2018 RiverEyes Monitoring Report

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EXECUTIVE SUMMARY

AJAC Enterprises (AJAC) was contracted by the U.S. Bureau of Reclamation (Reclamation) to conduct daily river monitoring and reporting during 2018 as part of a cooperative interagency effort to document channel drying in the Middle Rio Grande (MRG). The monitoring effort verifies compliance with the 2016 Biological Opinion related to Reclamation, Bureau of Indian Affairs, and Non-Federal Water Management and Maintenance Activities on the Middle Rio Grande, specifically Reasonable and Prudent Measure 4, and Terms and Conditions 3.2, 9.1 and 9.2. Field reconnaissance observations were relayed to an interagency water management team and, particularly when channel intermittency was detected; reported to the U.S. Fish and Wildlife Service (USFWS) to support endangered Rio Grande Silvery Minnow (*Hybognathus amarus*) rescue and relocation activities. GeoSystems Analysis, Inc. (GSA) was subcontracted by AJAC to assist with project reporting and provide training and technical support on the project.

The U.S. Geological Service (USGS) maintains a large network of stream flow monitoring stations throughout the MRG that publish real-time, provisional streamflow volumes to the internet (e.g. https://waterdata.usgs.gov/nm/nwis/current/?type=flow). Field reconnaissance within specific segments of the MRG is contractually required when reported flows are below 300 cubic feet per second (cfs) at the USGS gage near San Acacia, New Mexico (NM; 08354900), and/or below 80 cfs at the Bosque Farms, NM, gage (08331160). During 2018, stream flows fell below these thresholds beginning in late-March. From this point forward, the monitoring team closely tracked current flow conditions at the San Acacia and Bosque Farms gages through late-October, and field reconnaissance was completed on a near daily basis during this period.

Flow interruption and drying occurred in the Isleta and San Acacia Reaches of the MRG during the spring, summer, and fall of 2018. Multiple segments of each reach were affected by drying (two segments of the Isleta Reach and three segments of the San Acacia Reach). Drying was first observed in the San Acacia Reach on April 1, 2018 and the Isleta Reach first dried on May 31, 2018. The total number of unique river miles (RM) affected by drying was 45.69, or 37.9 RM in the San Acacia Reach and 7.79 in the Isleta Reach, respectively. Field crews detected drying during 184 days of the monitoring season. Per reach, there were 74 days with river drying in the Isleta Reach and 179 days in the San Acacia Reach.

INTRODUCTION

Channel drying has been actively monitored since 1996. The monitoring effort became more formal in 2002 when SS Papadopulos and Associates, Inc. (SSPA) mapped channel intermittency under contract with New Mexico Interstate Stream Commission. Monitoring and reporting channel drying became formally mandated in 2003 (USFWS 2003) and the recently issued MRG water operations and maintenance Biological Opinion (USFWS 2016) reemphasizes the negative impact of channel drying on sensitive species conservation efforts. The intermittency monitoring program, known as “RiverEyes”, reports current flow conditions, drying events, and extent of affected river reaches each day to facilitate coordination among water management

agencies to prevent unexpected drying and/or slow the rate of drying to alleviate negative impacts on federally threatened and endangered fish and wildlife species. Amongst the species of concern, channel drying has the most direct effect on the Rio Grande Silvery Minnow (*Hybognathus amarus*; Silvery Minnow).

In addition to informing water management decisions, daily drying observations also assist U.S. Fish and Wildlife Service (USFWS) Silvery Minnow rescue crews with assessing rescue need and timing, and prioritizing salvage locations. Early detection and rapid rescue response are crucial because studies have shown that remnant pools created during flow intermittency frequently dry within 48 hours (USFWS 2016 and Smith 1999). Also, fish trapped in more persistent pools have been found not to survive past 48 hours due to elevated temperatures, predation, and poor water quality (USFWS 2016 and Smith 1999).

Channel drying has previously concentrated in two reaches of the Rio Grande – Isleta and San Acacia (SWCA 2015). Here, the Isleta Reach refers to the MRG segment that stretches from the Isleta Diversion Dam on Pueblo of Isleta land south of Albuquerque to the San Acacia Diversion Dam (see Figure 1). The San Acacia Reach lies downstream of the Isleta Reach and extends from the San Acacia Diversion Dam to Elephant Butte Reservoir. On average, drying is more frequent, extensive, and of longer duration in the San Acacia Reach than the Isleta Reach (Table 1).

