Table
- [Appendix C](#) - Event 1 (2020-03-02) CDPs
- [Appendix D](#) - Event 2 (2020-03-03 AM) CDPs
- [Appendix E](#) - Event 3 (2020-03-03 PM) CDPs
- [Appendix F](#) - Event 4 (2020-03-10) CDPs
- [Appendix G](#) - Event 5 (2020-03-18) CDPs
- [Appendix H](#) - Event 6 (2020-03-20) CDPs
- [Appendix I](#) - Event 7 (2020-03-23) CDPs
- [Appendix J](#) - Event 8 (2020-03-25) CDPs
- [Appendix K](#) - Event 9 (2020-03-28) CDPs

Appendix A - Gauge Performance Exclusion Table

Reason	Explanation
Clog (C)	Gauge appeared to be clogged
Zero (Z)	Gauge did not report any rainfall while radar rainfall estimates reported significant rainfall
Stop (S)	Gauge appeared to stop reporting rainfall while radar rainfall estimates reported significant rainfall
Over (O)	Gauge appeared to significantly over-report rainfall as compared to radar rainfall estimates and surrounding gauges (e.g. anomalously high rainfall values caused by field calibration, data transmission error, or switch malfunctions)
Under (U)	Gauge appeared to significantly under-report as compared to radar rainfall estimates and surrounding Gauges (e.g. half-tipper)
Sync (SY)	Gauge appeared to be reporting out-of-sync with the radar rainfall estimates
Frozen/Melt (F/M)	Gauge not reporting properly due to frozen or melting precipitation
Other (T)	Combination of multiple reasons
No Data (ND)	Gauge reported "no data" for a significant amount of time

Event #	<u>E1</u>	<u>E2a</u>	<u>E2b</u>	<u>E2c</u>	<u>E2d</u>
Event Date	2020-03-02	2020-03-03 AM	2020-03-03 AM	2020-03-03 AM	2020-03-03 AM
Start Time (EST/EDT)	2020-03-02 11:05	2020-03-03 00:05	2020-03-03 07:35	2020-03-03 08:20	2020-03-03 08:50
End Time (EST/EDT)	2020-03-03 00:00	2020-03-03 07:30	2020-03-03 08:15	2020-03-03 08:45	2020-03-03 14:00
Loc01	U		U		
Loc02					
Loc03					
Loc04					
Loc05					
Loc06	O				
Loc07					
Loc08					
Loc09					
Loc10	U				
Loc11					
Loc12					
Loc13	U				
Loc14					
Loc15	ND	ND	ND	ND	ND
Loc16					
Loc17			U		
Loc18					
Loc19					
Loc20					
Loc21					
Loc22					
Loc23	ND	ND	ND	ND	ND
Loc24					
Loc25					
Loc26					
Loc27		O			

Event #	<u>E1</u>	<u>E2a</u>	<u>E2b</u>	<u>E2c</u>	<u>E2d</u>
Event Date	2020-03-02	2020-03-03 AM	2020-03-03 AM	2020-03-03 AM	2020-03-03 AM
Start Time (EST/EDT)	2020-03-02 11:05	2020-03-03 00:05	2020-03-03 07:35	2020-03-03 08:20	2020-03-03 08:50
End Time (EST/EDT)	2020-03-03 00:00	2020-03-03 07:30	2020-03-03 08:15	2020-03-03 08:45	2020-03-03 14:00
Loc28					
Loc29					
Loc30					
Loc31					
Loc32					
Loc33					
KAGC			U		
KPIT		U	U	O	
03049500	U		U	U	
03085734	U		U		

Event #	E3a	E3b	E4a	E4b	E4c
Event Date	2020-03-03 PM	2020-03-03 PM	2020-03-10	2020-03-10	2020-03-10
Start Time (EST/EDT)	2020-03-03 14:05	2020-03-03 19:05	2020-03-10 01:05	2020-03-10 08:05	2020-03-10 14:20
End Time (EST/EDT)	2020-03-03 19:00	2020-03-03 23:00	2020-03-10 08:00	2020-03-10 14:15	2020-03-10 18:00
Loc01	U				
Loc02					
Loc03					
Loc04					
Loc05					
Loc06					
Loc07					
Loc08	U				
Loc09					
Loc10					
Loc11					T
Loc12					
Loc13					U
Loc14	U				
Loc15	ND	ND	ND	ND	ND
Loc16					
Loc17					
Loc18					
Loc19					
Loc20					
Loc21					
Loc22					
Loc23	ND	ND	ND	ND	ND
Loc24			O		
Loc25					

Event #	<u>E3a</u>	<u>E3b</u>	<u>E4a</u>	<u>E4b</u>	<u>E4c</u>
Event Date	2020-03-03 PM	2020-03-03 PM	2020-03-10	2020-03-10	2020-03-10
Start Time (EST/EDT)	2020-03-03 14:05	2020-03-03 19:05	2020-03-10 01:05	2020-03-10 08:05	2020-03-10 14:20
End Time (EST/EDT)	2020-03-03 19:00	2020-03-03 23:00	2020-03-10 08:00	2020-03-10 14:15	2020-03-10 18:00
Loc26					
Loc27					
Loc28					
Loc29					
Loc30					
Loc31					
Loc32					
Loc33					
KAGC				T	
KPIT				T	U
03049500	U		U	T	
03085734	U			T	

Event #	E5a	E5b	E5c	E5d	E5e
Event Date	2020-03-18	2020-03-18	2020-03-18	2020-03-18	2020-03-18
Start Time (EST/EDT)	2020-03-18 14:05	2020-03-18 19:05	2020-03-18 21:20	2020-03-18 23:05	2020-03-19 00:50
End Time (EST/EDT)	2020-03-18 19:00	2020-03-18 21:15	2020-03-18 23:00	2020-03-19 00:45	2020-03-19 02:15
Loc01					U
Loc02	U		U		
Loc03					
Loc04					
Loc05					
Loc06			O		O
Loc07					
Loc08					
Loc09					
Loc10					
Loc11					
Loc12					
Loc13					
Loc14					
Loc15					
Loc16					
Loc17					U
Loc18					
Loc19					
Loc20			U		
Loc21					
Loc22	O				
Loc23	ND	ND	ND	ND	ND
Loc24					
Loc25					
Loc26					

Event #	<u>E5a</u>	<u>E5b</u>	<u>E5c</u>	<u>E5d</u>	<u>E5e</u>
Event Date	2020-03-18	2020-03-18	2020-03-18	2020-03-18	2020-03-18
Start Time (EST/EDT)	2020-03-18 14:05	2020-03-18 19:05	2020-03-18 21:20	2020-03-18 23:05	2020-03-19 00:50
End Time (EST/EDT)	2020-03-18 19:00	2020-03-18 21:15	2020-03-18 23:00	2020-03-19 00:45	2020-03-19 02:15
Loc27					
Loc28					
Loc29					
Loc30	U		U		
Loc31					
Loc32					
Loc33					
KAGC				T	
KPIT				T	
03049500	U	U		T	
03085734	U	U		T	

Event #	E5f	E6a	E6b	E6c	E6d
Event Date	2020-03-18	2020-03-20	2020-03-20	2020-03-20	2020-03-20
Start Time (EST/EDT)	2020-03-19 02:20	2020-03-19 16:05	2020-03-19 20:35	2020-03-19 21:05	2020-03-19 22:05
End Time (EST/EDT)	2020-03-19 07:00	2020-03-19 20:30	2020-03-19 21:00	2020-03-19 22:00	2020-03-20 03:00
Loc01					U
Loc02			U		
Loc03					
Loc04					
Loc05					
Loc06					
Loc07					
Loc08					
Loc09					
Loc10					
Loc11					
Loc12					
Loc13					
Loc14					
Loc15					
Loc16					
Loc17					
Loc18		O			
Loc19					
Loc20					
Loc21					
Loc22					
Loc23	ND	ND	ND	ND	ND
Loc24					
Loc25					
Loc26					

Event #	<u>E5f</u>	<u>E6a</u>	<u>E6b</u>	<u>E6c</u>	<u>E6d</u>
Event Date	2020-03-18	2020-03-20	2020-03-20	2020-03-20	2020-03-20
Start Time (EST/EDT)	2020-03-19 02:20	2020-03-19 16:05	2020-03-19 20:35	2020-03-19 21:05	2020-03-19 22:05
End Time (EST/EDT)	2020-03-19 07:00	2020-03-19 20:30	2020-03-19 21:00	2020-03-19 22:00	2020-03-20 03:00
Loc27					
Loc28					
Loc29					
Loc30					
Loc31					
Loc32					
Loc33					
KAGC	T		U		
KPIT	T				
03049500	T	U	U		U
03085734	T	U	U		

Event #	E6e	E6f	E6g	E6h	E6i
Event Date	2020-03-20	2020-03-20	2020-03-20	2020-03-20	2020-03-20
Start Time (EST/EDT)	2020-03-20 03:05	2020-03-20 04:35	2020-03-20 06:05	2020-03-20 07:50	2020-03-20 09:05
End Time (EST/EDT)	2020-03-20 04:30	2020-03-20 06:00	2020-03-20 07:45	2020-03-20 09:00	2020-03-20 14:00
Loc01	U	U		U	
Loc02					
Loc03					
Loc04					
Loc05			U		
Loc06					
Loc07					
Loc08					
Loc09					
Loc10					
Loc11					
Loc12					
Loc13					
Loc14					
Loc15					
Loc16					
Loc17					
Loc18					
Loc19					
Loc20					
Loc21					
Loc22					
Loc23	ND	ND	ND	ND	ND
Loc24					
Loc25					
Loc26					

Event #	<u>E6e</u>	<u>E6f</u>	<u>E6g</u>	<u>E6h</u>	<u>E6i</u>
Event Date	2020-03-20	2020-03-20	2020-03-20	2020-03-20	2020-03-20
Start Time (EST/EDT)	2020-03-20 03:05	2020-03-20 04:35	2020-03-20 06:05	2020-03-20 07:50	2020-03-20 09:05
End Time (EST/EDT)	2020-03-20 04:30	2020-03-20 06:00	2020-03-20 07:45	2020-03-20 09:00	2020-03-20 14:00
Loc27					
Loc28					
Loc29					
Loc30	U				
Loc31					
Loc32					
Loc33					
KAGC			U		
KPIT			U	O	
03049500	U	U	U	U	
03085734					

Event #	E6i	E7a	E7b	E7c	E7d
Event Date	2020-03-20	2020-03-23	2020-03-23	2020-03-23	2020-03-23
Start Time (EST/EDT)	2020-03-20 14:05	2020-03-23 01:05	2020-03-23 09:20	2020-03-23 11:05	2020-03-23 13:20
End Time (EST/EDT)	2020-03-20 20:00	2020-03-23 09:15	2020-03-23 11:00	2020-03-23 13:15	2020-03-23 20:00
Loc01					
Loc02					
Loc03					
Loc04					
Loc05					
Loc06					
Loc07					
Loc08					
Loc09					
Loc10					
Loc11					
Loc12					
Loc13					
Loc14					
Loc15					
Loc16					
Loc17					
Loc18					
Loc19					
Loc20					
Loc21					
Loc22					
Loc23	ND	ND	ND	ND	ND
Loc24					
Loc25					
Loc26					

Event #	<u>E6i</u>	<u>E7a</u>	<u>E7b</u>	<u>E7c</u>	<u>E7d</u>
Event Date	2020-03-20	2020-03-23	2020-03-23	2020-03-23	2020-03-23
Start Time (EST/EDT)	2020-03-20 14:05	2020-03-23 01:05	2020-03-23 09:20	2020-03-23 11:05	2020-03-23 13:20
End Time (EST/EDT)	2020-03-20 20:00	2020-03-23 09:15	2020-03-23 11:00	2020-03-23 13:15	2020-03-23 20:00
Loc27					
Loc28					
Loc29					
Loc30					
Loc31					
Loc32					
Loc33					
KAGC					T
KPIT					T
03049500	U			U	T
03085734	U				T

Event #	<u>E8a</u>	<u>E8b</u>	<u>E9a</u>	<u>E9b</u>	<u>E9c</u>
Event Date	2020-03-25	2020-03-25	2020-03-28	2020-03-28	2020-03-28
Start Time (EST/EDT)	2020-03-24 21:05	2020-03-25 04:35	2020-03-27 20:05	2020-03-28 00:05	2020-03-28 04:05
End Time (EST/EDT)	2020-03-25 04:30	2020-03-25 10:00	2020-03-28 00:00	2020-03-28 04:00	2020-03-28 08:00
Loc01					U
Loc02					
Loc03					
Loc04					
Loc05					
Loc06					
Loc07					
Loc08					
Loc09					
Loc10					
Loc11					
Loc12					
Loc13					
Loc14					
Loc15					
Loc16					
Loc17					
Loc18					
Loc19					
Loc20					
Loc21					
Loc22					
Loc23	ND	ND	ND	ND	ND
Loc24		U			
Loc25					
Loc26					

Event #	<u>E8a</u>	<u>E8b</u>	<u>E9a</u>	<u>E9b</u>	<u>E9c</u>
Event Date	2020-03-25	2020-03-25	2020-03-28	2020-03-28	2020-03-28
Start Time (EST/EDT)	2020-03-24 21:05	2020-03-25 04:35	2020-03-27 20:05	2020-03-28 00:05	2020-03-28 04:05
End Time (EST/EDT)	2020-03-25 04:30	2020-03-25 10:00	2020-03-28 00:00	2020-03-28 04:00	2020-03-28 08:00
Loc27					
Loc28					
Loc29					
Loc30					
Loc31					
Loc32					
Loc33					
KAGC					
KPIT					
03049500				U	
03085734					

Event #	<u>E9d</u>	<u>E9e</u>	<u>E9f</u>	<u>E9g</u>	<u>E9h</u>
Event Date	2020-03-28	2020-03-28	2020-03-28	2020-03-28	2020-03-28
Start Time (EST/EDT)	2020-03-28 08:05	2020-03-28 15:35	2020-03-28 17:05	2020-03-28 20:05	2020-03-28 23:05
End Time (EST/EDT)	2020-03-28 15:30	2020-03-28 17:00	2020-03-28 20:00	2020-03-28 23:00	2020-03-29 03:00
Loc01					
Loc02					
Loc03					
Loc04					
Loc05					
Loc06					
Loc07					
Loc08					
Loc09					
Loc10					
Loc11					
Loc12					
Loc13					
Loc14					
Loc15					
Loc16					
Loc17					
Loc18					
Loc19					
Loc20					
Loc21					
Loc22					
Loc23	ND	ND	ND	ND	ND
Loc24					
Loc25					
Loc26					

Event #	<u>E9d</u>	<u>E9e</u>	<u>E9f</u>	<u>E9g</u>	<u>E9h</u>
Event Date	2020-03-28	2020-03-28	2020-03-28	2020-03-28	2020-03-28
Start Time (EST/EDT)	2020-03-28 08:05	2020-03-28 15:35	2020-03-28 17:05	2020-03-28 20:05	2020-03-28 23:05
End Time (EST/EDT)	2020-03-28 15:30	2020-03-28 17:00	2020-03-28 20:00	2020-03-28 23:00	2020-03-29 03:00
Loc27					
Loc28					
Loc29					
Loc30					
Loc31					
Loc32					
Loc33					
KAGC					
KPIT					
03049500				U	
03085734					

Event #	<u>E9i</u>
Event Date	2020-03-28
Start Time (EST/EDT)	2020-03-29 03:05
End Time (EST/EDT)	2020-03-29 10:00
Loc01	
Loc02	
Loc03	
Loc04	
Loc05	
Loc06	
Loc07	
Loc08	
Loc09	
Loc10	
Loc11	
Loc12	
Loc13	
Loc14	
Loc15	
Loc16	
Loc17	
Loc18	
Loc19	
Loc20	
Loc21	
Loc22	
Loc23	ND
Loc24	
Loc25	
Loc26	
Loc27	
Loc28	

Event #	<u>E9i</u>
Event Date	2020-03-28
Start Time (EST/EDT)	2020-03-29 03:05
End Time (EST/EDT)	2020-03-29 10:00
Loc29	
Loc30	
Loc31	
Loc32	
Loc33	
KAGC	
KPIT	
03049500	
03085734	

Appendix B - Gauge Statistical Criteria Exclusion Table

Reason	Explanation
Minimum Storm Total Threshold (MSTT)	The radar or gauge cumulative sum during the event or sub-event period was less than MSTT
Outlier Based on Mean Field Bias (OMFB)	The RG pair bias (G/R) was greater than three standard deviations from the mean bias (e.g. G>>R)
Outlier Based on Average Difference (OAD)	The RG pair average difference ((G-R)/G)) was greater than three standard deviations from the mean average difference (e.g. G<<R)

Event #	<u>E1</u>	<u>E2a</u>	<u>E2b</u>	<u>E2c</u>	<u>E2d</u>
Event Date	2020-03-02	2020-03-03 AM	2020-03-03 AM	2020-03-03 AM	2020-03-03 AM
Start Time (EST)	2020-03-02 11:05	2020-03-03 00:05	2020-03-03 07:35	2020-03-03 08:20	2020-03-03 08:50
End Time (EST)	2020-03-03 00:00	2020-03-03 07:30	2020-03-03 08:15	2020-03-03 08:45	2020-03-03 14:00
Source	KPBZ LII	KPBZ LII	KPBZ LII	KPBZ LII	KPBZ LII
Loc01		MSTT			
Loc02		MSTT			
Loc03		MSTT			
Loc04		MSTT		MSTT	
Loc05		MSTT			
Loc06		MSTT		MSTT	
Loc07		MSTT			
Loc08		MSTT			
Loc09		MSTT			
Loc10		MSTT			
Loc11		MSTT			
Loc12		MSTT			
Loc13		MSTT			
Loc14		MSTT			
Loc15					
Loc16		MSTT			
Loc17		MSTT			
Loc18	MSTT	MSTT		MSTT	
Loc19		MSTT			
Loc20		MSTT			
Loc21				MSTT	
Loc22	MSTT	MSTT		MSTT	
Loc23					
Loc24		MSTT			
Loc25		MSTT	MSTT		
Loc26	OAD	MSTT	MSTT		

Event #	<u>E1</u>	<u>E2a</u>	<u>E2b</u>	<u>E2c</u>	<u>E2d</u>
Event Date	2020-03-02	2020-03-03 AM	2020-03-03 AM	2020-03-03 AM	2020-03-03 AM
Start Time (EST)	2020-03-02 11:05	2020-03-03 00:05	2020-03-03 07:35	2020-03-03 08:20	2020-03-03 08:50
End Time (EST)	2020-03-03 00:00	2020-03-03 07:30	2020-03-03 08:15	2020-03-03 08:45	2020-03-03 14:00
Source	KPBZ LII	KPBZ LII	KPBZ LII	KPBZ LII	KPBZ LII
Loc27				MSTT	
Loc28		MSTT			
Loc29		MSTT		MSTT	
Loc30		MSTT		MSTT	
Loc31		MSTT			
Loc32		MSTT			
Loc33		MSTT	MSTT		
KAGC		MSTT			
KPIT	MSTT				
03049500		MSTT			
03085734		MSTT		MSTT	

Event #	<u>E3a</u>	<u>E3b</u>	<u>E4a</u>	<u>E4c</u>	<u>E5a</u>
Event Date	2020-03-03 PM	2020-03-03 PM	2020-03-10	2020-03-10	2020-03-18
Start Time (EST/EDT)	2020-03-03 14:05	2020-03-03 19:05	2020-03-10 01:05	2020-03-10 14:20	2020-03-18 14:05
End Time (EST/EDT)	2020-03-03 19:00	2020-03-03 23:00	2020-03-10 08:00	2020-03-10 18:00	2020-03-18 19:00
Source	KPBZ LII	KPBZ LII	KPBZ LII	KPBZ LII	KPBZ LII
Loc01		MSTT	MSTT		
Loc02		MSTT	MSTT		
Loc03		MSTT			
Loc04					
Loc05	MSTT	MSTT	MSTT		
Loc06	MSTT	MSTT			
Loc07		MSTT	MSTT		
Loc08		MSTT			
Loc09		MSTT			
Loc10		MSTT			
Loc11		MSTT	MSTT		
Loc12	MSTT	MSTT			
Loc13		MSTT	MSTT		
Loc14					
Loc15					
Loc16	MSTT	MSTT	MSTT		
Loc17	MSTT	MSTT			
Loc18	MSTT	MSTT			
Loc19		MSTT			
Loc20		MSTT	MSTT		
Loc21		MSTT			
Loc22		MSTT			
Loc23					
Loc24	MSTT	MSTT			MSTT

Event #	<u>E3a</u>	<u>E3b</u>	<u>E4a</u>	<u>E4c</u>	<u>E5a</u>
Event Date	2020-03-03 PM	2020-03-03 PM	2020-03-10	2020-03-10	2020-03-18
Start Time (EST/EDT)	2020-03-03 14:05	2020-03-03 19:05	2020-03-10 01:05	2020-03-10 14:20	2020-03-18 14:05
End Time (EST/EDT)	2020-03-03 19:00	2020-03-03 23:00	2020-03-10 08:00	2020-03-10 18:00	2020-03-18 19:00
Source	KPBZ LII	KPBZ LII	KPBZ LII	KPBZ LII	KPBZ LII
Loc25		MSTT	MSTT		
Loc26	OAD		MSTT		
Loc27					
Loc28		MSTT			
Loc29		MSTT			
Loc30		MSTT			
Loc31		MSTT			
Loc32		MSTT		OAD	
Loc33					
KAGC		MSTT	MSTT		
KPIT			MSTT		
03049500		MSTT		MSTT	
03085734		MSTT	MSTT		

Event #	<u>E5b</u>	<u>E5c</u>	<u>E5e</u>	<u>E6a</u>	<u>E6b</u>
Event Date	2020-03-18	2020-03-18	2020-03-18	2020-03-20	2020-03-20
Start Time (EDT)	2020-03-18 19:05	2020-03-18 21:20	2020-03-19 00:50	2020-03-19 16:05	2020-03-19 20:35
End Time (EDT)	2020-03-18 21:15	2020-03-18 23:00	2020-03-19 02:15	2020-03-19 20:30	2020-03-19 21:00
Source	KPBZ LII				
Loc01					
Loc02					
Loc03					
Loc04					
Loc05					
Loc06					
Loc07					
Loc08					
Loc09					
Loc10					
Loc11					
Loc12					
Loc13					
Loc14					
Loc15					
Loc16					
Loc17					
Loc18					
Loc19					
Loc20					
Loc21					MSTT
Loc22					
Loc23					
Loc24					
Loc25					

Event #	<u>E5b</u>	<u>E5c</u>	<u>E5e</u>	<u>E6a</u>	<u>E6b</u>
Event Date	2020-03-18	2020-03-18	2020-03-18	2020-03-20	2020-03-20
Start Time (EDT)	2020-03-18 19:05	2020-03-18 21:20	2020-03-19 00:50	2020-03-19 16:05	2020-03-19 20:35
End Time (EDT)	2020-03-18 21:15	2020-03-18 23:00	2020-03-19 02:15	2020-03-19 20:30	2020-03-19 21:00
Source	KPBZ LII				
Loc26					
Loc27					MSTT
Loc28					
Loc29			MSTT		MSTT
Loc30			MSTT		MSTT
Loc31					
Loc32			MSTT		
Loc33					
KAGC					
KPIT					MSTT
03049500			MSTT		
03085734					

Event #	E6c	E6d	E6e	E6f	E6g
Event Date	2020-03-20	2020-03-20	2020-03-20	2020-03-20	2020-03-20
Start Time (EDT)	2020-03-19 21:05	2020-03-19 22:05	2020-03-20 03:05	2020-03-20 04:35	2020-03-20 06:05
End Time (EDT)	2020-03-19 22:00	2020-03-20 03:00	2020-03-20 04:30	2020-03-20 06:00	2020-03-20 07:45
Source	KPBZ LII				
Loc01					
Loc02					
Loc03					
Loc04					
Loc05	MSTT				
Loc06	MSTT				
Loc07	MSTT				
Loc08	MSTT				
Loc09					
Loc10	MSTT				
Loc11	MSTT				
Loc12	MSTT	MSTT			
Loc13		MSTT			
Loc14			MSTT		
Loc15	MSTT	MSTT			
Loc16	MSTT	MSTT			
Loc17	MSTT				
Loc18	MSTT				
Loc19	MSTT				
Loc20			MSTT		
Loc21	MSTT				
Loc22	MSTT				
Loc23					
Loc24	MSTT	MSTT	MSTT		
Loc25	MSTT	MSTT	MSTT		

Event #	E6c	E6d	E6e	E6f	E6g
Event Date	2020-03-20	2020-03-20	2020-03-20	2020-03-20	2020-03-20
Start Time (EDT)	2020-03-19 21:05	2020-03-19 22:05	2020-03-20 03:05	2020-03-20 04:35	2020-03-20 06:05
End Time (EDT)	2020-03-19 22:00	2020-03-20 03:00	2020-03-20 04:30	2020-03-20 06:00	2020-03-20 07:45
Source	KPBZ LII				
Loc26	MSTT		MSTT		
Loc27	MSTT				
Loc28					
Loc29	MSTT				
Loc30	MSTT				
Loc31					
Loc32					
Loc33	MSTT				
KAGC	MSTT	MSTT			
KPIT	MSTT		MSTT		
03049500					
03085734					

Event #	E6h	E6i	E6i	E7a	E7b
Event Date	2020-03-20	2020-03-20	2020-03-20	2020-03-23	2020-03-23
Start Time (EDT)	2020-03-20 07:50	2020-03-20 09:05	2020-03-20 14:05	2020-03-23 01:05	2020-03-23 09:20
End Time (EDT)	2020-03-20 09:00	2020-03-20 14:00	2020-03-20 20:00	2020-03-23 09:15	2020-03-23 11:00
Source	KPBZ LII				
Loc01		MSTT		MSTT	
Loc02		MSTT		MSTT	
Loc03		MSTT		MSTT	
Loc04		MSTT		MSTT	
Loc05		MSTT	MSTT	MSTT	
Loc06			MSTT	MSTT	
Loc07			MSTT	MSTT	
Loc08			MSTT		
Loc09			MSTT		
Loc10			MSTT		
Loc11			MSTT		
Loc12		MSTT	MSTT		
Loc13		MSTT	MSTT		
Loc14			MSTT		
Loc15			MSTT	MSTT	
Loc16		MSTT	MSTT		
Loc17			MSTT	MSTT	
Loc18			MSTT	MSTT	
Loc19			MSTT		
Loc20			MSTT	MSTT	
Loc21				MSTT	
Loc22				MSTT	
Loc23					
Loc24			MSTT	MSTT	
Loc25			MSTT	MSTT	

Event #	<u>E6h</u>	<u>E6i</u>	<u>E6j</u>	<u>E7a</u>	<u>E7b</u>
Event Date	2020-03-20	2020-03-20	2020-03-20	2020-03-23	2020-03-23
Start Time (EDT)	2020-03-20 07:50	2020-03-20 09:05	2020-03-20 14:05	2020-03-23 01:05	2020-03-23 09:20
End Time (EDT)	2020-03-20 09:00	2020-03-20 14:00	2020-03-20 20:00	2020-03-23 09:15	2020-03-23 11:00
Source	KPBZ LII				
Loc26			MSTT	MSTT	
Loc27				MSTT	
Loc28			MSTT	MSTT	
Loc29				MSTT	
Loc30				MSTT	
Loc31			MSTT	MSTT	
Loc32		MSTT	MSTT		
Loc33					
KAGC		MSTT	MSTT		
KPIT				MSTT	
03049500					
03085734		MSTT		MSTT	

Event #	<u>E7c</u>	<u>E8a</u>	<u>E8b</u>	<u>E9a</u>	<u>E9b</u>
Event Date	2020-03-23	2020-03-25	2020-03-25	2020-03-28	2020-03-28
Start Time (EDT)	2020-03-23 11:05	2020-03-24 21:05	2020-03-25 04:35	2020-03-27 20:05	2020-03-28 00:05
End Time (EDT)	2020-03-23 13:15	2020-03-25 04:30	2020-03-25 10:00	2020-03-28 00:00	2020-03-28 04:00
Source	KPBZ LII				
Loc01					
Loc02					
Loc03					
Loc04					
Loc05					
Loc06					
Loc07	MSTT				
Loc08					
Loc09		MSTT			
Loc10					
Loc11		MSTT			
Loc12					
Loc13		MSTT			
Loc14		MSTT			
Loc15		MSTT			
Loc16		MSTT			
Loc17	MSTT				
Loc18					
Loc19					
Loc20		MSTT			
Loc21	MSTT		MSTT		
Loc22	MSTT	MSTT			
Loc23					
Loc24					
Loc25		MSTT			

Event #	<u>E7c</u>	<u>E8a</u>	<u>E8b</u>	<u>E9a</u>	<u>E9b</u>
Event Date	2020-03-23	2020-03-25	2020-03-25	2020-03-28	2020-03-28
Start Time (EDT)	2020-03-23 11:05	2020-03-24 21:05	2020-03-25 04:35	2020-03-27 20:05	2020-03-28 00:05
End Time (EDT)	2020-03-23 13:15	2020-03-25 04:30	2020-03-25 10:00	2020-03-28 00:00	2020-03-28 04:00
Source	KPBZ LII				
Loc26		MSTT			
Loc27	MSTT			MSTT	
Loc28				MSTT	
Loc29	MSTT		MSTT	MSTT	
Loc30	MSTT		MSTT	MSTT	
Loc31				MSTT	
Loc32		OAD		MSTT	
Loc33	MSTT			MSTT	
KAGC					
KPIT	MSTT		MSTT		
03049500				MSTT	
03085734	MSTT		MSTT	MSTT	

Event #	<u>E9c</u>	<u>E9d</u>	<u>E9e</u>	<u>E9f</u>	<u>E9g</u>
Event Date	2020-03-28	2020-03-28	2020-03-28	2020-03-28	2020-03-28
Start Time (EDT)	2020-03-28 04:05	2020-03-28 08:05	2020-03-28 15:35	2020-03-28 17:05	2020-03-28 20:05
End Time (EDT)	2020-03-28 08:00	2020-03-28 15:30	2020-03-28 17:00	2020-03-28 20:00	2020-03-28 23:00
Source	KPBZ LII				
Loc01					
Loc02		MSTT			
Loc03					
Loc04					
Loc05		MSTT			
Loc06		MSTT			
Loc07		MSTT			
Loc08					
Loc09					
Loc10					
Loc11		MSTT			
Loc12		MSTT			
Loc13		MSTT			
Loc14					
Loc15		MSTT			
Loc16		MSTT			
Loc17		MSTT			
Loc18		MSTT			
Loc19					
Loc20					
Loc21					
Loc22		MSTT			
Loc23					
Loc24					
Loc25			OAD		

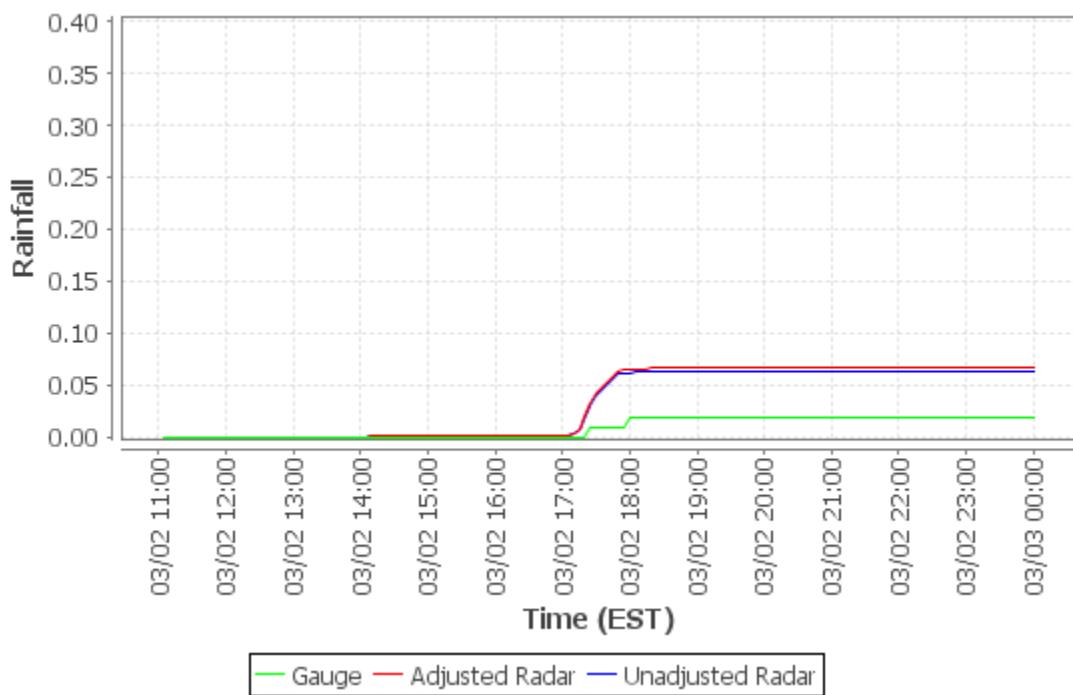
Event #	E9c	E9d	E9e	E9f	E9g
Event Date	2020-03-28	2020-03-28	2020-03-28	2020-03-28	2020-03-28
Start Time (EDT)	2020-03-28 04:05	2020-03-28 08:05	2020-03-28 15:35	2020-03-28 17:05	2020-03-28 20:05
End Time (EDT)	2020-03-28 08:00	2020-03-28 15:30	2020-03-28 17:00	2020-03-28 20:00	2020-03-28 23:00
Source	KPBZ LII				
Loc26		MSTT			
Loc27					
Loc28					
Loc29					
Loc30					MSTT
Loc31					
Loc32					
Loc33					
KAGC		MSTT			
KPIT					
03049500					
03085734					

Event #	<u>E9h</u>	<u>E9i</u>
Event Date	2020-03-28	2020-03-28
Start Time (EDT)	2020-03-28 23:05	2020-03-29 03:05
End Time (EDT)	2020-03-29 03:00	2020-03-29 10:00
Source	KPBZ LII	KPBZ LII
Loc01		
Loc02		
Loc03		
Loc04		MSTT
Loc05		MSTT
Loc06		MSTT
Loc07		MSTT
Loc08		MSTT
Loc09		MSTT
Loc10		MSTT
Loc11		MSTT
Loc12		MSTT
Loc13		MSTT
Loc14		MSTT
Loc15		MSTT
Loc16		MSTT
Loc17		MSTT
Loc18		
Loc19		MSTT
Loc20		MSTT
Loc21		
Loc22		MSTT
Loc23		
Loc24		MSTT
Loc25		MSTT
Loc26		MSTT
Loc27		MSTT

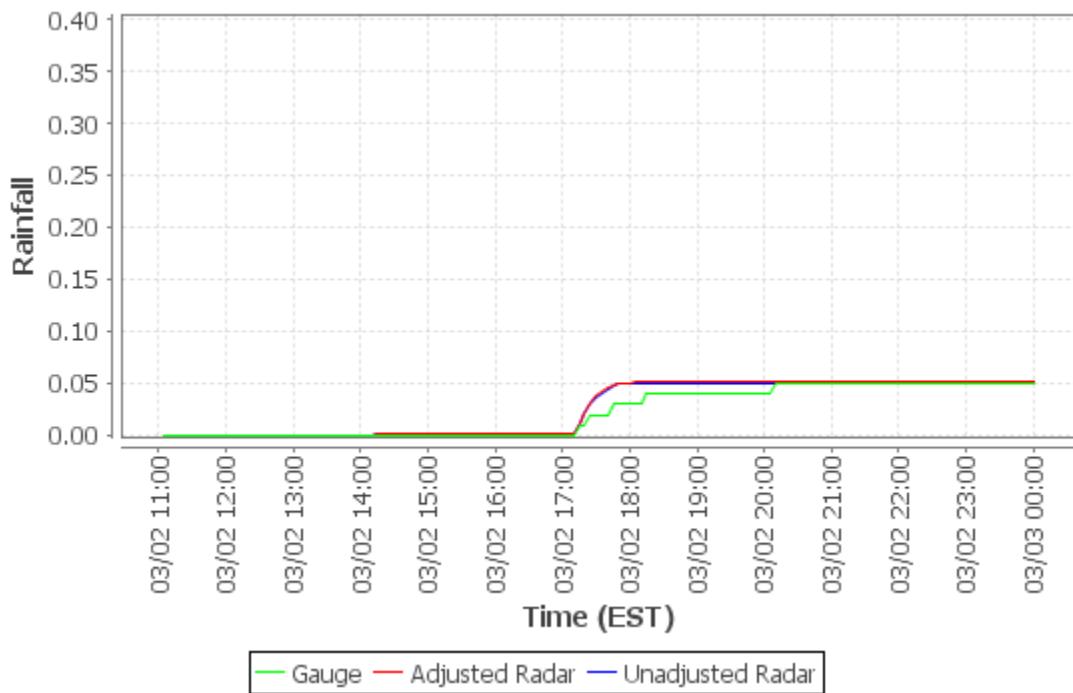
Event #	E9h	E9i
Event Date	2020-03-28	2020-03-28
Start Time (EDT)	2020-03-28 23:05	2020-03-29 03:05
End Time (EDT)	2020-03-29 03:00	2020-03-29 10:00
Source	KPBZ LII	KPBZ LII
Loc28		MSTT
Loc29		
Loc30		MSTT
Loc31		
Loc32		MSTT
Loc33		MSTT
KAGC		MSTT
KPIT		MSTT
03049500		MSTT
03085734		MSTT

Appendix C - Event 1 (2020-03-02) CDPs

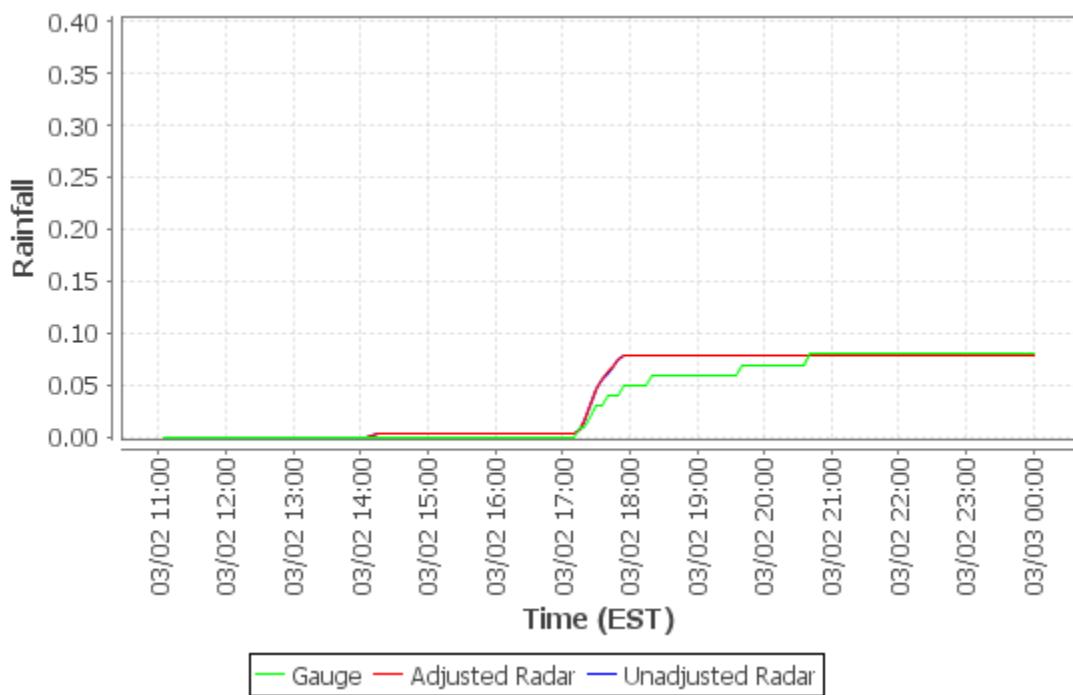
Cumulative Distribution Plot - PWSA-Montana St. (Loc01)



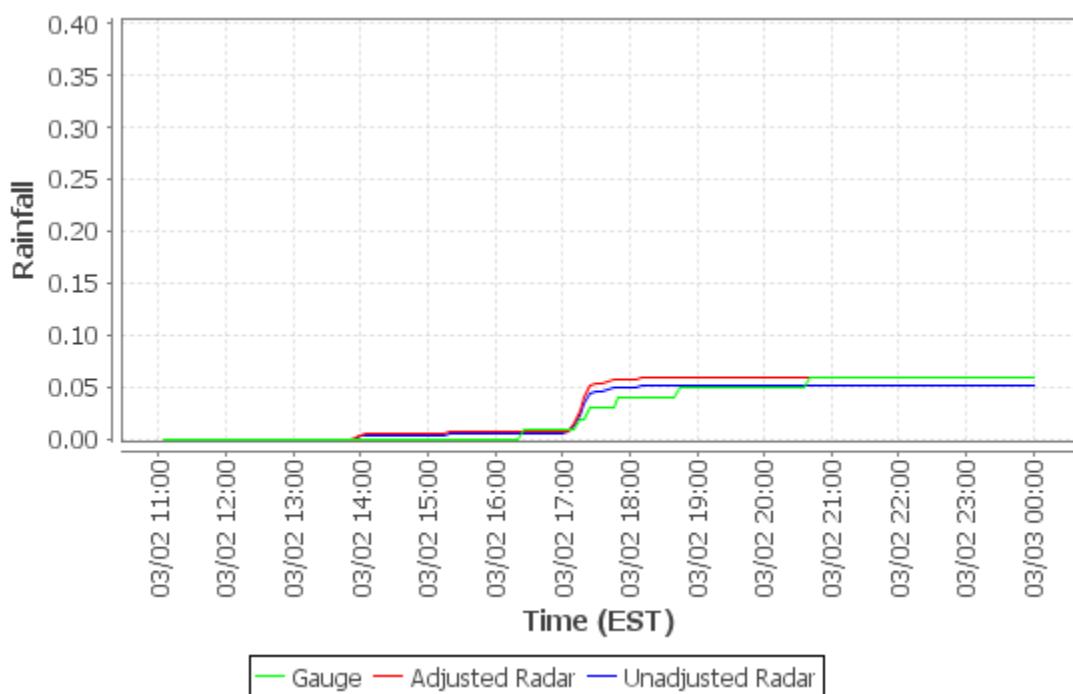
Cumulative Distribution Plot - ALCOSAN WWTP Lab (Loc02)



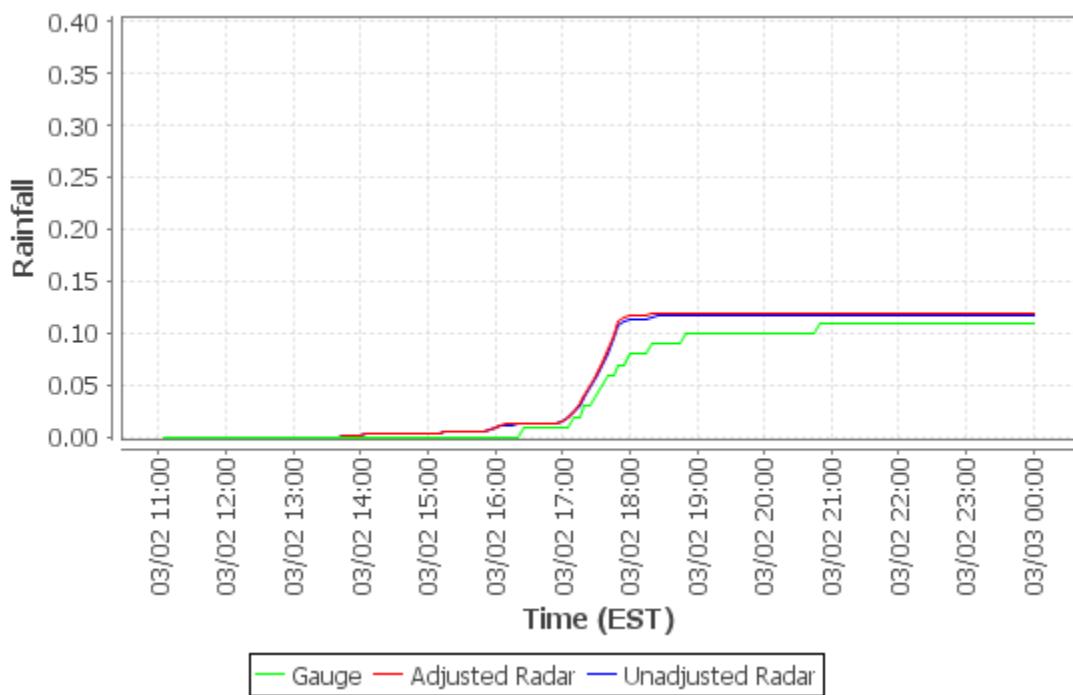
Cumulative Distribution Plot - Shaler Munic Bldg (Loc03)



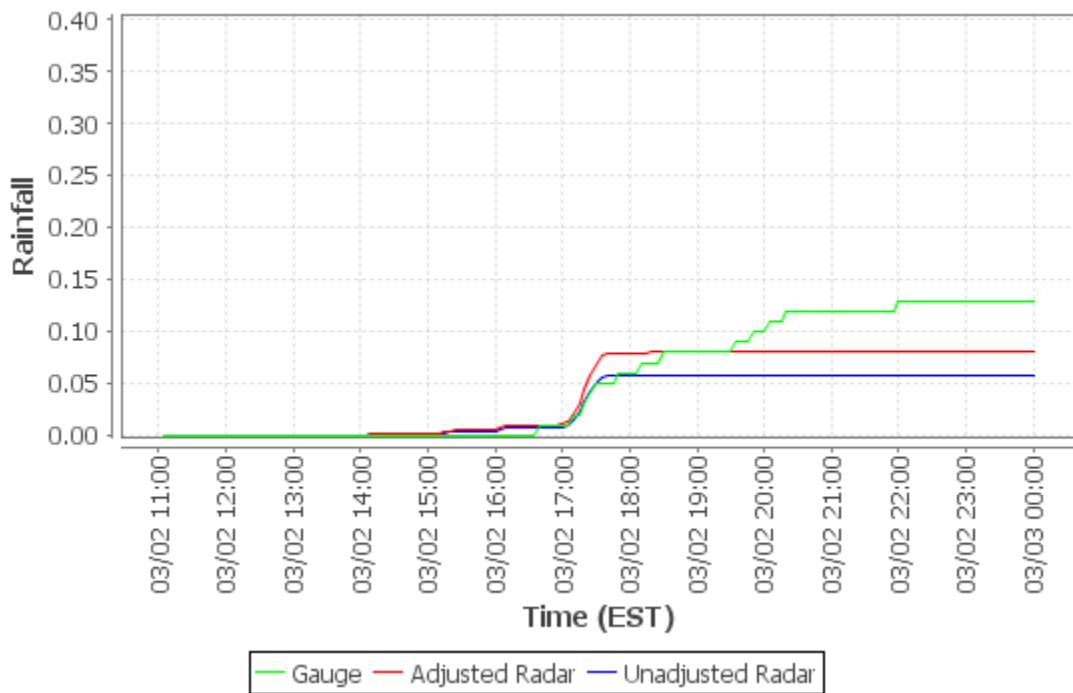
Cumulative Distribution Plot - Kennedy Twp PS (Loc04)



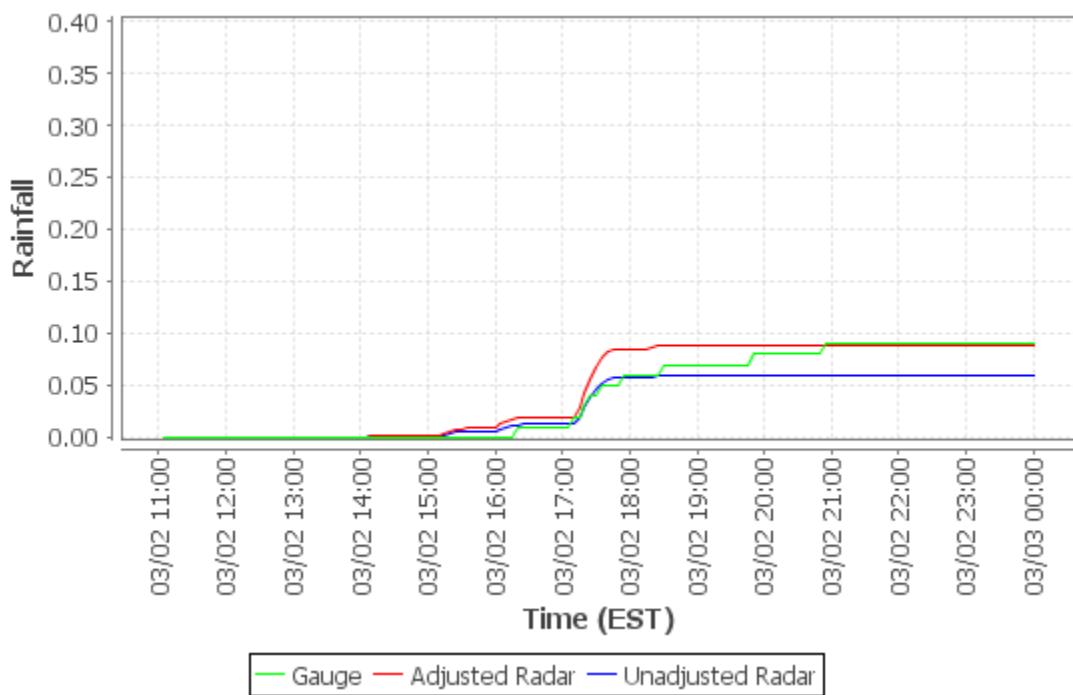
Cumulative Distribution Plot - Upper St. Clair (Loc05)



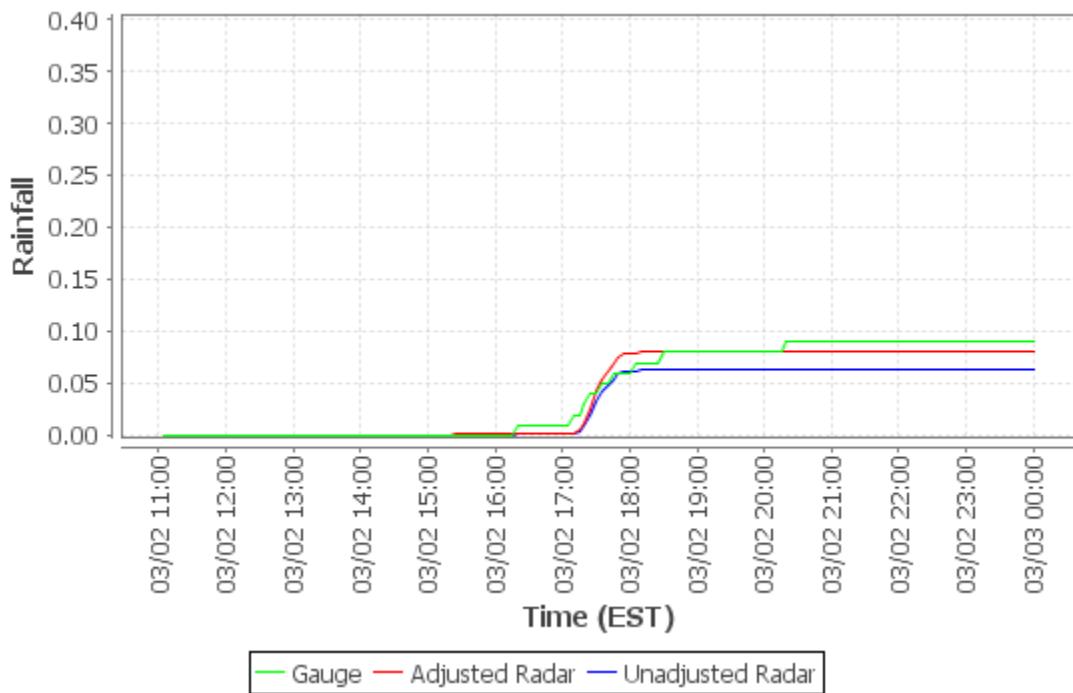
Cumulative Distribution Plot - Carnegie Transit Time (Loc06)



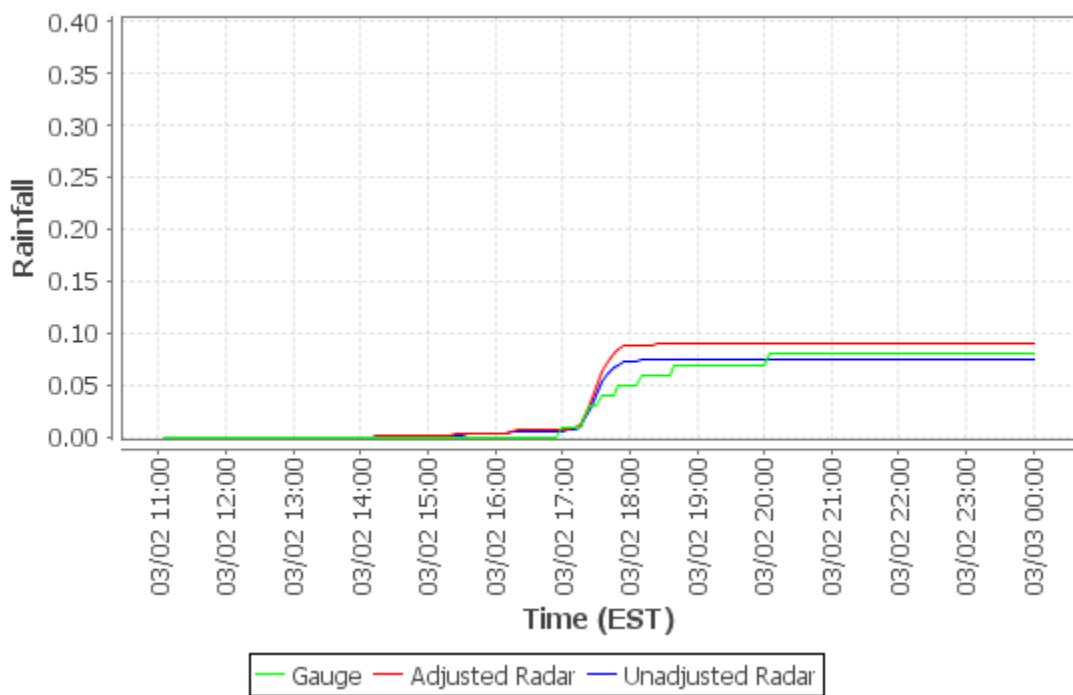
Cumulative Distribution Plot - Greentree Munic Bldg (Loc07)



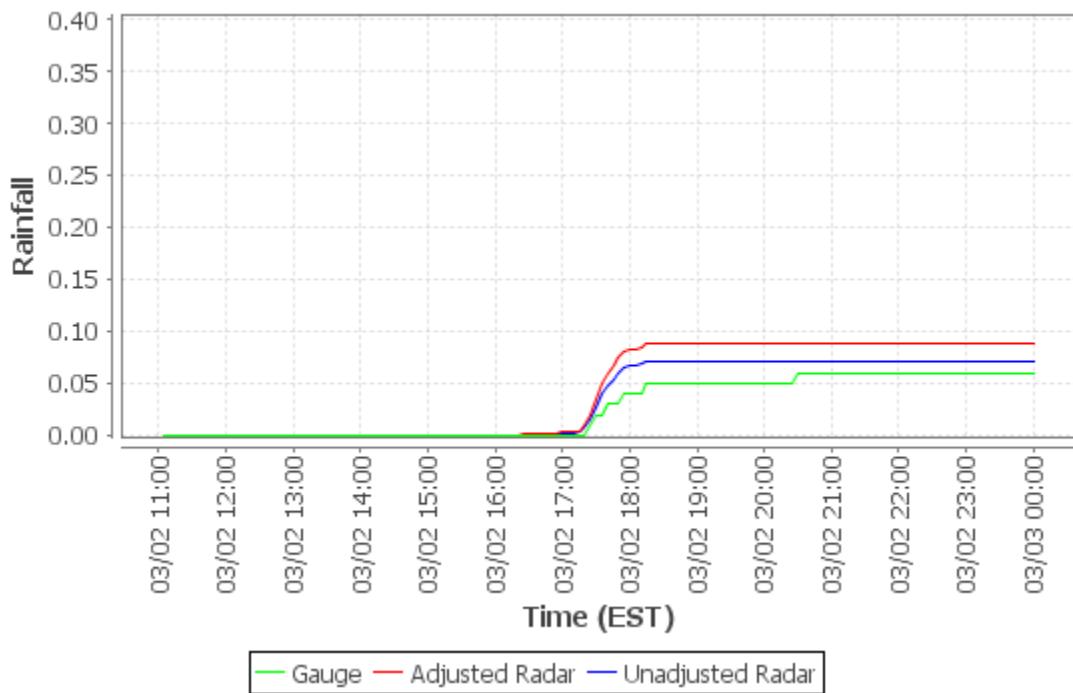
Cumulative Distribution Plot - AC Health Dept Bldg (Loc08)



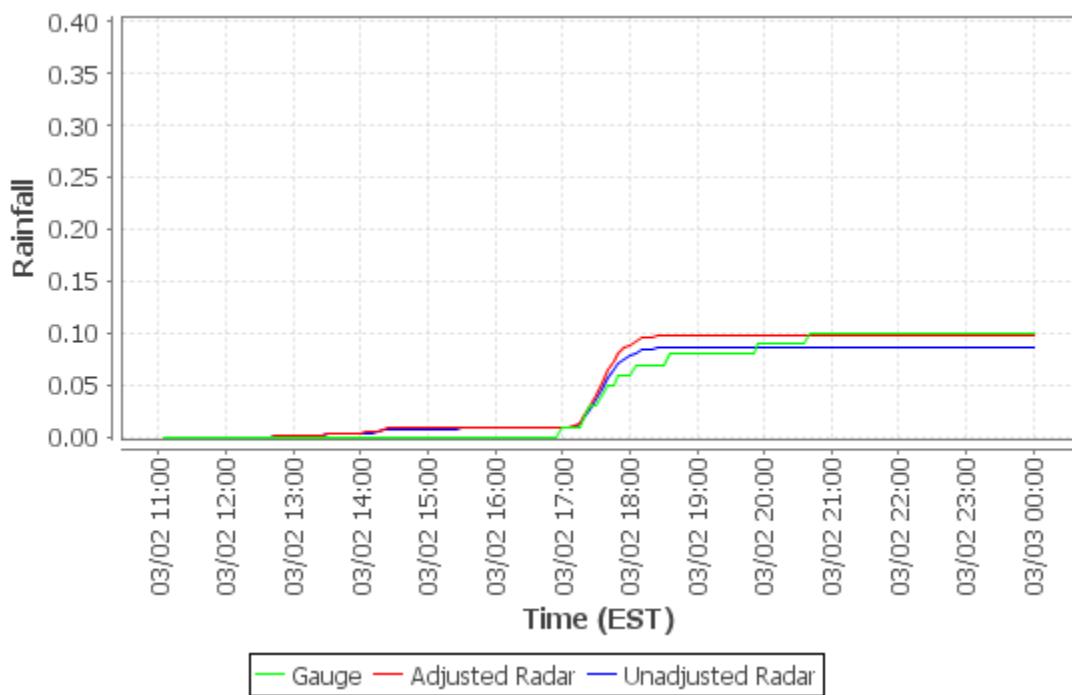
Cumulative Distribution Plot - Univ of Pittsburgh (Loc09)



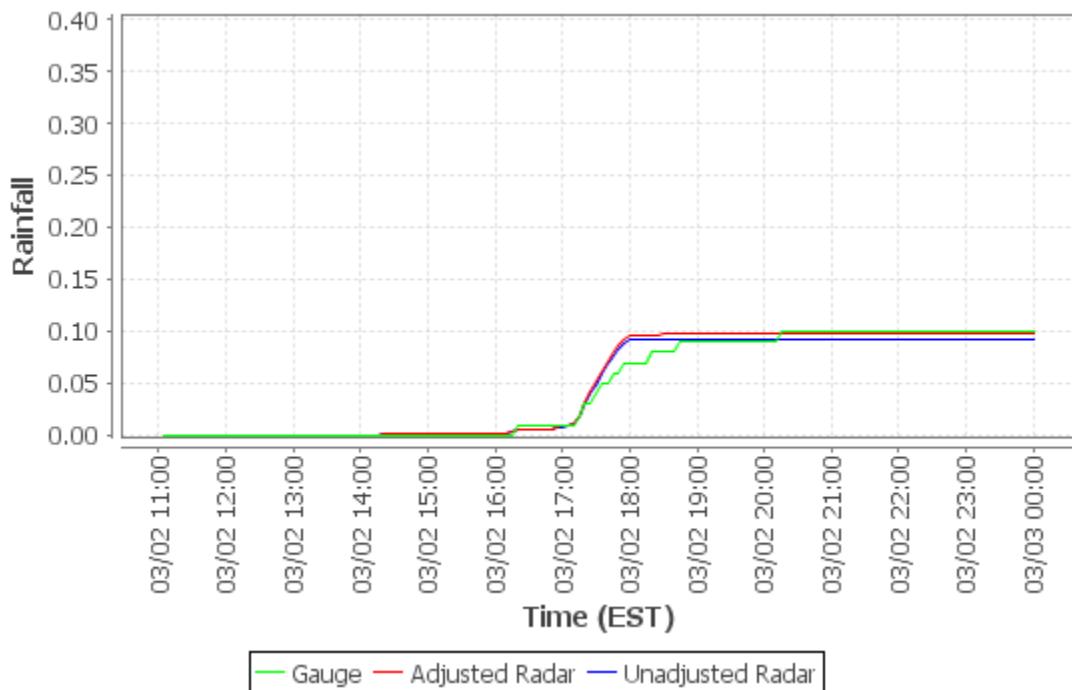
Cumulative Distribution Plot - PWSA-Highland Park (Loc10)



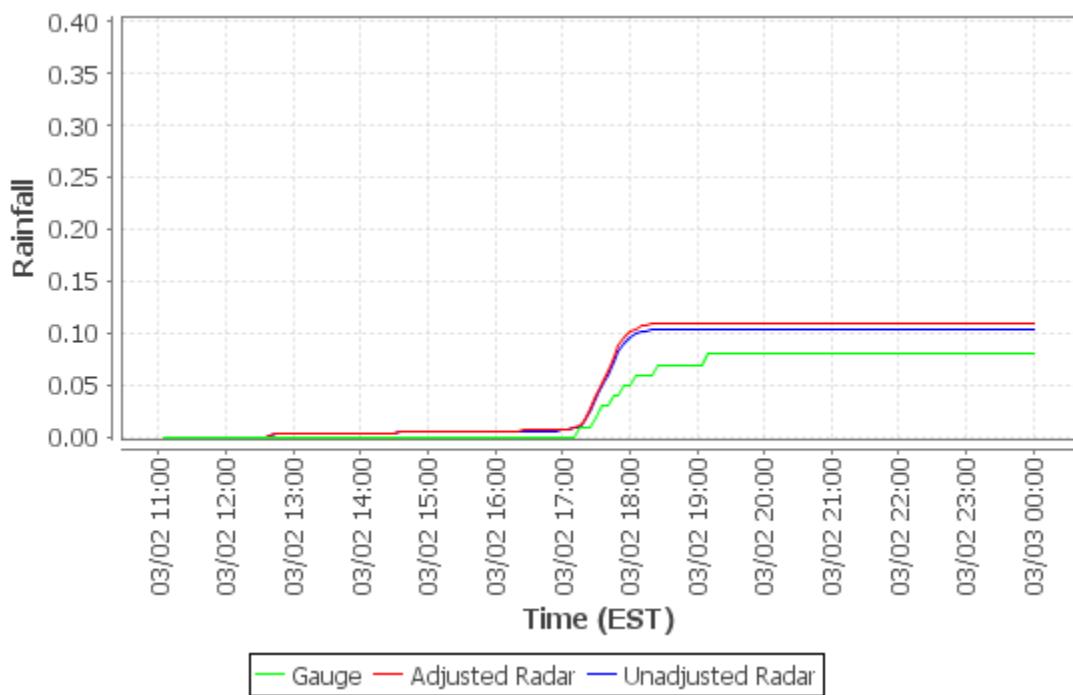
Cumulative Distribution Plot - M-46 Access Shaft (Loc11)



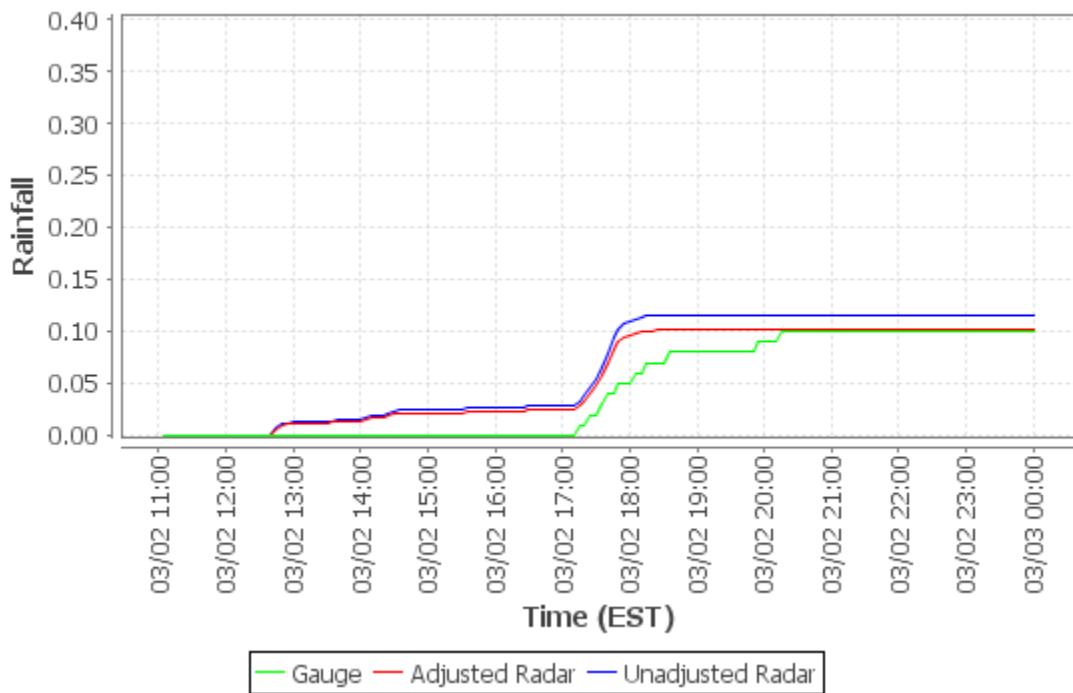
Cumulative Distribution Plot - Baldwin (Loc12)



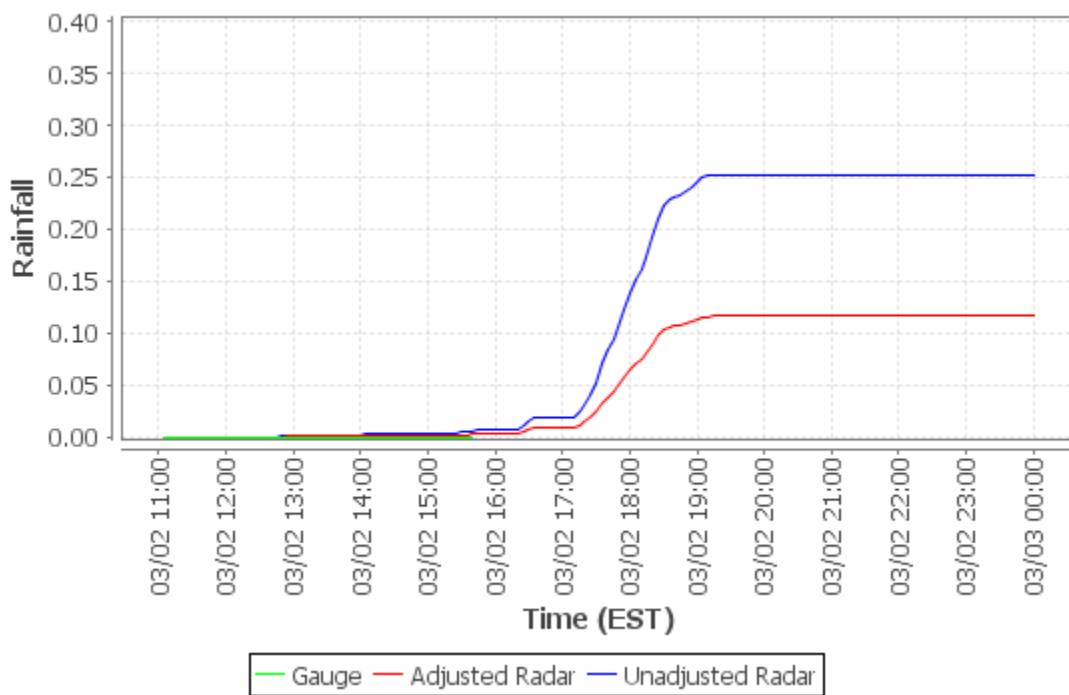
Cumulative Distribution Plot - M-59 Access Shaft (Loc13)



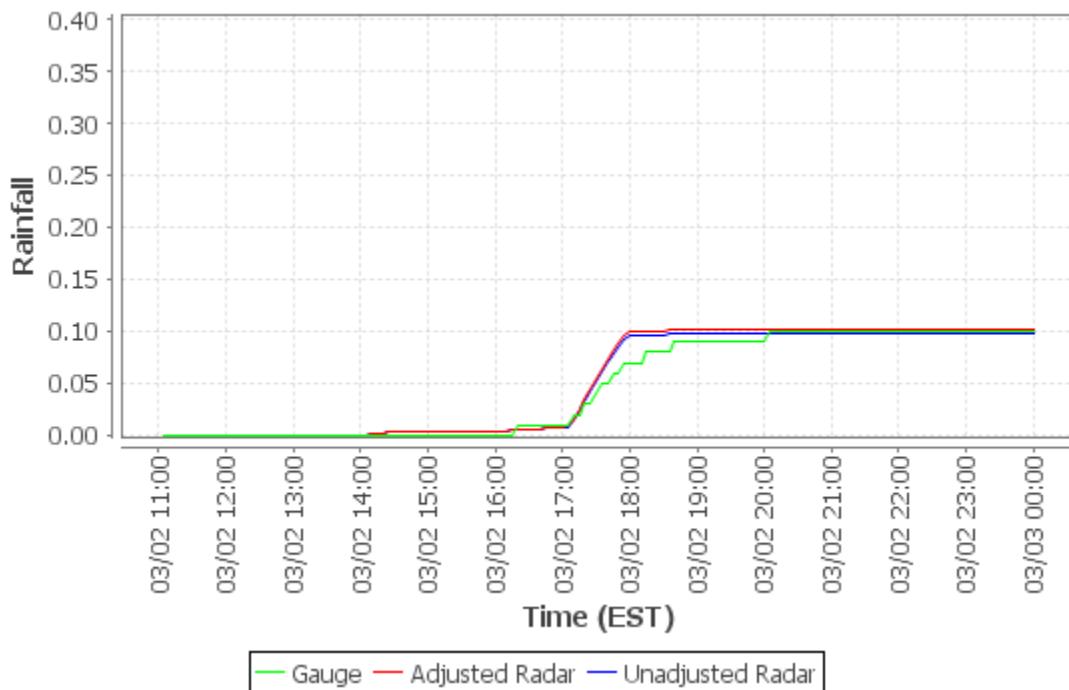
Cumulative Distribution Plot - Churchill Munic Bldg (Loc14)



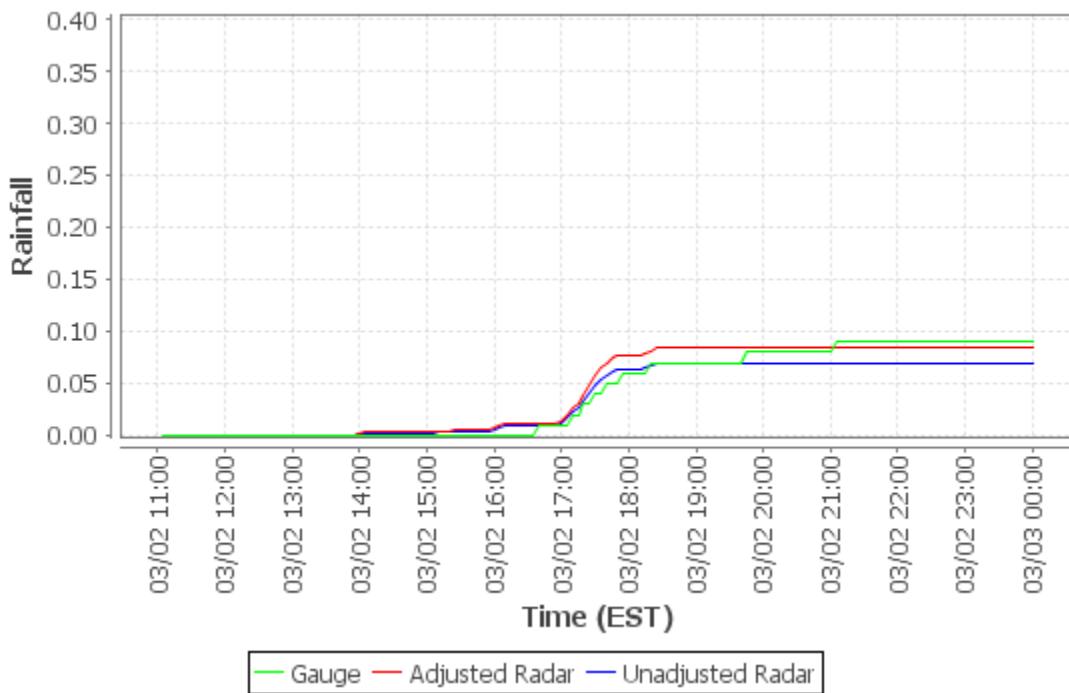
Cumulative Distribution Plot - Trafford Maint Bldg (Loc15)



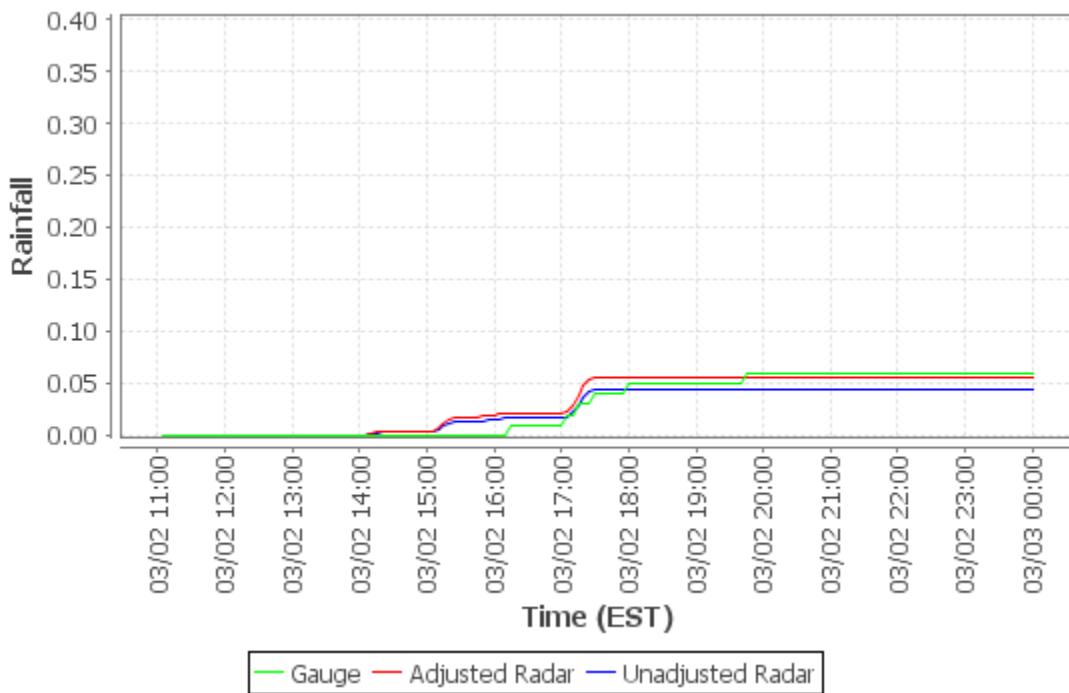
Cumulative Distribution Plot - Castle Shannon (Loc16)



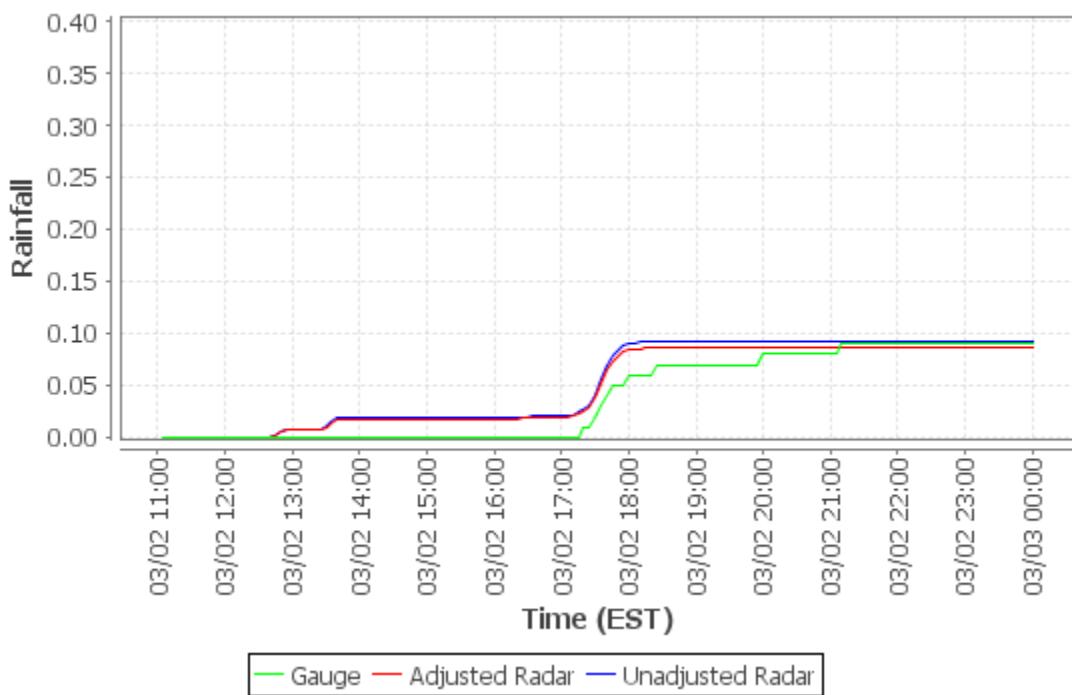
Cumulative Distribution Plot - Chartiers Pump Station (Loc17)



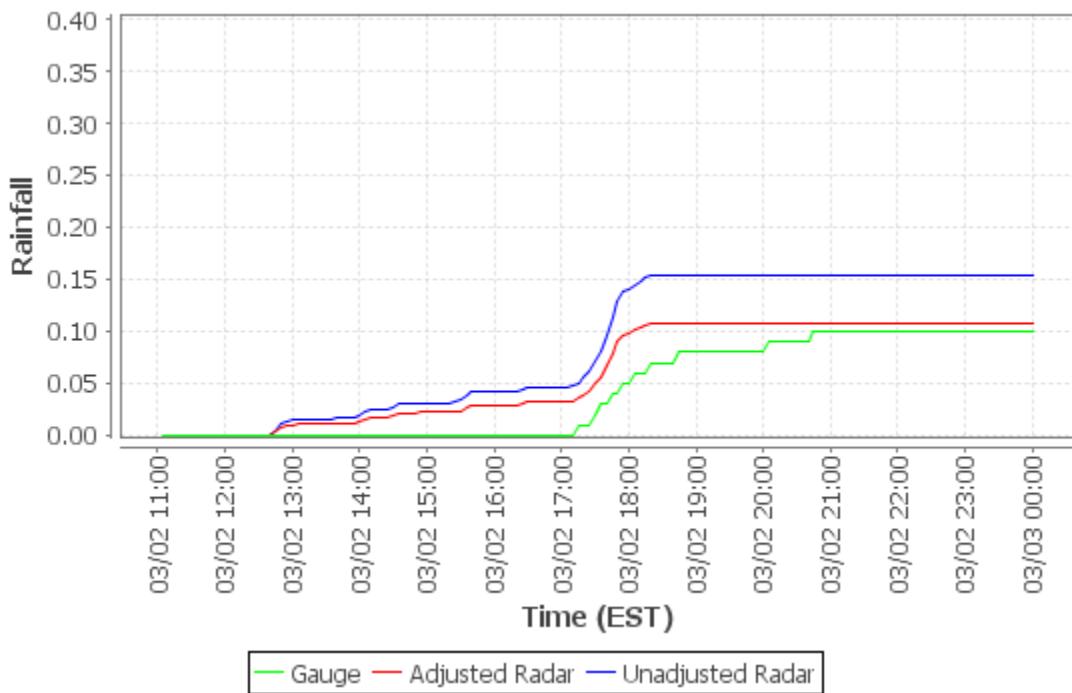
Cumulative Distribution Plot - Oakdale Pump Station (Loc18)



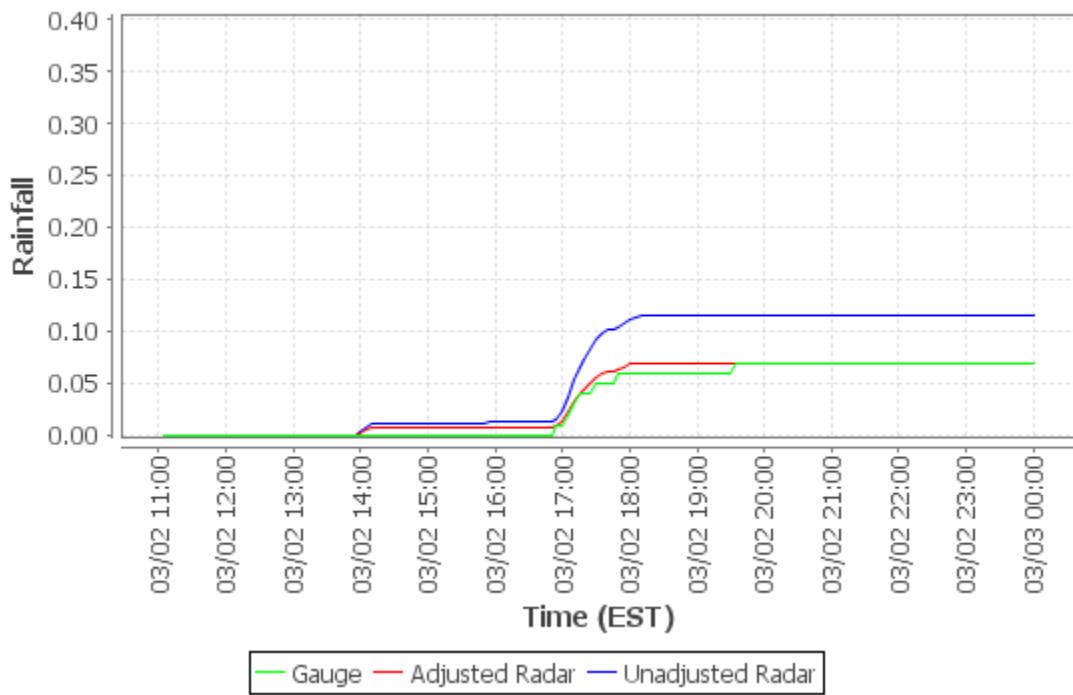
Cumulative Distribution Plot - Sandy Creek Eq Facility (Loc19)



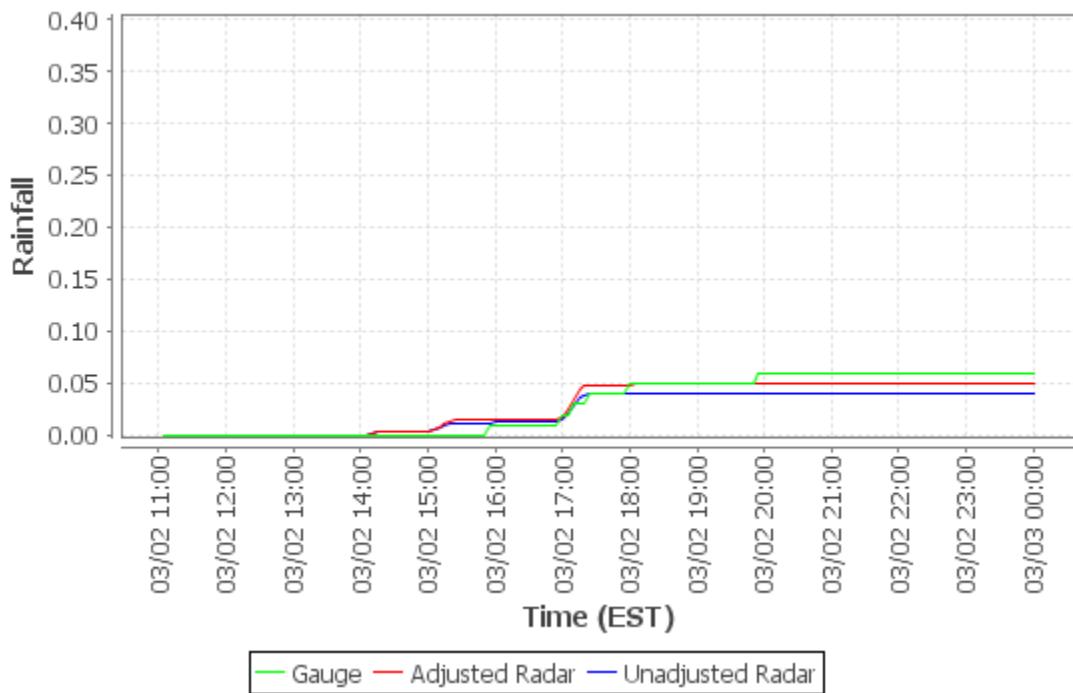
Cumulative Distribution Plot - Gascola Eq Facility (Loc20)



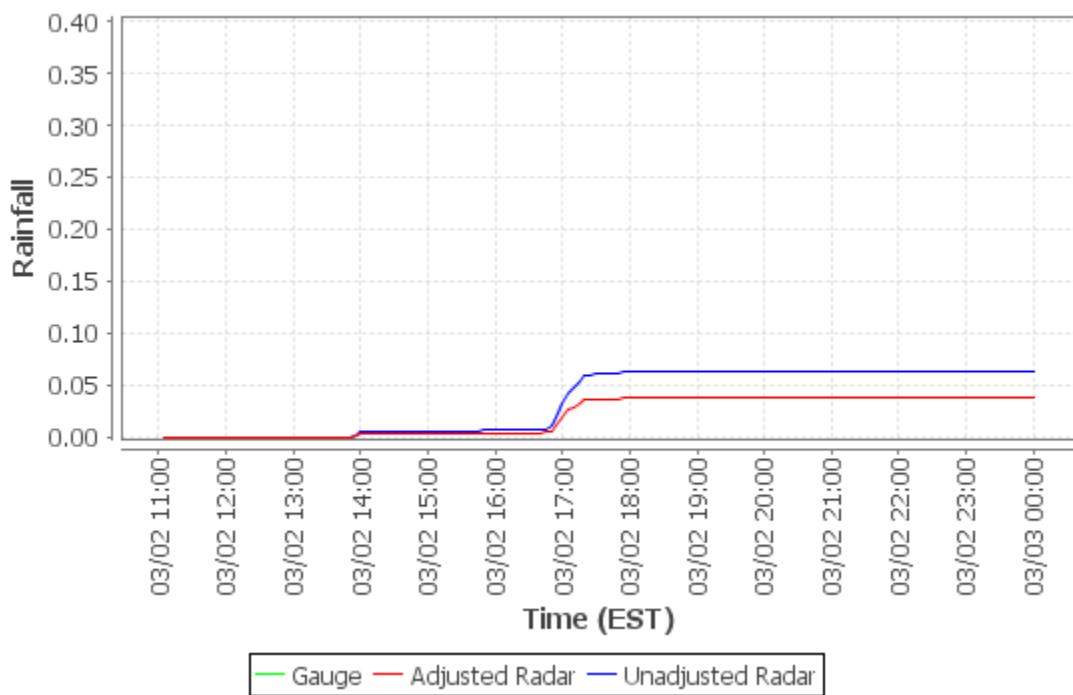
Cumulative Distribution Plot - Moon TWP (Loc21)



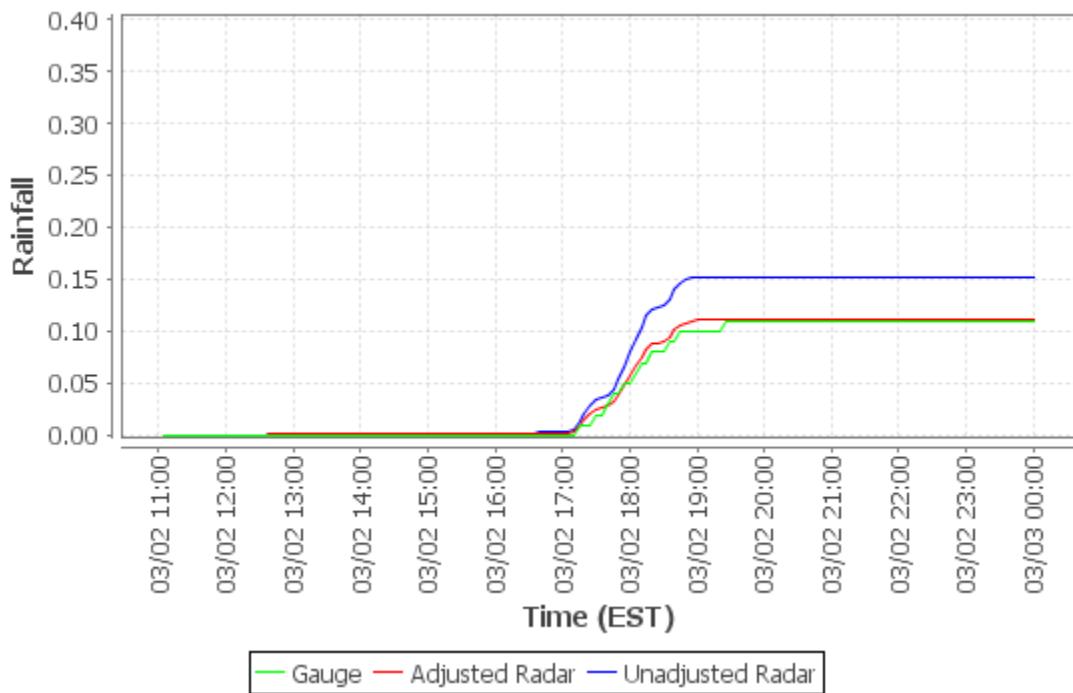
Cumulative Distribution Plot - North Fayette TWP (Loc22)



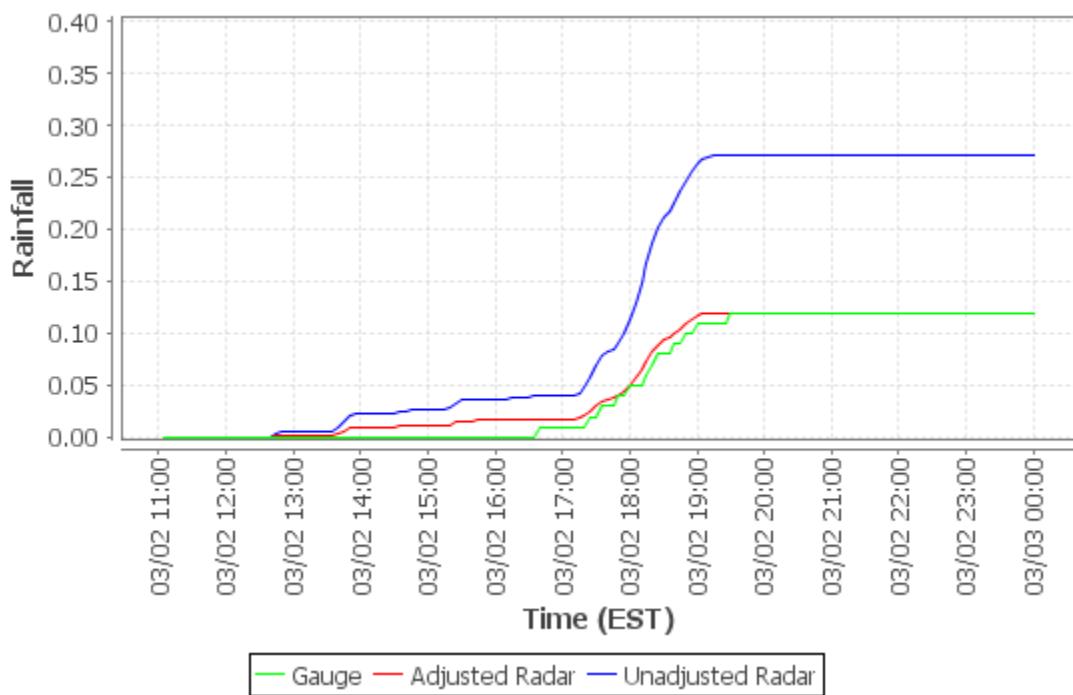
Cumulative Distribution Plot - Clinton Munic Bldg (Loc23)



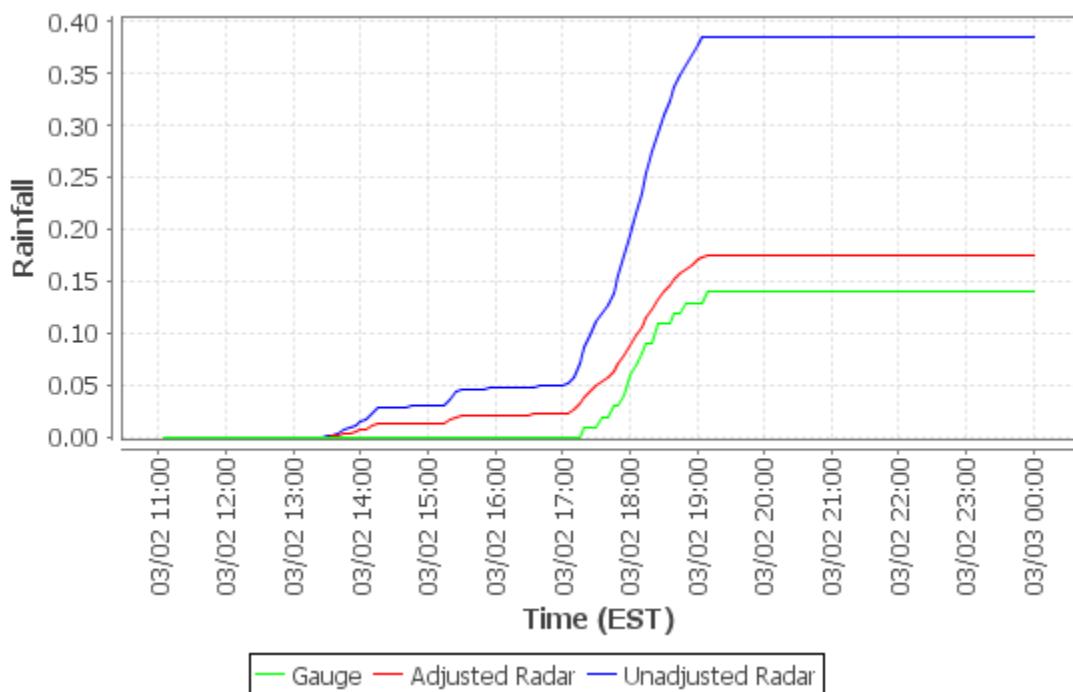
Cumulative Distribution Plot - Jefferson Hills (Loc24)



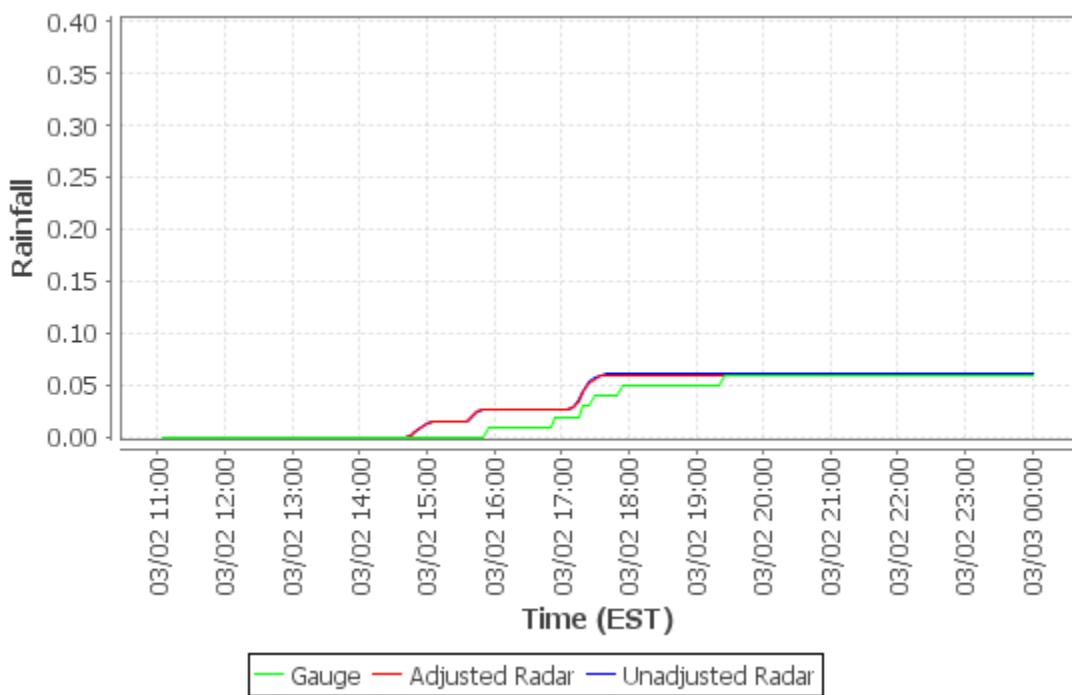
Cumulative Distribution Plot - White Oak Public Works Bldg (Loc25)



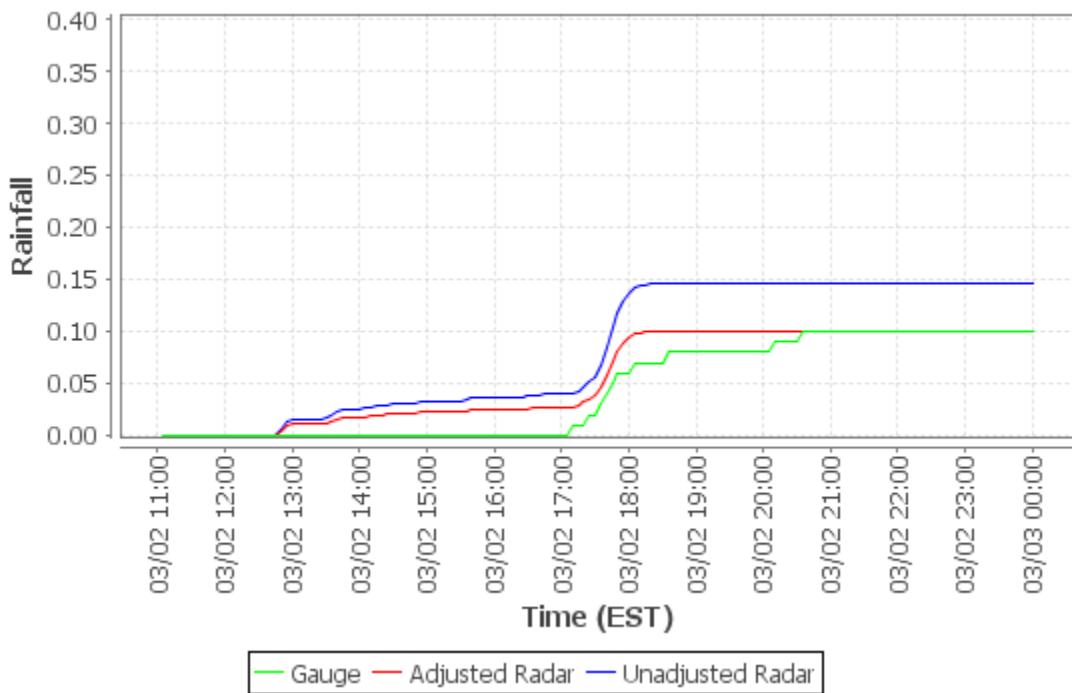
Cumulative Distribution Plot - Elizabeth TWP Municipal Bldg (Loc26)



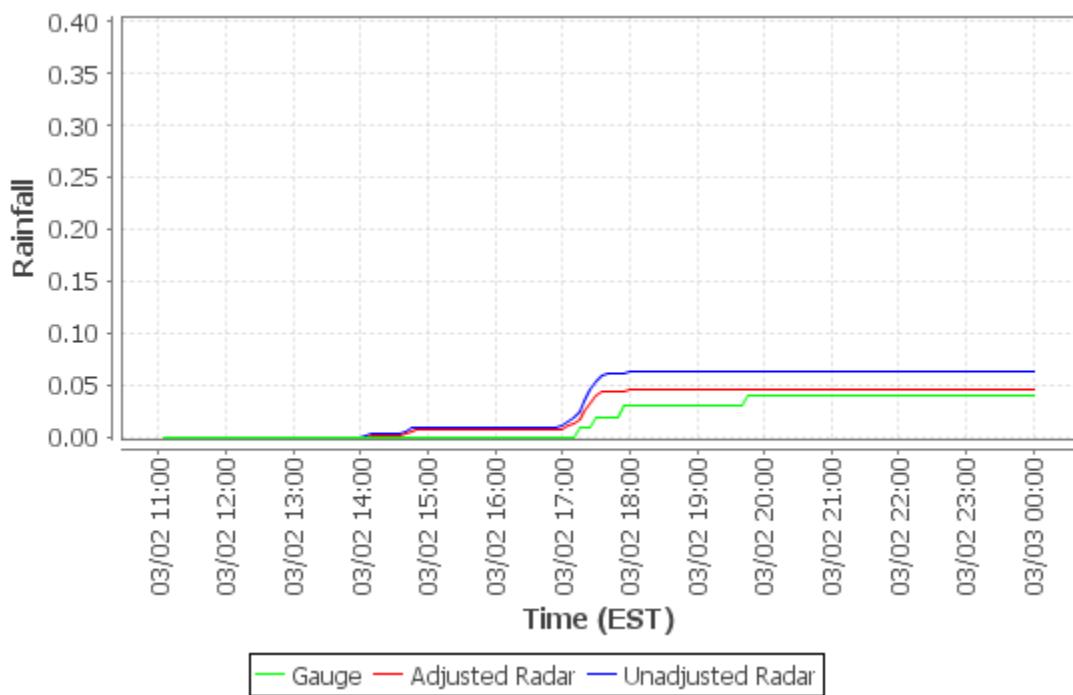
Cumulative Distribution Plot - Marshall TWP (Loc27)



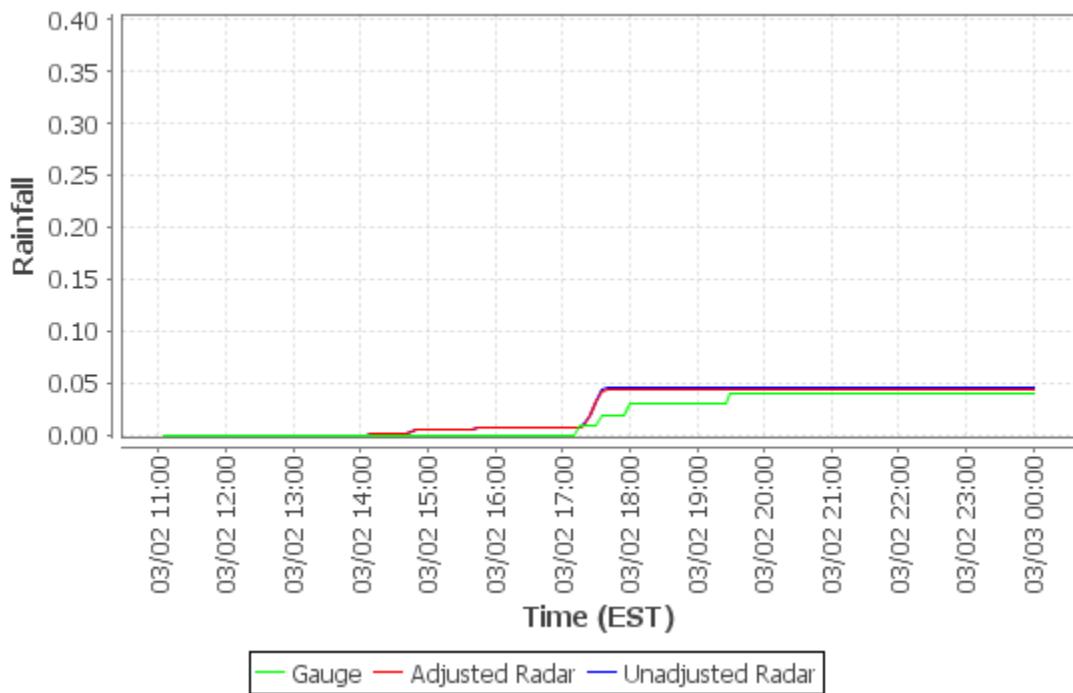
Cumulative Distribution Plot - Plum Municipal Bldg (Loc28)



