2017 RiverEyes Monitoring Report

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EXECUTIVE SUMMARY

AJAC Enterprises (AJAC) was contracted by the U.S. Bureau of Reclamation (USBR) to conduct daily river monitoring and reporting during 2017 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 on USBR, 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. Daily observations were relayed to an interagency water management team and, particularly when channel intermittency is detected, reported to the U.S. Fish and Wildlife Service (USFWS) to support endangered Rio Grande silvery minnow (*Hyboganthus amarus*) rescue and relocation activities. GeoSystems Analysis, Inc. (GSA) was subcontracted by AJAC to provide technical support on the project.

The U.S. Geological Service (USGS) maintains a large network of stream flow monitoring stations throughout the MRG that post real-time, provisional flow volumes to the internet. Field reconnaissance of specific segments of the MRG is contractually required when reported flows are below 300 cubic feet per second (cfs) at the USGS gauge near San Acacia, New Mexico (NM), and below 80 cfs at the Bosque Farms, NM, gauge. During 2017, flows were substantially greater than these thresholds until late-June. The monitoring team examined current flow conditions at the San Acacia and Bosque Farms gauges on the USGS website daily from late June through mid-October, and field reconnaissance was completed on a near daily basis beginning in early-July.

Flow interruption and drying occurred in the Isleta and San Acacia reaches of the MRG during the summer of 2017. Only one segment in each reach was affected by drying – a portion of the Isleta Reach between the Los Chavez Wasteway and the Peralta Wasteway, and a segment of the San Acacia reach approximately between Brown Arroyo and the south boundary of Bosque del Apache National Wildlife Refuge (BDA). Drying was first observed in the San Acacia reach on July 9, 2017, while the Isleta Reach did not dry until September 4, 2017. The total number of unique rive miles affected by drying was 23.68: 21.31 in the San Acacia reach and 2.37 in the Isleta Reach. Field crews detected drying during 63 days through the monitoring season. Per reach, there were 14 days with river drying in the Isleta Reach, and 63 days in the San Acacia reach. A large, multi-day storm system wetted the basin in late September 2017 and the last day of drying was September 28 and September 22 in the San Acacia and Isleta Reaches, respectively. River flows remained relatively high through October and field reconnaissance was no longer necessary.

INTRODUCTION

Channel drying has been actively monitored since 1996. Monitoring was initially 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 segmentation extent 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. 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 teams with determining rescue need, timing, and priority locations. Early detection and rapid rescue response is crucial because studies have shown that remnant pools detected during periods of flow intermittency typically dry within 48 hours (USFWS 2016 and Smith 1999). 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).

Previous monitoring efforts have shown that channel drying has concentrated in two reaches of the Rio Grande – Isleta and San Acacia (SWCA 2015). The Isleta Reach typically refers to the MRG segment that stretches from the Isleta Diversion Dam south of Albuquerque to the San Acacia Diversion Dam (see Figure 1). The San Acacia Reach is downstream of the Isleta Reach and extends from the San Acacia Diversion Dam to Elephant Butte Reservoir. Drying is more widespread and common in the San Acacia Reach than the Isleta Reach (Table 1).

Per USFWS 2016, from 2001 to 2015, an average of 33 miles of the Rio Grande has dried each year, mostly in the San Acacia Reach. Drying was most extensive during the drought years of 2003 (70 miles) and 2004 (68 miles), while the longest drying event occurred more recently (~117 days of drying in 2012). The only year since 1996 without any intermittency or drying in the system was 2008. On average, drying is more frequent, extensive, and longer duration in the San Acacia reach. The Isleta Reach has remained wet during several years when drying occurred in the San Acacia reach; including 2001, 2008, and 2009 (USFWS 2016).

Based on previous RiverEyes project observations, approximate river miles (RM) segments with highest drying probability are as follows (per USFWS 2016 and various SWCA RiverEyes reports, e.g. SWCA 2015):

<u>Isleta Reach</u> --- 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).

<u>San Acacia Reach</u> --- One segment from near Brown Arroyo (Socorro, NM) downstream to the pump site near the BDA south boundary (RM 74 to 105).