Per USFWS 2016 and based on RiverEyes project data collected since then, an average of 32 miles of the Rio Grande has dried each year from 2001 to 2017. Based on previous RiverEyes project observations, approximate river mile (RM) segments with highest drying probability are as follows (per USFWS 2016 and various SWCA RiverEyes reports, e.g. SWCA 2015). Note that Appendix D includes a table showing specific RM locations for landmarks mentioned in this report and throughout the 2018 monitoring season.

Isleta Reach --- Two segments:

1. A section near Tomé, NM, approximately between the Los Chavez Wasteway and the Peralta Wasteway (approximately RM 150 to 155)
2. Downstream near the Abeytas Heading above U.S. Highway 60 Bridge in Bernardo, NM (approximately RM 127 to 132).

San Acacia Reach --- One segment from near Brown Arroyo (Socorro, NM) downstream to the pump site near the BDA south boundary (this segment extends from RM 74 to 105). However, during 2018, it also became necessary to monitor from the south boundary pump site down to the Low Flow Conveyance Channel (LFCC) return channel (at approximately RM 54.5) when the supplemental pumping operation stopped due to insufficient flow in the LFCC. A summary of 2018 pumping operations is shown in Appendix C.

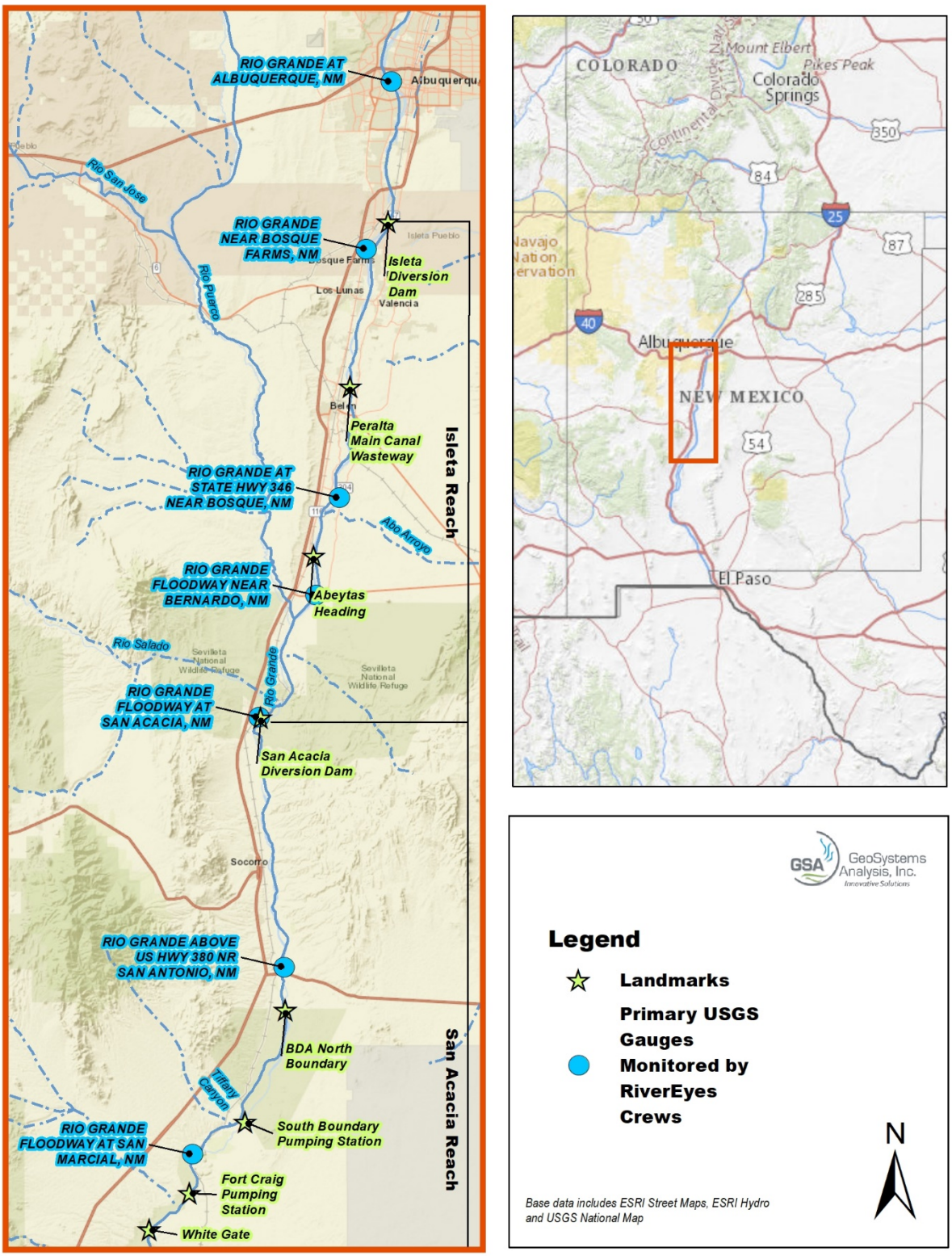

Figure 1. Map showing the location of Isleta and San Acacia Reaches of the Middle Rio Grande plus other landmarks mentioned in this report.

Through the 2018 monitoring period, Reclamation contracted AJAC Enterprises to complete the RiverEyes project and AJAC sub-contracted GSA to provide technical support, assist with finding qualified field staff, train AJAC field crews, assist with daily reporting, manage data, and develop this annual report. The report sections that follow present the field methods and monitoring results from this season.

Table 1. Total number of river miles affected by drying in the Isleta and San Acacia Reaches (adapted and expanded from USFWS 2016)

	Isleta		**San Acacia**		**Combined**	
	53 Miles		58.5 Miles		111.5 Miles	
Year	Miles	Percent	Miles	Percent	Miles	Percent
2001	0	0	7	12	7	6.3
2002	18.2	34.3	25	42.7	43.2	38.7
2003	30	56.6	40	68.4	70	62.8
2004	31	58.5	37	63.2	68	61
2005	4	7.5	24.5	41.9	28.5	25.6
2006	9.5	17.9	16.5	28.2	26	23.3
2007	9.5	17.9	20.5	35	30	26.9
2008	0	0	0	0	0	0
2009	0	0	20	34.2	20	17.9
2010	8.5	16	19.7	33.7	28.2	25.3