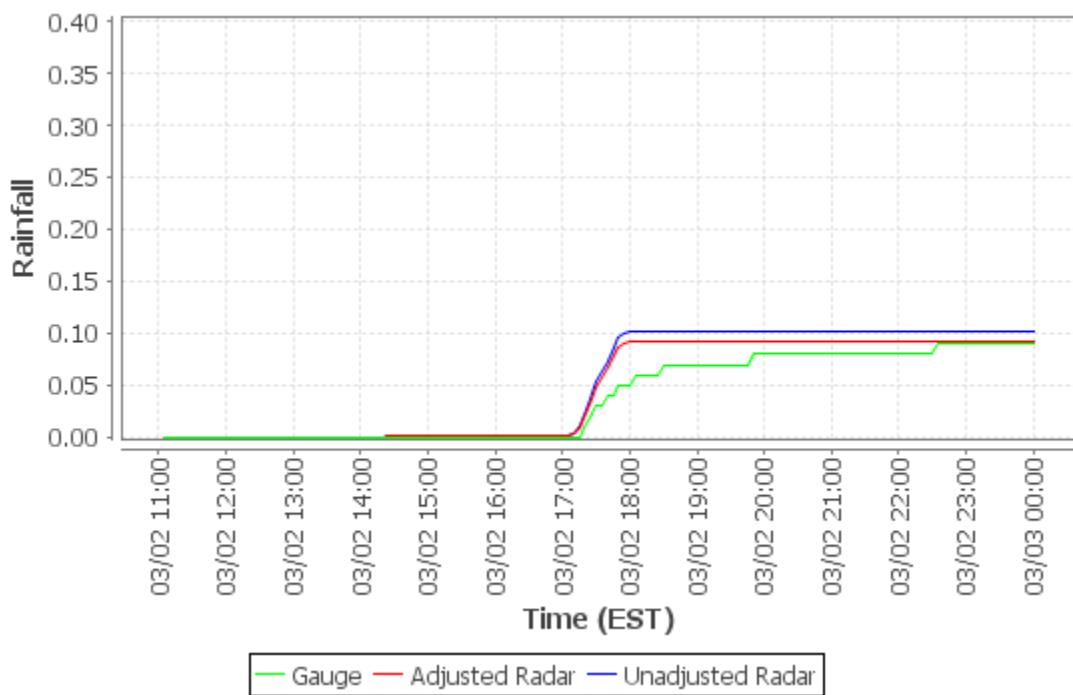
Cumulative Distribution Plot - Bell Acres Munic Bldg (Loc29)



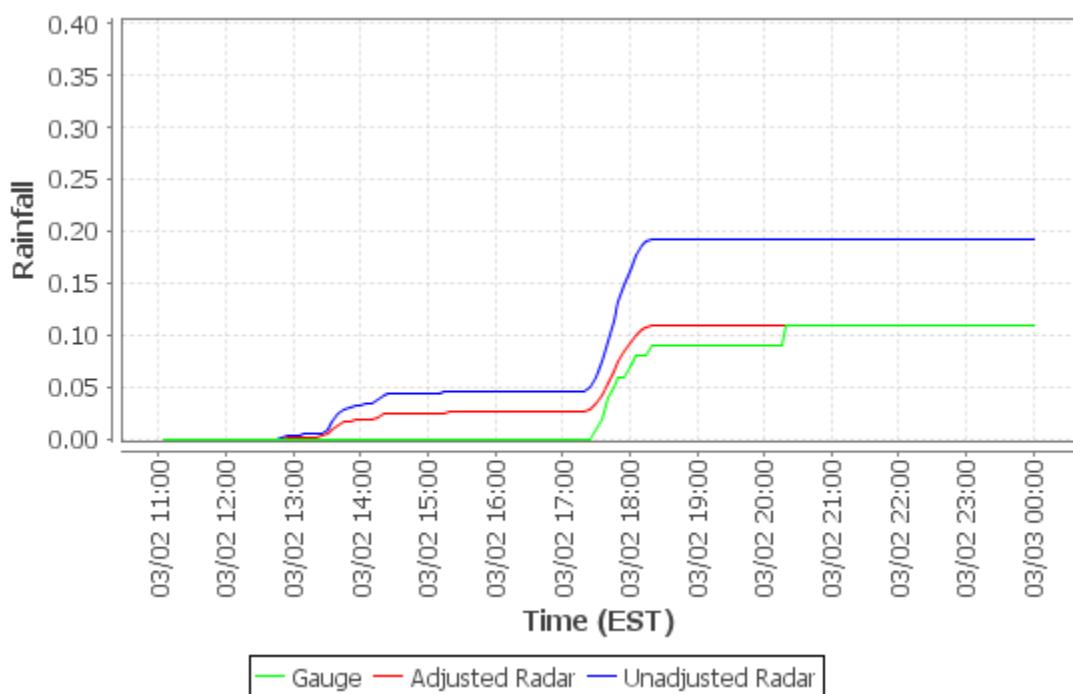
Cumulative Distribution Plot - McCandless Twn Hall (Loc30)



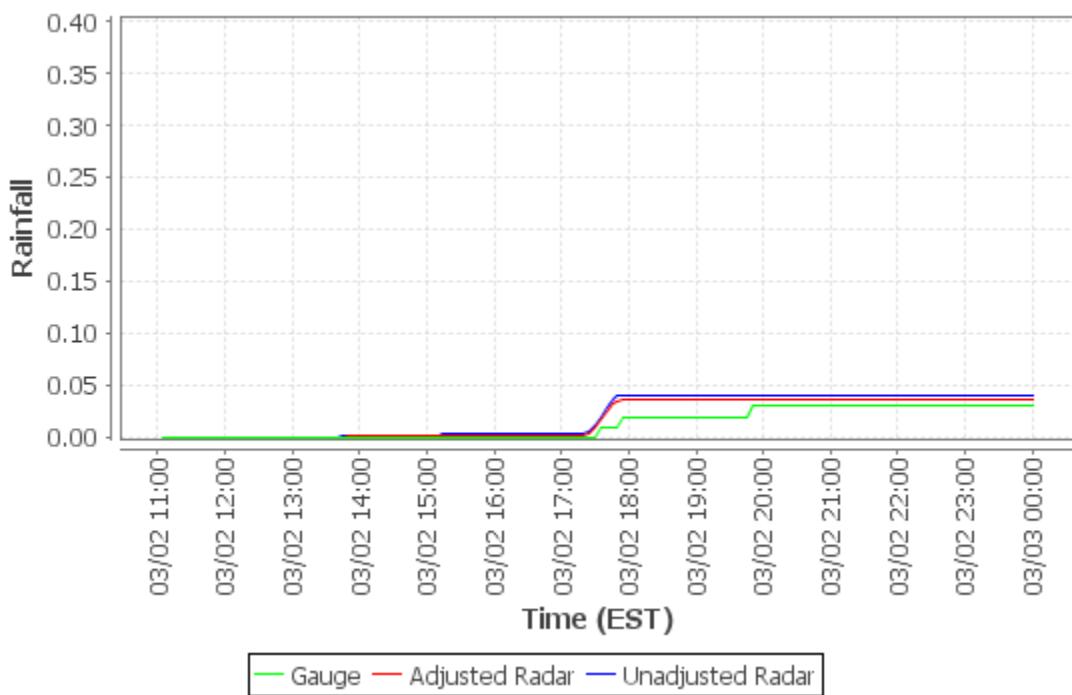
Cumulative Distribution Plot - Hampton Municipal Bldg (Loc31)



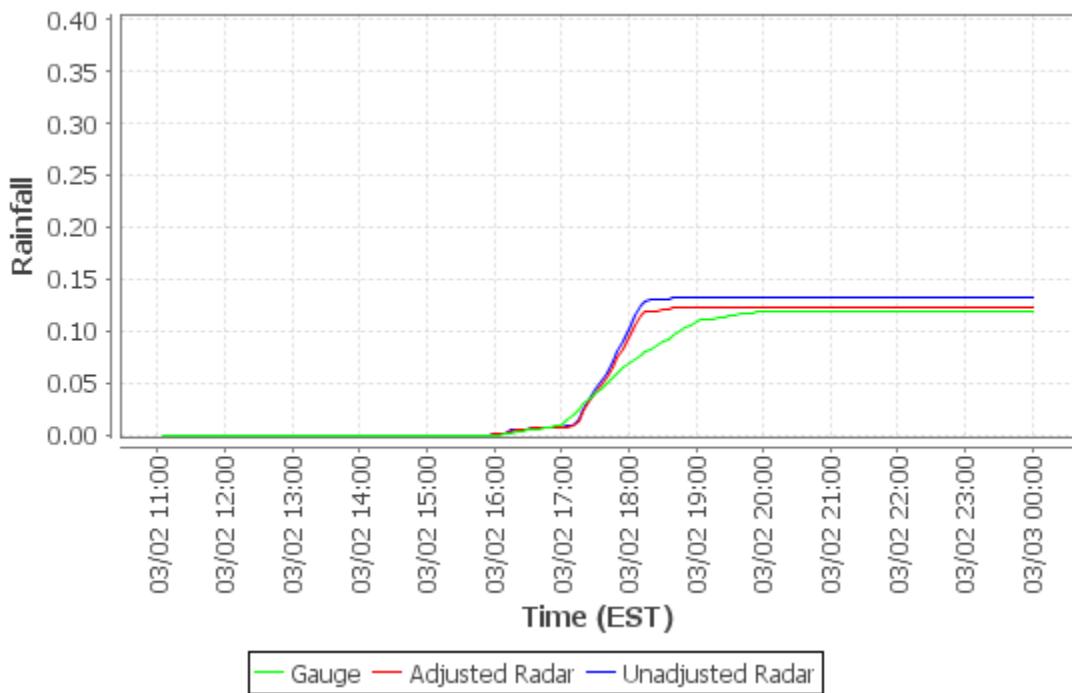
Cumulative Distribution Plot - Arnold (Loc32)



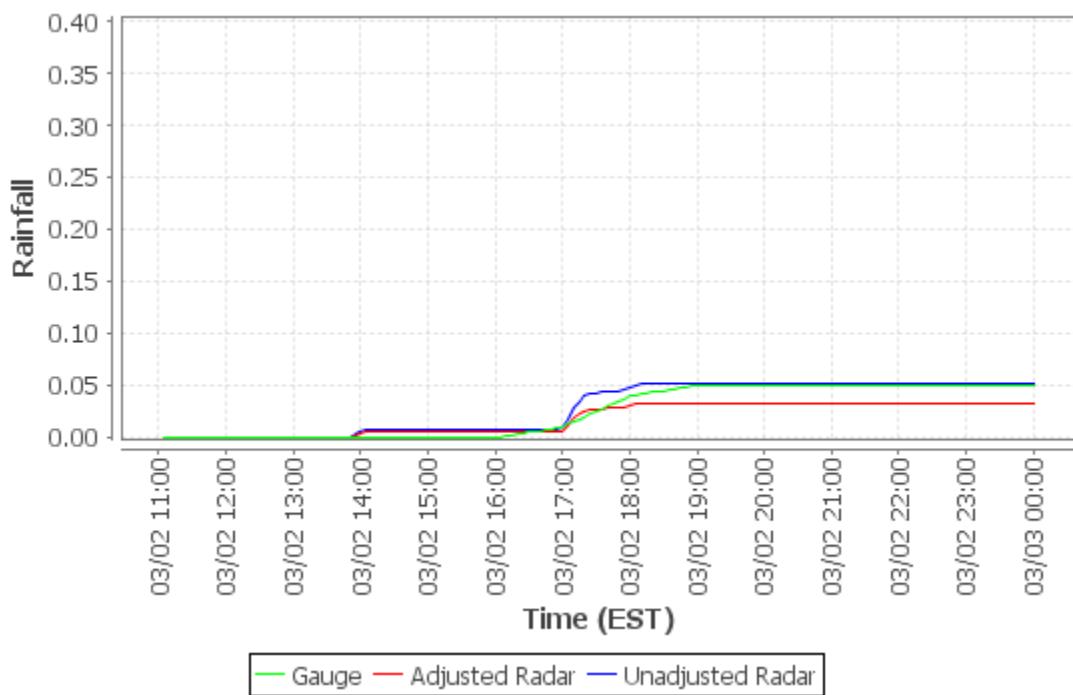
Cumulative Distribution Plot - Richland TWP (Loc33)



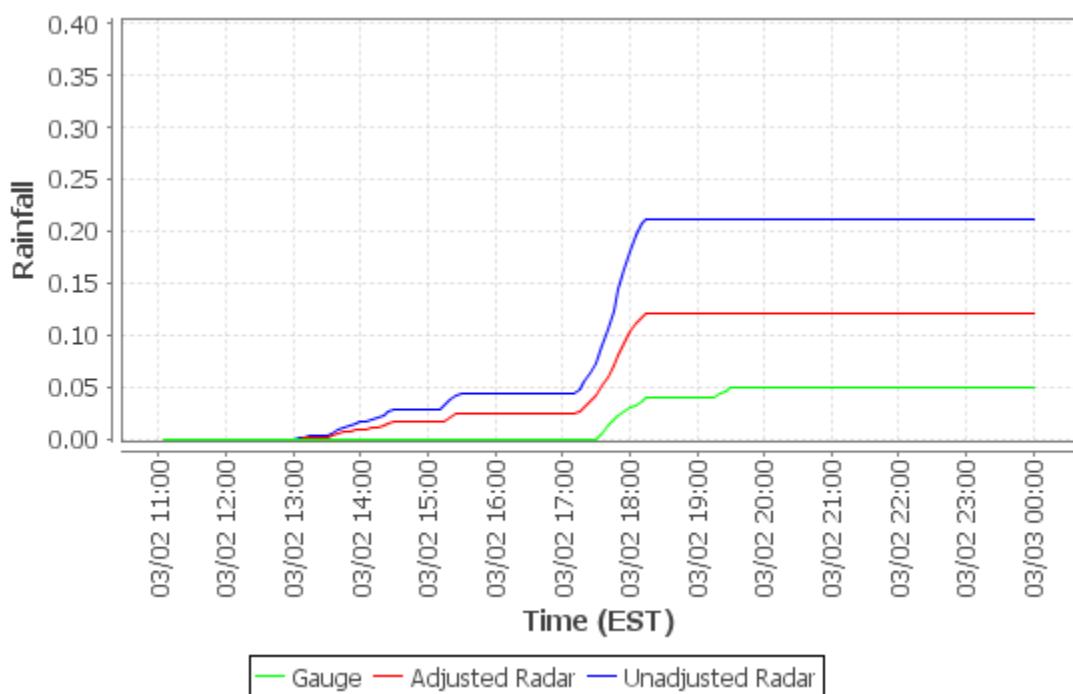
Cumulative Distribution Plot - Pittsburgh Allegheny Cty (KAGC)



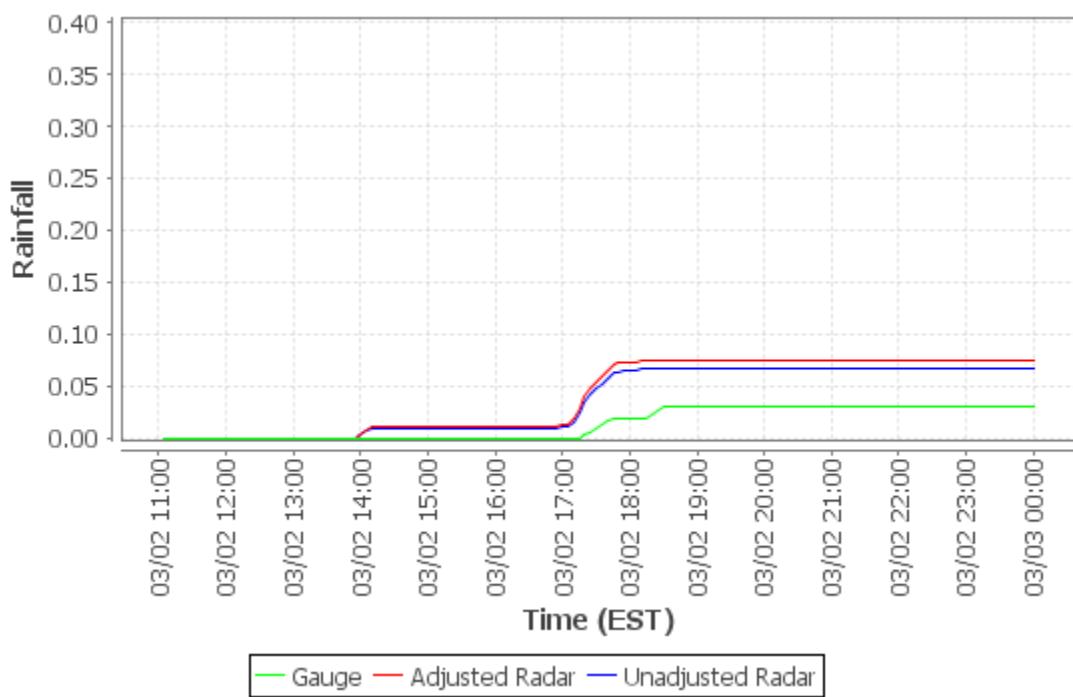
Cumulative Distribution Plot - Greater Pittsburgh Int'l (KPIT)



Cumulative Distribution Plot - Allegheny River at Natrona (03049500)

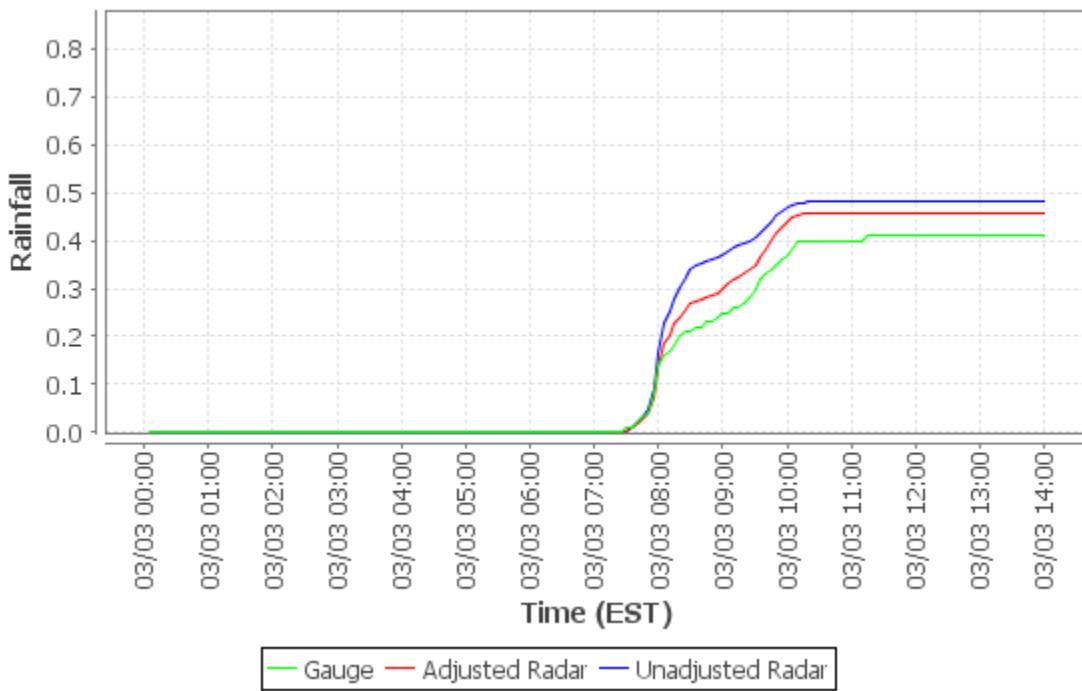


**Cumulative Distribution Plot - Ohio River at Emsworth Dam Lower Pool at Emsworth
(03085734)**

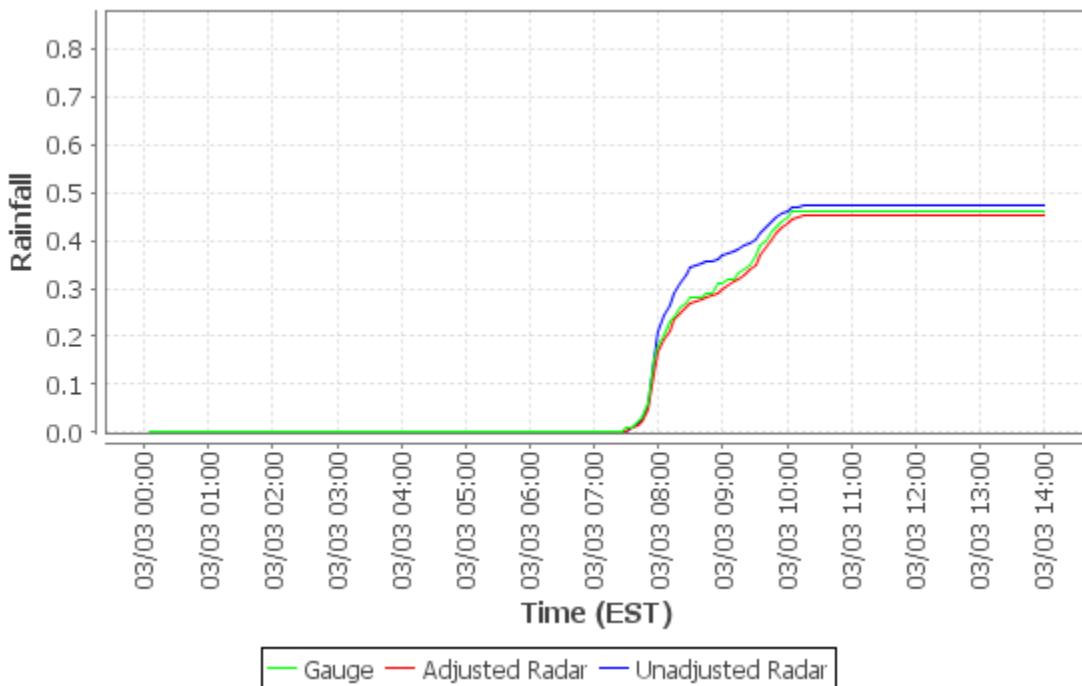


Appendix D - Event 2 (2020-03-03 AM) CDPs

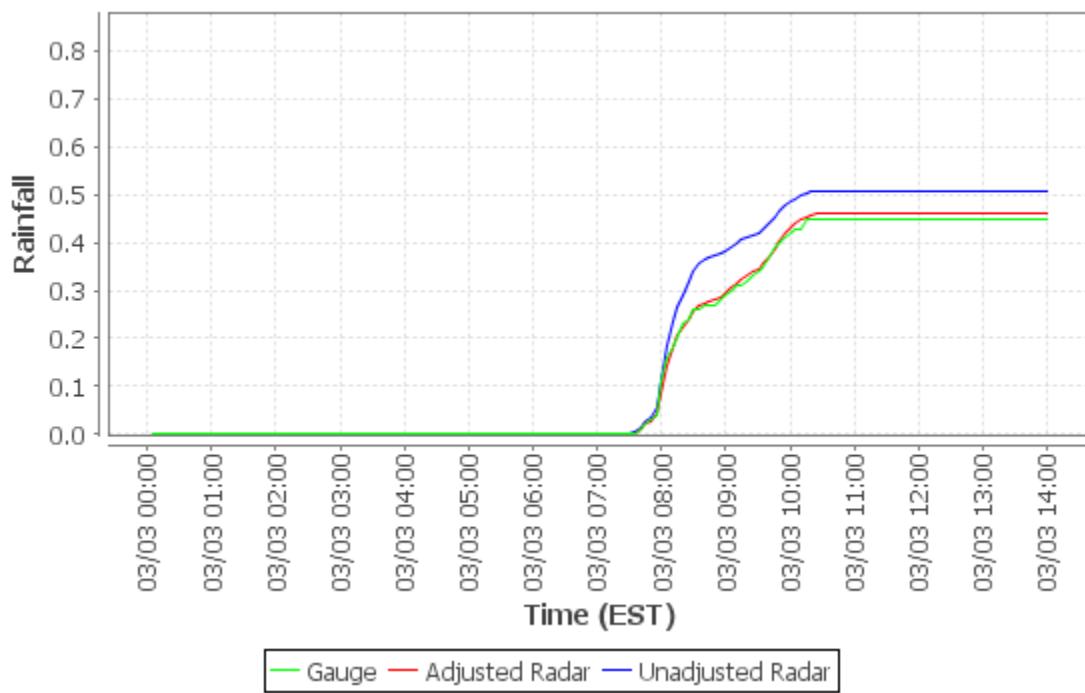
Cumulative Distribution Plot - PWSA-Montana St. (Loc01)



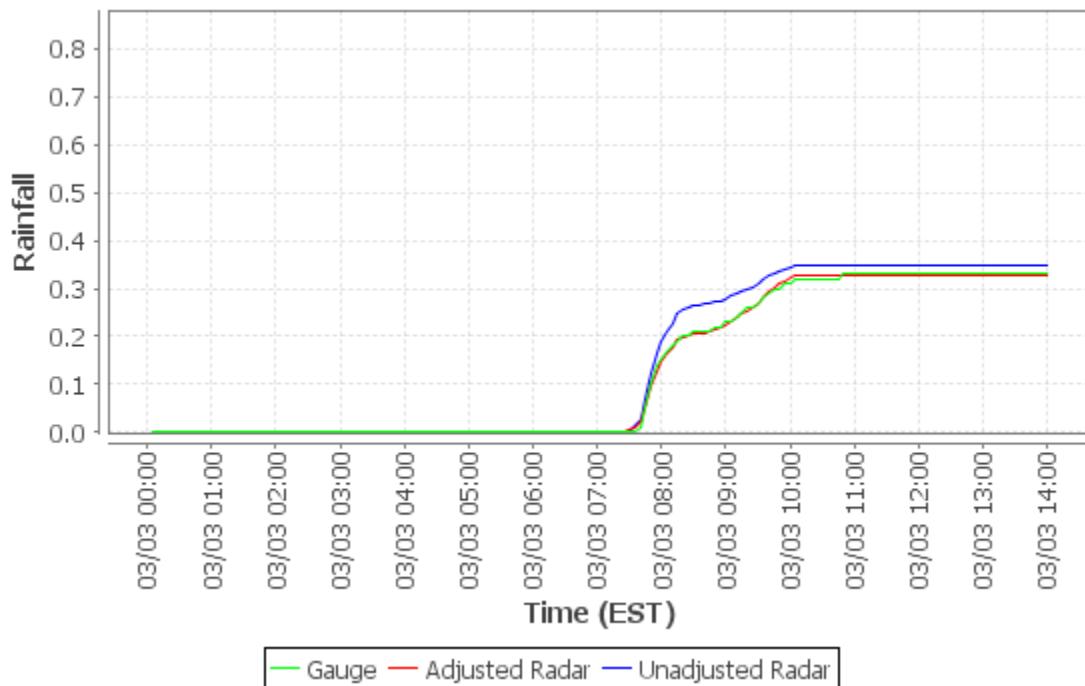
Cumulative Distribution Plot - ALCOSAN WWTP Lab (Loc02)



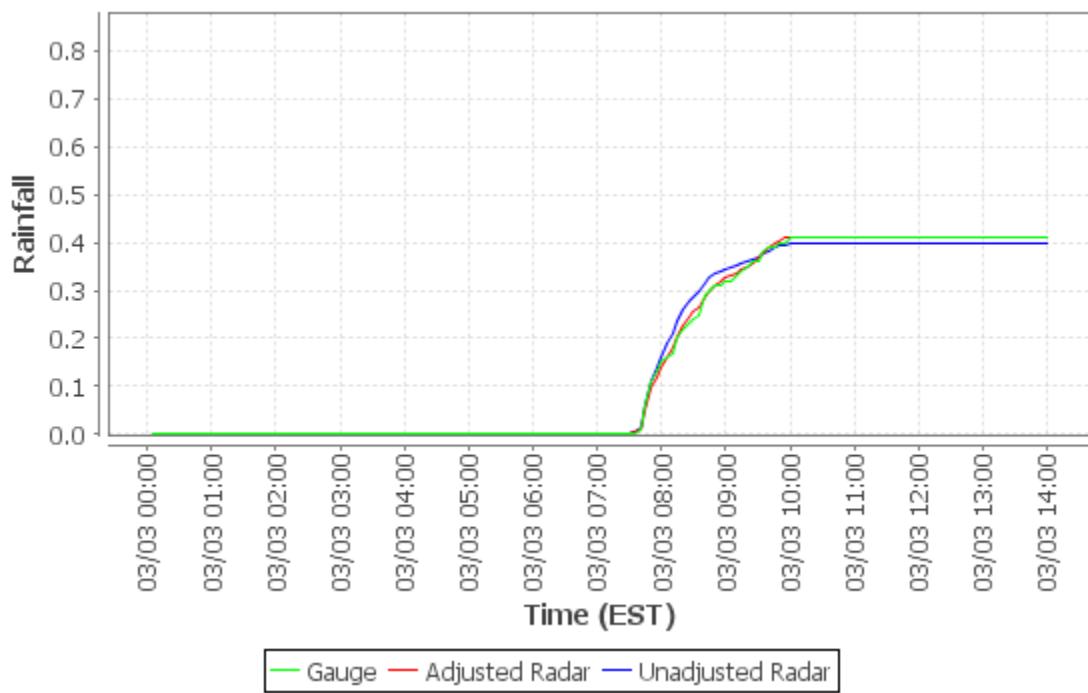
Cumulative Distribution Plot - Shaler Munic Bldg (Loc03)



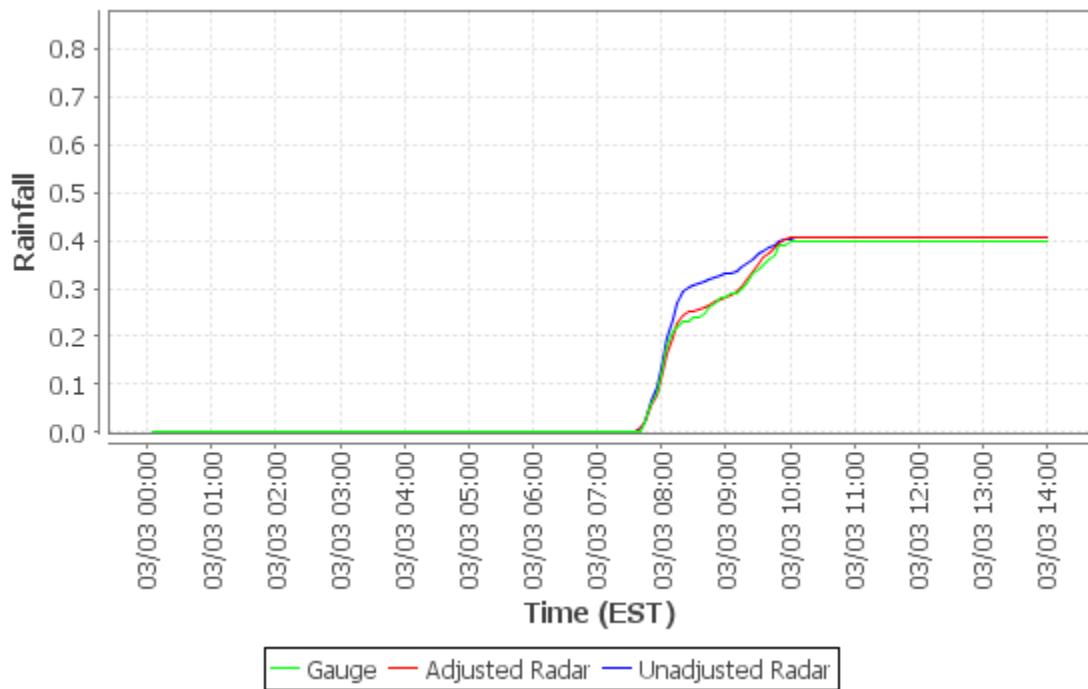
Cumulative Distribution Plot - Kennedy Twp PS (Loc04)



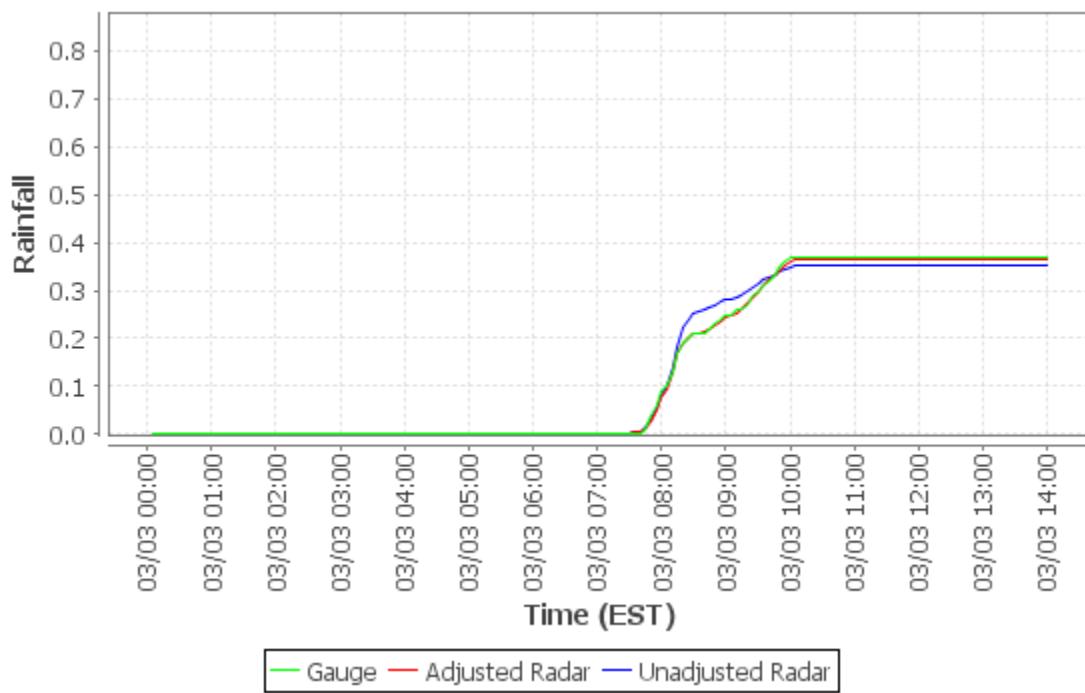
Cumulative Distribution Plot - Upper St. Clair (Loc05)



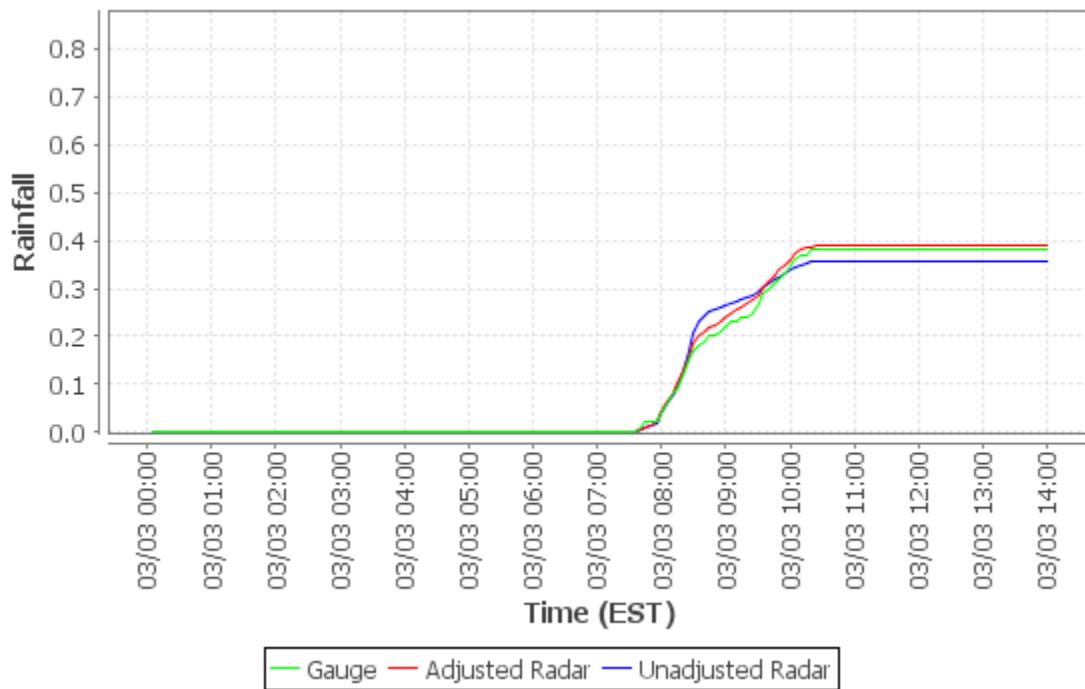
Cumulative Distribution Plot - Carnegie Transit Time (Loc06)



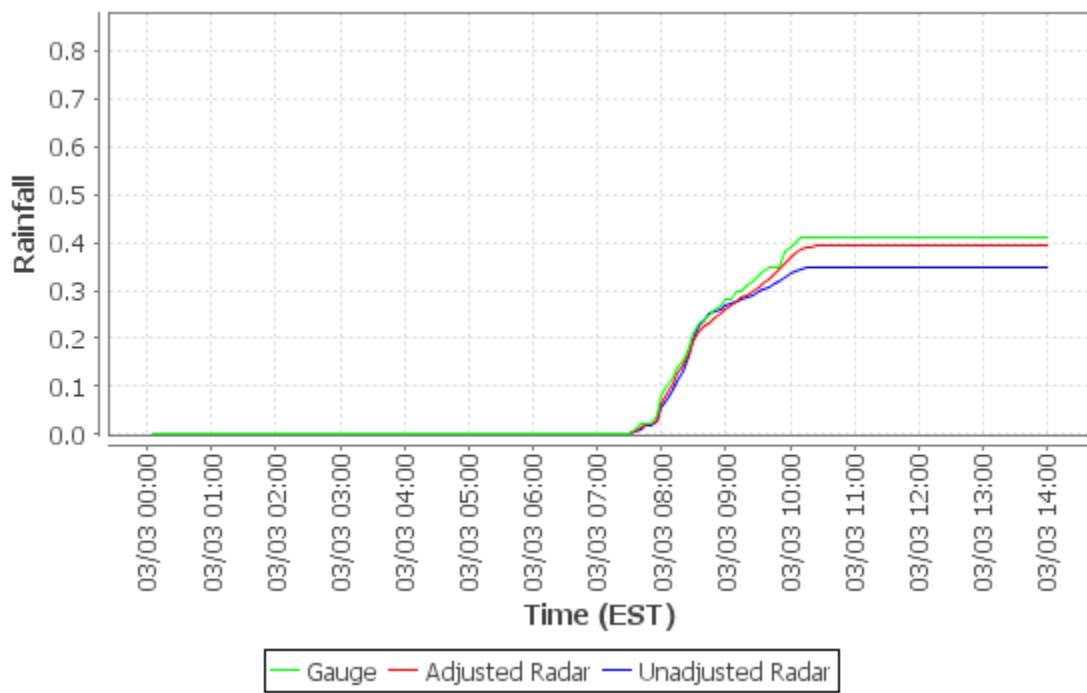
Cumulative Distribution Plot - Greentree Munic Bldg (Loc07)



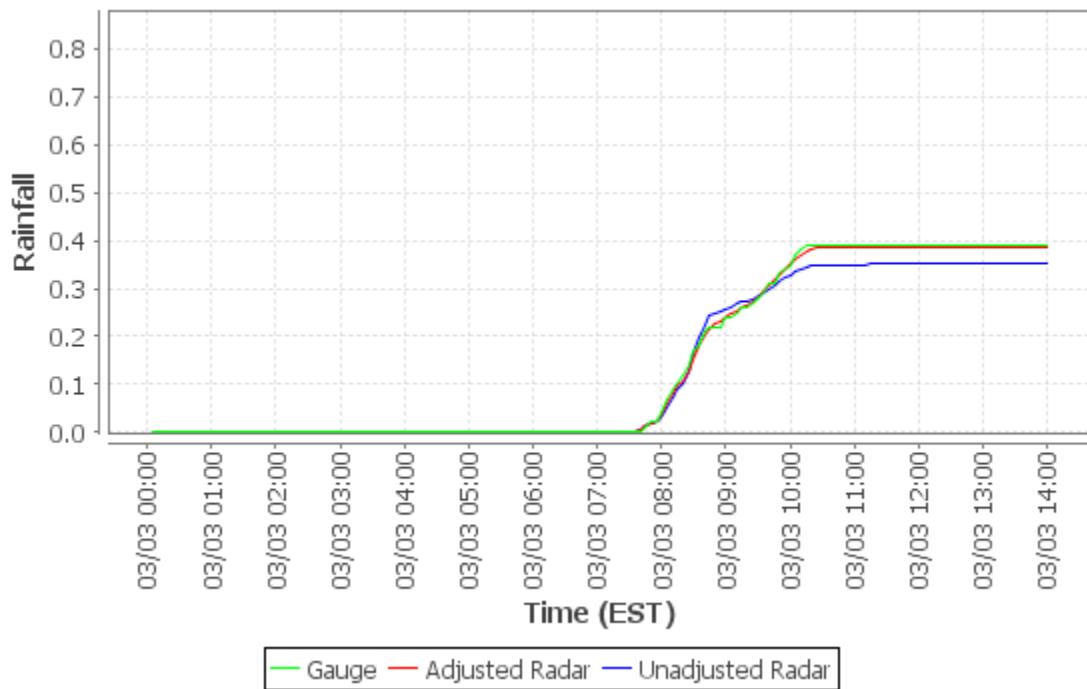
Cumulative Distribution Plot - AC Health Dept Bldg (Loc08)



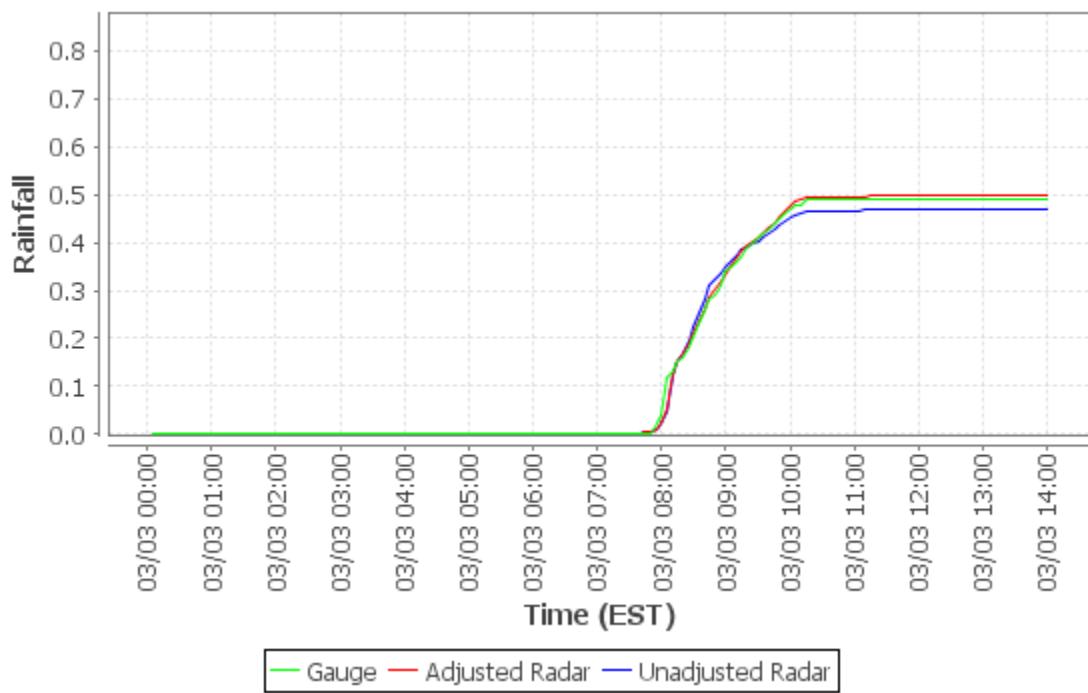
Cumulative Distribution Plot - Univ of Pittsburgh (Loc09)



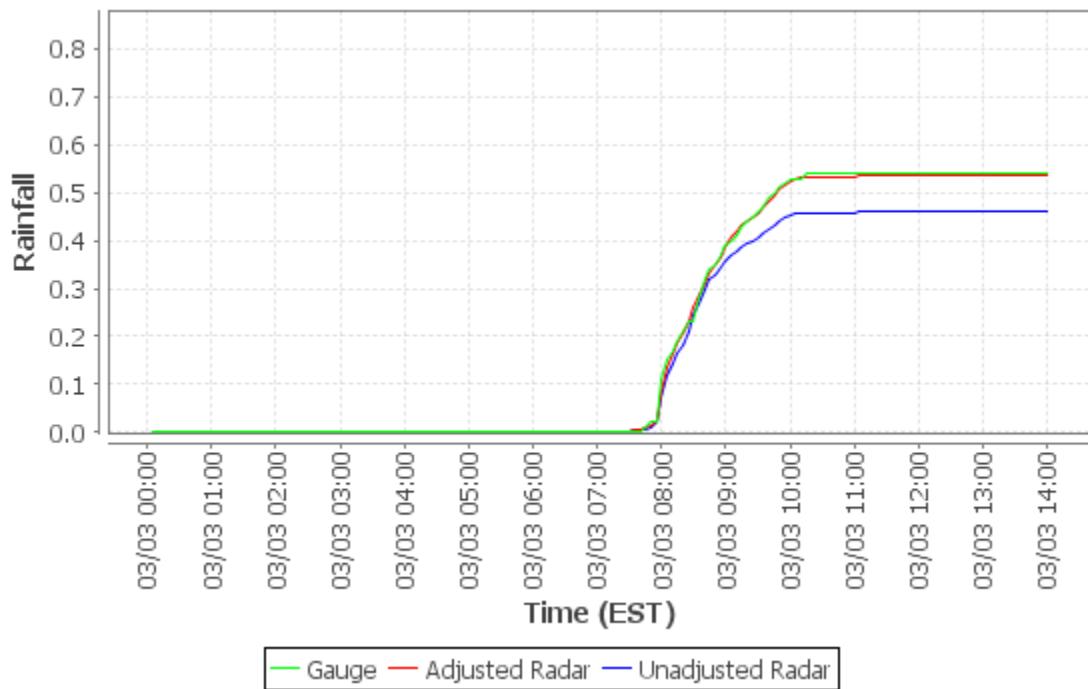
Cumulative Distribution Plot - PWSA-Highland Park (Loc10)



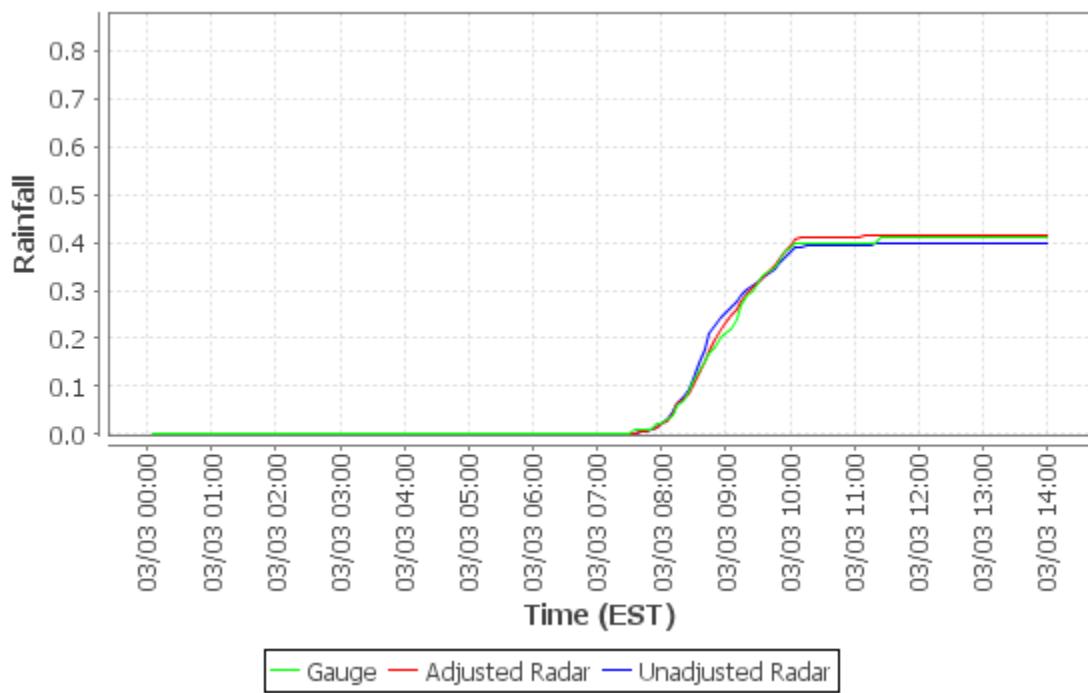
Cumulative Distribution Plot - M-46 Access Shaft (Loc11)



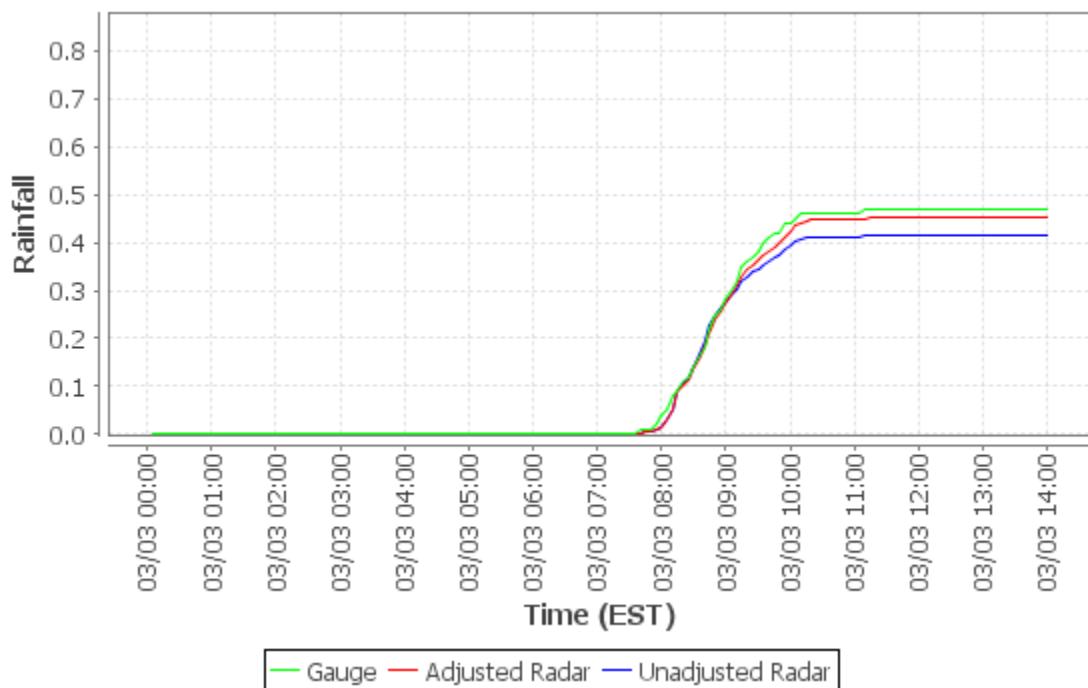
Cumulative Distribution Plot - Baldwin (Loc12)



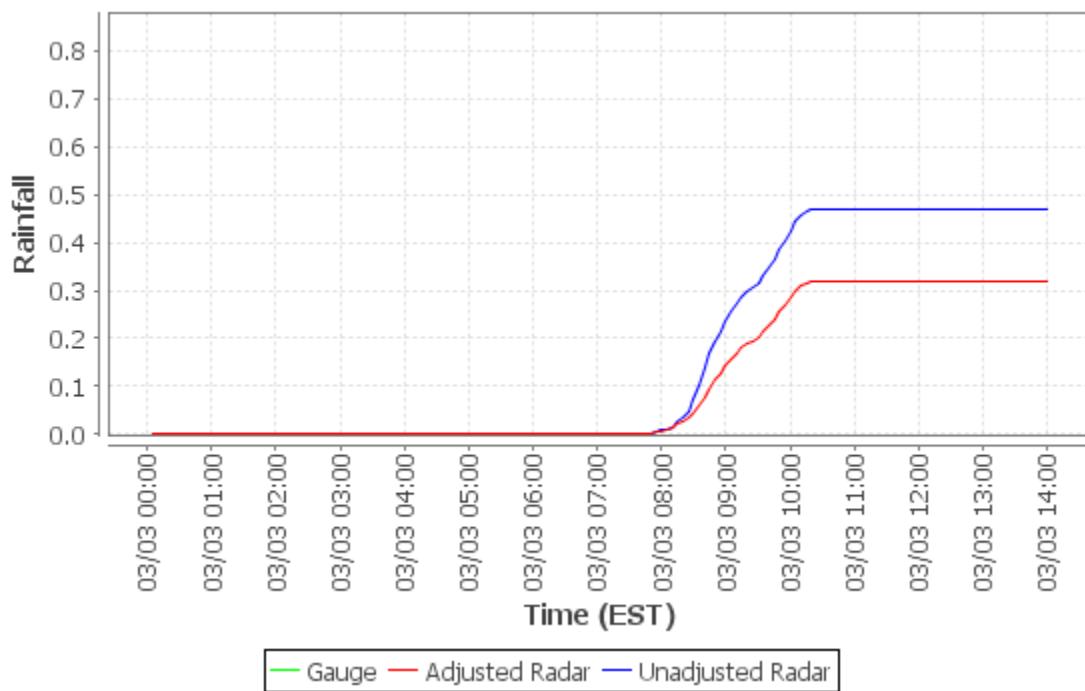
Cumulative Distribution Plot - M-59 Access Shaft (Loc13)



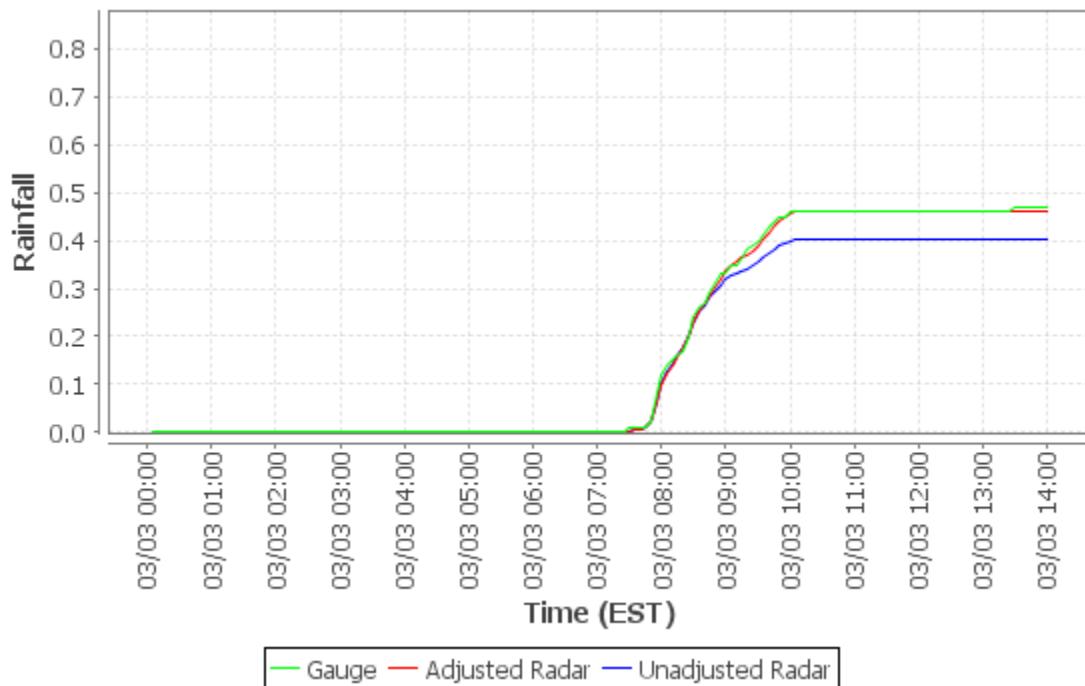
Cumulative Distribution Plot - Churchill Munic Bldg (Loc14)



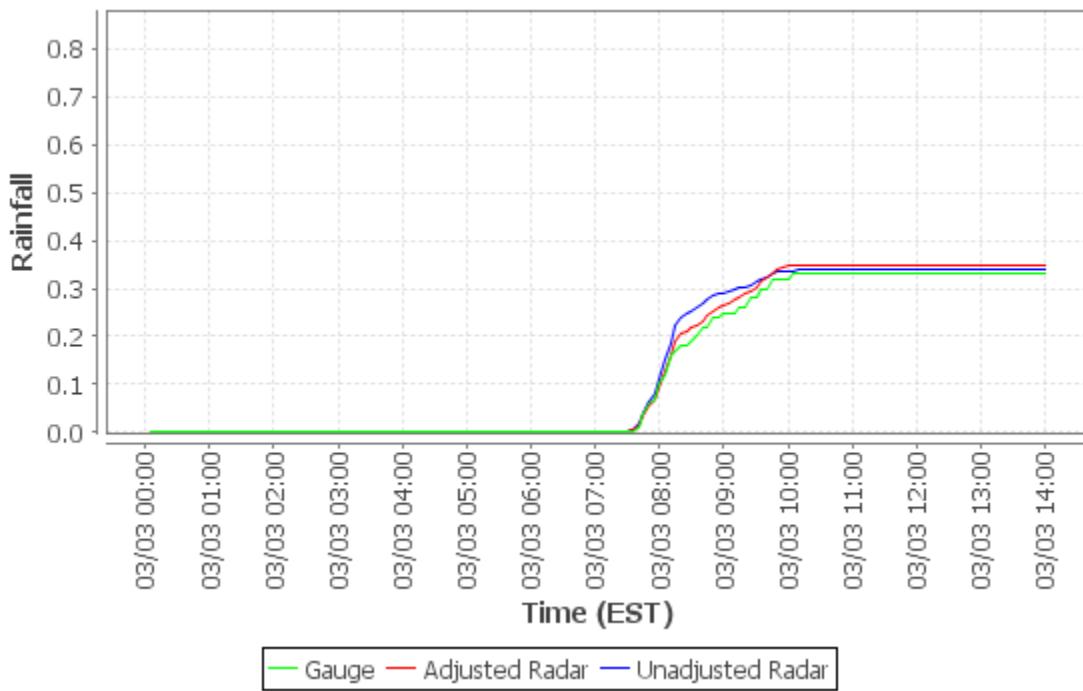
Cumulative Distribution Plot - Trafford Maint Bldg (Loc15)



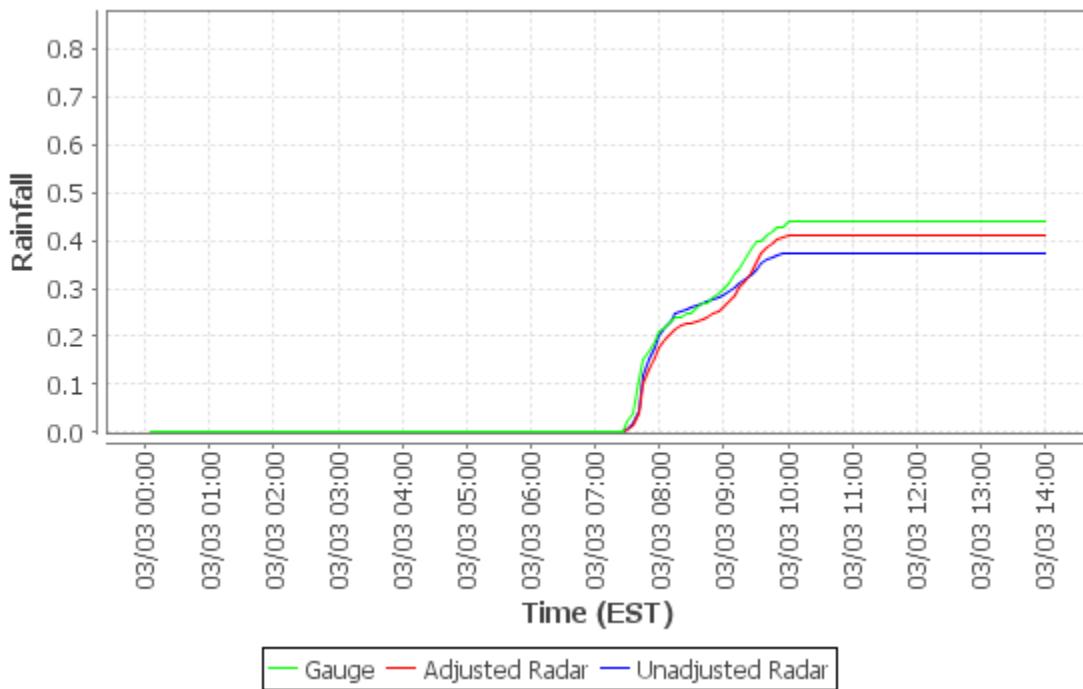
Cumulative Distribution Plot - Castle Shannon (Loc16)



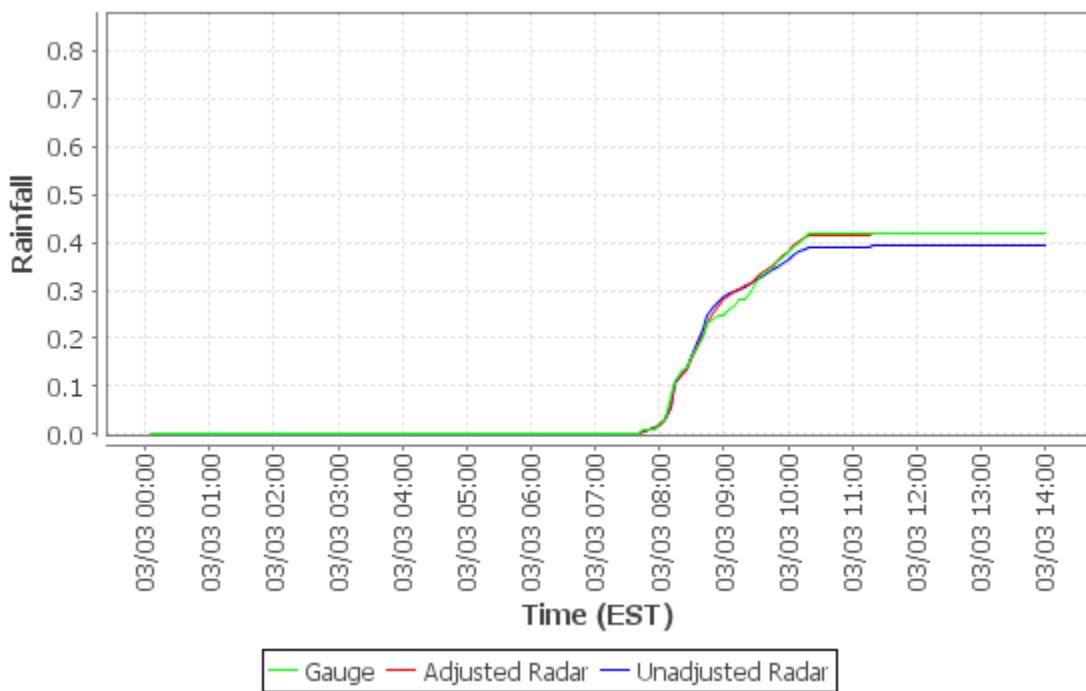
Cumulative Distribution Plot - Chartiers Pump Station (Loc17)



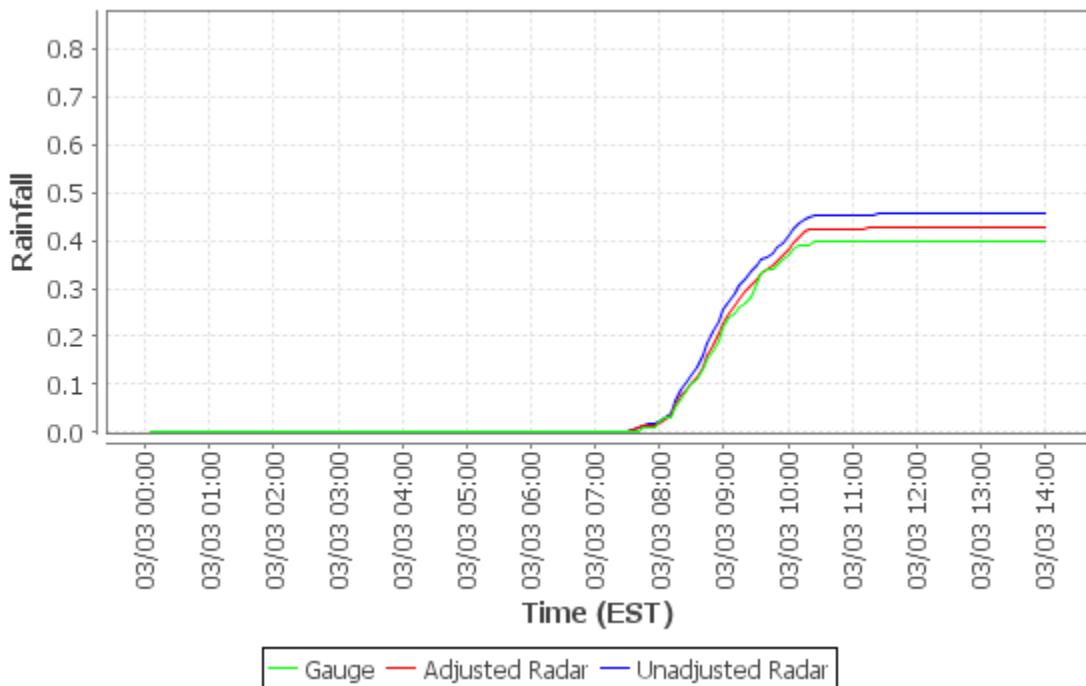
Cumulative Distribution Plot - Oakdale Pump Station (Loc18)



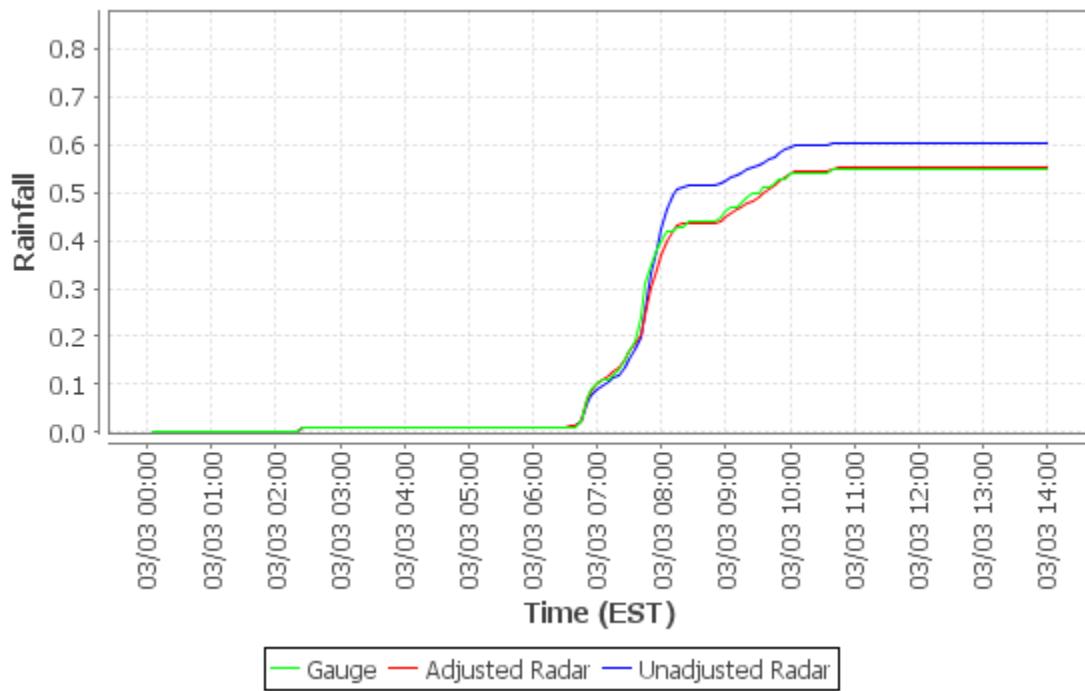
Cumulative Distribution Plot - Sandy Creek Eq Facility (Loc19)



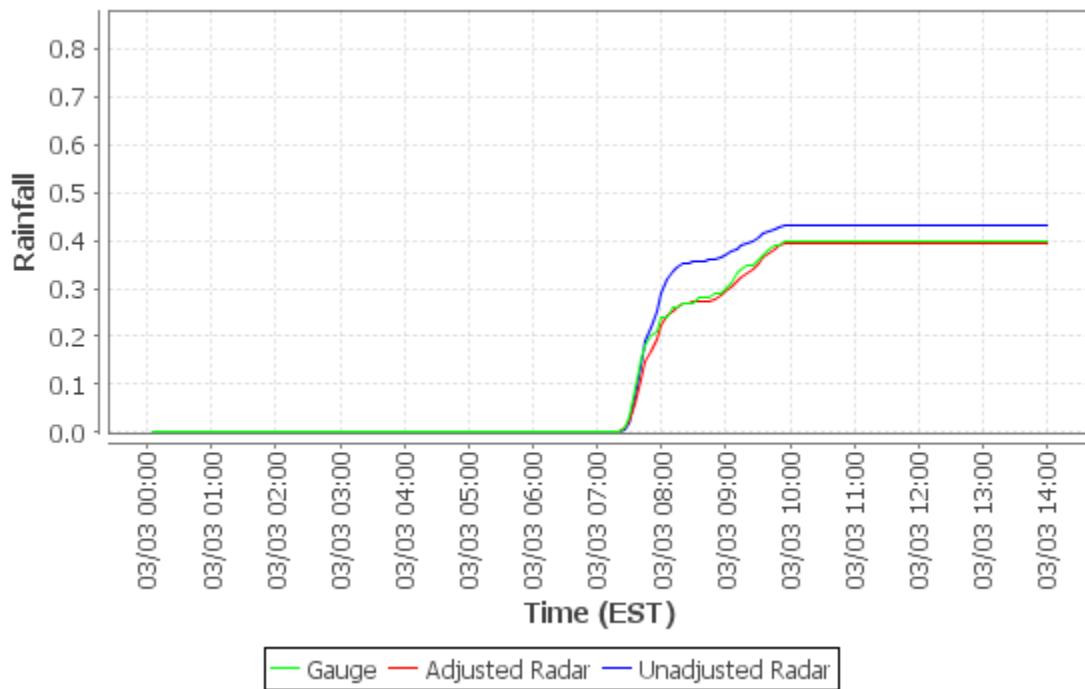
Cumulative Distribution Plot - Gascola Eq Facility (Loc20)



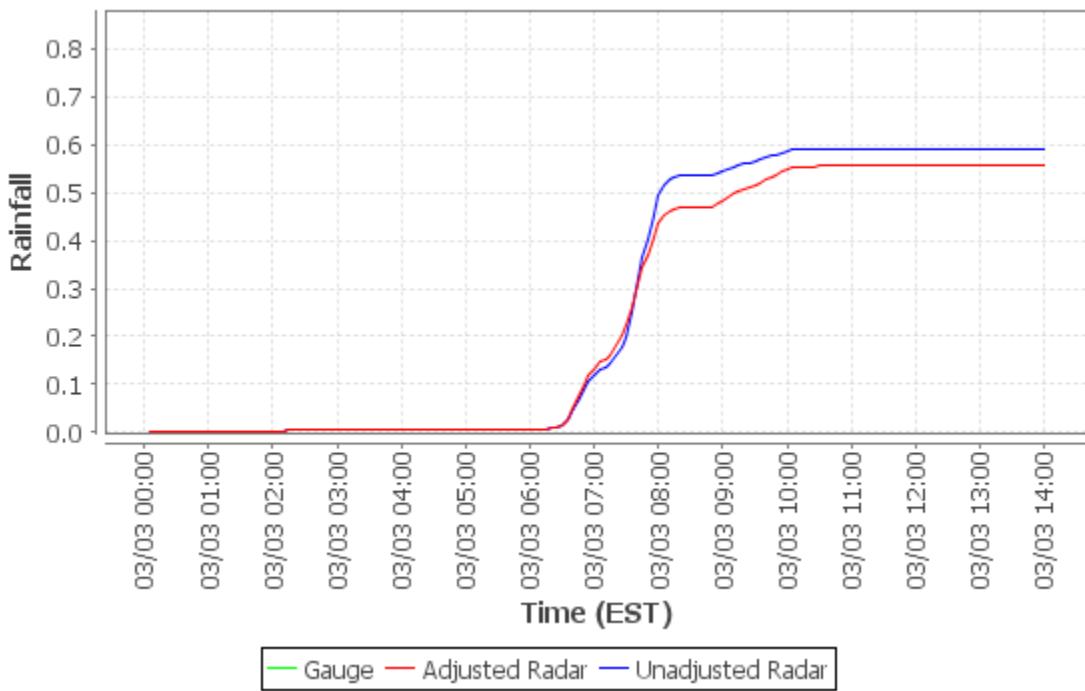
Cumulative Distribution Plot - Moon TWP (Loc21)



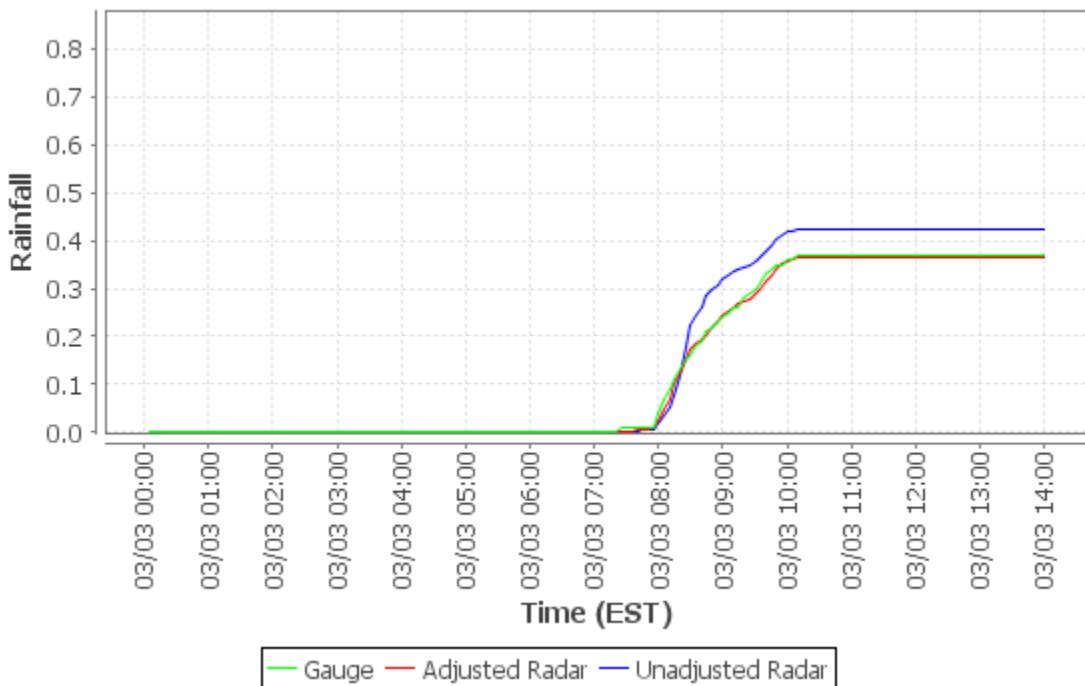
Cumulative Distribution Plot - North Fayette TWP (Loc22)



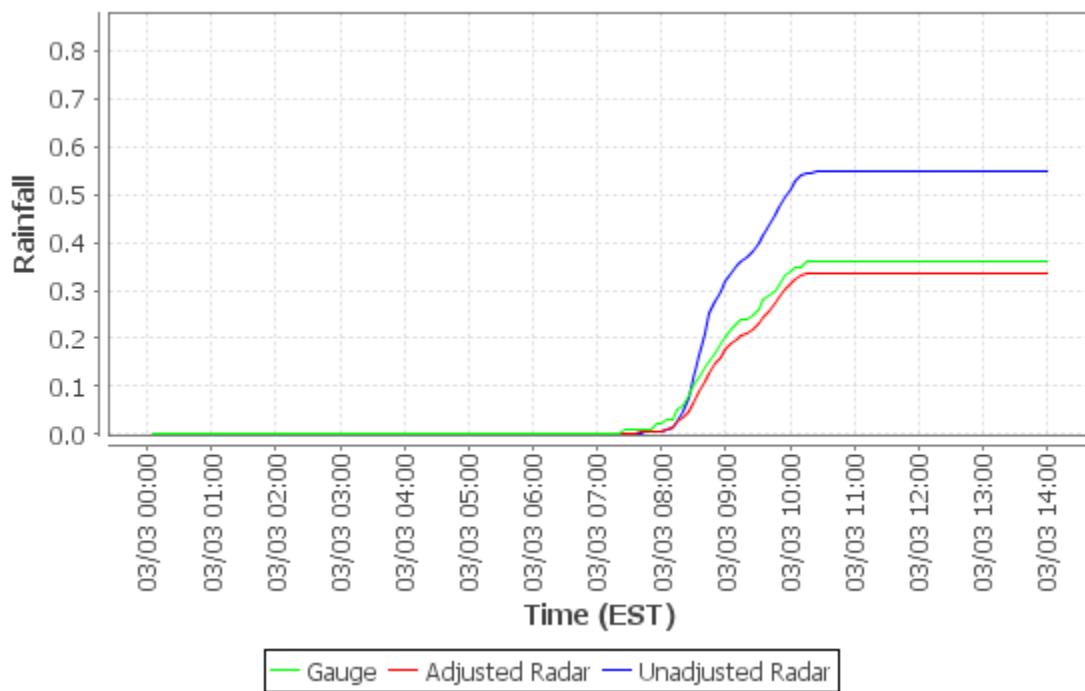
Cumulative Distribution Plot - Clinton Munic Bldg (Loc23)



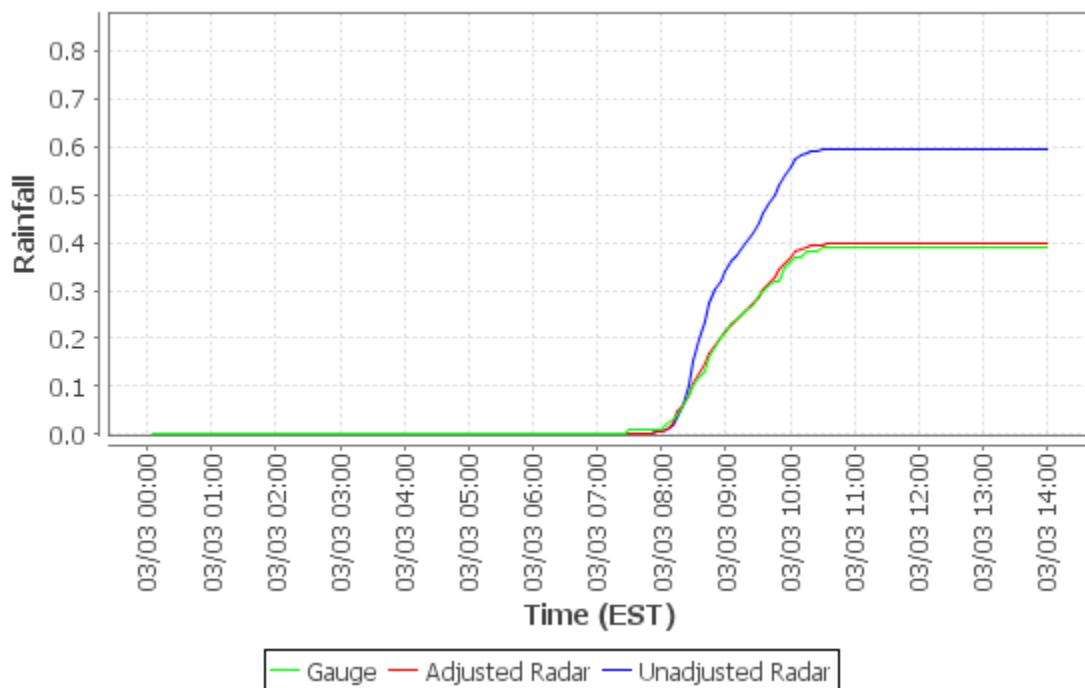
Cumulative Distribution Plot - Jefferson Hills (Loc24)



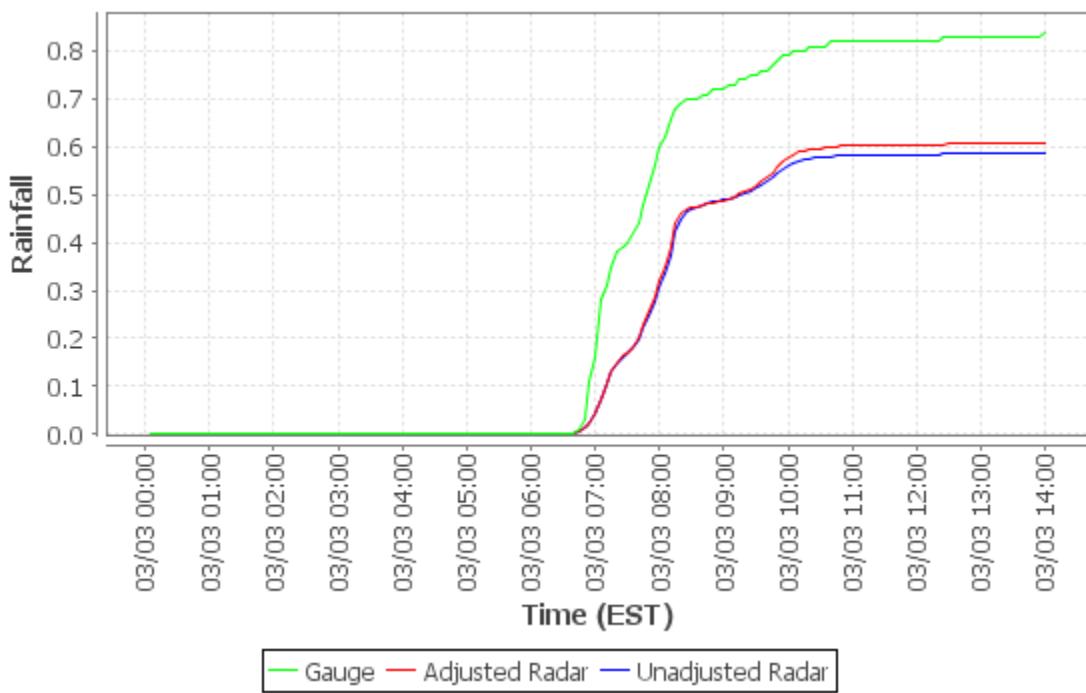
Cumulative Distribution Plot - White Oak Public Works Bldg (Loc25)



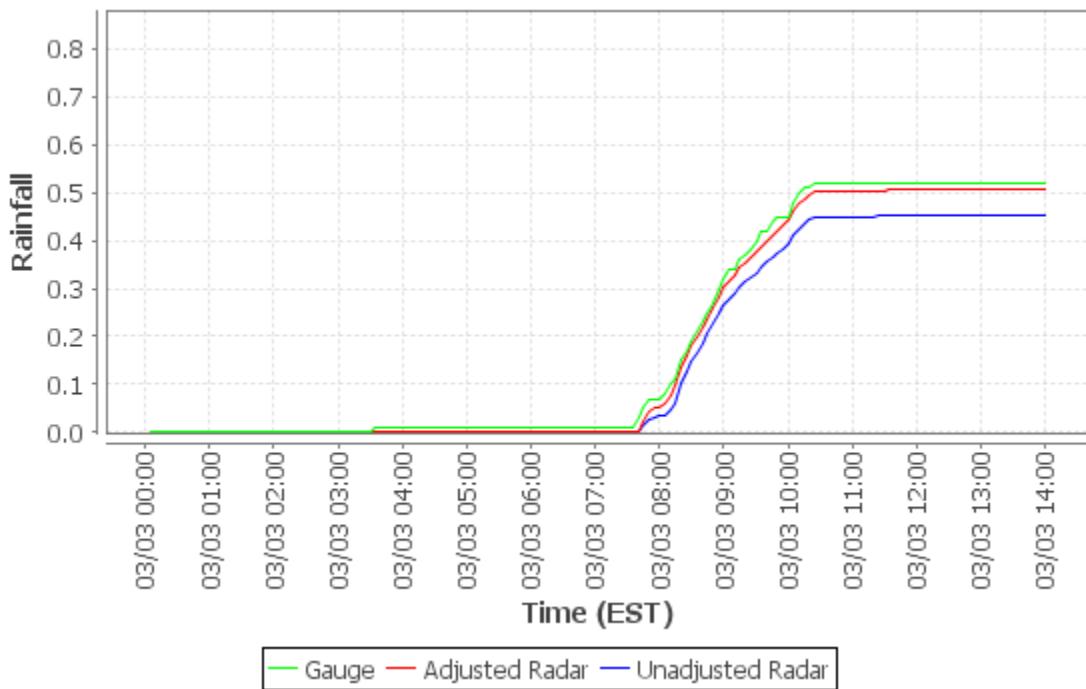
Cumulative Distribution Plot - Elizabeth TWP Municipal Bldg (Loc26)



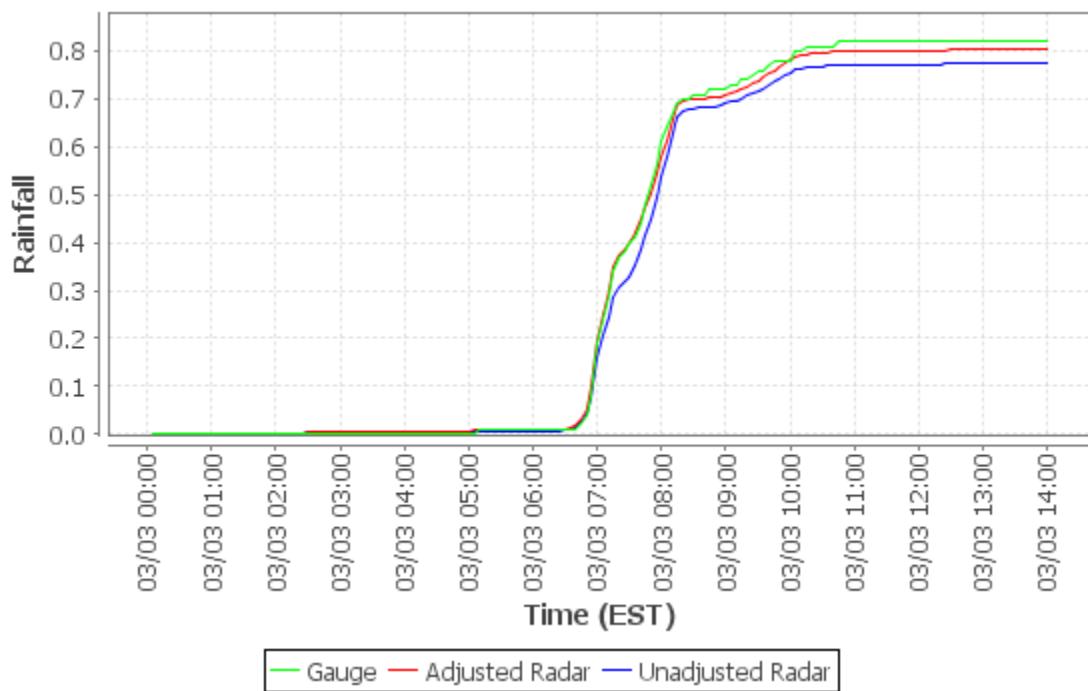
Cumulative Distribution Plot - Marshall TWP (Loc27)



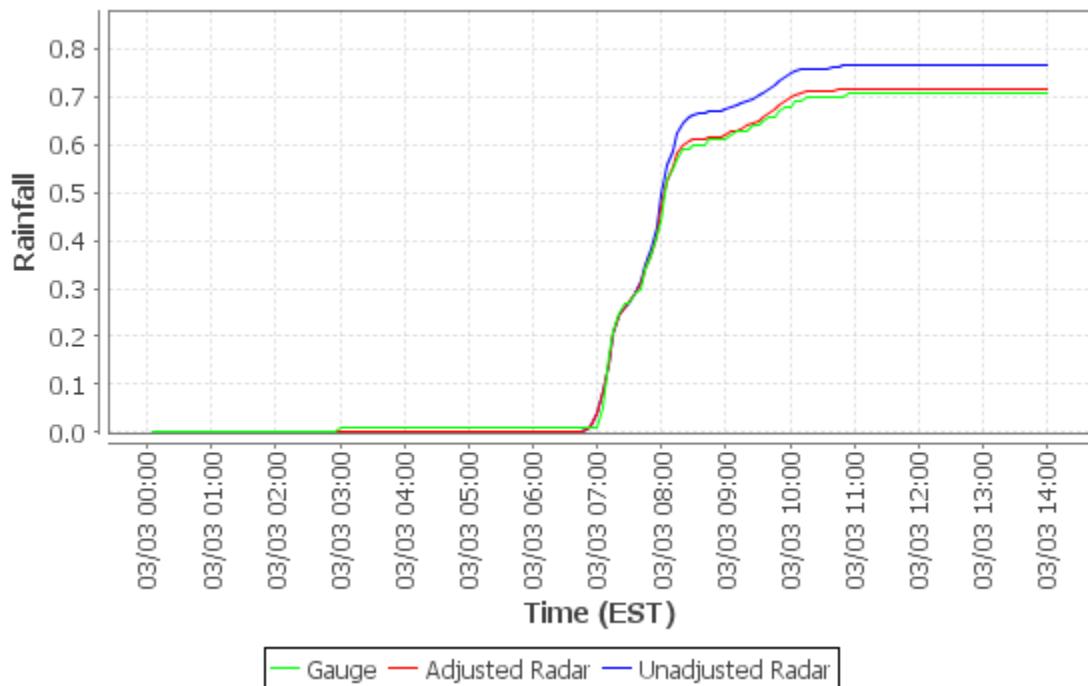
Cumulative Distribution Plot - Plum Municipal Bldg (Loc28)



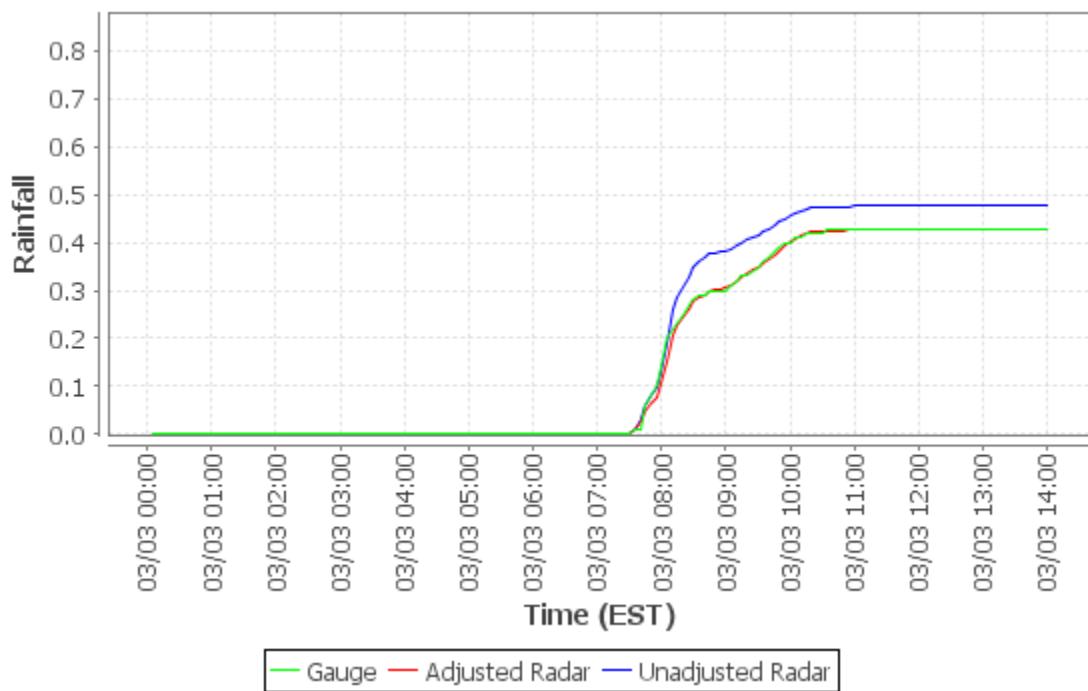
Cumulative Distribution Plot - Bell Acres Munic Bldg (Loc29)



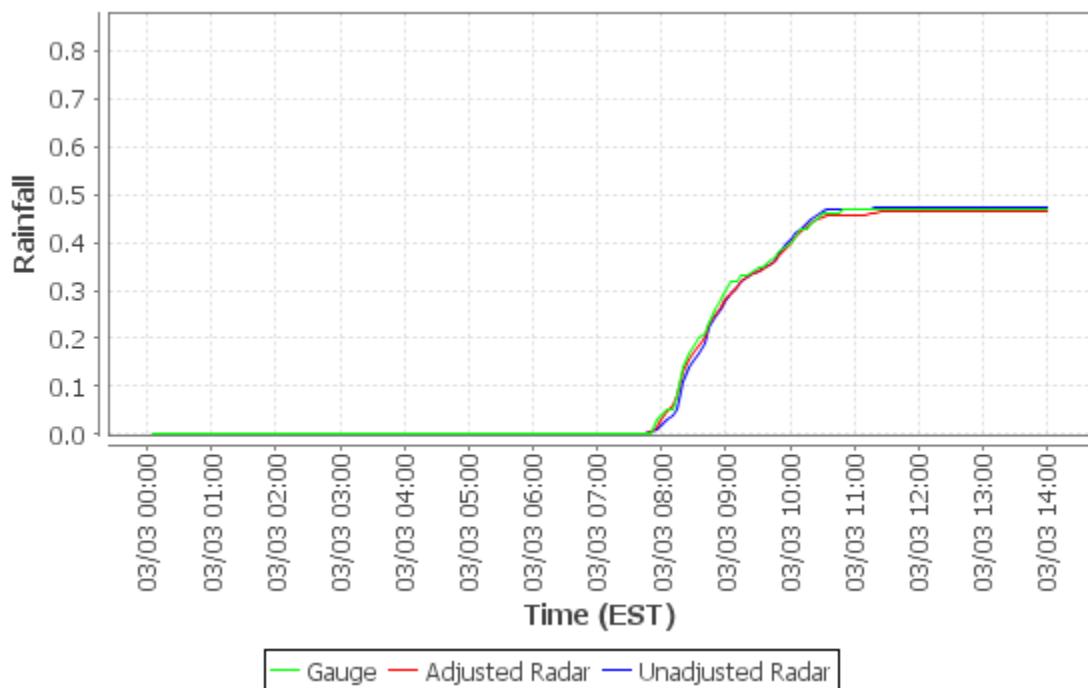
Cumulative Distribution Plot - McCandless Twn Hall (Loc30)



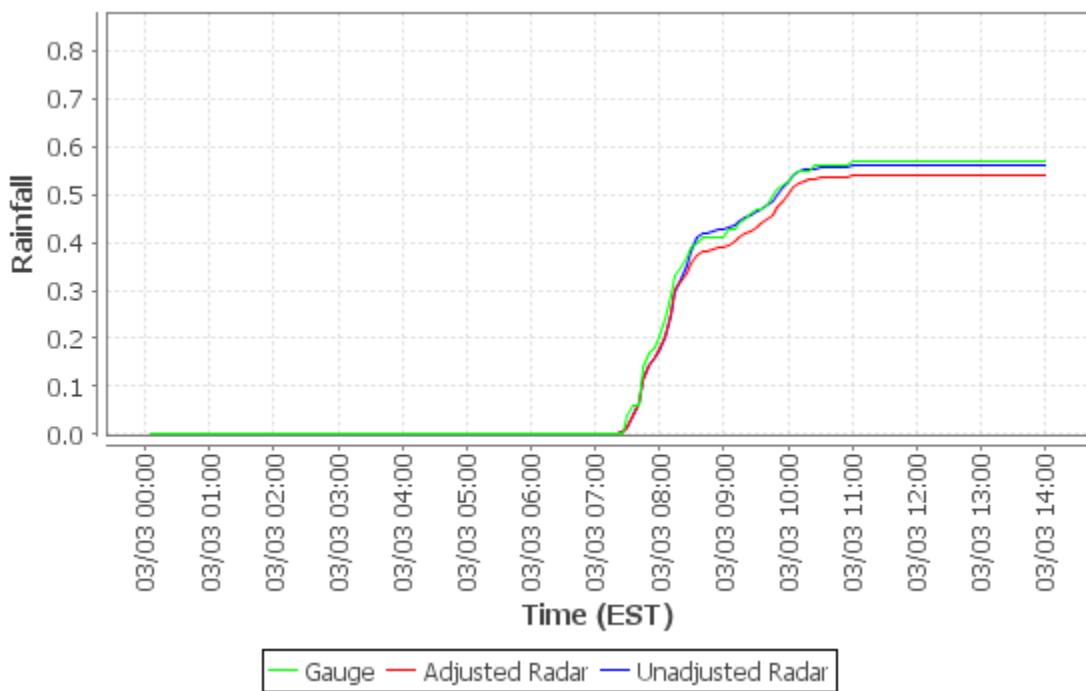
Cumulative Distribution Plot - Hampton Municipal Bldg (Loc31)



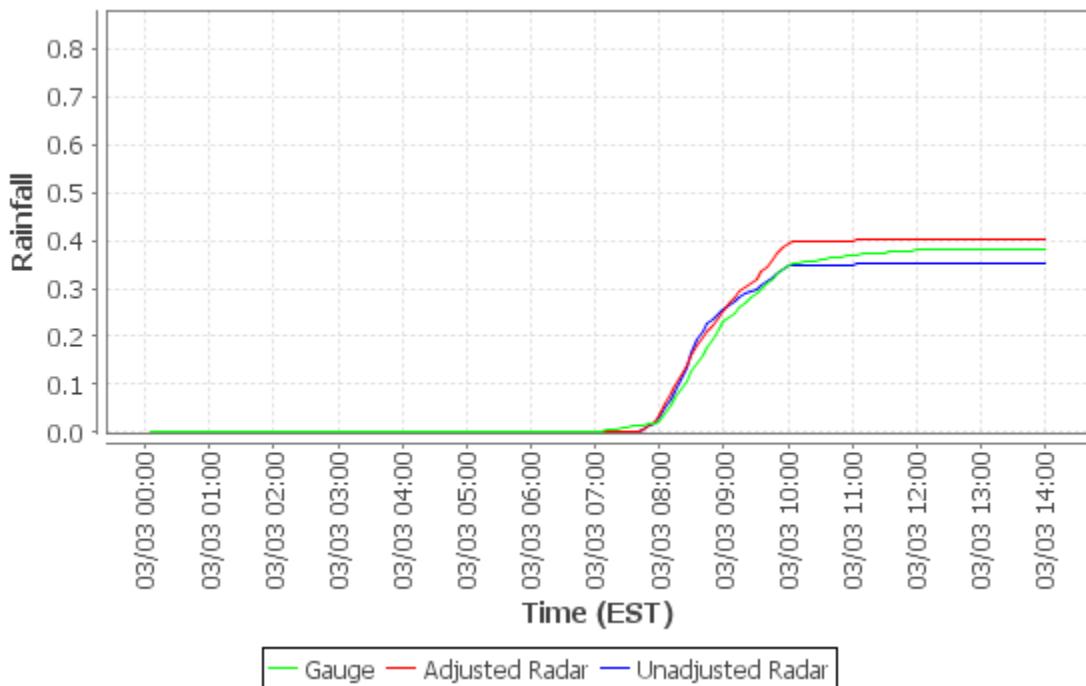
Cumulative Distribution Plot - Arnold (Loc32)



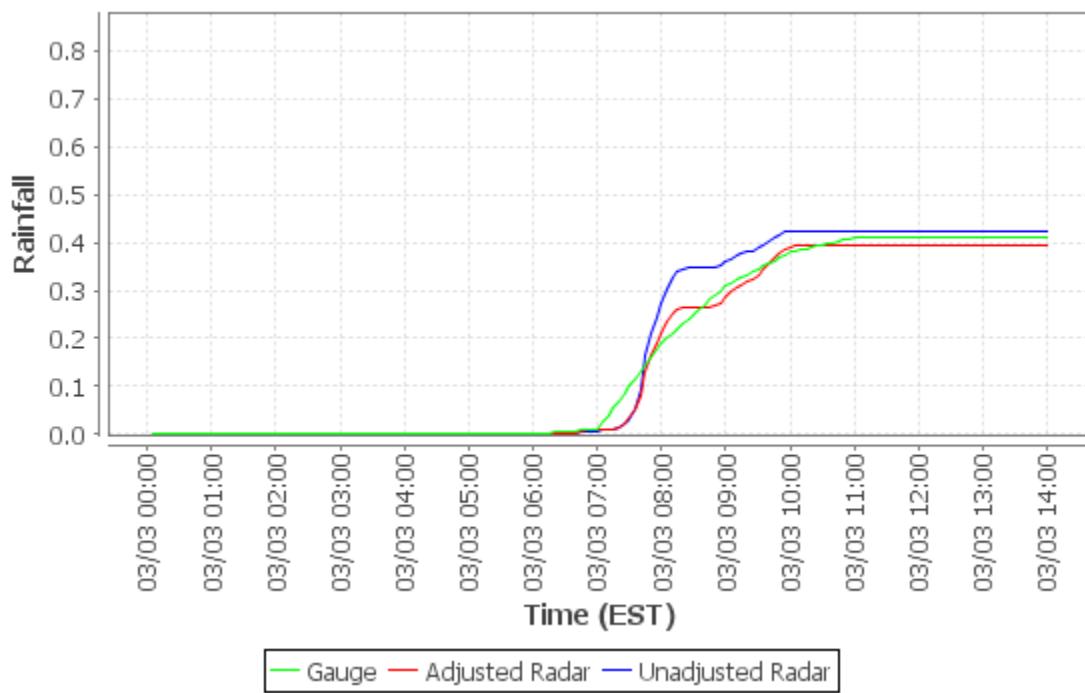
Cumulative Distribution Plot - Richland TWP (Loc33)



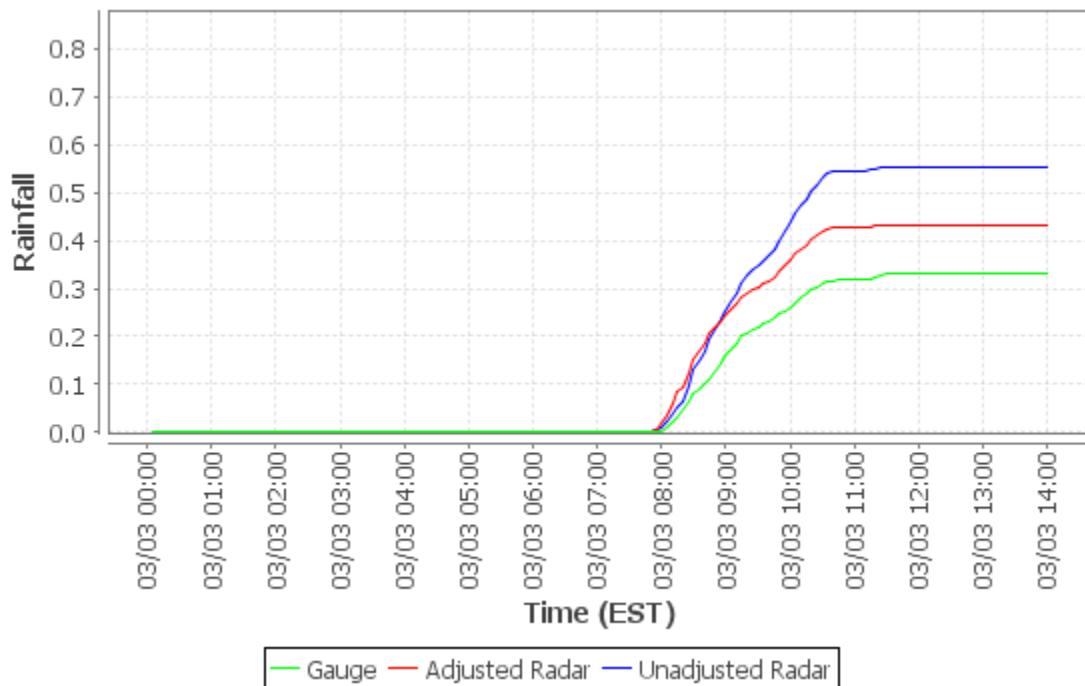
Cumulative Distribution Plot - Pittsburgh Allegheny Cty (KAGC)