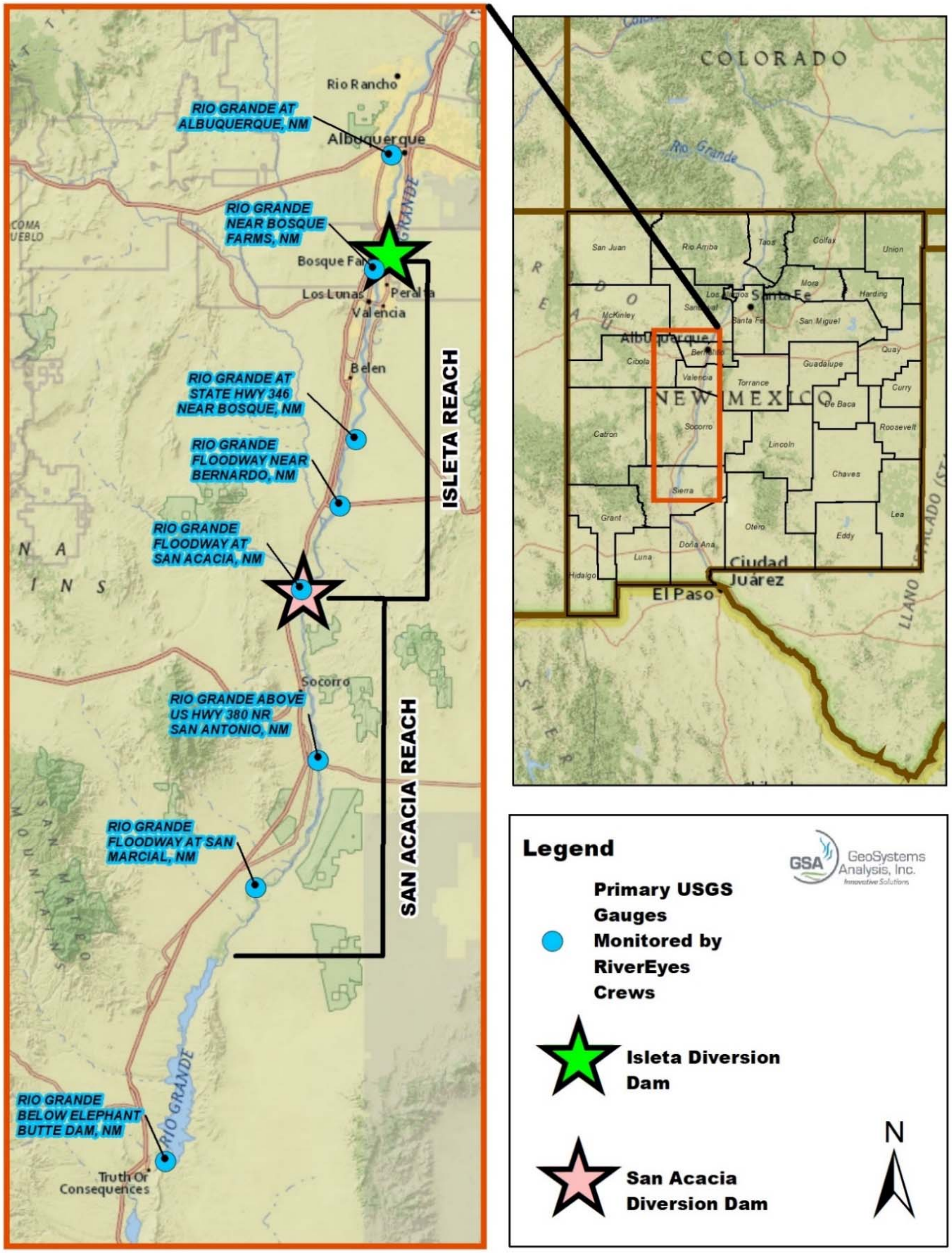

Figure 1. Map showing location of Isleta and San Acacia Reaches of the Middle Rio Grande.