2011	12.9	24.3	27.1	46.3	40	35.9
2012	19.2	36.2	31.8	54.4	51	45.7
2013	9.7	18.3	26.8	45.8	36.5	32.7
2014	3.3	6.2	23.1	39.5	16.4	23.7
2015	6.4	12.1	13.2	22.6	19.6	17.6
2016	10	18.9	20	34.2	30	26.9
2017	2.4	4.5	21.3	36.4	23.7	21.3
2018	7.8	14.7	37.9	64.8	45.7	41.0

METHODS

Daily Reconnaissance

Daily reconnaissance and reporting of locations affected by channel drying was conducted by field crews when provisional flow reported on the USGS real-time streamflow website (https://waterdata.usgs.gov/nm/nwis/current/?type=flow) was below specific discharge thresholds. Field reconnaissance was completed in the Isleta Reach whenever the USGS reported less than 80 cubic feet per second (cfs) at the Bosque Farms gage (Station 08331160). Reconnaissance of the San Acacia Reach occurred whenever the San Acacia gage (Station 08354900) was less than 300 cfs. Field staff also periodically checked flow conditions on days when the reported discharge exceeded those levels if 1) requested by Reclamation, 2) drying had been detected during the previous couple days, 3) recent field observations suggested that channel separation was highly possible, or 4) gage readings on the USGS website were suspect.

Field crews drove the riverbed through the survey reaches with an all-terrain vehicle (ATV) when channel conditions allowed. Mud, deep water, high flow velocity, obstructed riverbed access due to steep banks or dense vegetation, and/or quick-sand often prompted monitoring via foot. Reconnaissance began at daybreak, so observations could be relayed to agencies early enough (before 8 A.M. whenever possible) to inform water operational adjustments and daily fish rescue activities. If drying was detected, affected extents were communicated via text messages circulated to pre-designated Reclamation staff and the USFWS Fish Rescue Coordinator. A more comprehensive email summary was also sent on most days during the monitoring period.

To ensure safety, reporting accuracy, and consistency between field observers; field staff also regularly conveyed observations during internal team (AJAC/GSA) phone calls. A RiverEyes team member also participated in regular water operations conference calls (generally Monday, Wednesday, and Friday) to communicate the primary field observations from that morning, including dried extent, and listen to proposed water operational changes.