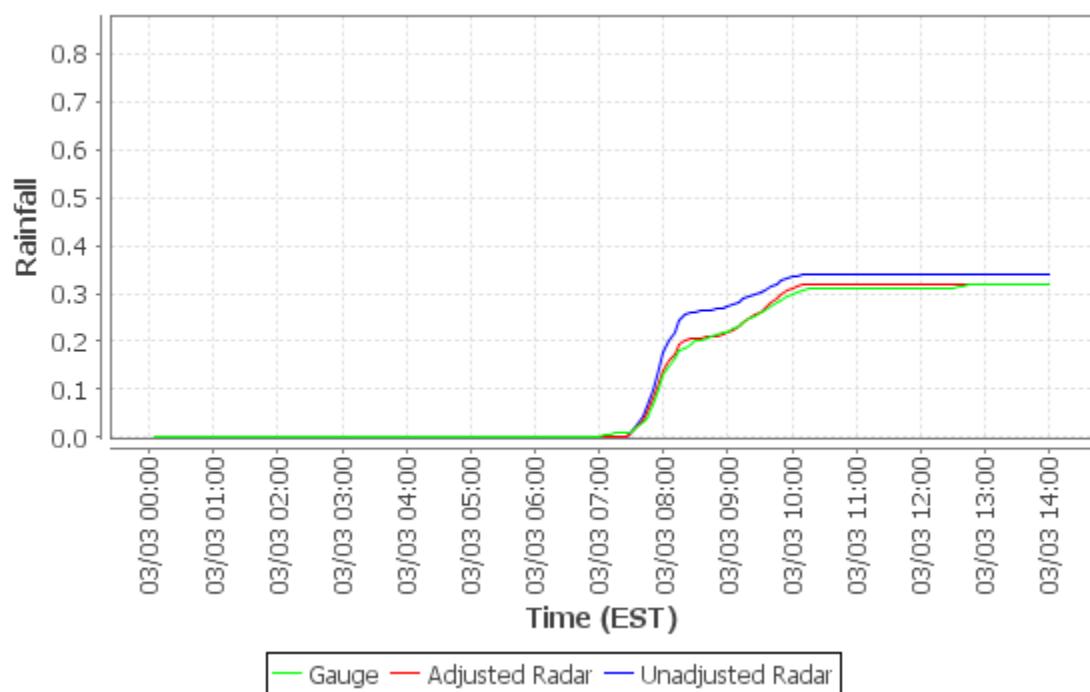
Cumulative Distribution Plot - Greater Pittsburgh Int'l (KPIT)



Cumulative Distribution Plot - Allegheny River at Natrona (03049500)

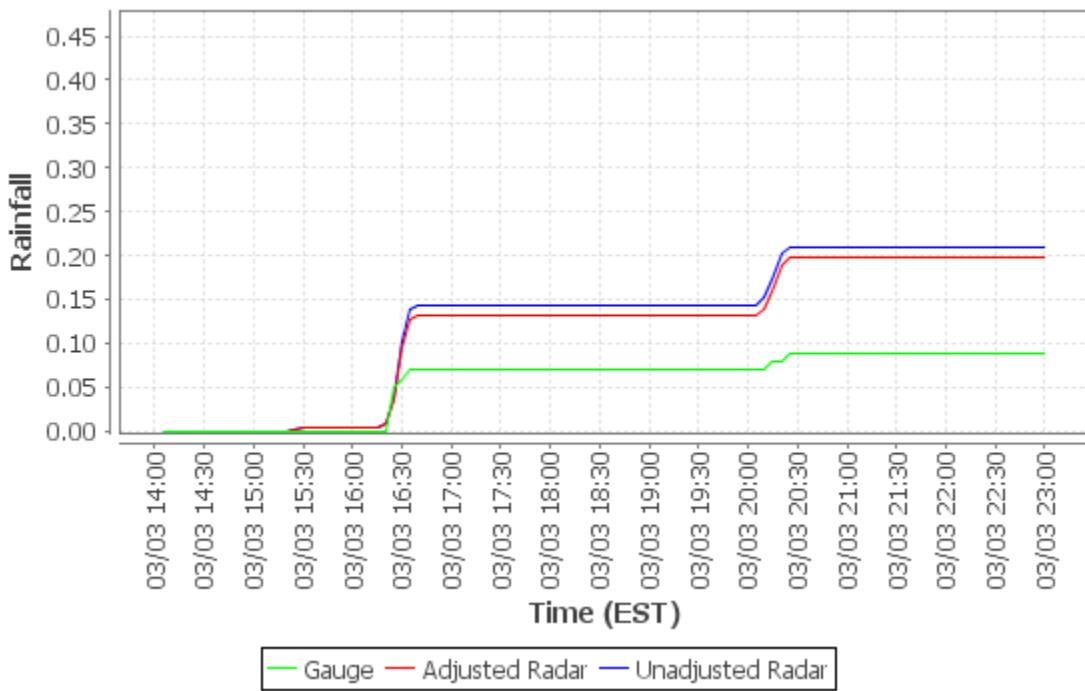


**Cumulative Distribution Plot - Ohio River at Emsworth Dam Lower Pool at Emsworth
(03085734)**

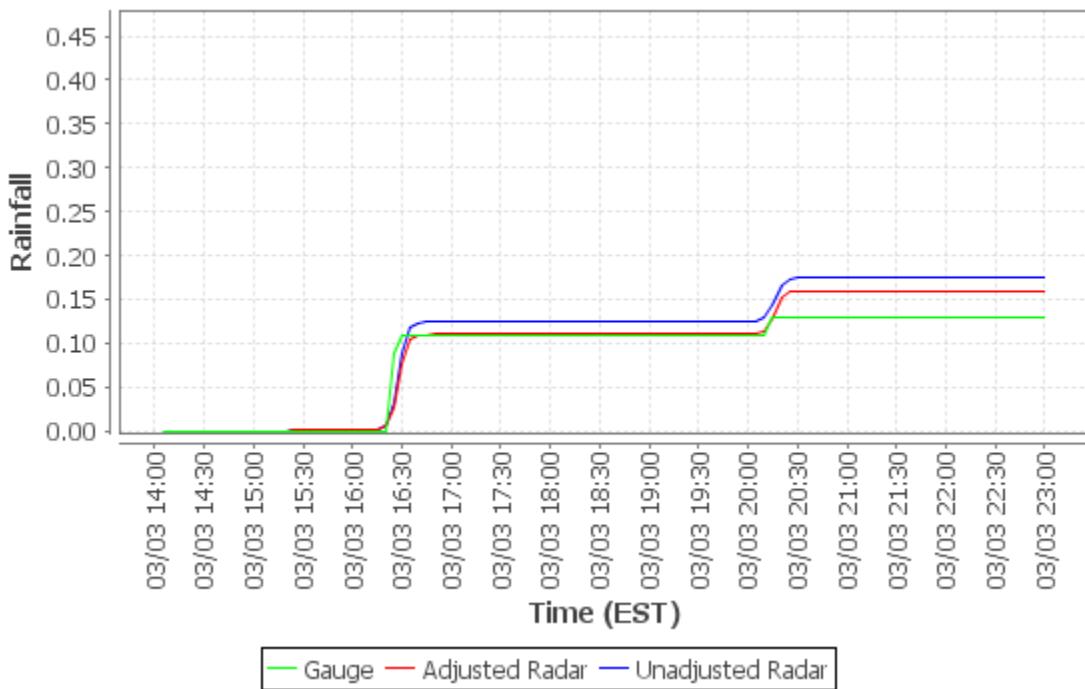


Appendix E - Event 3 (2020-03-03 PM) CDPs

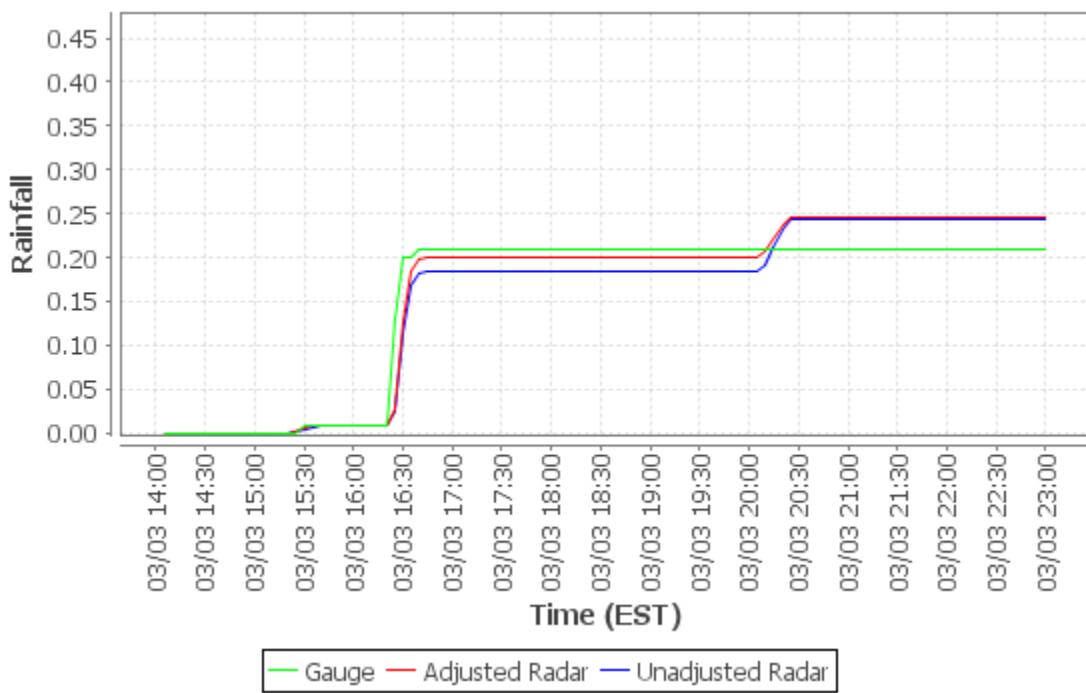
Cumulative Distribution Plot - PWSA-Montana St. (Loc01)



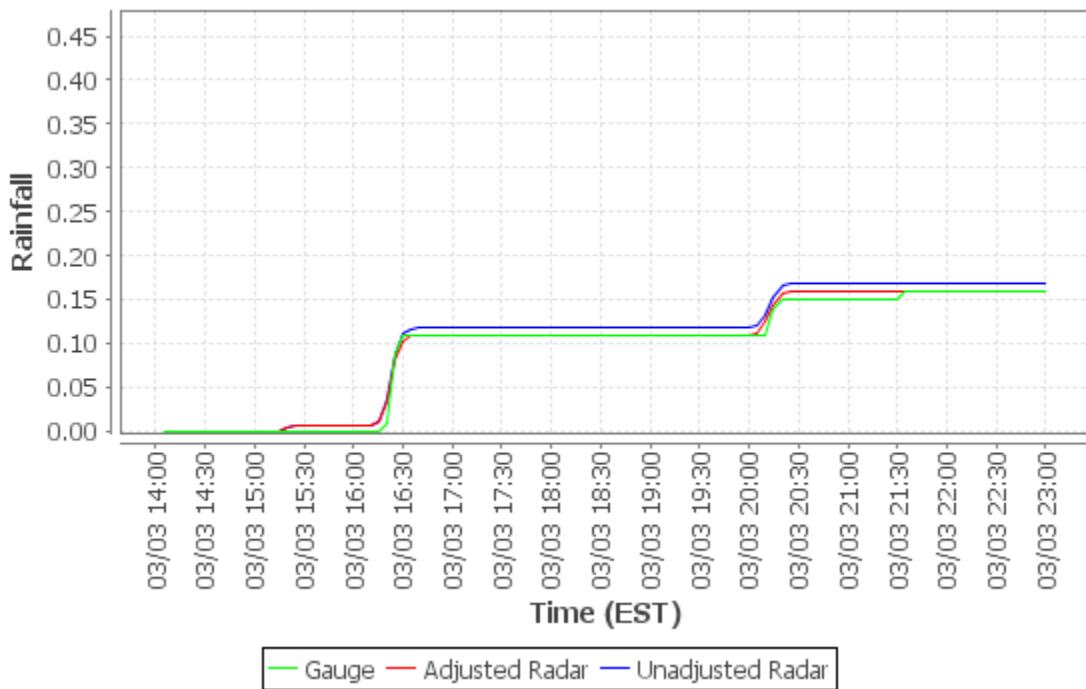
Cumulative Distribution Plot - ALCOSAN WWTP Lab (Loc02)



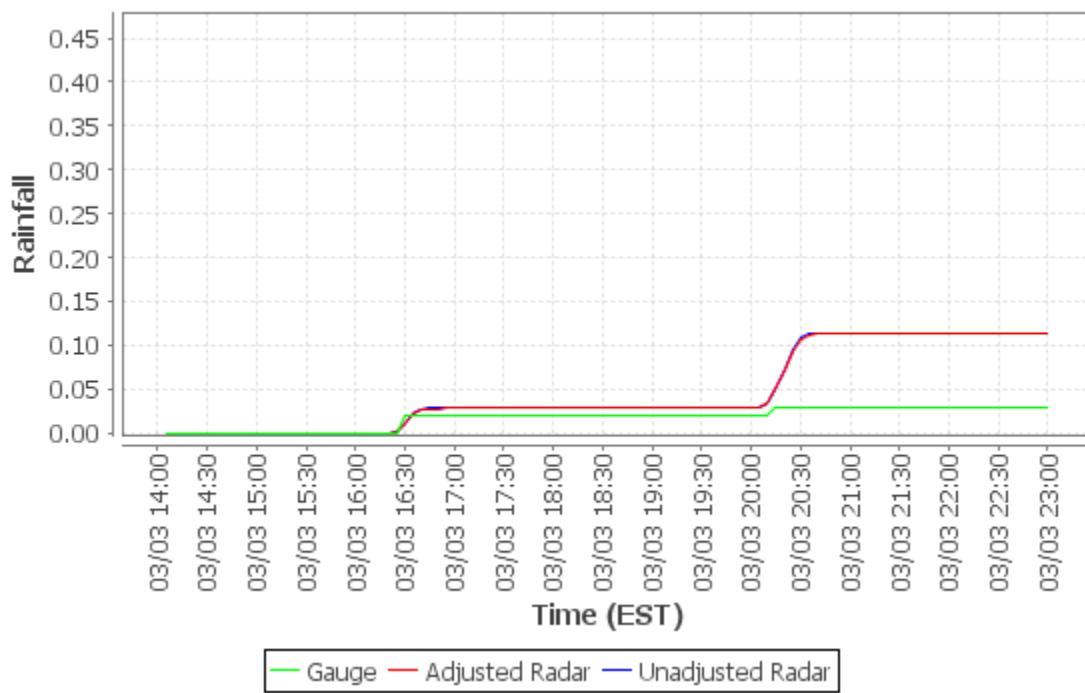
Cumulative Distribution Plot - Shaler Munic Bldg (Loc03)



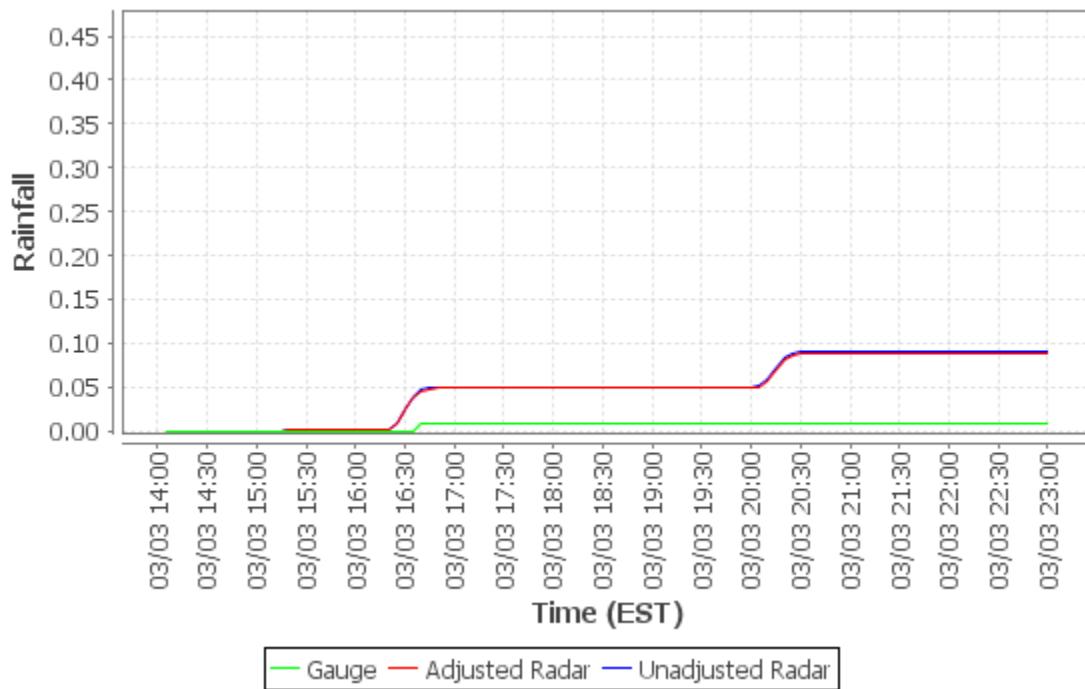
Cumulative Distribution Plot - Kennedy Twp PS (Loc04)



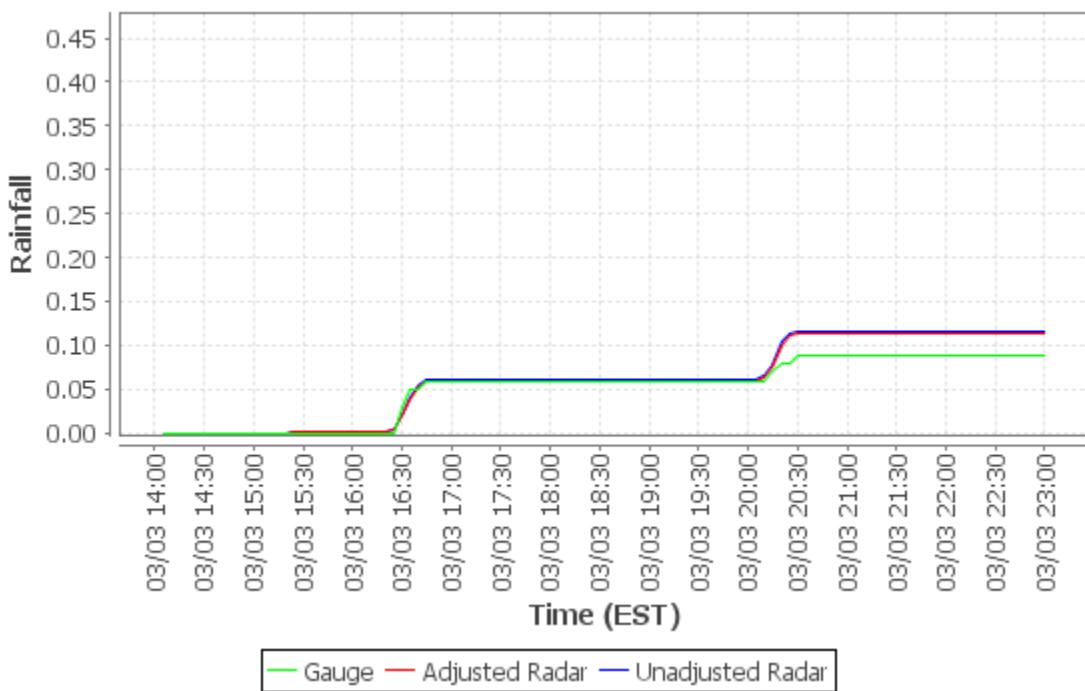
Cumulative Distribution Plot - Upper St. Clair (Loc05)



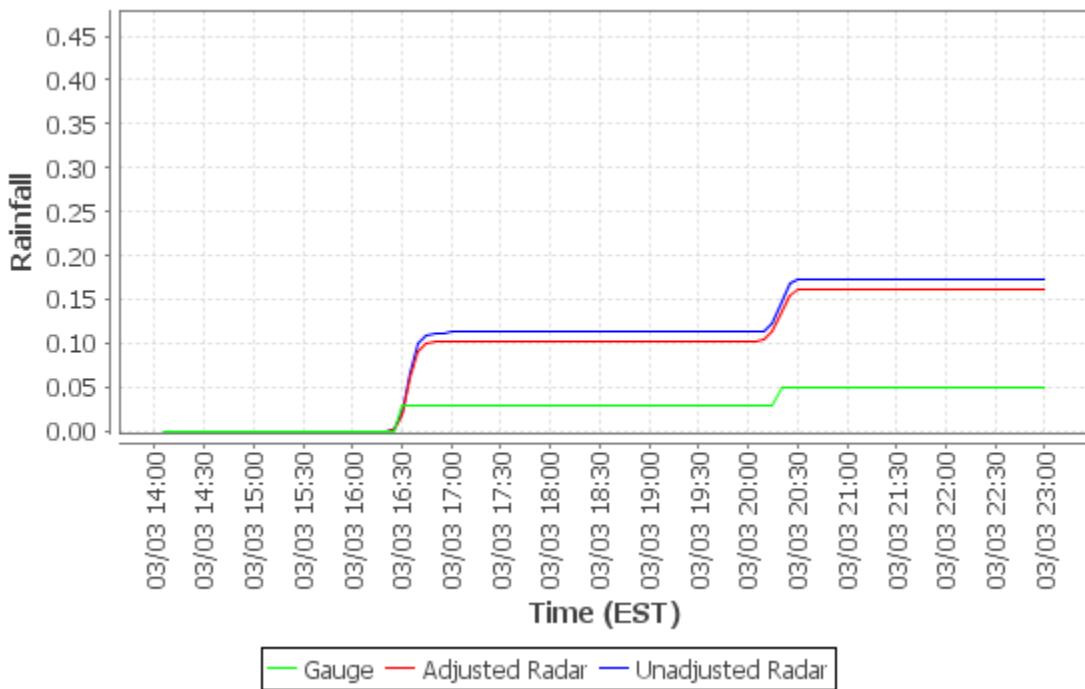
Cumulative Distribution Plot - Carnegie Transit Time (Loc06)



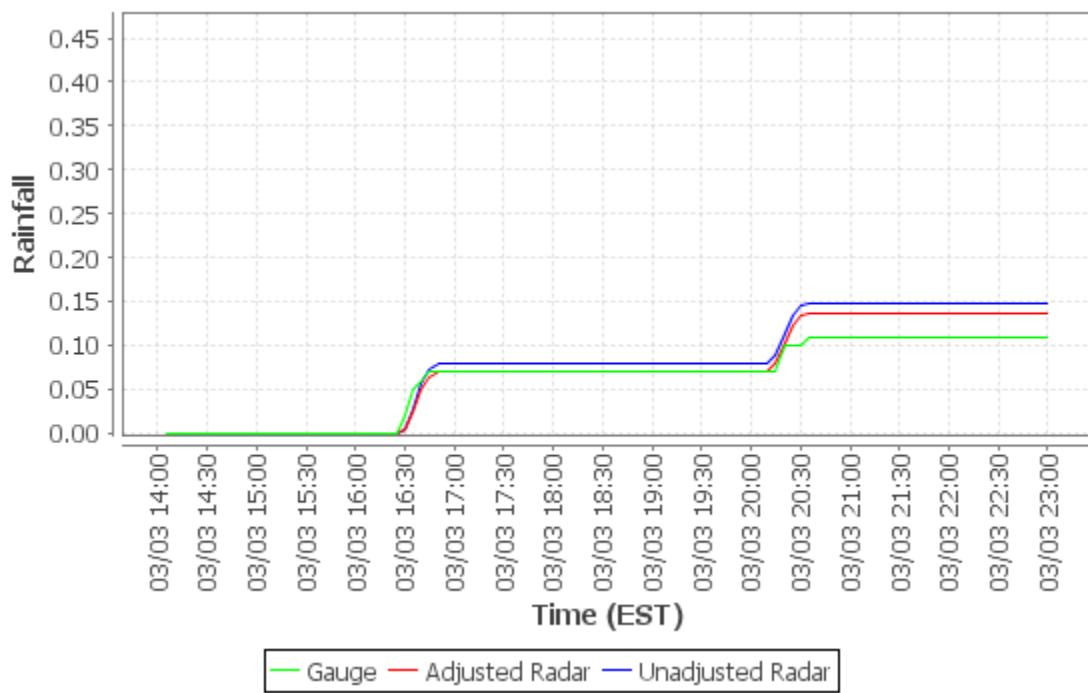
Cumulative Distribution Plot - Greentree Munic Bldg (Loc07)



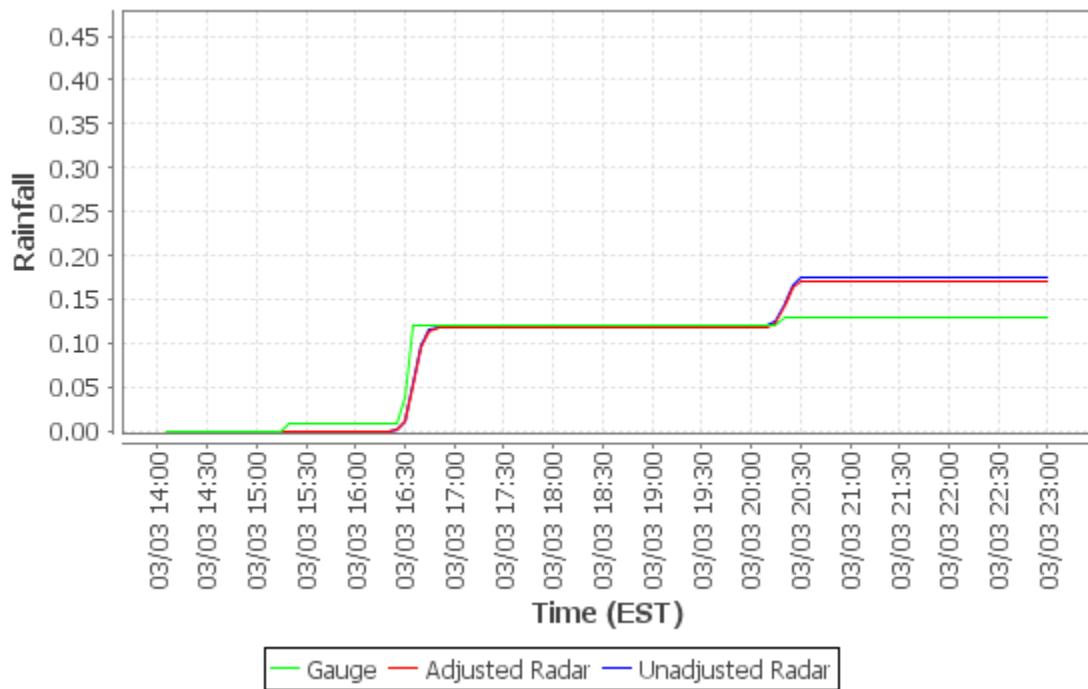
Cumulative Distribution Plot - AC Health Dept Bldg (Loc08)



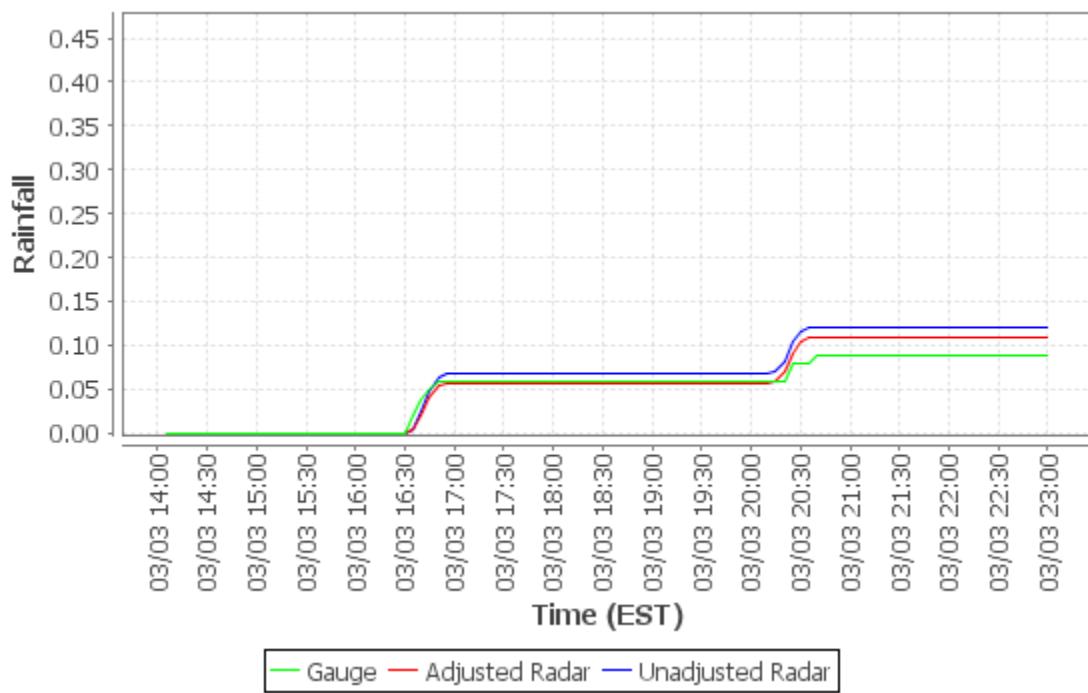
Cumulative Distribution Plot - Univ of Pittsburgh (Loc09)



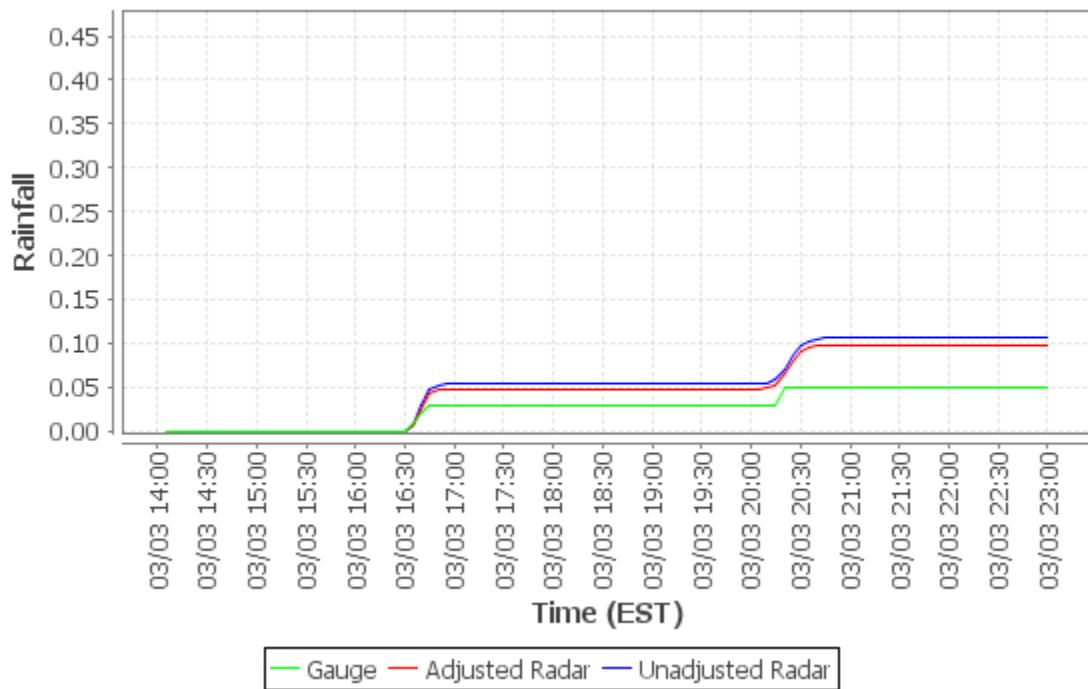
Cumulative Distribution Plot - PWSA-Highland Park (Loc10)



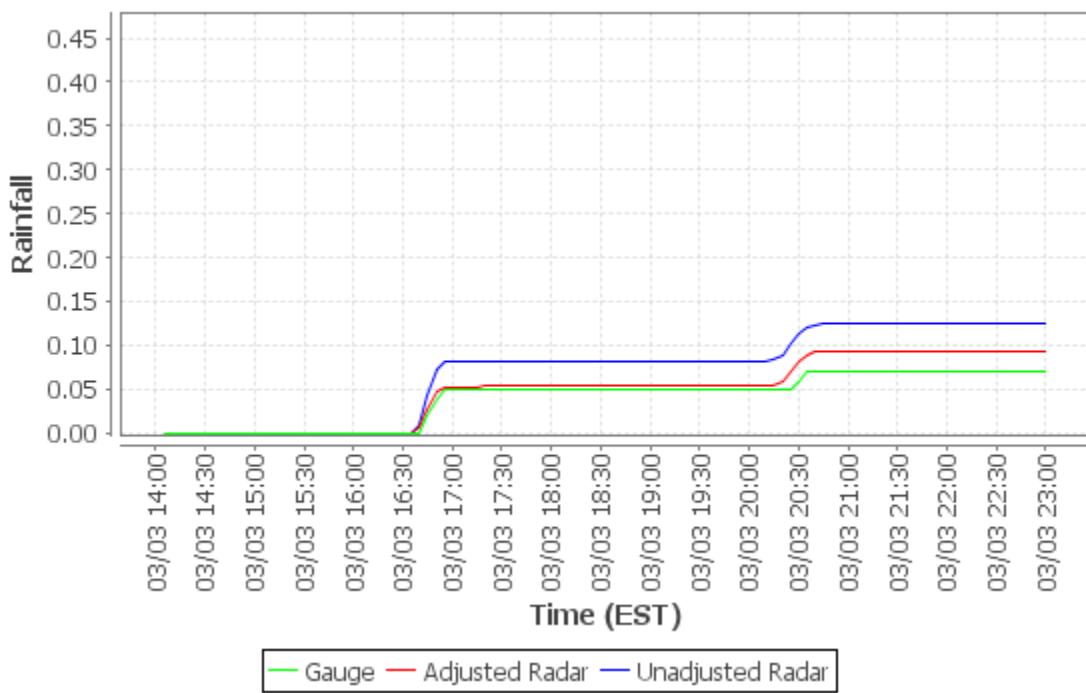
Cumulative Distribution Plot - M-46 Access Shaft (Loc11)



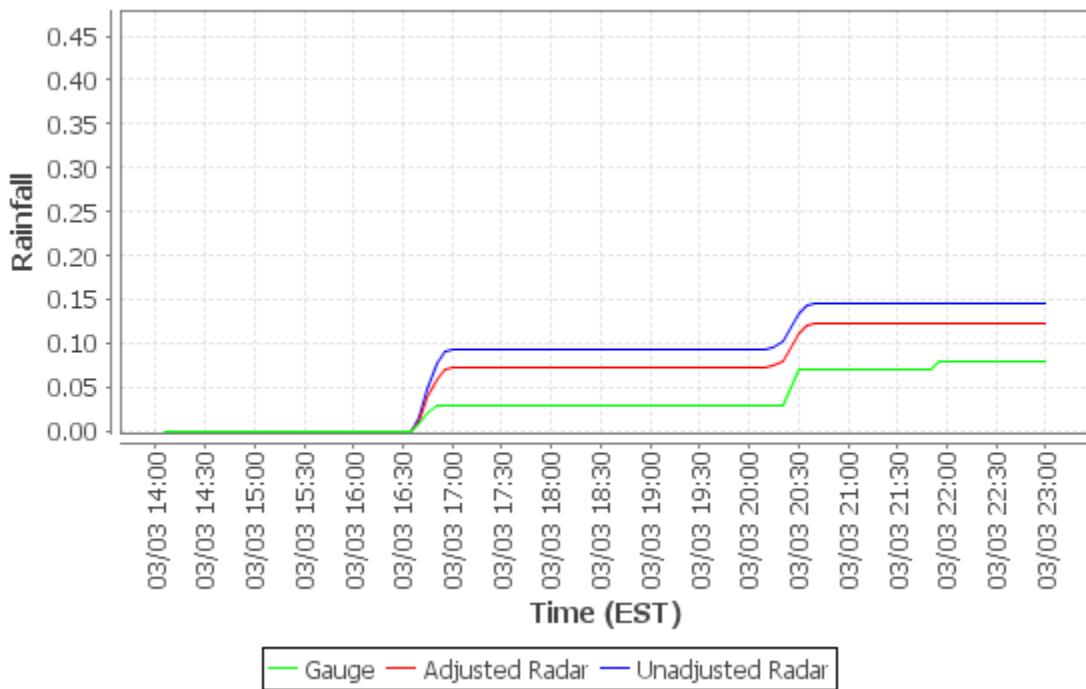
Cumulative Distribution Plot - Baldwin (Loc12)



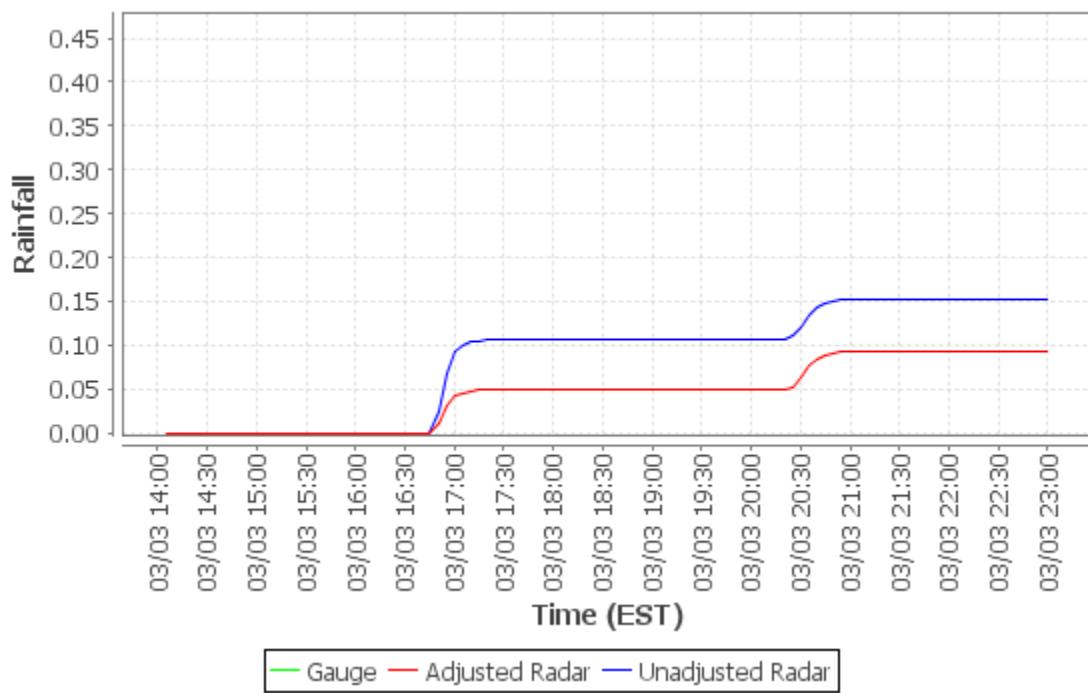
Cumulative Distribution Plot - M-59 Access Shaft (Loc13)



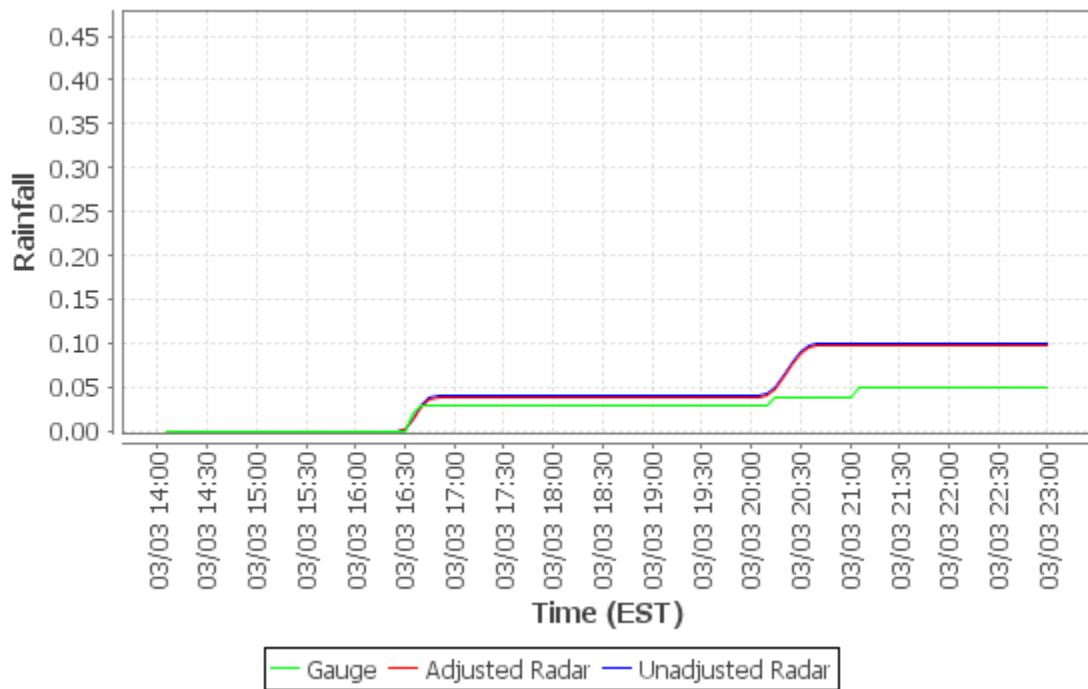
Cumulative Distribution Plot - Churchill Munic Bldg (Loc14)



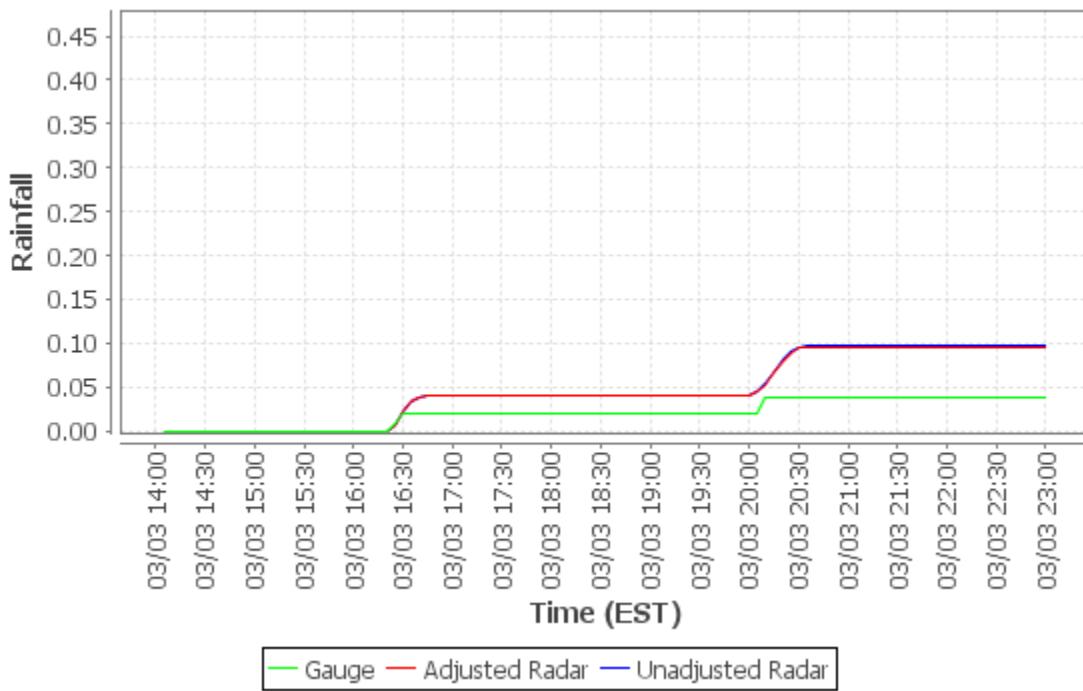
Cumulative Distribution Plot - Trafford Maint Bldg (Loc15)



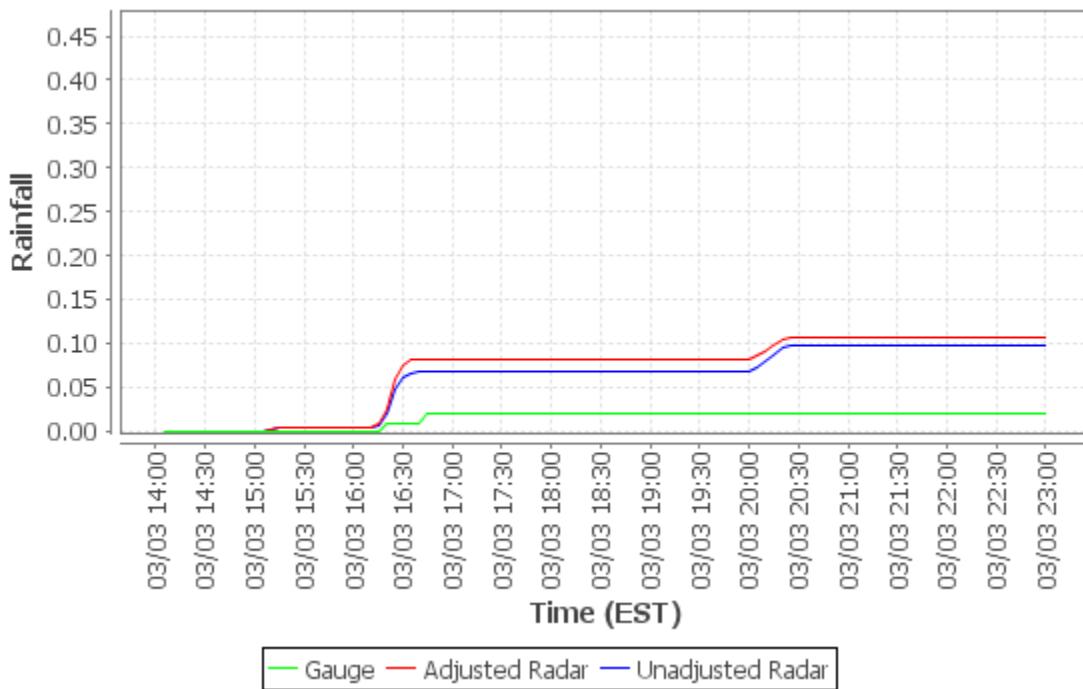
Cumulative Distribution Plot - Castle Shannon (Loc16)



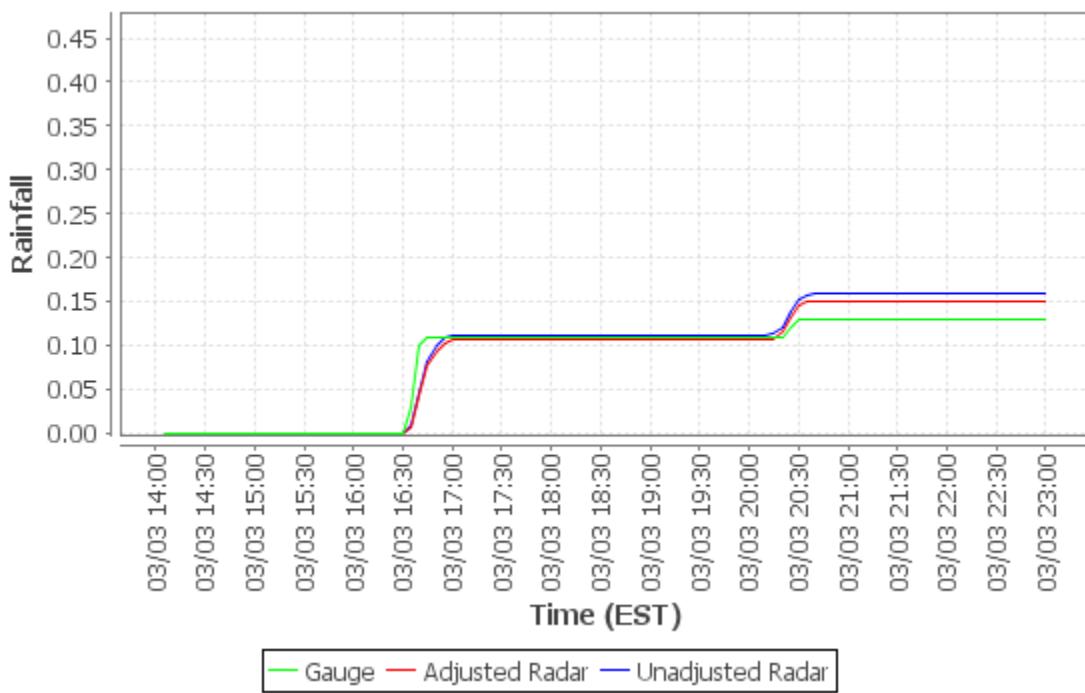
Cumulative Distribution Plot - Chartiers Pump Station (Loc17)



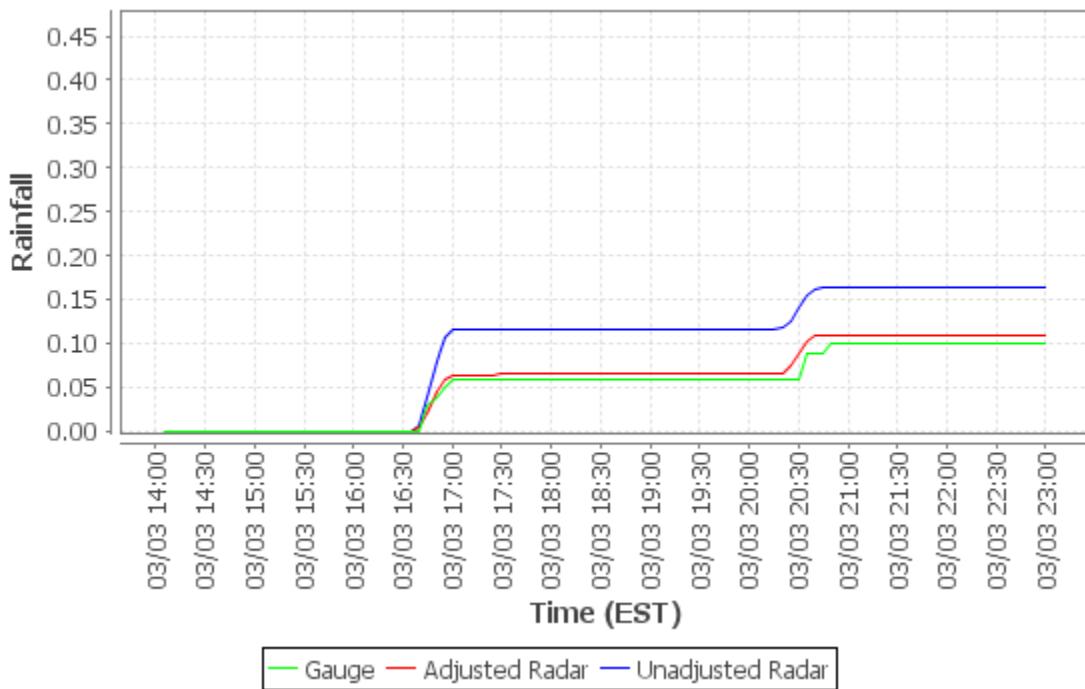
Cumulative Distribution Plot - Oakdale Pump Station (Loc18)



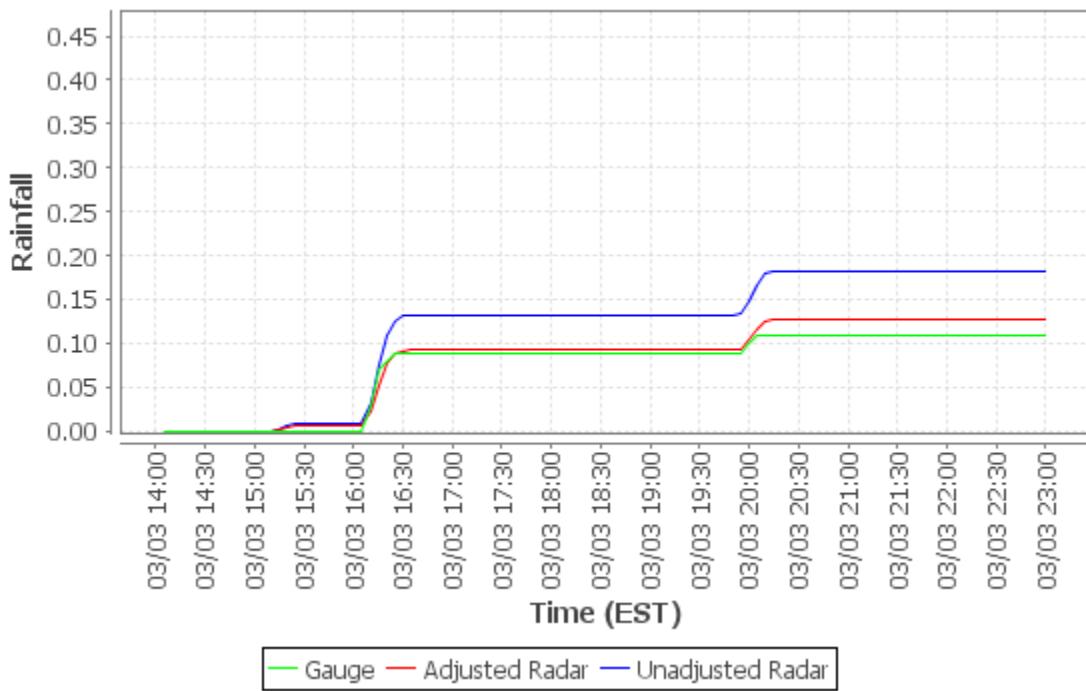
Cumulative Distribution Plot - Sandy Creek Eq Facility (Loc19)



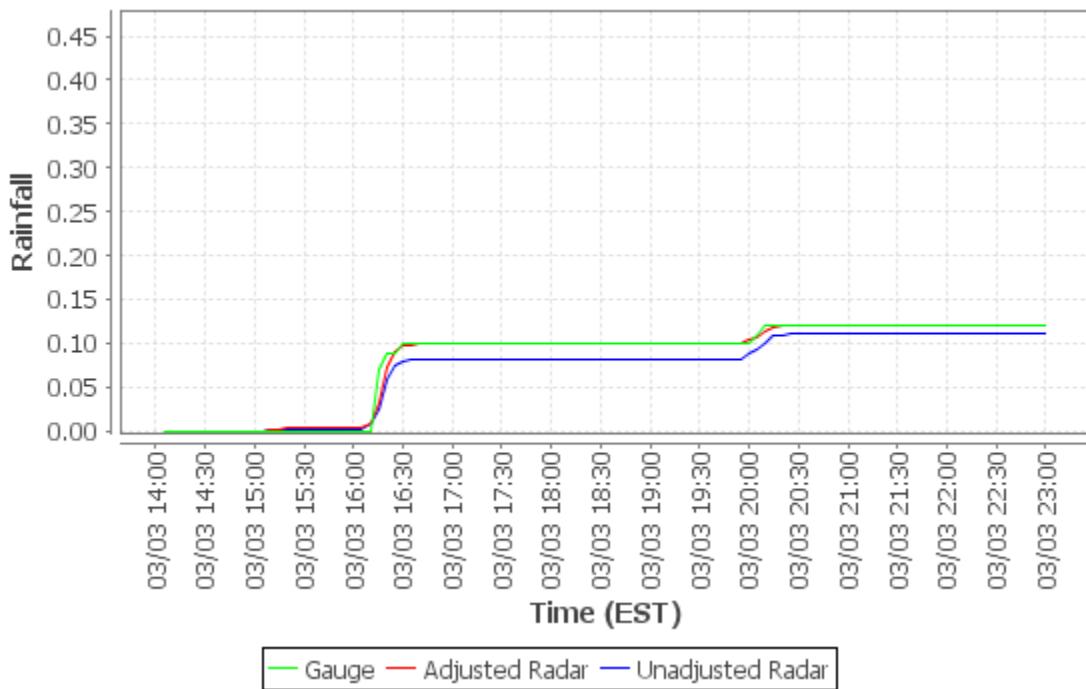
Cumulative Distribution Plot - Gascola Eq Facility (Loc20)



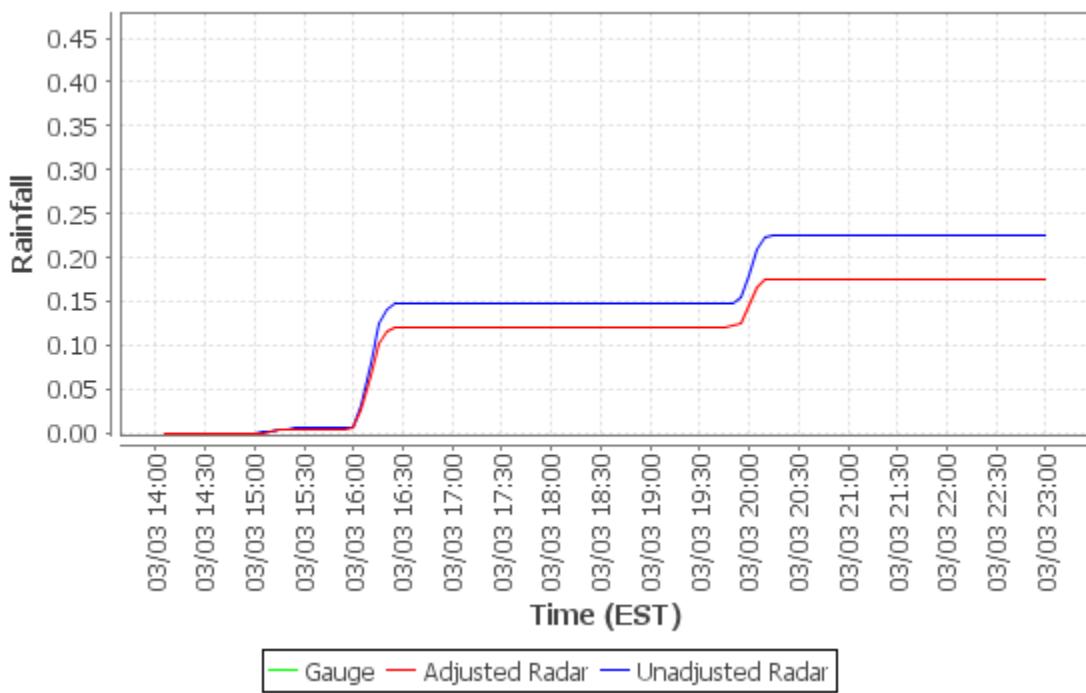
Cumulative Distribution Plot - Moon TWP (Loc21)



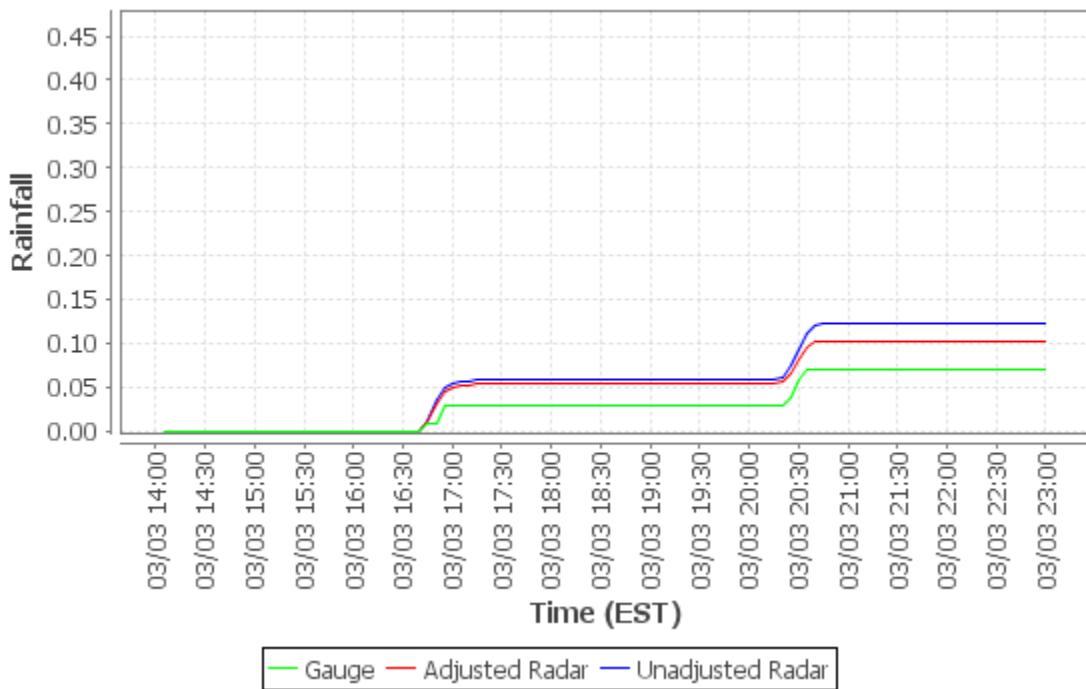
Cumulative Distribution Plot - North Fayette TWP (Loc22)



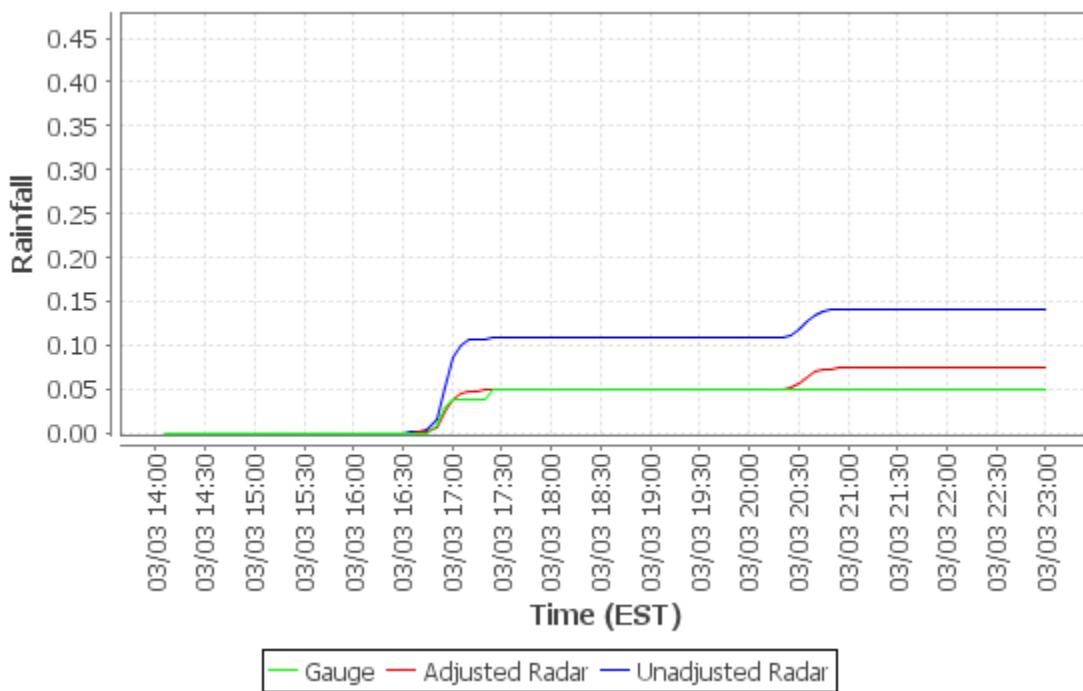
Cumulative Distribution Plot - Clinton Munic Bldg (Loc23)



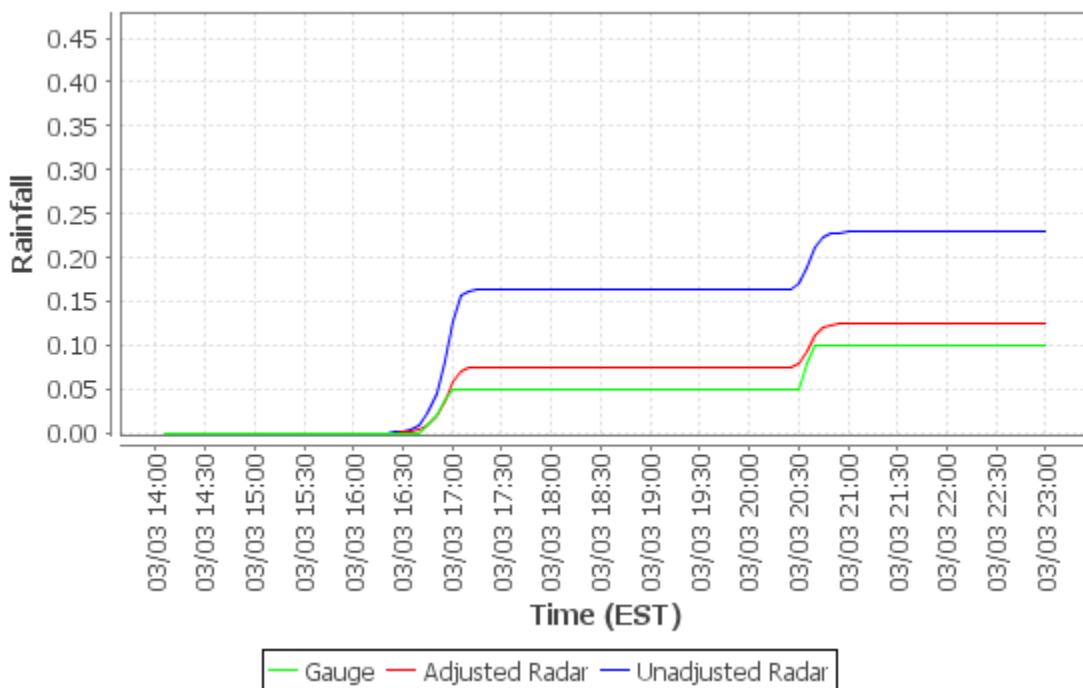
Cumulative Distribution Plot - Jefferson Hills (Loc24)



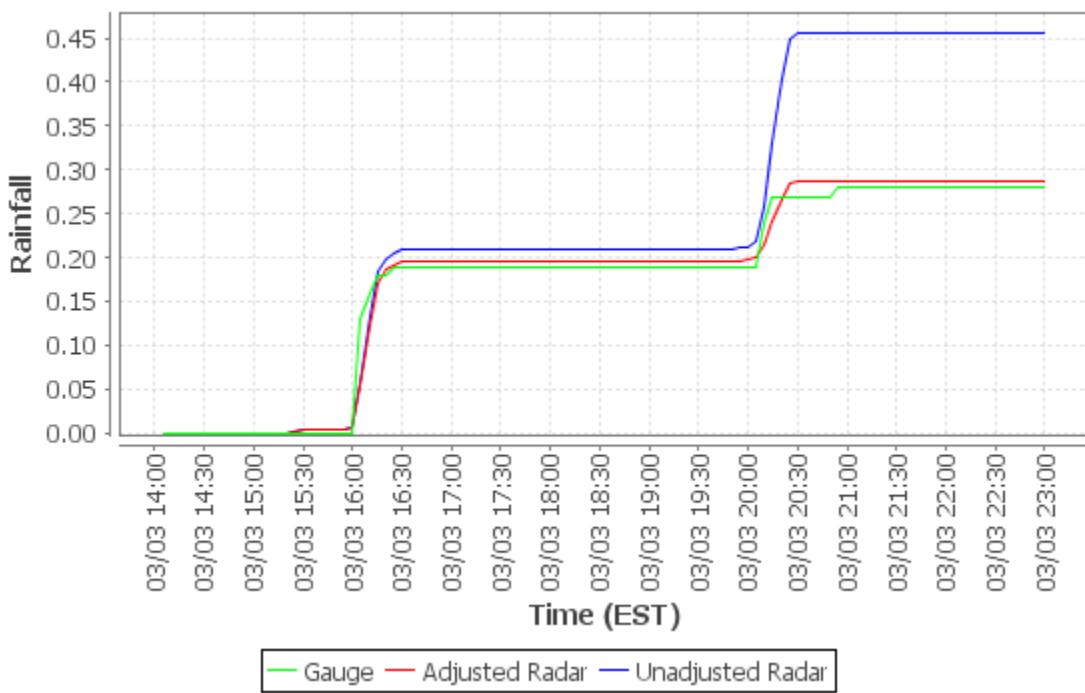
Cumulative Distribution Plot - White Oak Public Works Bldg (Loc25)



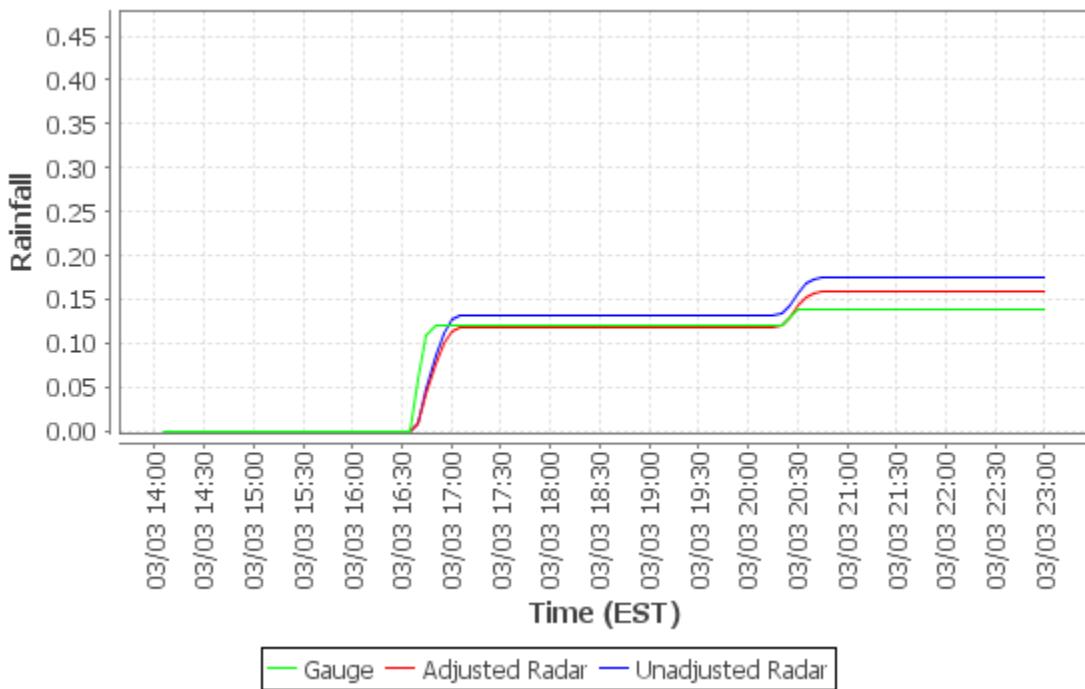
Cumulative Distribution Plot - Elizabeth TWP Municipal Bldg (Loc26)



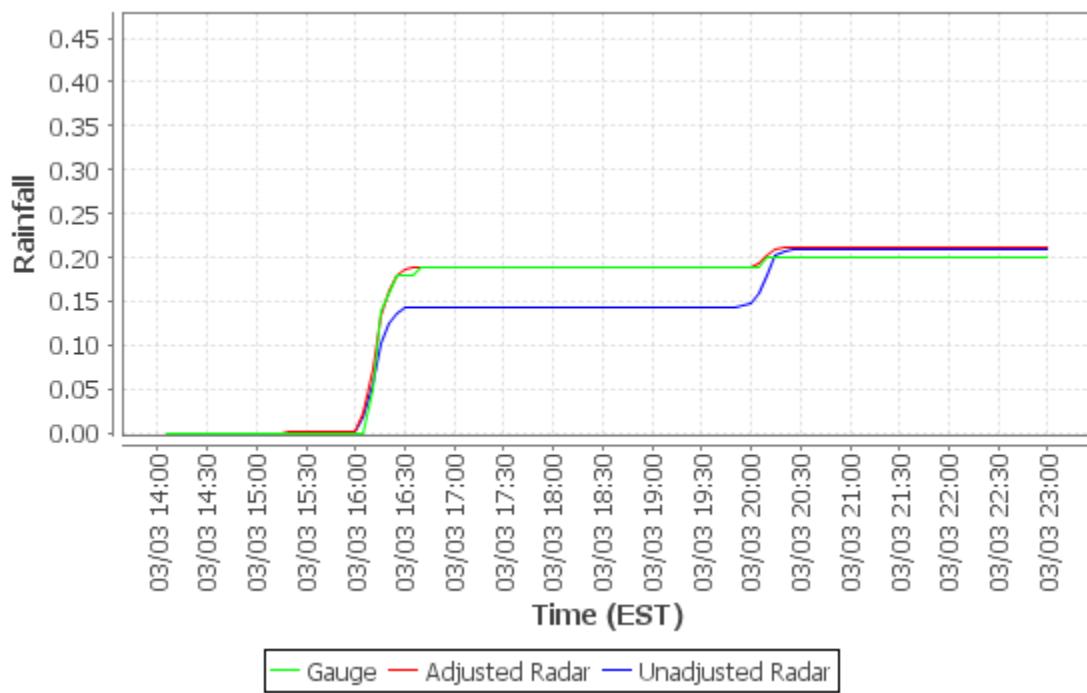
Cumulative Distribution Plot - Marshall TWP (Loc27)



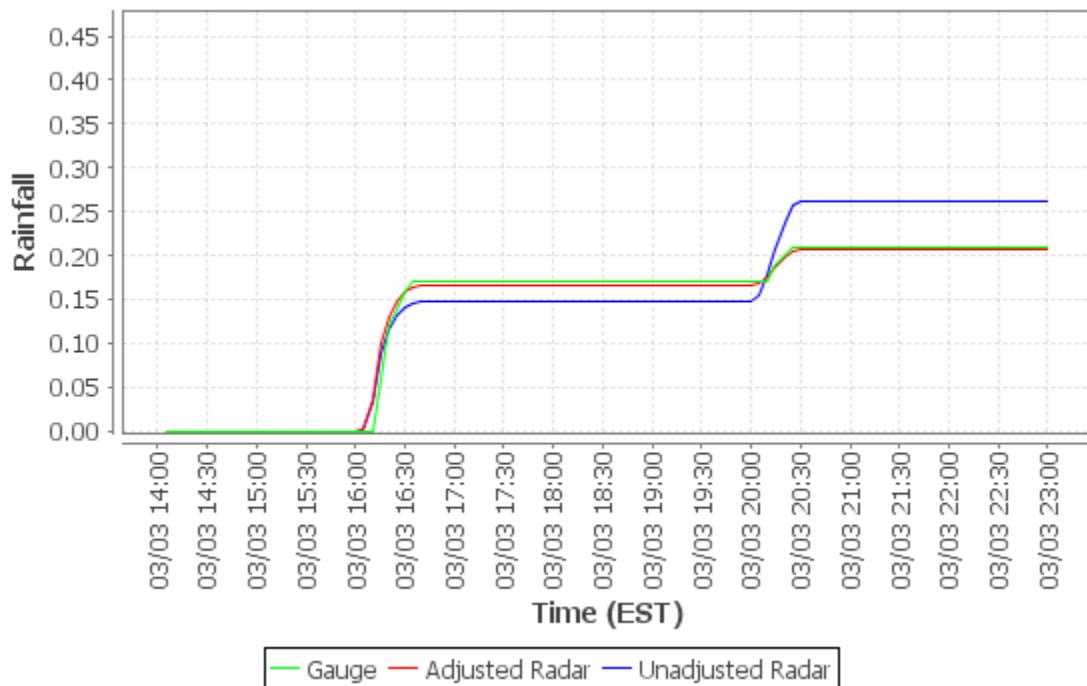
Cumulative Distribution Plot - Plum Municipal Bldg (Loc28)



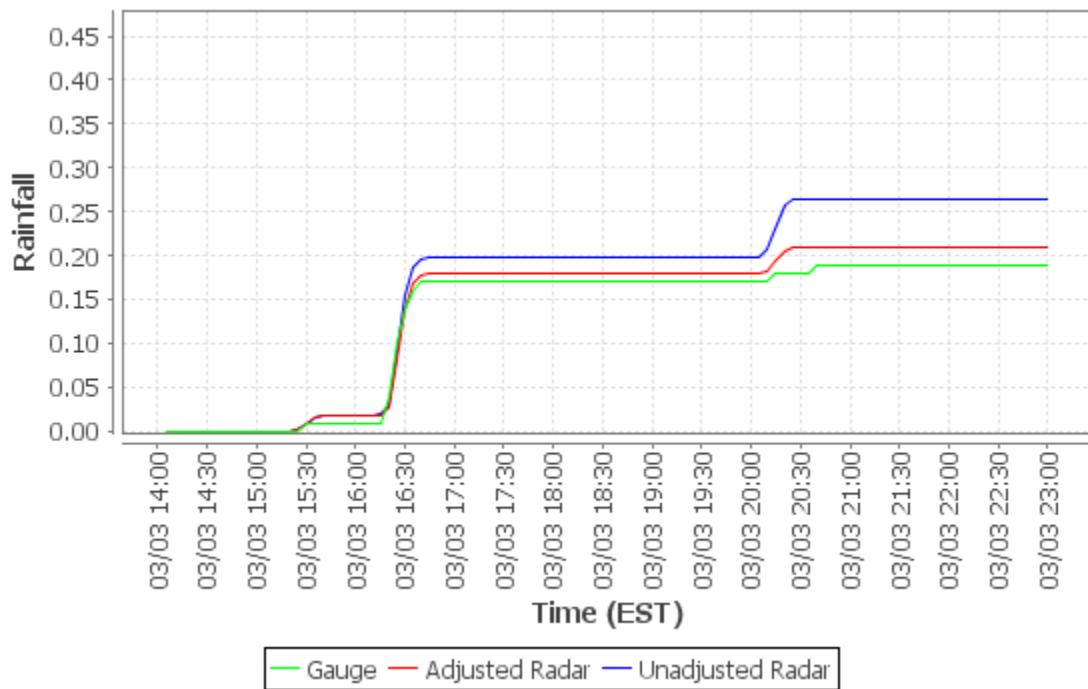
Cumulative Distribution Plot - Bell Acres Munic Bldg (Loc29)



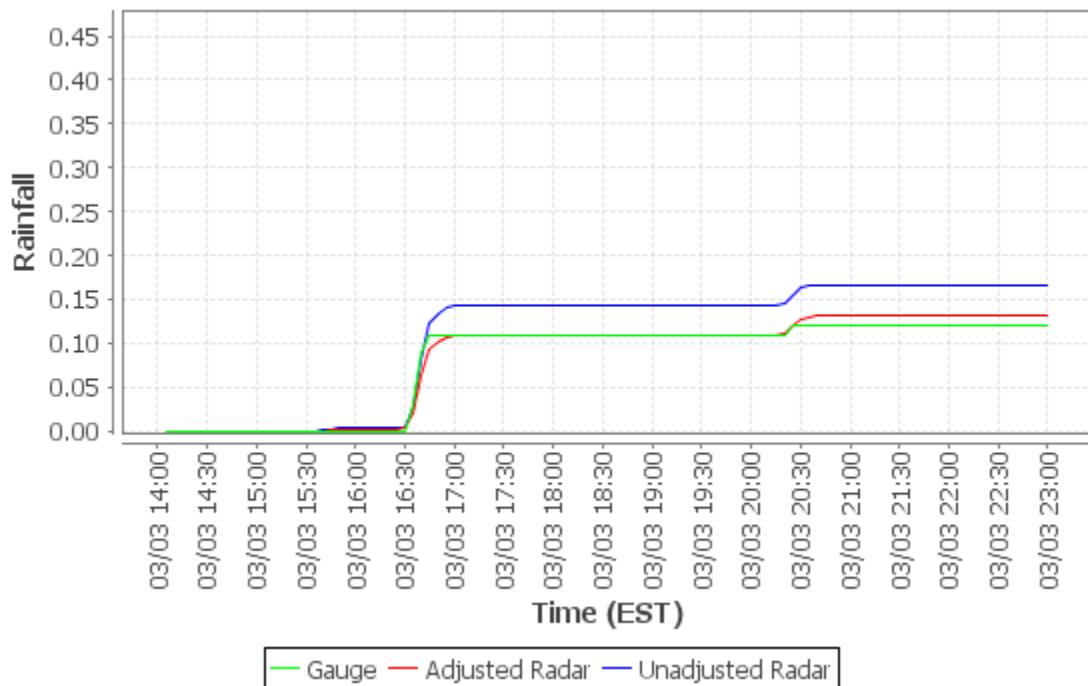
Cumulative Distribution Plot - McCandless Twn Hall (Loc30)



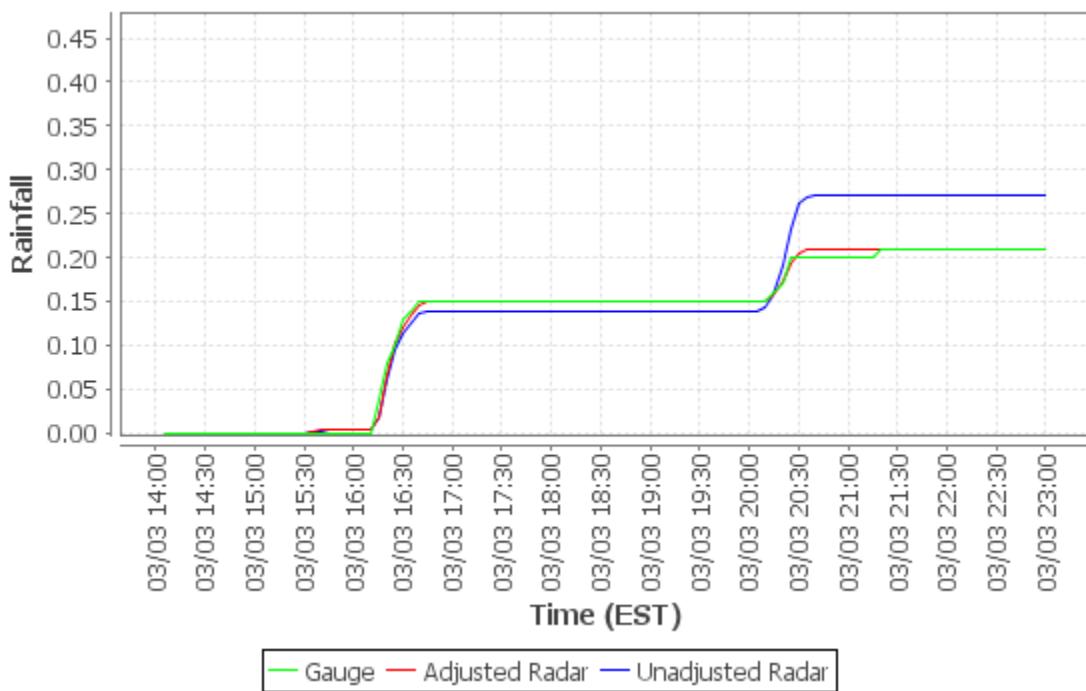
Cumulative Distribution Plot - Hampton Municipal Bldg (Loc31)



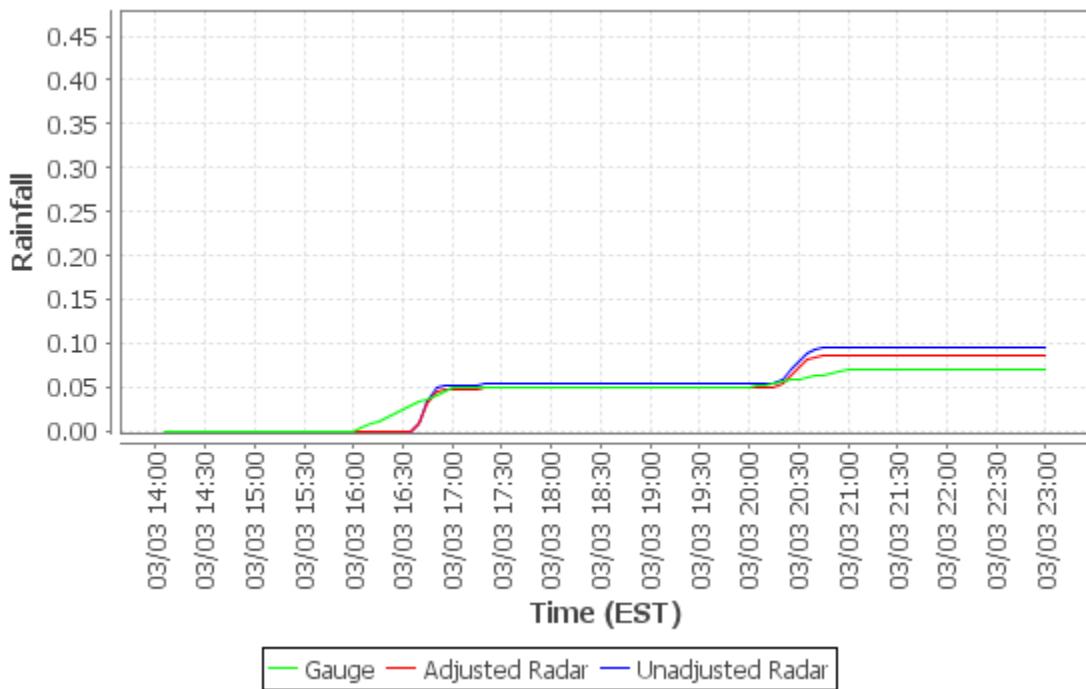
Cumulative Distribution Plot - Arnold (Loc32)



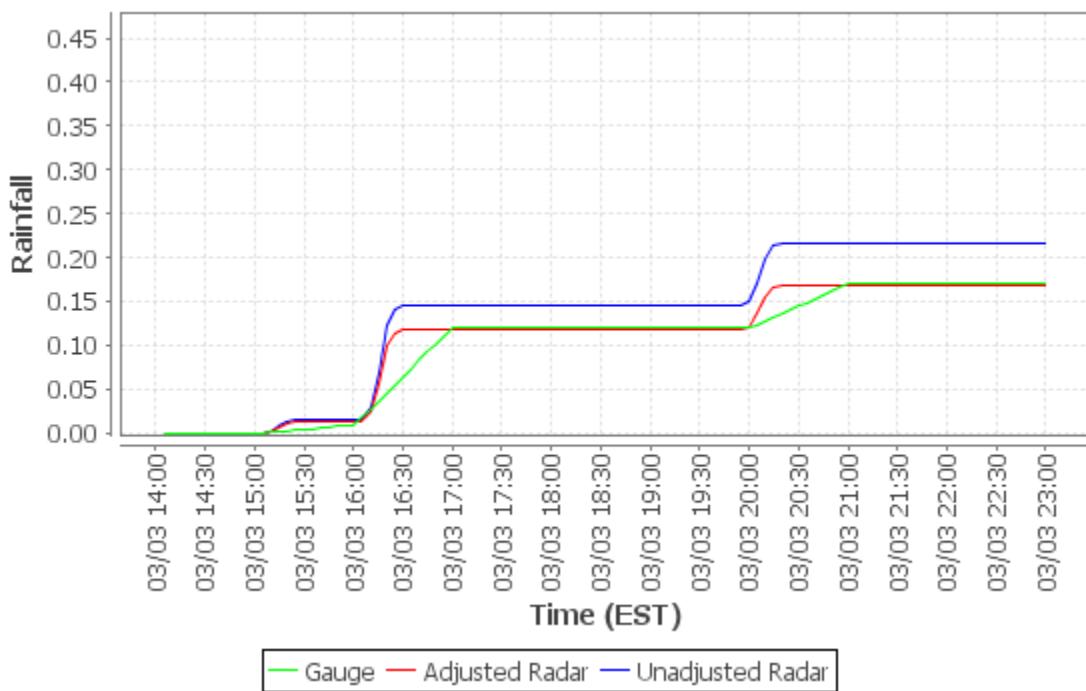
Cumulative Distribution Plot - Richland TWP (Loc33)



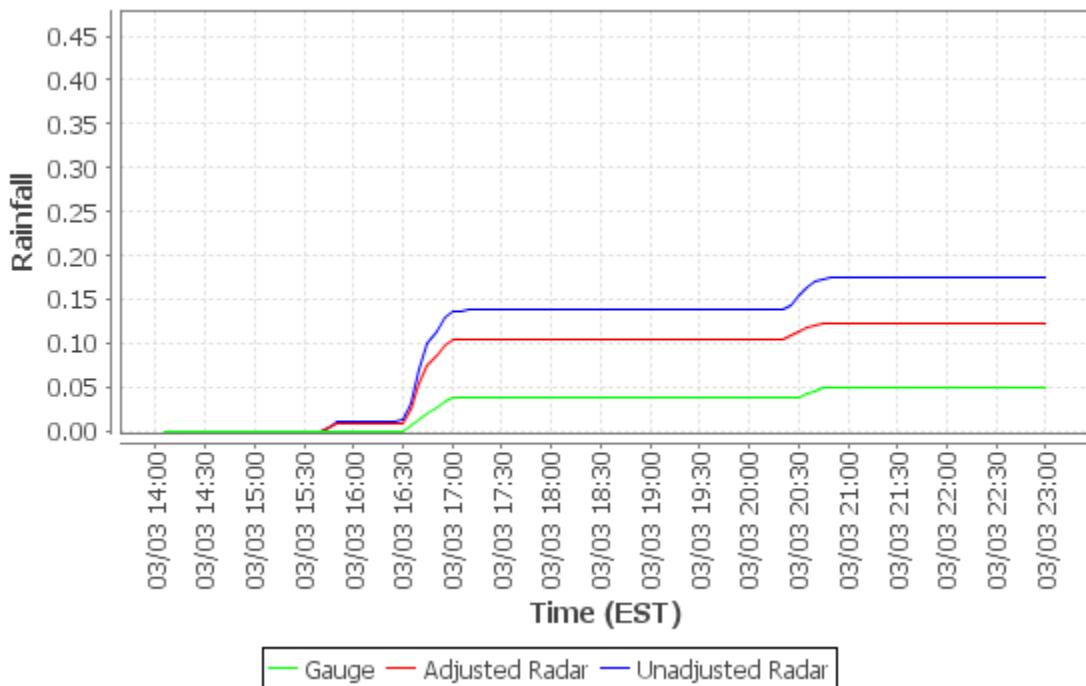
Cumulative Distribution Plot - Pittsburgh Allegheny Cty (KAGC)



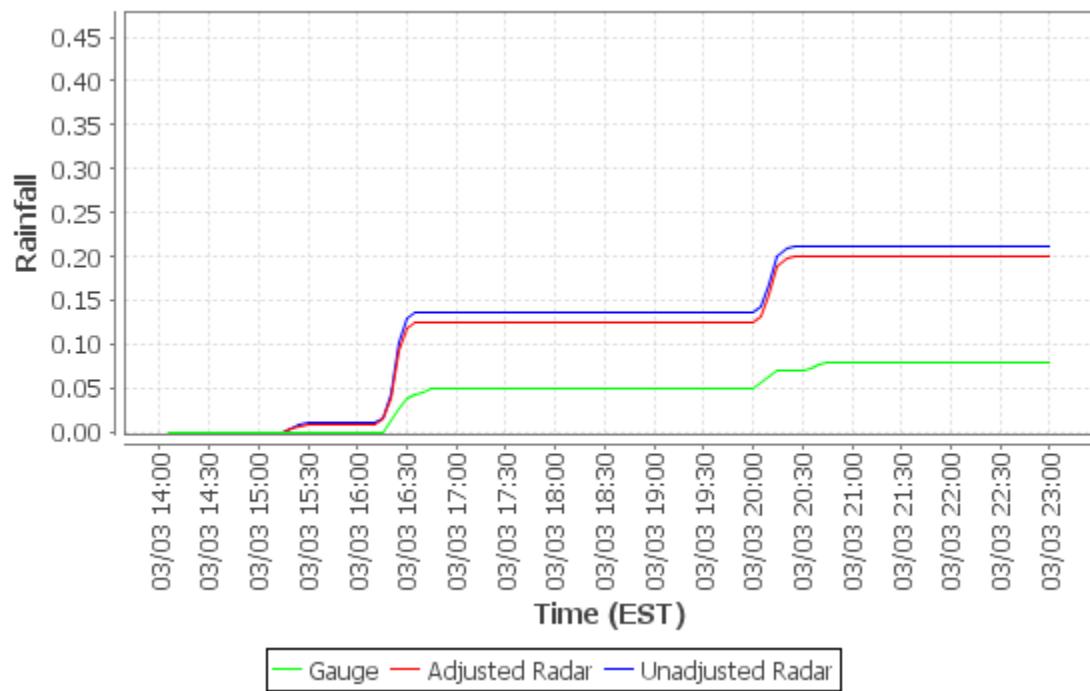
Cumulative Distribution Plot - Greater Pittsburgh Int'l (KPIT)



Cumulative Distribution Plot - Allegheny River at Natrona (03049500)

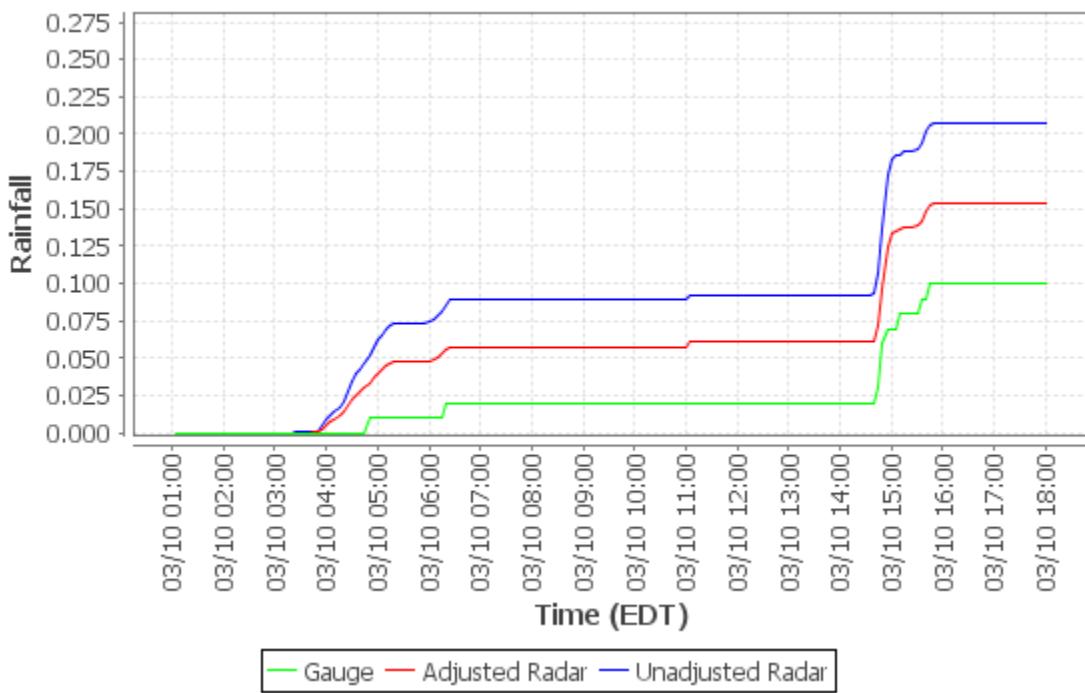


**Cumulative Distribution Plot - Ohio River at Emsworth Dam Lower Pool at Emsworth
(03085734)**

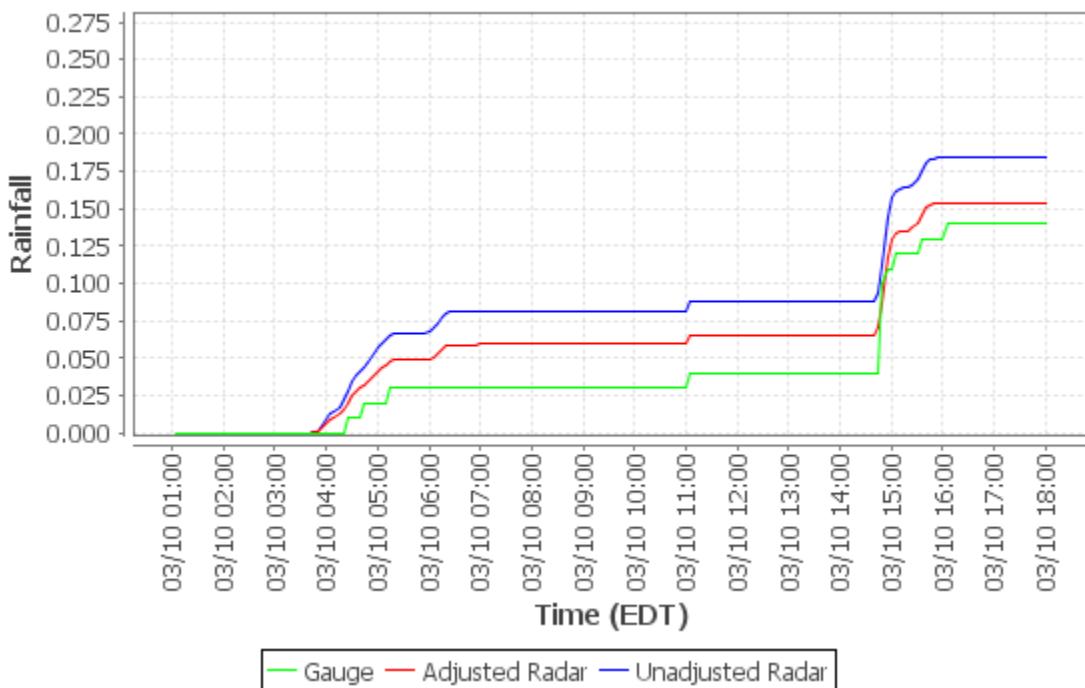


Appendix F - Event 4 (2020-03-10) CDPs

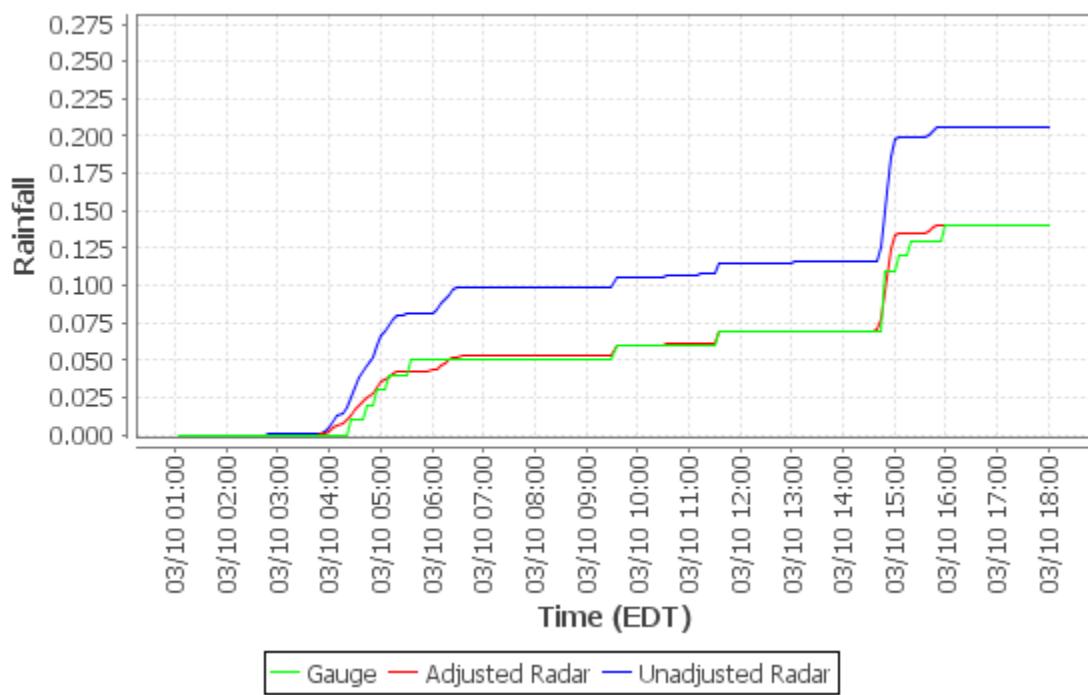
Cumulative Distribution Plot - PWSA-Montana St. (Loc01)



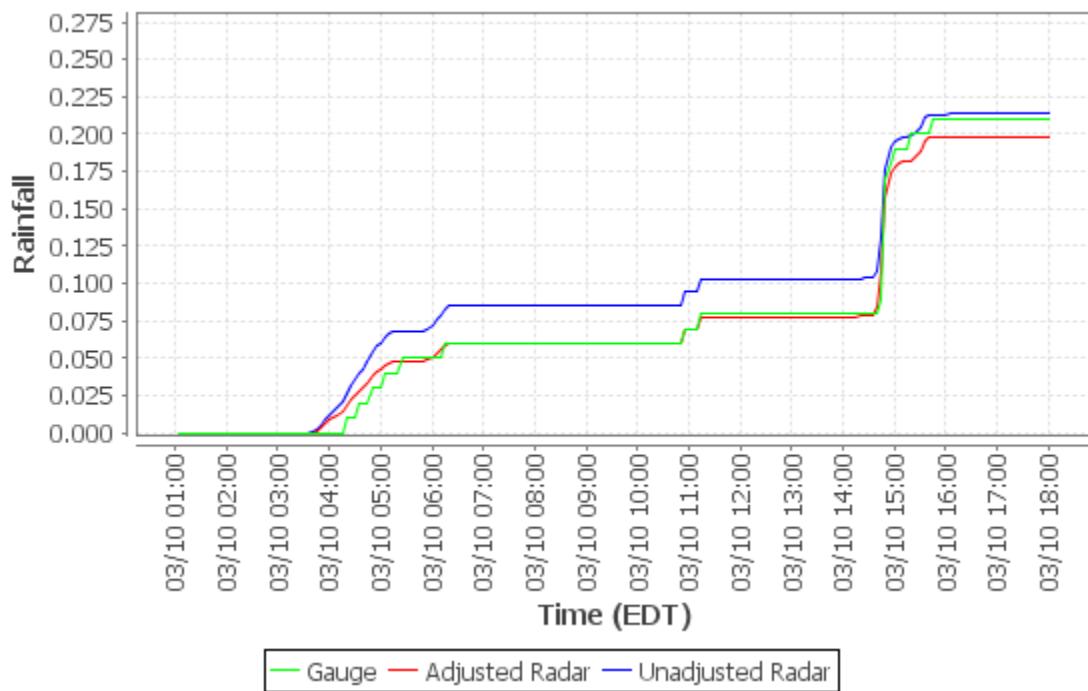
Cumulative Distribution Plot - ALCOSAN WWTP Lab (Loc02)



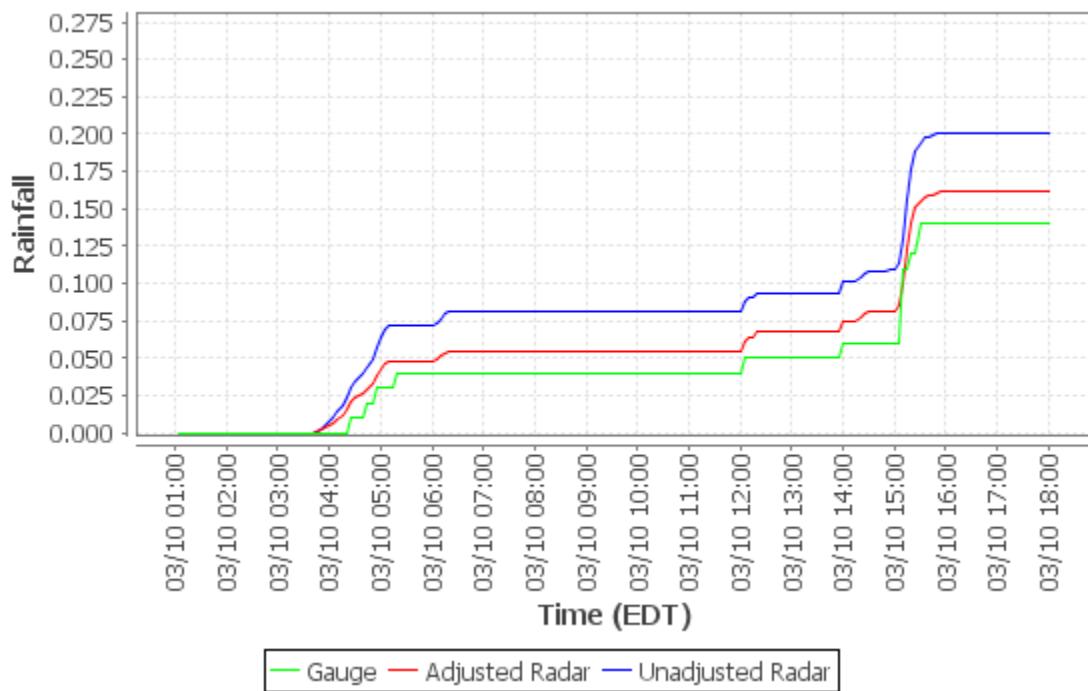
Cumulative Distribution Plot - Shaler Munic Bldg (Loc03)