During the 2017 monitoring period, USBR contracted AJAC Enterprises to perform the RiverEyes project field monitoring and reporting requirements. 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 following sections 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 (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

METHODS

Daily Reconnaissance

Daily reconnaissance and reporting of channel intermittency was conducted by field crews when real-time (updated at 15-minute intervals for most gauges) provisional flow reporting on the USGS streamflow website (https://waterdata.usgs.gov/nm/nwis/current/?type=flow) was below specific discharge thresholds. Channel conditions were checked in the Isleta Reach whenever the USGS reported less than 80 cubic feet per second (cfs) at the Bosque Farms gauge (Station 08331160). Reconnaissance of the San Acacia Reach occurred whenever the San Acacia gauge (Station 08354900) was less than 300 cfs. Field crews also periodically checked for river conditions if the reported discharge exceeded those levels when 1) requested by USBR, 2) drying had been detected during the previous couple days, 3) if recent field observations suggested that channel separation was highly possible, or 4) gauge readings on the USGS website were suspect.

Field crews accessed the survey reaches with an all-terrain vehicle (ATV) as the riverbed conditions allowed. Mud, deep water, inundated access routes through the sediment plug at BDA, and/or quick-sand often prompted monitoring via foot. Reconnaissance was performed early in the morning, beginning at daybreak, so observations could be communicated to agencies early enough to inform daily water operational adjustments and fish rescue activities (before 8 A.M. whenever possible). When intermittency was detected, affected locations were relayed via text messages sent to designated USBR staff and the USFWS Fish Rescue Coordinator. A more comprehensive email summary was also circulated during most days when drying occurred.

To ensure safety, reporting accuracy, consistency between field observers, and data quality, field crews also conveyed observations to the data manager during internal team (AJAC/GSA) phone calls early each morning (typically between 7 to 7:30 A.M.). A RiverEyes team member participated in regular (Monday, Wednesday, and Friday during the peak drying period) water operations conference calls to communicate that morning's dry channel extent and listen to proposed water operational changes.

Reconnaissance observations were documented in the field on an iPad tablet with a Bluetooth connection to a Garmin Glo Global Positioning System (GPS) to improve locational accuracy (consistently ~5-foot accuracy) over the iPad's GPS chip. River mile proximity was determined to the nearest 0.01 of a mile using a spatially-referenced .pdf file opened in the Avenza Maps app (https://www.avenza.com/avenza-maps/). To enable placement to this precision, we segmented the 2012 USBR 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 map with a red-colored river centerline to assist field staff with targeting "hot spots" to check during intermittent periods. The map also enabled field staff to see adjacent land ownership, irrigation infrastructure, flow metering priorities, municipalities, arroyos, USBR range lines, roads, etc. Locating nearby range lines was especially important when surveying by foot because dense vegetation was recently cleared along the cross-sections from the levee to river.

Field crews entered daily field observations into a customized mobile app developed specially for recording and storing RiverEyes data. Receding (in the case of drying) and advancing (during rewetting) extents of connected, running water habitat was recorded along with general notes, field photos, and flow volume estimates. Dry channel extent and other locations were registered as a GPS position (automatically marked by the app), as well as the nearest 0.01 RM. When flow interruption was encountered, we also drove the disconnected riverbed segment to check for presence of isolated pools, if the bed was navigable.

Figure 2. Sample RiverEyes field maps from the 2017 monitoring season. Maps were spatially-referenced electronic files that could be used to precisely determine a field location to the nearest 0.01 river mile.

Discharge Measurements

The RiverEyes contract required two methods for determining flow rate (cfs) – 1) metered discharge measurements, and 2) visual estimates. Field crews were prepared to collect metered discharge measurements at wasteway outfalls, near USGS gauges, and at other locations, with a SONTEK FlowTracker 2 meter, if requested by USBR. In 2017, however, metered discharge estimates were never formally requested.

Field crews visually estimated flow using a measuring tape, depth rod, small floating ball, and stop watch (per EPA 1997). 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 estimated 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 an estimated 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.

Daily Reports

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

- accessibility;
- current river conditions;
- visual flow estimates in "hot spots" or other locations that might be useful for predicting flow trends or intermittency risk;
- affected extent of disconnected river as RM;
- the RM change of drying/shrinkage or rewetting over the past 24 hours; and,
- observations of disconnected lateral pools.

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 that controlled data quality and improved efficiency. The app was designed to store the extent of drying, visual estimates of flow, and general observations. Data recording requirements, visible data elements, relevant lists, and the overall app display were designed to be adjusted according to the type of observation being stored. Data were synched in the field using an automated process that organizes data and uploads it to the cloud so reconnaissance observations, monitoring locations, and photos could be safely backed up and reviewed by staff in the office, even in real-time, when required.