Reconnaissance observations were documented in the field on an iPad tablet connected with a Bluetooth Global Positioning System (GPS; Garmin Glo, consistently ~5-foot accuracy). Field proximity was determined to the nearest 0.01 river mile using a spatially-referenced .pdf base map accessed via Avenza Maps (https://www.avenza.com/avenza-maps/). To enable placement to this precision, we utilized various utilities and addons to ESRI ArcMap to clean and re-segment the 2012 Reclamation RM Geographic Information System (GIS) file into symbolized half-mile, tenths, and hundredths of a mile on the electronic field map (Figure 2).

River segments with a historically high probability for drying were denoted on the electronic field map with a red-colored river centerline to assist field staff with targeting “hot spots” to check during low flow conditions. The map also displayed adjacent land ownership, irrigation infrastructure, landmarks, wasteways, and interior drains that frequently contribute supplemental water, municipalities, arroyos, Reclamation range lines, roads, streamflow gages,

important river access locations, etc. Locating nearby range lines was especially important when surveying by foot because dense vegetation may have been recently cleared along the range line from the levee to river, which improved accessibility.

Field crews recorded daily field observations into a customized mobile app specially developed for storing RiverEyes data. All field observations were registered with underlying GPS coordinates (automatically marked by the app), as well as the nearest 0.01 RM, which was keyed in by the field observer. At times, the crew also drove the intermittent riverbed segment to check for presence of remnant pools, if the bed was navigable, but determining the dry length was the main priority each day.

Figure 2. Sample RiverEyes field maps from the 2018 monitoring season. When accessed via the Avenza Maps app, current field location is clearly marked with a large blue dot and the interface allows for panning, zooming, etc.

Discharge Measurements

The RiverEyes field crew assessed current river discharge (cfs) via three methods with varying degrees of accuracy and precision: 1) metered discharge measurements, 2) ball and tape discharge measurements, and 3) visual estimates. Field crews were prepared to meter flow volume at wasteway outfalls, near USGS gages, and at other locations (per RiverEyes contract requirements), with a SONTEK FlowTracker 2, if requested by Reclamation. In 2018, however, metered discharge measurements were never formally requested.

Field crews frequently measured flow using a measuring tape, depth rod, small floating ball, and stop watch (per EPA 1997). With this method, the observer measured the channel width perpendicular to the flow angle to the nearest foot. Depth was measured to the nearest 0.1

foot at four representative locations through the channel cross-section and used to compute an average. These width and depth measurements were then multiplied together to calculate the approximate cross-section area. Flow velocity was measured by timing the number of seconds required for a small plastic ball to float down a 20-foot section of the channel. The RiverEyes field app calculated discharge by multiplying velocity by the cross-sectional area and a typical correction factor (0.9) that is used when measuring discharge with this method.

Ball and tape measurements were frequently used to calibrate observers prior visually estimating flow volume. When flow estimates were recorded, no systematic measurements occurred, the field observer recorded their minimum and maximum flow estimate (cfs) and the field app calculated and recorded the mean as the visual estimate for that observation.

Daily Reports

As mentioned, email and text summaries were regularly circulated between the contractors, Reclamation, and USFWS when low flow conditions warranted. The contractual team also reported current conditions during water operations conference calls. Daily email reports (submitted electronically with this report) focused on:

- affected extent of disconnected river as RMs and distance to major landmarks;
- the RM change of drying/shrinkage or rewetting over the past 24 hours;
- accessibility;
- current river conditions;
- visual flow estimates in “hot spots” or other locations that might be useful for predicting flow trends or intermittency risk;
- observations of disconnected lateral pools;
- summarizing USGS reported flows at USGS gages over the past 24 hours; and,
- 24-hour precipitation in the Rio Grande watershed.

Data Management

The mobile data form was developed specifically for this project in the Fulcrum app (www.fulcrumapp.com) and it contained various design elements to promote data quality and improve efficiency. The app was set up to store the extent of drying, visual estimates of flow, and general observations. Data format, visible data elements, relevant lists, and the overall app display changed according to the type of observation being logged. Data were synched between monitoring staff in the field using a utility that automatically packages data across users and devices, and uploads data to the cloud so reconnaissance observations, monitoring locations, and photos are safely backed up and accessible for other field personnel and/or office staff, even in real-time, as required.

Raw RiverEyes data were reviewed on the web on a near daily basis, downloaded and cleaned regularly, and used to compile information for summary emails, ops calls, this report, and accompanying deliverables. RiverEyes observational data exported off the cloud were locally managed as a Microsoft Excel spreadsheet. The data were post-processed and re-formatted to ensure the information displayed in the Appendices of this report are relatively consistent with RiverEyes reports from previous years.