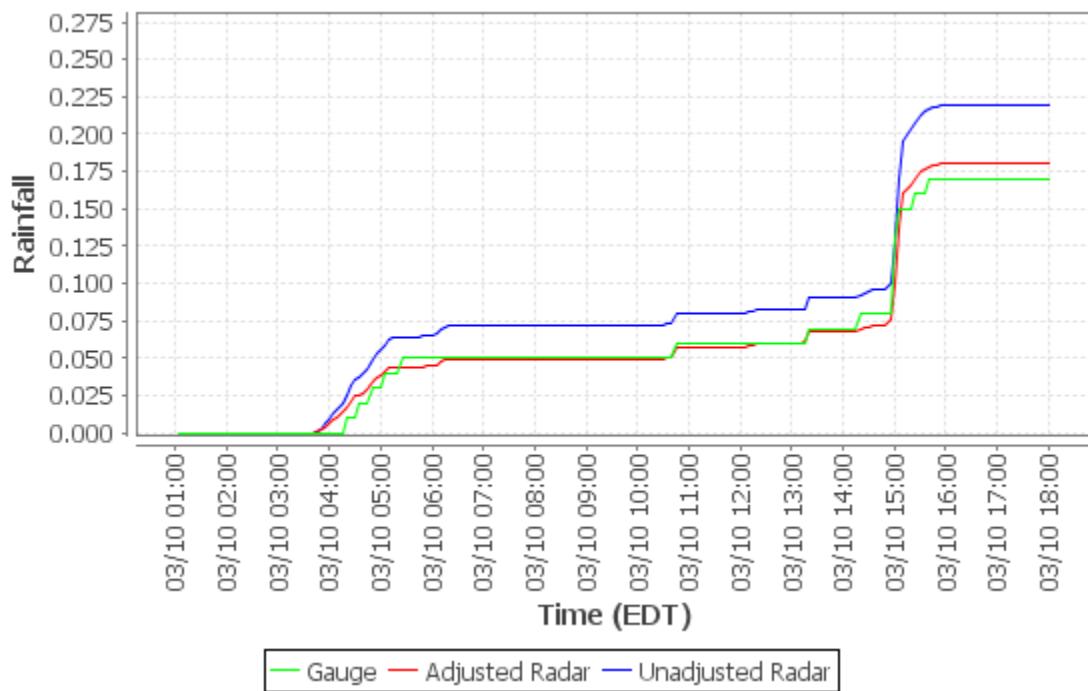
Cumulative Distribution Plot - Kennedy Twp PS (Loc04)



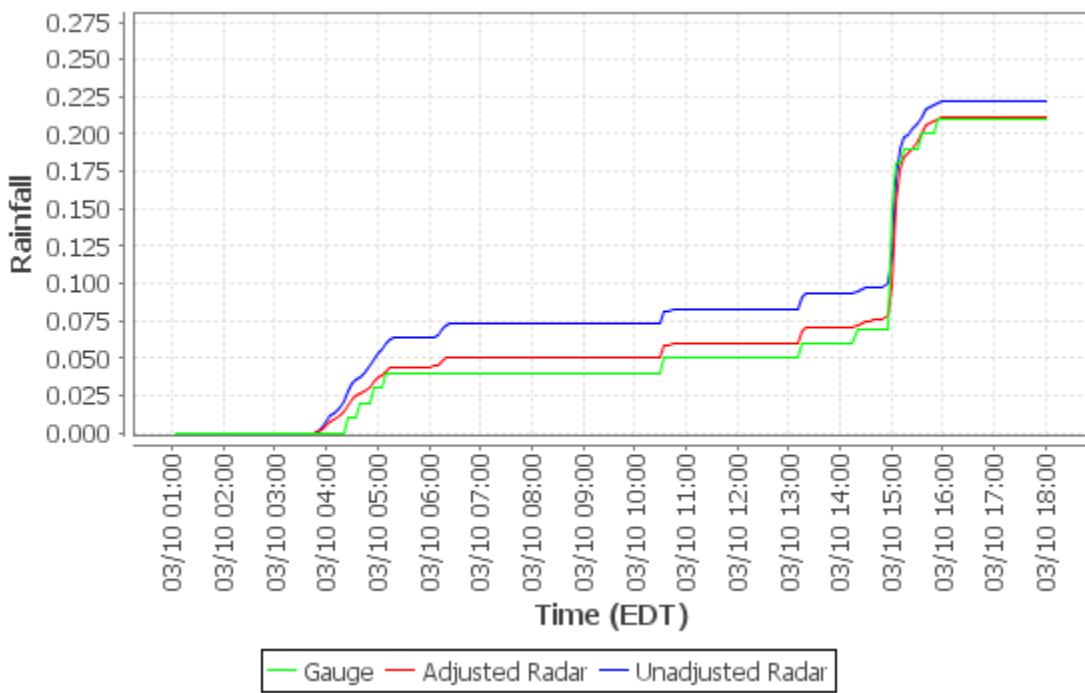
Cumulative Distribution Plot - Upper St. Clair (Loc05)



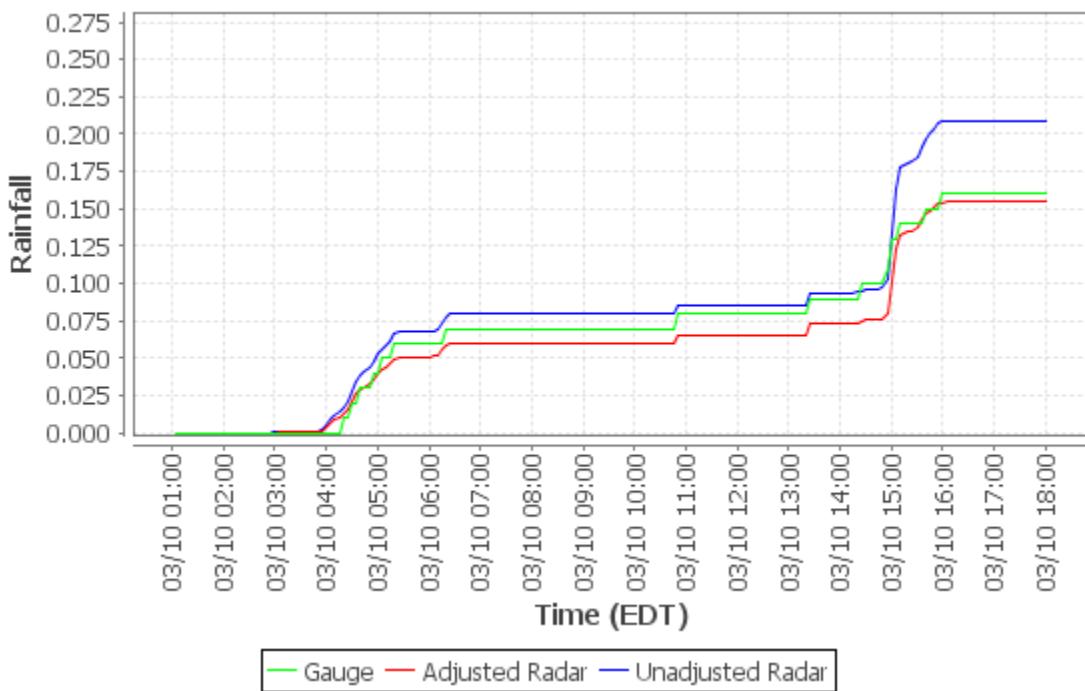
Cumulative Distribution Plot - Carnegie Transit Time (Loc06)



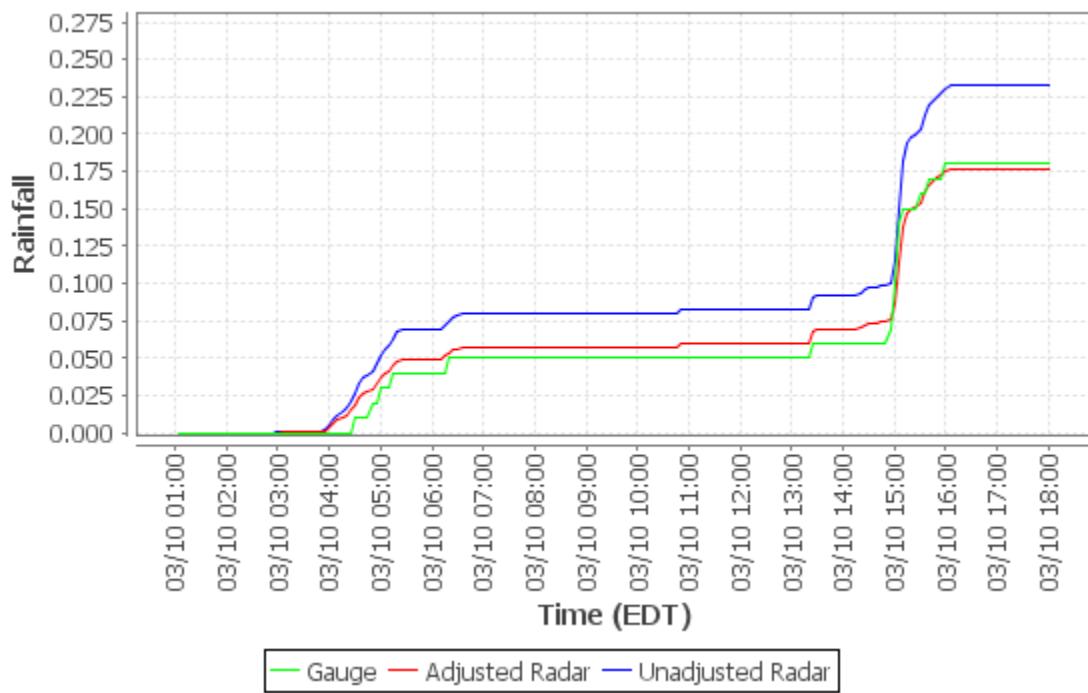
Cumulative Distribution Plot - Greentree Munic Bldg (Loc07)



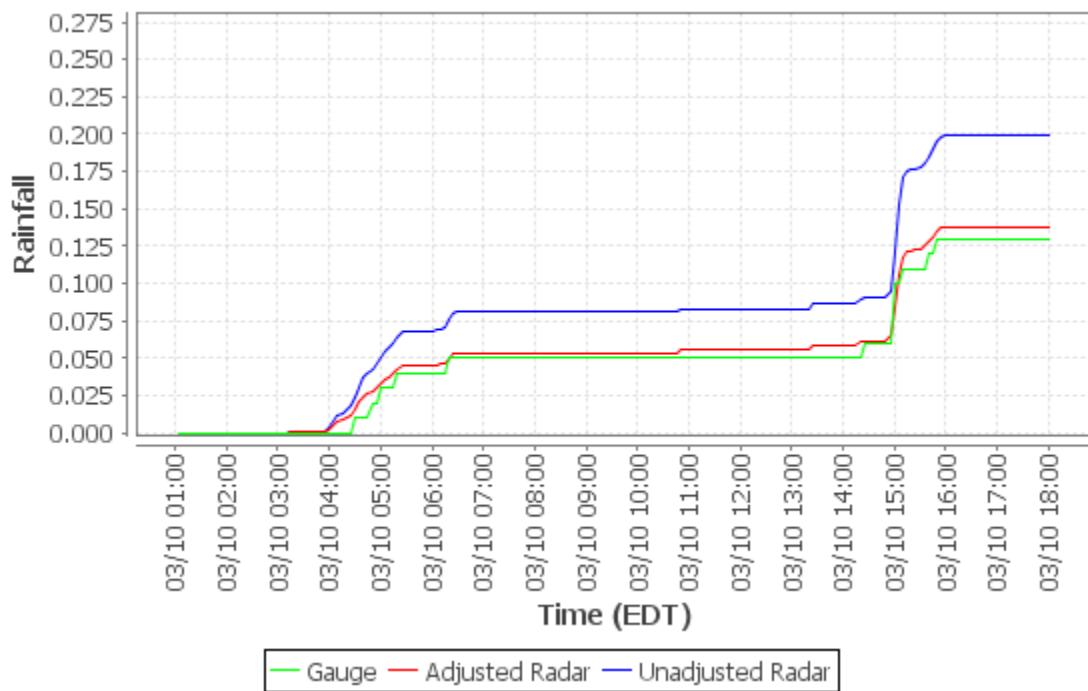
Cumulative Distribution Plot - AC Health Dept Bldg (Loc08)



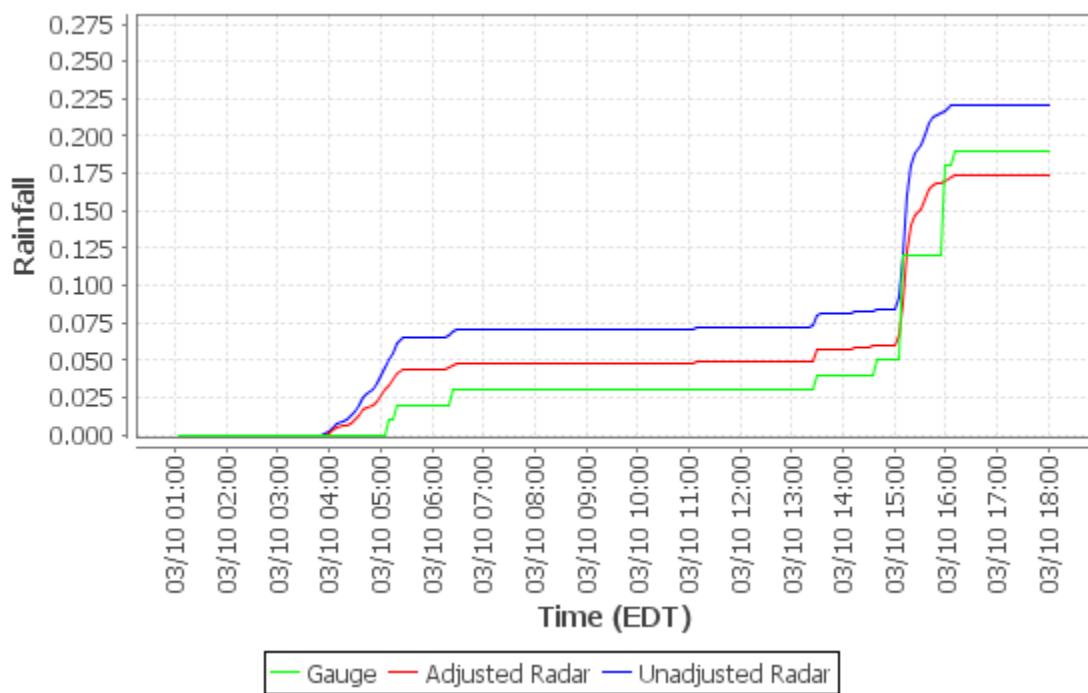
Cumulative Distribution Plot - Univ of Pittsburgh (Loc09)



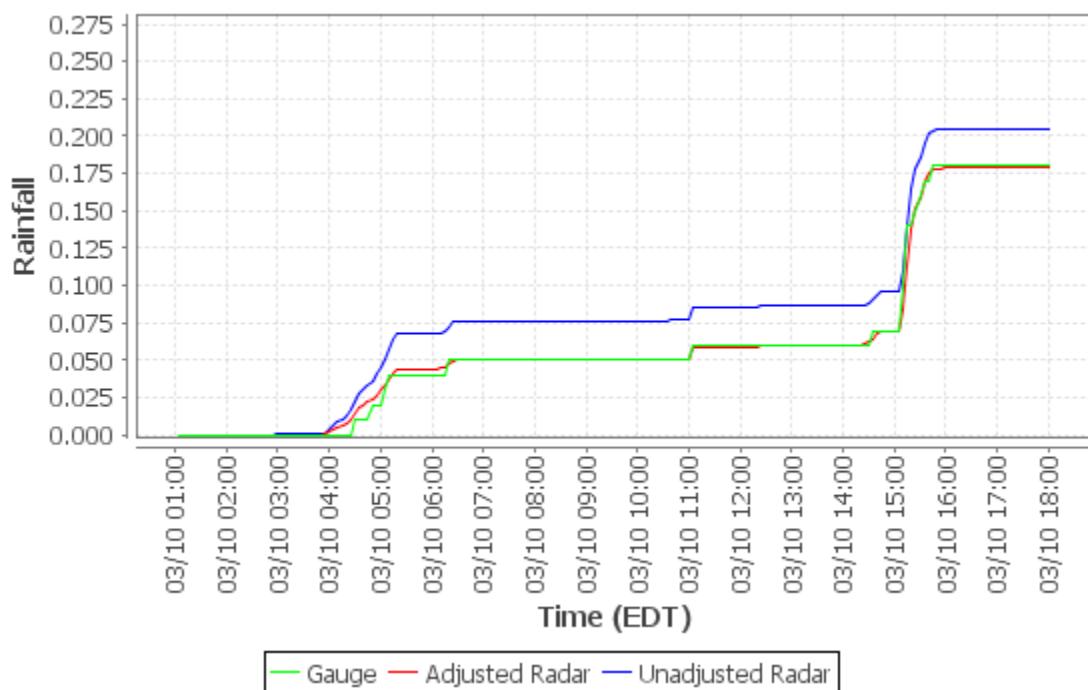
Cumulative Distribution Plot - PWSA-Highland Park (Loc10)



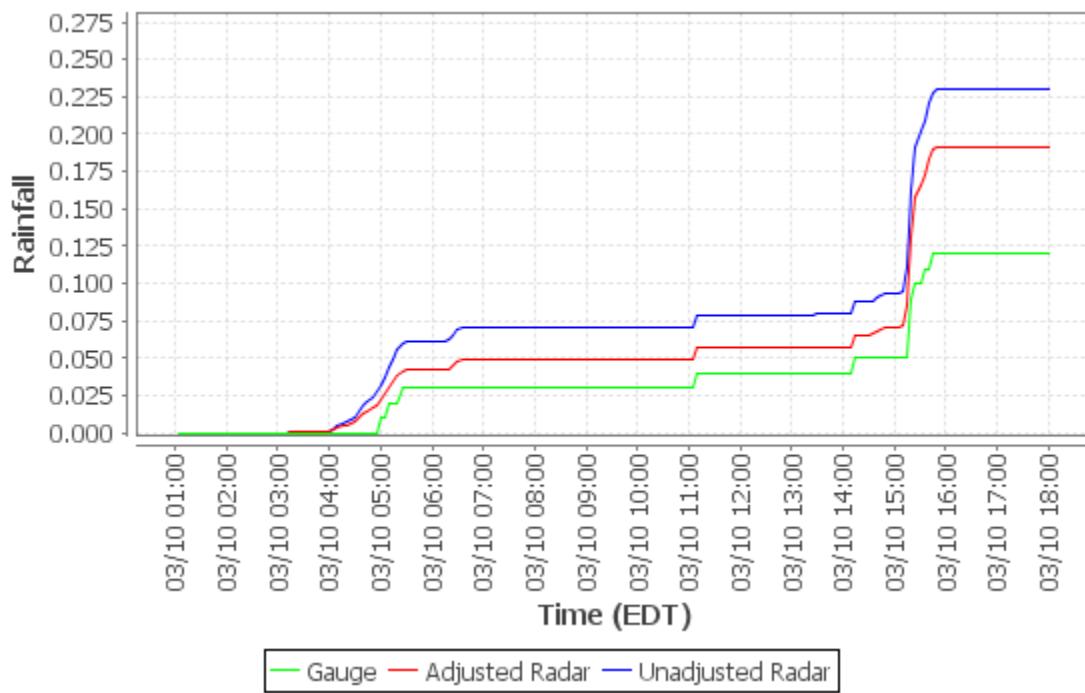
Cumulative Distribution Plot - M-46 Access Shaft (Loc11)



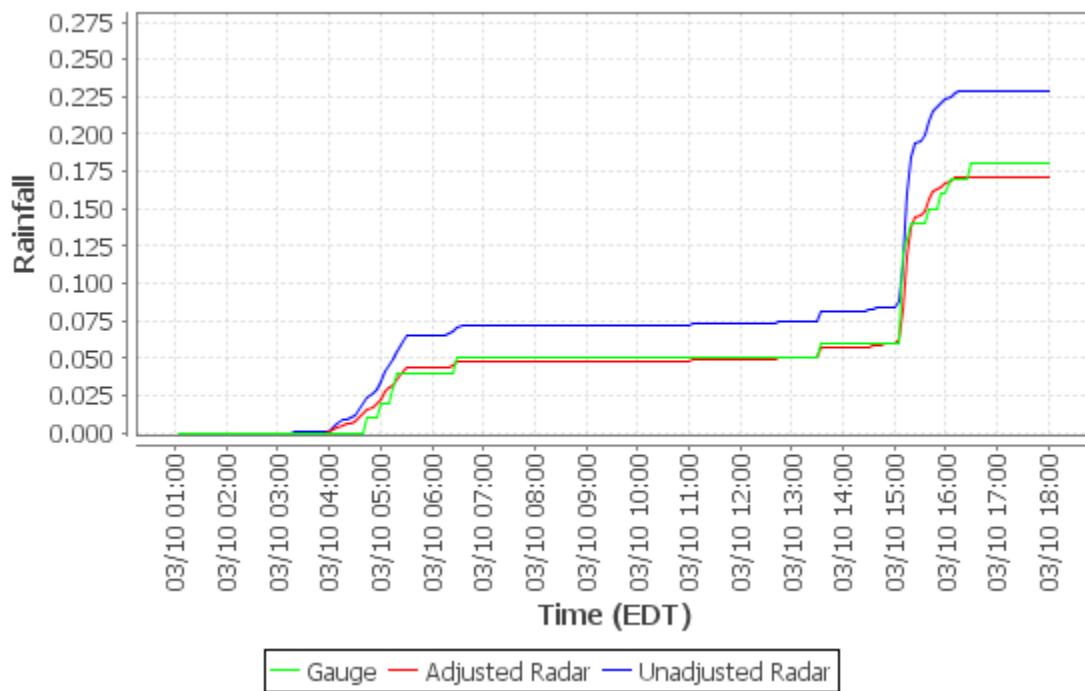
Cumulative Distribution Plot - Baldwin (Loc12)



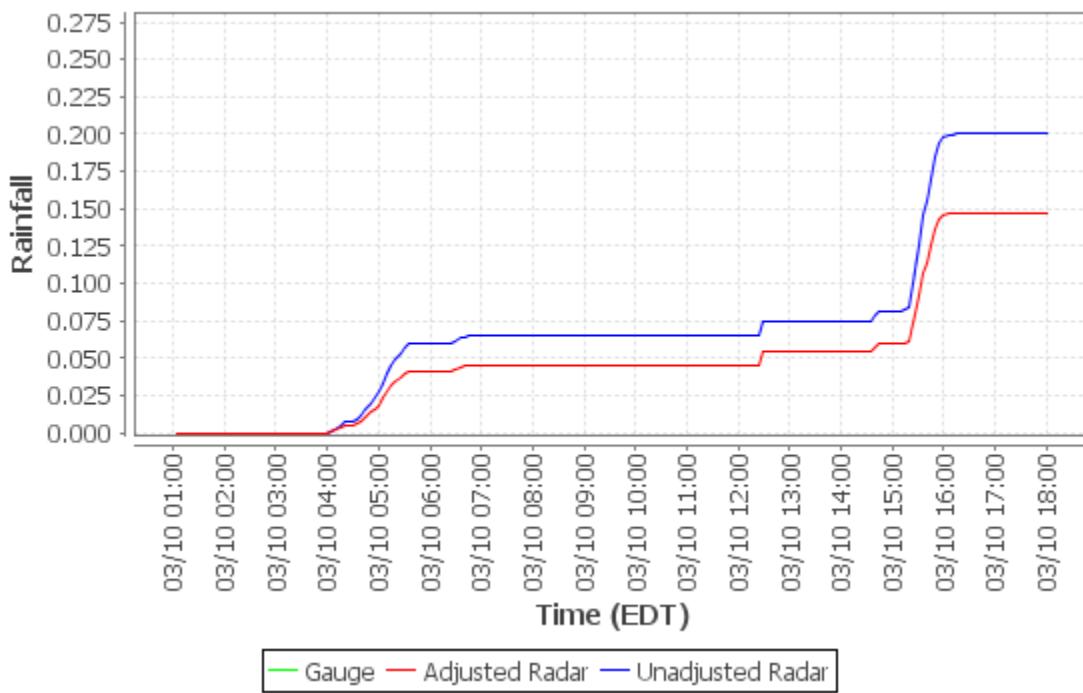
Cumulative Distribution Plot - M-59 Access Shaft (Loc13)



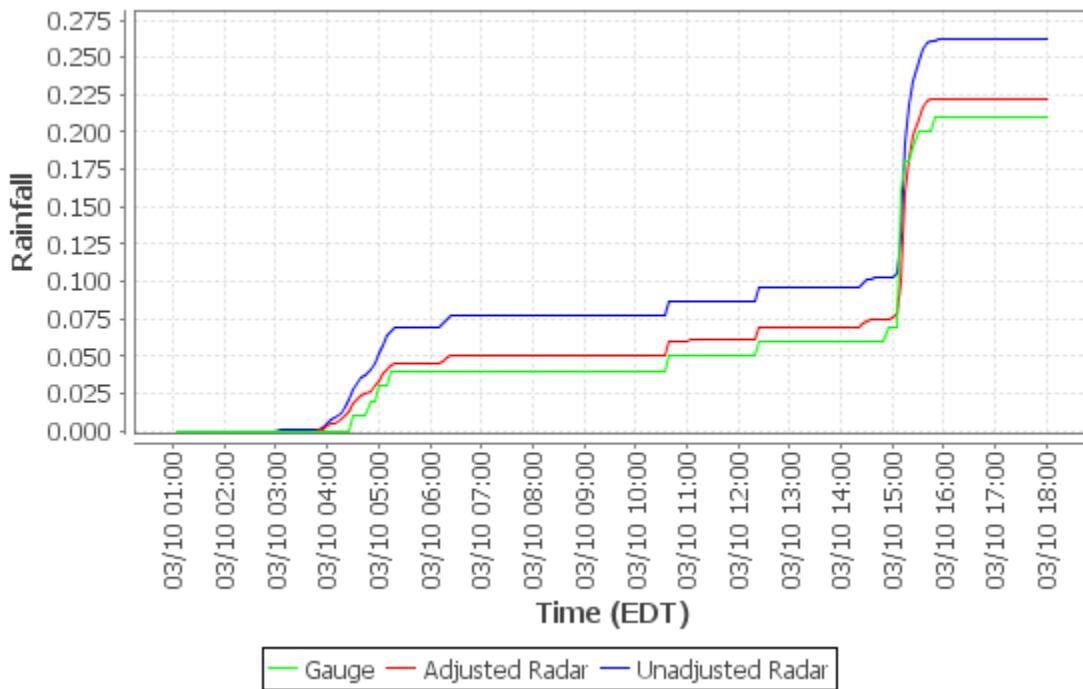
Cumulative Distribution Plot - Churchill Munic Bldg (Loc14)



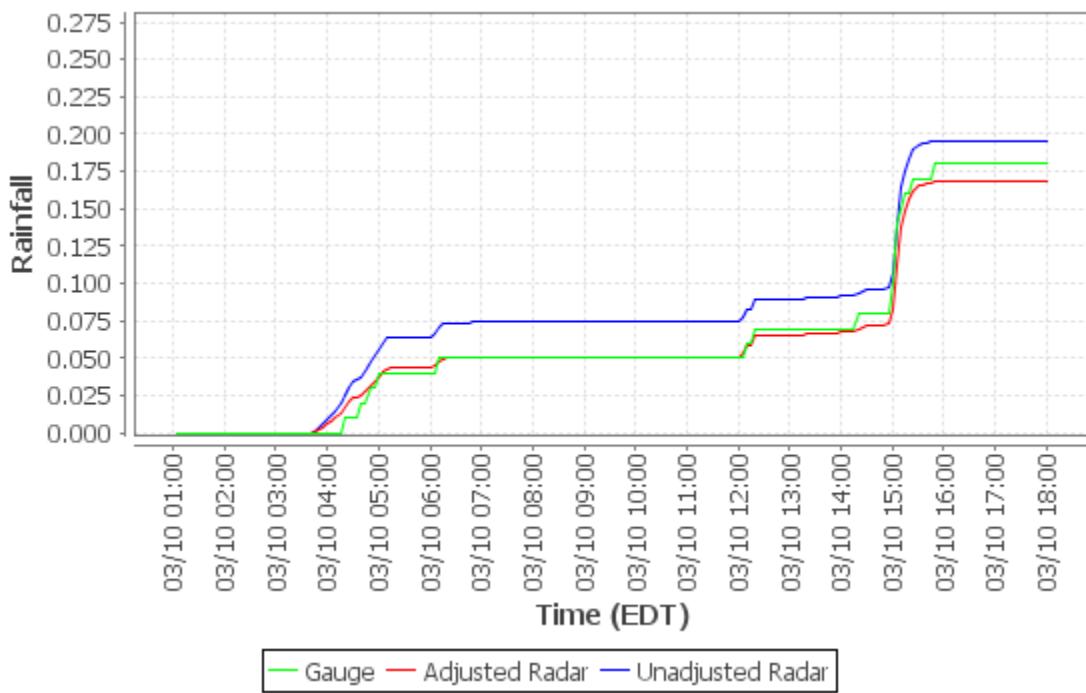
Cumulative Distribution Plot - Trafford Maint Bldg (Loc15)



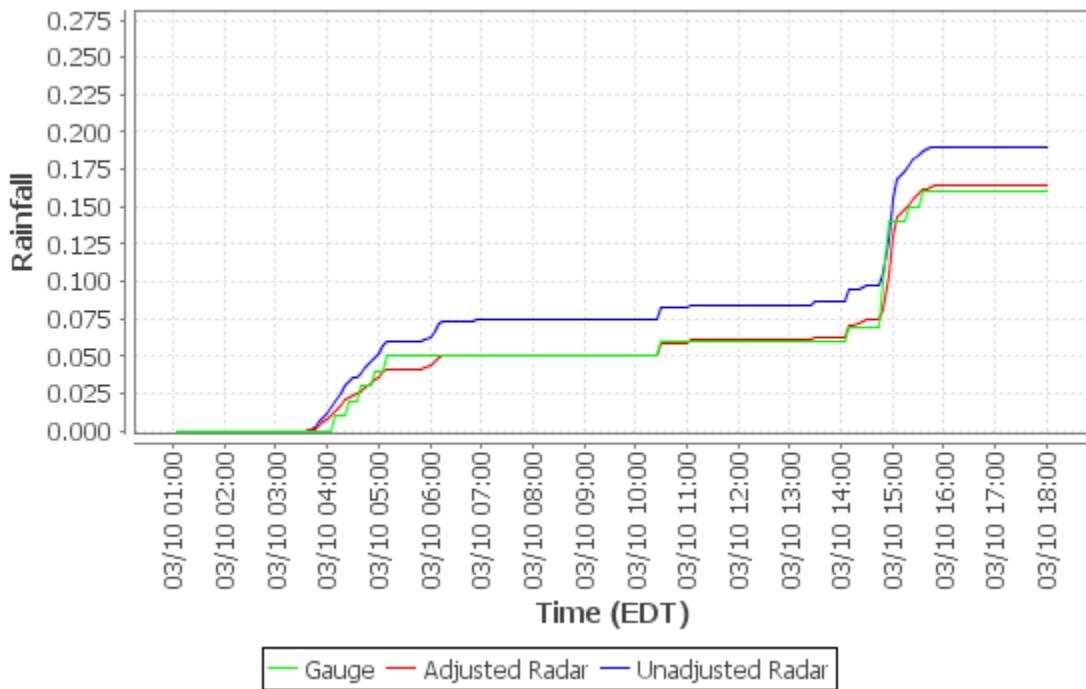
Cumulative Distribution Plot - Castle Shannon (Loc16)



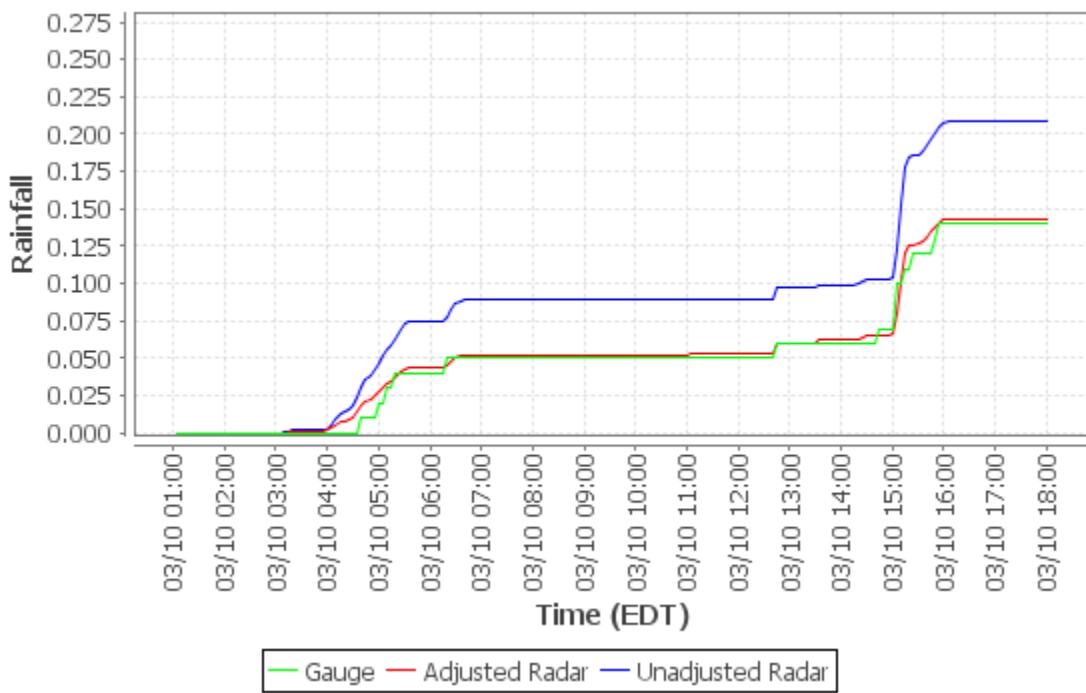
Cumulative Distribution Plot - Chartiers Pump Station (Loc17)



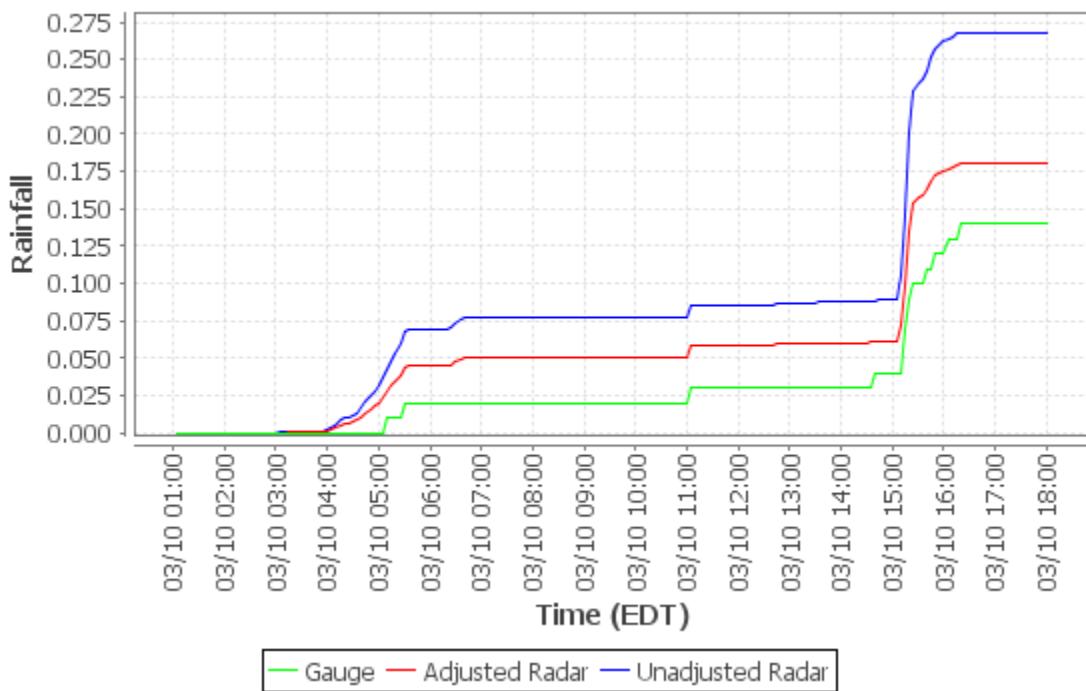
Cumulative Distribution Plot - Oakdale Pump Station (Loc18)



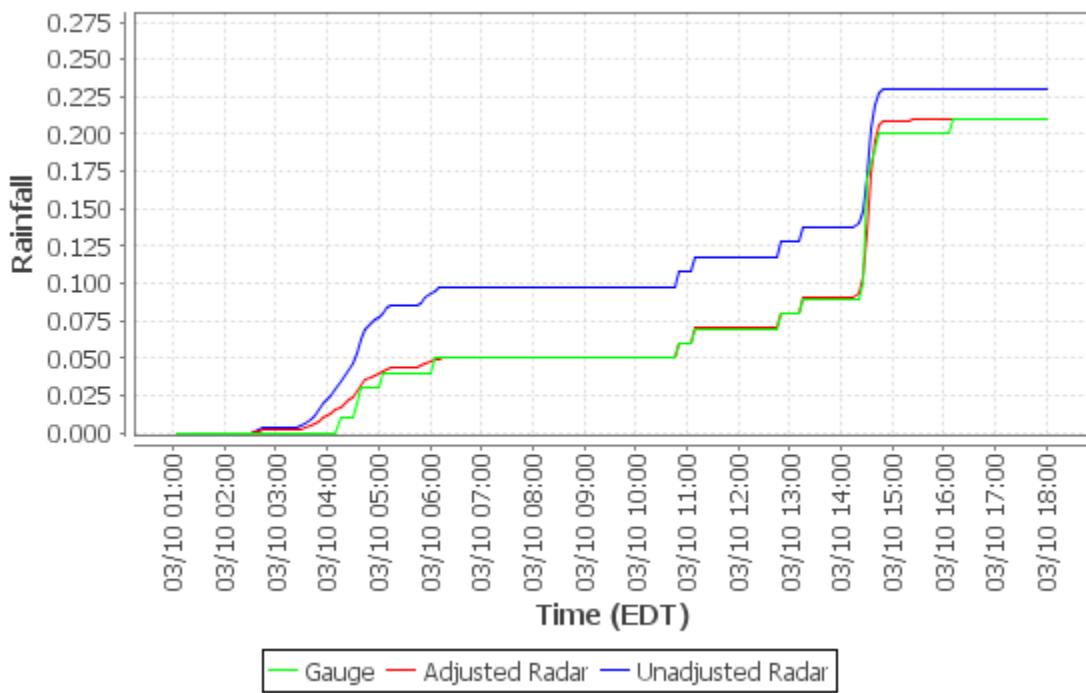
Cumulative Distribution Plot - Sandy Creek Eq Facility (Loc19)



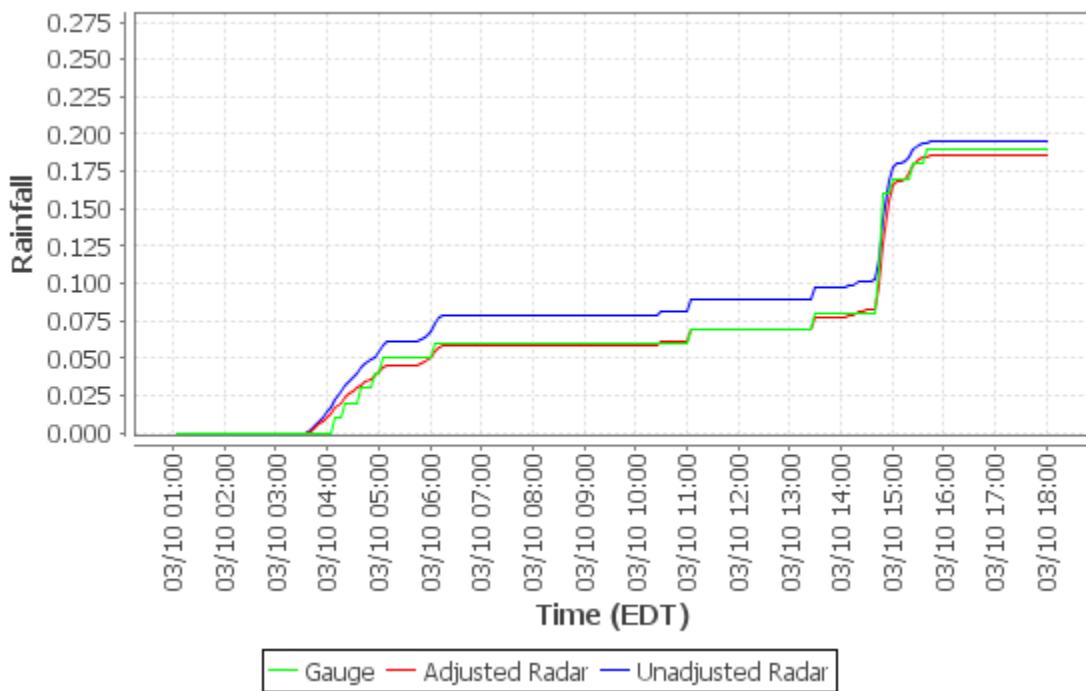
Cumulative Distribution Plot - Gascola Eq Facility (Loc20)



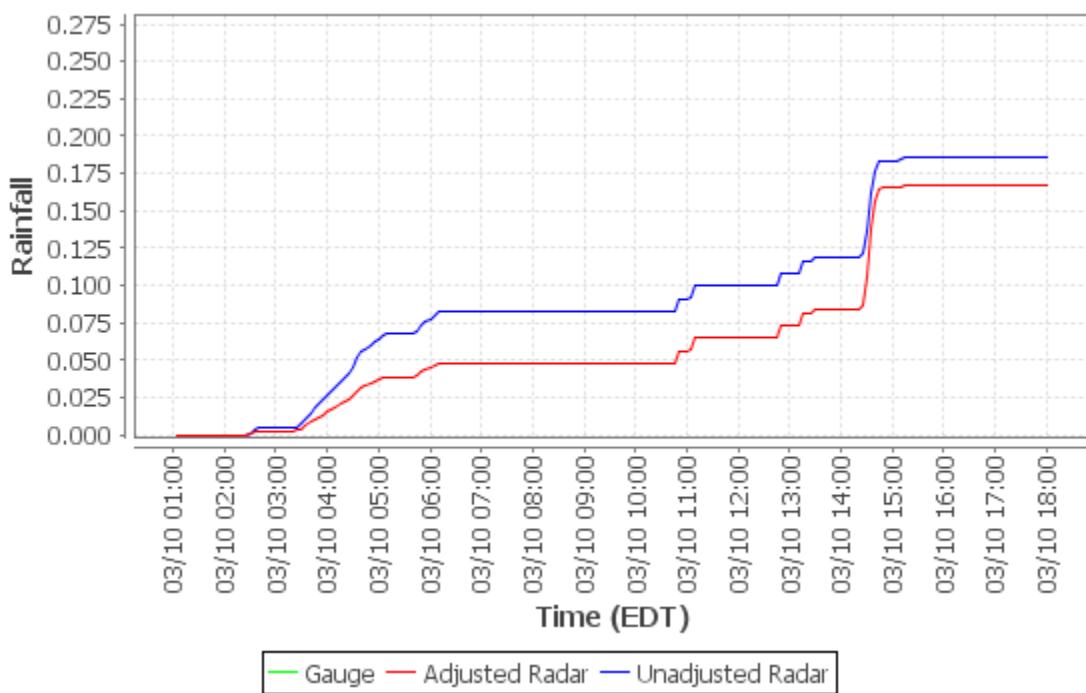
Cumulative Distribution Plot - Moon TWP (Loc21)



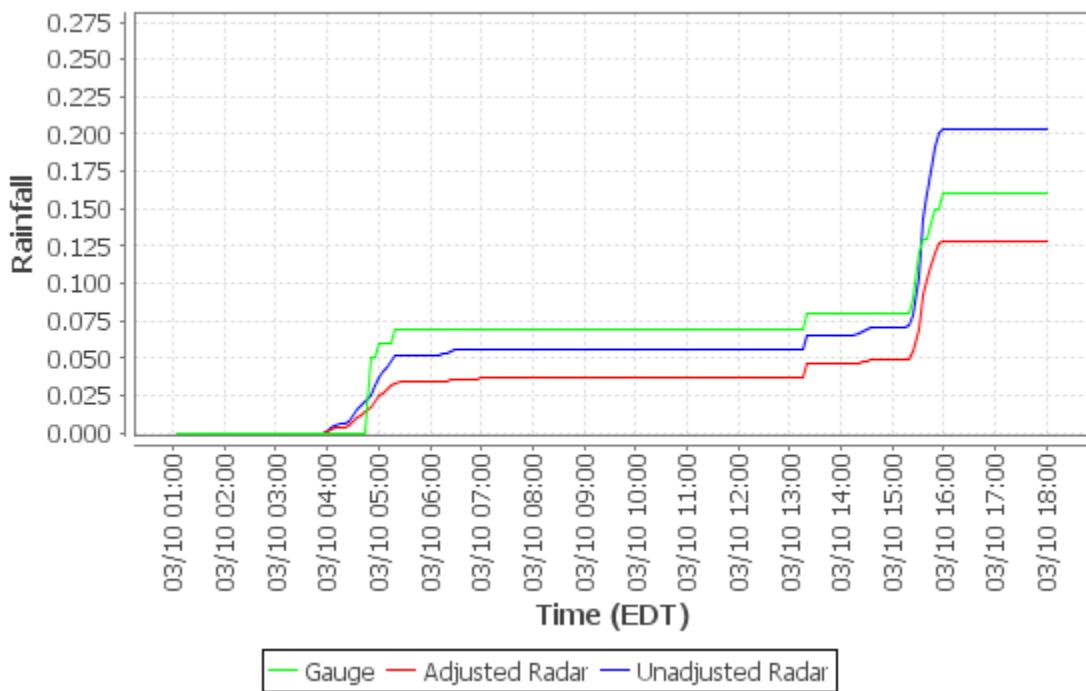
Cumulative Distribution Plot - North Fayette TWP (Loc22)



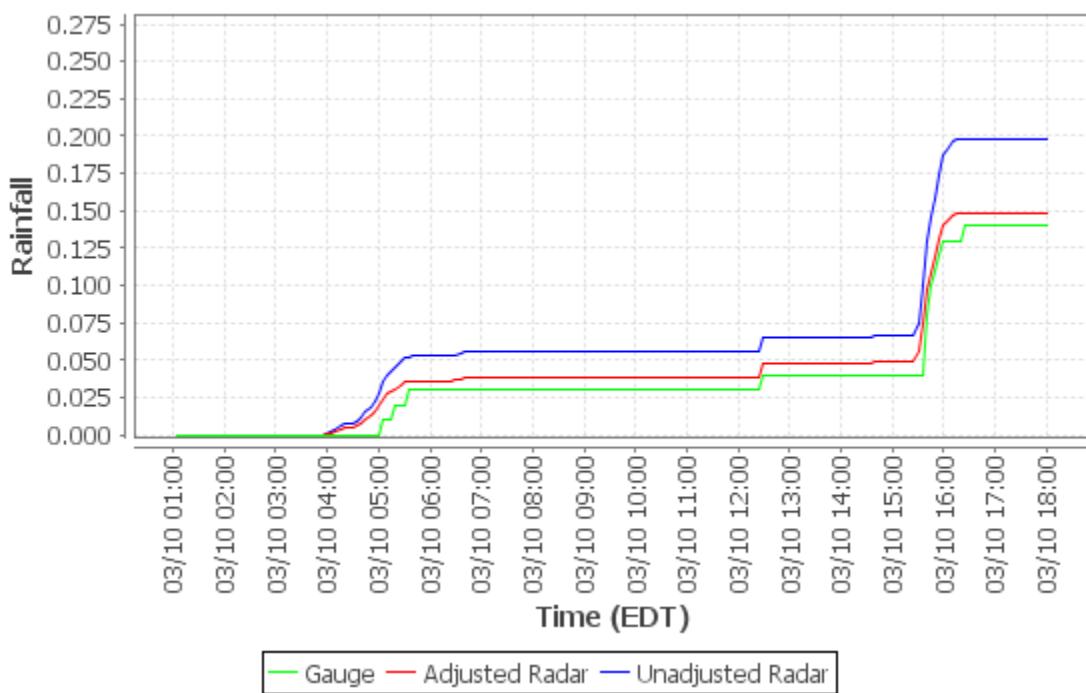
Cumulative Distribution Plot - Clinton Munic Bldg (Loc23)



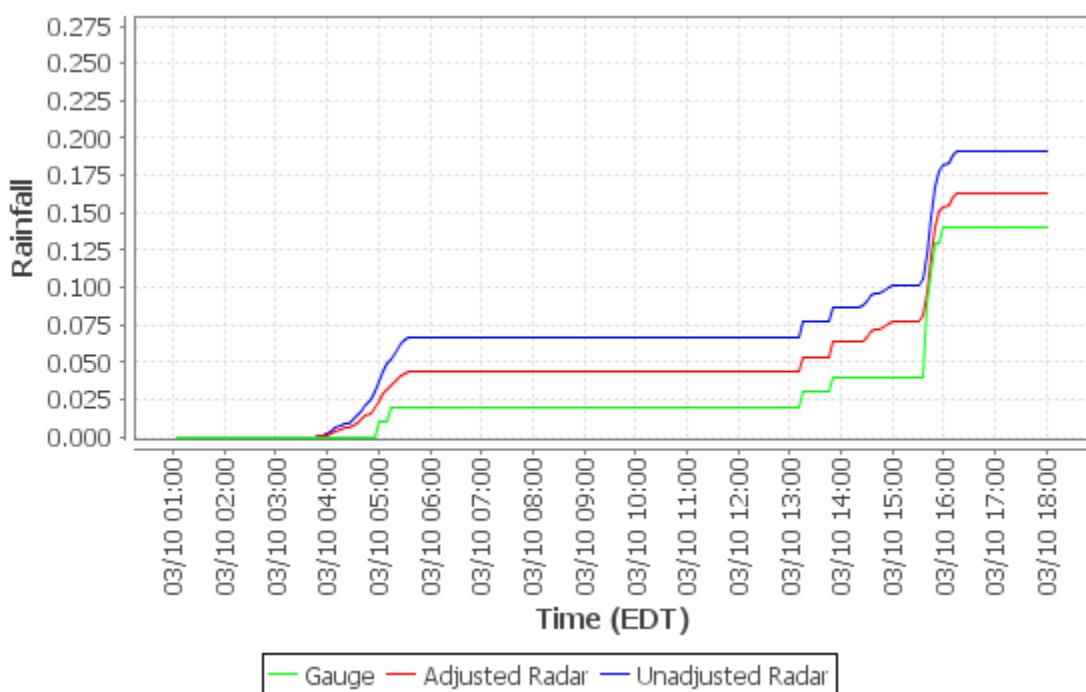
Cumulative Distribution Plot - Jefferson Hills (Loc24)



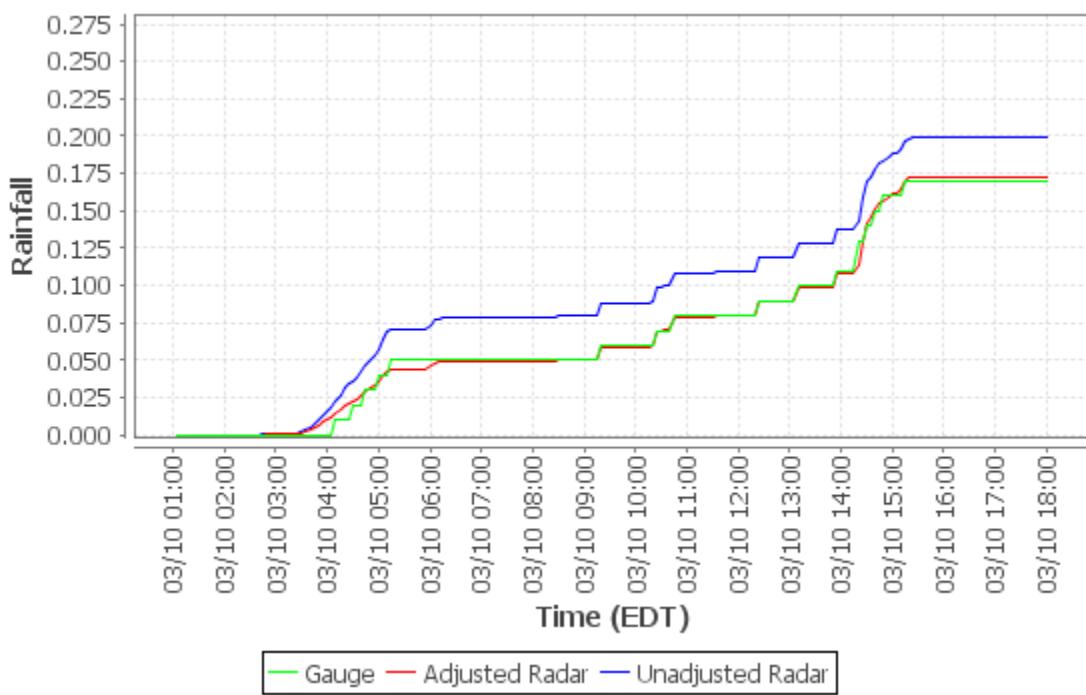
Cumulative Distribution Plot - White Oak Public Works Bldg (Loc25)



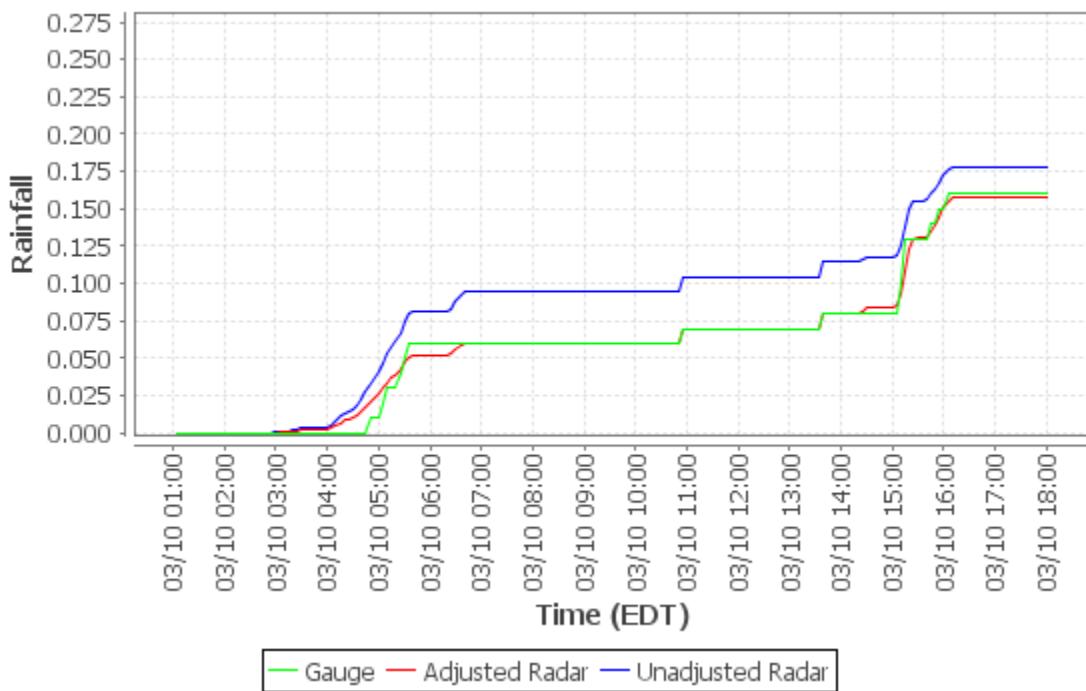
Cumulative Distribution Plot - Elizabeth TWP Municipal Bldg (Loc26)



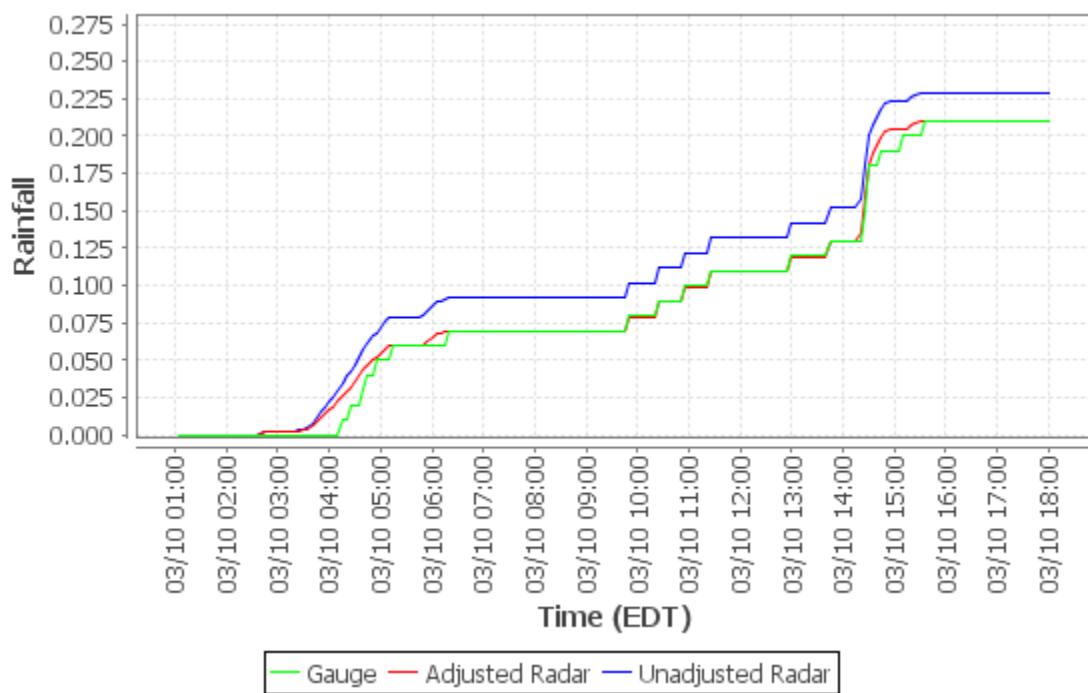
Cumulative Distribution Plot - Marshall TWP (Loc27)



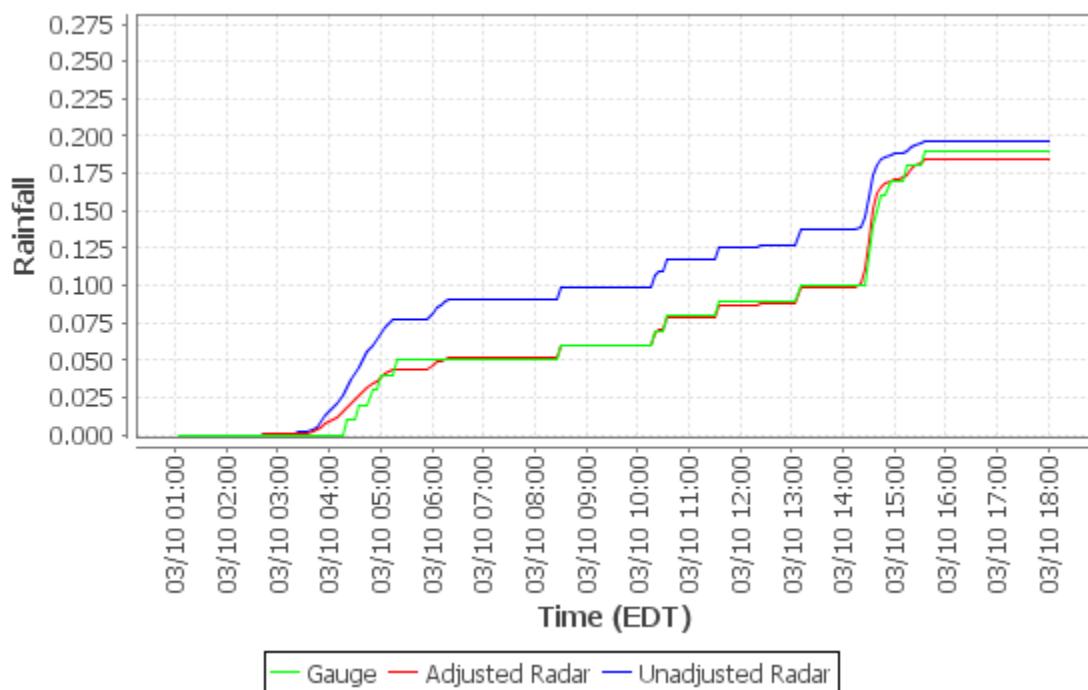
Cumulative Distribution Plot - Plum Municipal Bldg (Loc28)



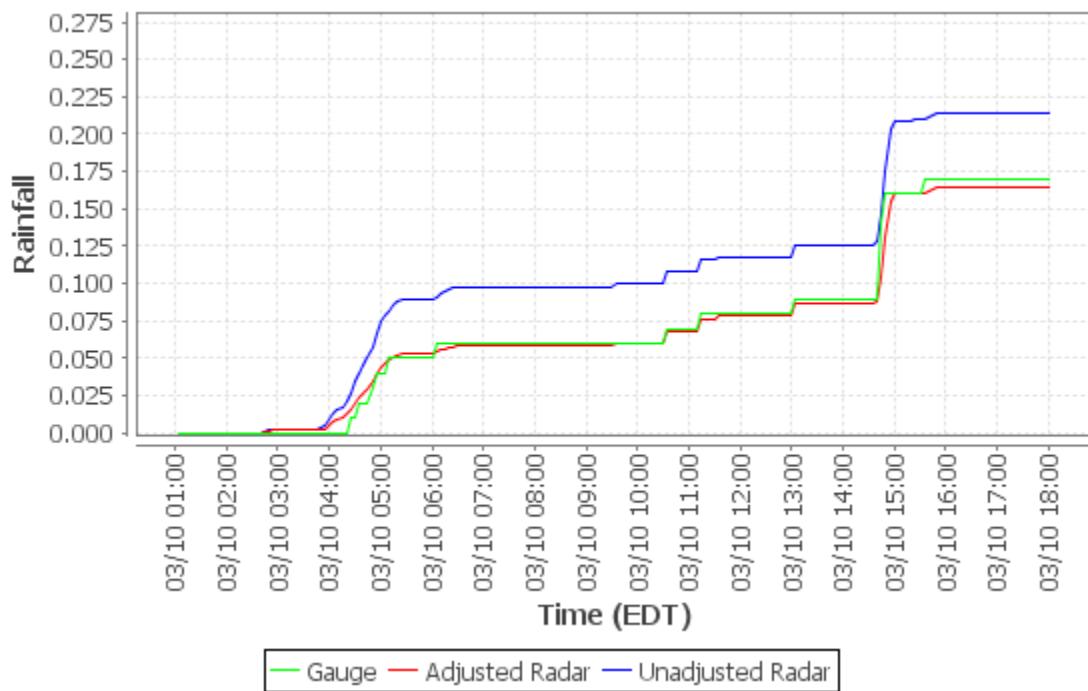
Cumulative Distribution Plot - Bell Acres Munic Bldg (Loc29)



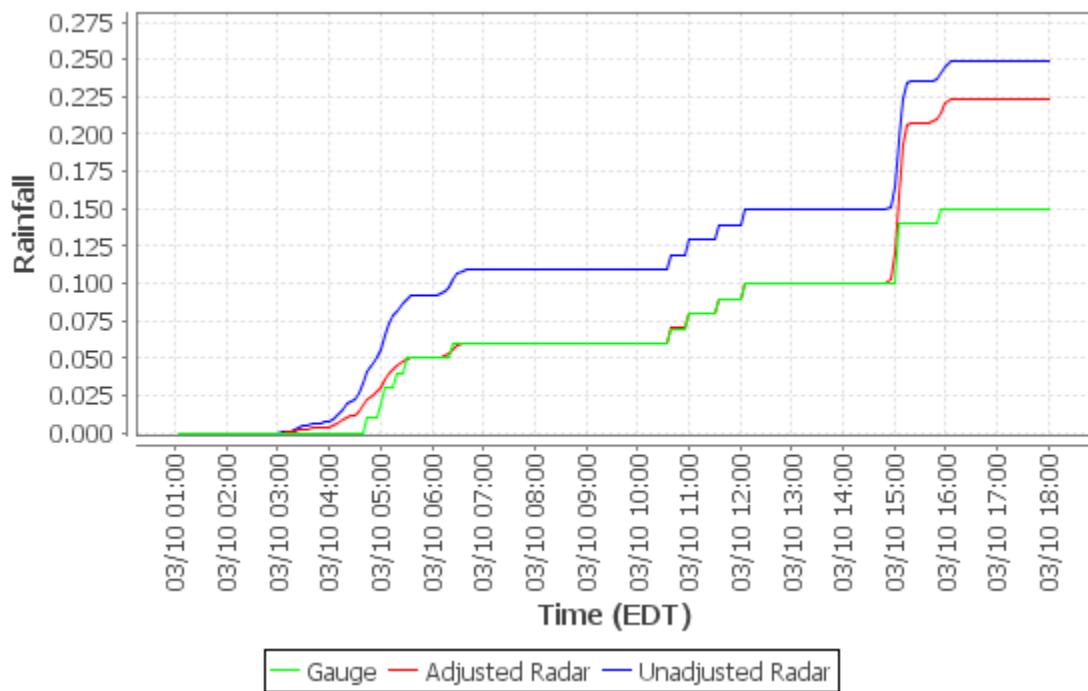
Cumulative Distribution Plot - McCandless Twn Hall (Loc30)



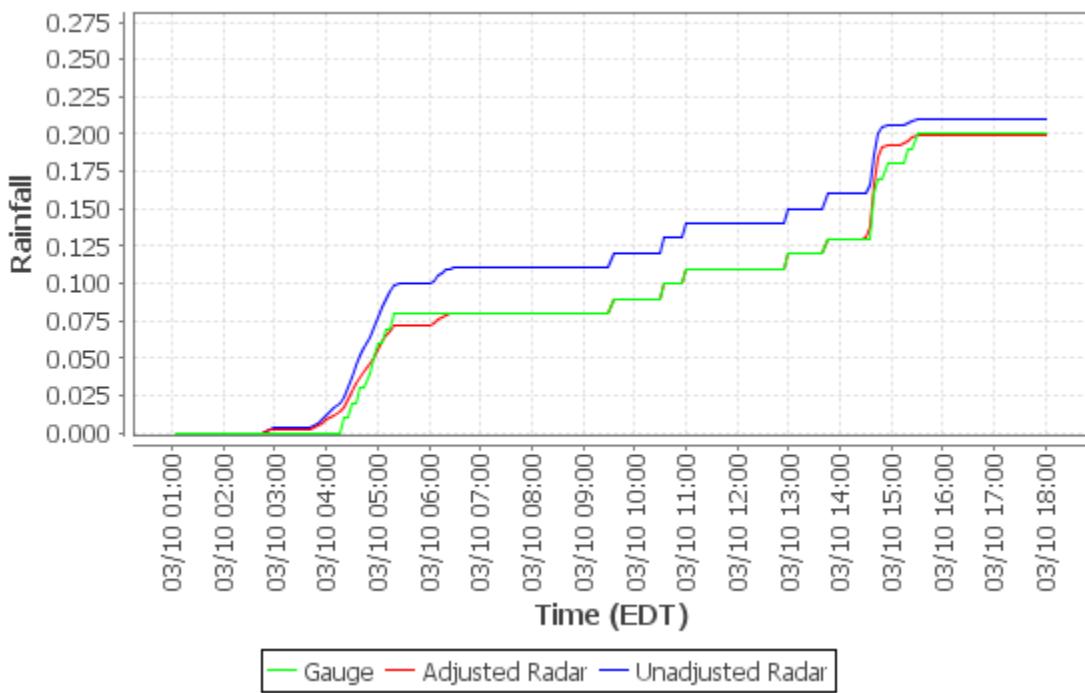
Cumulative Distribution Plot - Hampton Municipal Bldg (Loc31)



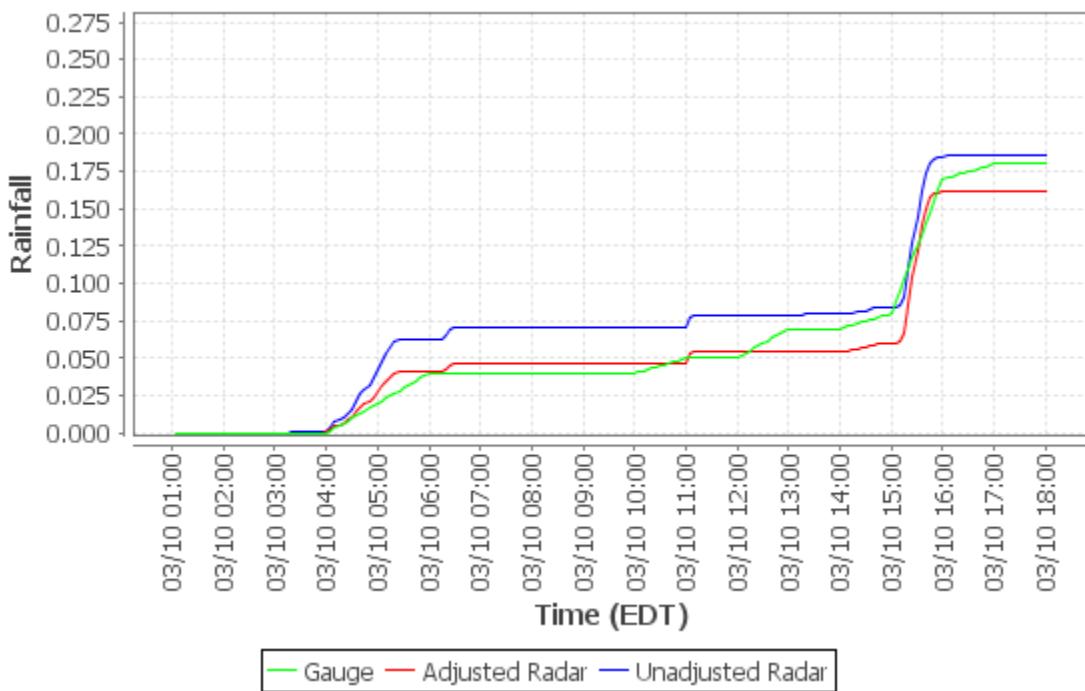
Cumulative Distribution Plot - Arnold (Loc32)



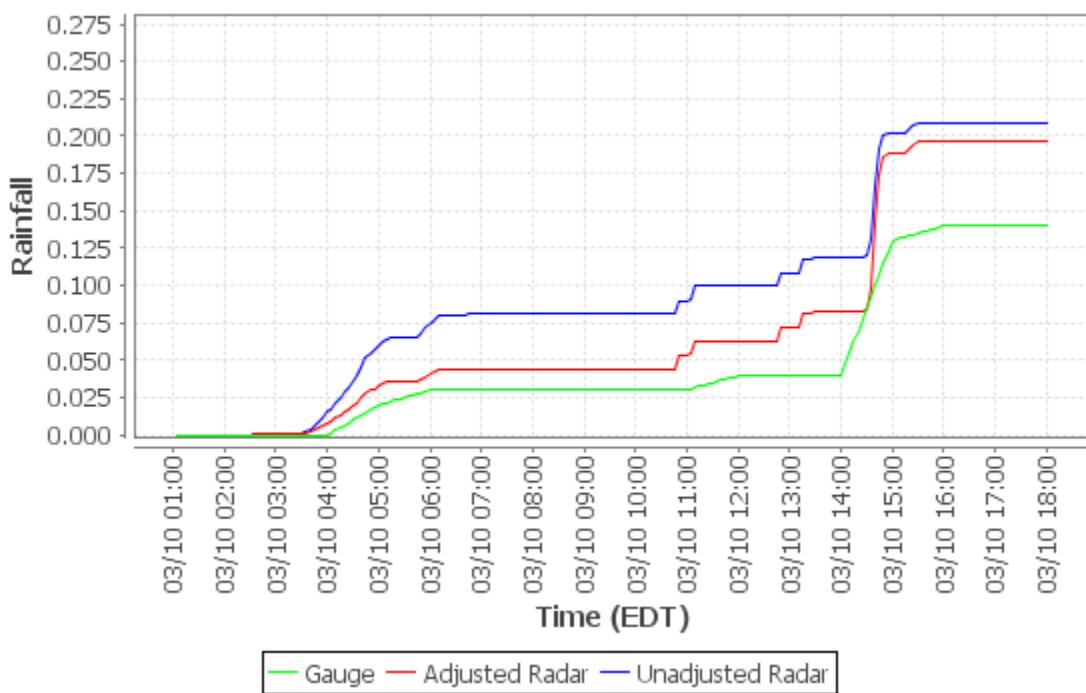
Cumulative Distribution Plot - Richland TWP (Loc33)



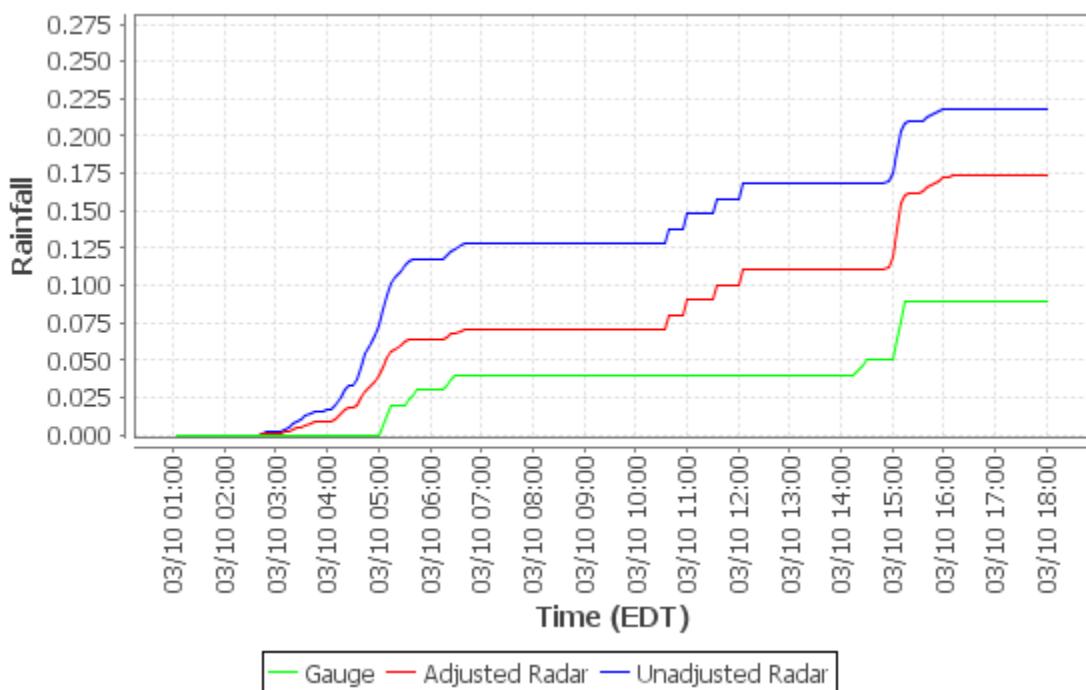
Cumulative Distribution Plot - Pittsburgh Allegheny Cty (KAGC)



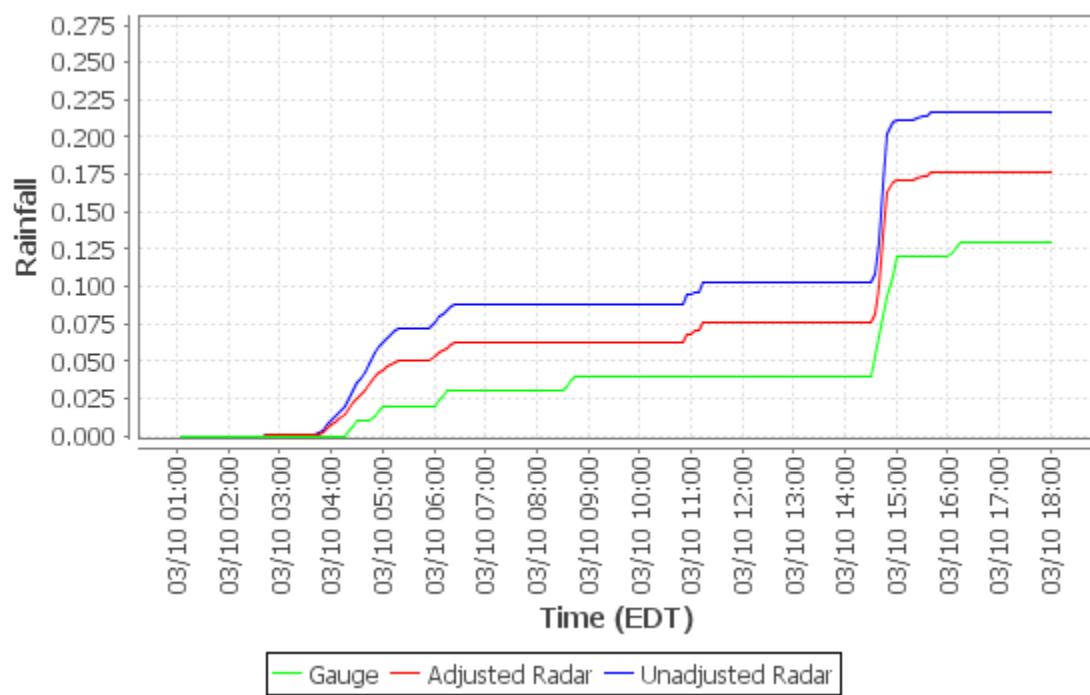
Cumulative Distribution Plot - Greater Pittsburgh Int'l (KPIT)



Cumulative Distribution Plot - Allegheny River at Natrona (03049500)

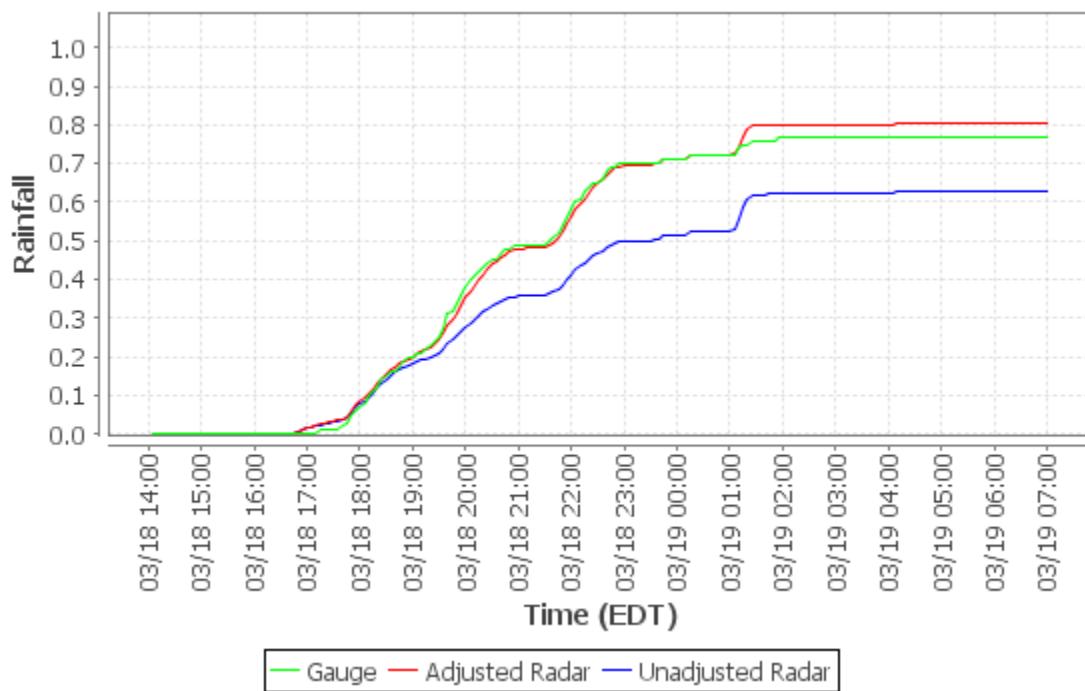


**Cumulative Distribution Plot - Ohio River at Emsworth Dam Lower Pool at Emsworth
(03085734)**

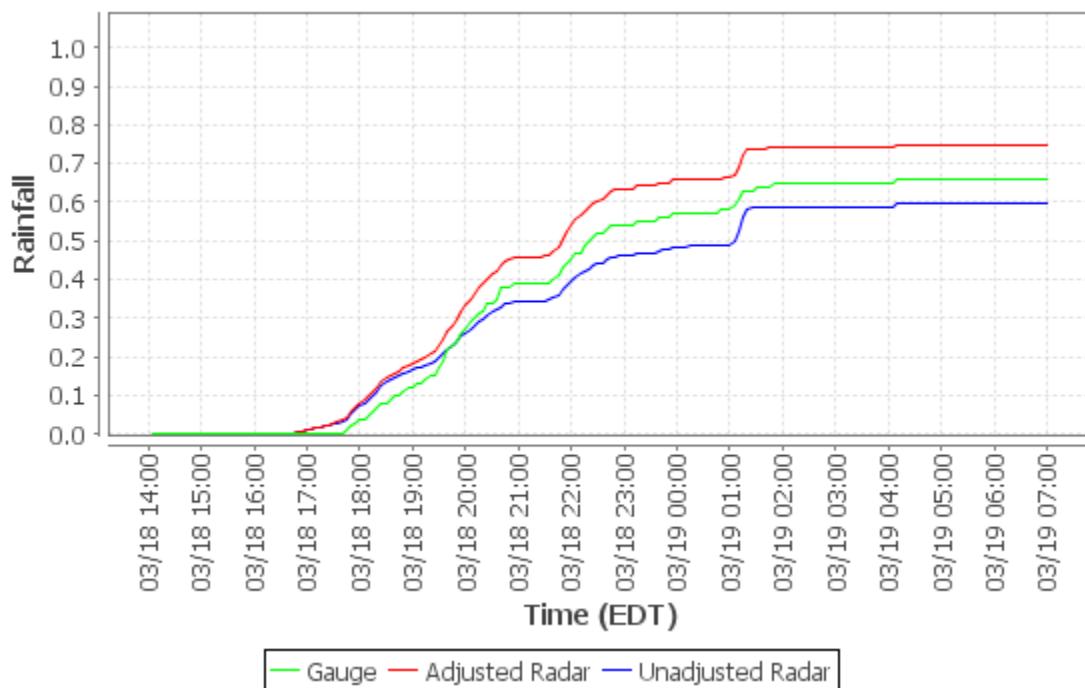


Appendix G - Event 5 (2020-03-18) CDPs

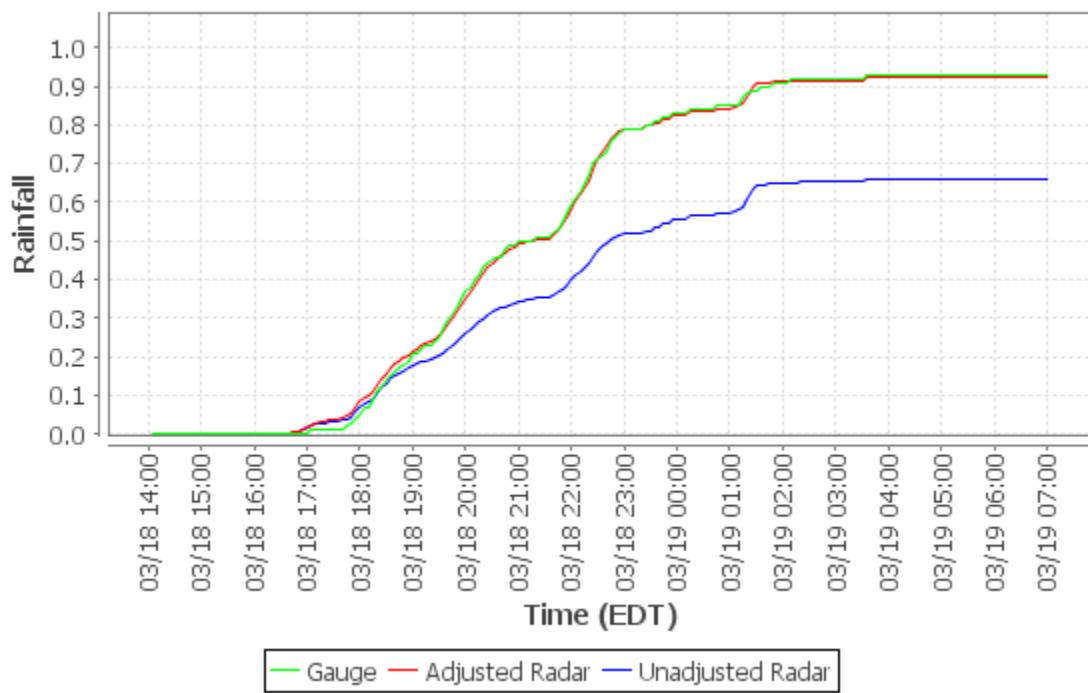
Cumulative Distribution Plot - PWSA-Montana St. (Loc01)



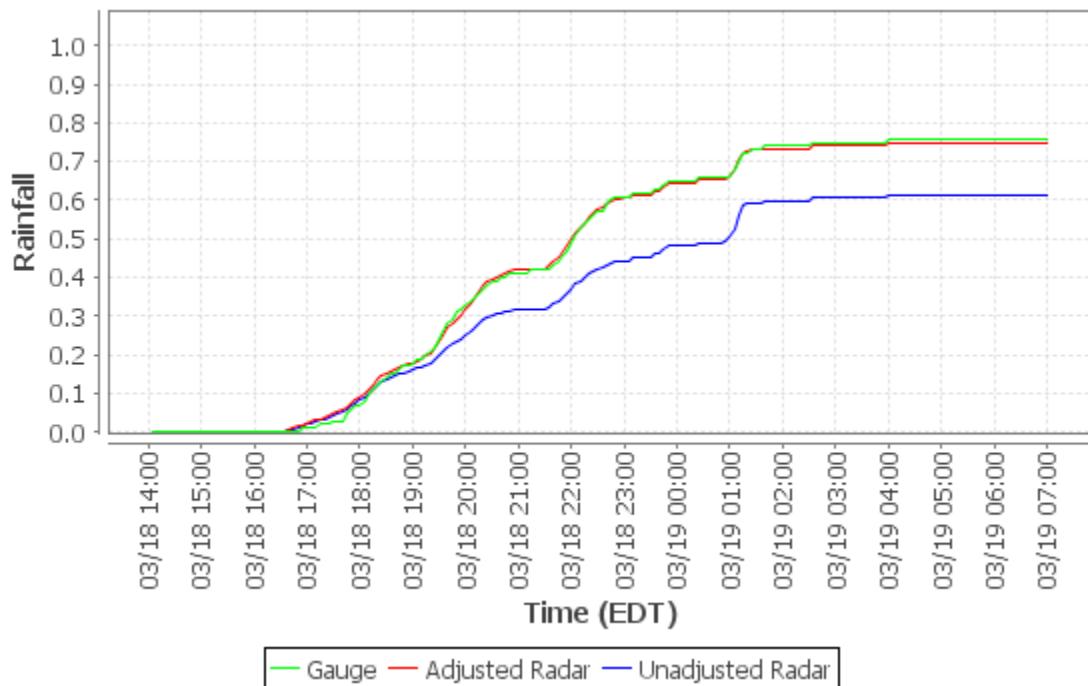
Cumulative Distribution Plot - ALCOSAN WWTP Lab (Loc02)



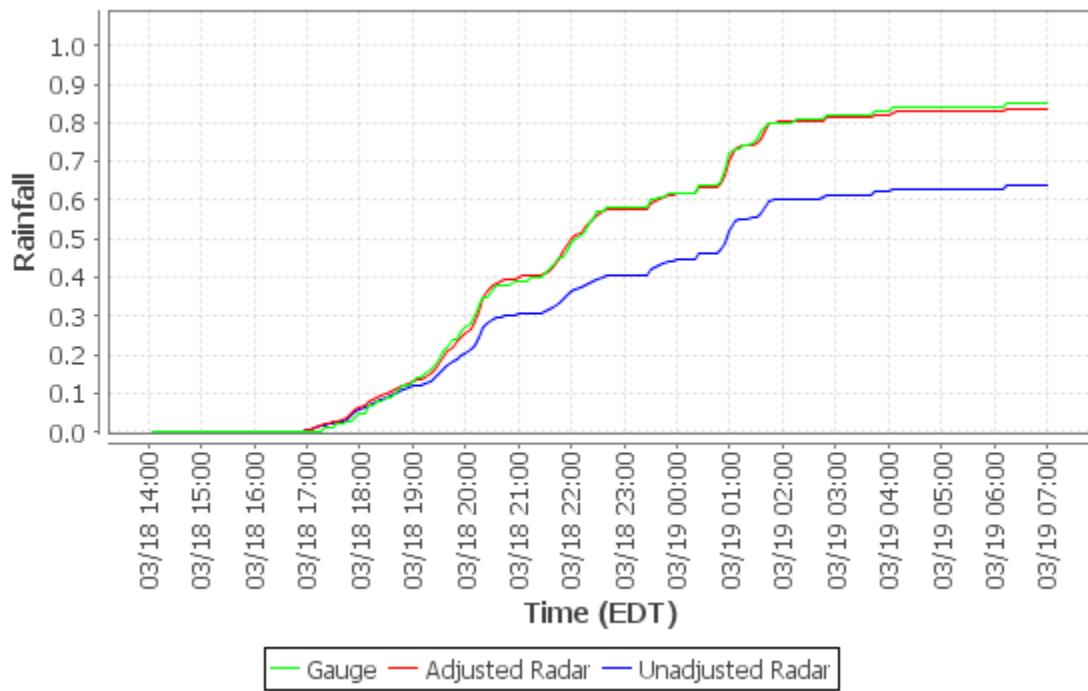
Cumulative Distribution Plot - Shaler Munic Bldg (Loc03)



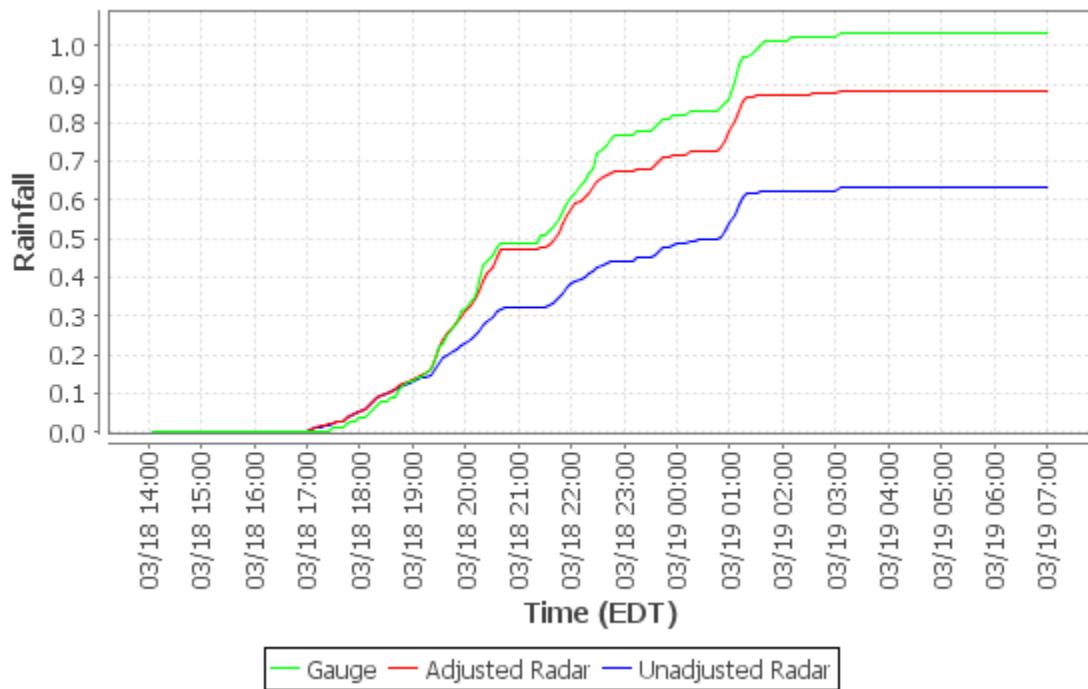
Cumulative Distribution Plot - Kennedy Twp PS (Loc04)



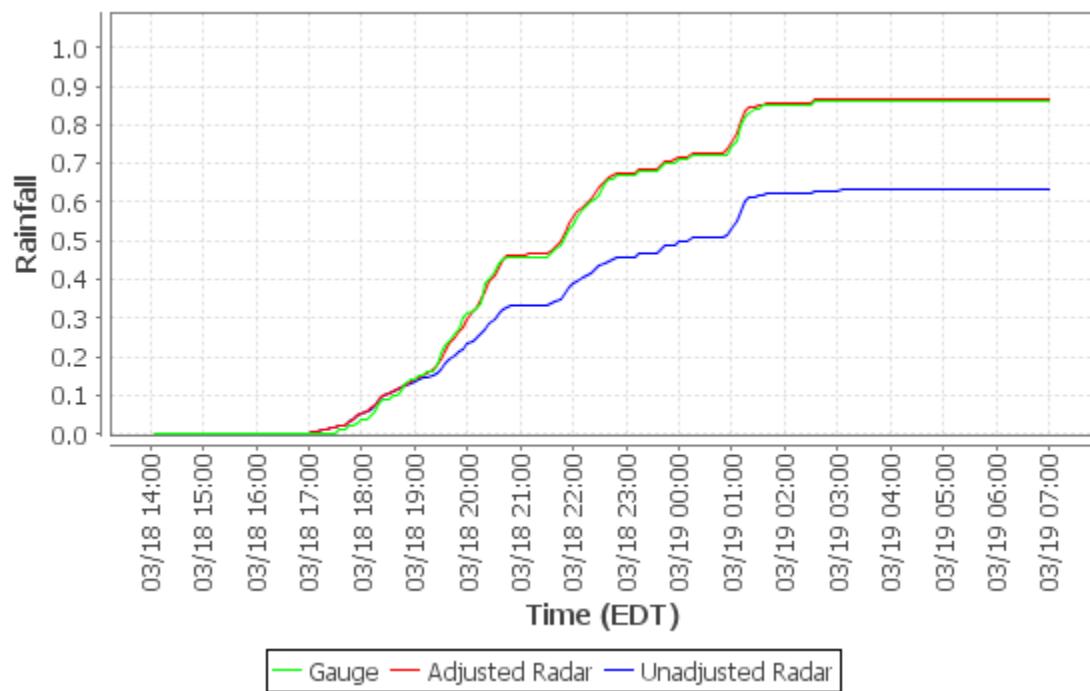
Cumulative Distribution Plot - Upper St. Clair (Loc05)



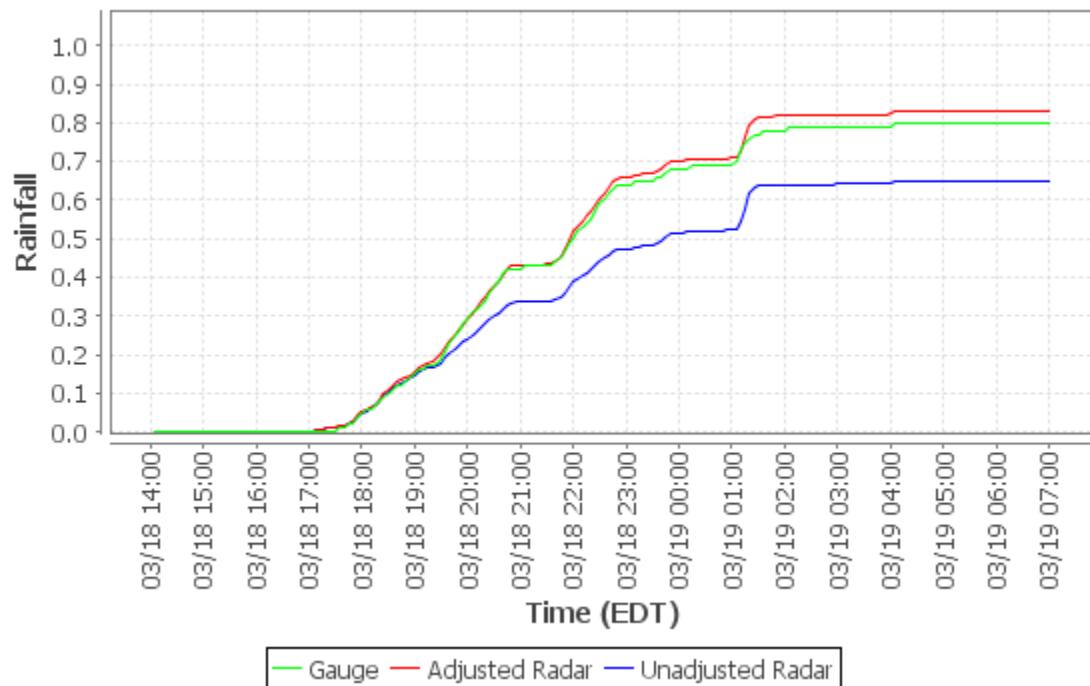
Cumulative Distribution Plot - Carnegie Transit Time (Loc06)



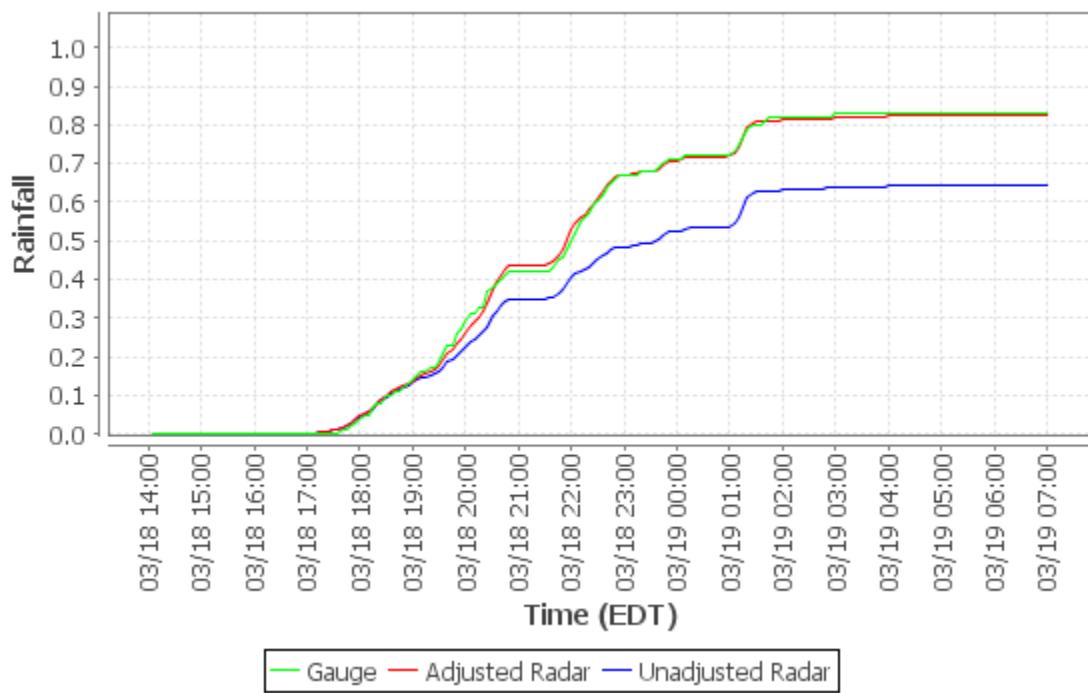
Cumulative Distribution Plot - Greentree Munic Bldg (Loc07)



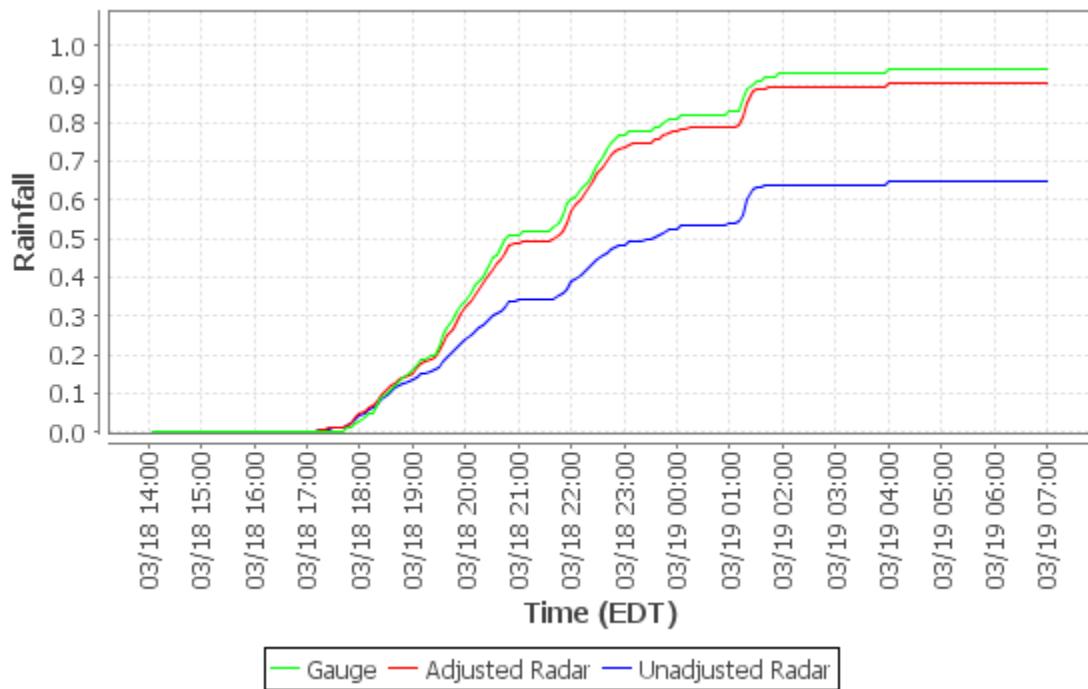
Cumulative Distribution Plot - AC Health Dept Bldg (Loc08)



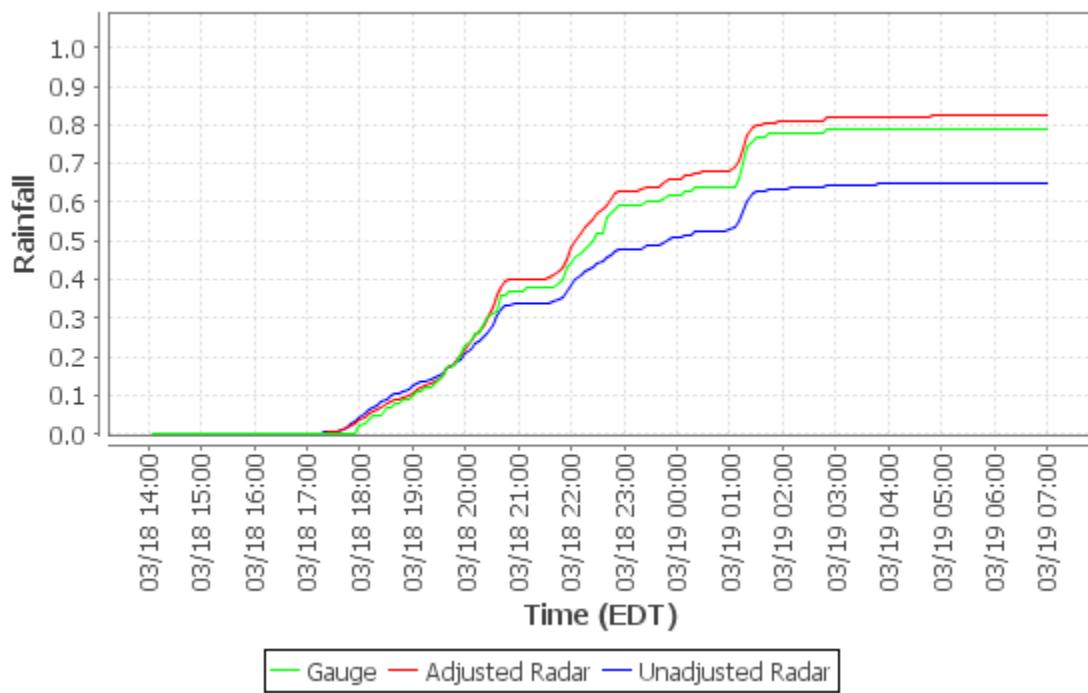
Cumulative Distribution Plot - Univ of Pittsburgh (Loc09)



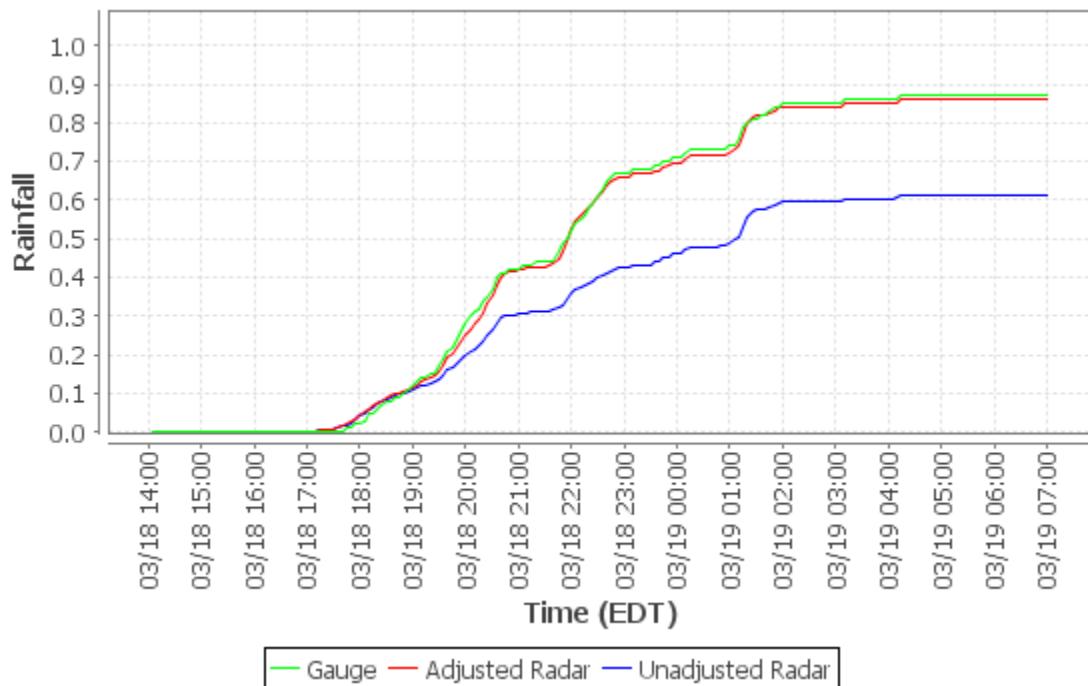
Cumulative Distribution Plot - PWSA-Highland Park (Loc10)



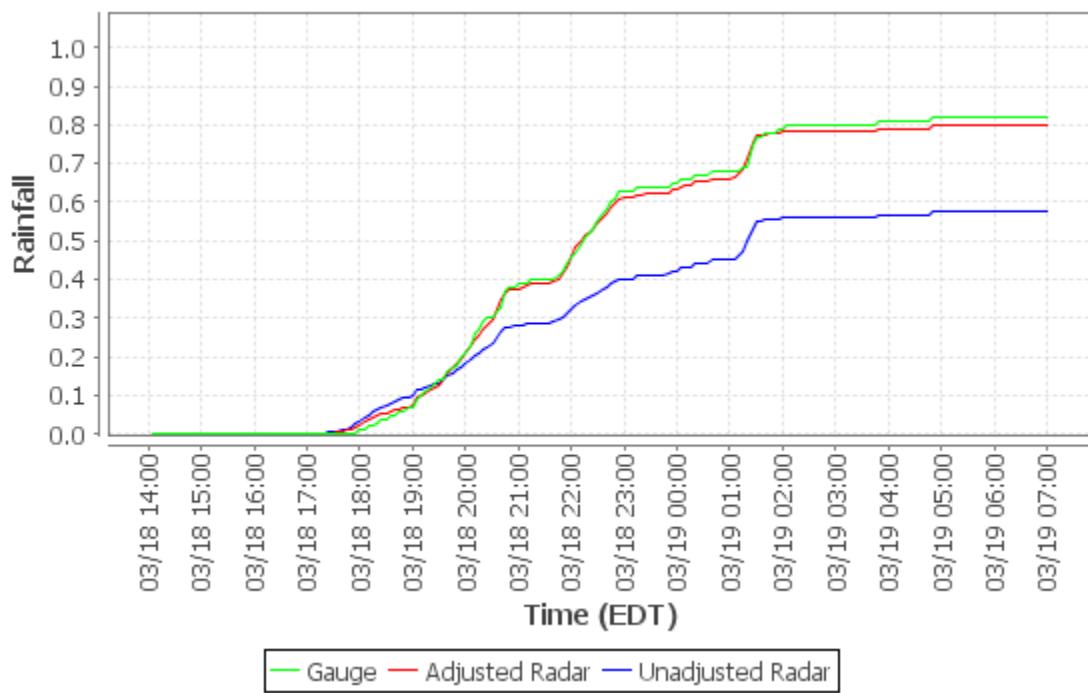
Cumulative Distribution Plot - M-46 Access Shaft (Loc11)



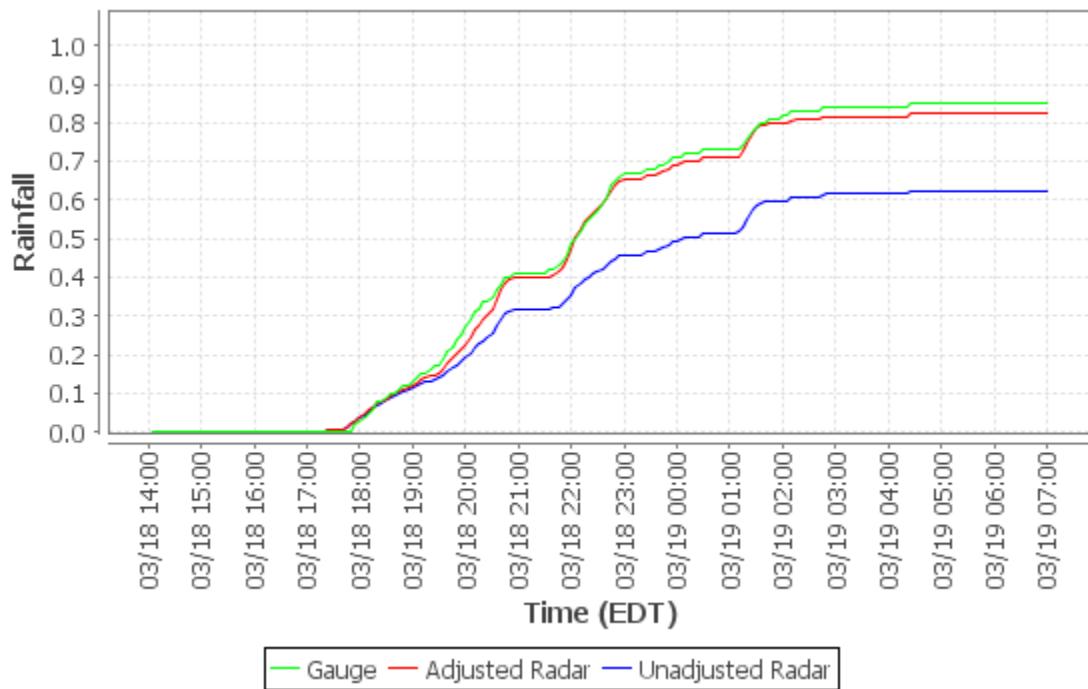
Cumulative Distribution Plot - Baldwin (Loc12)



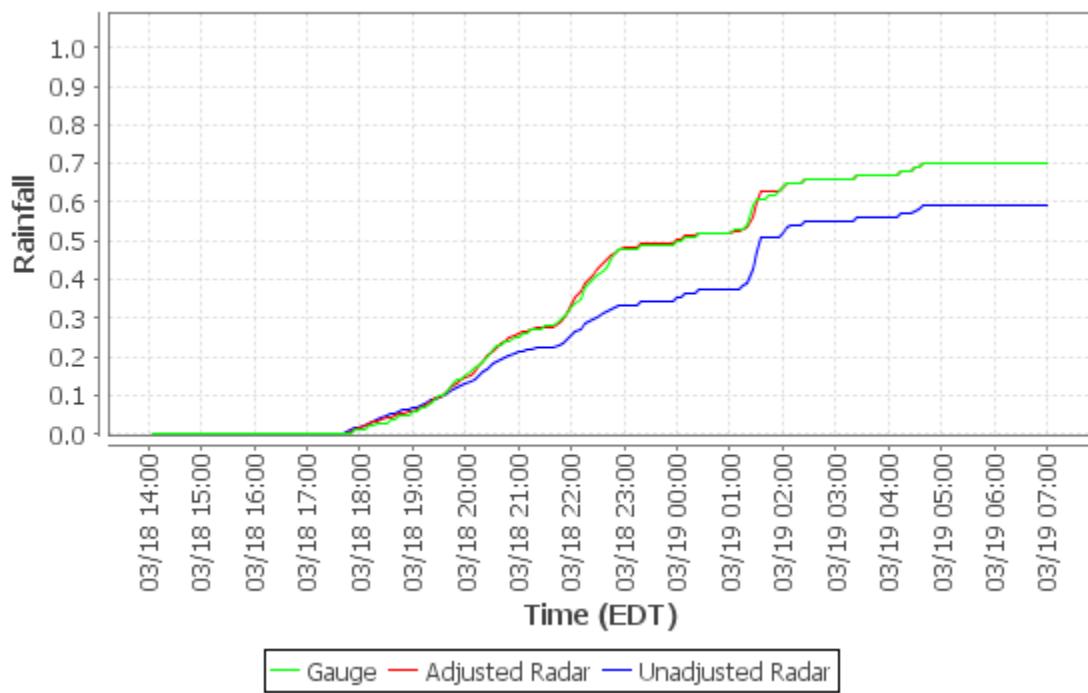
Cumulative Distribution Plot - M-59 Access Shaft (Loc13)



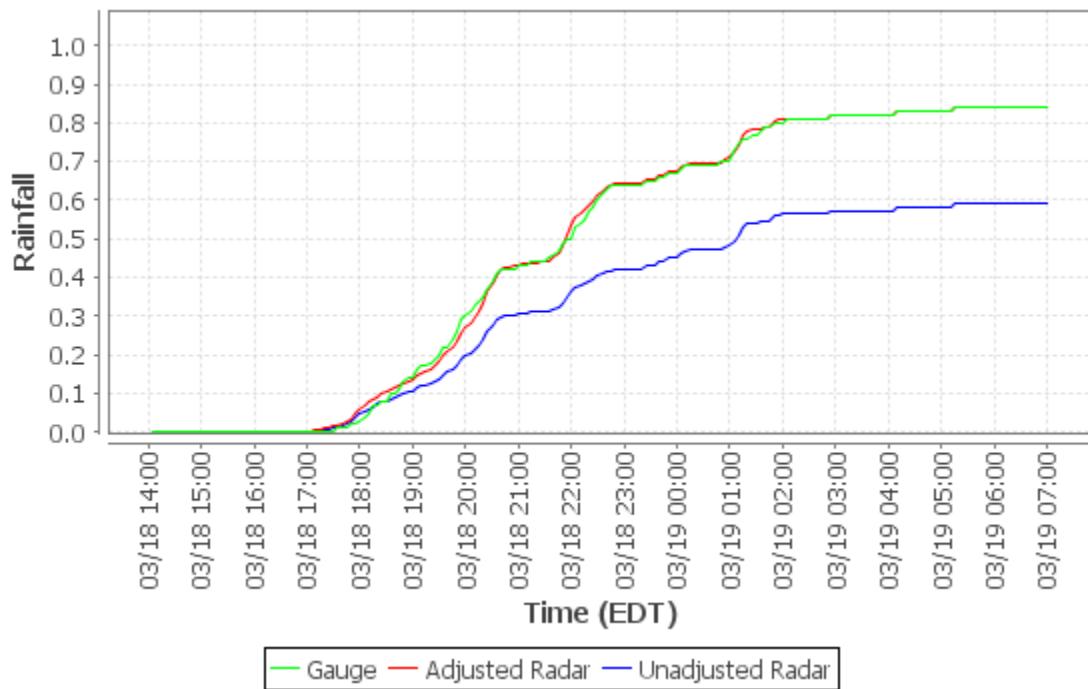
Cumulative Distribution Plot - Churchill Munic Bldg (Loc14)



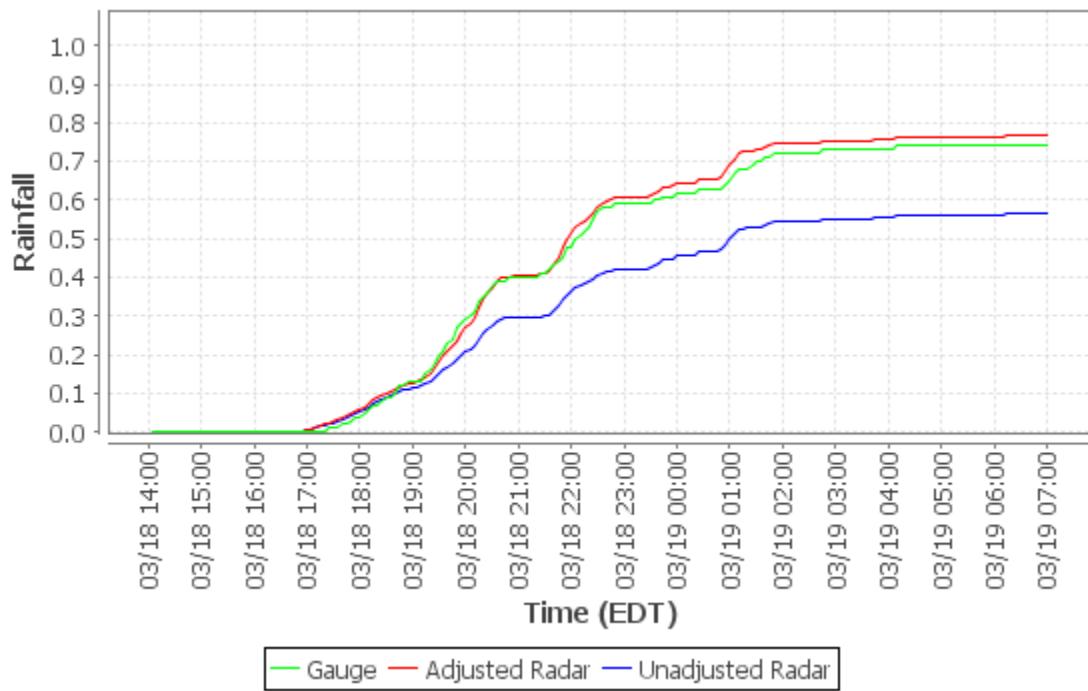
Cumulative Distribution Plot - Trafford Maint Bldg (Loc15)



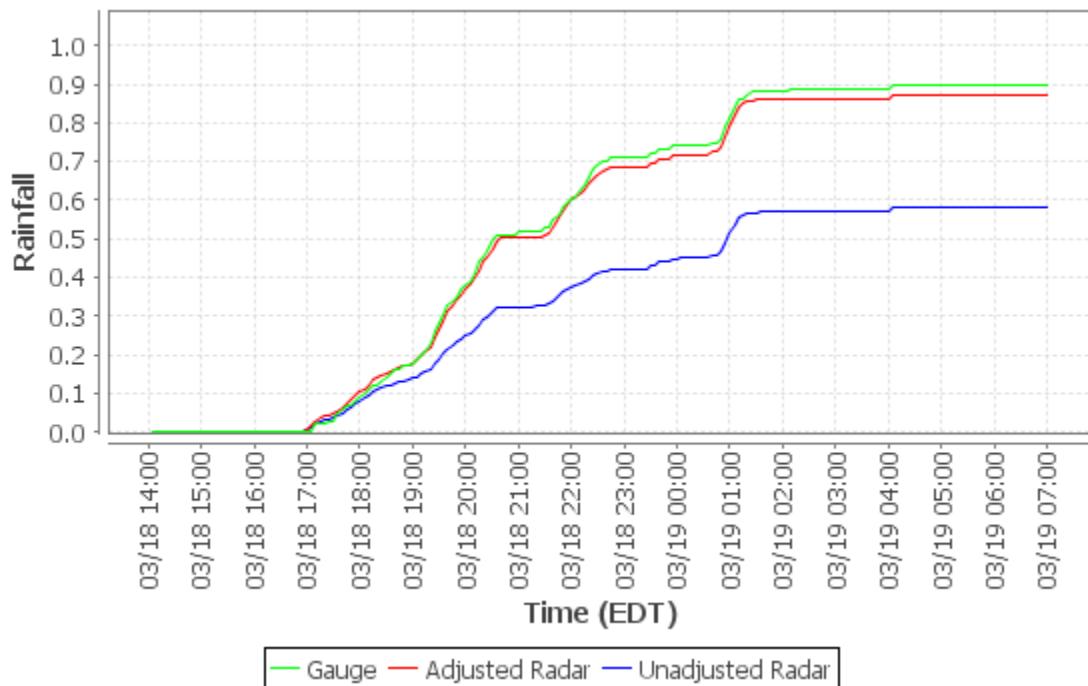
Cumulative Distribution Plot - Castle Shannon (Loc16)



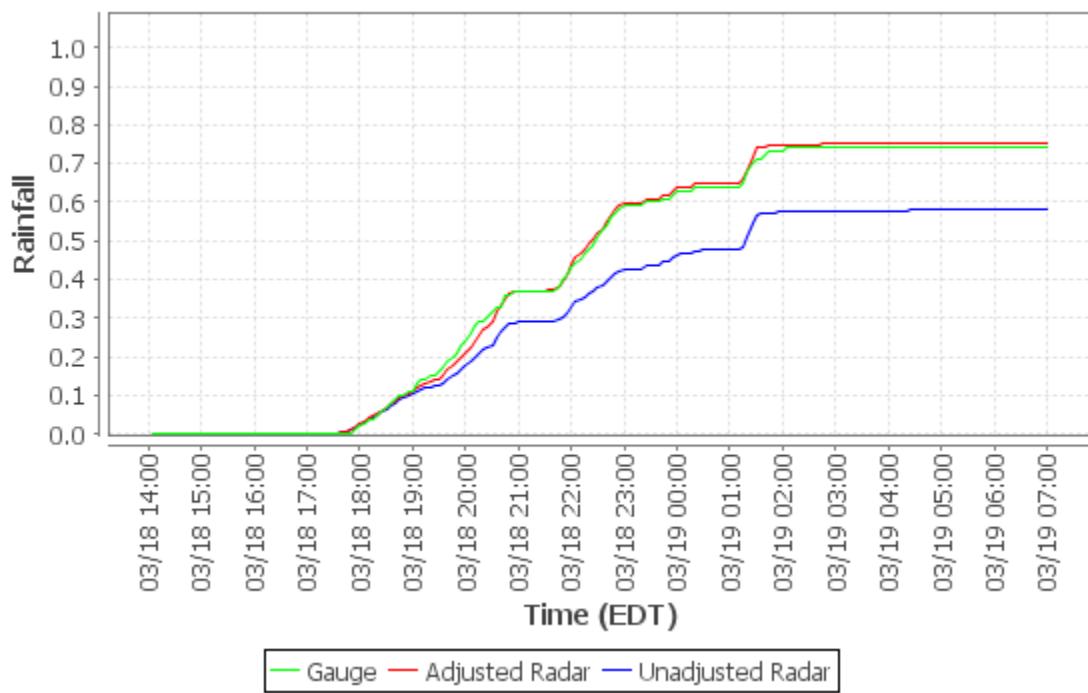
Cumulative Distribution Plot - Chartiers Pump Station (Loc17)



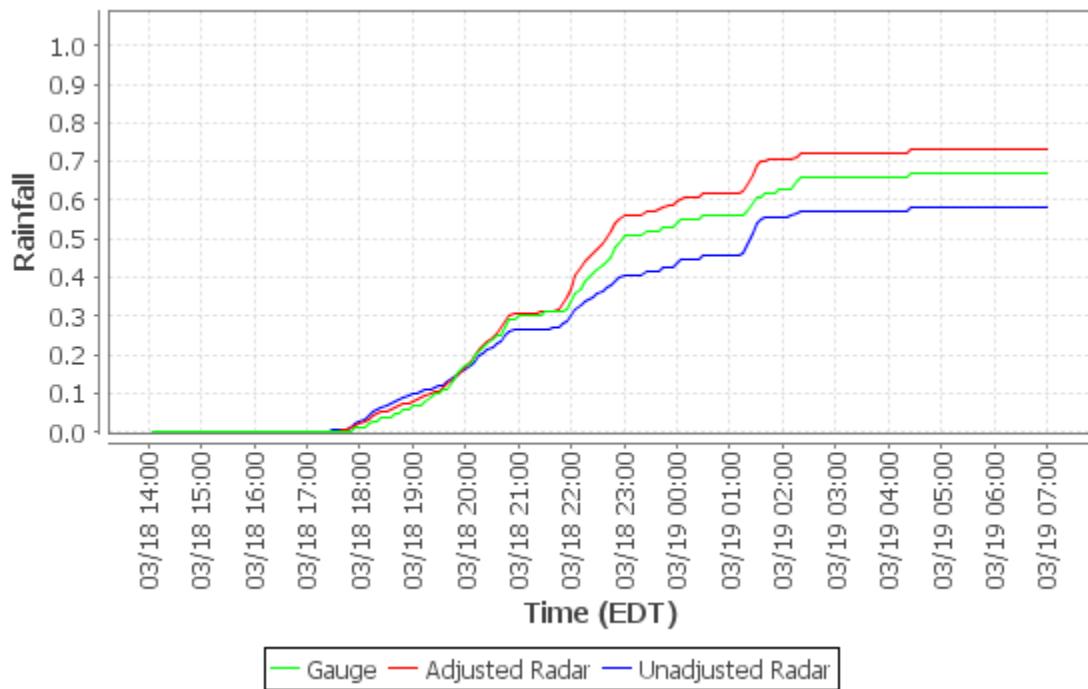
Cumulative Distribution Plot - Oakdale Pump Station (Loc18)



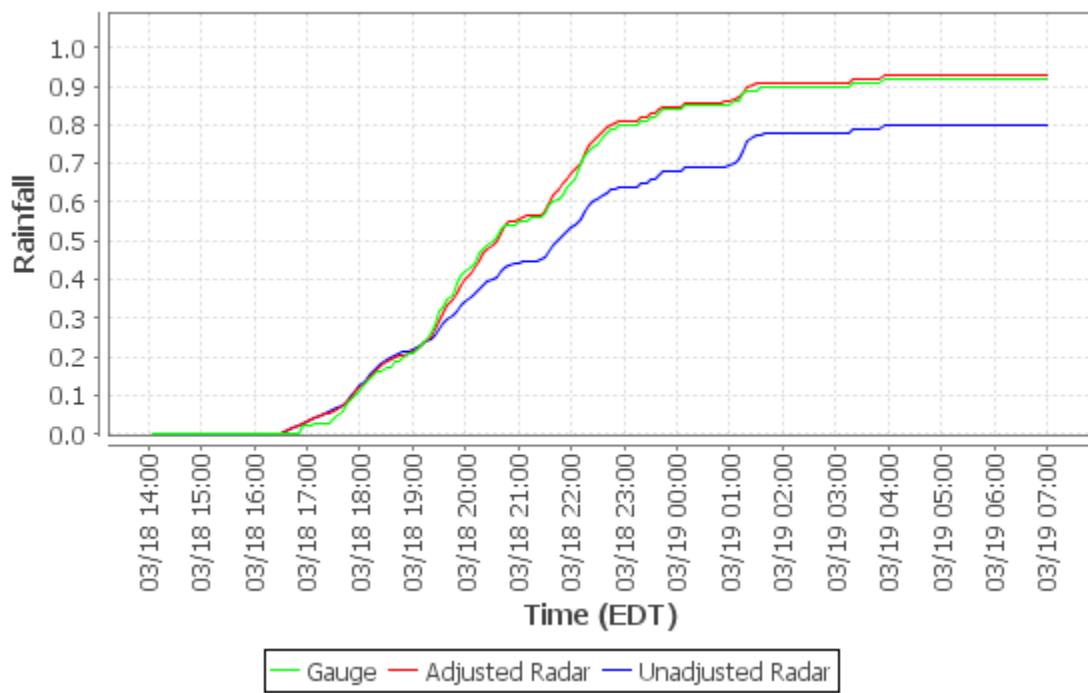
Cumulative Distribution Plot - Sandy Creek Eq Facility (Loc19)



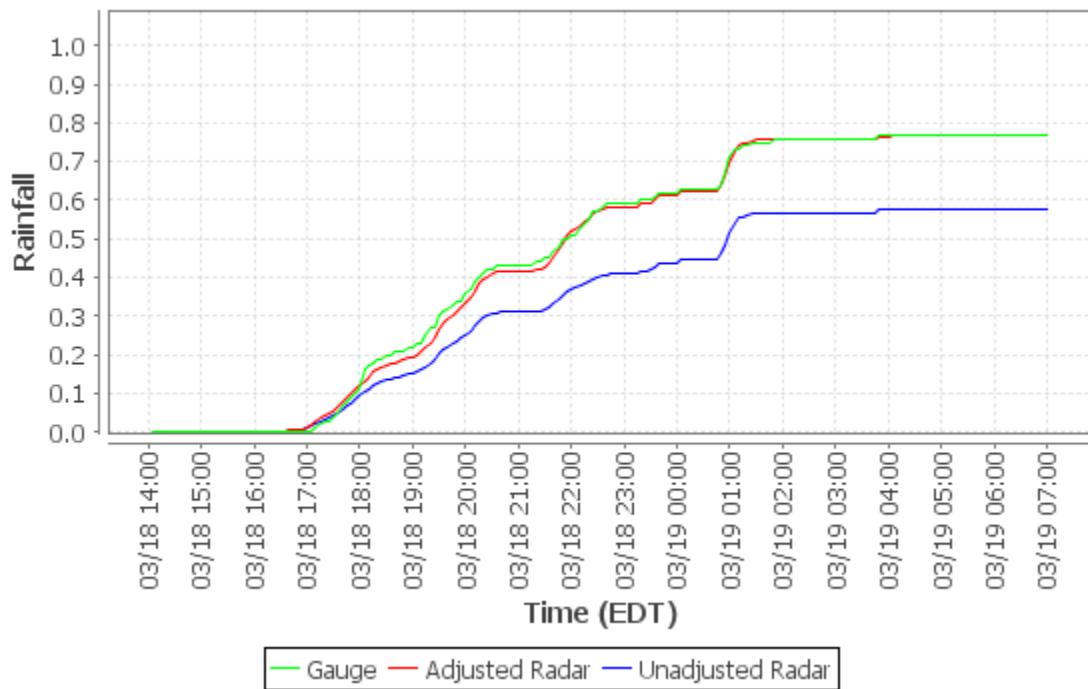
Cumulative Distribution Plot - Gascola Eq Facility (Loc20)



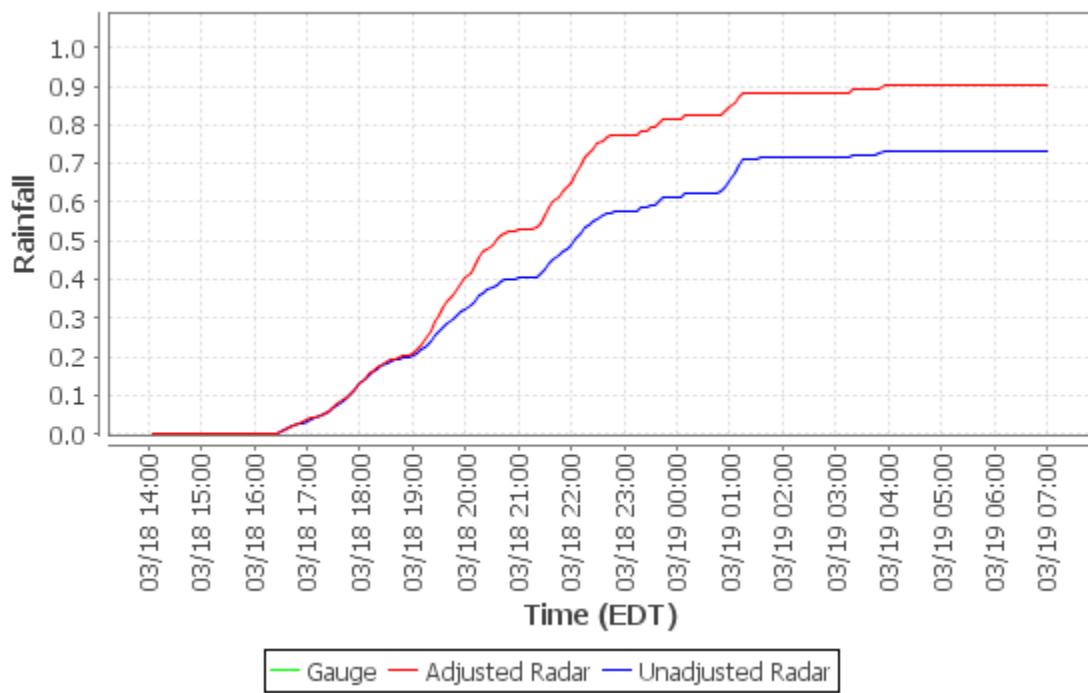
Cumulative Distribution Plot - Moon TWP (Loc21)



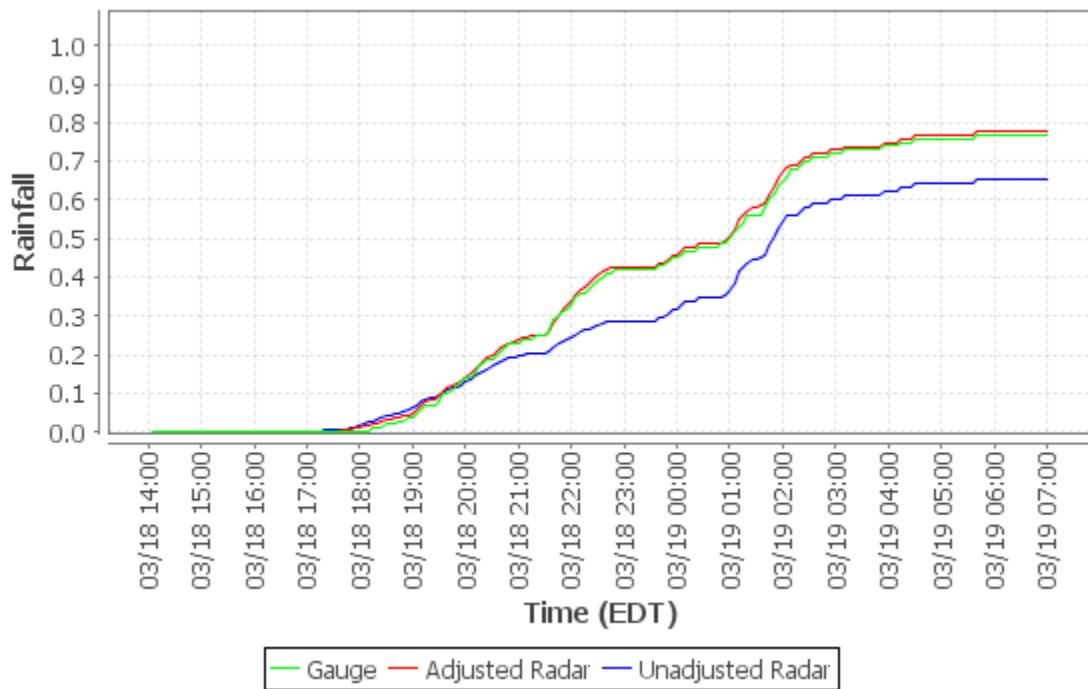
Cumulative Distribution Plot - North Fayette TWP (Loc22)



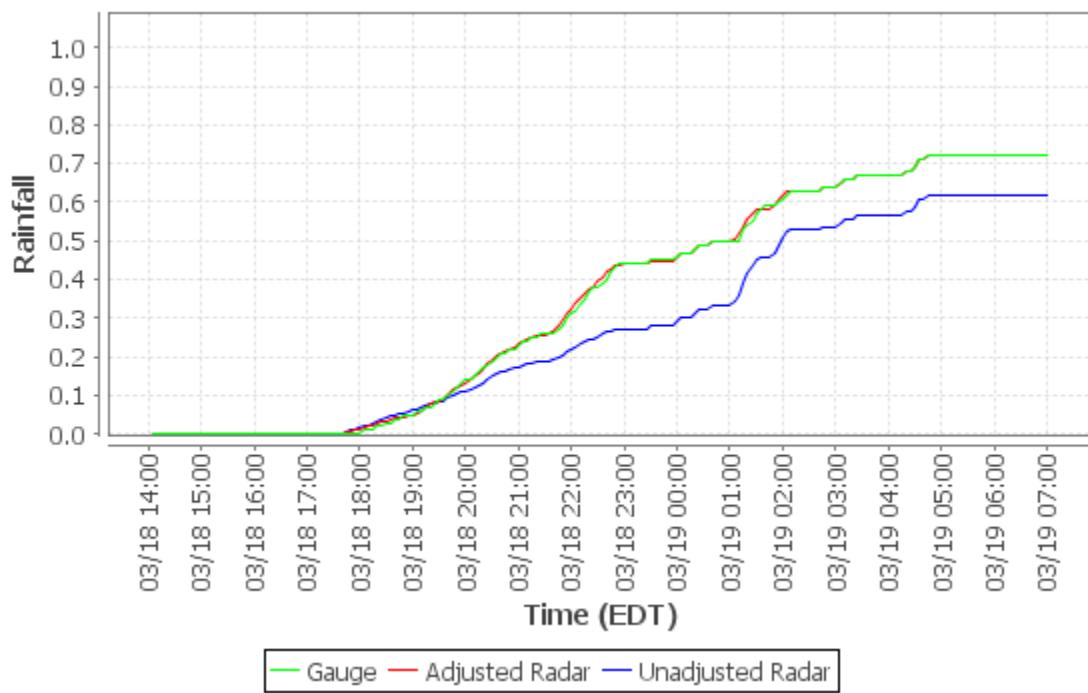
Cumulative Distribution Plot - Clinton Munic Bldg (Loc23)



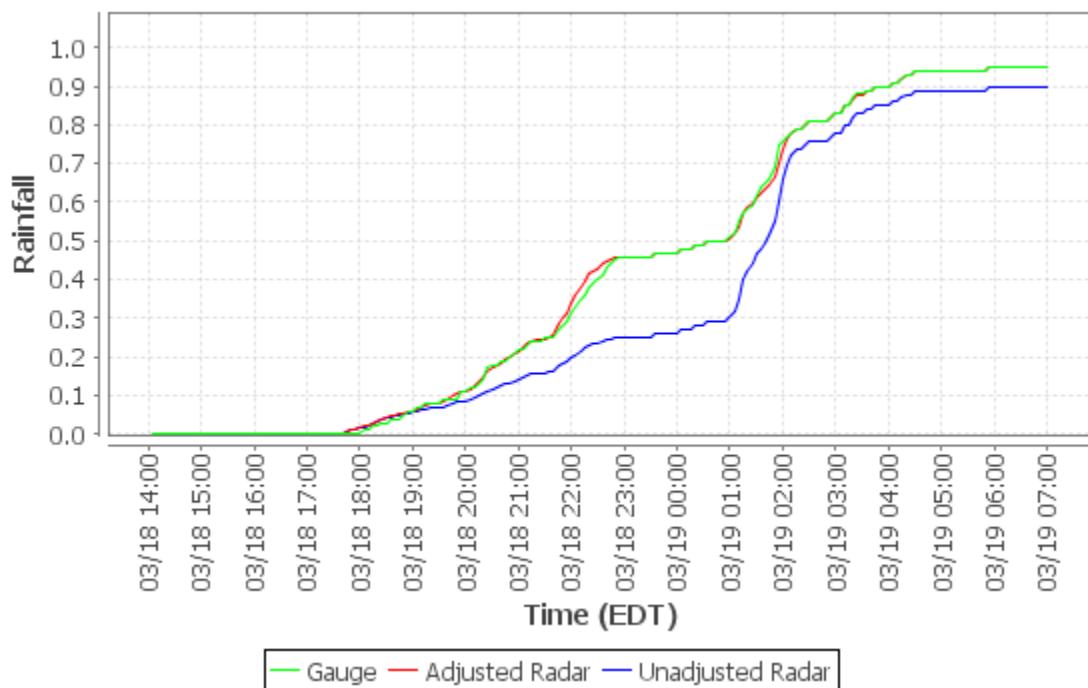
Cumulative Distribution Plot - Jefferson Hills (Loc24)



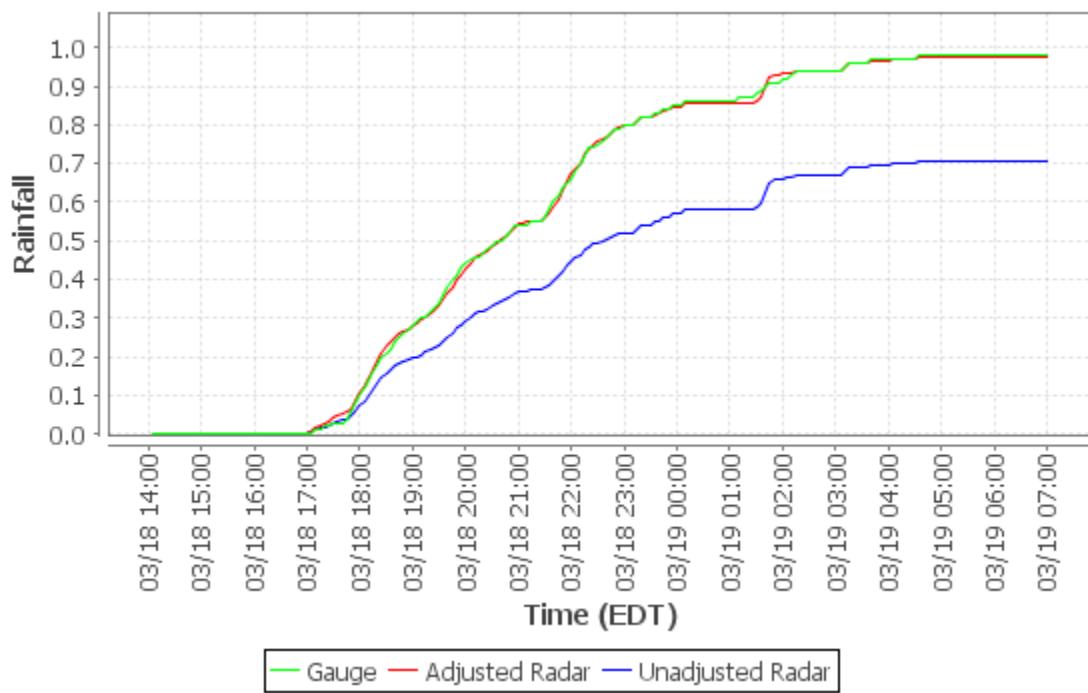
Cumulative Distribution Plot - White Oak Public Works Bldg (Loc25)



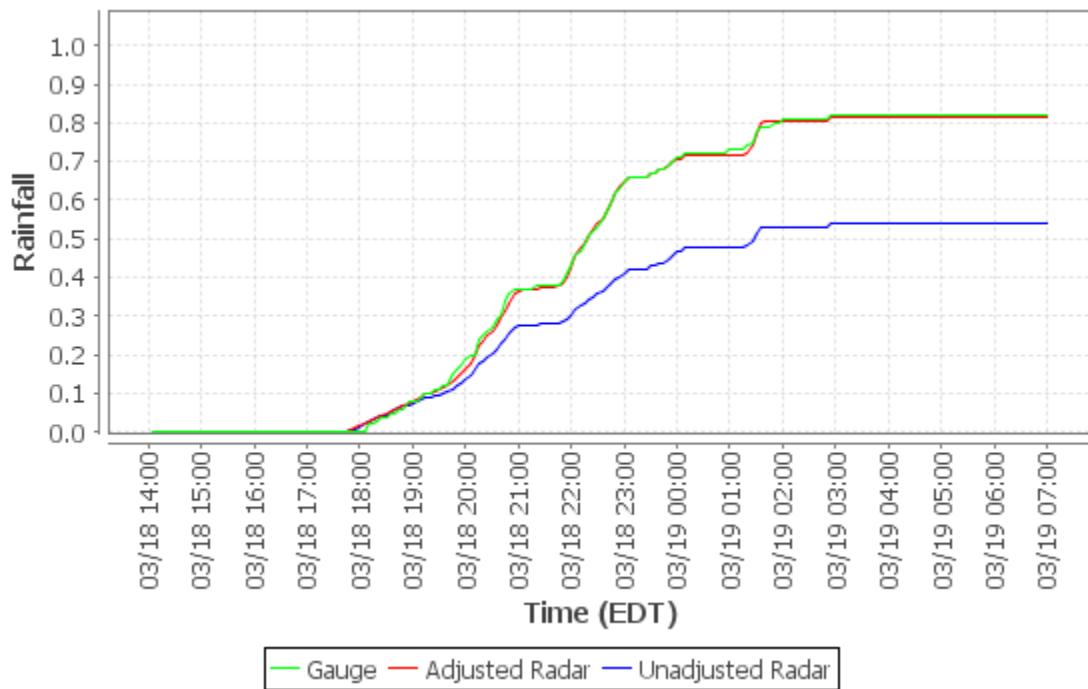
Cumulative Distribution Plot - Elizabeth TWP Municipal Bldg (Loc26)



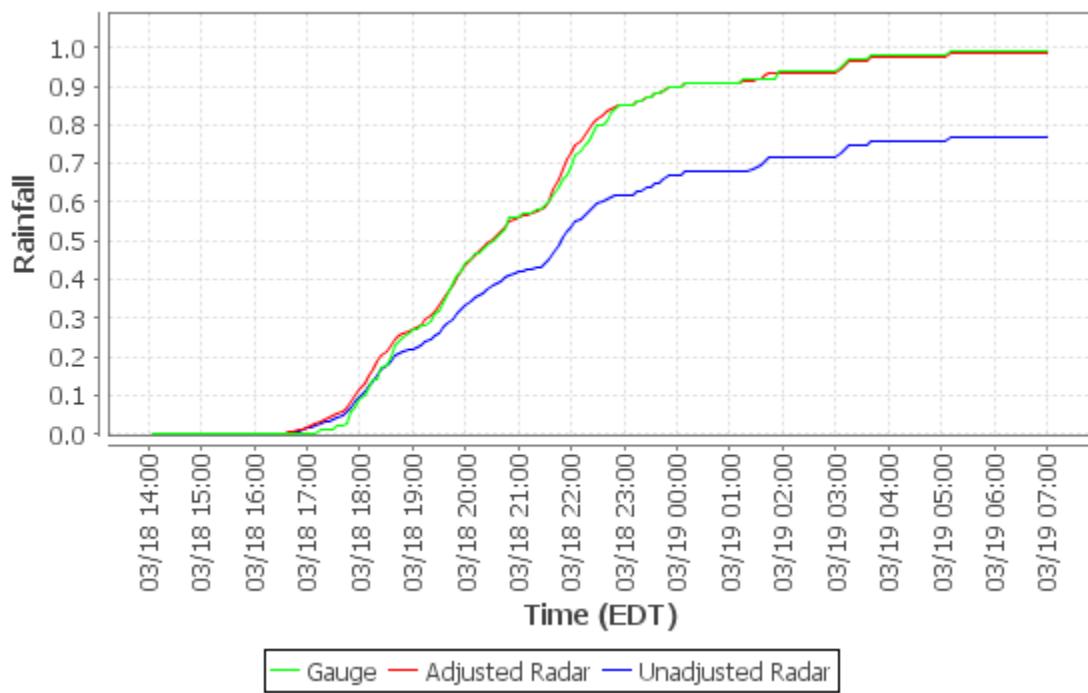
Cumulative Distribution Plot - Marshall TWP (Loc27)



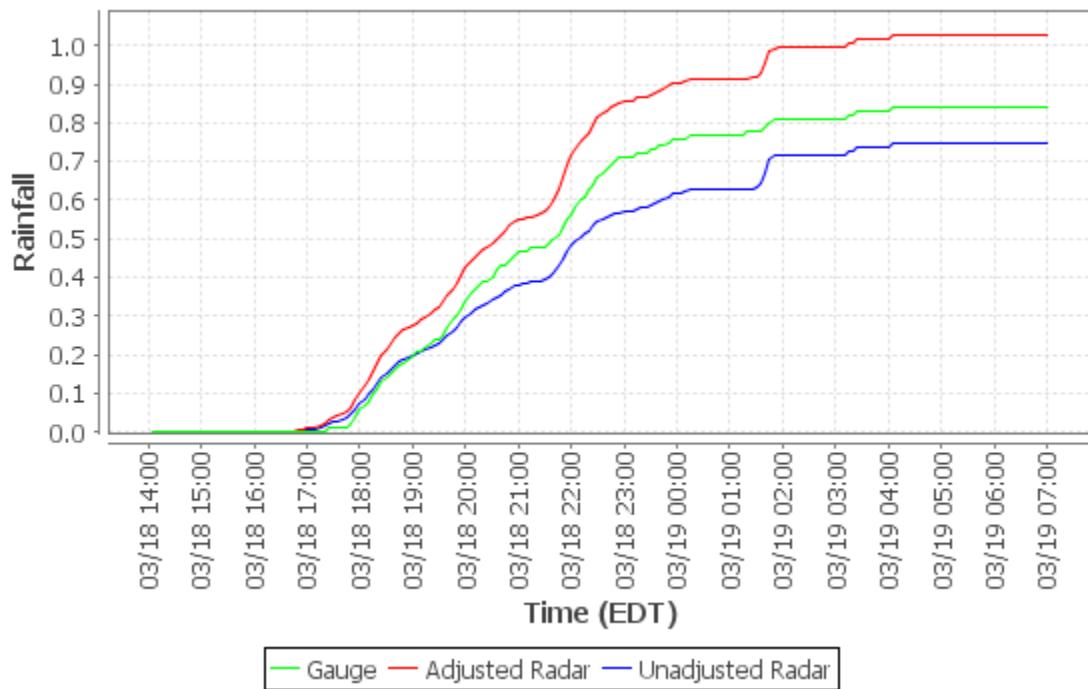
Cumulative Distribution Plot - Plum Municipal Bldg (Loc28)



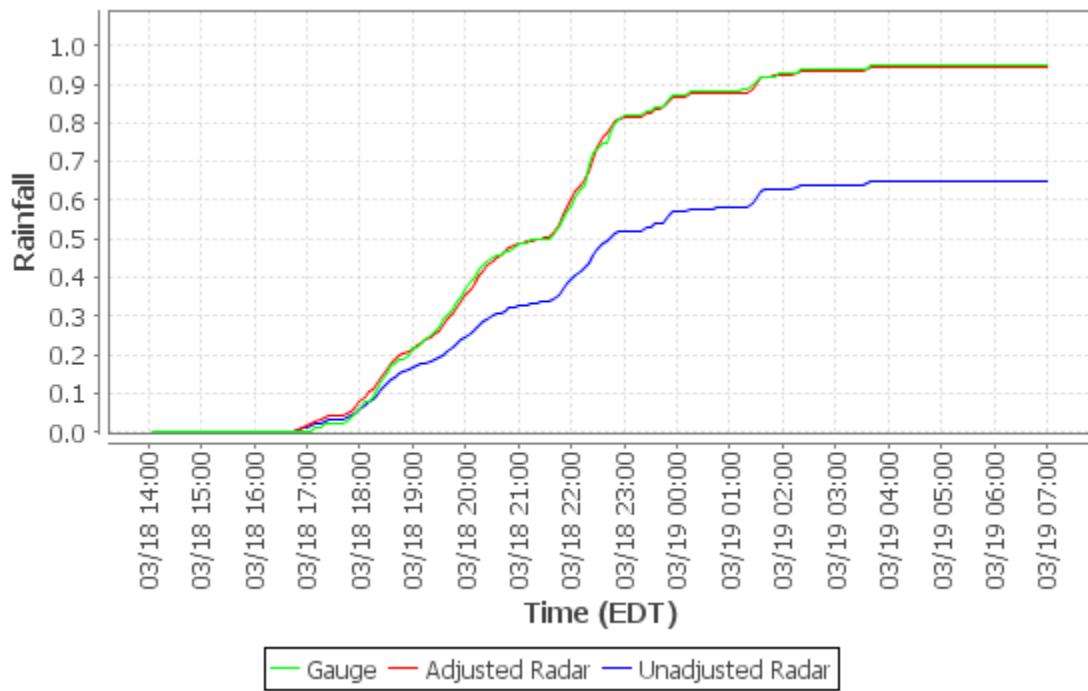
Cumulative Distribution Plot - Bell Acres Munic Bldg (Loc29)



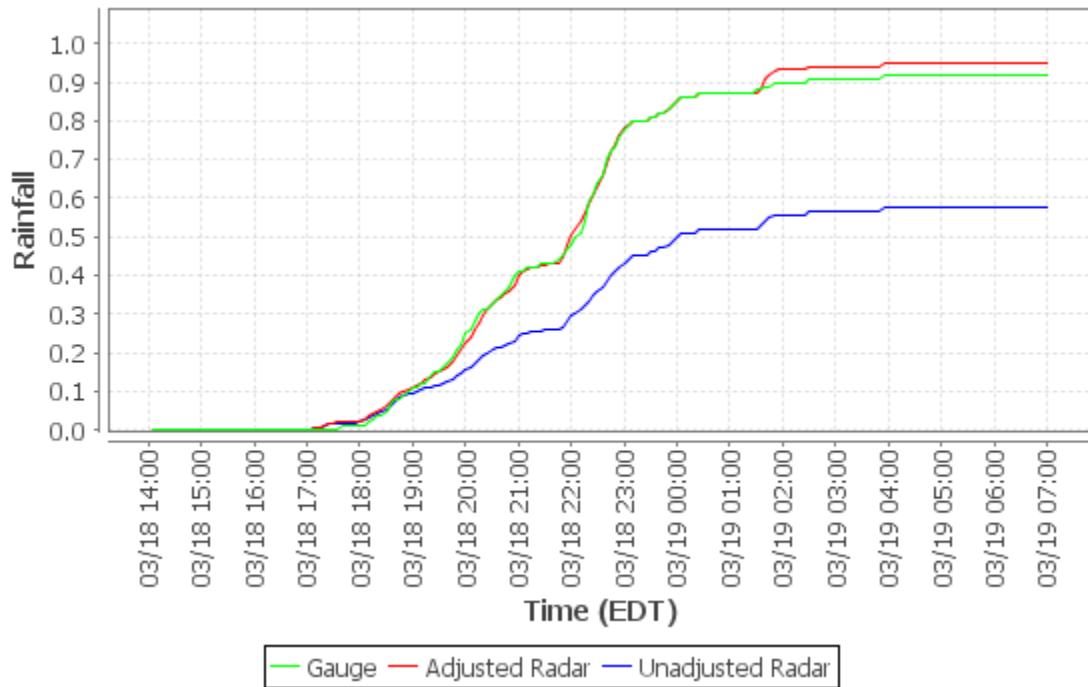
Cumulative Distribution Plot - McCandless Twn Hall (Loc30)



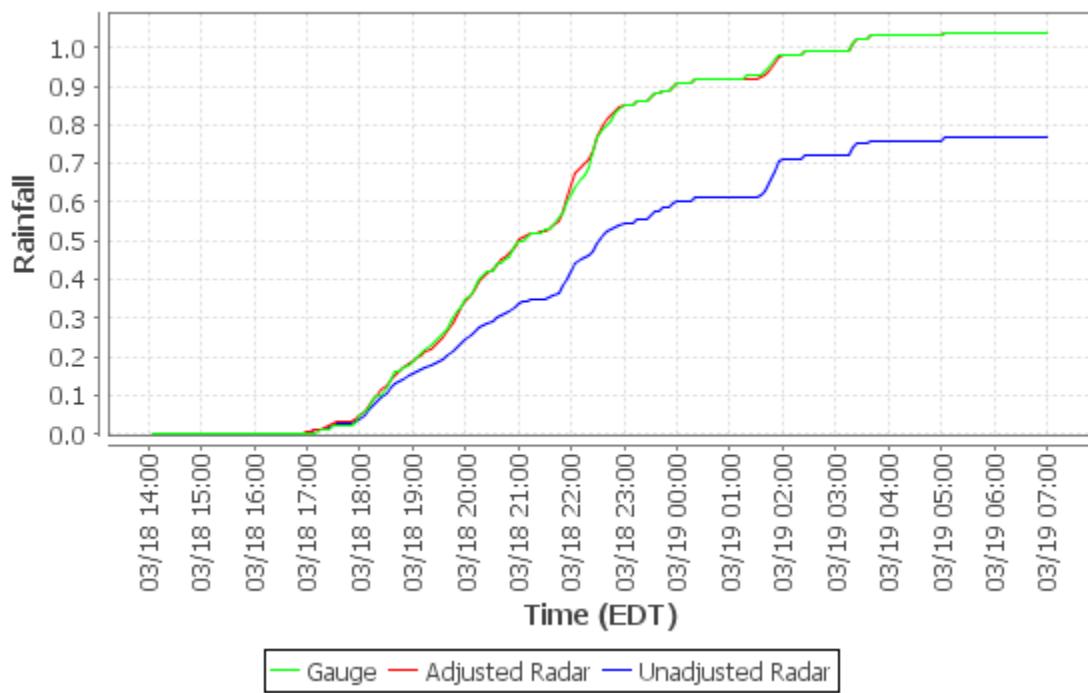
Cumulative Distribution Plot - Hampton Municipal Bldg (Loc31)



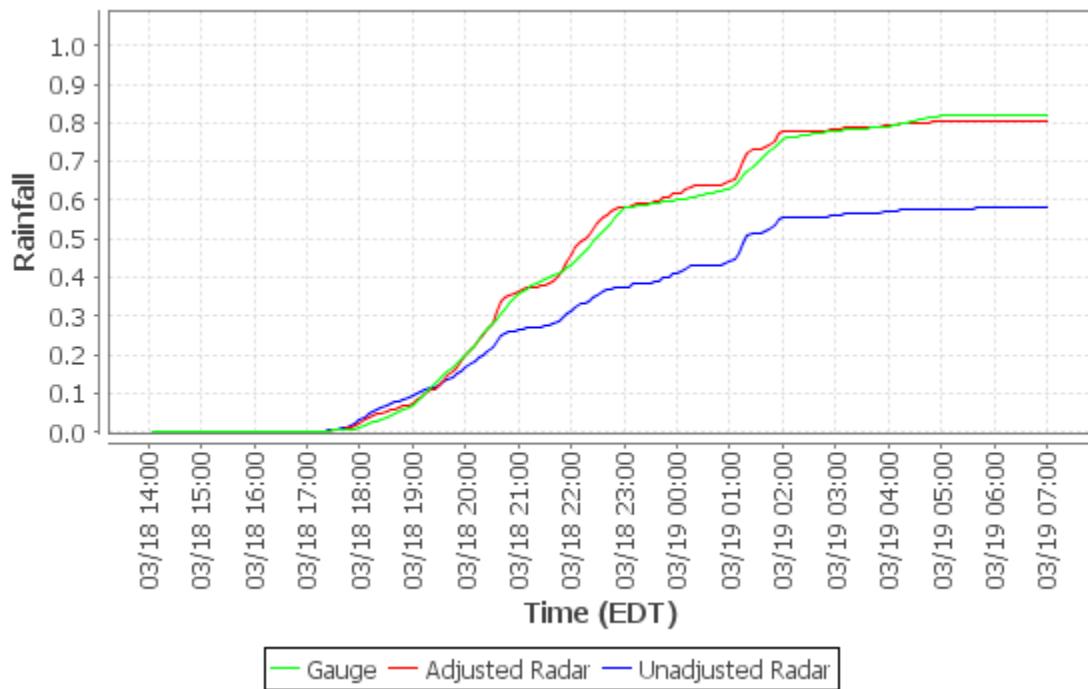
Cumulative Distribution Plot - Arnold (Loc32)



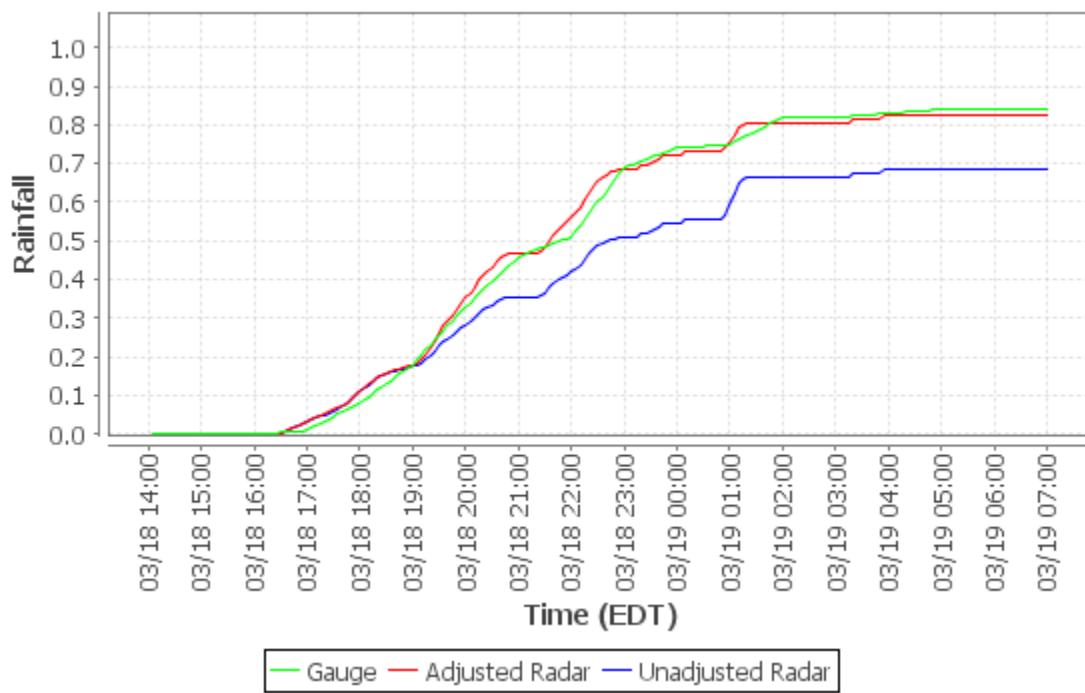
Cumulative Distribution Plot - Richland TWP (Loc33)



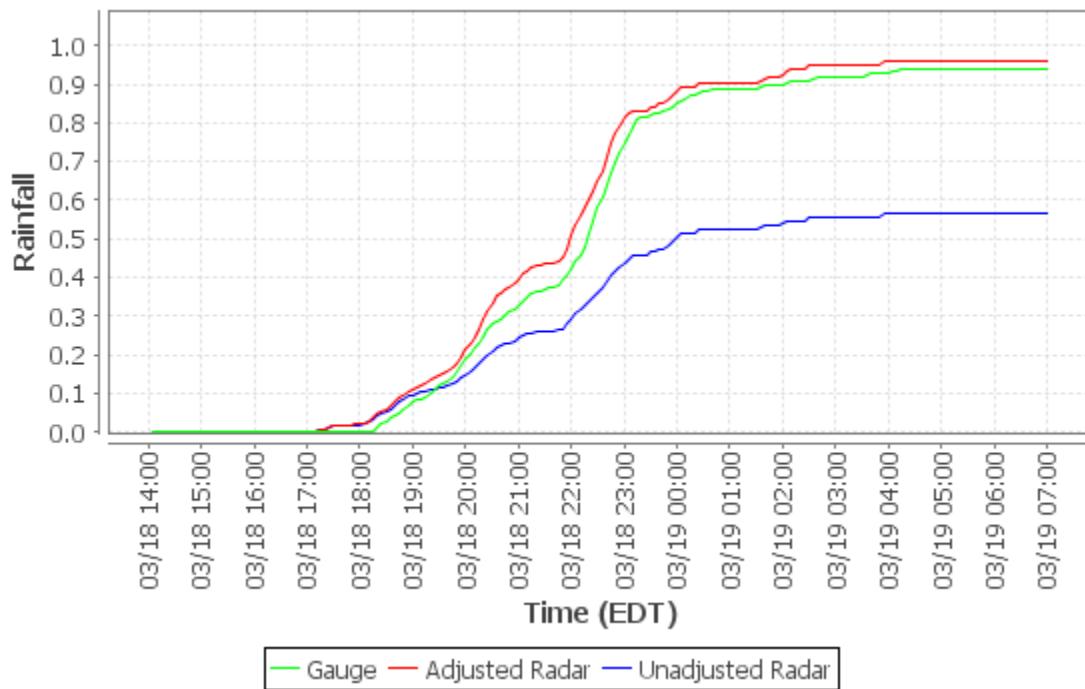
Cumulative Distribution Plot - Pittsburgh Allegheny Cty (KAGC)



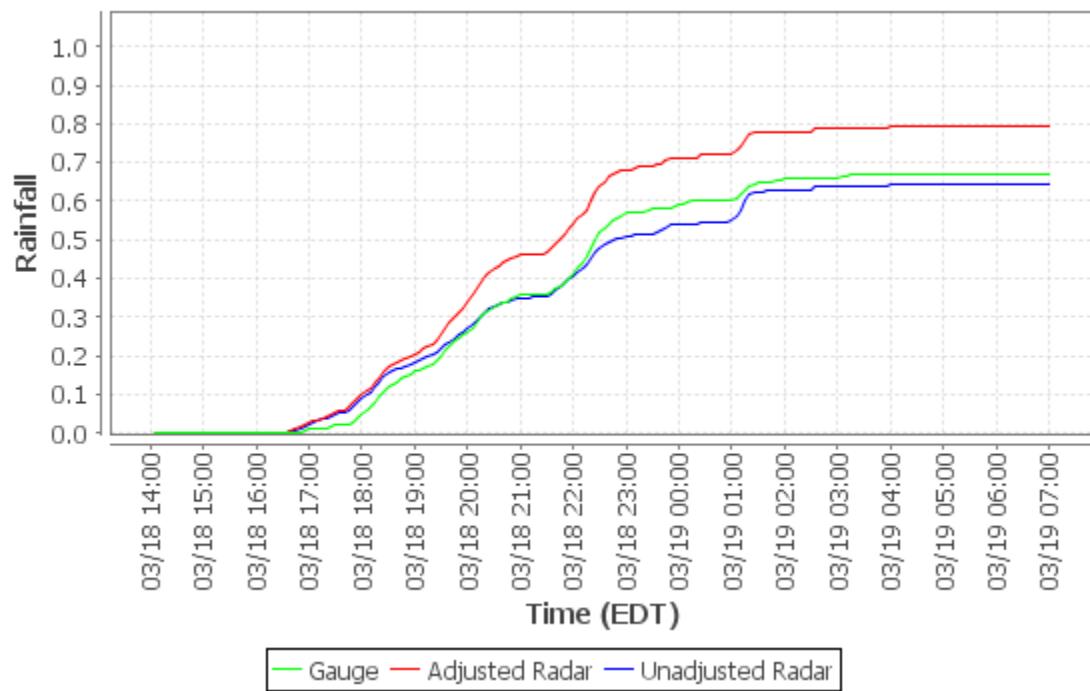
Cumulative Distribution Plot - Greater Pittsburgh Int'l (KPIT)



Cumulative Distribution Plot - Allegheny River at Natrona (03049500)

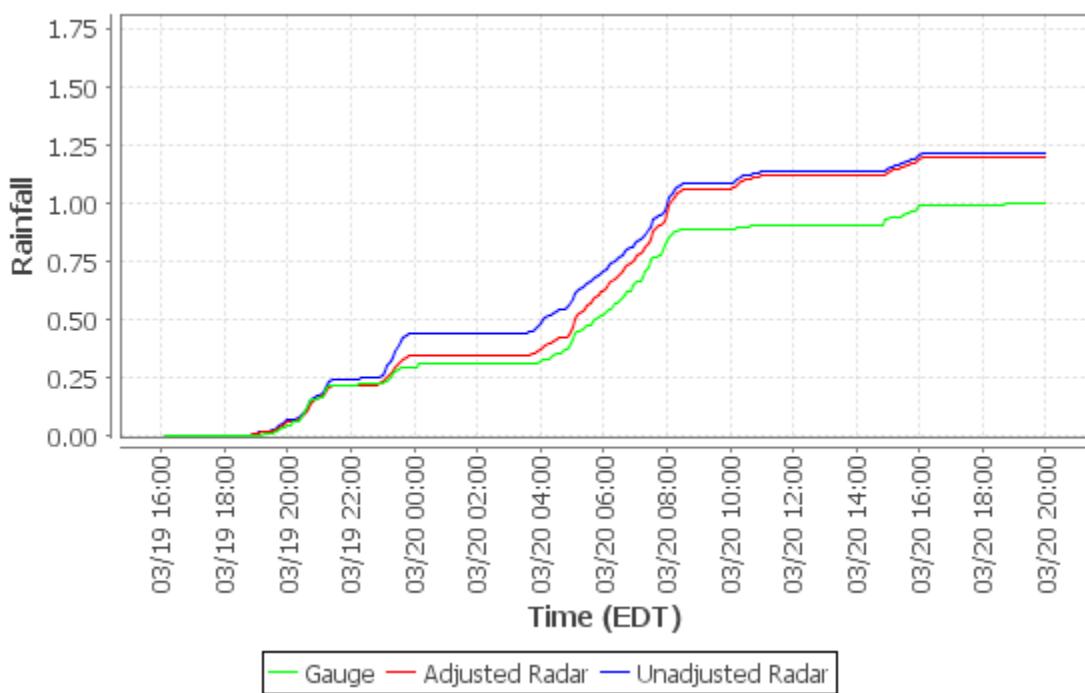


**Cumulative Distribution Plot - Ohio River at Emsworth Dam Lower Pool at Emsworth
(03085734)**

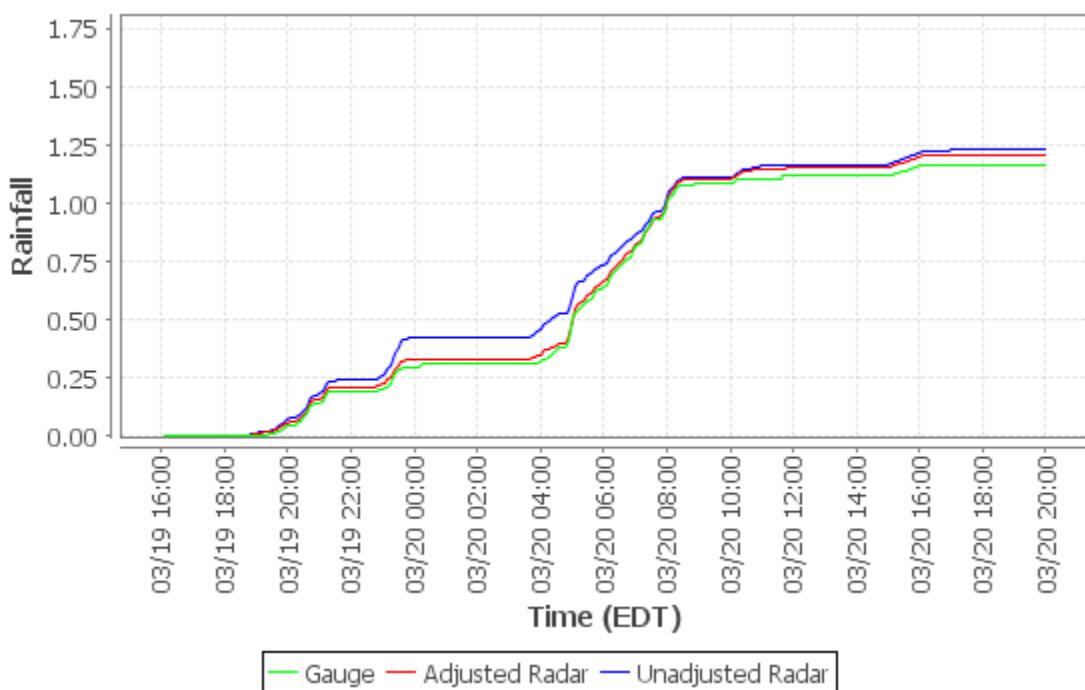


Appendix H - Event 6 (2020-03-20) CDPs

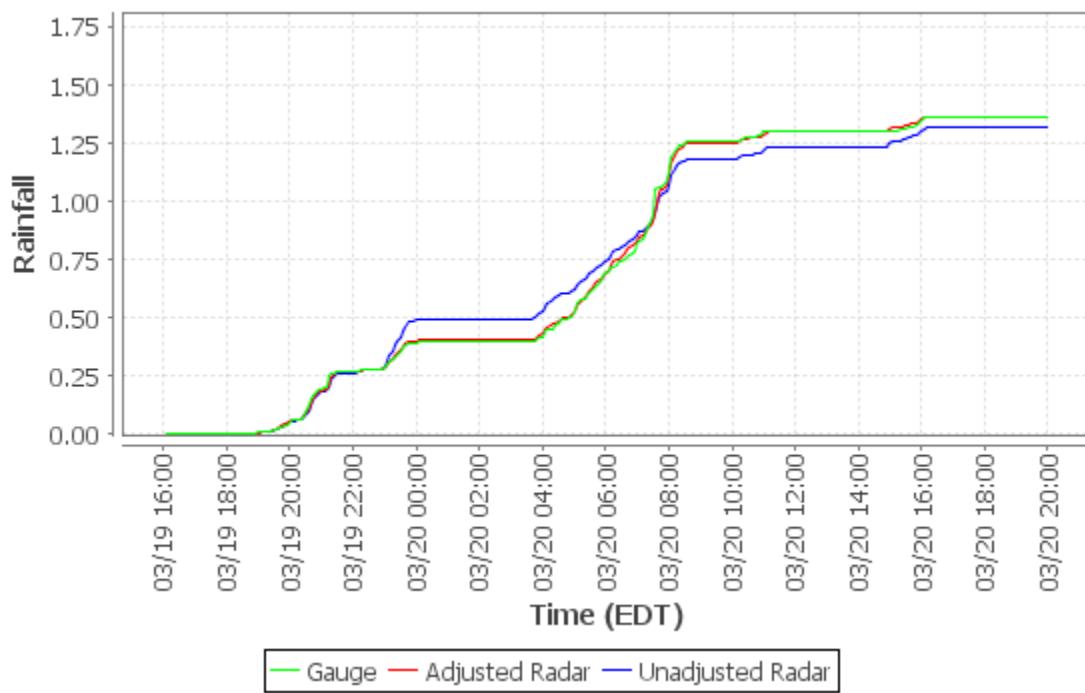
Cumulative Distribution Plot - PWSA-Montana St. (Loc01)



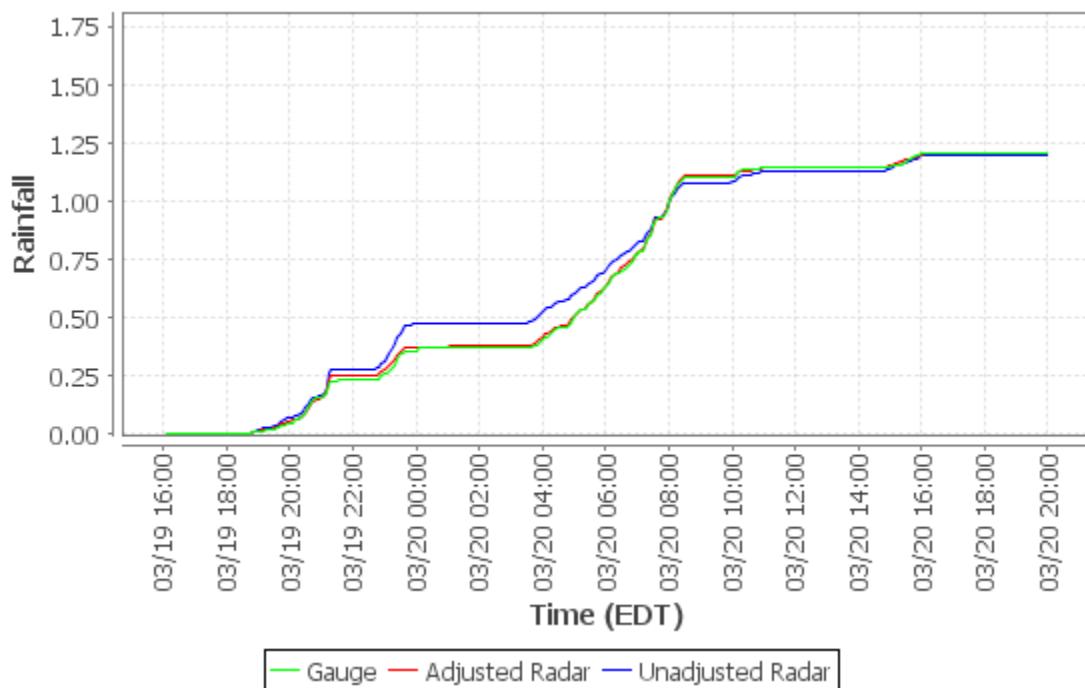
Cumulative Distribution Plot - ALCOSAN WWTP Lab (Loc02)



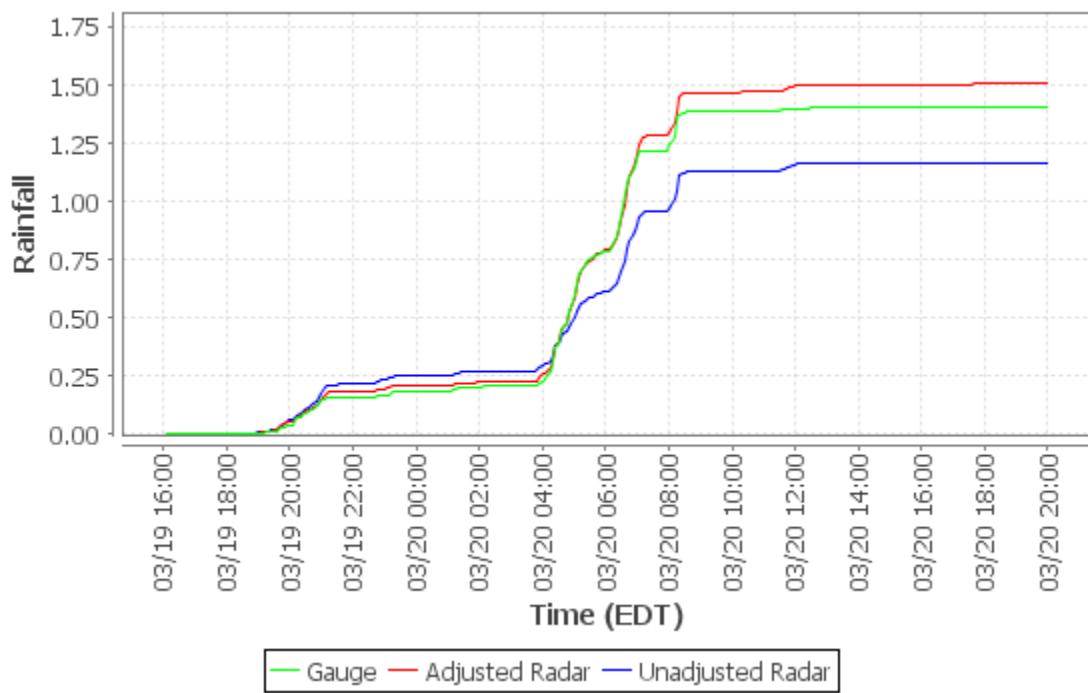
Cumulative Distribution Plot - Shaler Munic Bldg (Loc03)



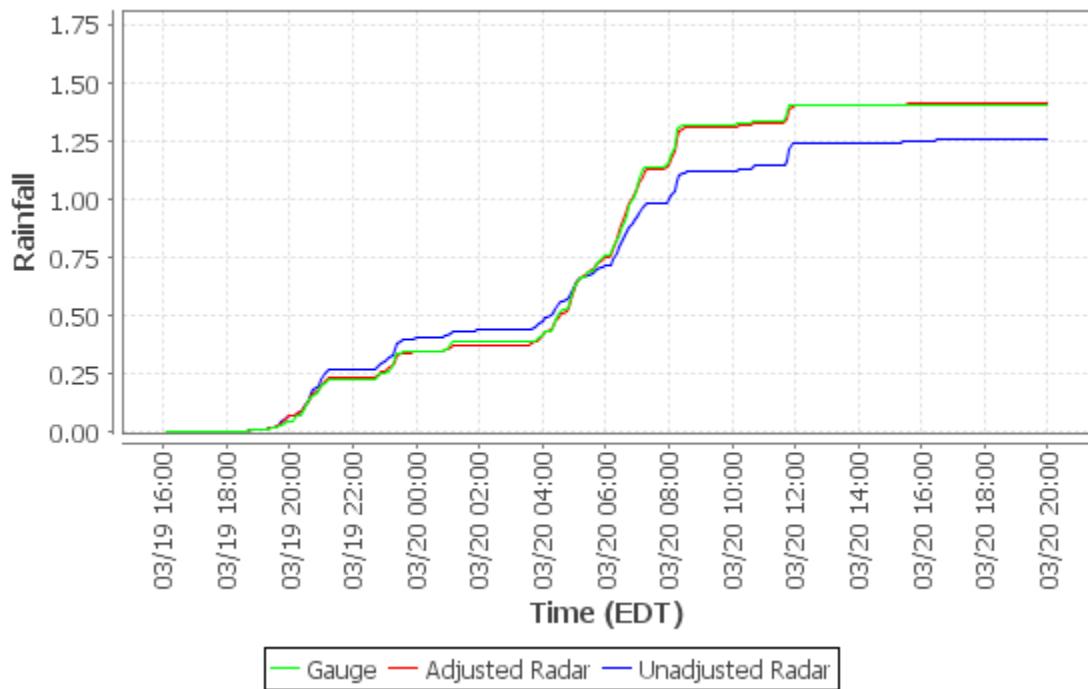
Cumulative Distribution Plot - Kennedy Twp PS (Loc04)



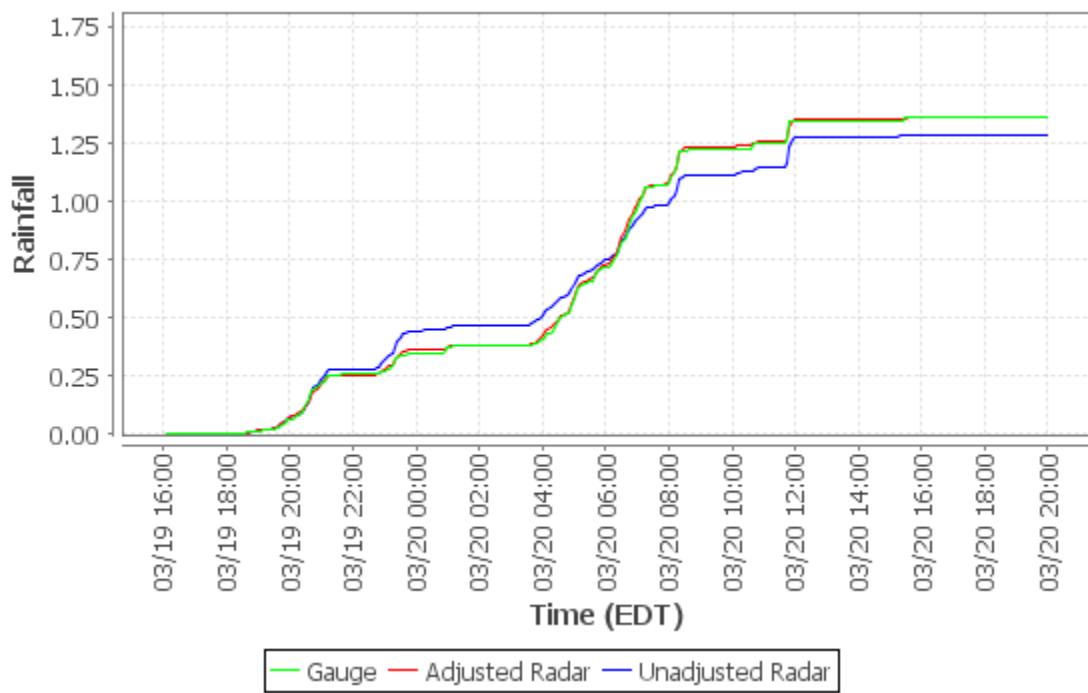
Cumulative Distribution Plot - Upper St. Clair (Loc05)



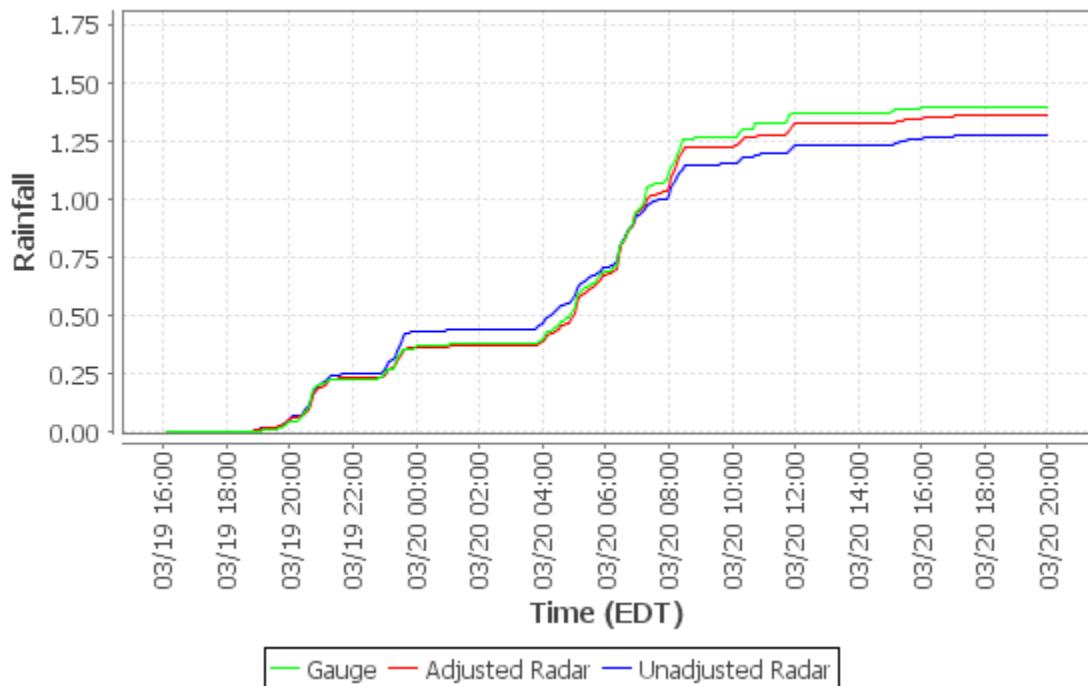
Cumulative Distribution Plot - Carnegie Transit Time (Loc06)



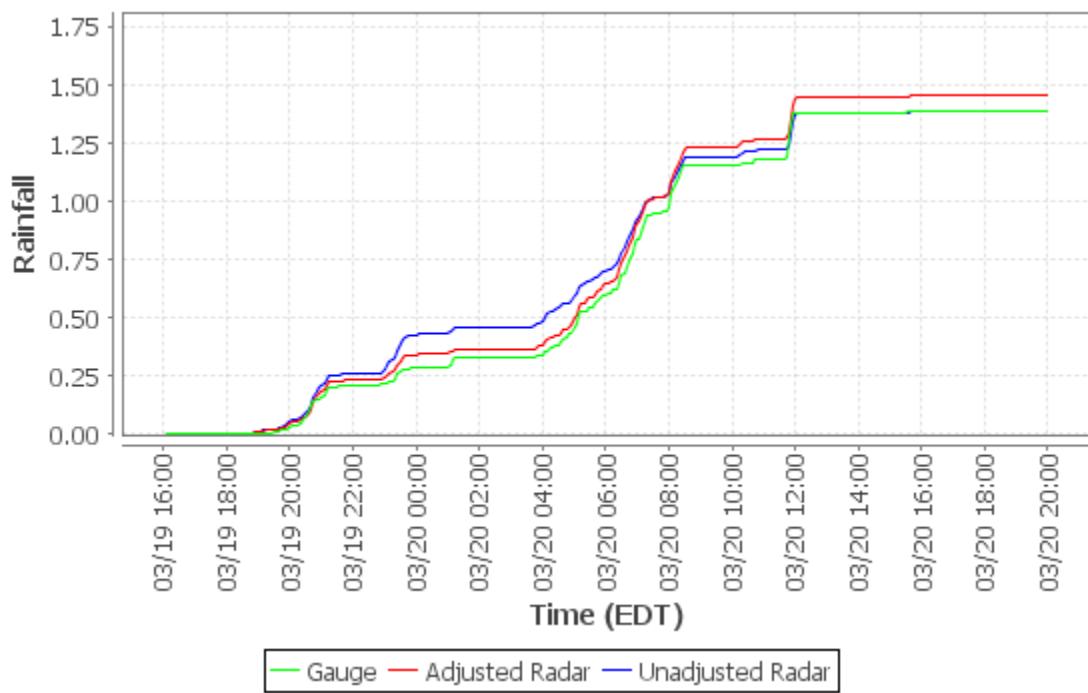
Cumulative Distribution Plot - Greentree Munic Bldg (Loc07)



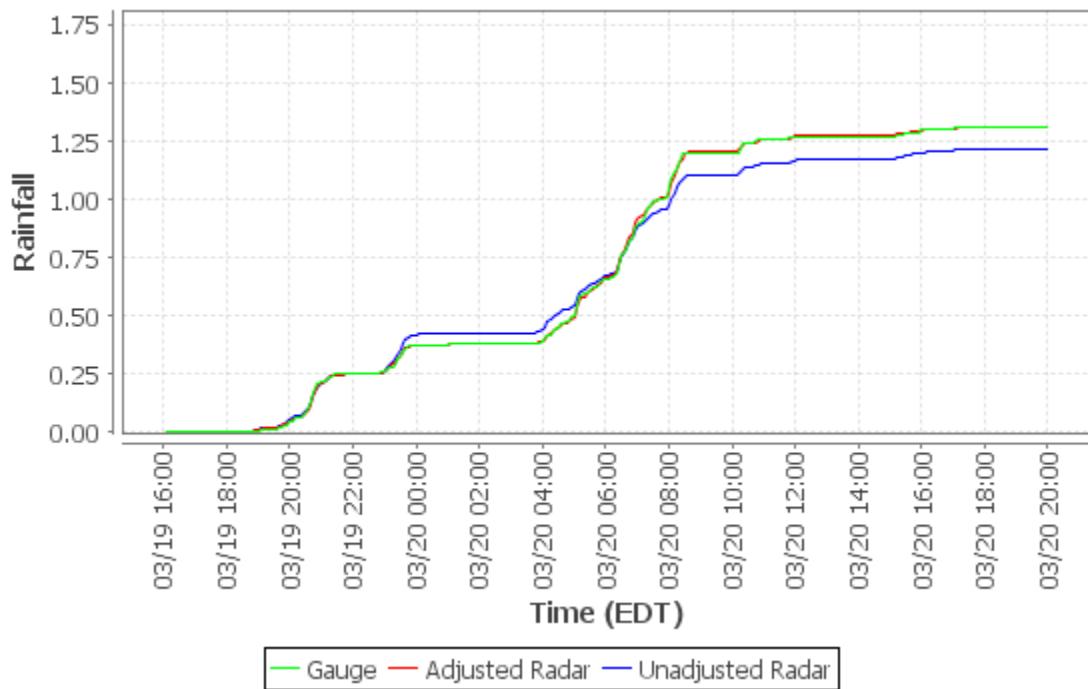
Cumulative Distribution Plot - AC Health Dept Bldg (Loc08)



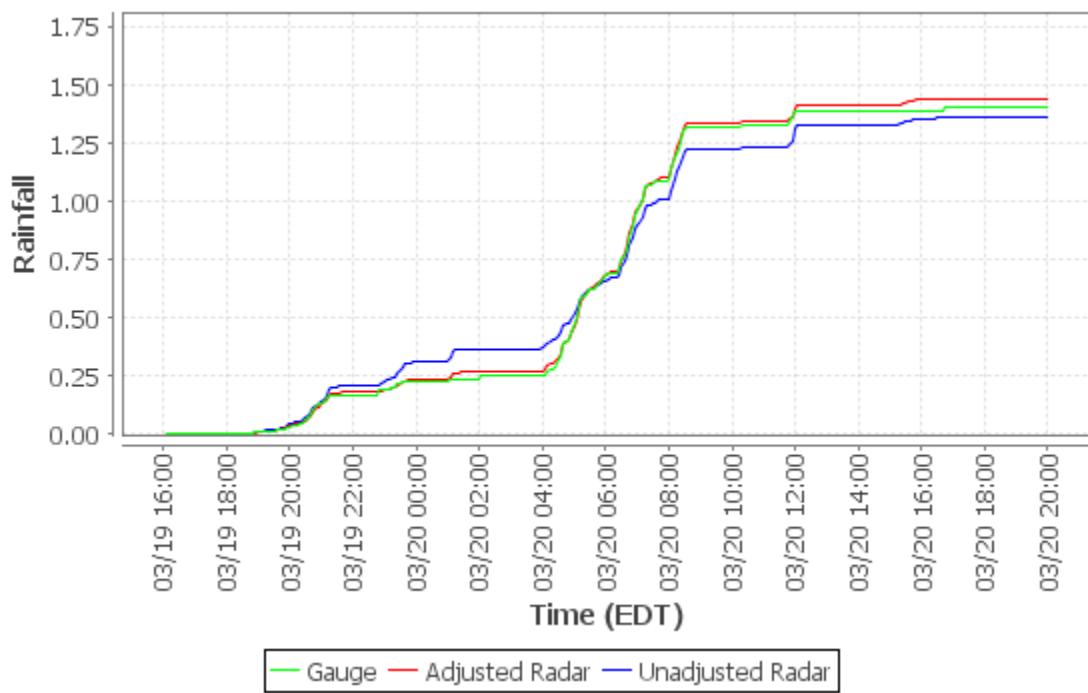
Cumulative Distribution Plot - Univ of Pittsburgh (Loc09)



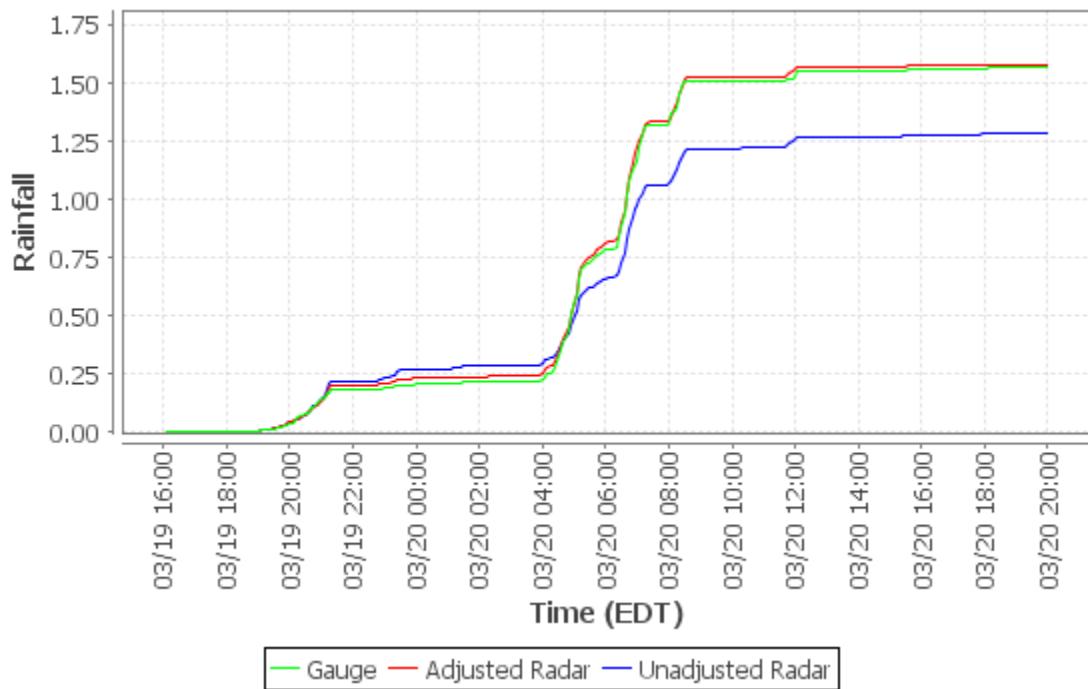
Cumulative Distribution Plot - PWSA-Highland Park (Loc10)



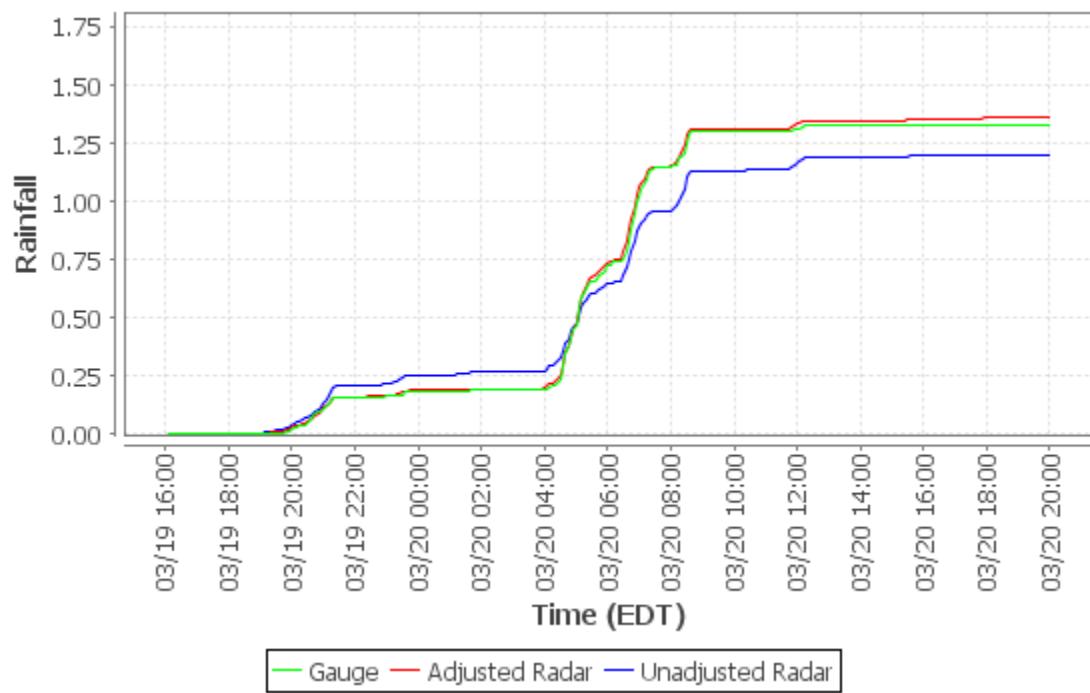
Cumulative Distribution Plot - M-46 Access Shaft (Loc11)



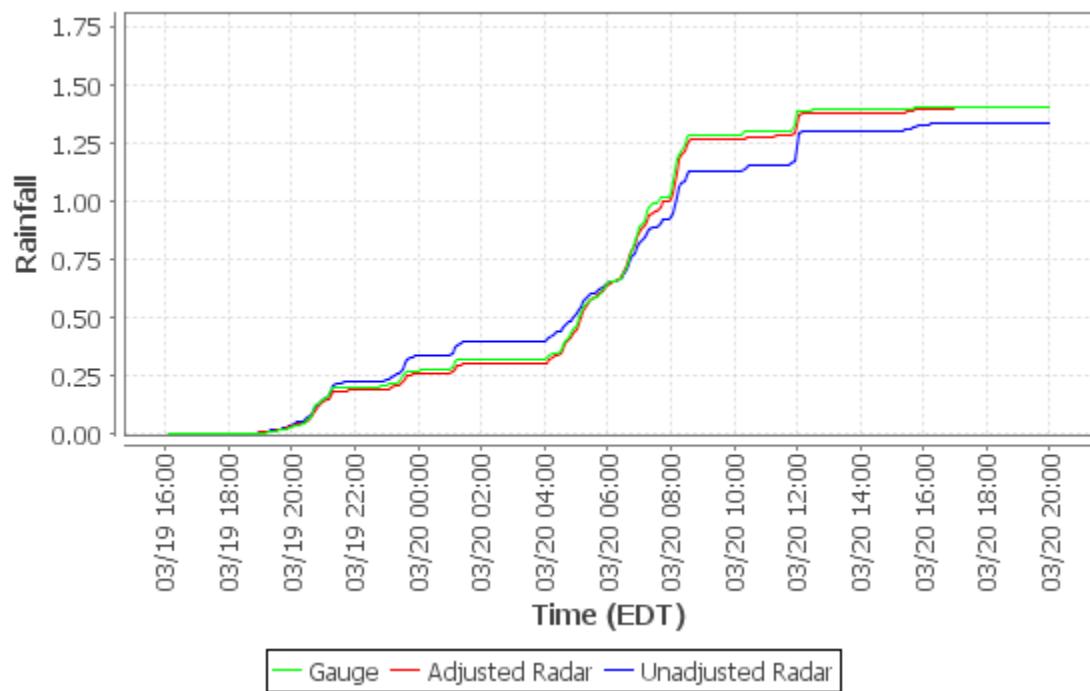
Cumulative Distribution Plot - Baldwin (Loc12)



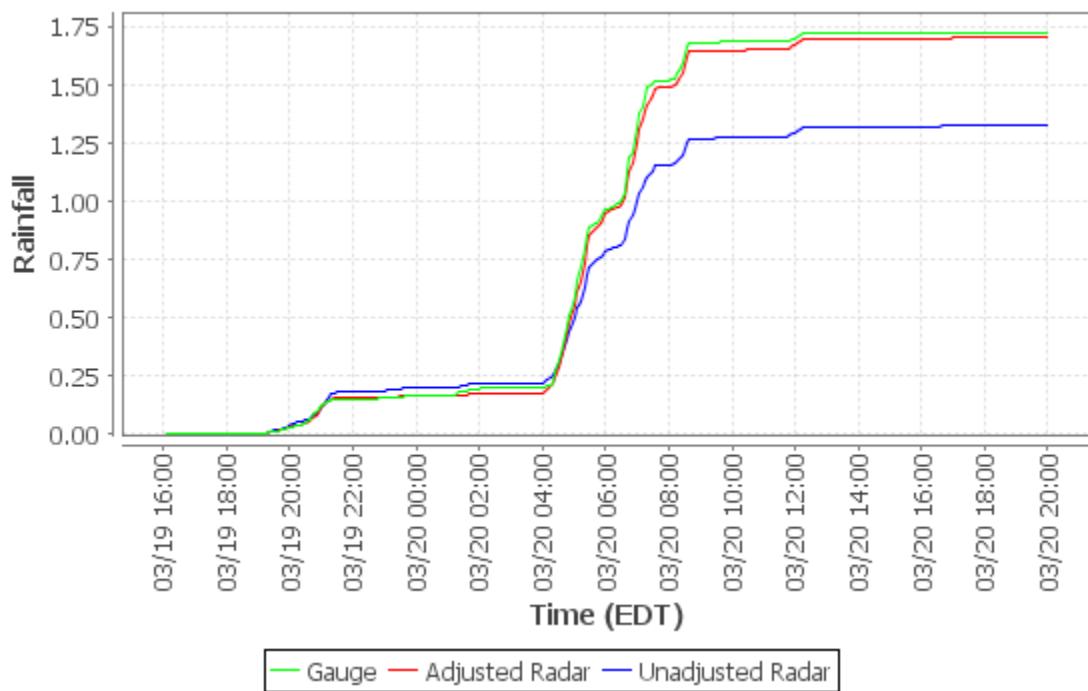
Cumulative Distribution Plot - M-59 Access Shaft (Loc13)



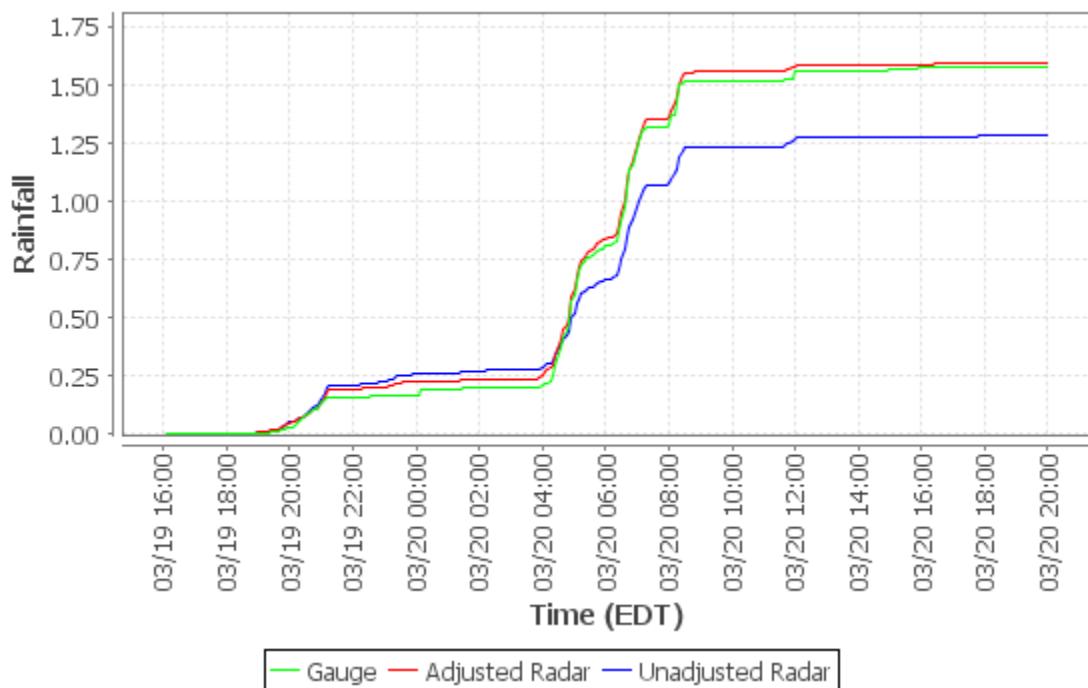
Cumulative Distribution Plot - Churchill Munic Bldg (Loc14)



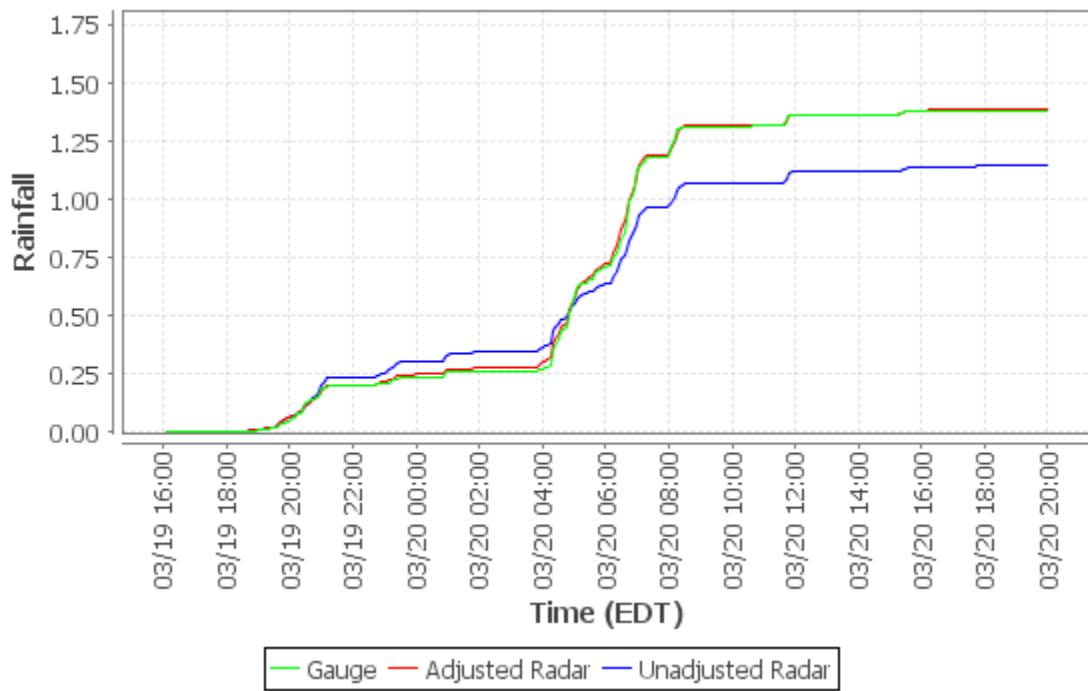
Cumulative Distribution Plot - Trafford Maint Bldg (Loc15)



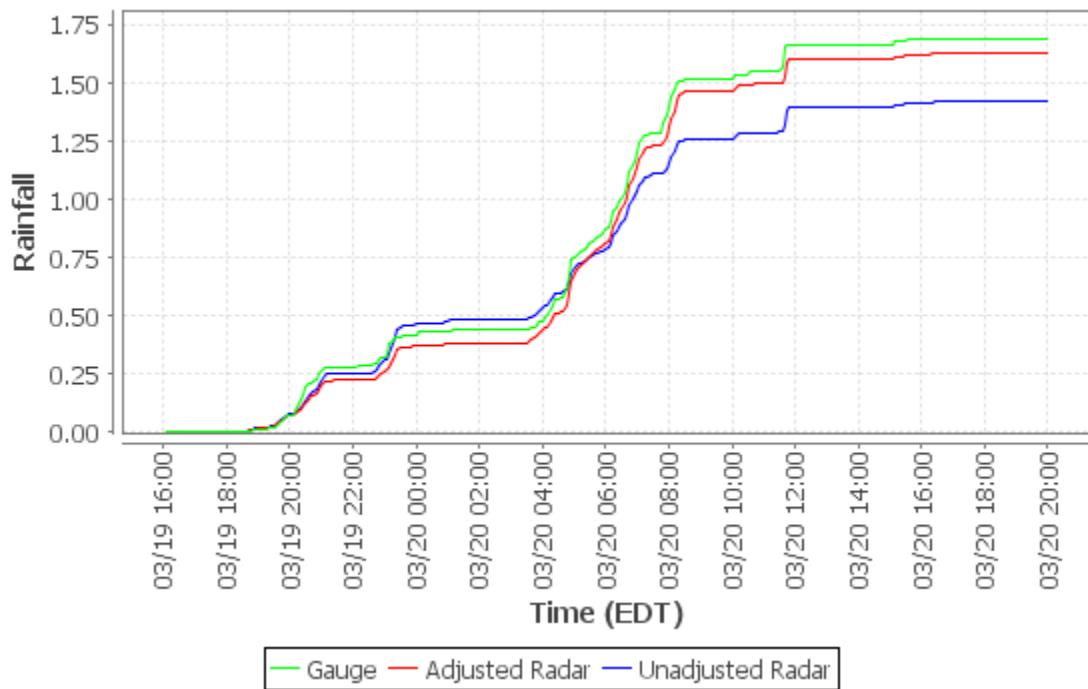
Cumulative Distribution Plot - Castle Shannon (Loc16)