The DVD that accompanies this report includes:

- Raw and post-processed 2018 data files as .xls, raw data as shp;
- Spatially-referenced .pdf map files that can be used on tablets and/or smartphones to determine the nearest 0.01 RM to your current location while conducting fieldwork;
- RiverEyes landmarks (shp);
- Daily email summaries (pdf);
- Field photos; and
- This report as .doc and .pdf.

Safety

AJAC drafted a Job Hazard Analysis (JHA) for this project (see Appendix B). Field personnel certified that they reviewed the document and complied with the JHA requirements in practice each day. All staff who operated ATVs received a formal safety instruction and certification. Motor vehicle and ATV inspections were conducted at the start of each day. Field personnel communicated between themselves regularly and checked in with the safety officer and/or other AJAC/GSA staff via phone call or text message after daily monitoring responsibilities were finished. All safety guidelines were followed, and no injuries occurred on the project.

RESULTS

Daily Reconnaissance

In the results section in this report channel drying refers a segment of the mainstem channel where continuous surface water was absent. Channel drying was detected in both the Isleta and San Acacia Reaches during the 2018 monitoring year. As is typical, drying was more frequent, extensive, and of longer duration in the San Acacia Reach than the Isleta Reach. Drying within the mainstem active channel began in the San Acacia Reach on April 1 and the last day drying observed in the reach was October 19. The Isleta Reach first dried on May 31 and the last day of drying was October 16.

Based on provisional data from the USGS, mean daily discharge at the San Acacia gage was 140 cfs on the first day that drying occurred in the San Acacia Reach. Mean daily discharge at the Bosque Farms gage was 79 cfs (provisional data) during the first drying event in the Isleta Reach. Flow at these gages represents the main source of inflow to the San Acacia and Isleta

reaches, respectively. The total number of affected days in the San Acacia Reach during 2018 was 179 while there were 74 days of drying in the Isleta Reach (Table 2).

The Isleta Reach dried and then reconnected seven times, while this occurred six times in the San Acacia Reach. The longest consecutive drying event in the Isleta Reach was 42 days (September 9 to October 16) and 118 days in the San Acacia Reach (April 1 to July 27; refer to Figures in Appendix A for information on the extent and duration of subsequent drying events). The longest extent of drying during a single day in the San Acacia Reach was July 12, when dry length reached 36.52 RM. The longest segment recorded during a single morning in the Isleta Reach was 2.28 RM on September 8.

During most irrigation seasons, supplemental pumping at the BDA south boundary (approximately RM 74) augments river flow and maintains flow connectivity downstream from that location. Water is pumped from the LFCC into a spur canal and routed directly into the Rio Grande active channel to prevent drying. Flow volume in the LFCC was insufficient to maintain the pump operation during the 2018 irrigation season. Pump volume was reduced beginning July 1 and pumping ceased completely from the afternoon of July 8 until August 3. Two segments dried below the south boundary pump site during that period.

In 2018, drying affected multiple segments in each reach. The total number of unique miles affected by drying was 45.69 --- 37.9 in the San Acacia Reach and 7.79 in the Isleta Reach. The affected segments within each reach included:

Isleta Reach Segments

1. Near Peralta Wasteway. A total of 6.9 unique RM were affected from RM 151.22 (drying extended this far downstream on June 30) to RM 158.12 (intermittency extended to this point upstream on September 17). Occasionally, this section was partially divided into two dry sub-segments via irrigation return flow out of the Los Chavez Wasteway, however, rewetting from Los Chavez never extended more than about a half mile.
2. Downstream of Sabinal Drain near Abeytas Heading. A total of 0.89 unique RM were affected from RM 133.19 (drying extended this far downstream on July 26) to RM 134.08 (intermittency extended to this point upstream on July 25).

San Acacia Reach Segments

1. A segment from ~3.5 RM above Brown Arroyo downstream to ~11 RM below the BDA south boundary pump site. A total of 34.69 RM were affected from RM 62.83 (drying extended this far downstream on July 11) to RM 97.52 (intermittency extended to this point upstream on July 8).

2. Near "White Gate". A total of 0.75 RM were affected from RM 60.37 (drying reached this point downstream on July 13) to RM 61.12 (drying extended this far upstream on July 12).
3. Above the LFCC confluence with the Rio Grande. A total of 2.46 RM were affected from RM 54.51 (drying reached this location on July 13) to RM 56.97 (drying extended to this point upstream on July 11).