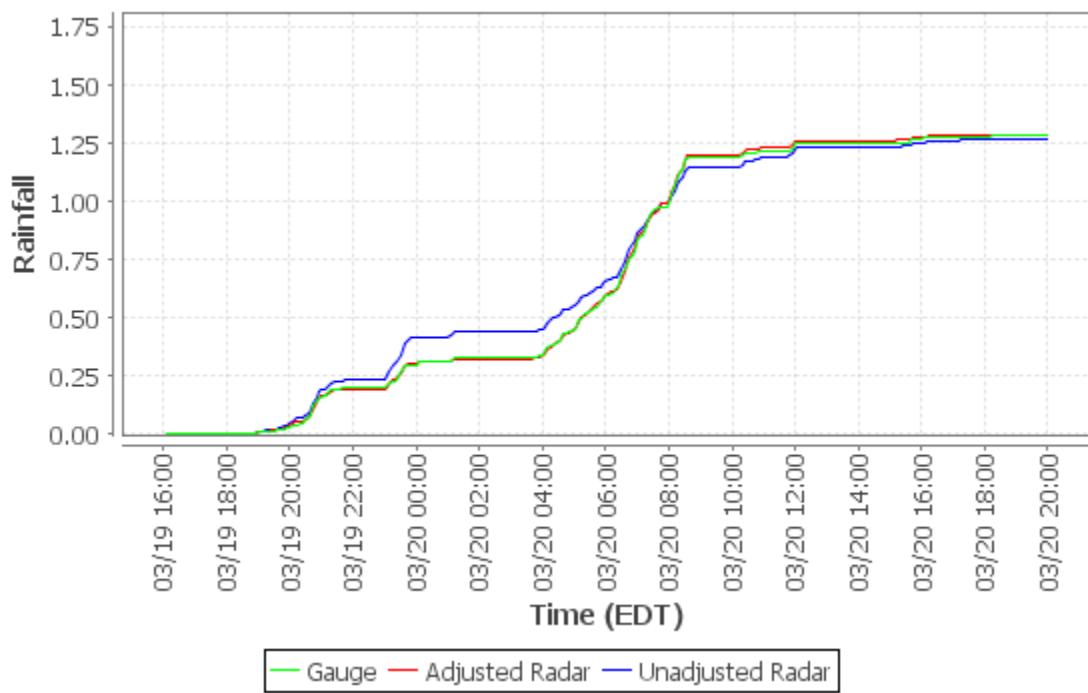
Cumulative Distribution Plot - Chartiers Pump Station (Loc17)



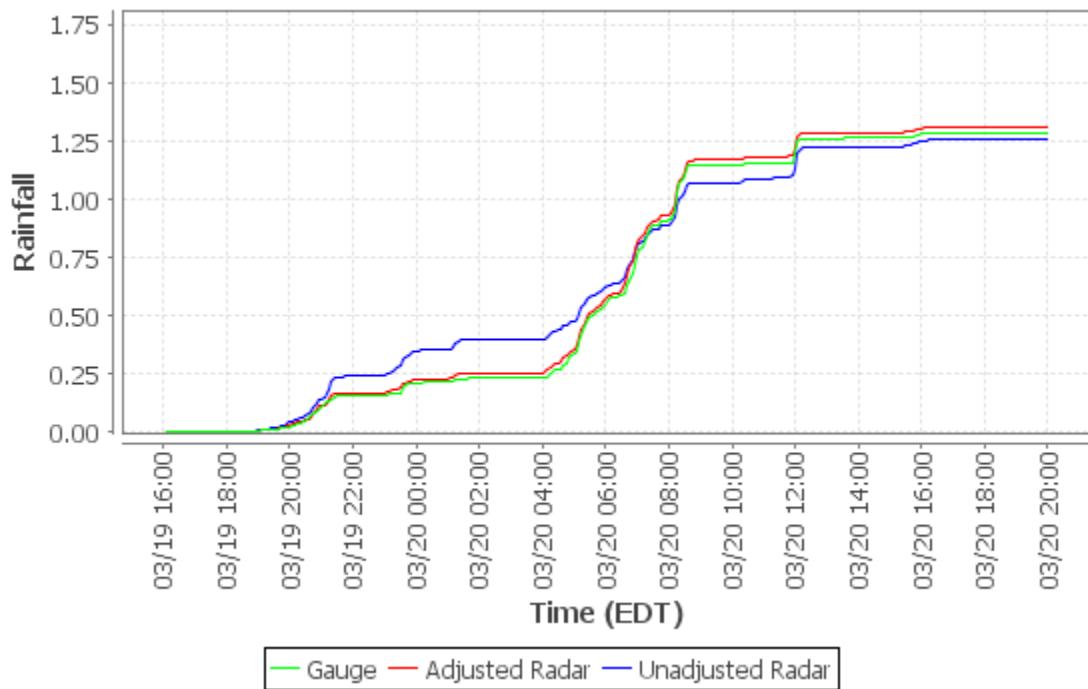
Cumulative Distribution Plot - Oakdale Pump Station (Loc18)



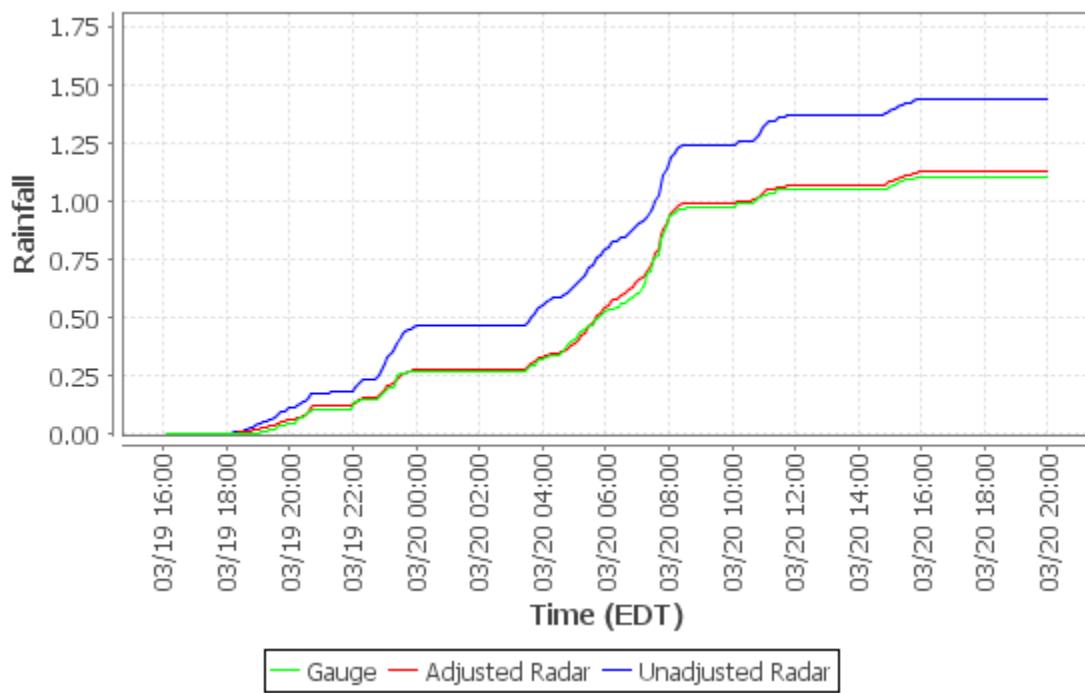
Cumulative Distribution Plot - Sandy Creek Eq Facility (Loc19)



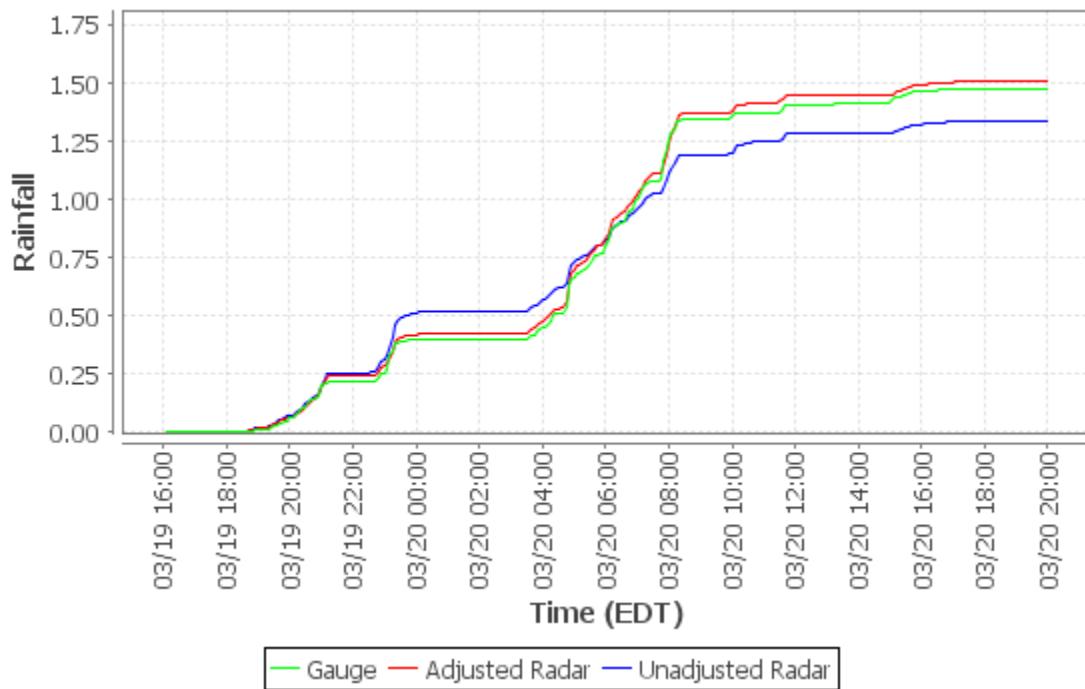
Cumulative Distribution Plot - Gascola Eq Facility (Loc20)



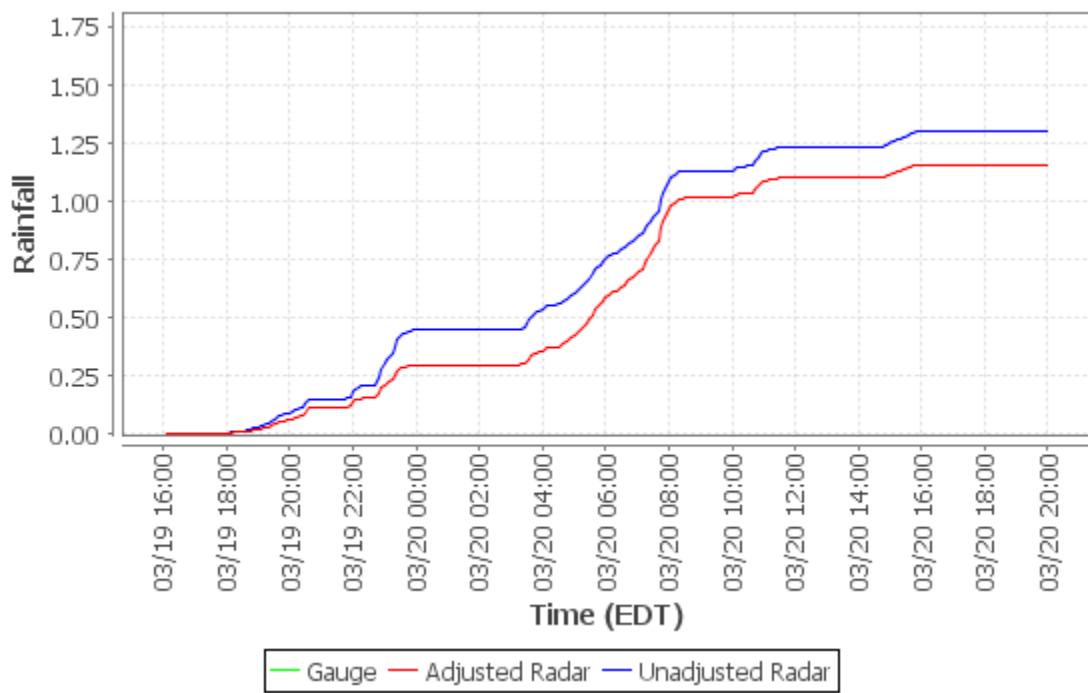
Cumulative Distribution Plot - Moon TWP (Loc21)



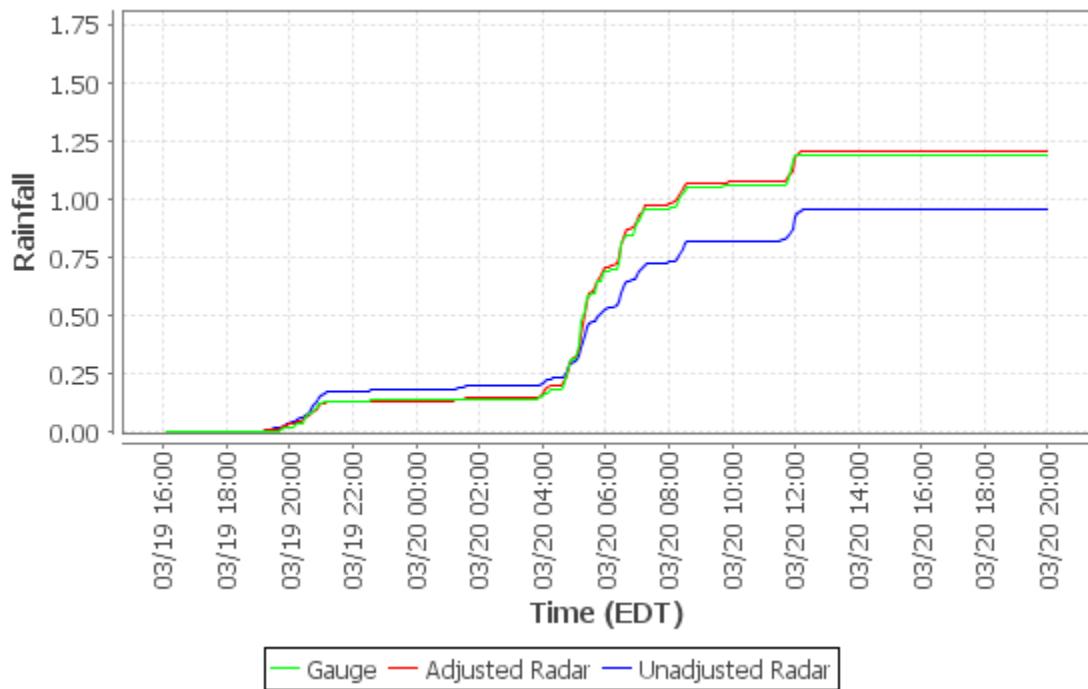
Cumulative Distribution Plot - North Fayette TWP (Loc22)



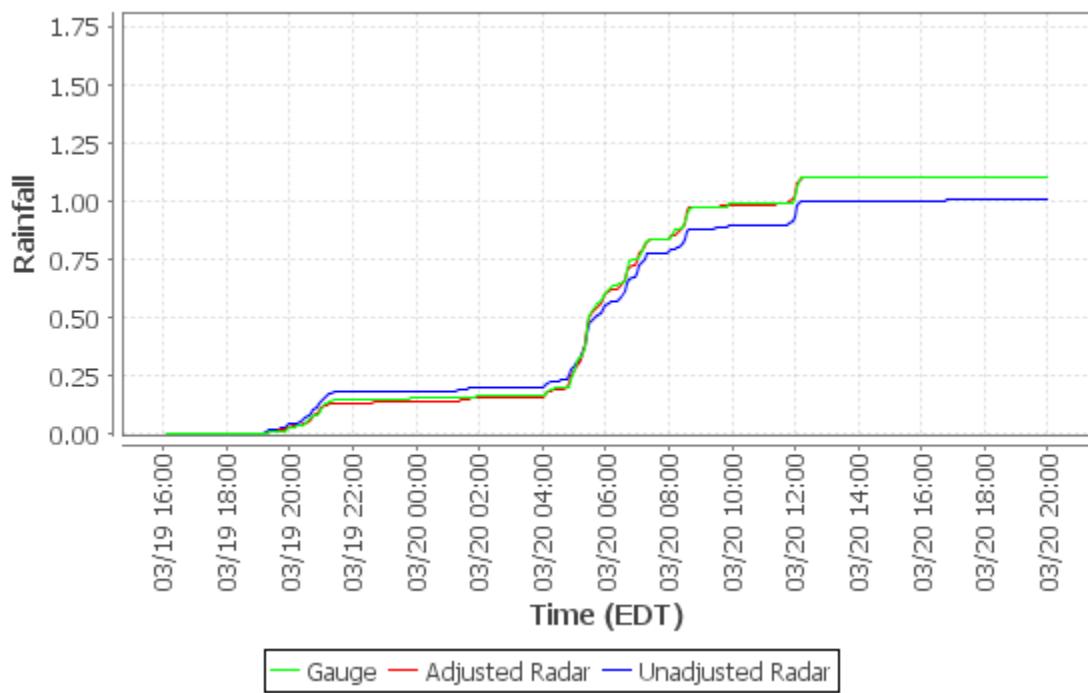
Cumulative Distribution Plot - Clinton Munic Bldg (Loc23)



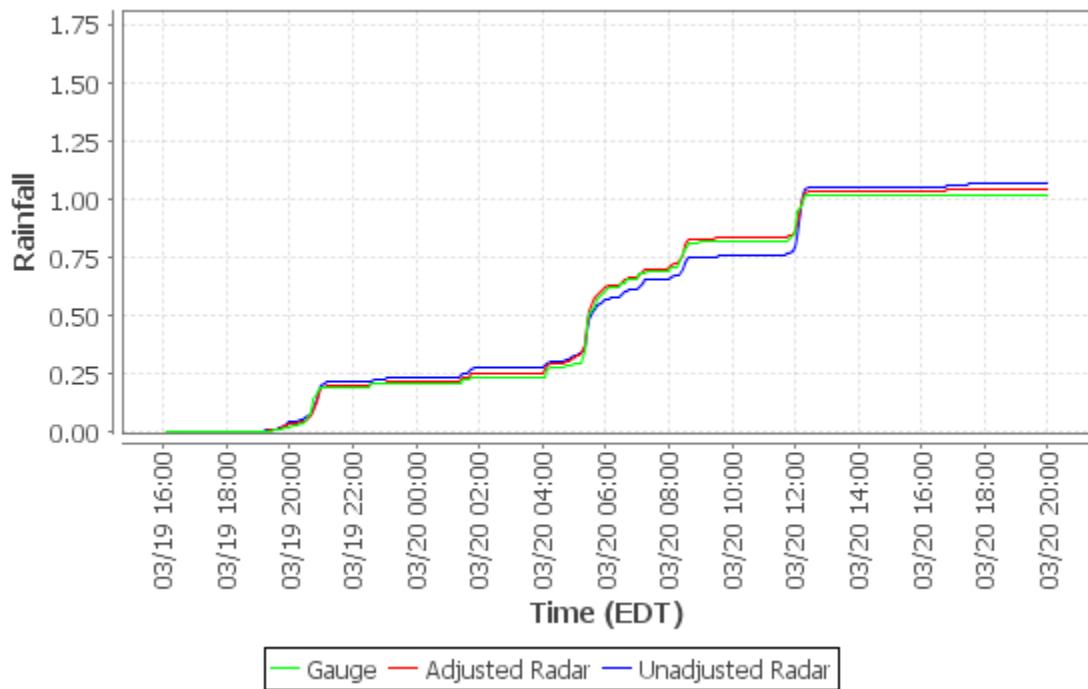
Cumulative Distribution Plot - Jefferson Hills (Loc24)



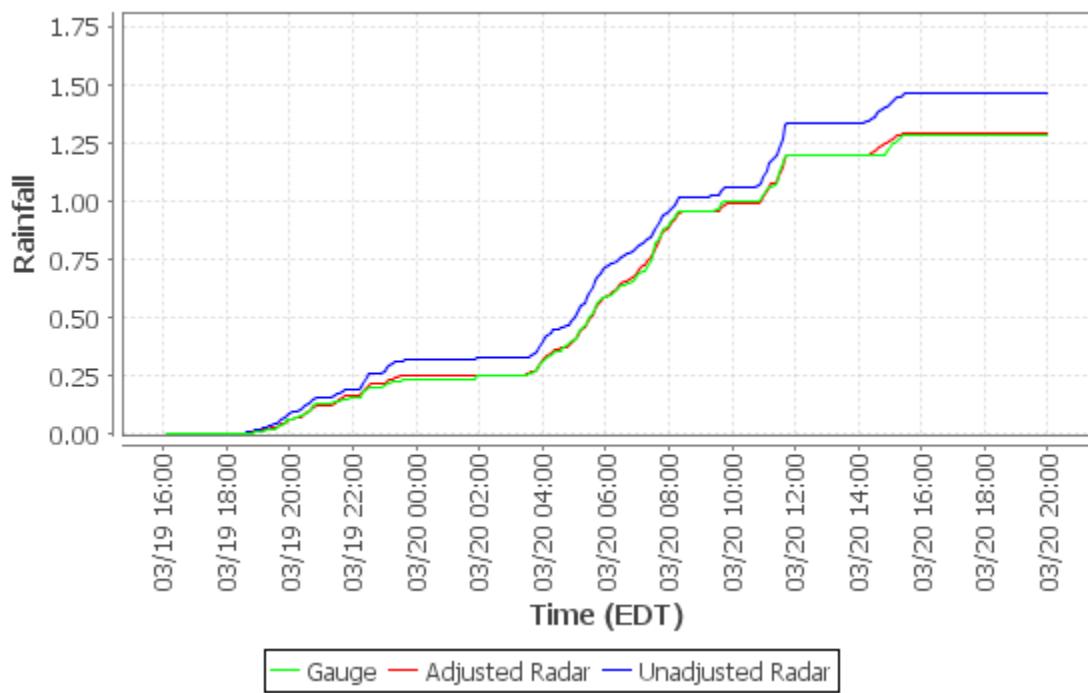
Cumulative Distribution Plot - White Oak Public Works Bldg (Loc25)



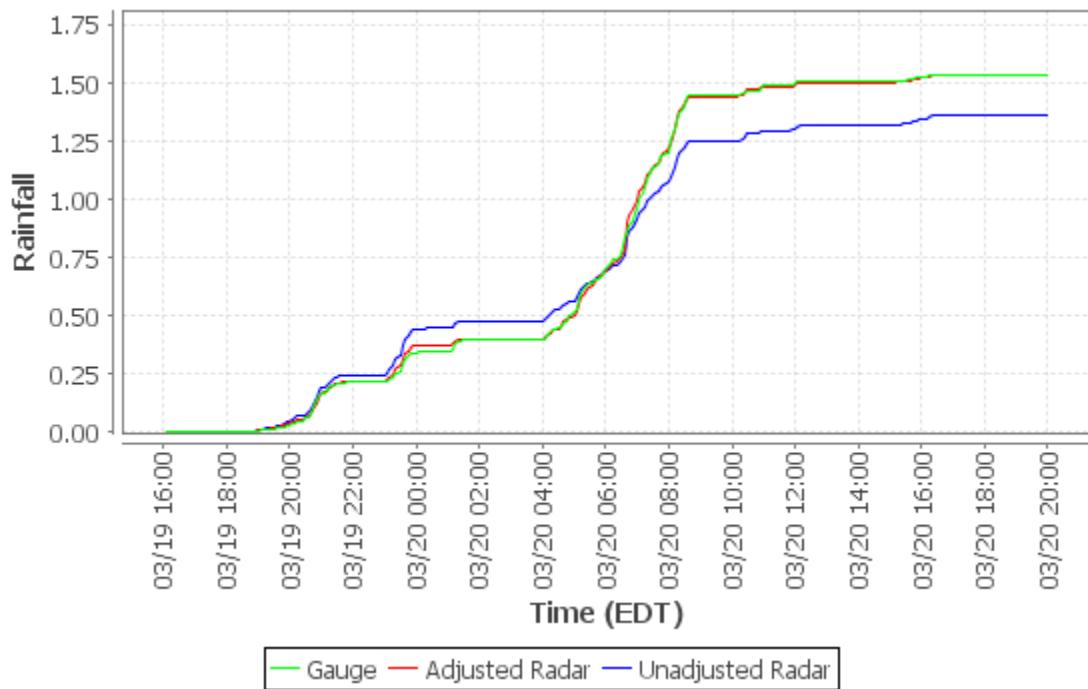
Cumulative Distribution Plot - Elizabeth TWP Municipal Bldg (Loc26)



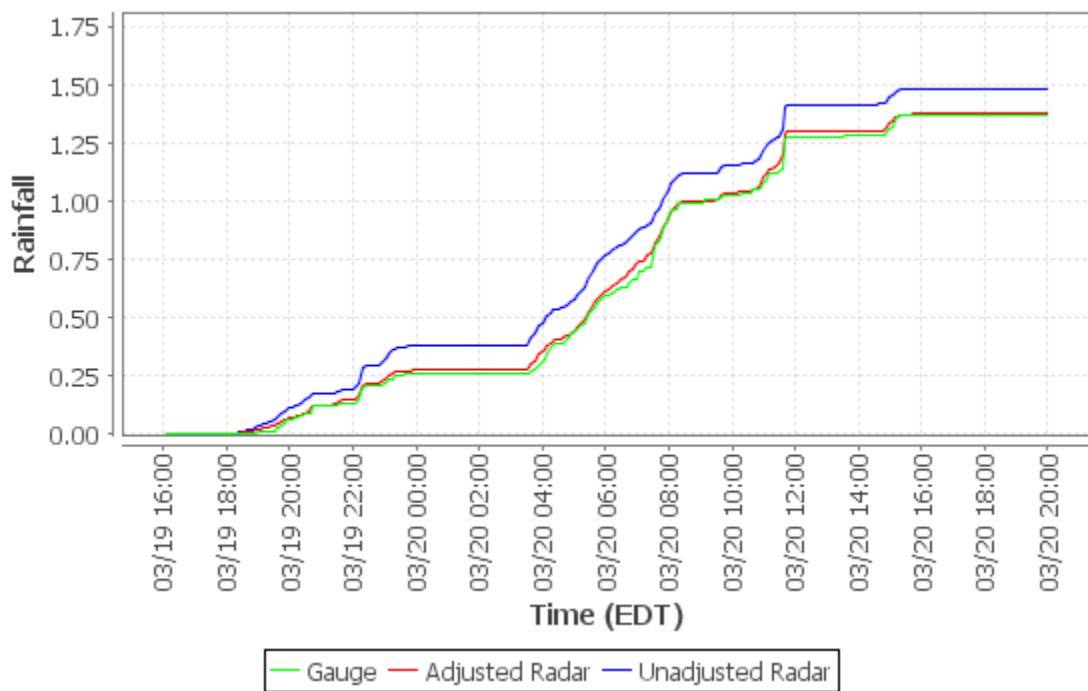
Cumulative Distribution Plot - Marshall TWP (Loc27)



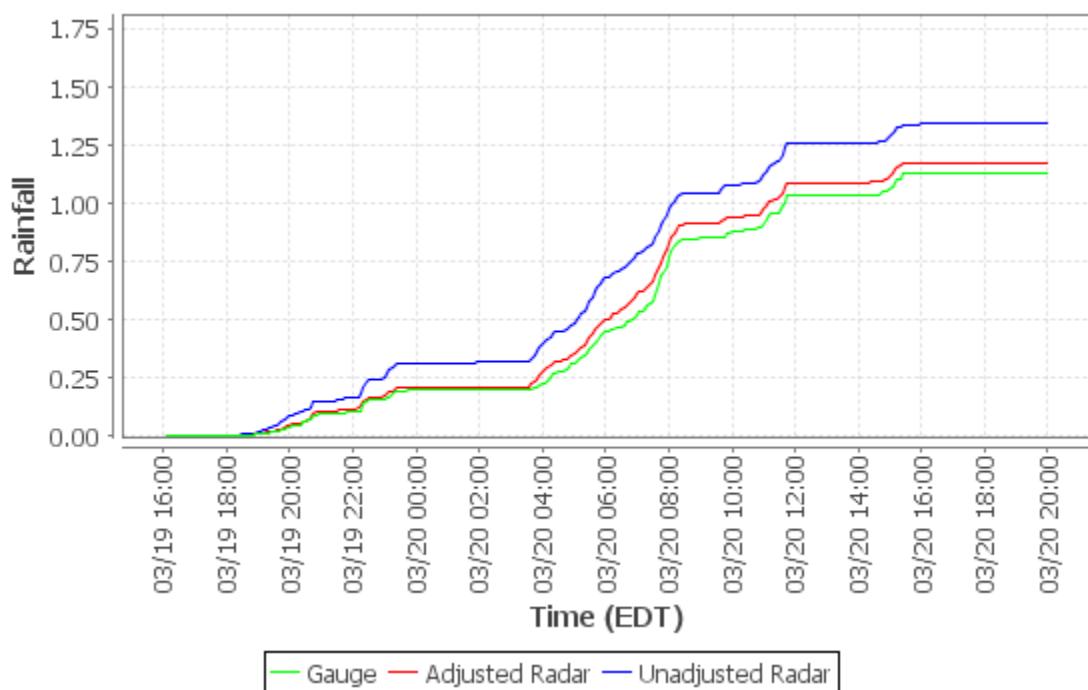
Cumulative Distribution Plot - Plum Municipal Bldg (Loc28)



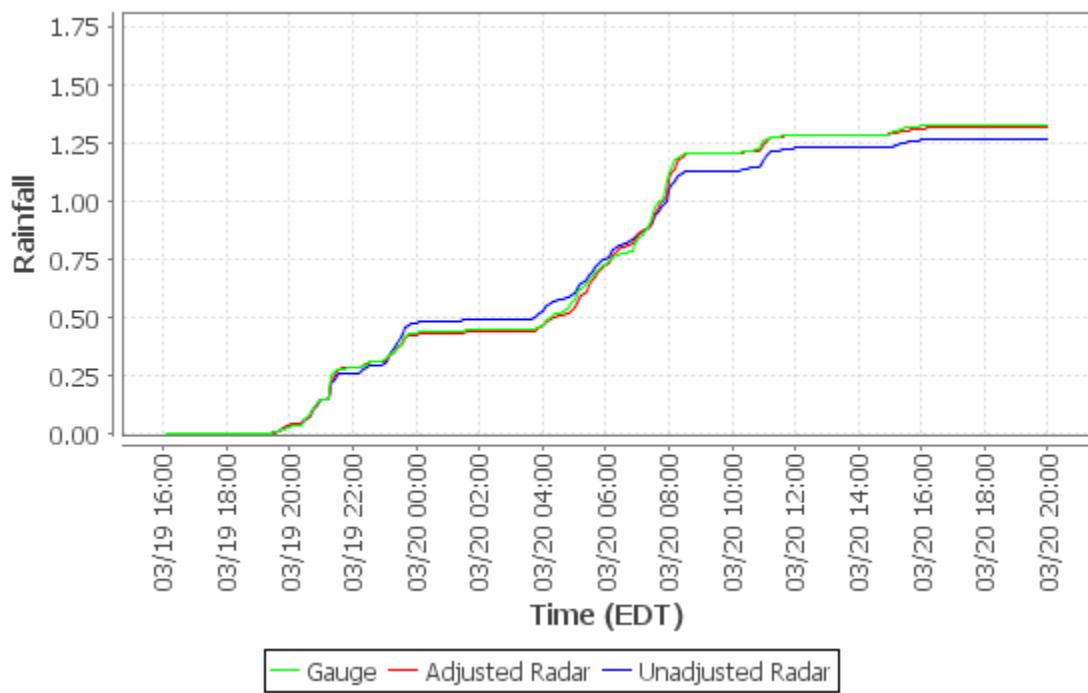
Cumulative Distribution Plot - Bell Acres Munic Bldg (Loc29)



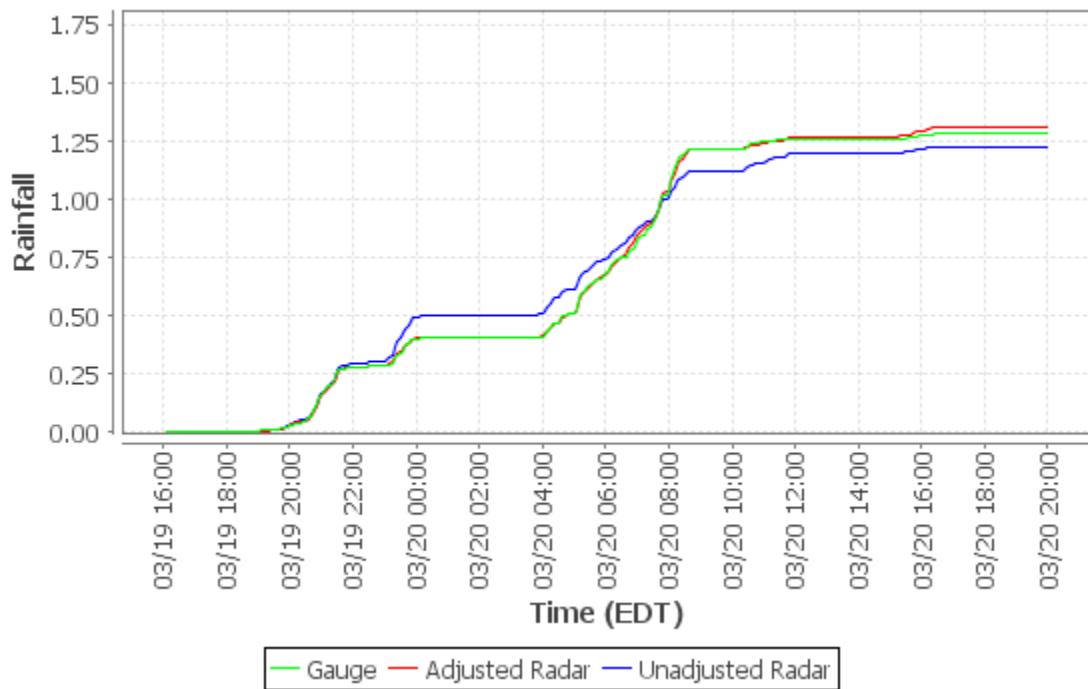
Cumulative Distribution Plot - McCandless Twn Hall (Loc30)



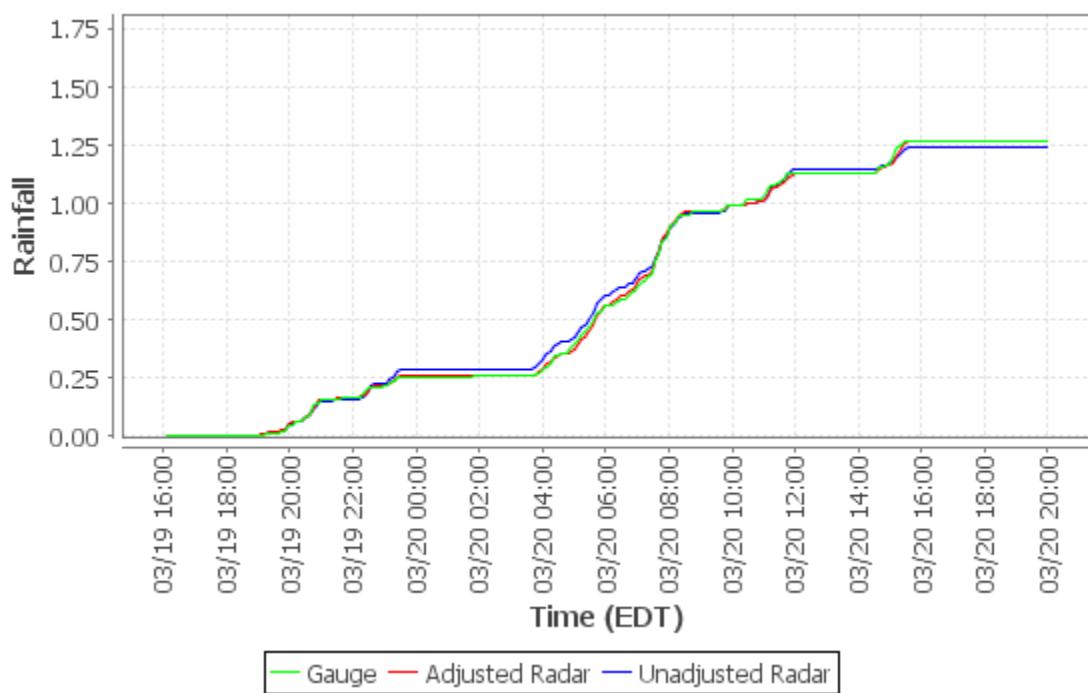
Cumulative Distribution Plot - Hampton Municipal Bldg (Loc31)



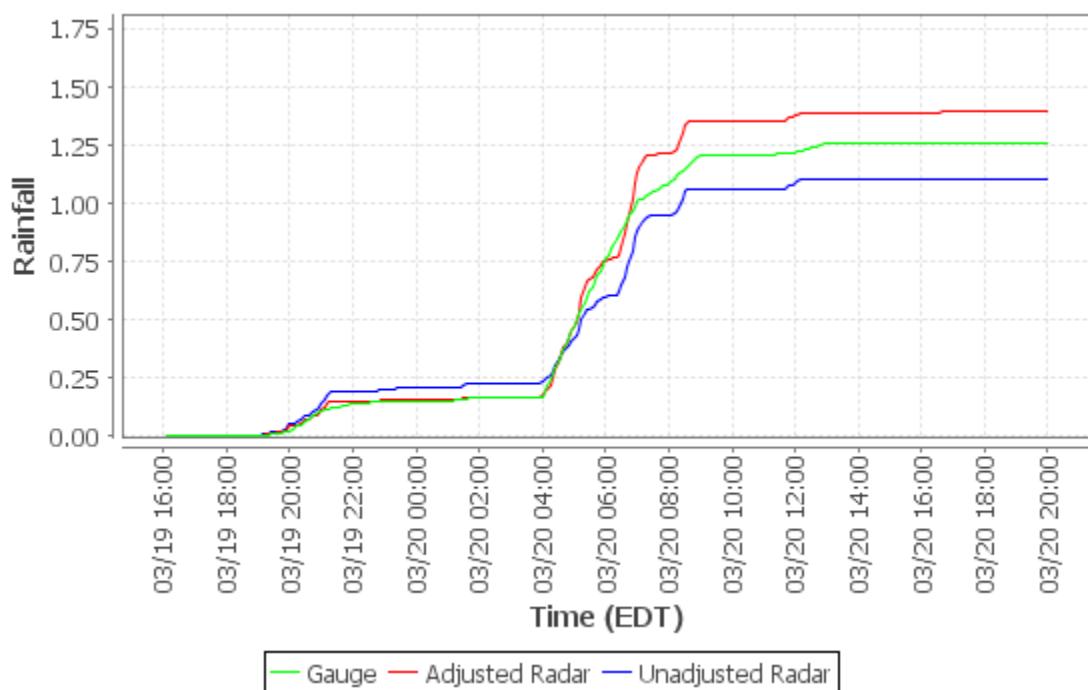
Cumulative Distribution Plot - Arnold (Loc32)



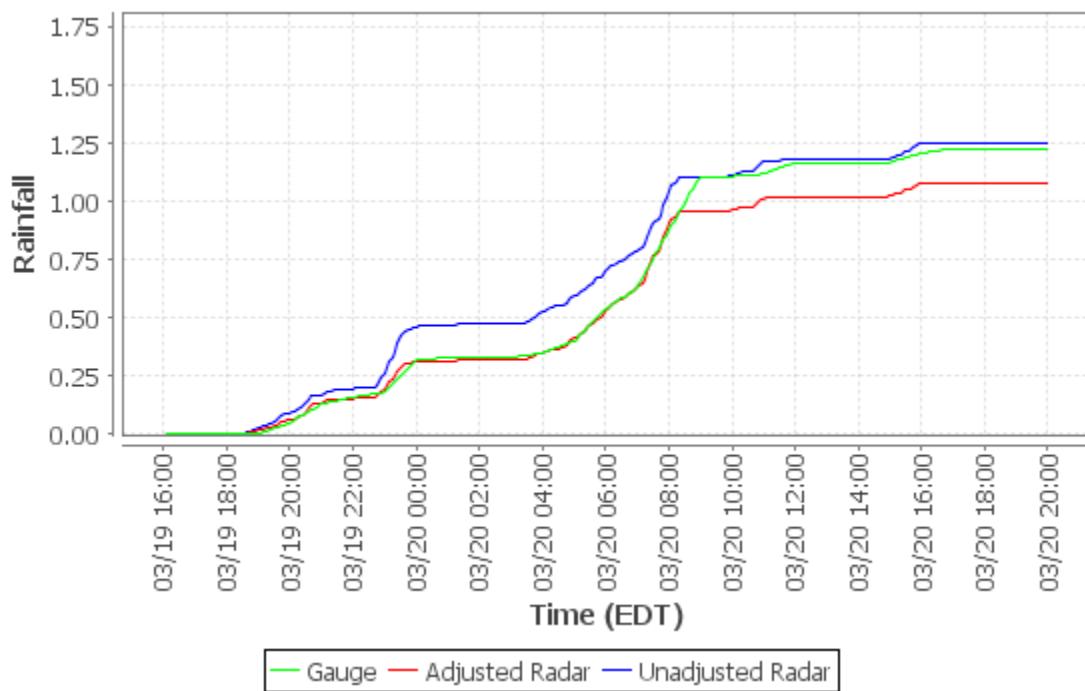
Cumulative Distribution Plot - Richland TWP (Loc33)



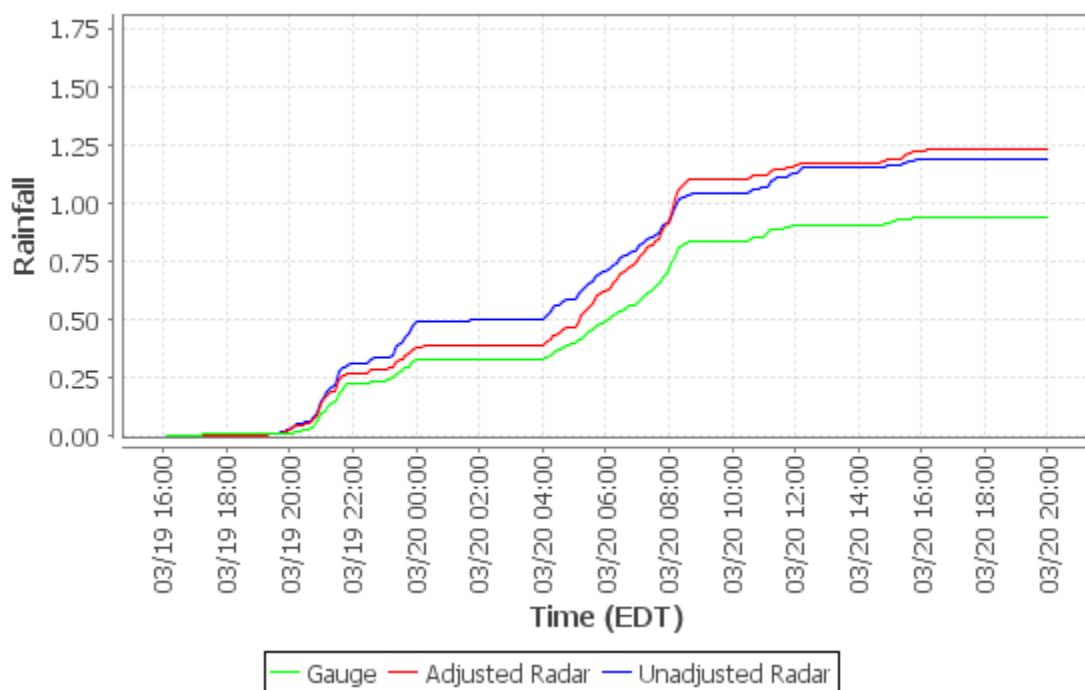
Cumulative Distribution Plot - Pittsburgh Allegheny Cty (KAGC)



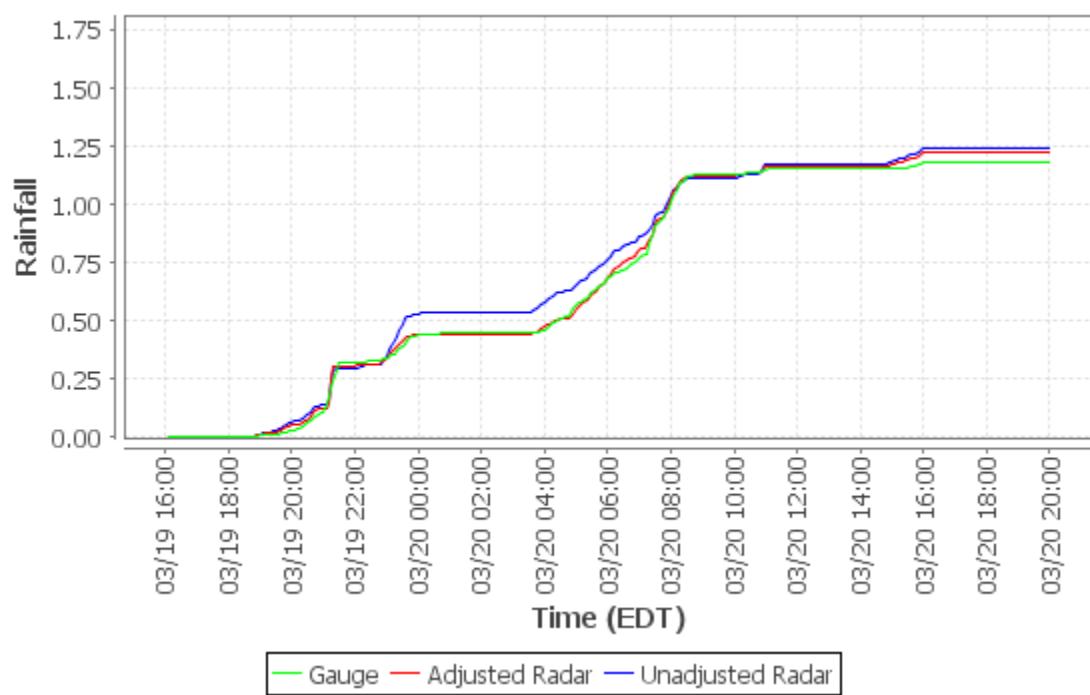
Cumulative Distribution Plot - Greater Pittsburgh Int'l (KPIT)



Cumulative Distribution Plot - Allegheny River at Natrona (03049500)

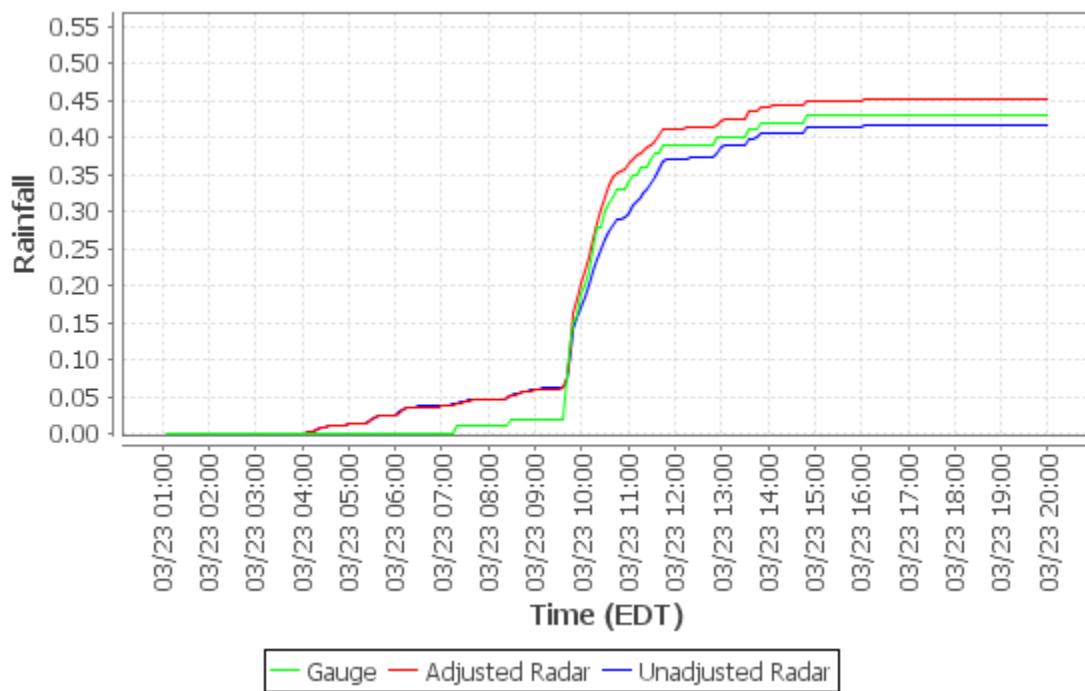


**Cumulative Distribution Plot - Ohio River at Emsworth Dam Lower Pool at Emsworth
(03085734)**

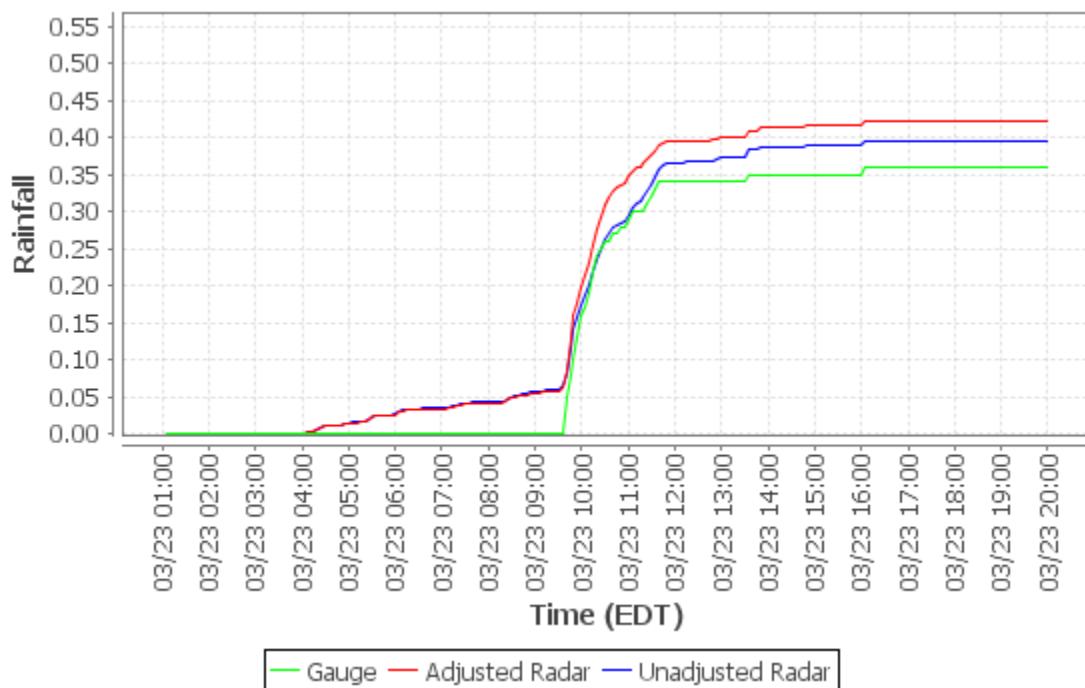


Appendix I - Event 7 (2020-03-23) CDPs

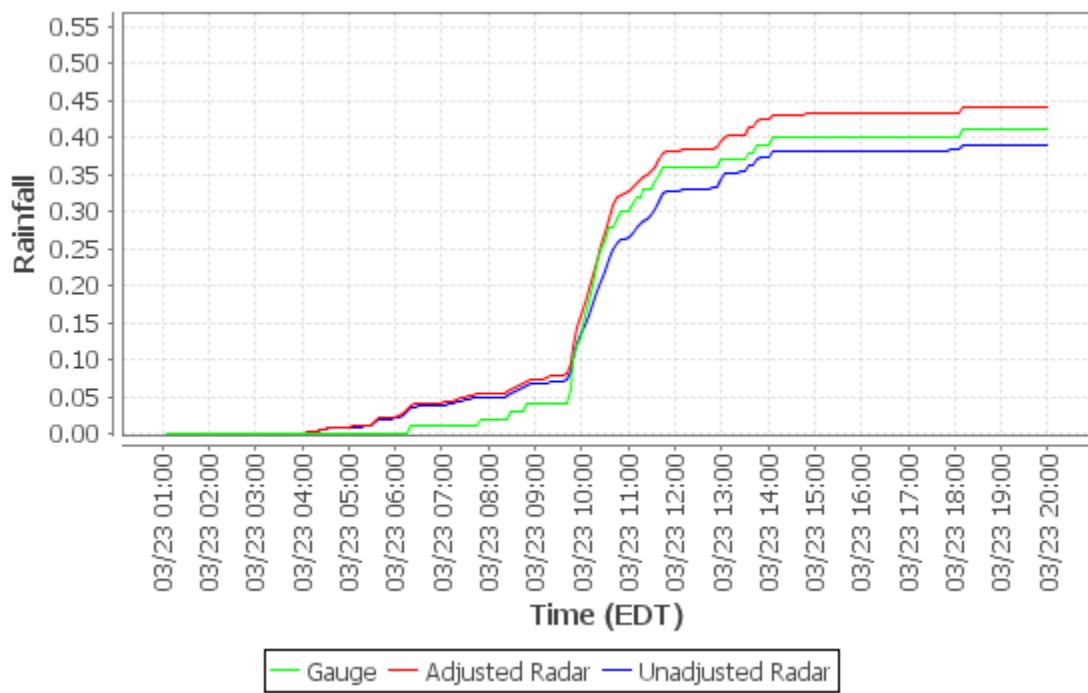
Cumulative Distribution Plot - PWSA-Montana St. (Loc01)



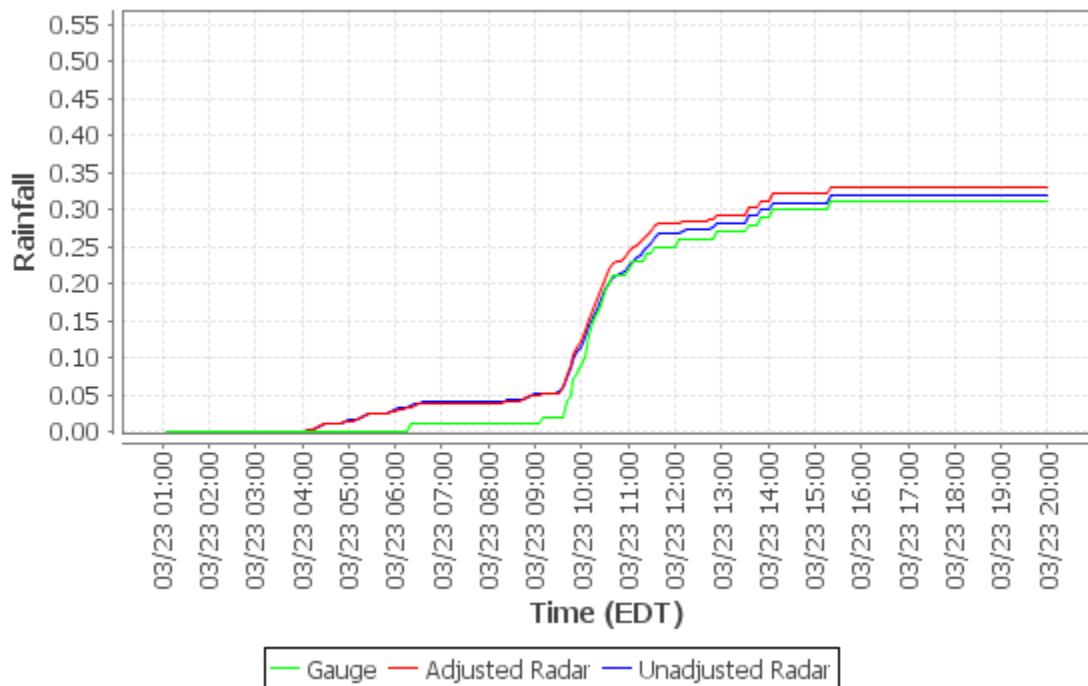
Cumulative Distribution Plot - ALCOSAN WWTP Lab (Loc02)



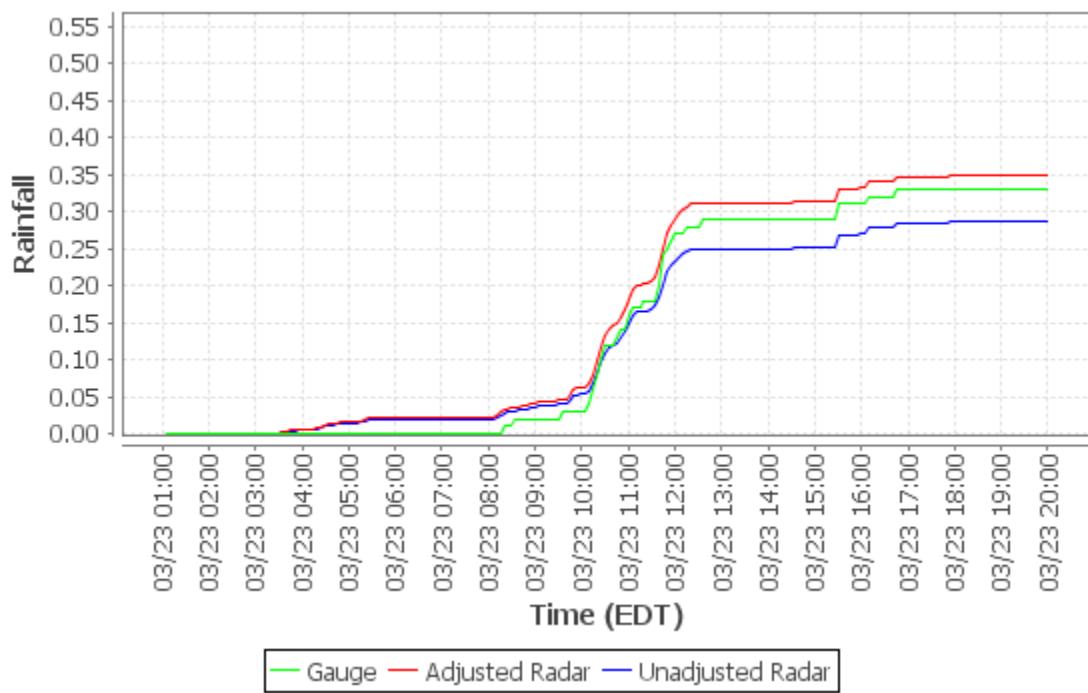
Cumulative Distribution Plot - Shaler Munic Bldg (Loc03)



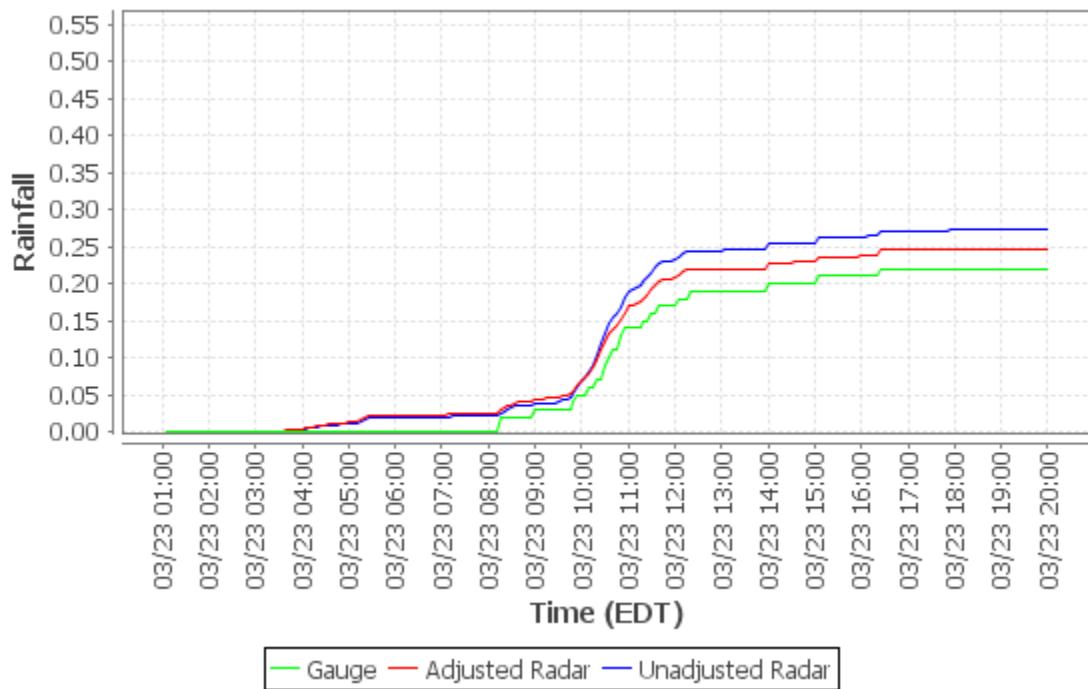
Cumulative Distribution Plot - Kennedy Twp PS (Loc04)



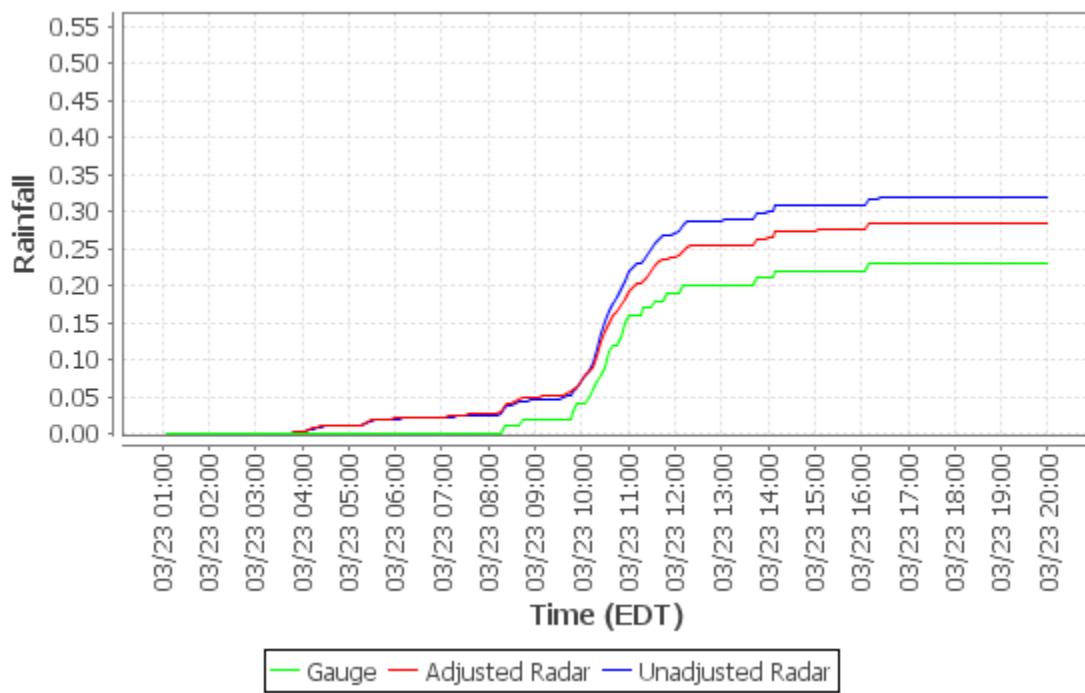
Cumulative Distribution Plot - Upper St. Clair (Loc05)



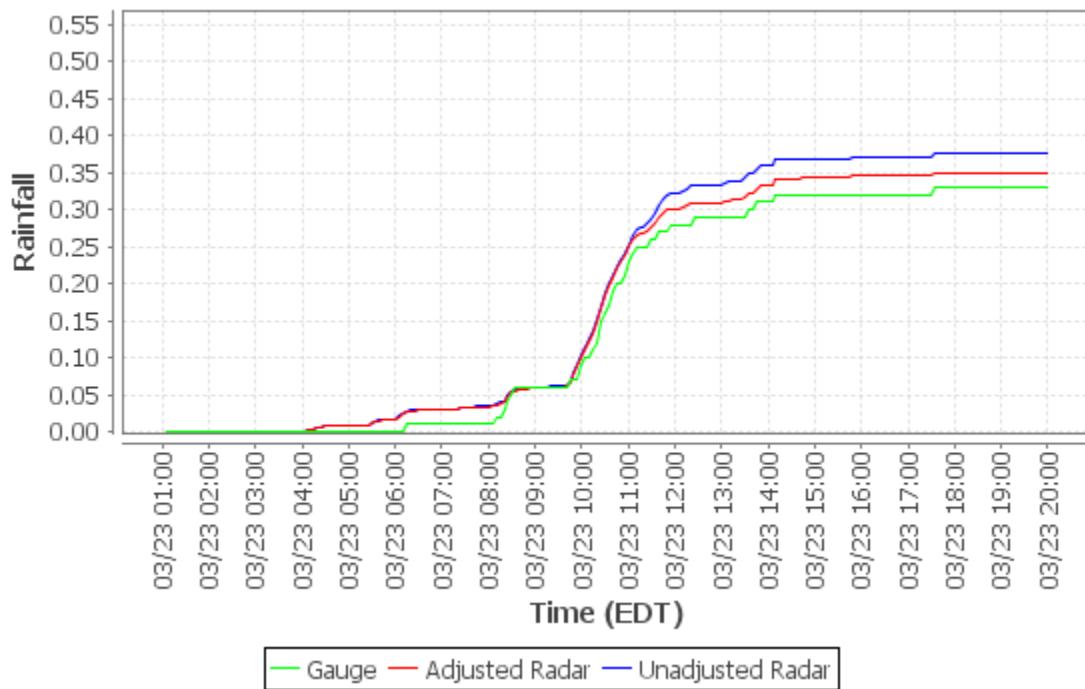
Cumulative Distribution Plot - Carnegie Transit Time (Loc06)



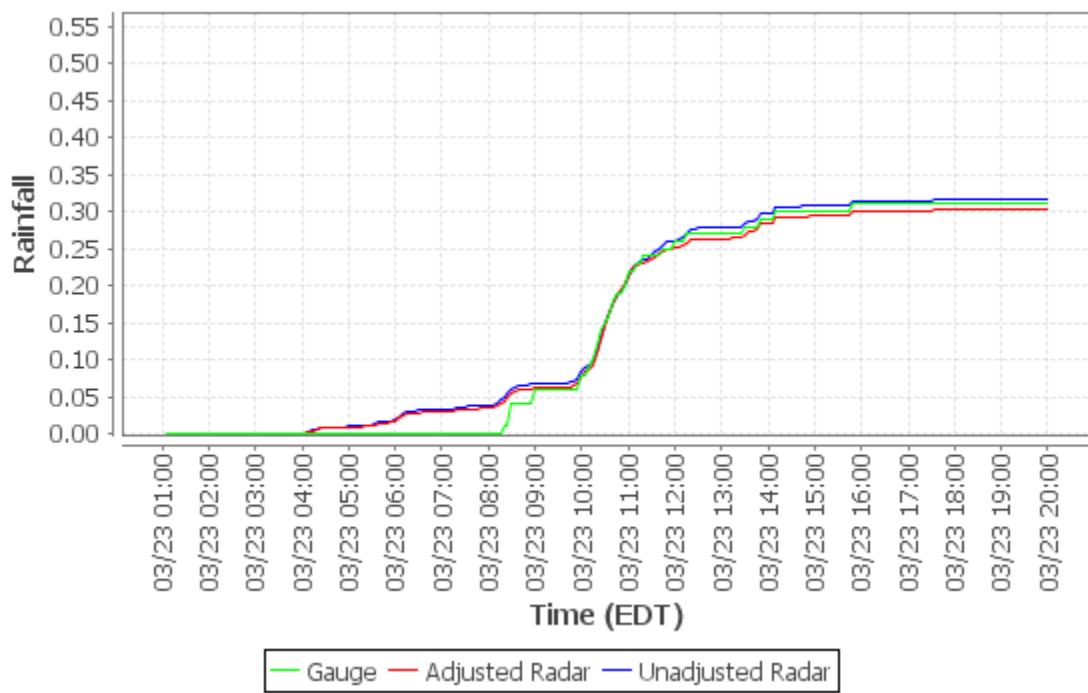
Cumulative Distribution Plot - Greentree Munic Bldg (Loc07)



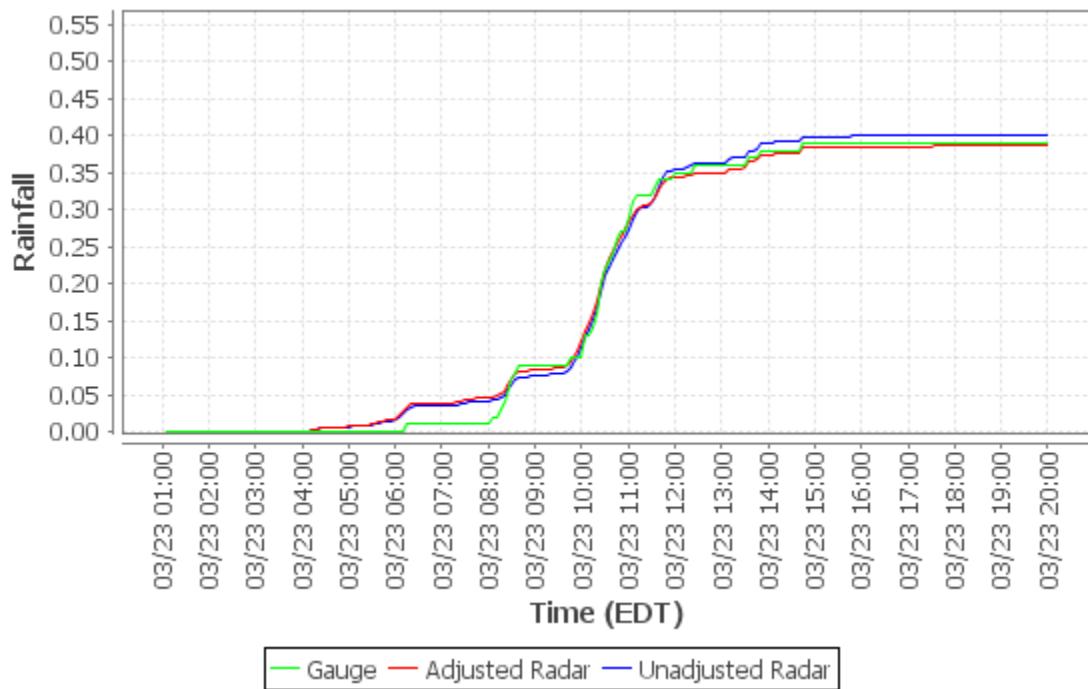
Cumulative Distribution Plot - AC Health Dept Bldg (Loc08)



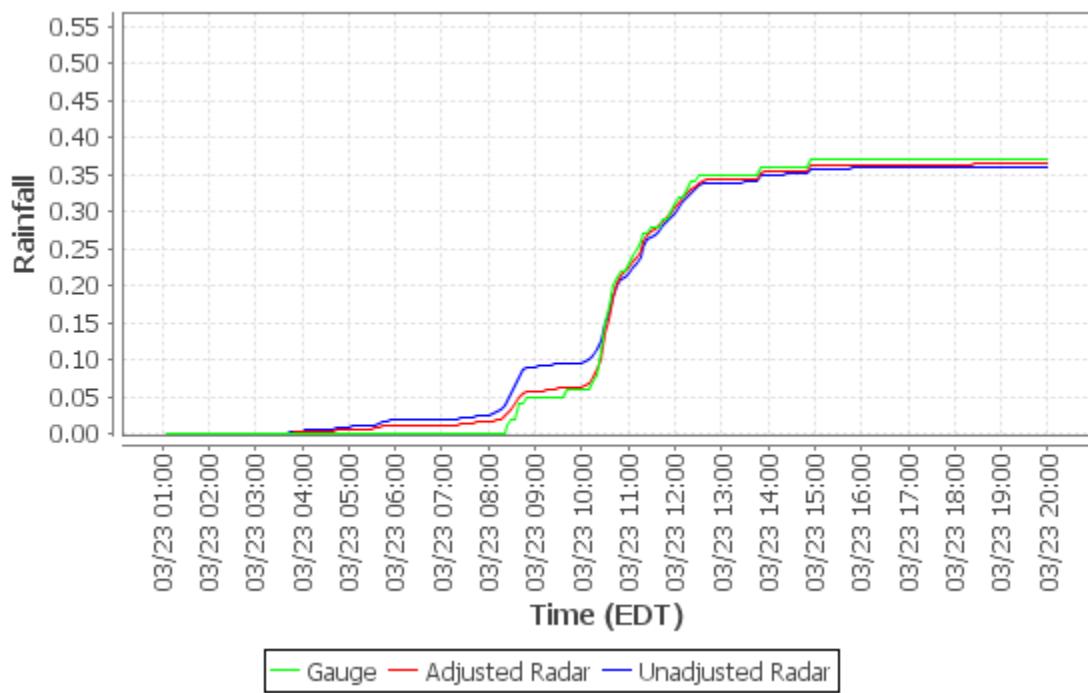
Cumulative Distribution Plot - Univ of Pittsburgh (Loc09)



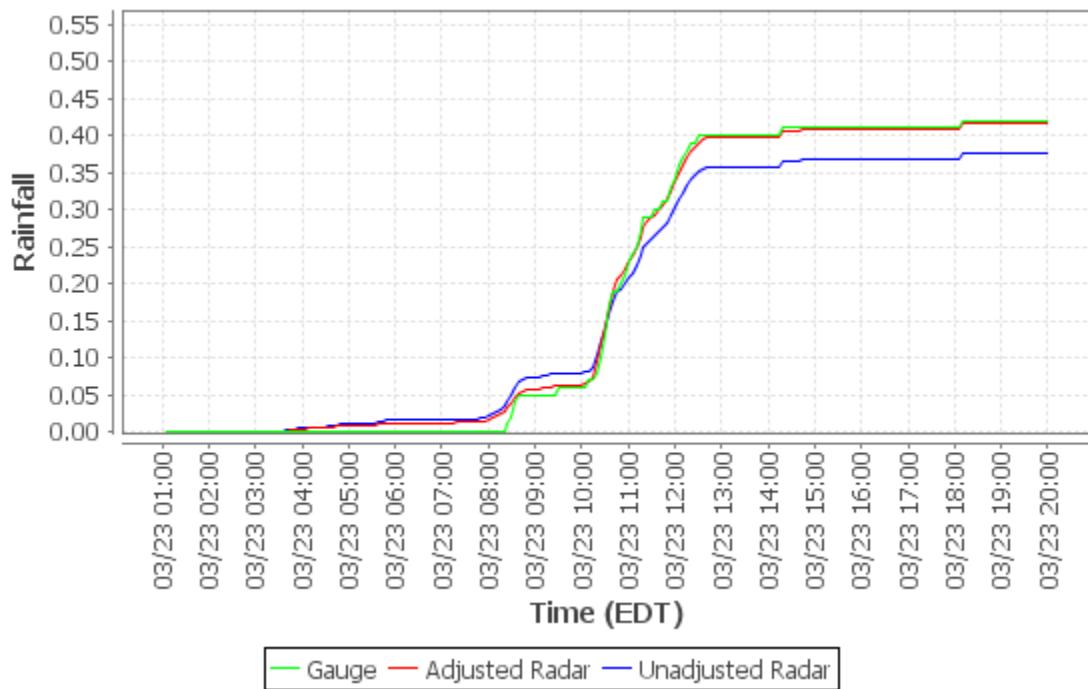
Cumulative Distribution Plot - PWSA-Highland Park (Loc10)



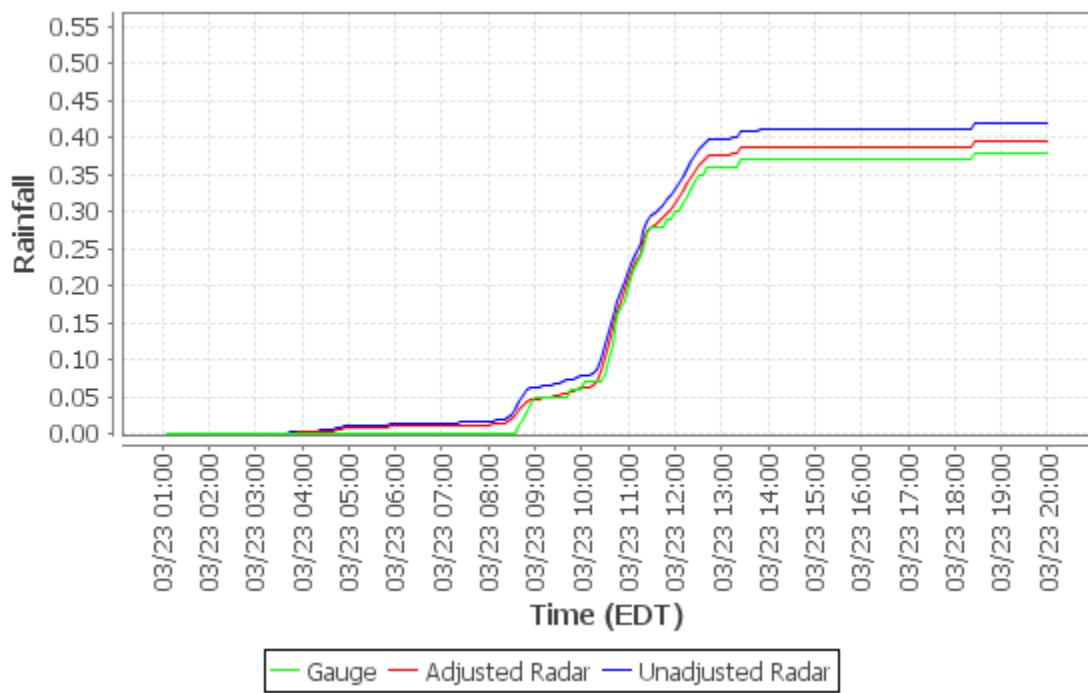
Cumulative Distribution Plot - M-46 Access Shaft (Loc11)



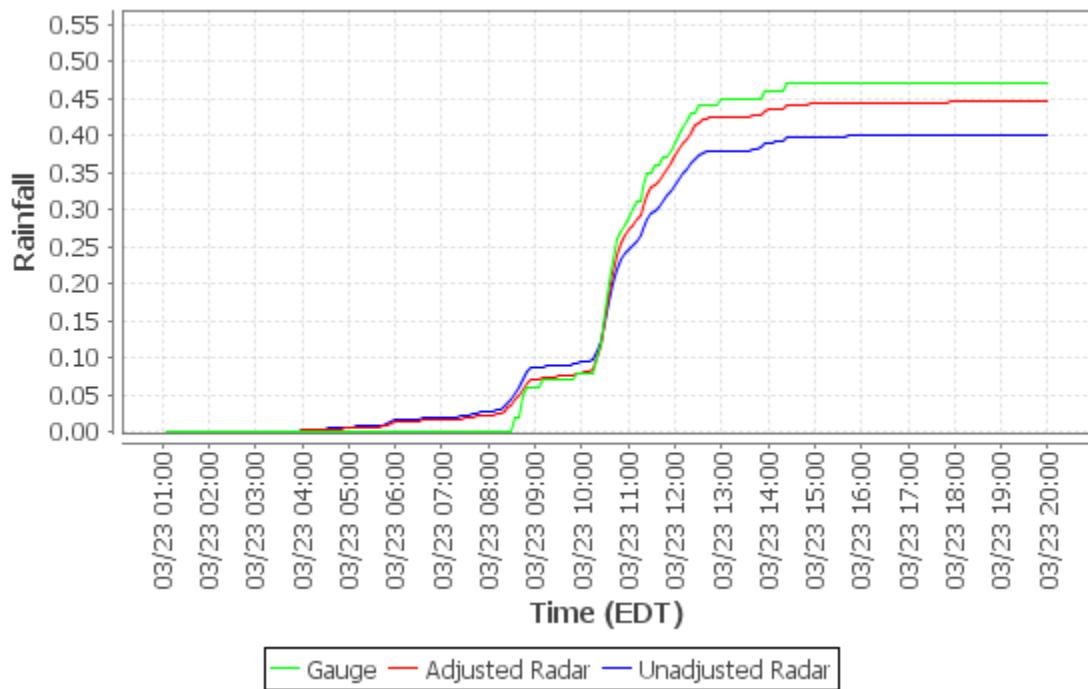
Cumulative Distribution Plot - Baldwin (Loc12)



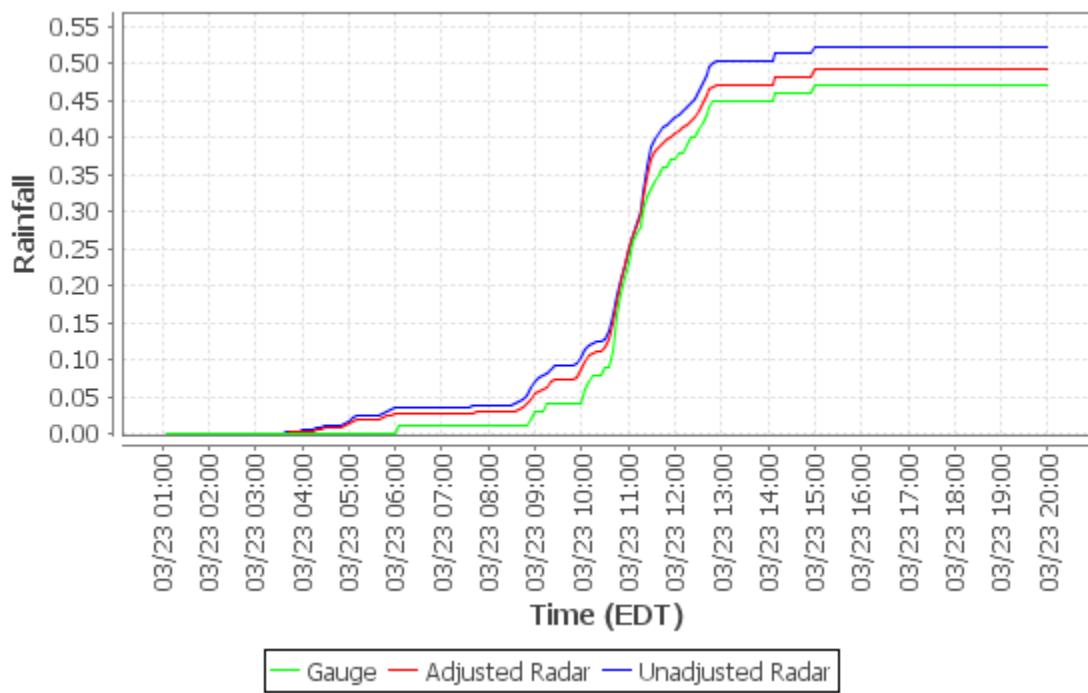
Cumulative Distribution Plot - M-59 Access Shaft (Loc13)



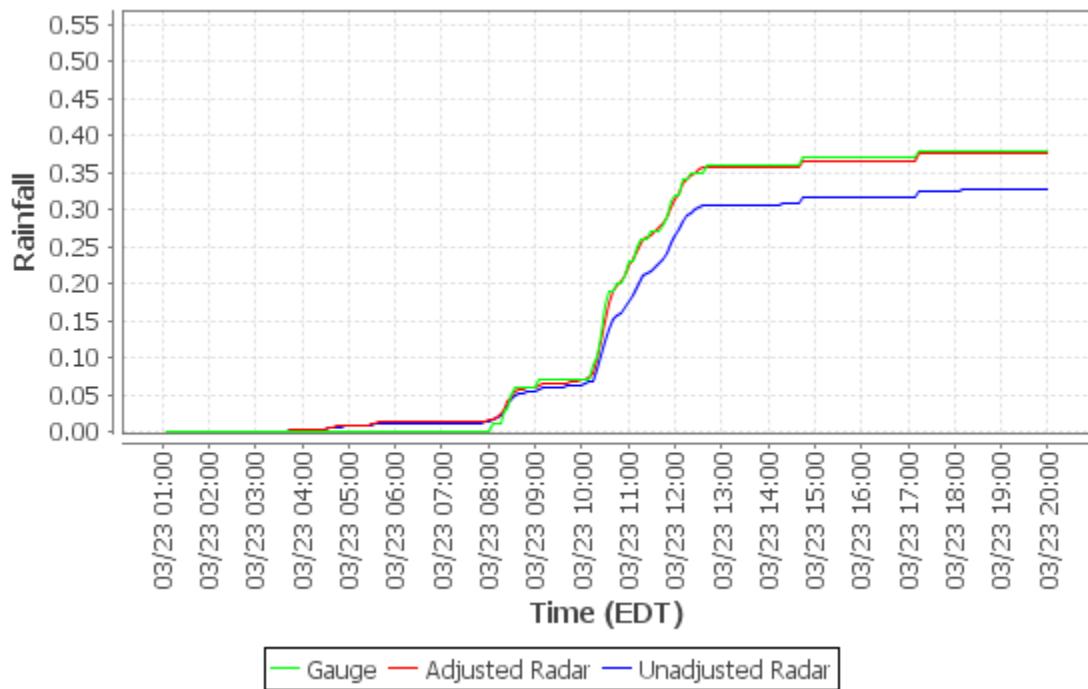
Cumulative Distribution Plot - Churchill Munic Bldg (Loc14)



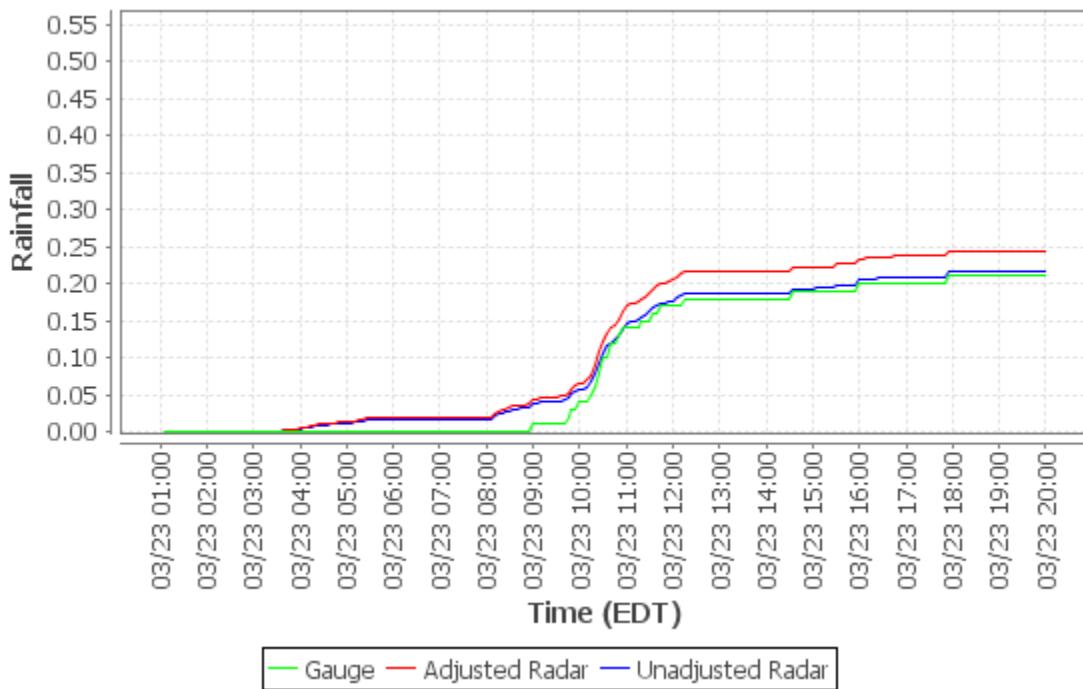
Cumulative Distribution Plot - Trafford Maint Bldg (Loc15)



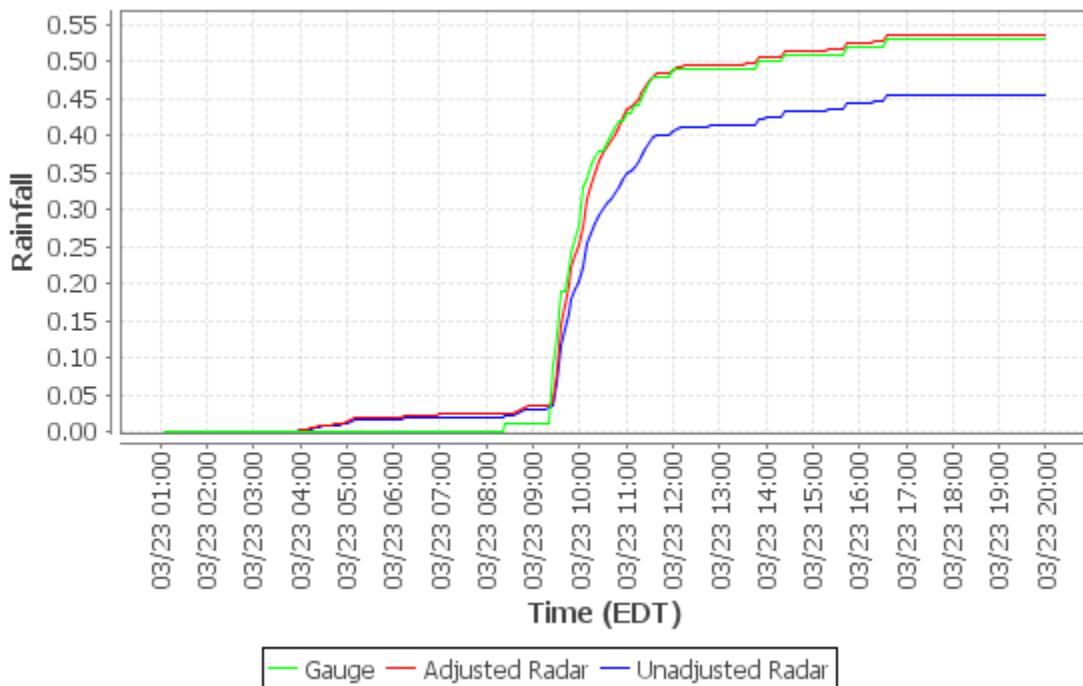
Cumulative Distribution Plot - Castle Shannon (Loc16)



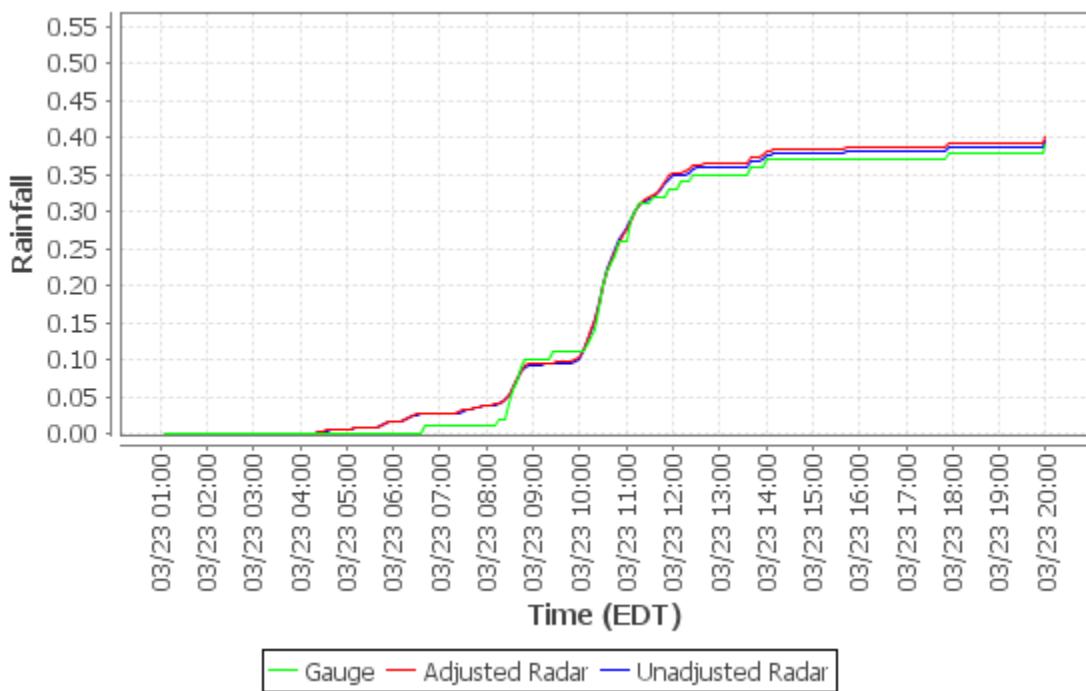
Cumulative Distribution Plot - Chartiers Pump Station (Loc17)



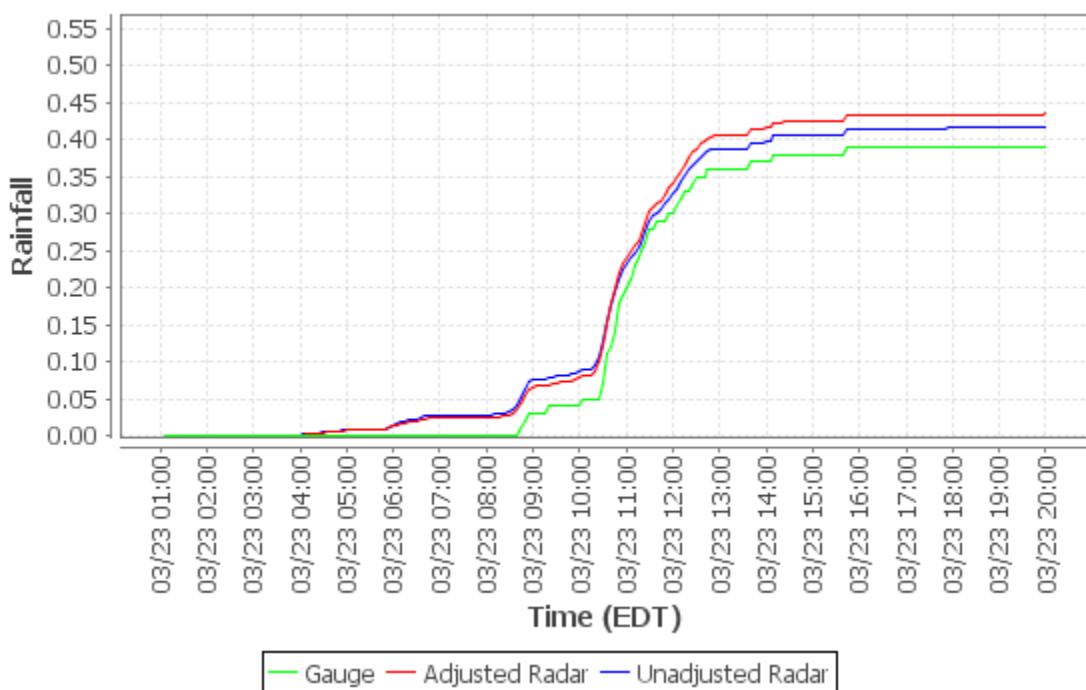
Cumulative Distribution Plot - Oakdale Pump Station (Loc18)



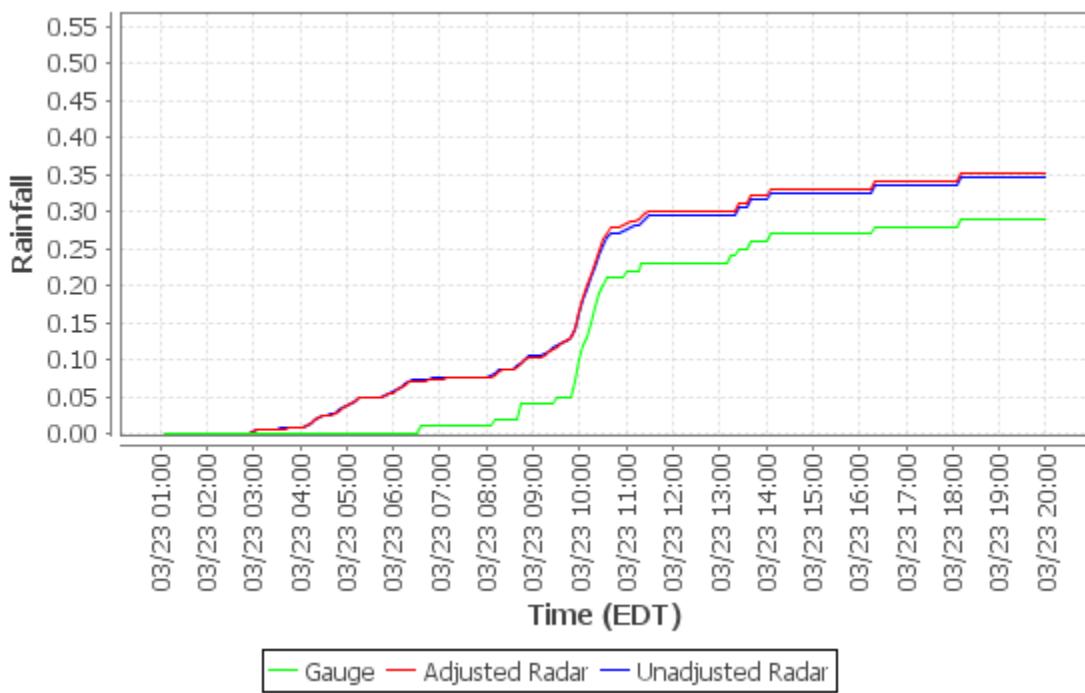
Cumulative Distribution Plot - Sandy Creek Eq Facility (Loc19)



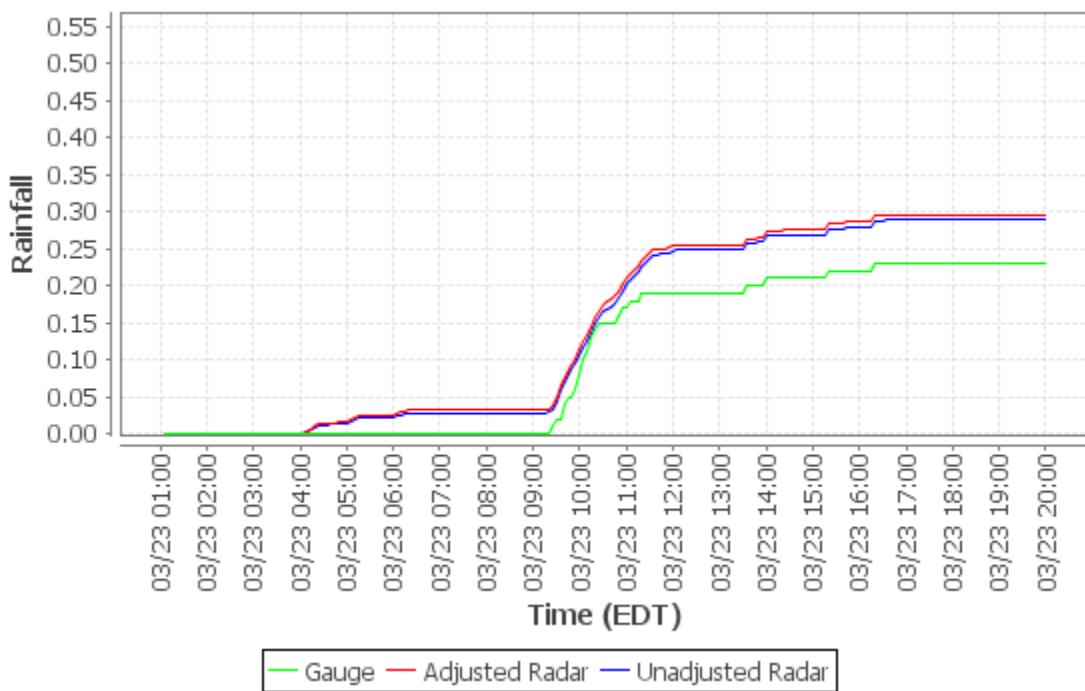
Cumulative Distribution Plot - Gascola Eq Facility (Loc20)



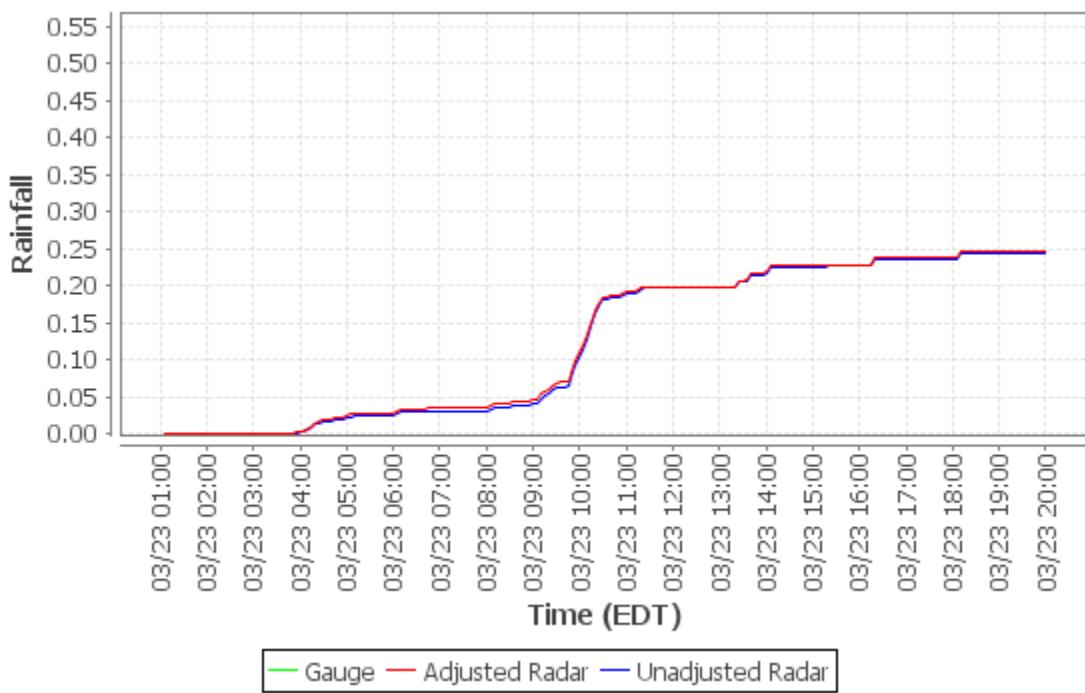
Cumulative Distribution Plot - Moon TWP (Loc21)



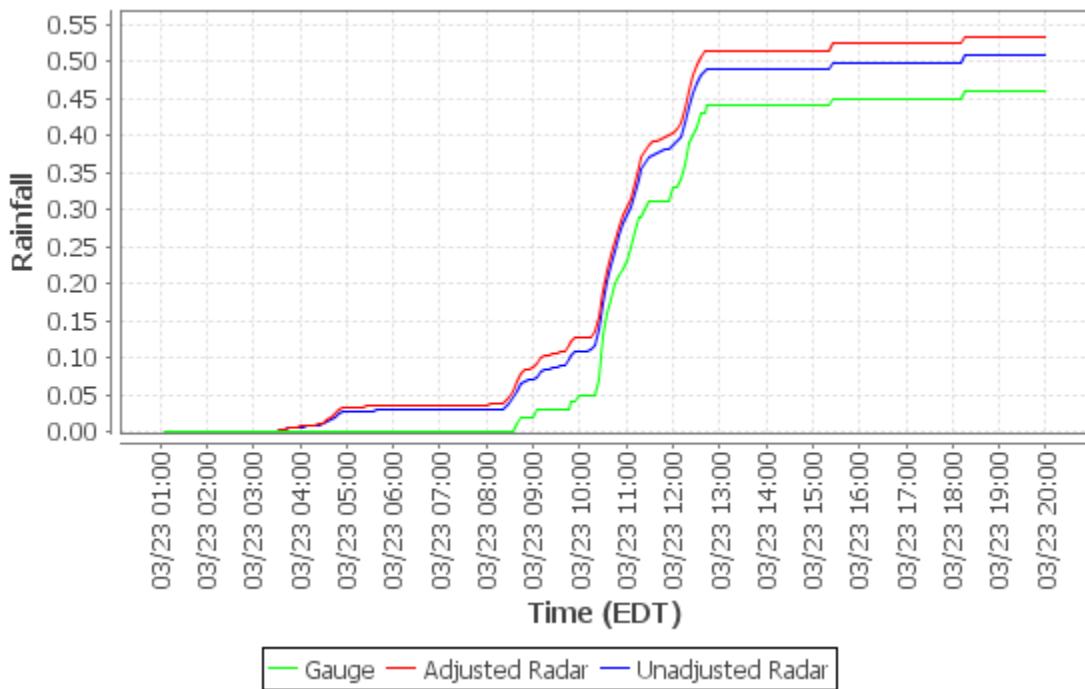
Cumulative Distribution Plot - North Fayette TWP (Loc22)



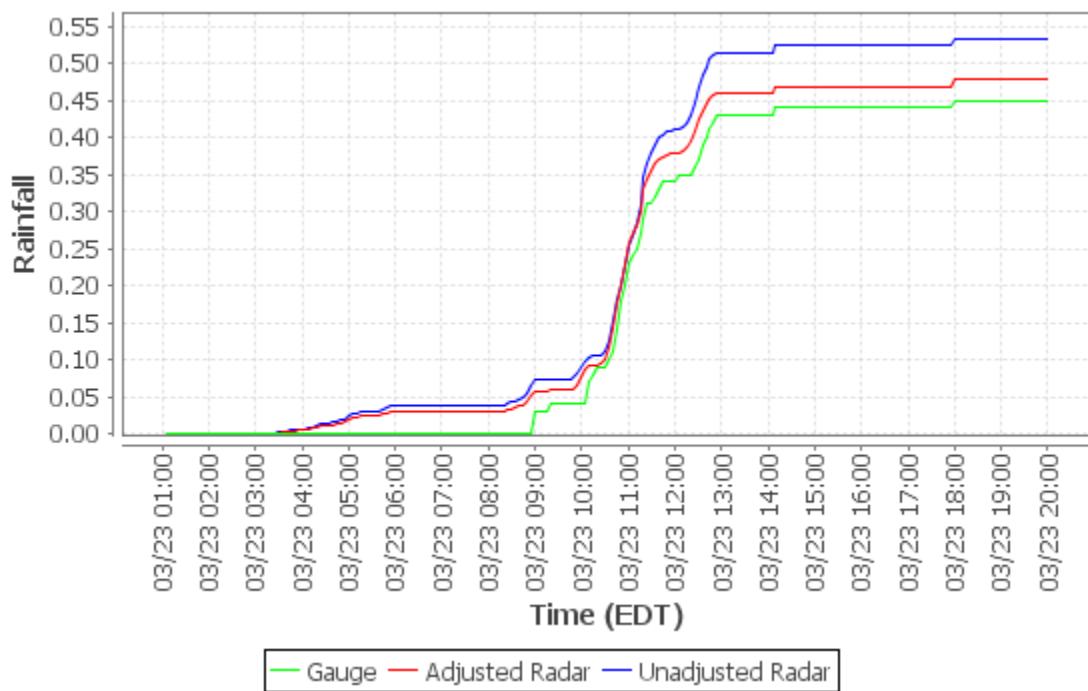
Cumulative Distribution Plot - Clinton Munic Bldg (Loc23)



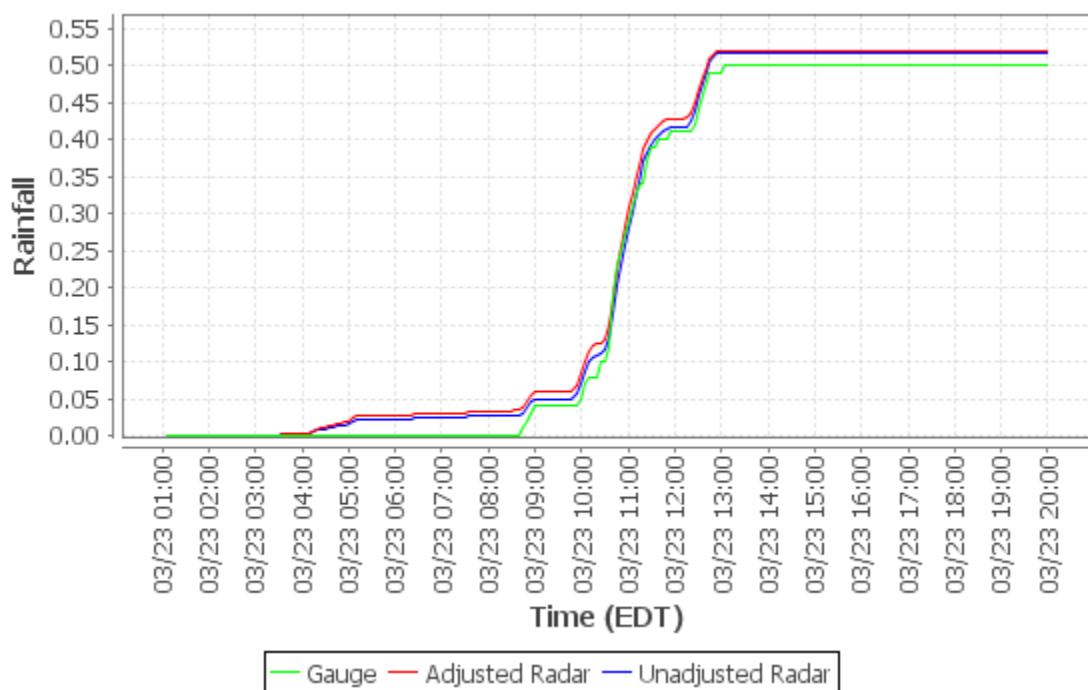
Cumulative Distribution Plot - Jefferson Hills (Loc24)



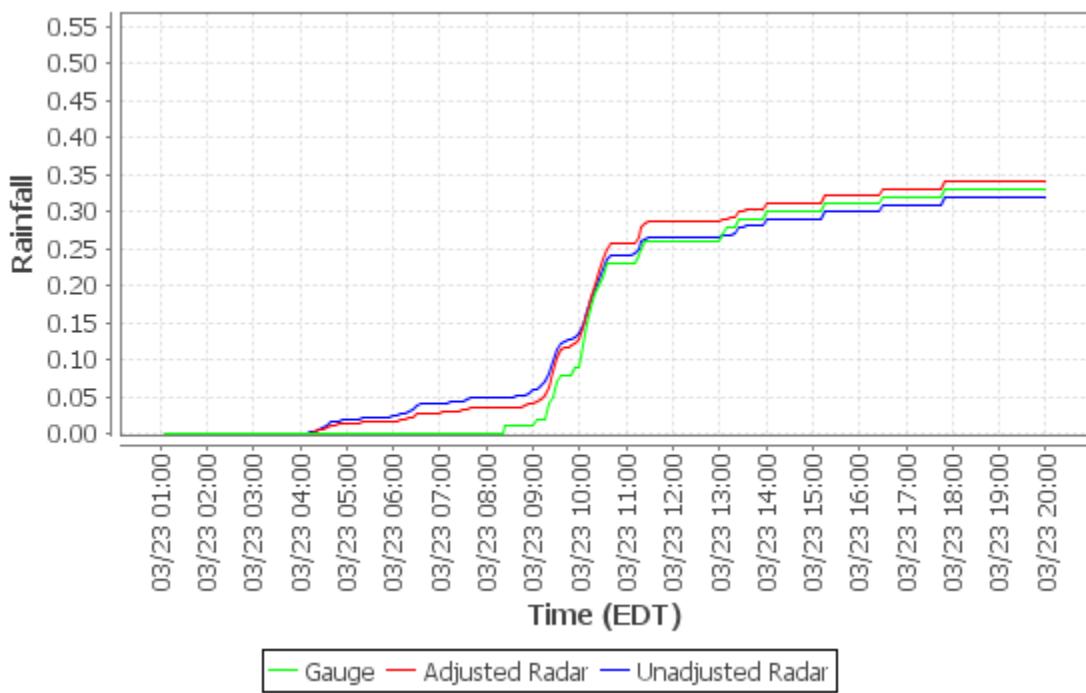
Cumulative Distribution Plot - White Oak Public Works Bldg (Loc25)



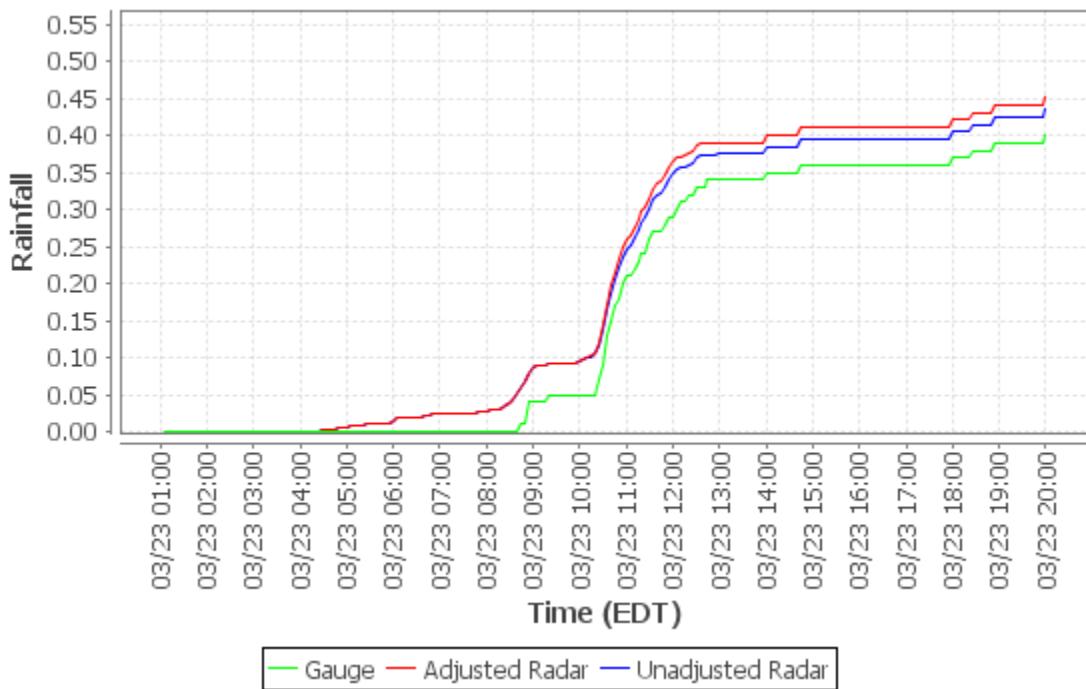
Cumulative Distribution Plot - Elizabeth TWP Municipal Bldg (Loc26)



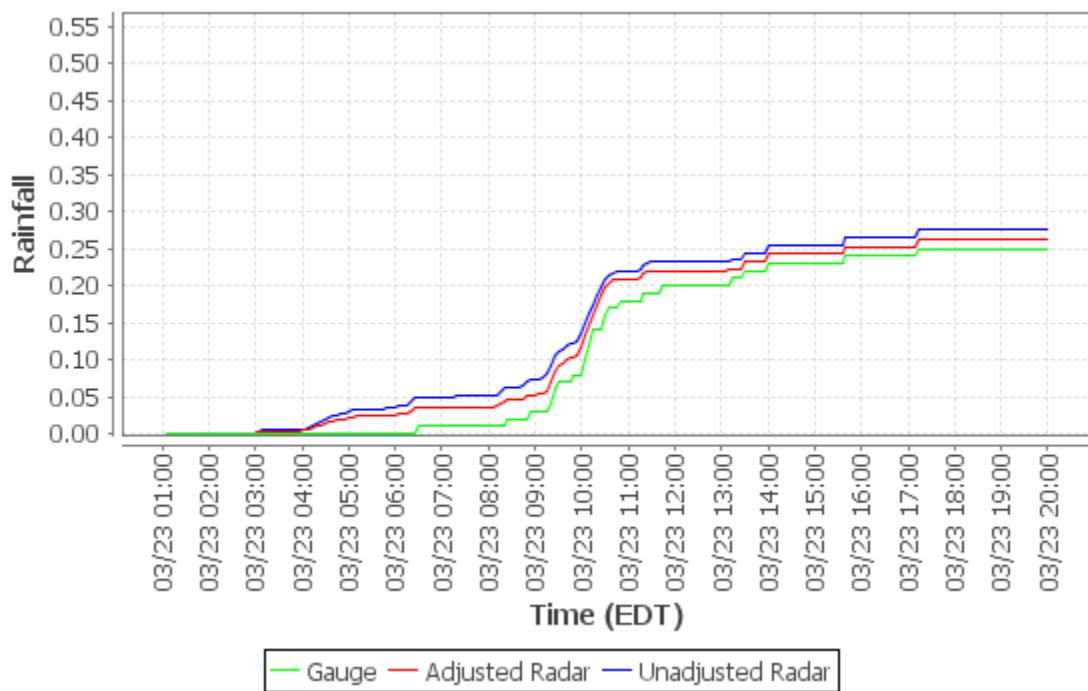
Cumulative Distribution Plot - Marshall TWP (Loc27)



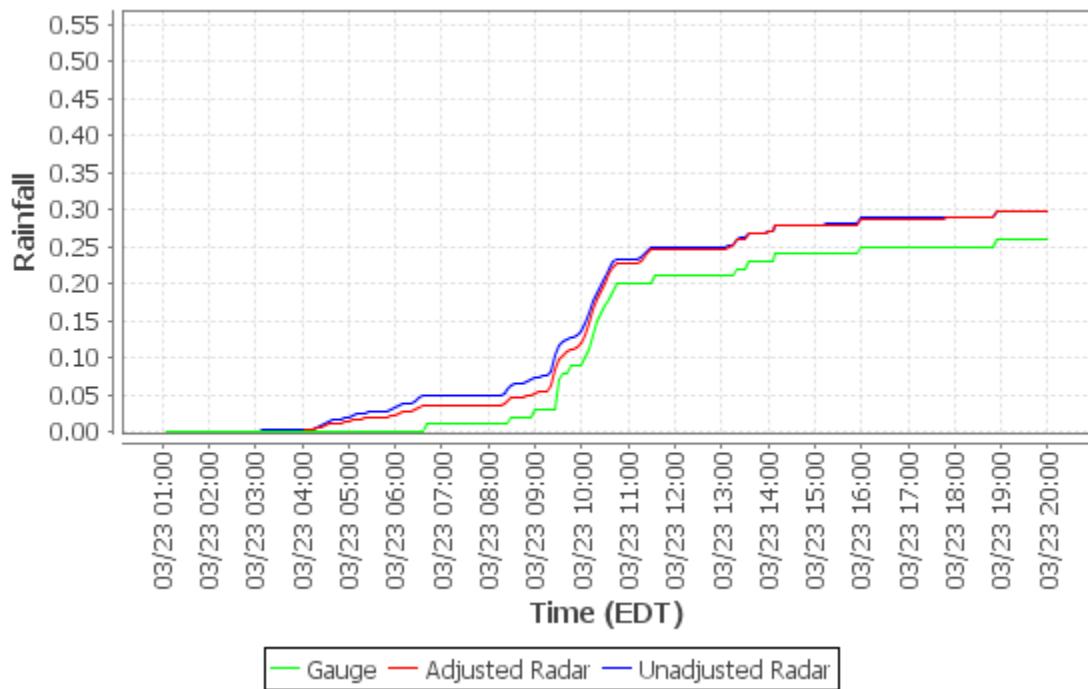
Cumulative Distribution Plot - Plum Municipal Bldg (Loc28)



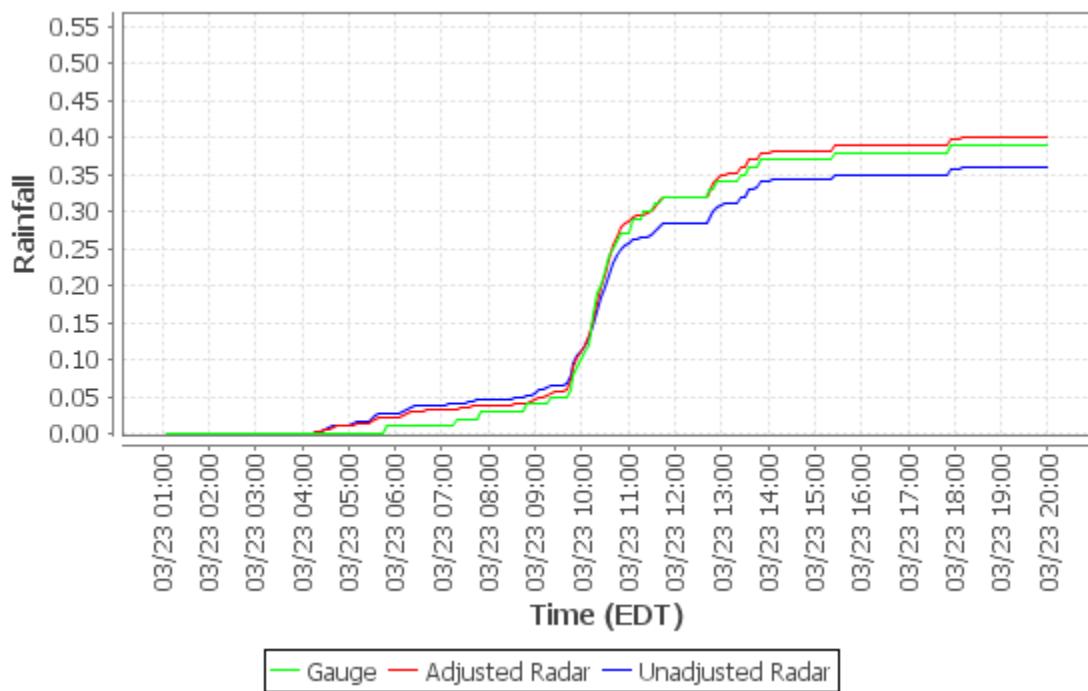
Cumulative Distribution Plot - Bell Acres Munic Bldg (Loc29)



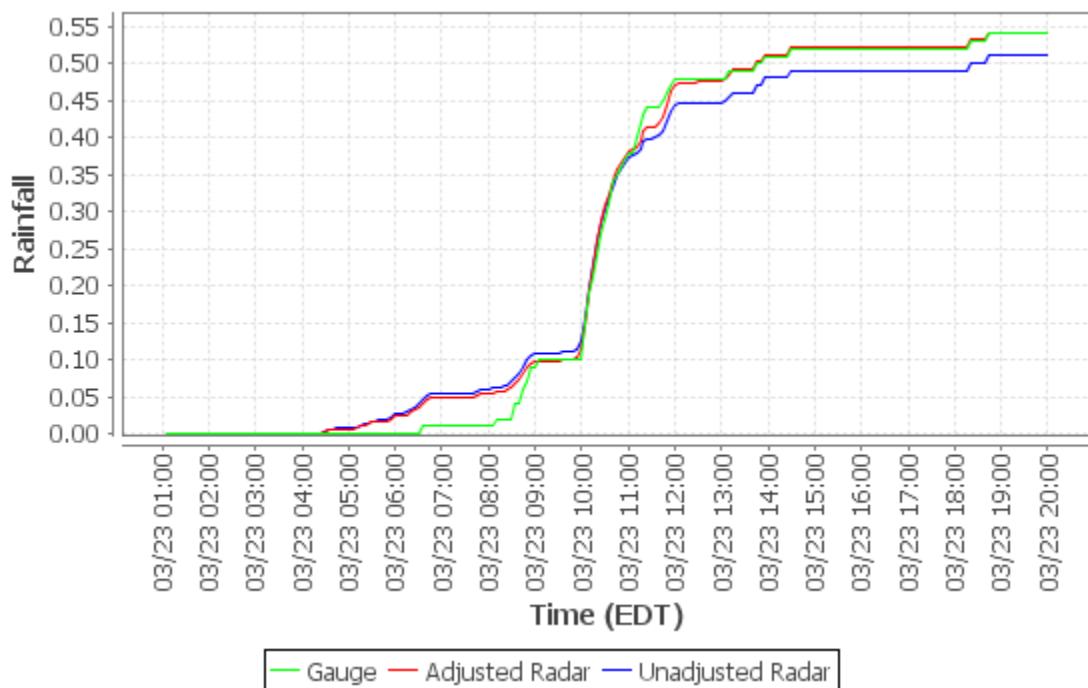
Cumulative Distribution Plot - McCandless Twn Hall (Loc30)



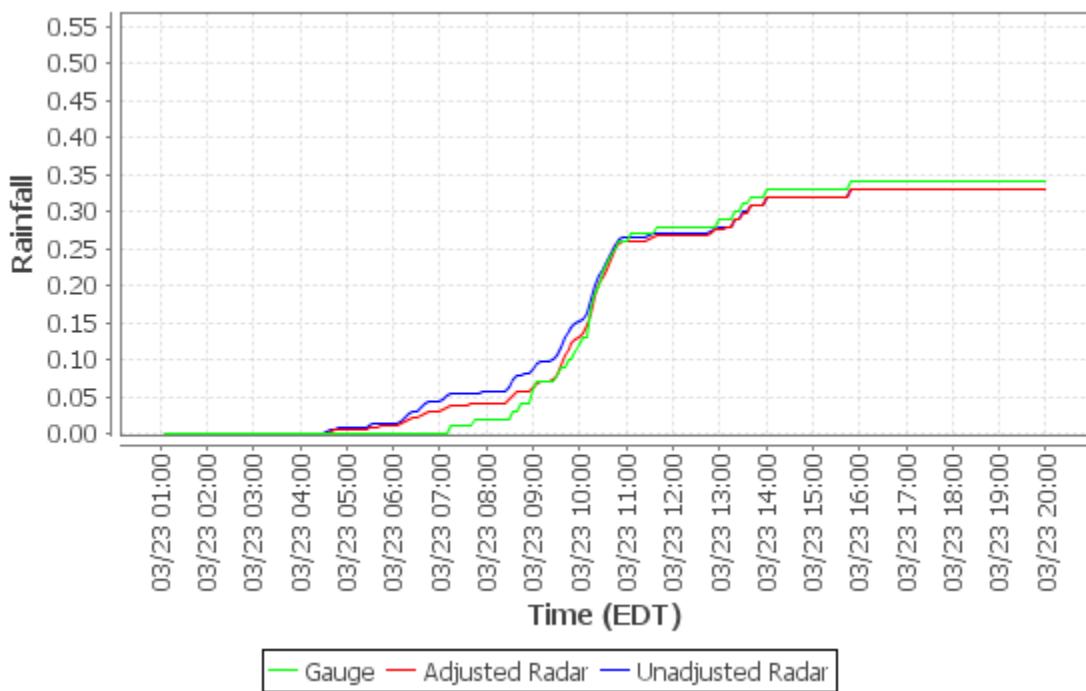
Cumulative Distribution Plot - Hampton Municipal Bldg (Loc31)



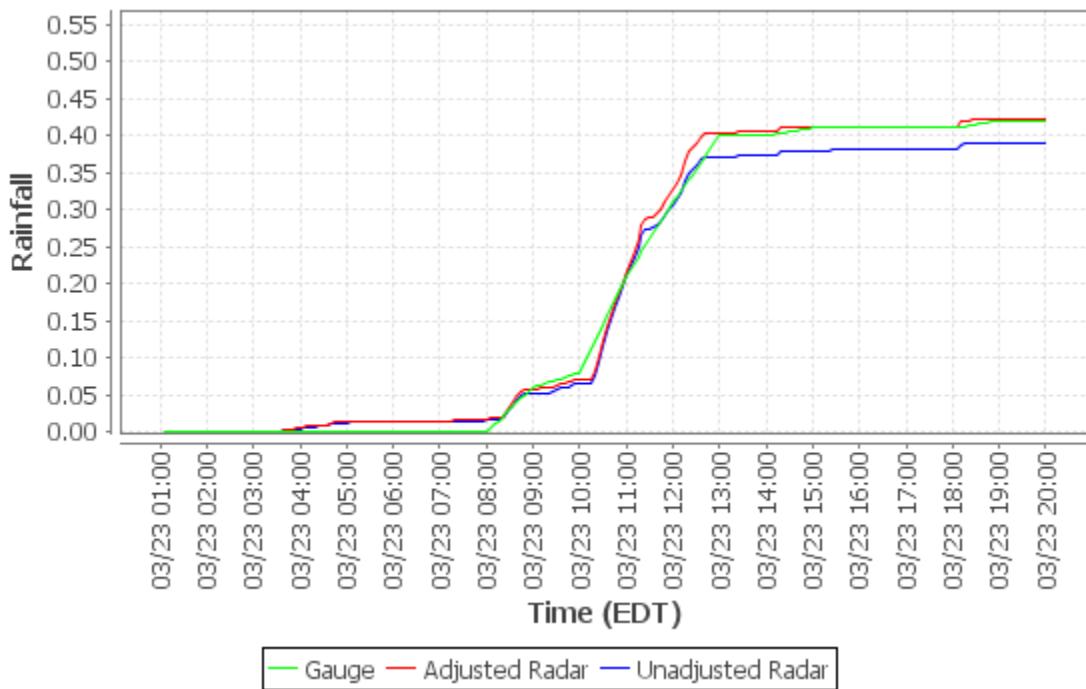
Cumulative Distribution Plot - Arnold (Loc32)



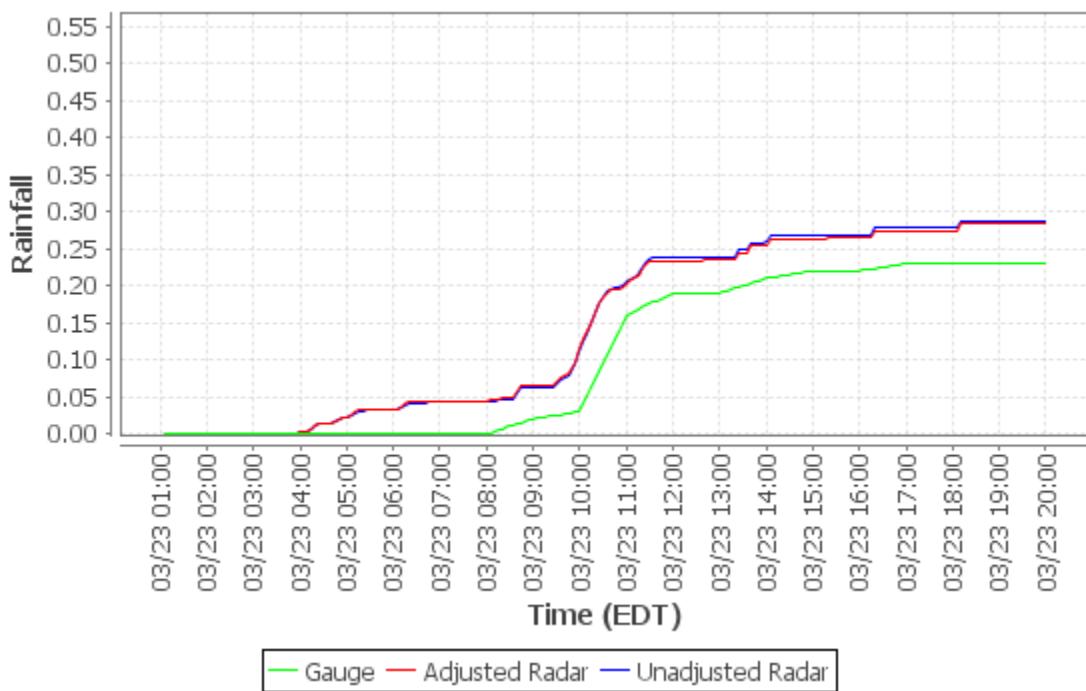
Cumulative Distribution Plot - Richland TWP (Loc33)



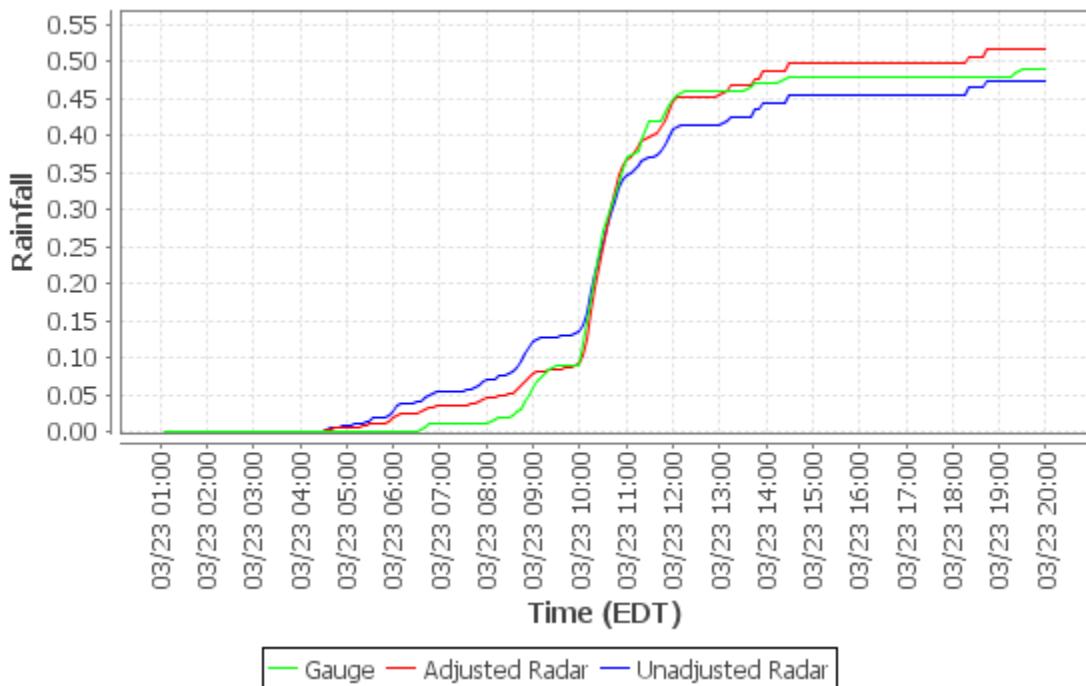
Cumulative Distribution Plot - Pittsburgh Allegheny Cty (KAGC)



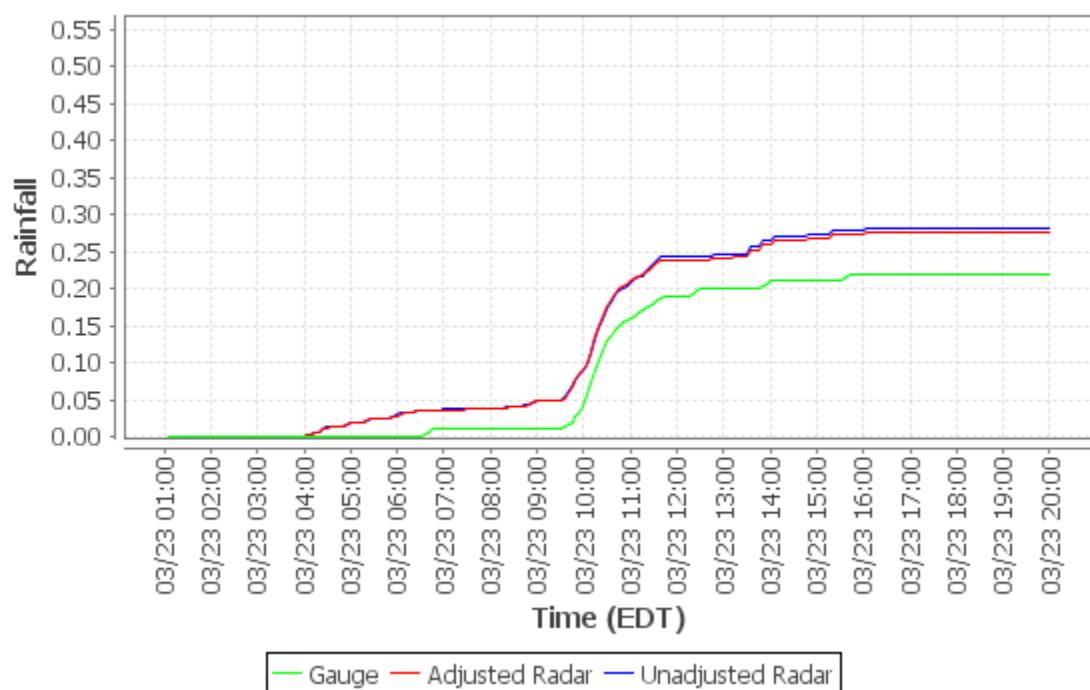
Cumulative Distribution Plot - Greater Pittsburgh Int'l (KPIT)



Cumulative Distribution Plot - Allegheny River at Natrona (03049500)

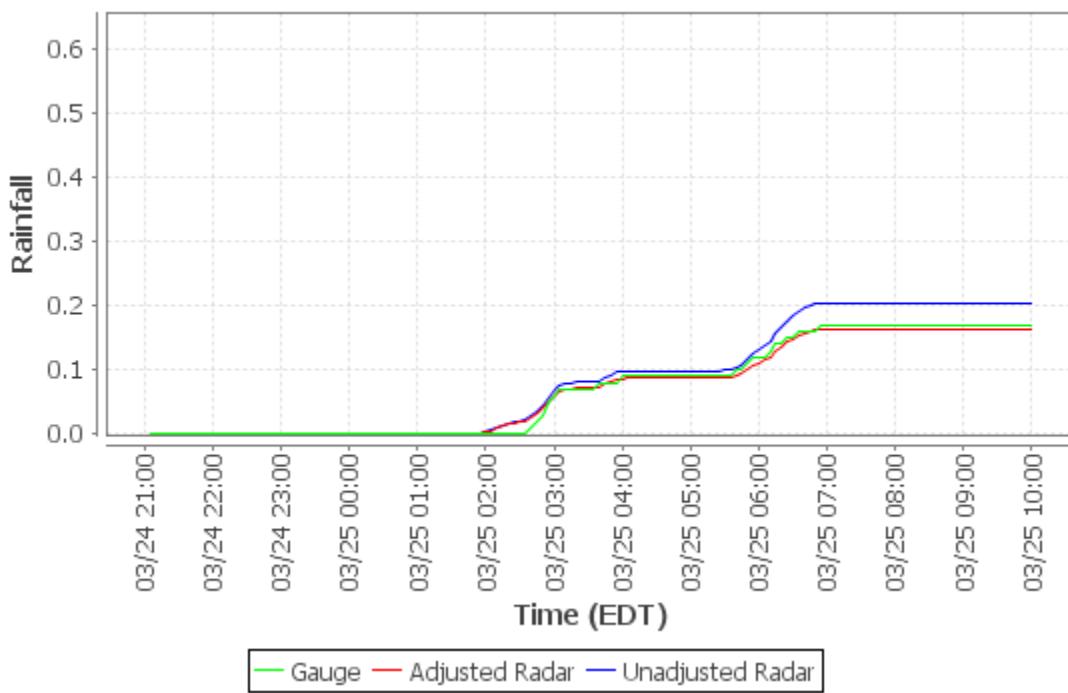


**Cumulative Distribution Plot - Ohio River at Emsworth Dam Lower Pool at Emsworth
(03085734)**

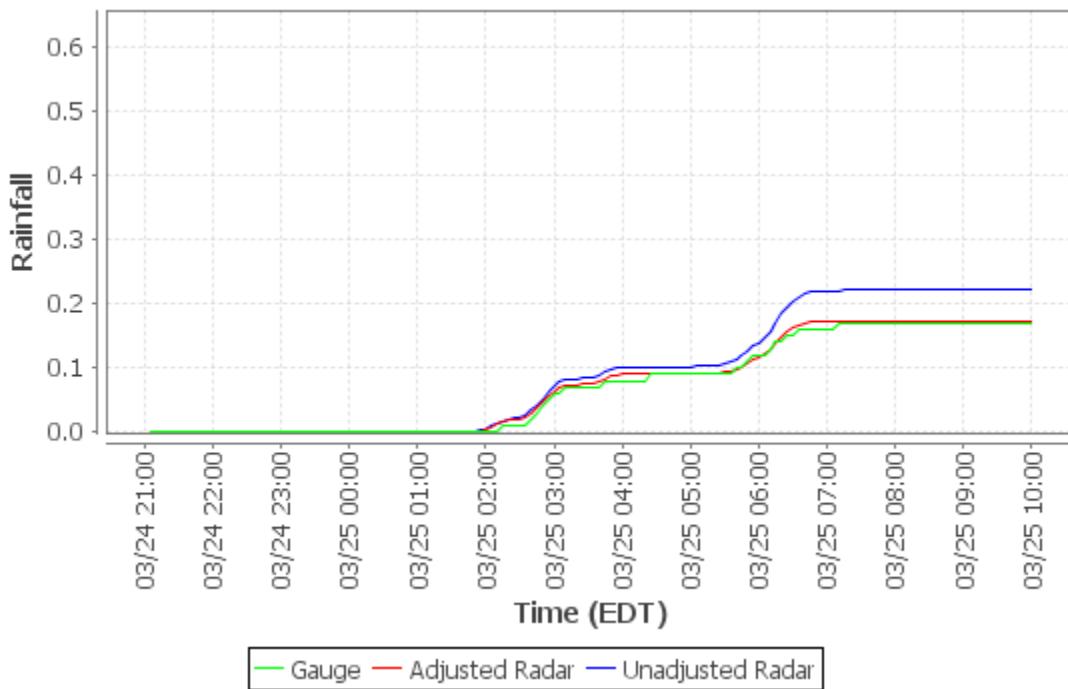


Appendix J - Event 8 (2020-03-25) CDPs

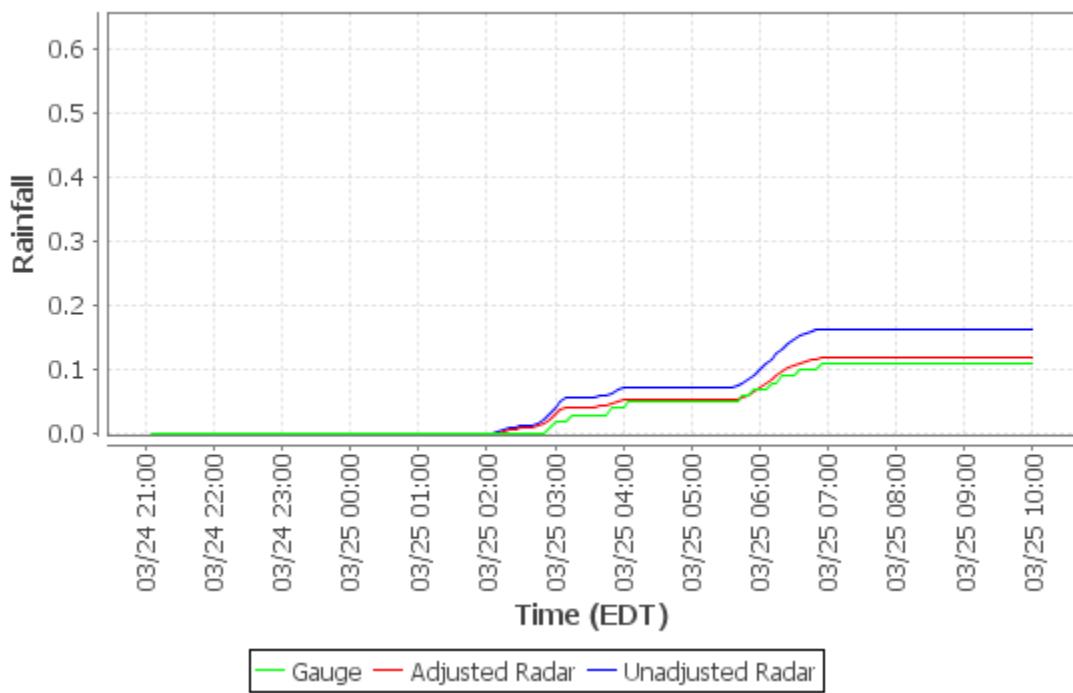
Cumulative Distribution Plot - PWSA-Montana St. (Loc01)



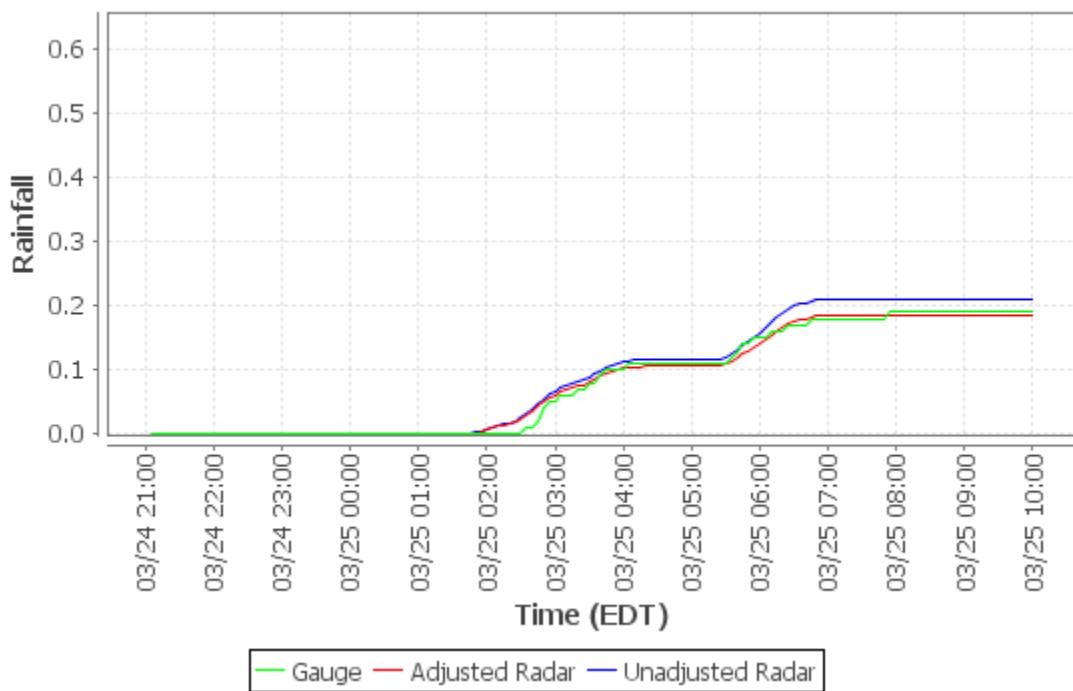
Cumulative Distribution Plot - ALCOSAN WWTP Lab (Loc02)



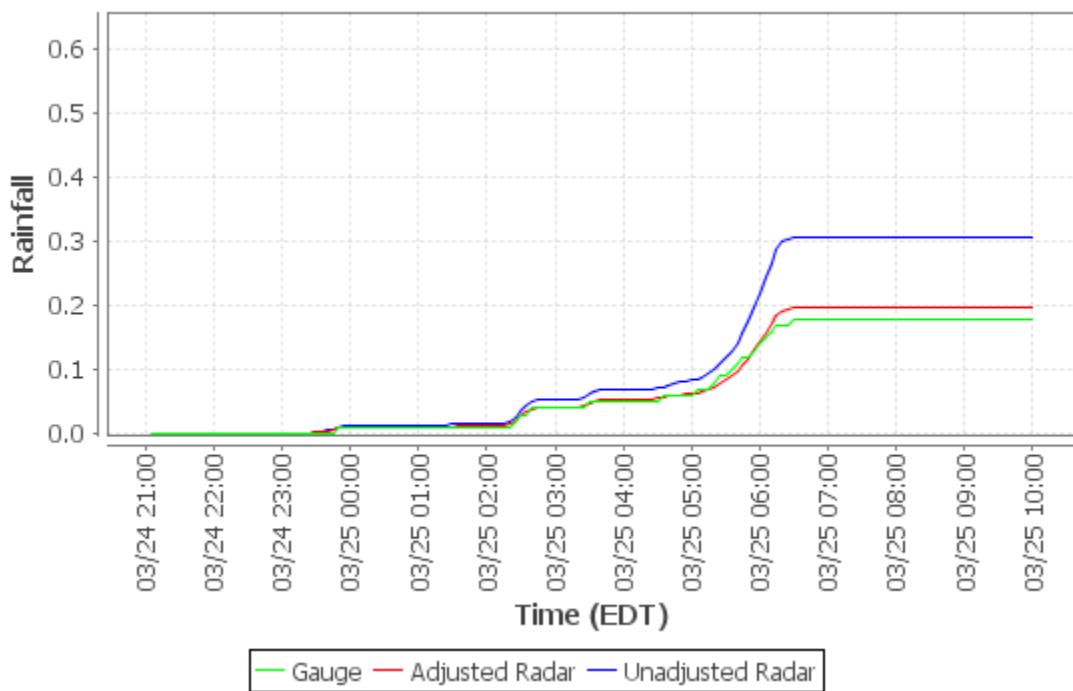
Cumulative Distribution Plot - Shaler Munic Bldg (Loc03)



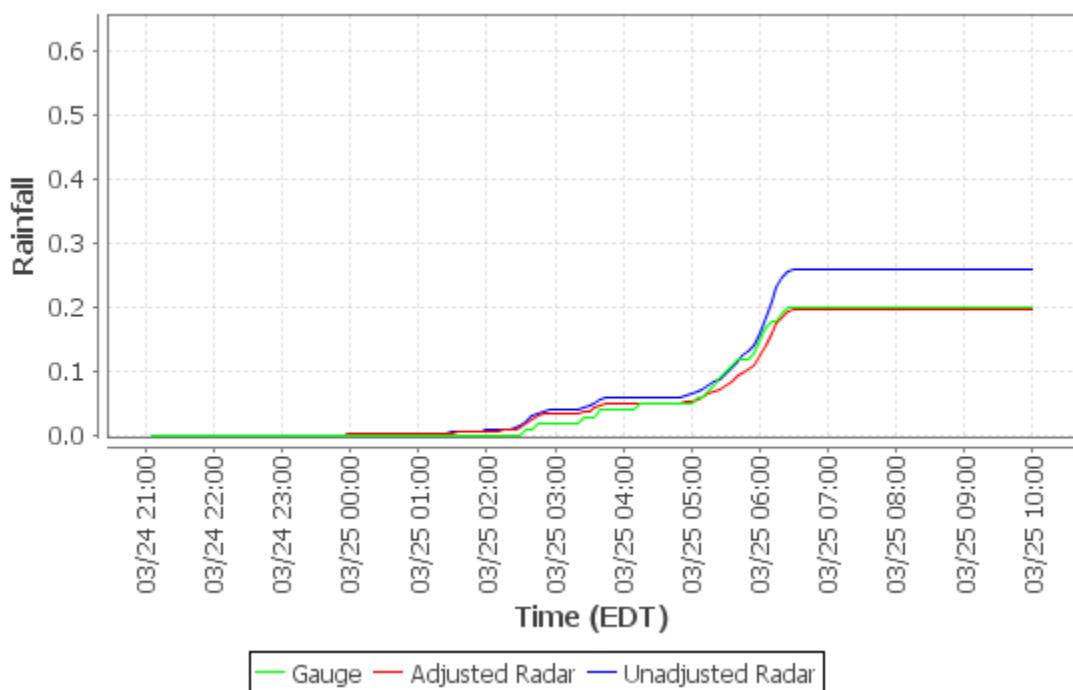
Cumulative Distribution Plot - Kennedy Twp PS (Loc04)



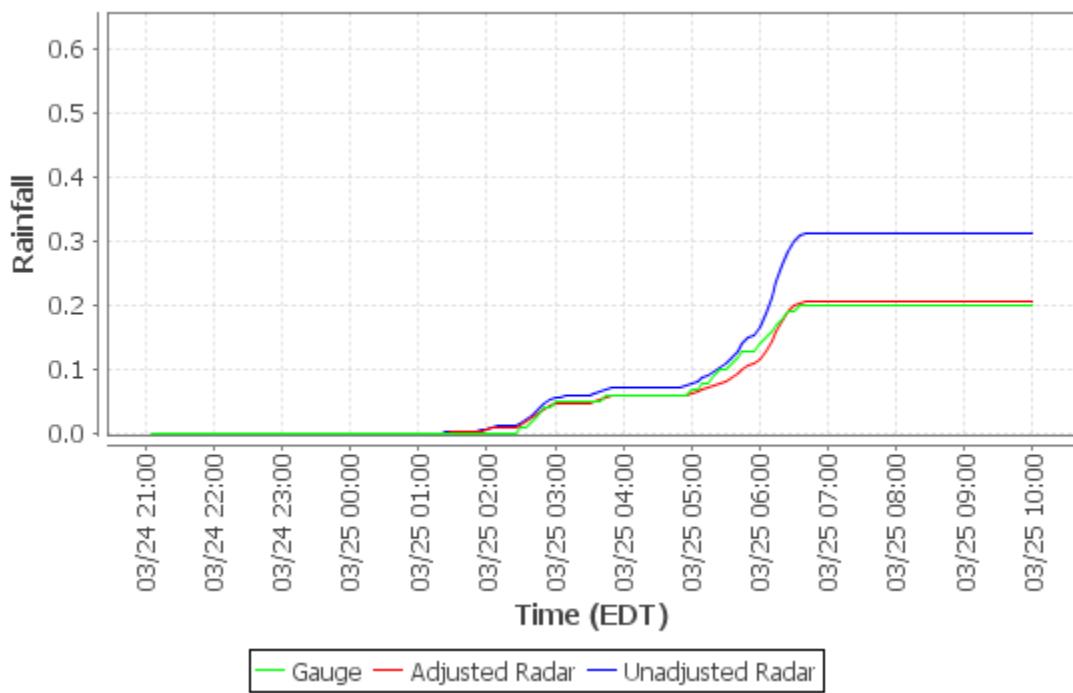
Cumulative Distribution Plot - Upper St. Clair (Loc05)



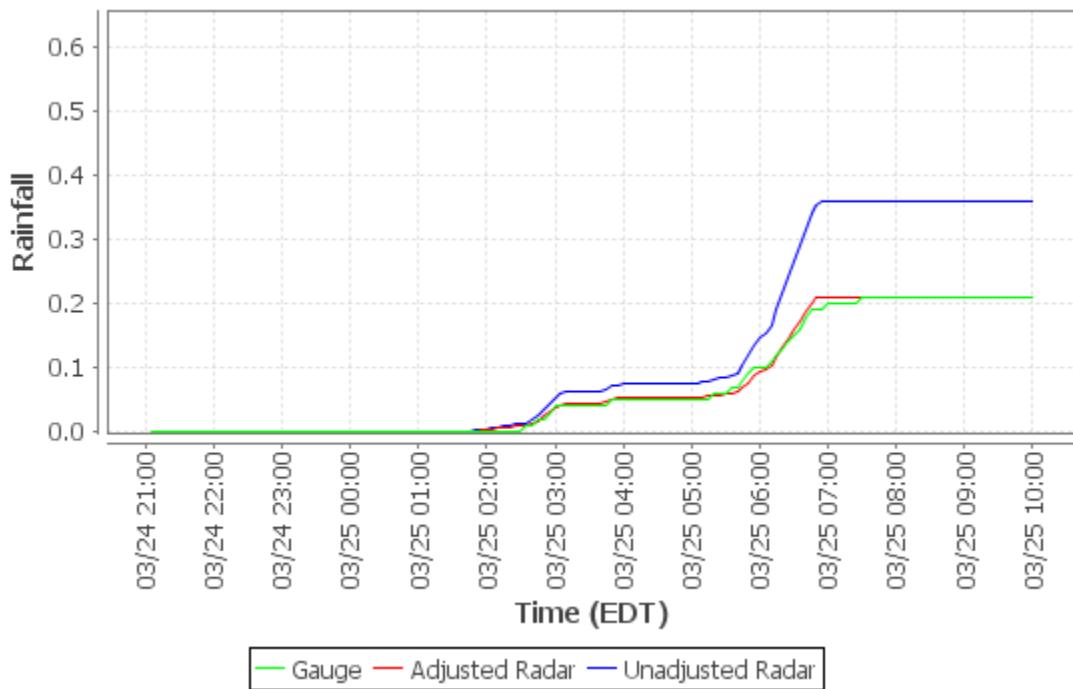
Cumulative Distribution Plot - Carnegie Transit Time (Loc06)



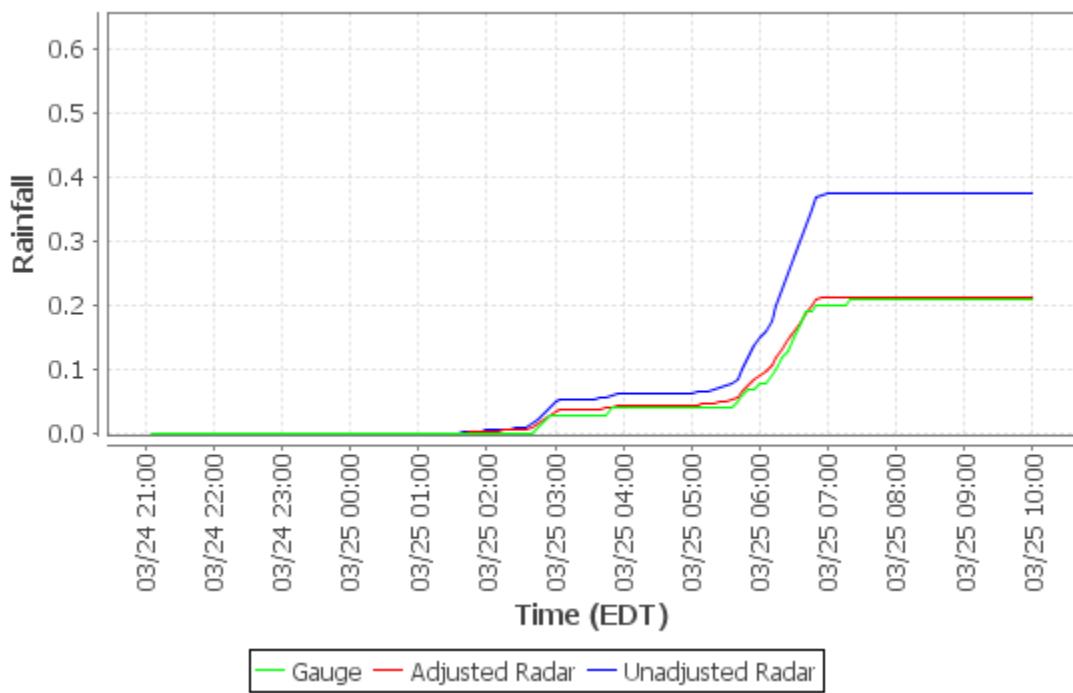
Cumulative Distribution Plot - Greentree Munic Bldg (Loc07)



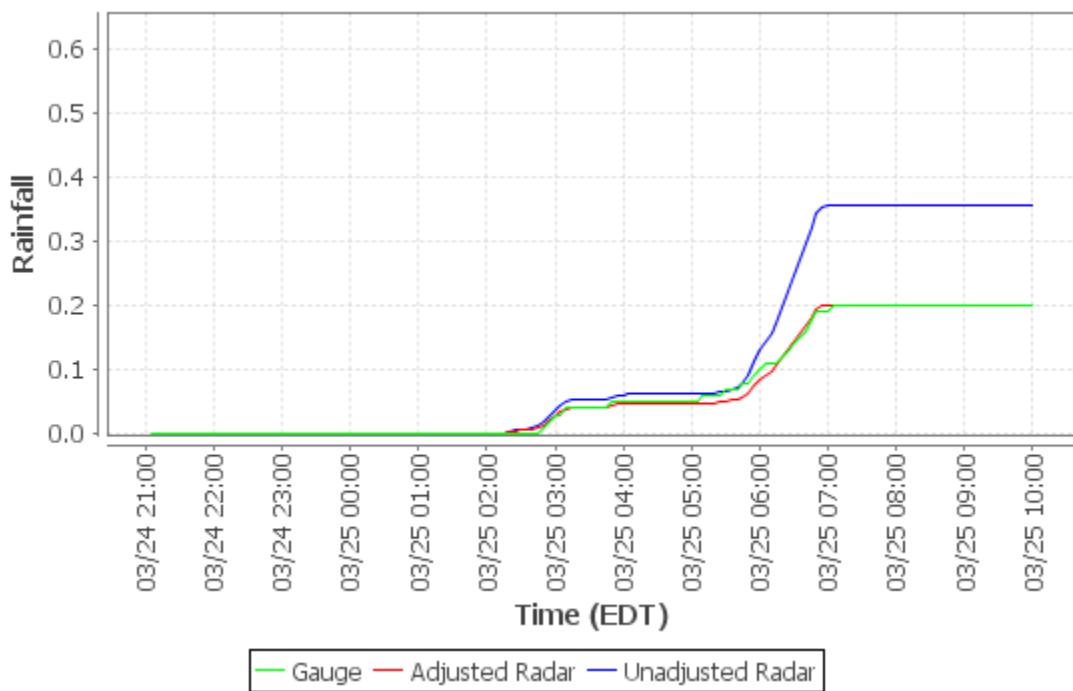
Cumulative Distribution Plot - AC Health Dept Bldg (Loc08)



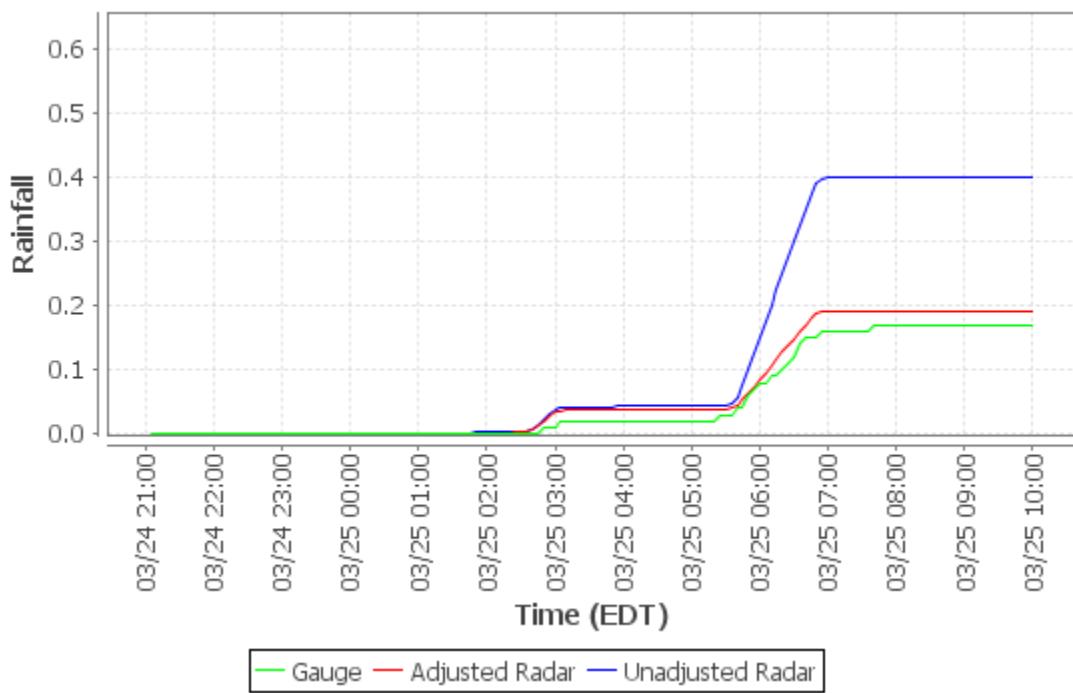
Cumulative Distribution Plot - Univ of Pittsburgh (Loc09)



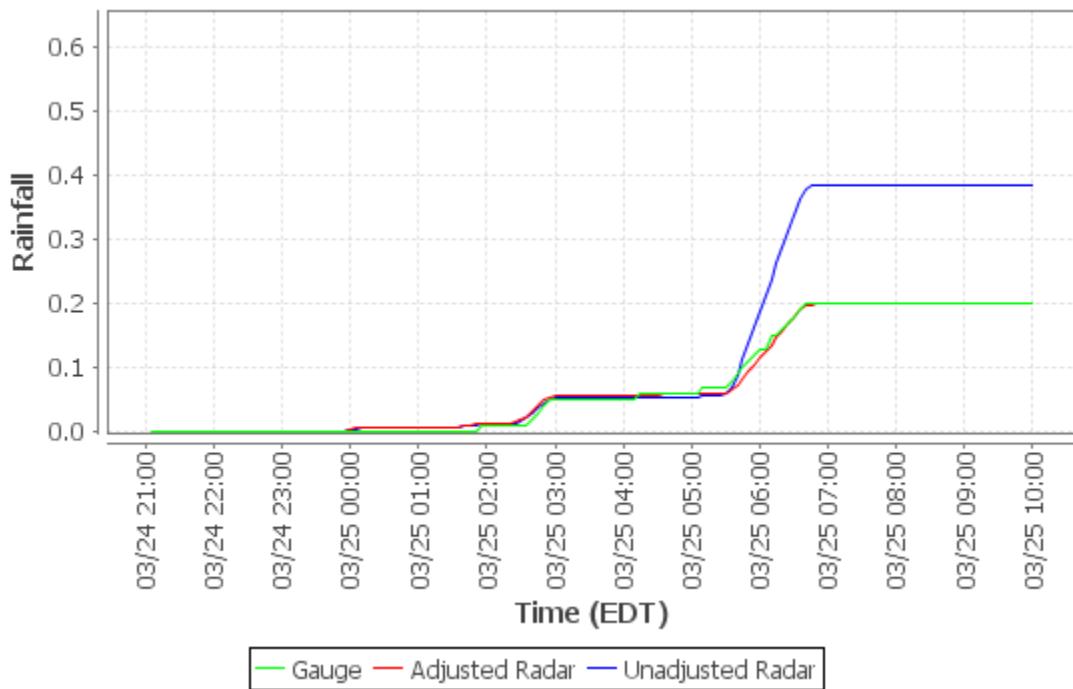
Cumulative Distribution Plot - PWSA-Highland Park (Loc10)



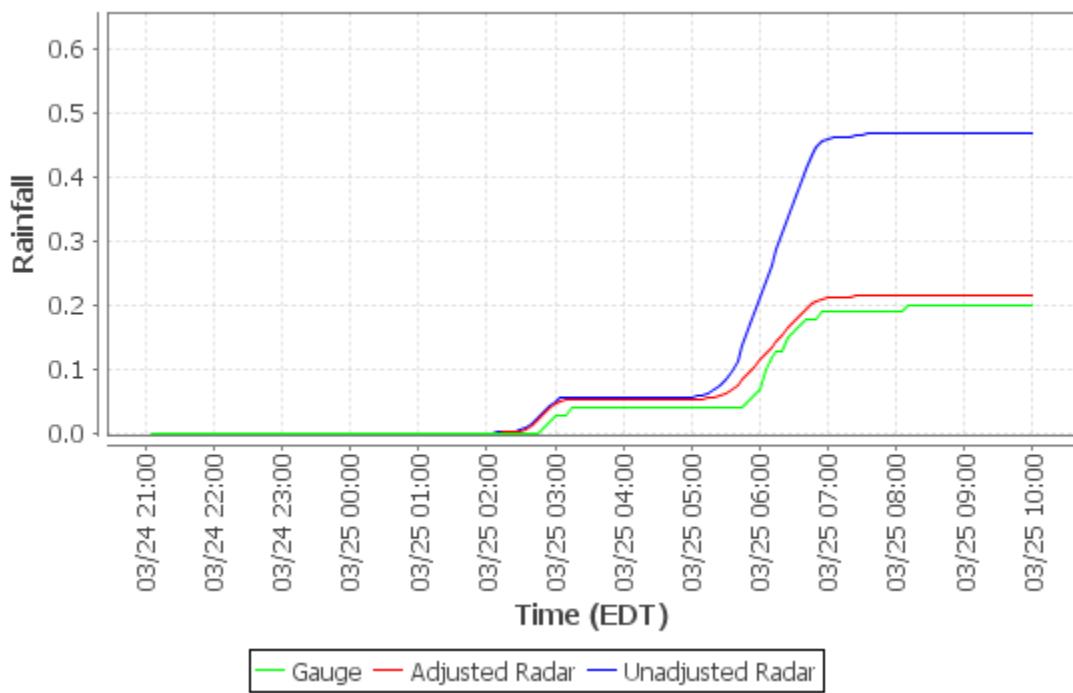
Cumulative Distribution Plot - M-46 Access Shaft (Loc11)



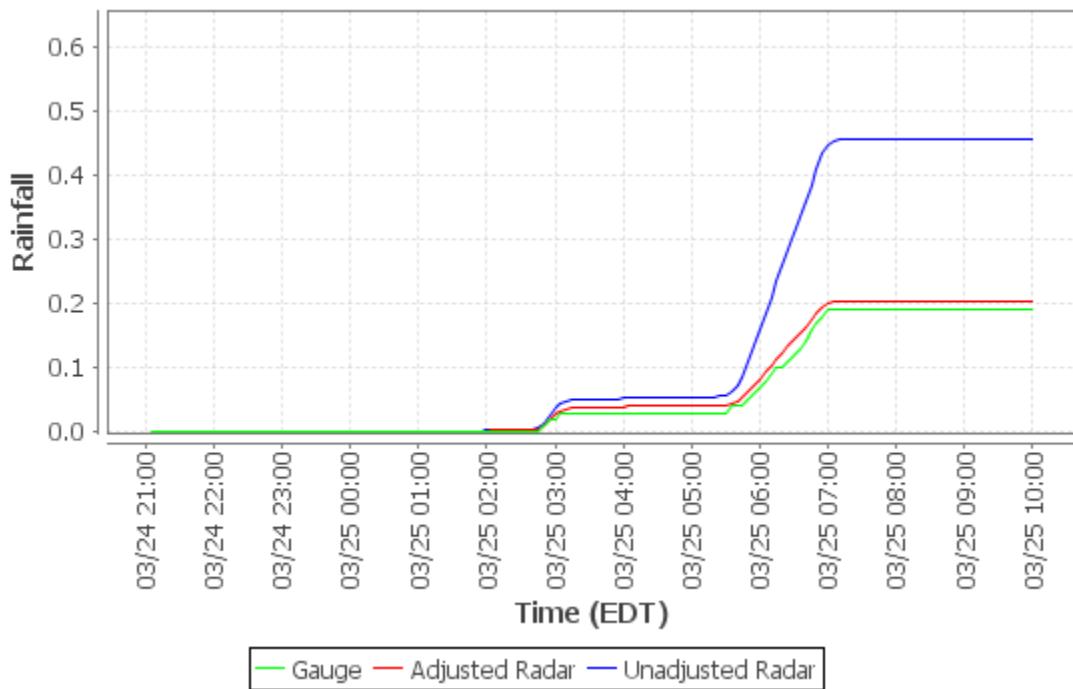
Cumulative Distribution Plot - Baldwin (Loc12)



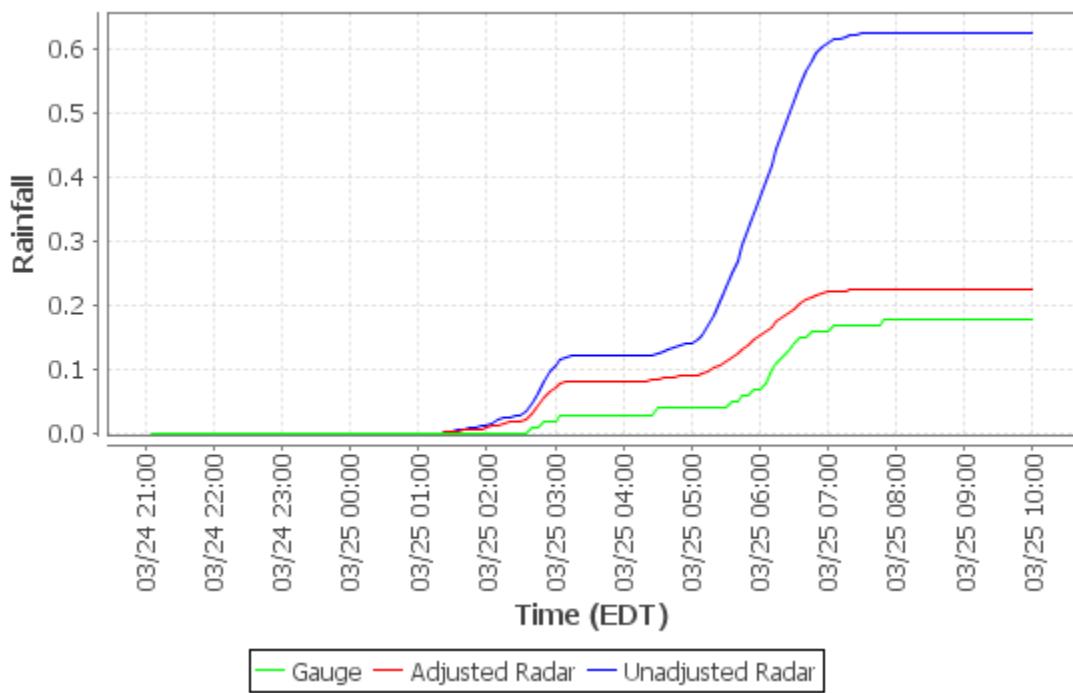
Cumulative Distribution Plot - M-59 Access Shaft (Loc13)



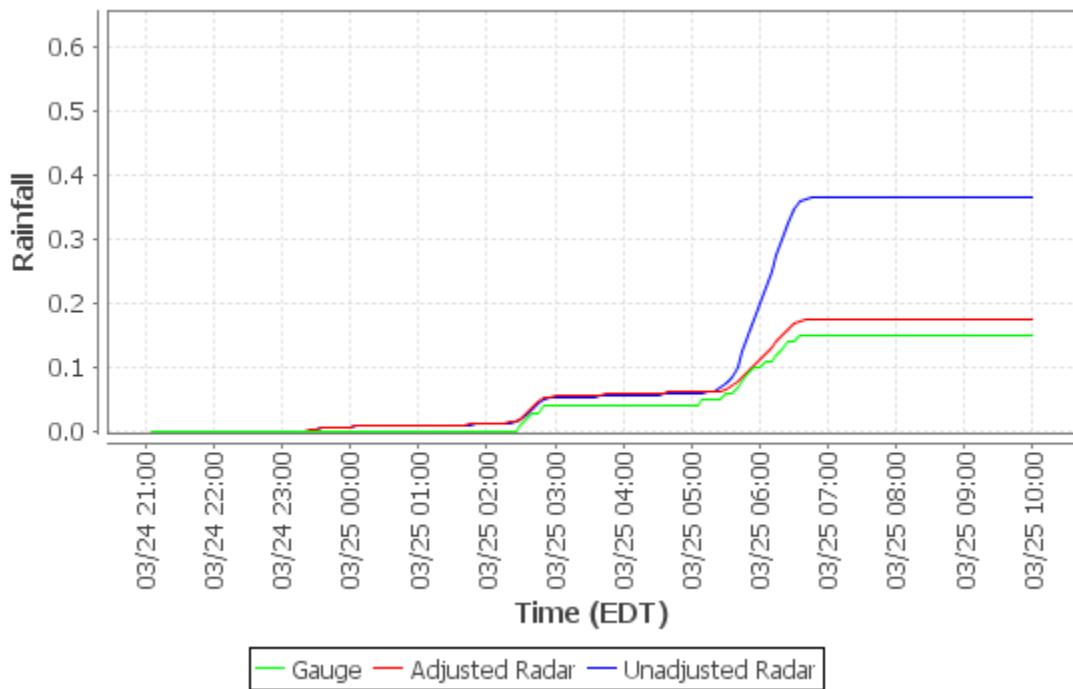
Cumulative Distribution Plot - Churchill Munic Bldg (Loc14)



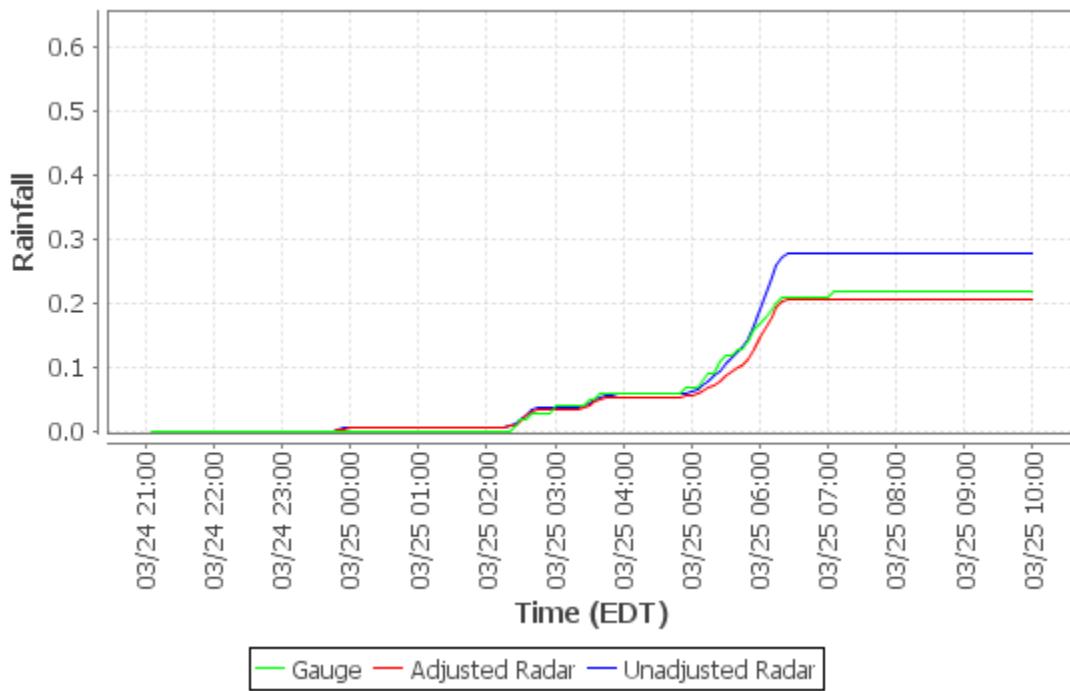
Cumulative Distribution Plot - Trafford Maint Bldg (Loc15)



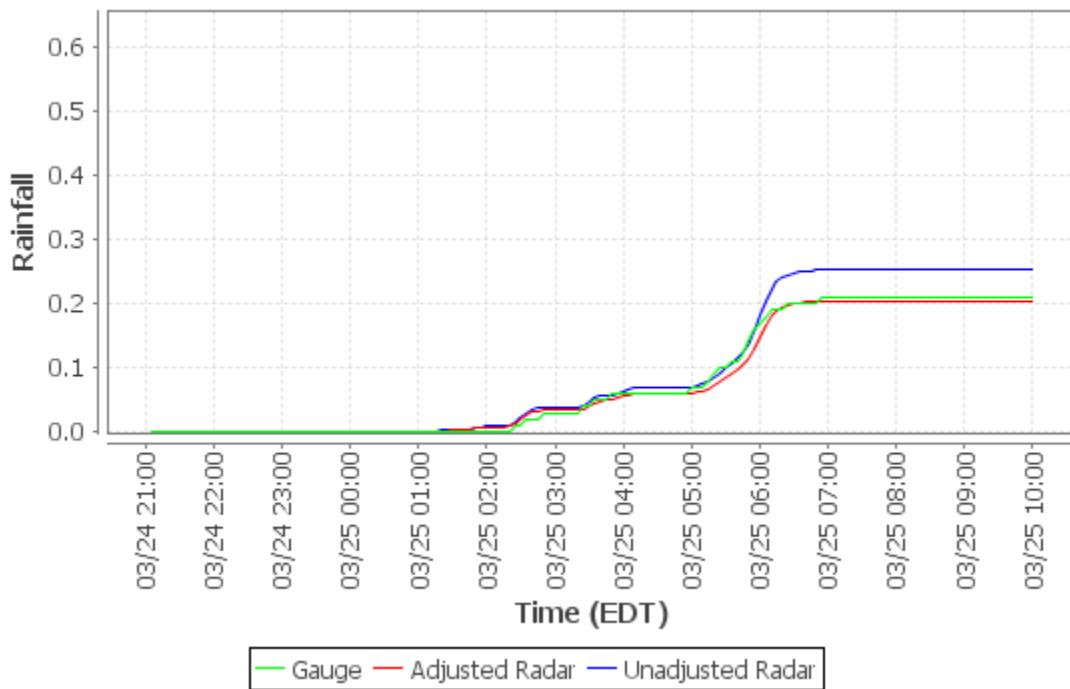
Cumulative Distribution Plot - Castle Shannon (Loc16)



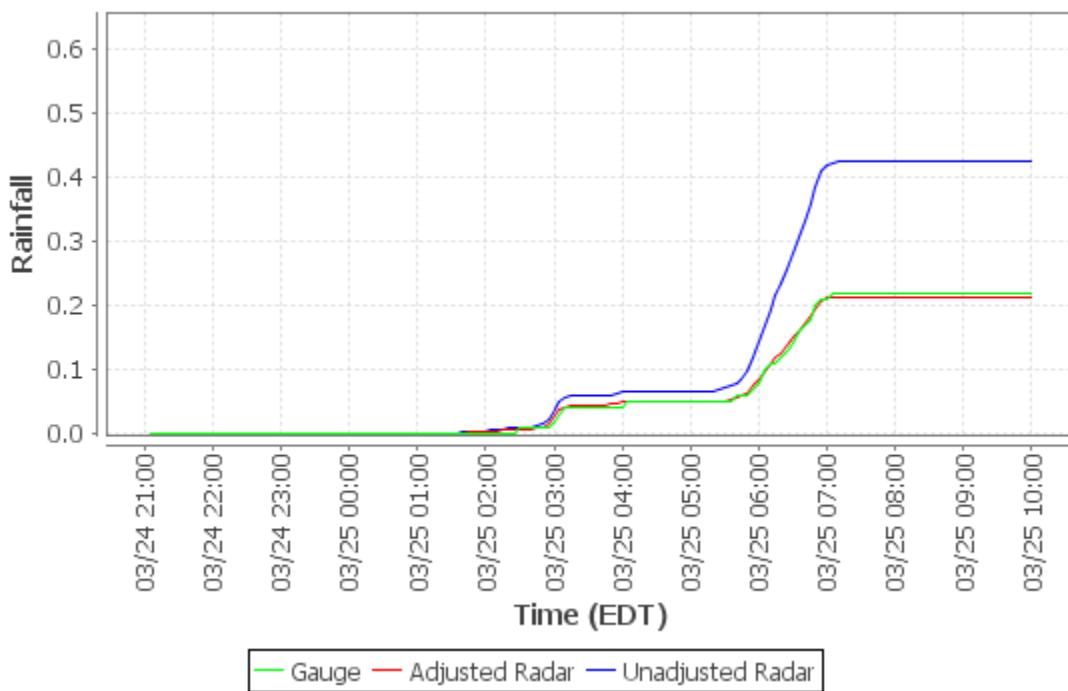
Cumulative Distribution Plot - Chartiers Pump Station (Loc17)



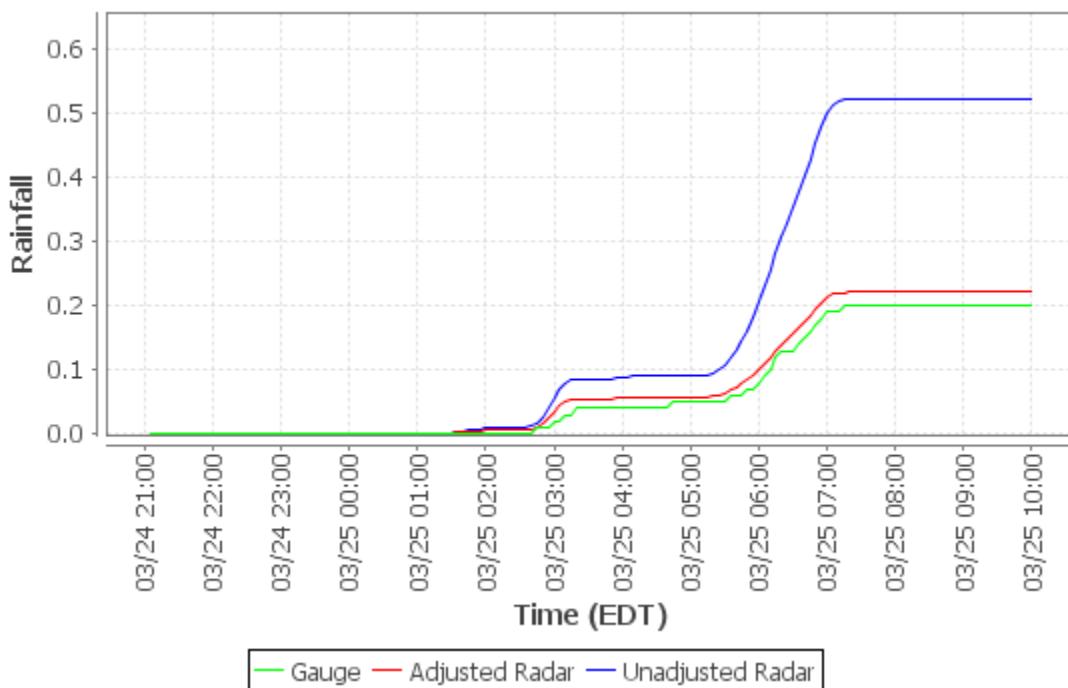
Cumulative Distribution Plot - Oakdale Pump Station (Loc18)



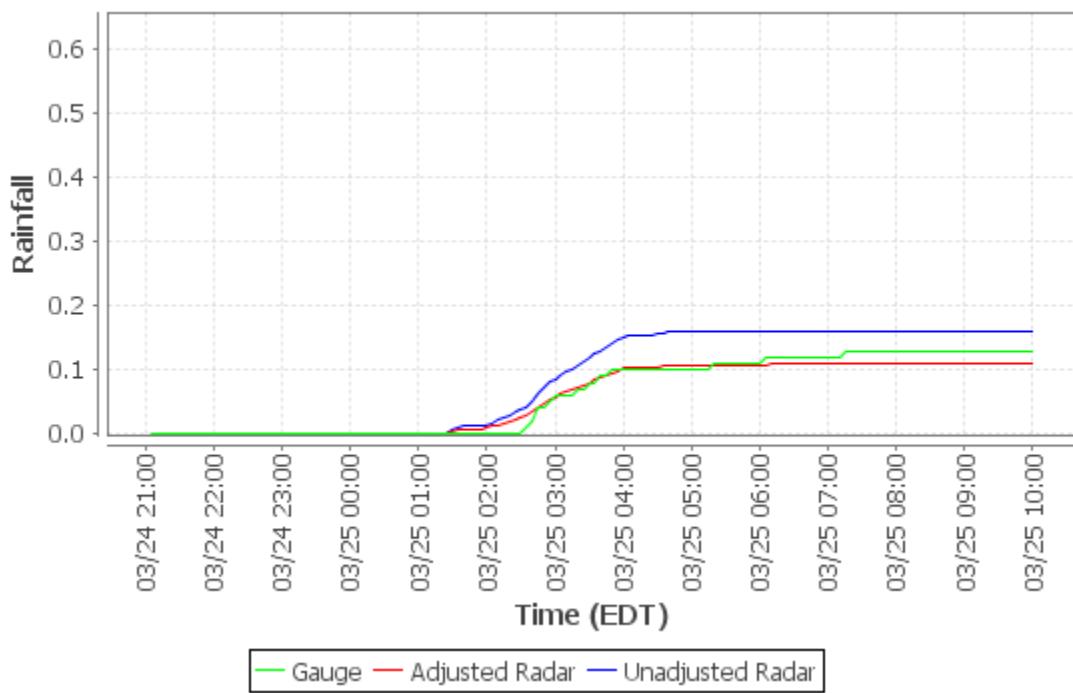
Cumulative Distribution Plot - Sandy Creek Eq Facility (Loc19)



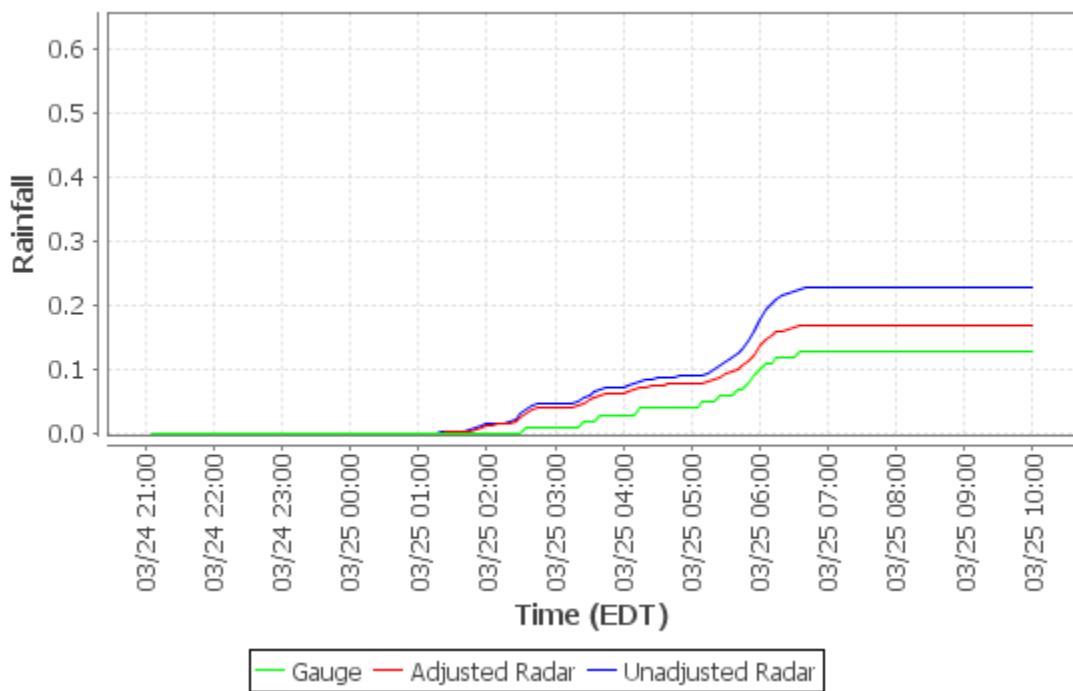
Cumulative Distribution Plot - Gascola Eq Facility (Loc20)



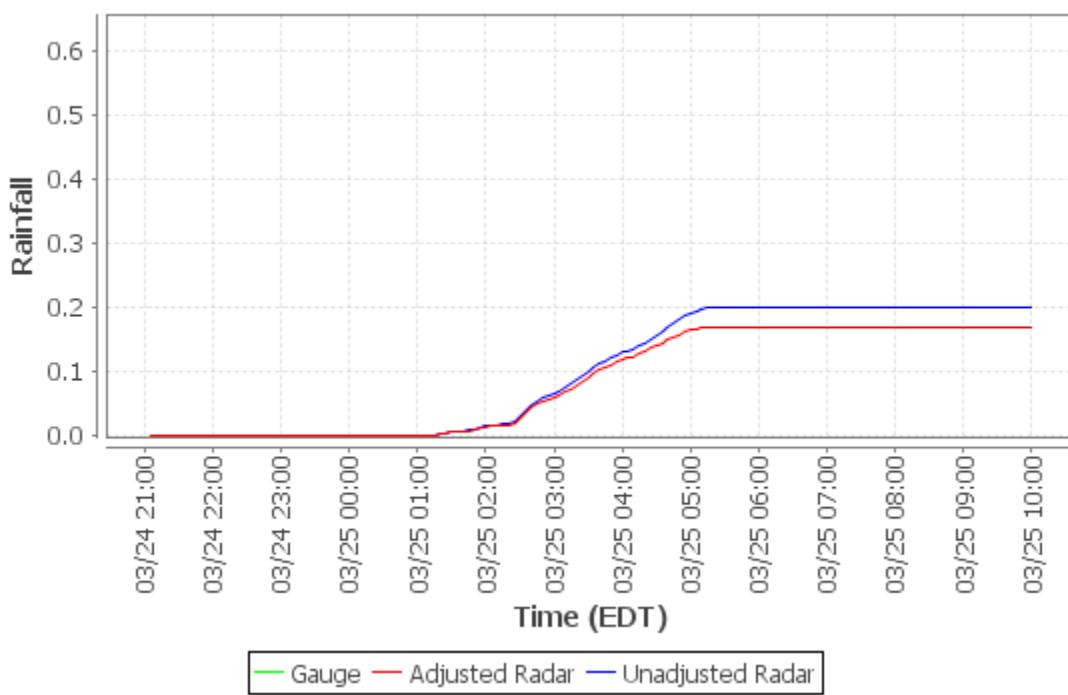
Cumulative Distribution Plot - Moon TWP (Loc21)



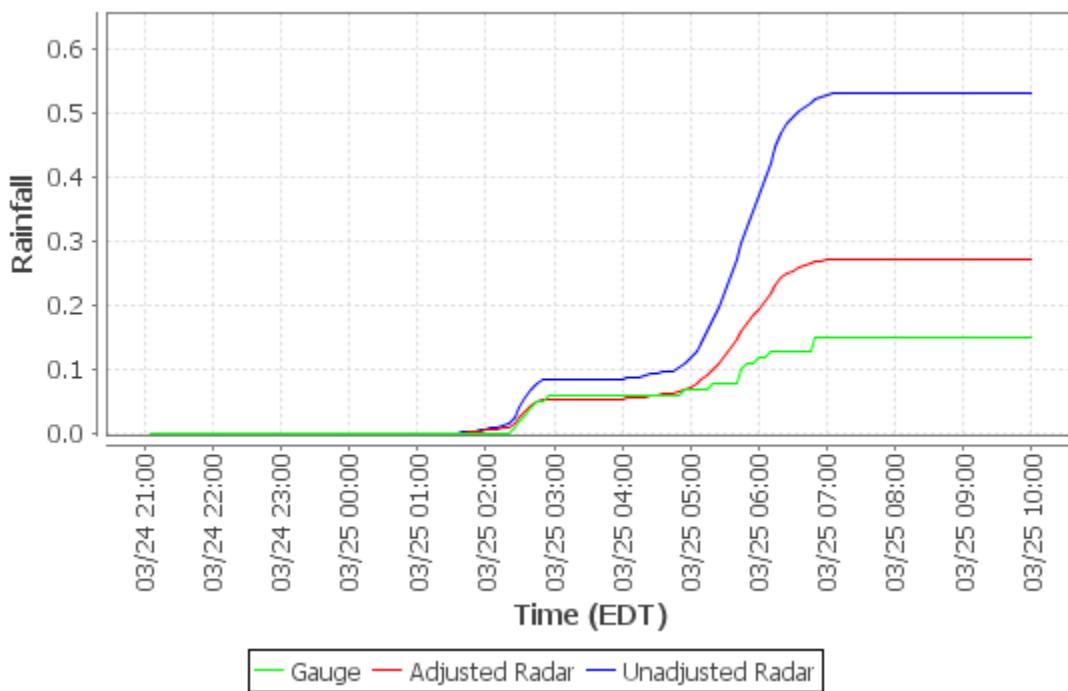
Cumulative Distribution Plot - North Fayette TWP (Loc22)



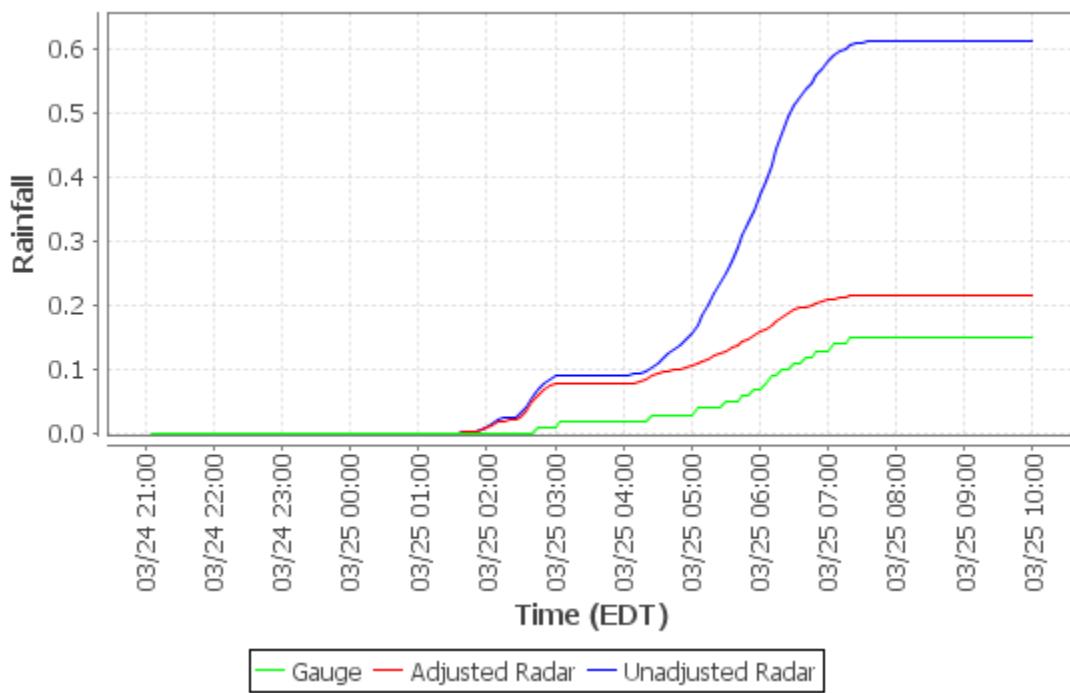
Cumulative Distribution Plot - Clinton Munic Bldg (Loc23)



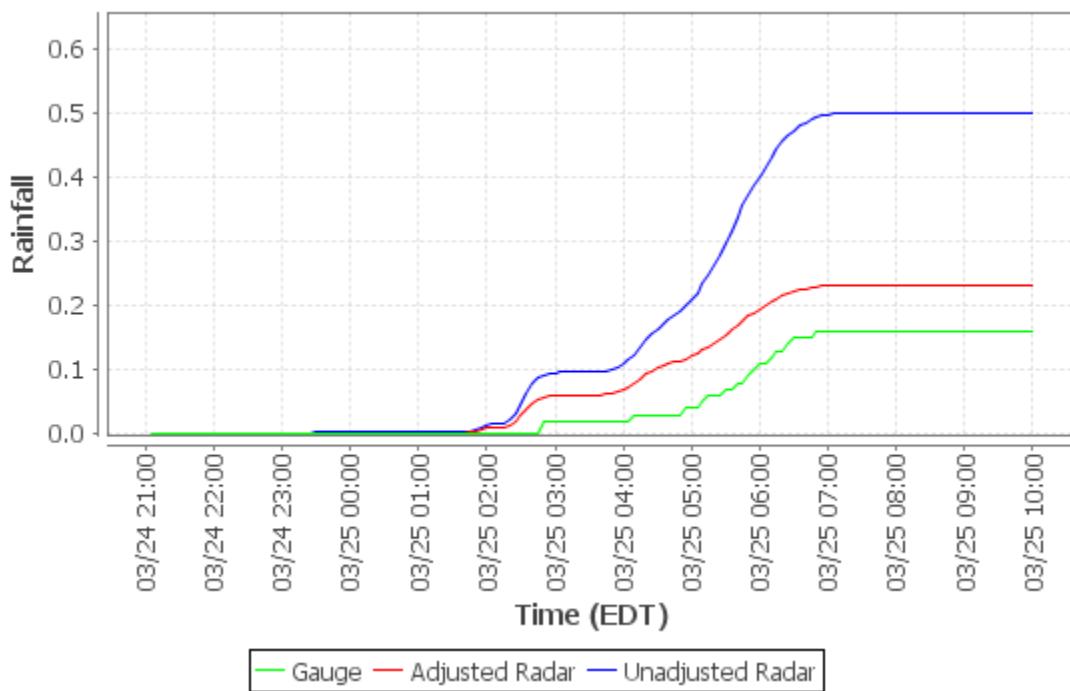
Cumulative Distribution Plot - Jefferson Hills (Loc24)



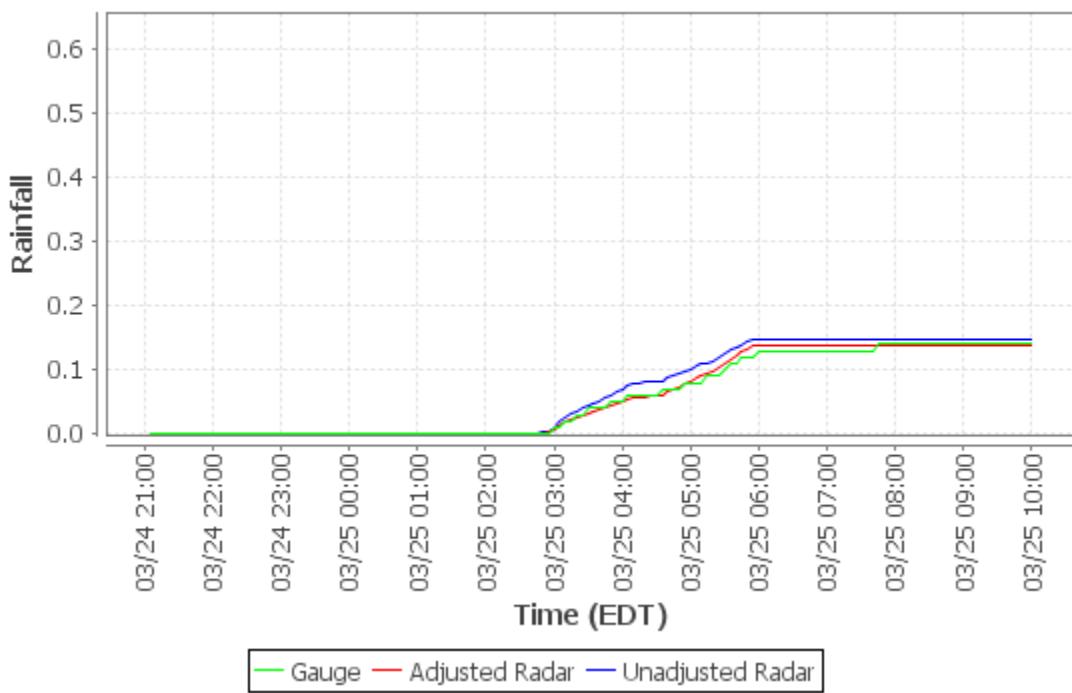
Cumulative Distribution Plot - White Oak Public Works Bldg (Loc25)



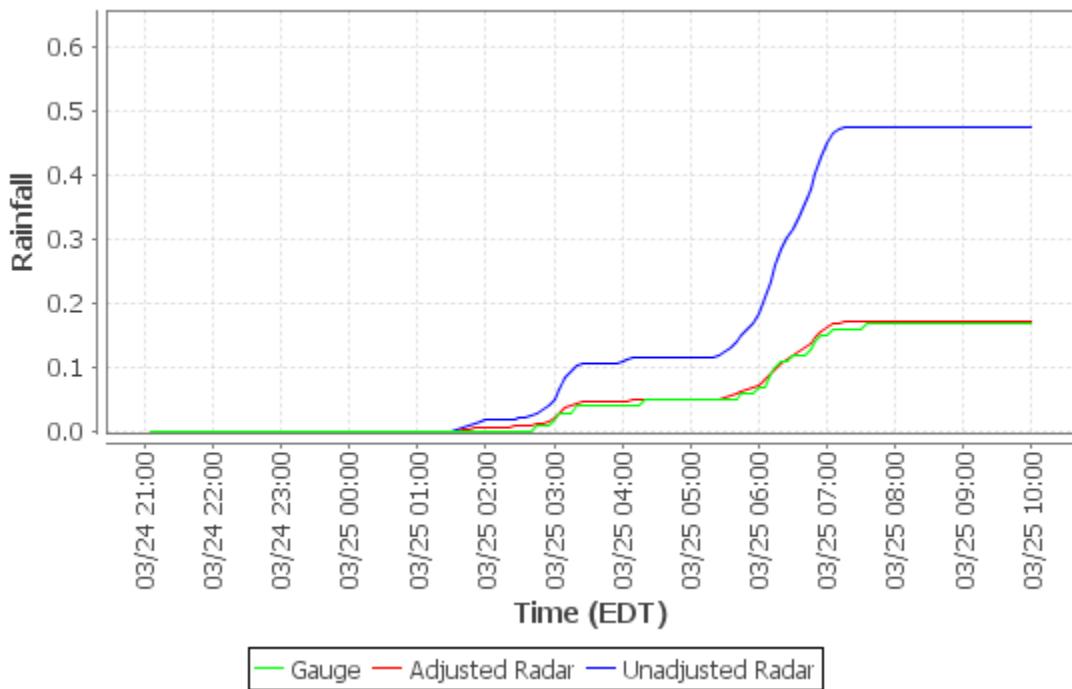
Cumulative Distribution Plot - Elizabeth TWP Municipal Bldg (Loc26)



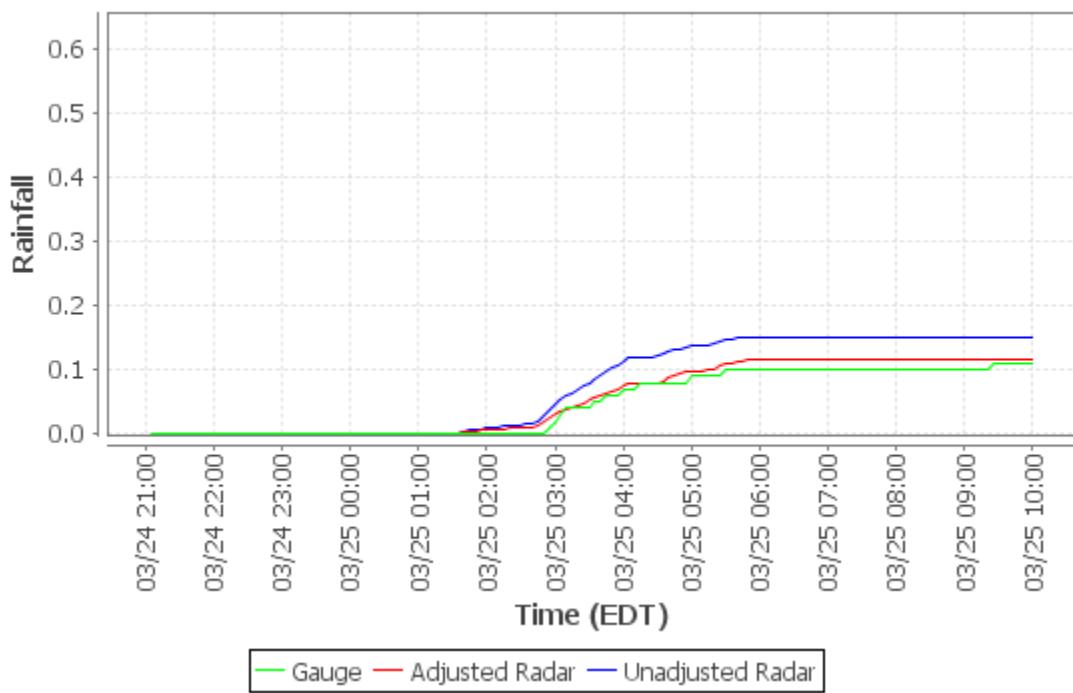
Cumulative Distribution Plot - Marshall TWP (Loc27)



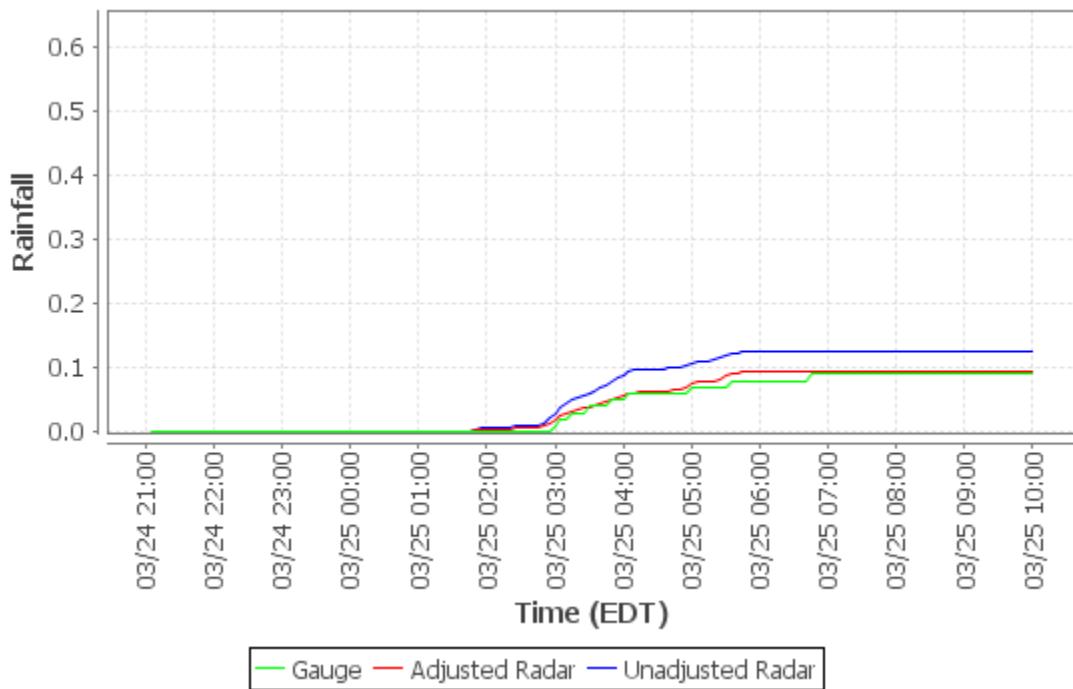
Cumulative Distribution Plot - Plum Municipal Bldg (Loc28)