Table 2. Summary of RiverEyes channel drying observations in the San Acacia Reach during 2018.

San Acacia Reach			
Month	**Total Number of Intermittent Days**	**Maximum Length (RM)**	**Mean Length (RM)**
Apr	30	18.9	13.1
May	31	20.52	19.2
Jun	30	22.63	20.0
Jul	27	36.52	22.1
Aug	18	20.62	9.0
Sep	24	18.28	8.9
Oct	19	14.38	5.3
Grand Total	**179**	**36.52**	**13.9**

Table 3. Summary of RiverEyes channel drying observations from the Isleta Reach during 2018.

Isleta Reach			
Month	**Total Number of Intermittent Days**	**Maximum Length (RM)**	**Mean Length (RM)**
Apr	0	0	0
May	1	1.1	0
Jun	16	4.75	1.4
Jul	14	4.77	1.4
Aug	1	2.44	0.1
Sep	26	6.2	3.3
Oct	16	4.56	1.6
Grand Total	**74**	**6.2**	**1.1**

As channel drying initially expanded into new segments, remnant pools often formed in the thalweg, scour holes, and/or other depressional features. After a more prolonged period of dewatering (typically after a few days to a week), remnant pools dried, creating an entirely dry riverbed. The presence, size, and location of remnant pools was sometimes (though inconsistently) recorded and often communicated to the managing agencies via daily emails; however, RM locations where the riverbed had entirely dried were not thoroughly differentiated from segments where remnant pools persisted during fieldwork. Summary emails and raw data provided electronically with this report include crew observations related to the distribution and size of remnant pools observed during 2018 but note that these data are not intended to represent a complete log of remnant pools in the channel during the season. Raw monitoring data are included in Appendix E.

DISCUSSION

Snowpack in the Rio Grande watershed during the winter 2017-2018 was historically low and snowmelt runoff produced very little volume. Spring flows at the USGS Embudo gage (08279500) were less than half of average through much of the spring. By June, the measured volume at that site, which has been reporting flows since 1889 and is the oldest streamflow gage in the country, neared the lowest levels ever recorded. Water managers anticipated and planned for these conditions, Reclamation's 2018 Annual Operating Plan (AOP) – April 1 Runoff Forecast model indicated snowpack was less than 50 percent of average through much of the Middle Rio Grande watershed, and inflow at El Vado Reservoir was forecasted to be less than 20 percent of average (Reclamation 2018). Given the severe drought conditions, drying was expected within the city of Albuquerque, and RiverEyes prepared to monitor drying on Pueblo of Isleta lands as well as through the Rio Grande State Park in Albuquerque.

This year (2018) was also atypical because it was the first monitoring season that drying occurred below the south boundary pump site since 2003 (SSPA 2004). During July, insufficient water was available to sustain the pumping operation at the BDA south boundary and pumping completely ceased between July 8 and August 3. Pumping was reduced from 3 to 2 pumps on the evening of July 1st, from 2 pumps to 1 pump on July 2nd, and the last pump was shut off during the afternoon of July 8th. Various segments extending nearly 20 miles below pump site were eventually affected by drying, which significantly contributed to the longer affected area in 2018 compared to the long-term average. Spot drying below the pumps began soon after the pump volume was reduced (drying was detected near RM 64 on July 4), and within a week, continuous drying extended more than ten miles below the pump site.

Drying began early in 2018 (San Acacia Reach on April 1) compared to previous years, but the area affected by drying turned out to be less than expected. The total dry length in 2018 (as shown on Table 1) was the fourth highest since 2001. Article VII (Section of the Rio Grande Compact that reduces upstream storage flexibility in upstream reservoirs like El Vado when Rio Grande Project storage is less than 400,000-acre-feet at Elephant Butte and Caballo) water

storage restrictions were in effect by late May (May 21 or 23, depending on accounting method). Prior and Paramount operations (when irrigation deliveries are restricted to the six Middle Rio Grande Pueblos) began on August 31. However, an August 2018 one-time water lease agreement between Reclamation and Albuquerque Bernalillo County Water Utility Authority provided up to 20,000-acre-feet of supplemental water to maintain continuous flow through Albuquerque (Reclamation 2018b). Due to the cooperation between agencies, drying ultimately never expanded onto Pueblo of Isleta or into Albuquerque, as had been feared.

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