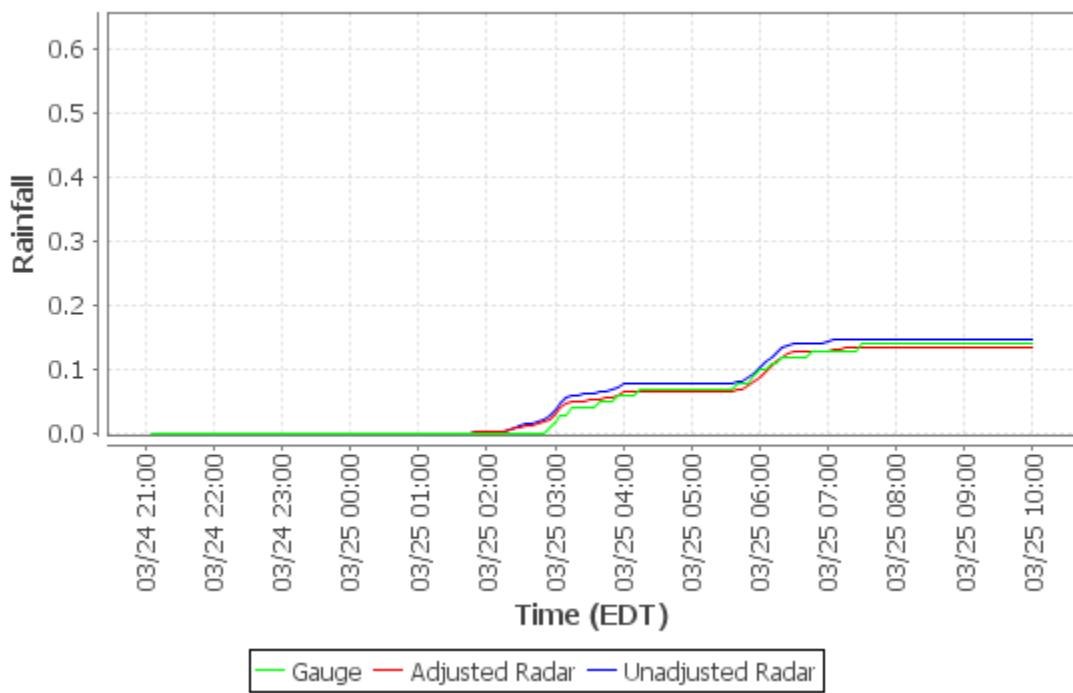
Cumulative Distribution Plot - Bell Acres Munic Bldg (Loc29)



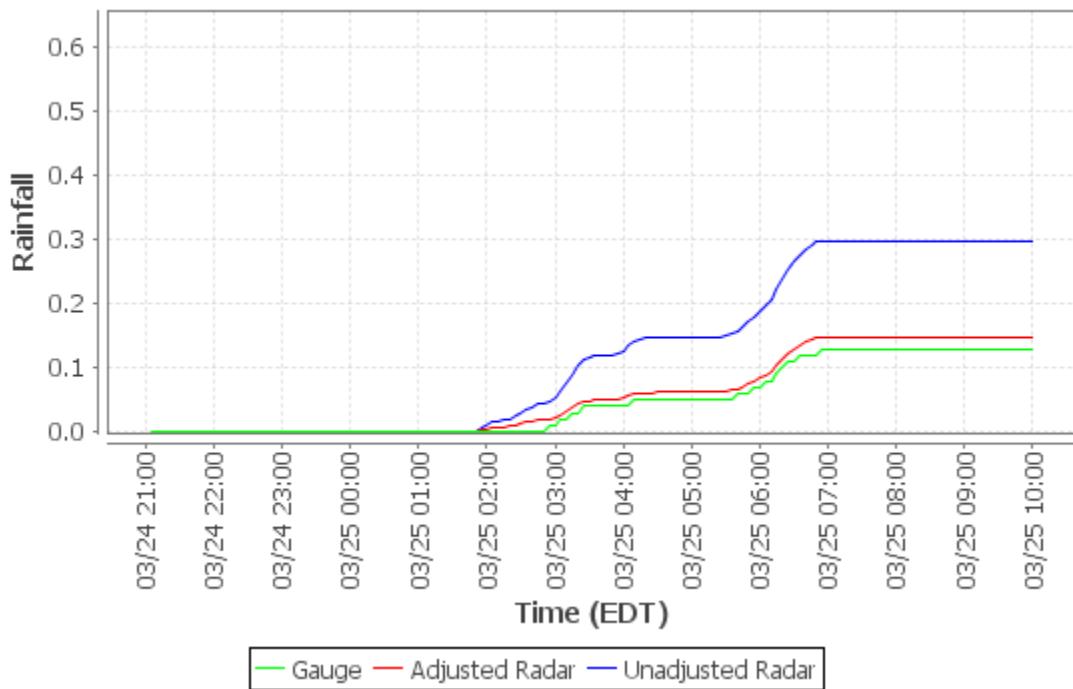
Cumulative Distribution Plot - McCandless Twn Hall (Loc30)



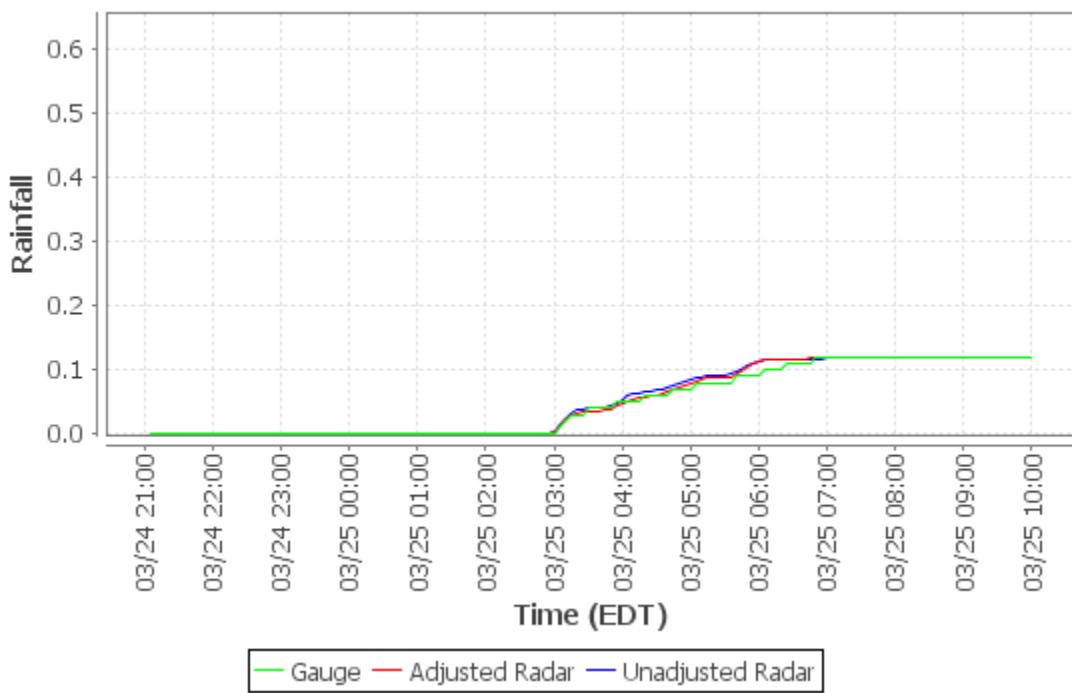
Cumulative Distribution Plot - Hampton Municipal Bldg (Loc31)



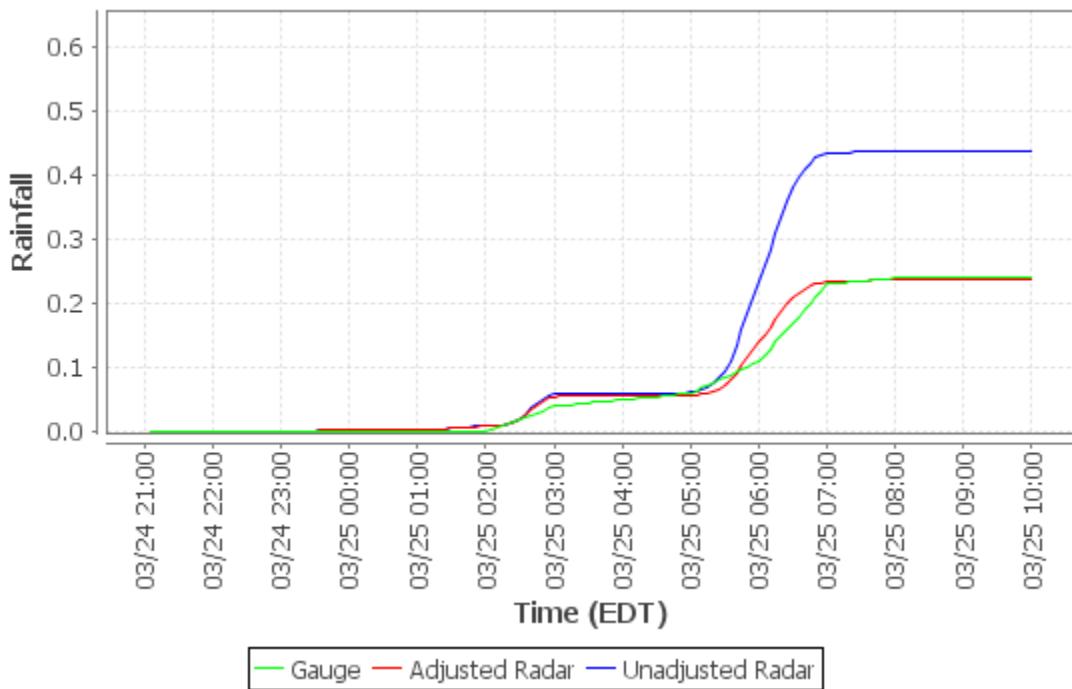
Cumulative Distribution Plot - Arnold (Loc32)



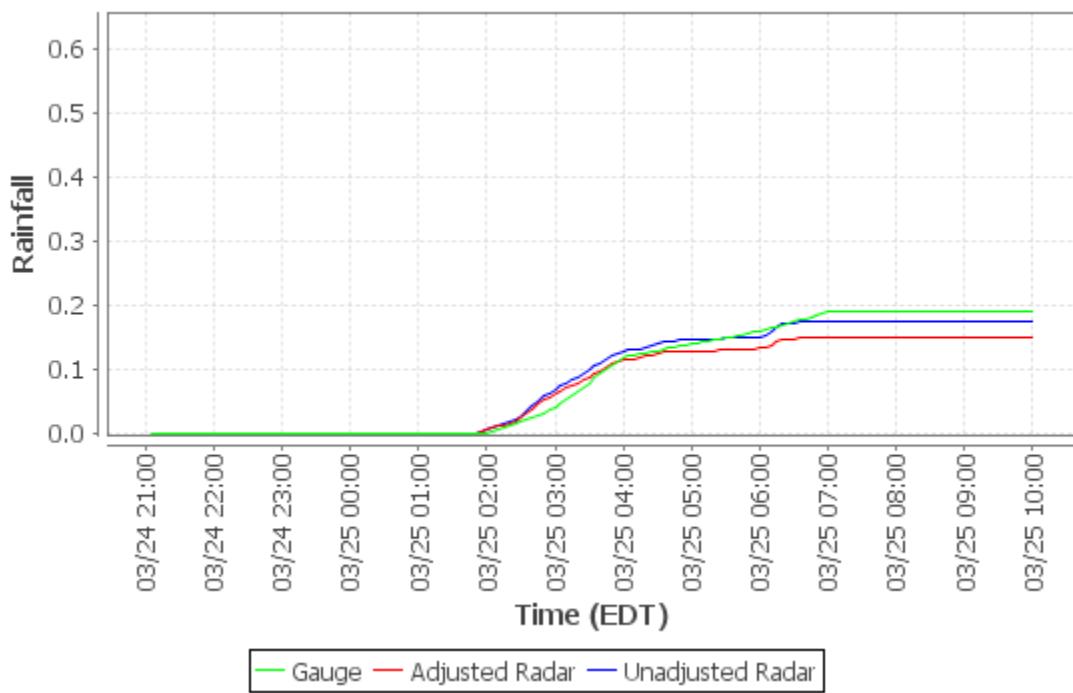
Cumulative Distribution Plot - Richland TWP (Loc33)



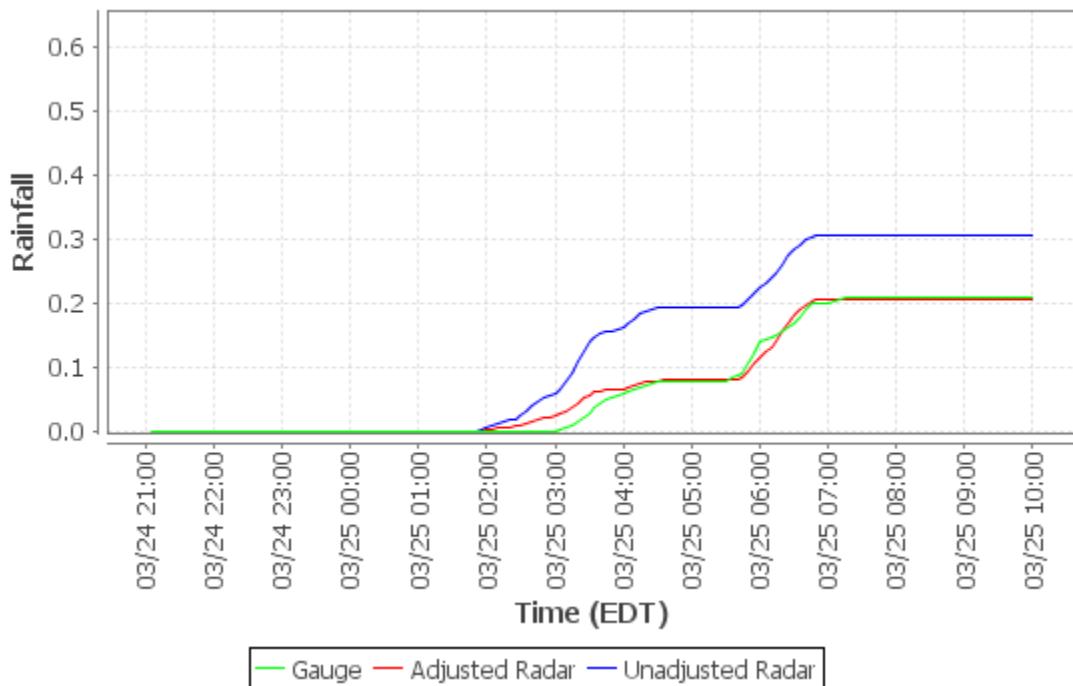
Cumulative Distribution Plot - Pittsburgh Allegheny Cty (KAGC)



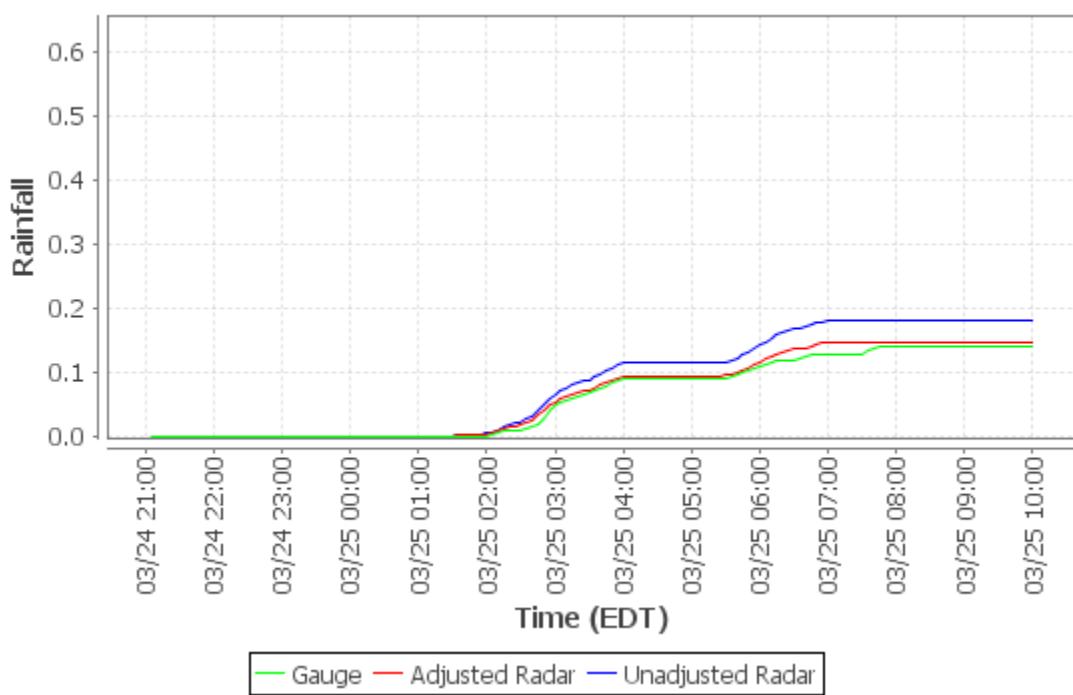
Cumulative Distribution Plot - Greater Pittsburgh Int'l (KPIT)



Cumulative Distribution Plot - Allegheny River at Natrona (03049500)

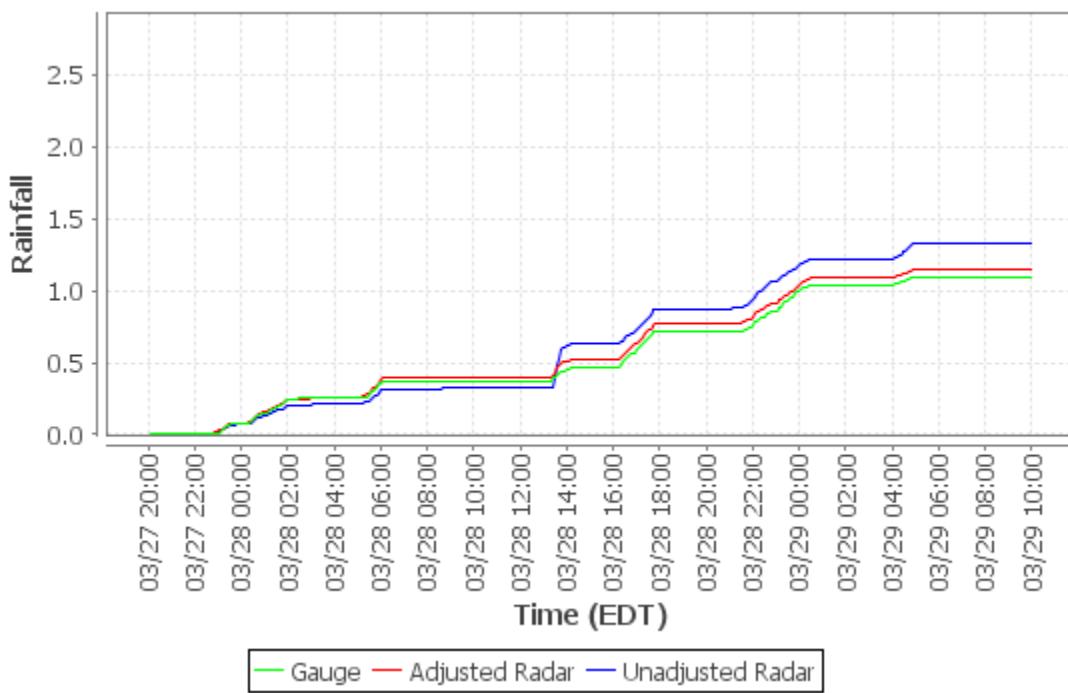


**Cumulative Distribution Plot - Ohio River at Emsworth Dam Lower Pool at Emsworth
(03085734)**

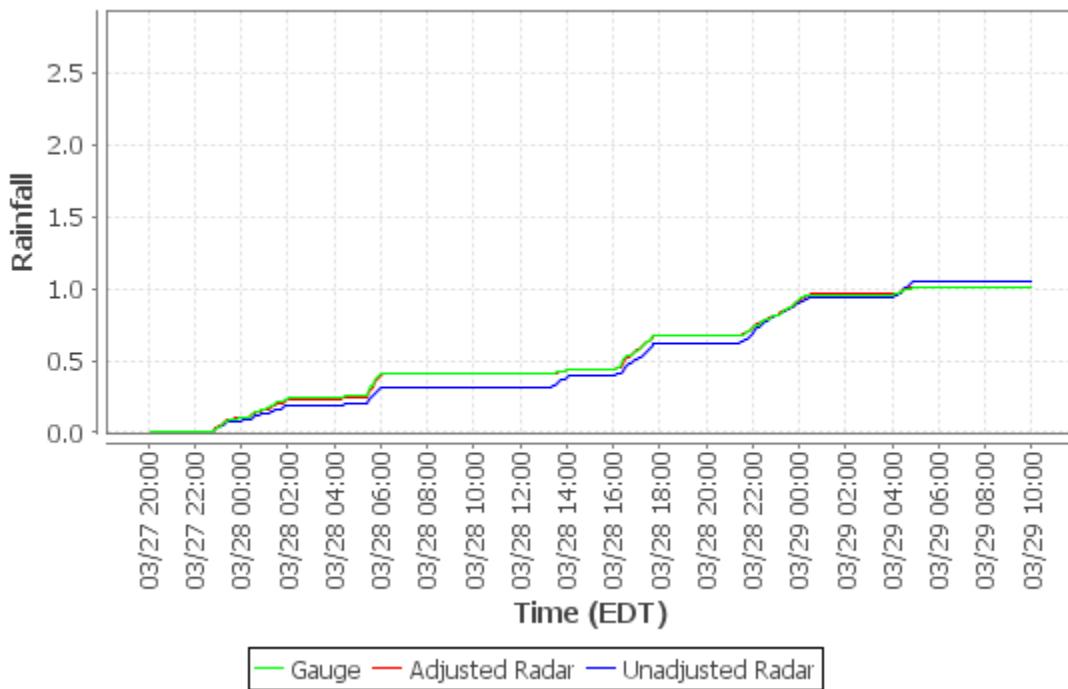


Appendix K - Event 9 (2020-03-28) CDPs

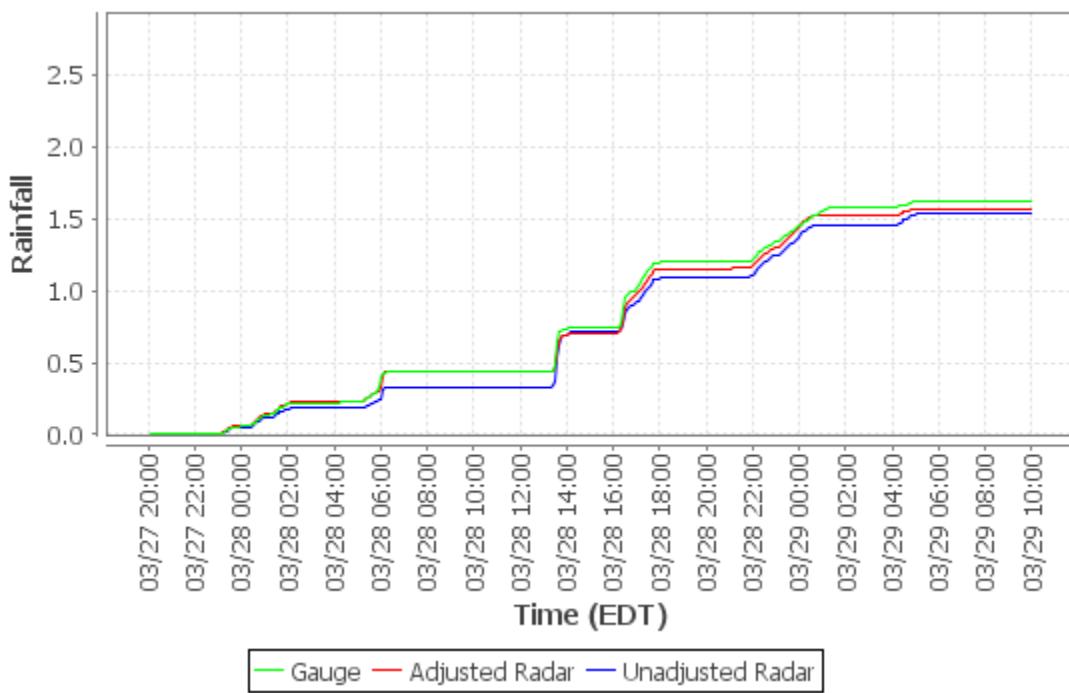
Cumulative Distribution Plot - PWSA-Montana St. (Loc01)



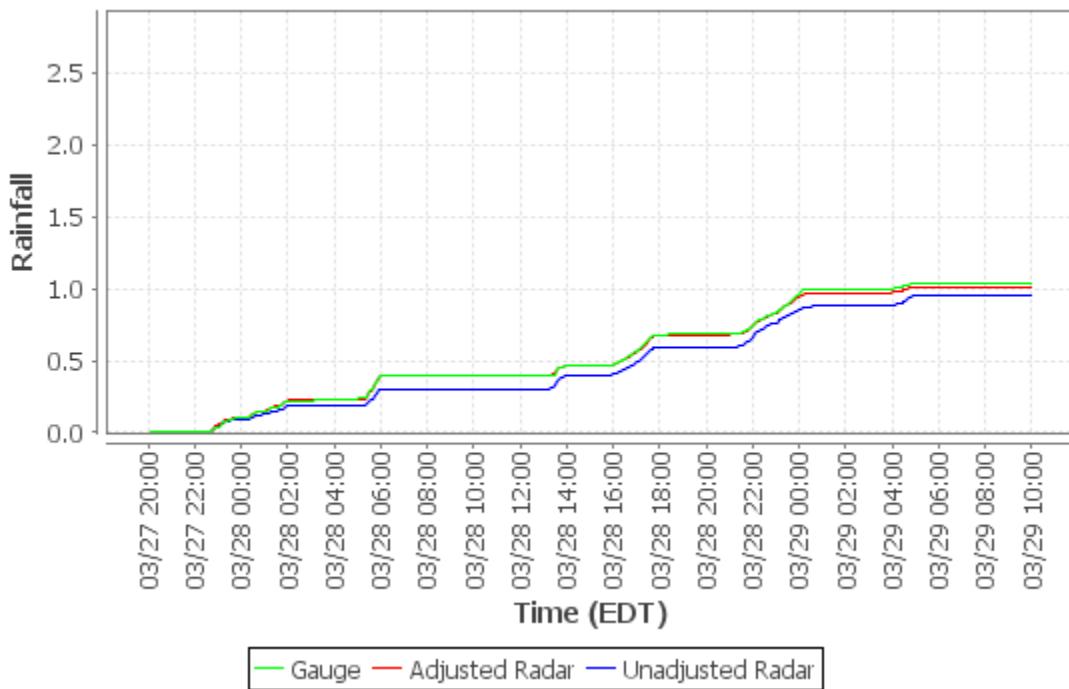
Cumulative Distribution Plot - ALCOSAN WWTP Lab (Loc02)



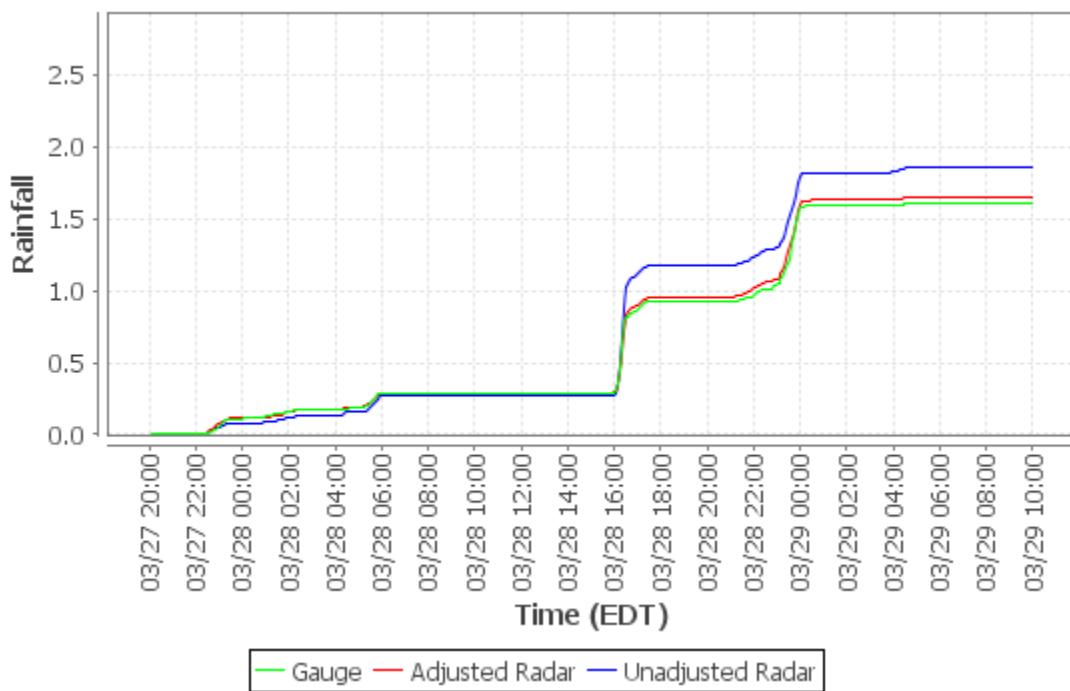
Cumulative Distribution Plot - Shaler Munic Bldg (Loc03)



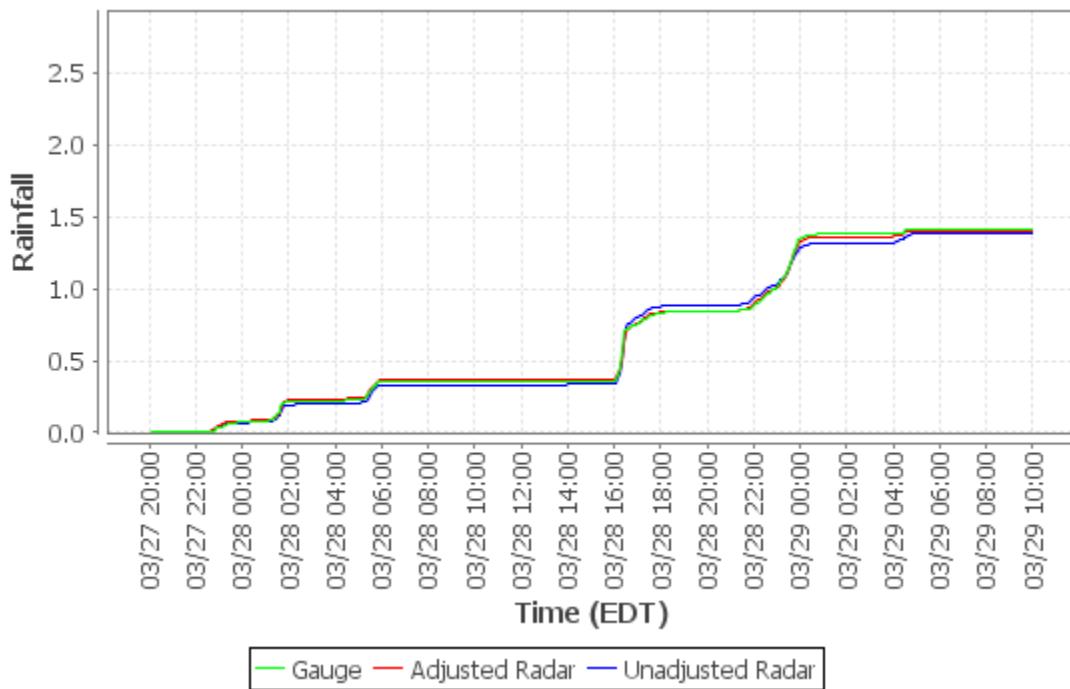
Cumulative Distribution Plot - Kennedy Twp PS (Loc04)



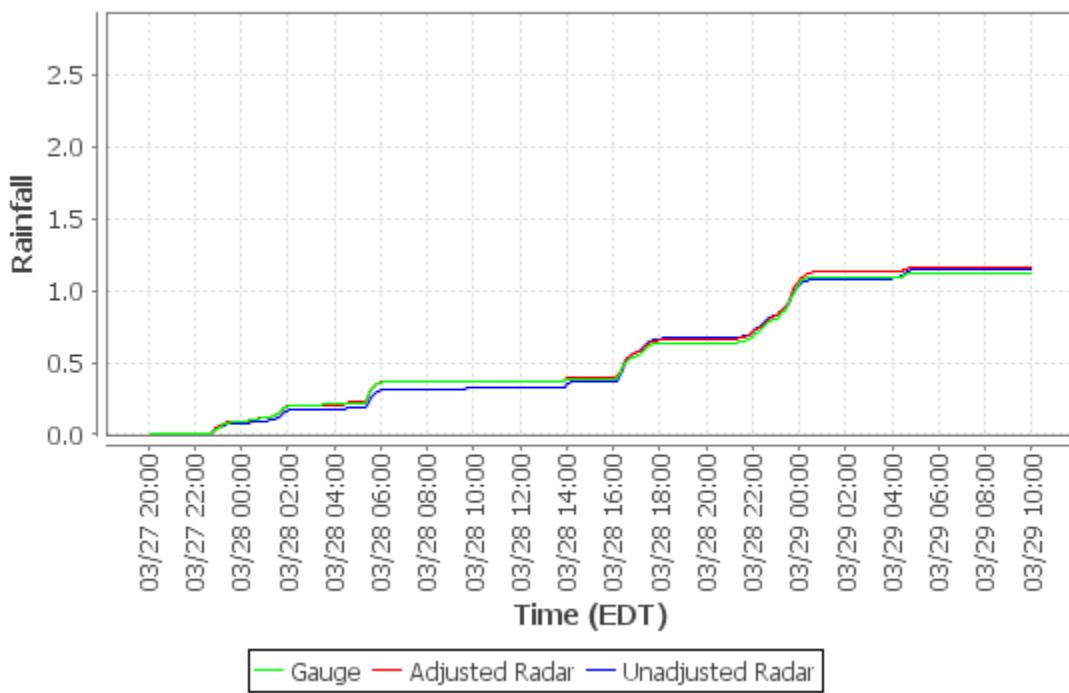
Cumulative Distribution Plot - Upper St. Clair (Loc05)



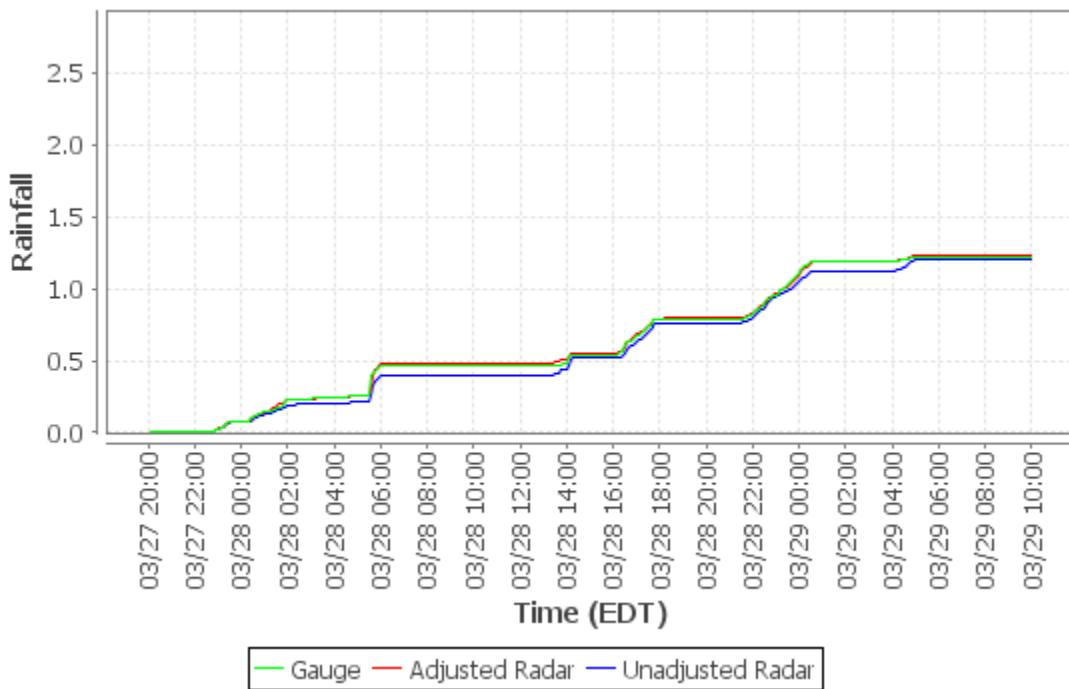
Cumulative Distribution Plot - Carnegie Transit Time (Loc06)



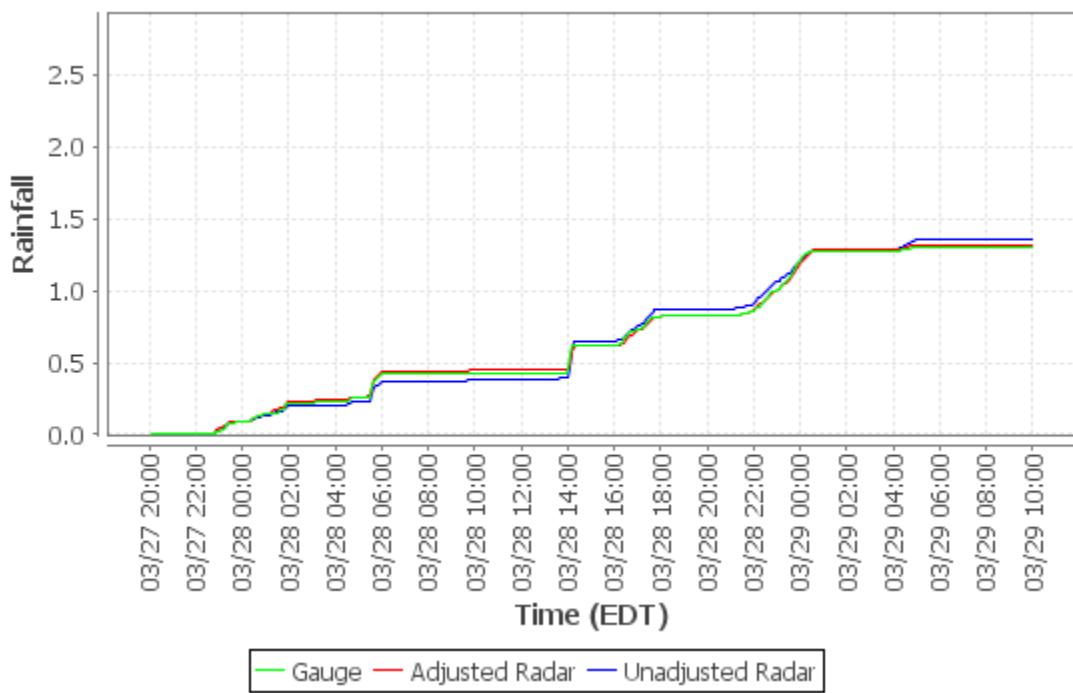
Cumulative Distribution Plot - Greentree Munic Bldg (Loc07)



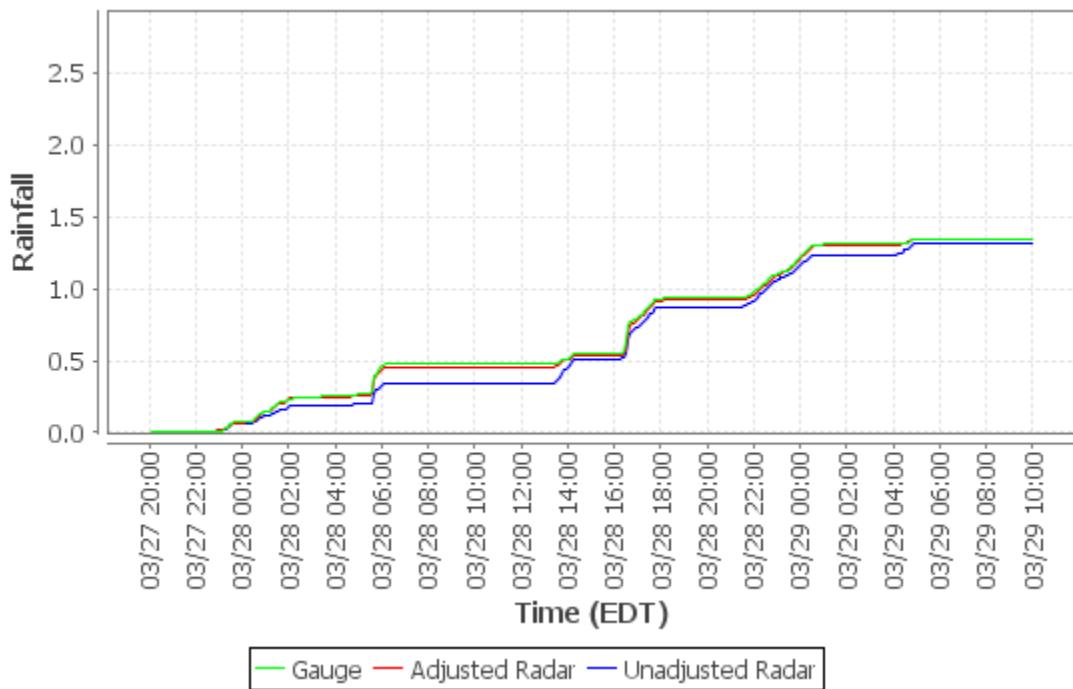
Cumulative Distribution Plot - AC Health Dept Bldg (Loc08)



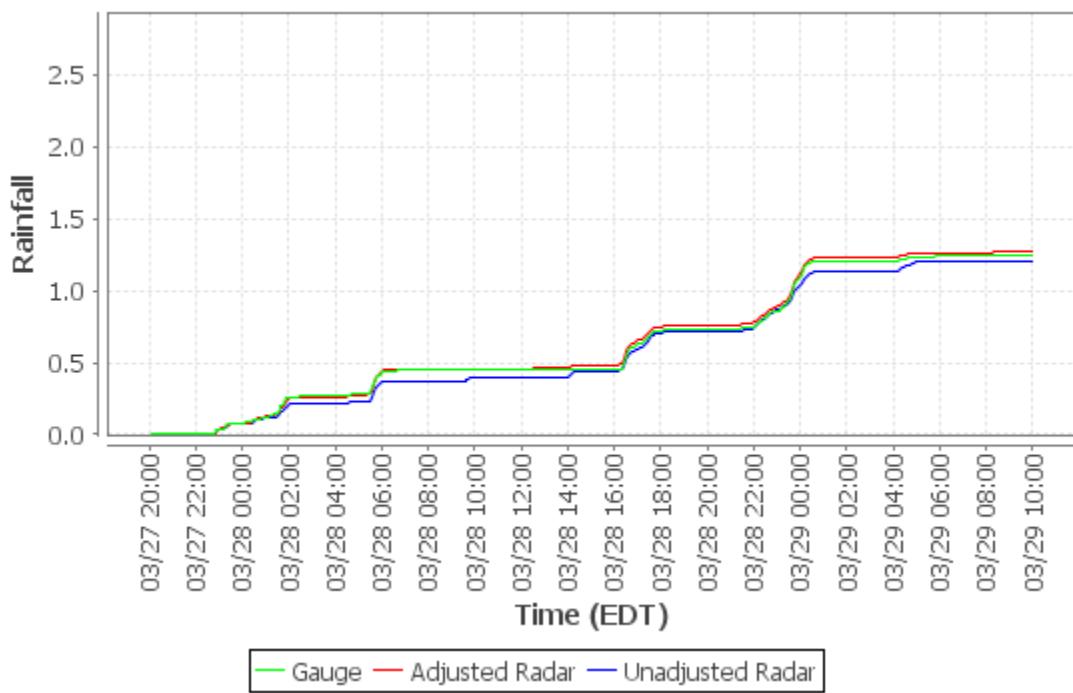
Cumulative Distribution Plot - Univ of Pittsburgh (Loc09)



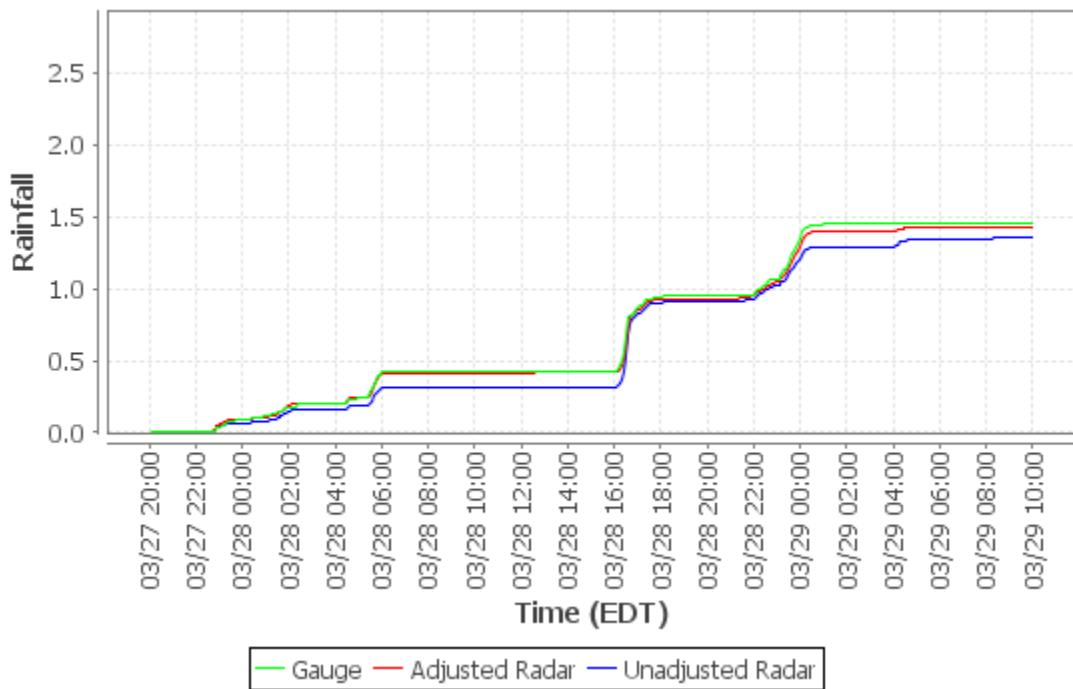
Cumulative Distribution Plot - PWSA-Highland Park (Loc10)



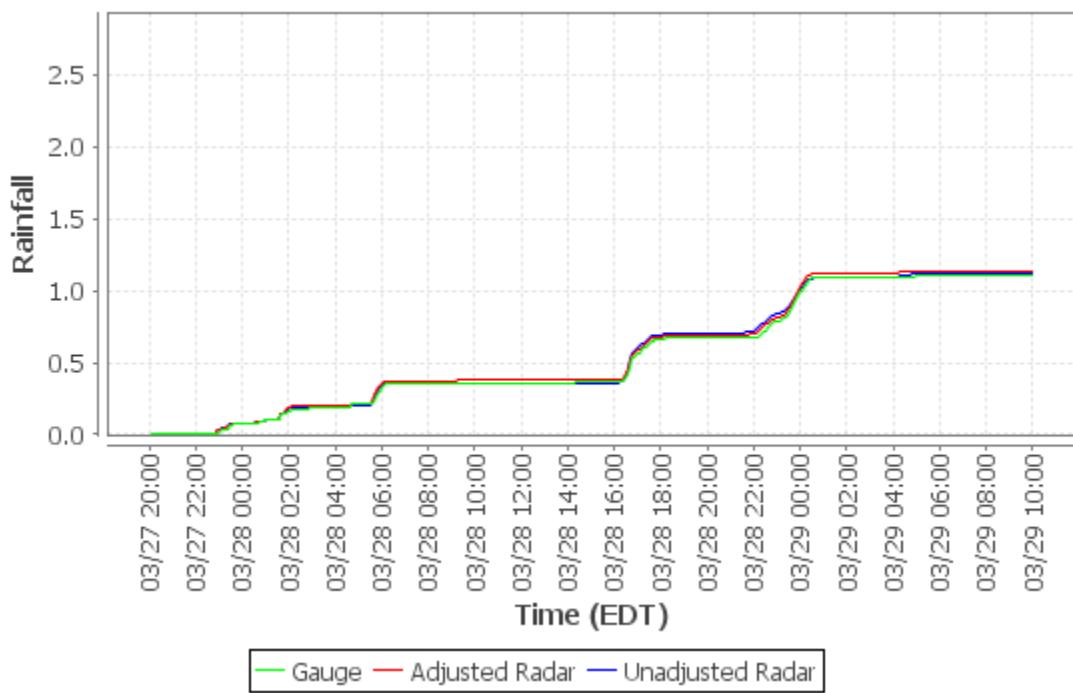
Cumulative Distribution Plot - M-46 Access Shaft (Loc11)



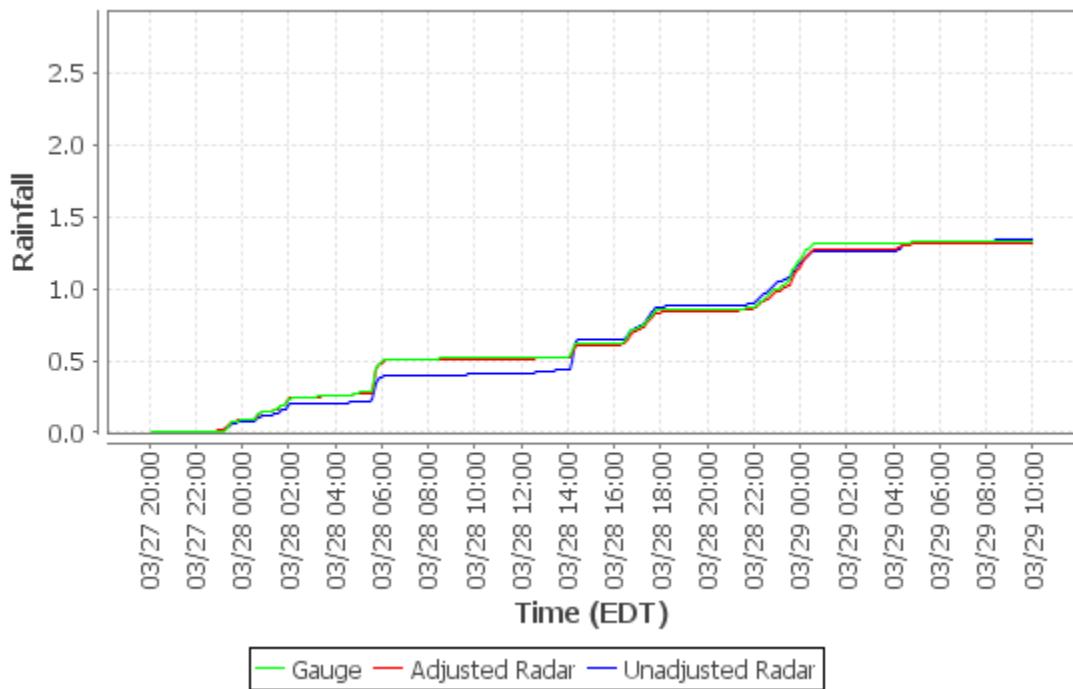
Cumulative Distribution Plot - Baldwin (Loc12)



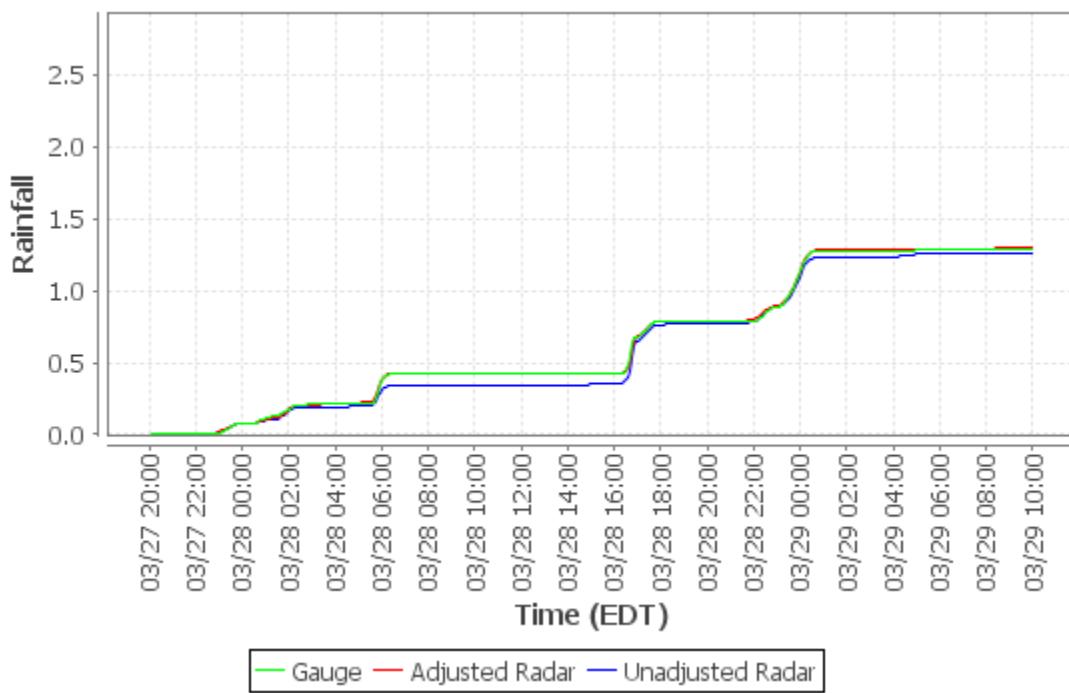
Cumulative Distribution Plot - M-59 Access Shaft (Loc13)



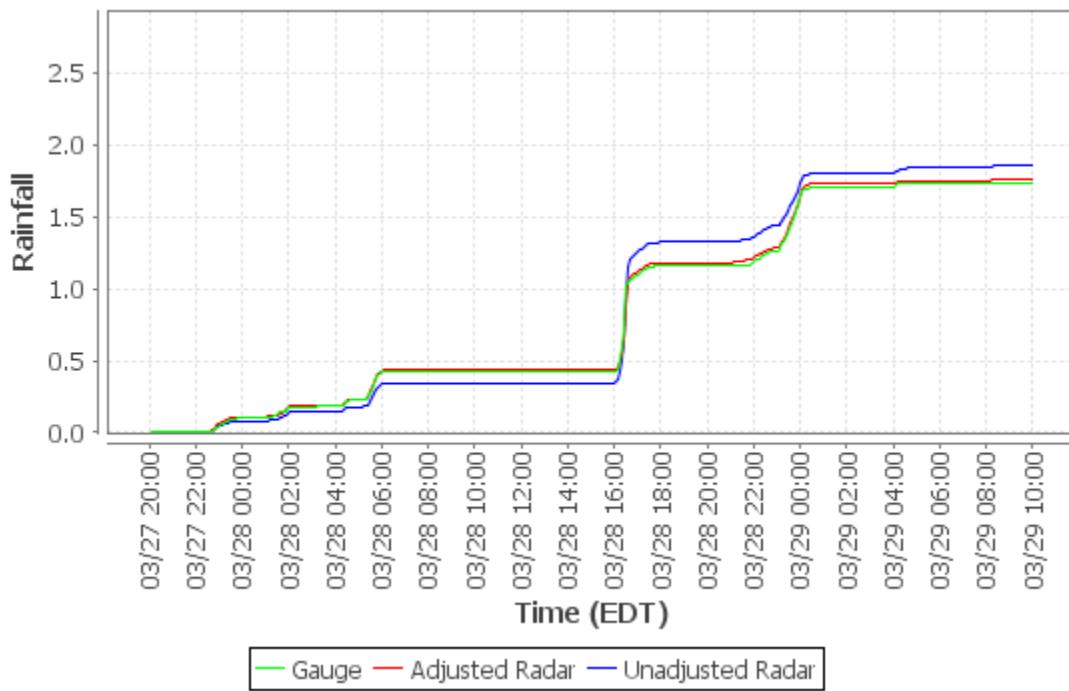
Cumulative Distribution Plot - Churchill Munic Bldg (Loc14)



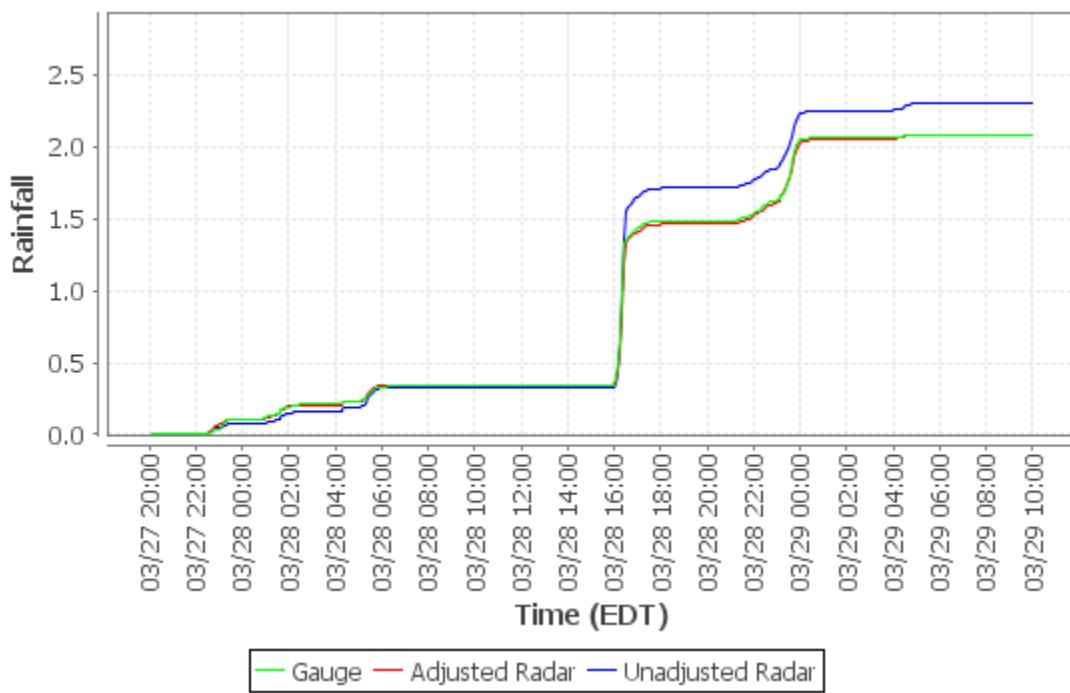
Cumulative Distribution Plot - Trafford Maint Bldg (Loc15)



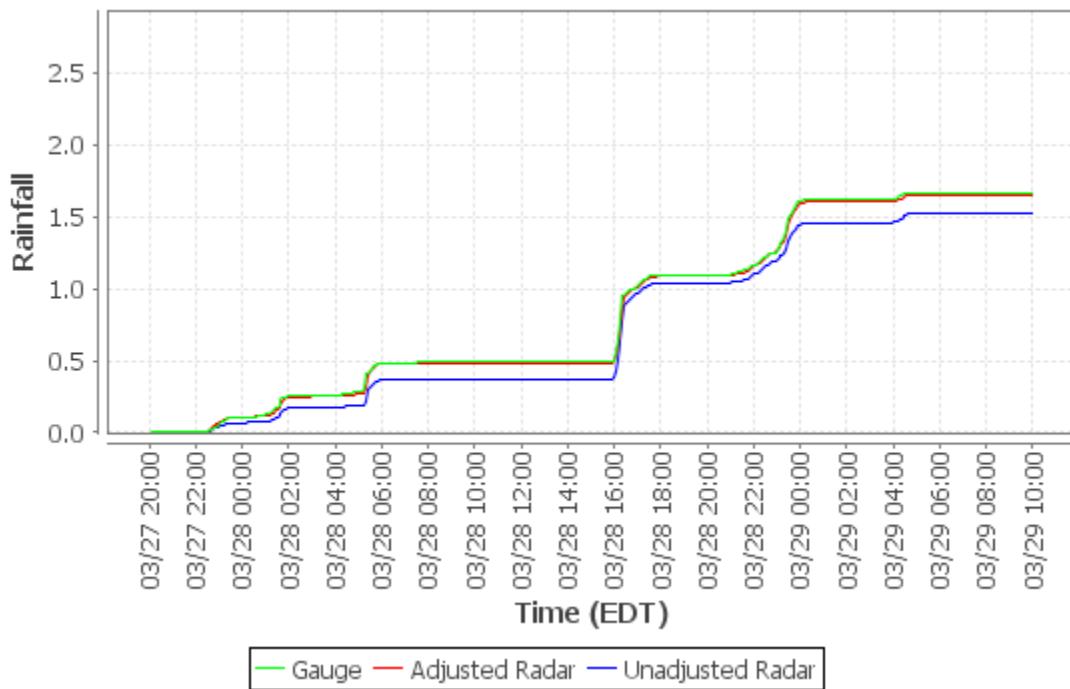
Cumulative Distribution Plot - Castle Shannon (Loc16)



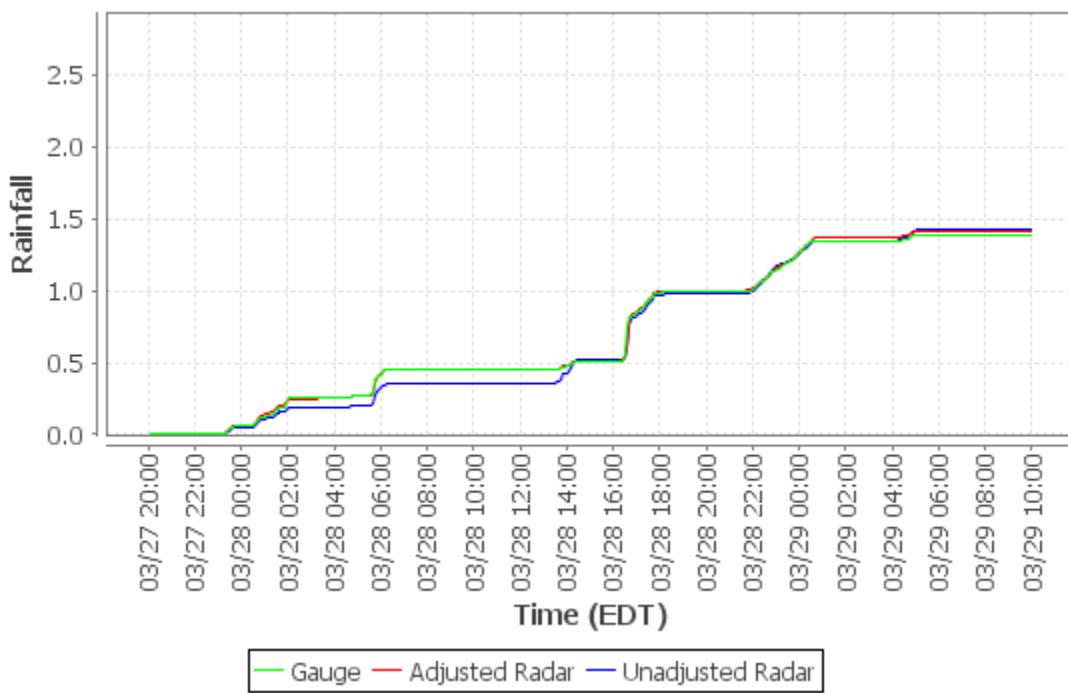
Cumulative Distribution Plot - Chartiers Pump Station (Loc17)



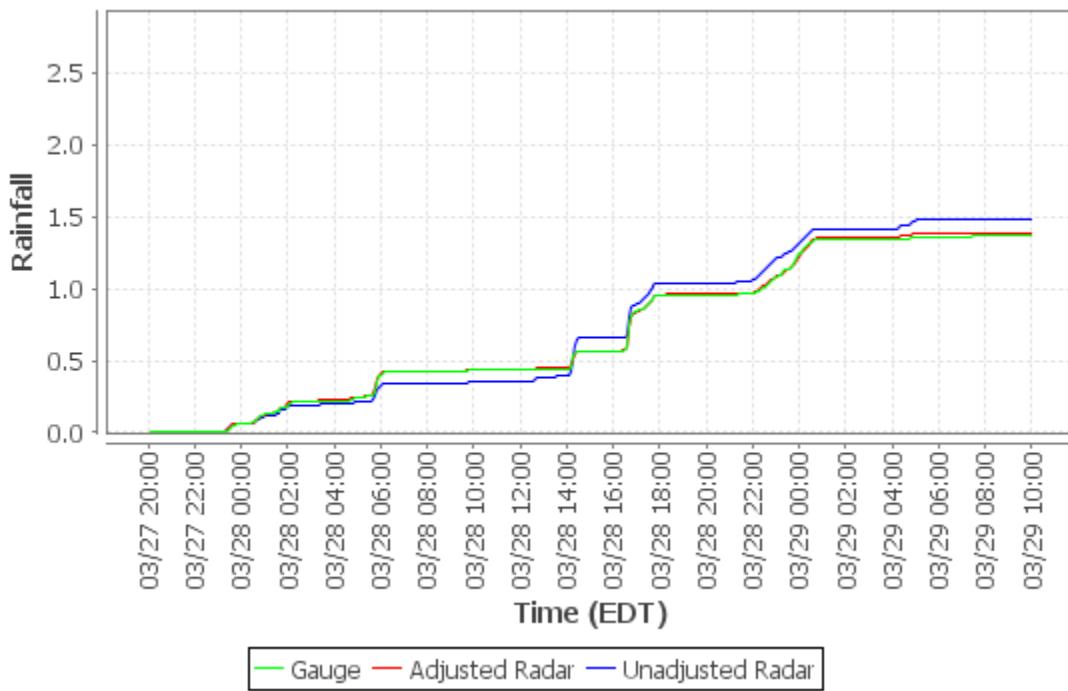
Cumulative Distribution Plot - Oakdale Pump Station (Loc18)



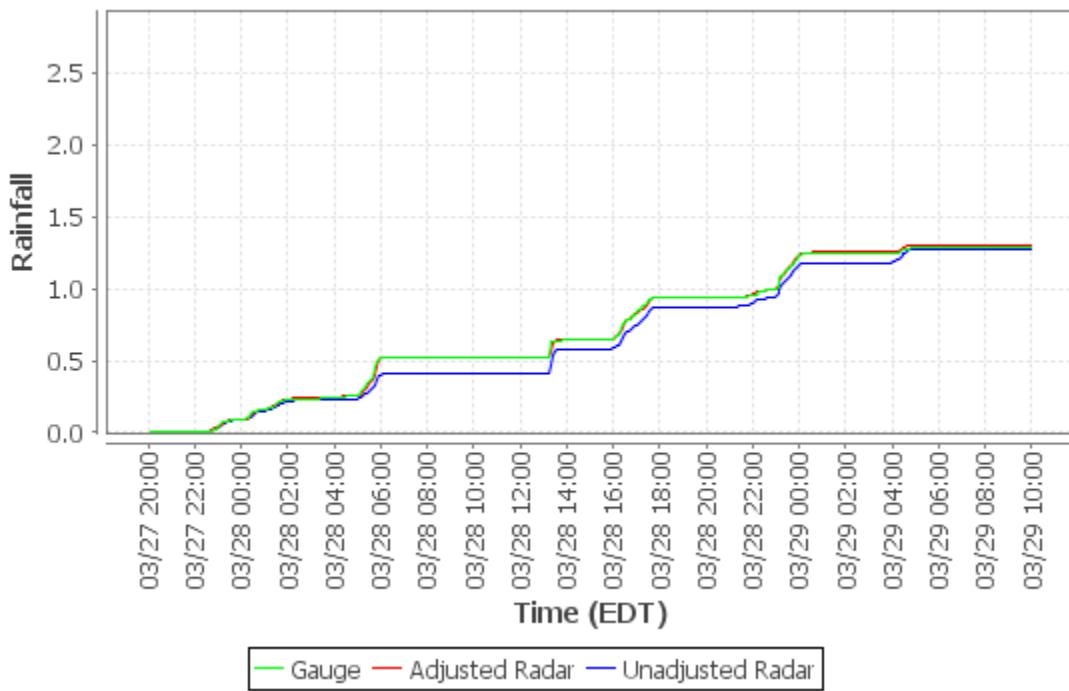
Cumulative Distribution Plot - Sandy Creek Eq Facility (Loc19)



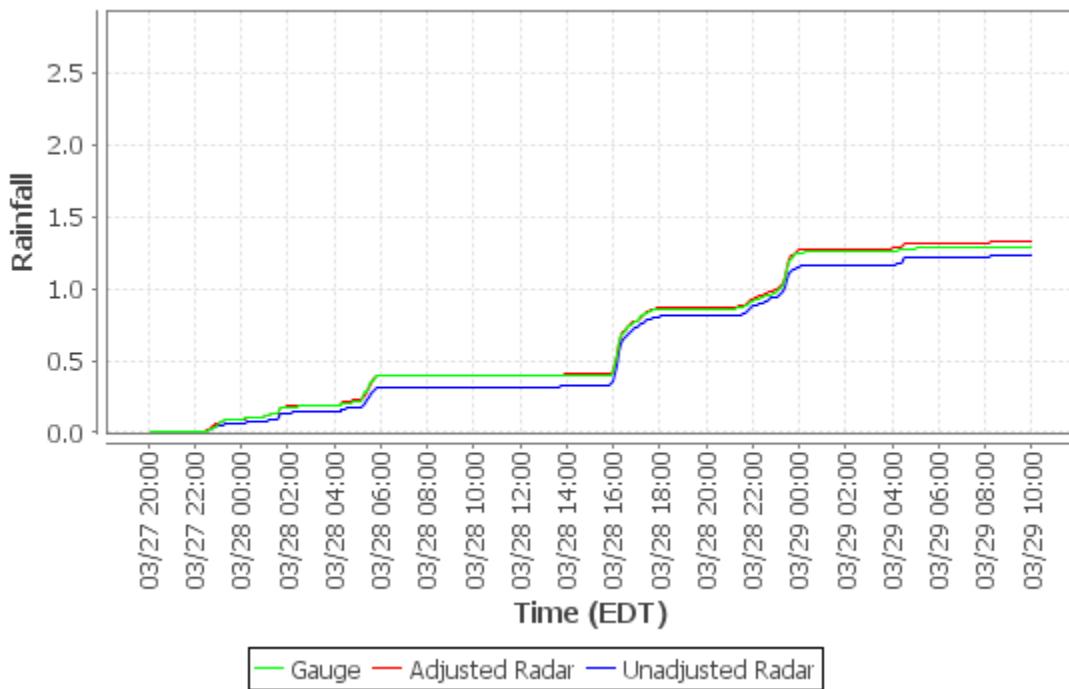
Cumulative Distribution Plot - Gascola Eq Facility (Loc20)



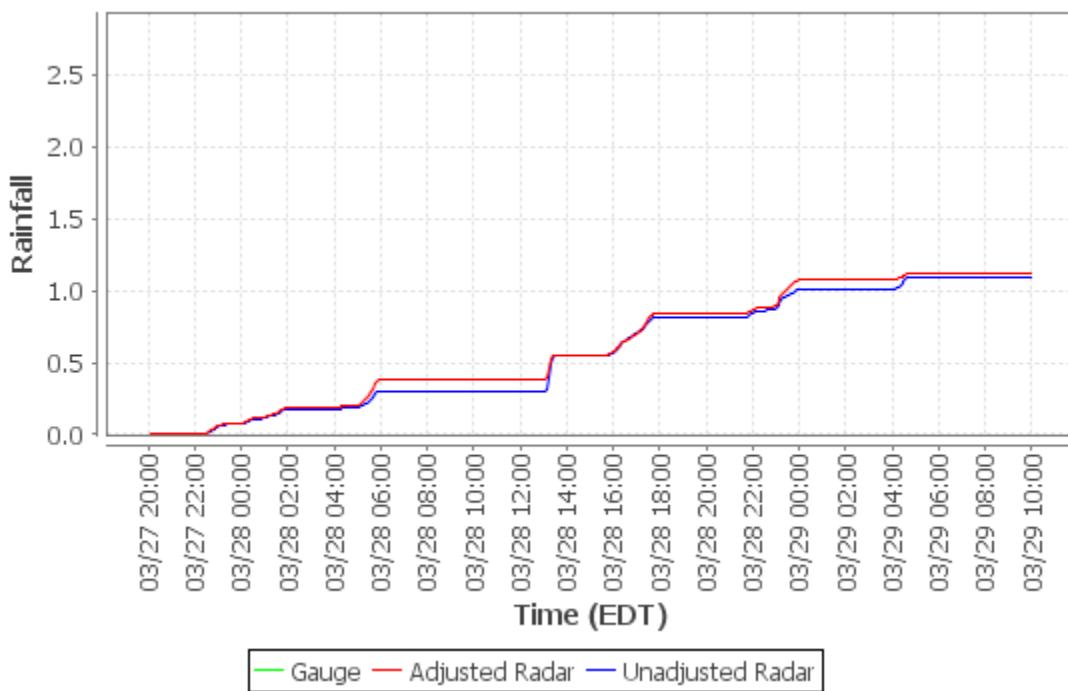
Cumulative Distribution Plot - Moon TWP (Loc21)



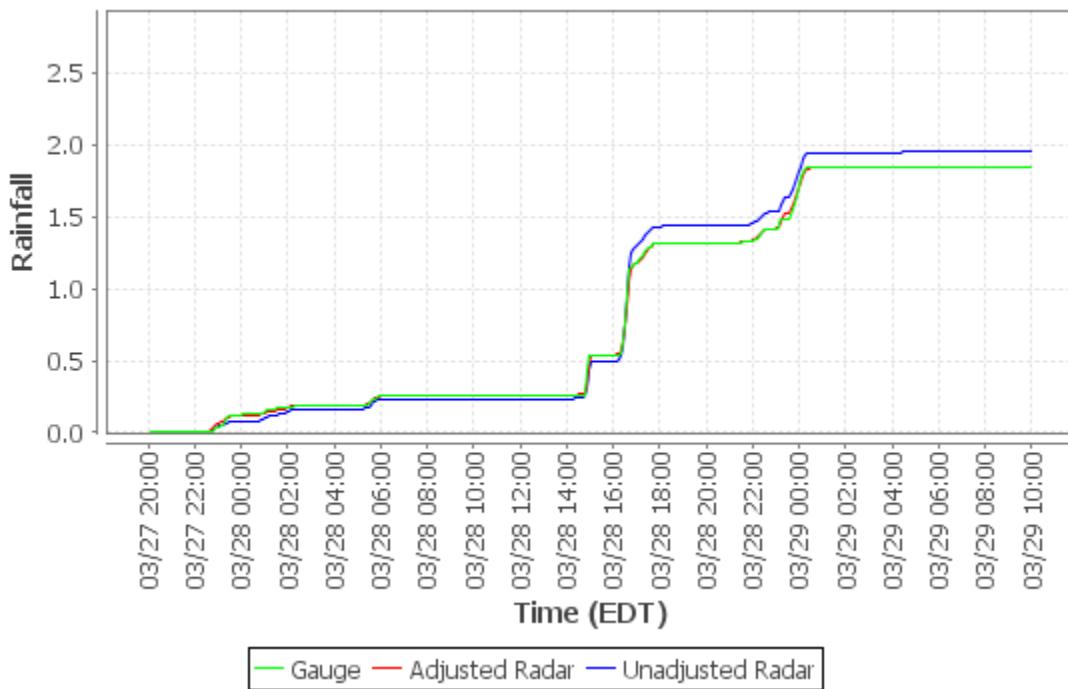
Cumulative Distribution Plot - North Fayette TWP (Loc22)



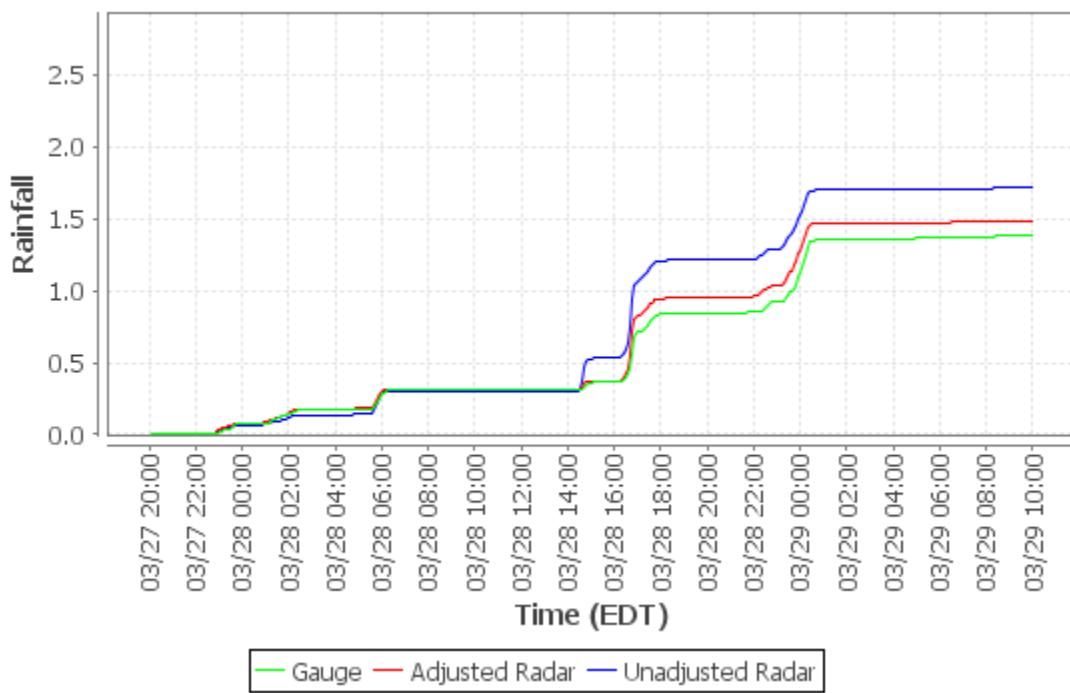
Cumulative Distribution Plot - Clinton Munic Bldg (Loc23)



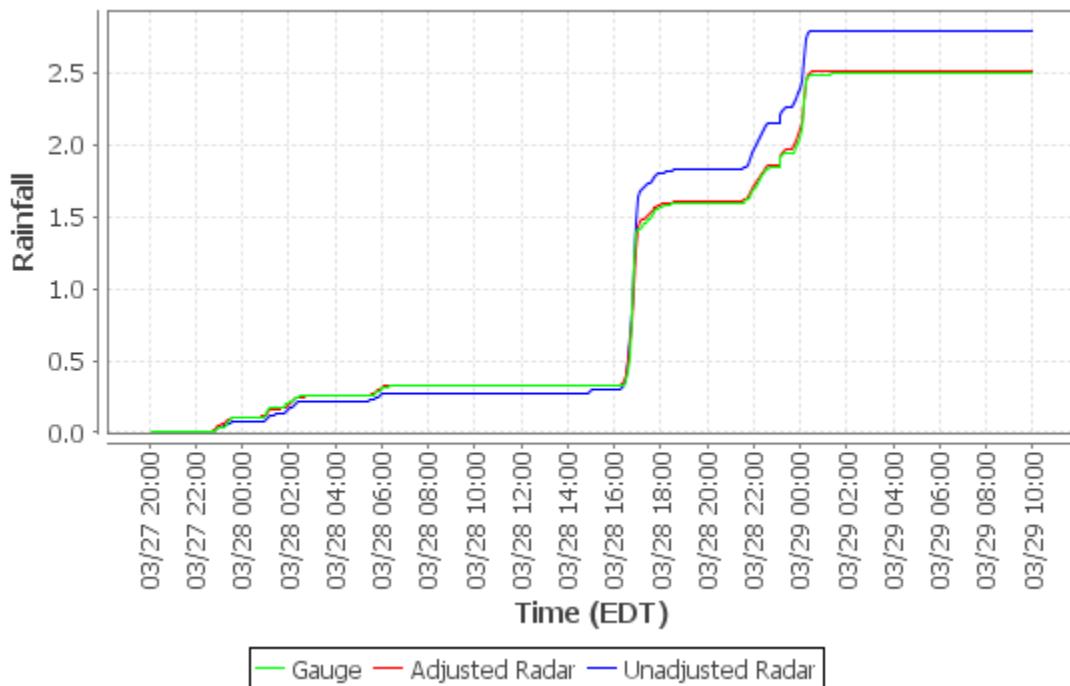
Cumulative Distribution Plot - Jefferson Hills (Loc24)



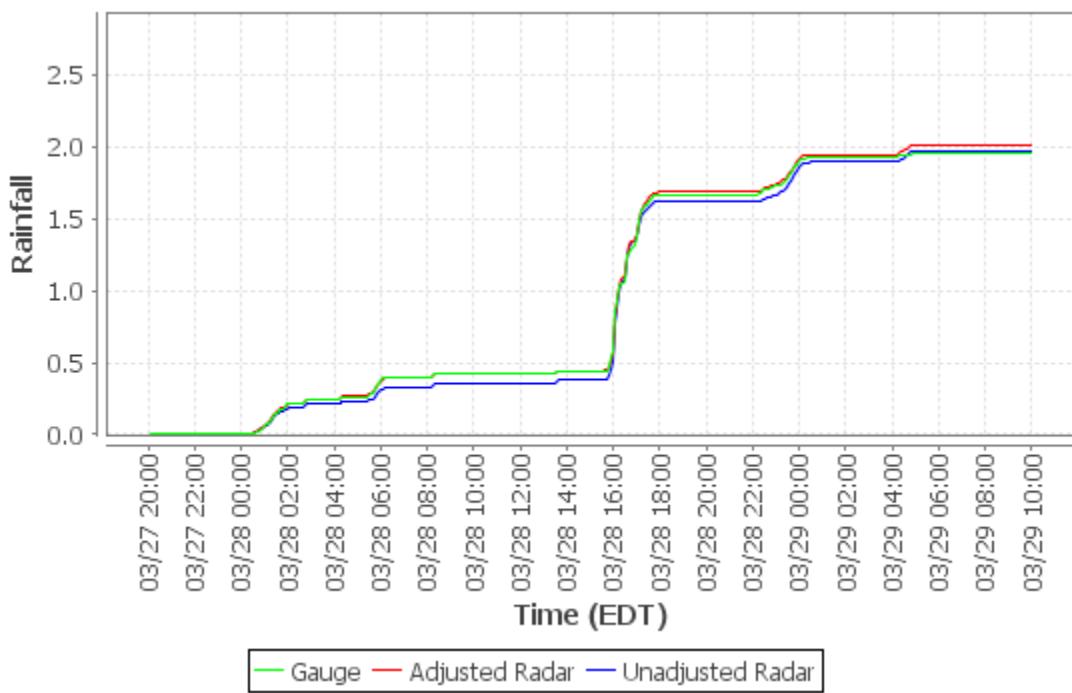
Cumulative Distribution Plot - White Oak Public Works Bldg (Loc25)



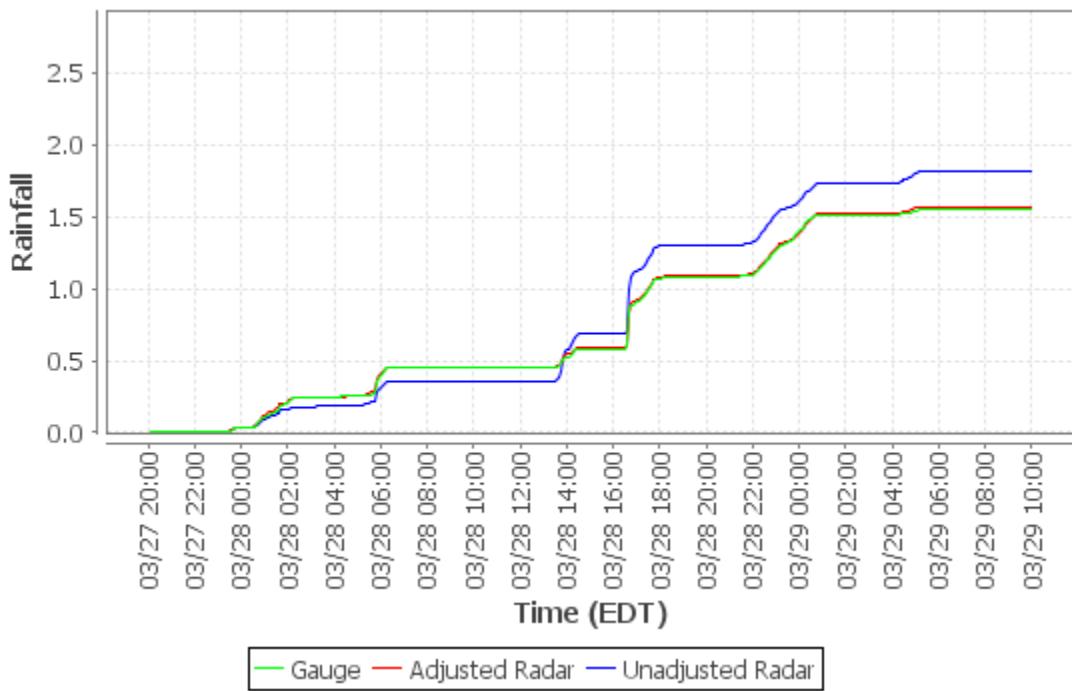
Cumulative Distribution Plot - Elizabeth TWP Municipal Bldg (Loc26)



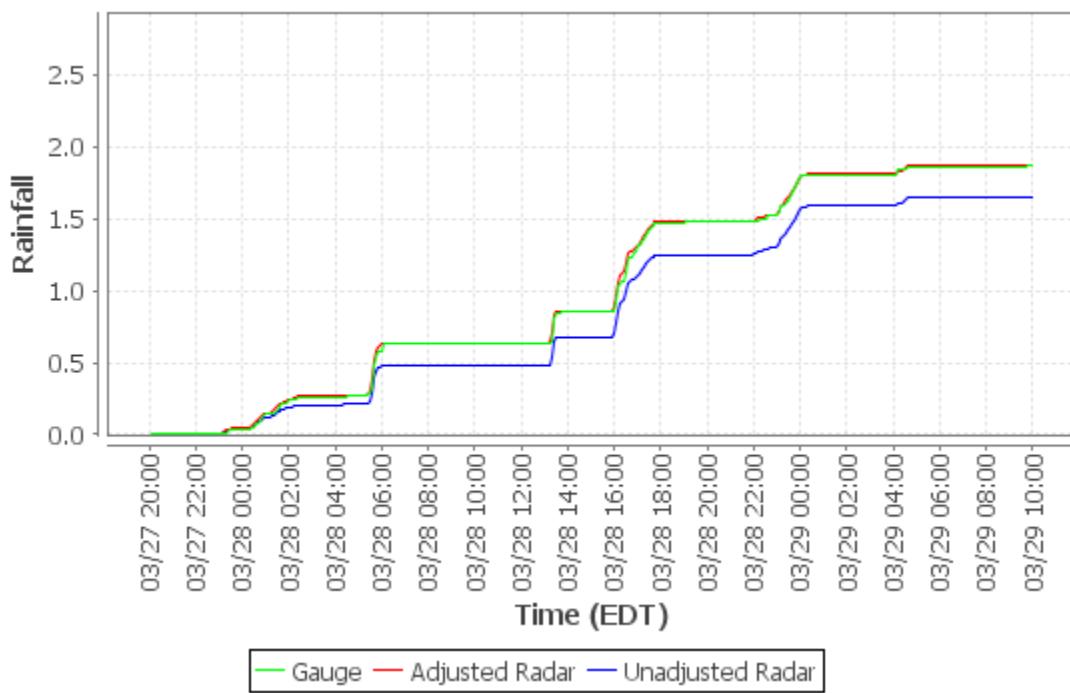
Cumulative Distribution Plot - Marshall TWP (Loc27)



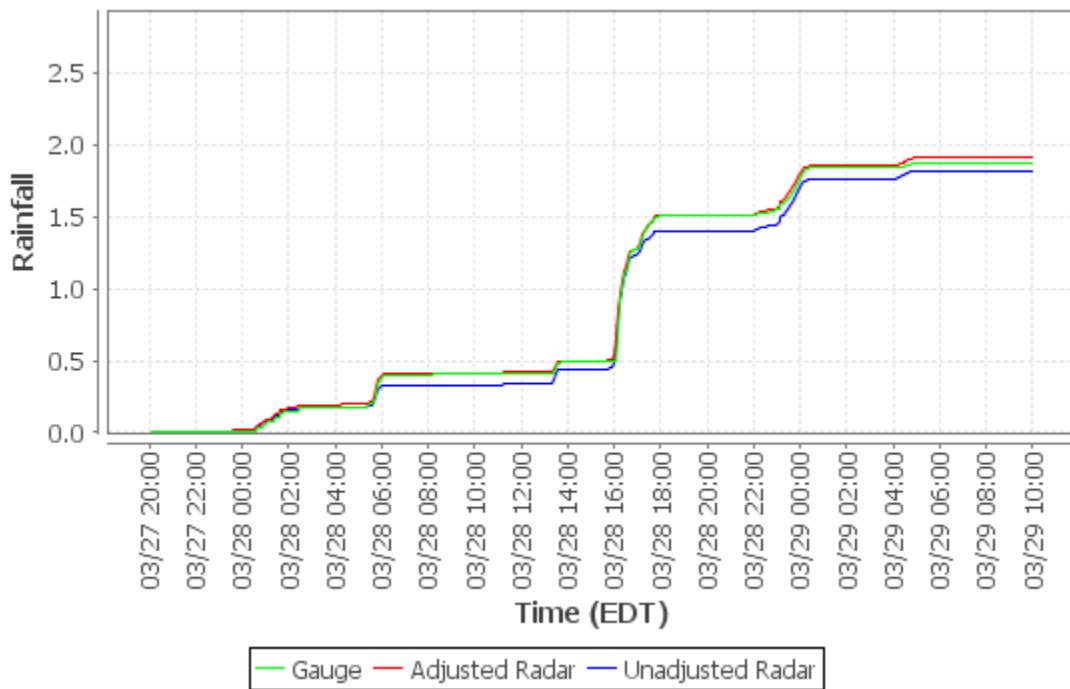
Cumulative Distribution Plot - Plum Municipal Bldg (Loc28)



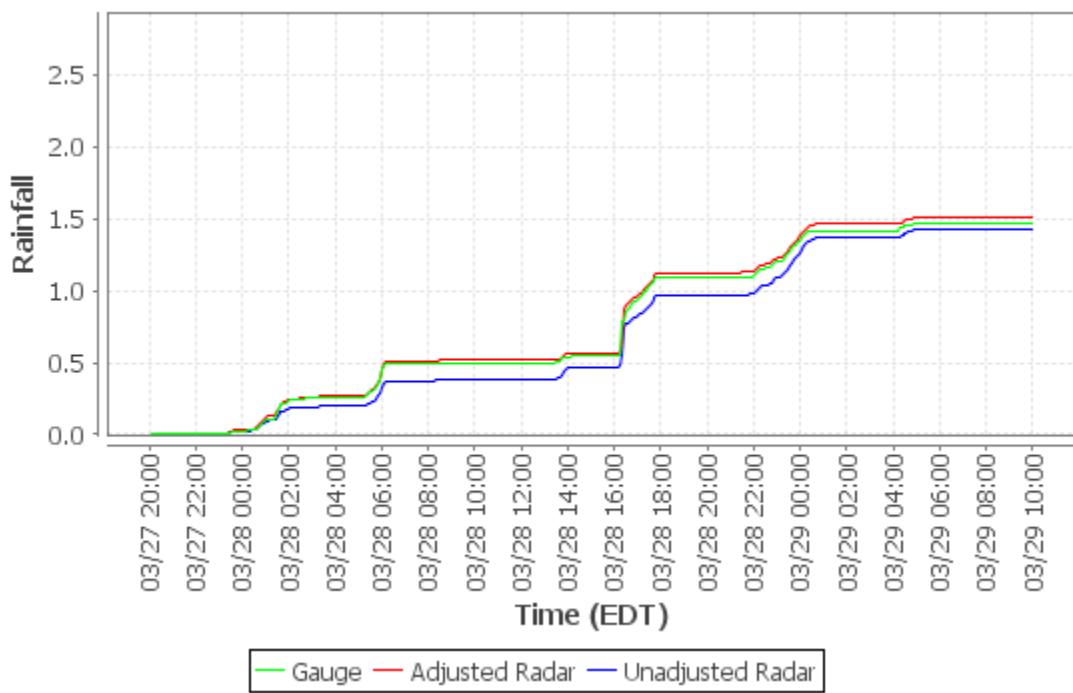
Cumulative Distribution Plot - Bell Acres Munic Bldg (Loc29)



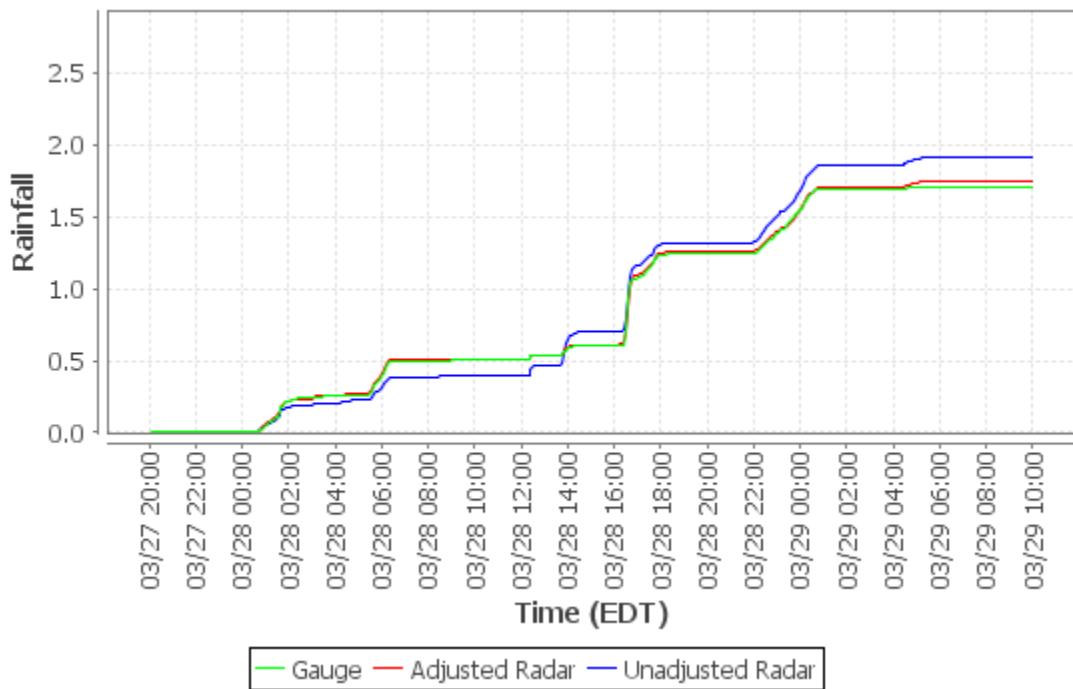
Cumulative Distribution Plot - McCandless Twn Hall (Loc30)



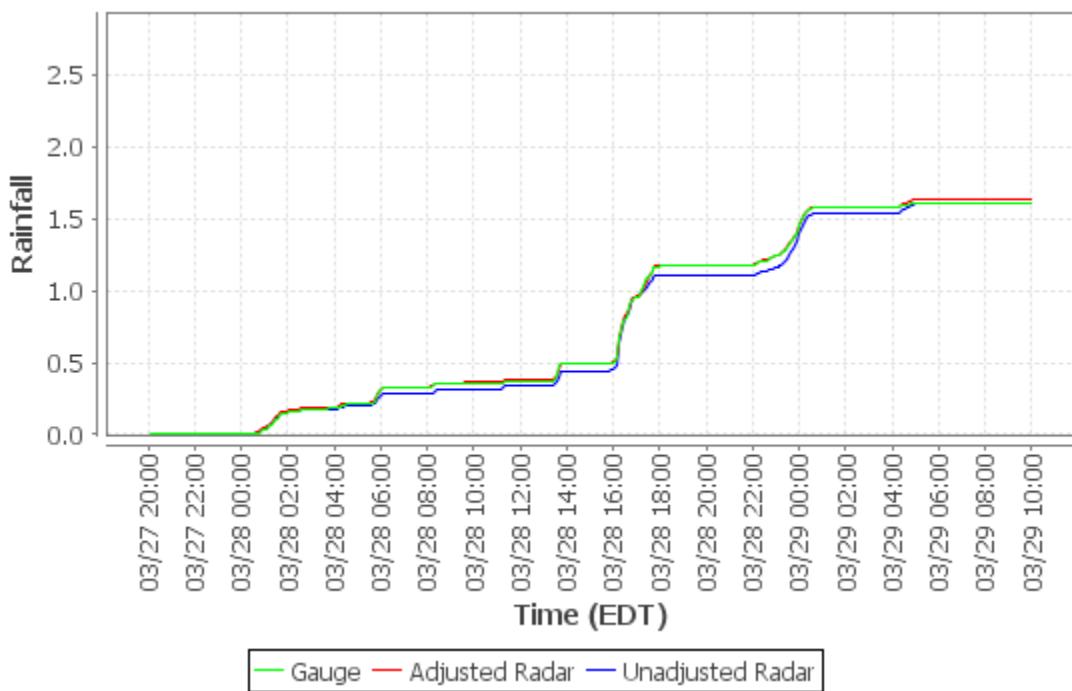
Cumulative Distribution Plot - Hampton Municipal Bldg (Loc31)



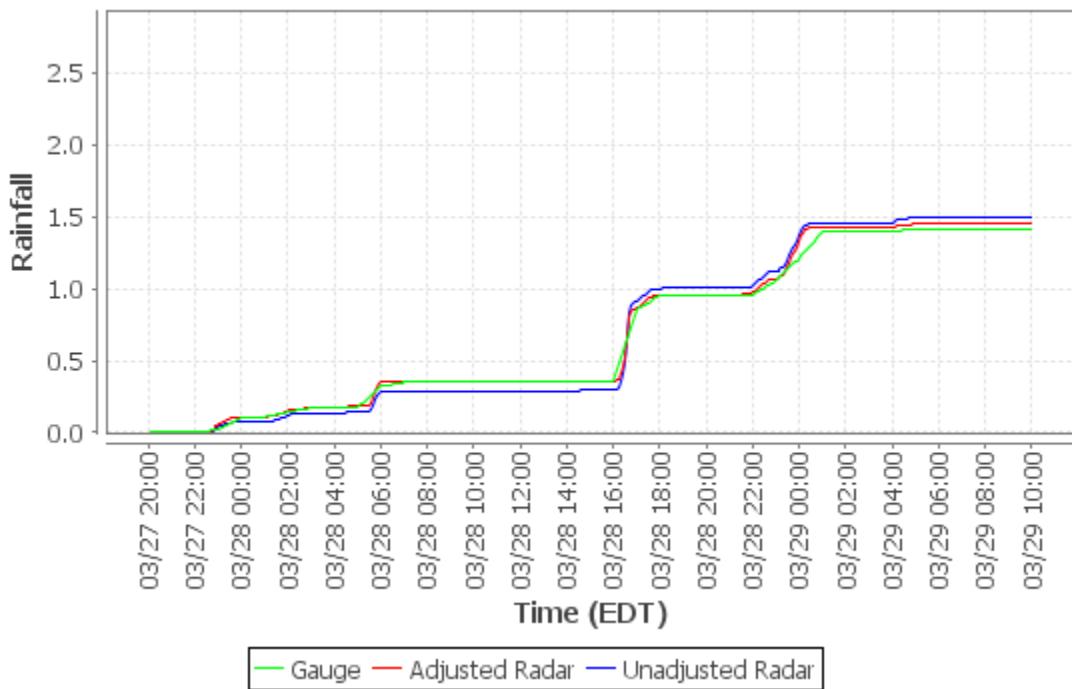
Cumulative Distribution Plot - Arnold (Loc32)



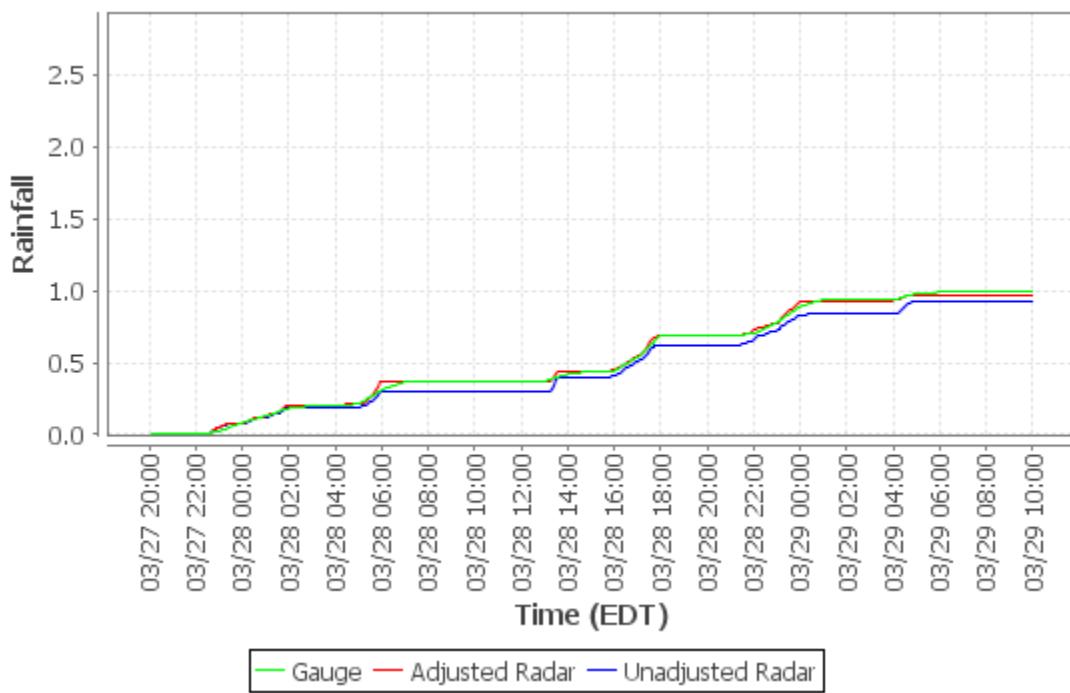
Cumulative Distribution Plot - Richland TWP (Loc33)



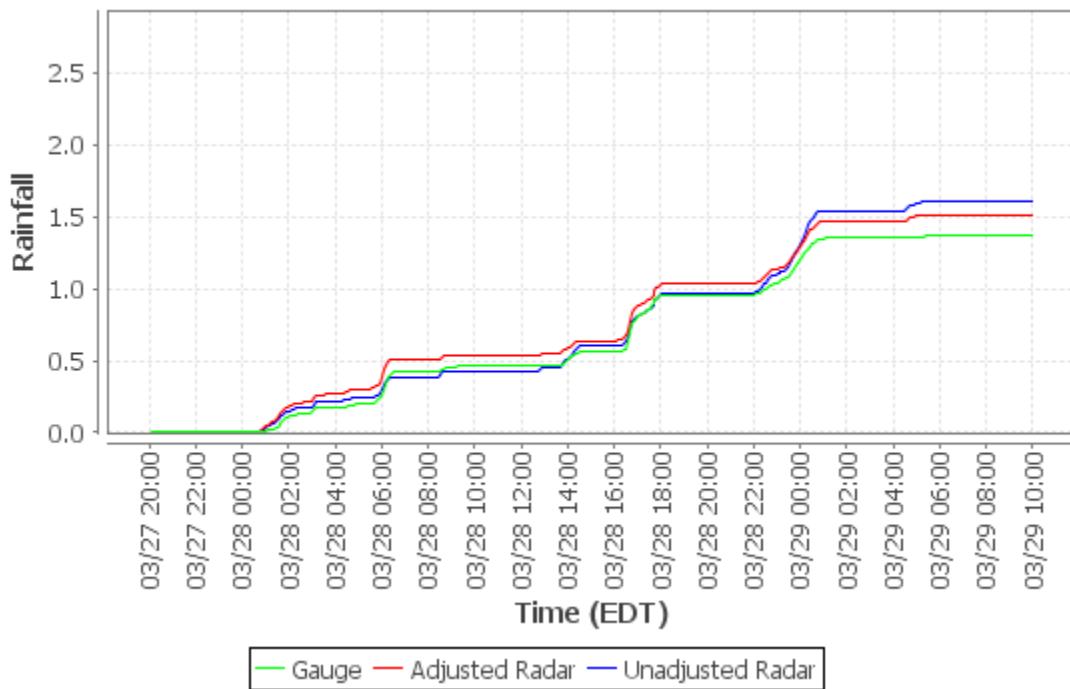
Cumulative Distribution Plot - Pittsburgh Allegheny Cty (KAGC)



Cumulative Distribution Plot - Greater Pittsburgh Int'l (KPIT)



Cumulative Distribution Plot - Allegheny River at Natrona (03049500)



**Cumulative Distribution Plot - Ohio River at Emsworth Dam Lower Pool at Emsworth
(03085734)**