Observational data were exported from the cloud and managed in two formats – GIS shapefile and MS Excel spreadsheet. Field photographs were also transferred off the cloud regularly and reviewed. The raw data was reviewed on a near daily basis, cleaned regularly, and used to compile information for various reporting requirements of this project including summary emails, ops calls, and this report. The data were post processed and re-formatted, so the information displayed in the Appendices of this report are relatively consistent with previous years.

The DVD that accompanies this report includes:

- raw and post-processed 2017 data files as .xls and .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;
- source GIS files used to create the field maps, such as:
    - a cleaned version of the USBR 2012 RM shapefile (we detected a few segmentation and attribution errors in the file we received),
    - 2012 USBR centerline coded with the "hot spots" where drying potential is highest,
    - RM segment points in 0.5-, 0.1-, and 0.01-mile increments as used during this year's RiverEyes monitoring;
- field photos; and
- this report as .doc and .pdf.

Safety

AJAC drafted a Job Hazard Analysis (JHA) for this project (see Appendix C). Field personnel certified that they reviewed the document and complied with the JHA requirements in practice each day. All staff that 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 data manager via phone call or text message after daily monitoring responsibilities were finished. All safety guidelines were followed, and no injuries occurred on the project. Stuck ATVs stalled work on just three days through the entire monitoring season.

RESULTS

Daily Reconnaissance

In the results section in this report, "channel drying", "flow interruption", "dewatering", and "intermittency" refer to the same general field condition – a segment of the mainstem channel where surface water was absent. After a prolonged period of flow interruption, remnant pools dried, creating entirely dry riverbed. However, while the presence of isolated pools was recorded as a general observation and often communicated to the agencies, RM locations where the riverbed had entirely dried were not differentiated from segments where remnant pools remained during field monitoring.

Channel drying was detected in both the Isleta and San Acacia Reaches during the 2017 monitoring year. Flow interruption was more frequent, extensive, and longer duration in the San Acacia Reach than the Isleta Reach. Drying affected a single segment in each reach. Intermittency within the mainstem active channel began in the San Acacia Reach on July 9, while the Isleta Reach did not dry until September 3. Based on provisional data from the USGS, mean daily discharge at the San Acacia gauge was 54.8 cfs on the first day that drying was detected in the San Acacia reach and that followed nine consecutive days of mean daily discharge below 200 cfs.

On the first day that flow interruption occurred in the Isleta Reach, real-time provisional reporting on the USGS website indicated that flows at the Bosque farms gauge the exceeded 90 cfs. Within a few days, the USGS metered and corrected the gauge and the corrected discharges now show that the volume was about 80 cfs on that day. The initial drying event in the Isleta Reach occurred on a day when mean daily discharge at the Bosque Farms gauge was 80.9 cfs, which was the third consecutive day with mean flows below 100 cfs.

The total number of intermittent days in the San Acacia Reach during 2017 was 63, while drying was reported on 14 days in the Isleta Reach (Table 2). Drying occurred in the San Acacia Reach during every day that the Isleta Reach dried. The Isleta Reach had three drying episodes, all in September. The longest consecutive drying event in the Isleta Reach was 11 days long (September 3rd to the 13th). The reach was also dry on September 16, and from September 21 to 22. There were two drying episodes in the San Acacia Reach. The first drying event began on July 9 and lasted 23 consecutive days, to July 31. The second event began on August 20, lasted 40 consecutive days, and ended on September 28 (refer to Figures in Appendix B).

Total number of unique miles affected by drying was 23.68 --- 21.31 (from RM 73.81 to RM 95.12) in the San Acacia reach and 2.37 (from RM 152.01 to 154.38) in the Isleta Reach. The longest extent of drying during a single day in the San Acacia reach was on September 13, with 21.31 miles dry (note that was also the entire affected extent in the reach during 2017). The longest intermittent segment recorded during a single morning in the Isleta Reach was 2.28 RM on September 8.

Flow conditions became very dry during September and RiverEyes crew observations indicate that flow volumes were below 10 cfs through much of the Isleta Reach above the lower San Juan Drain. Inputs (even relatively low volume) from irrigation wasteways became crucial for maintaining channel connectivity, but beaver dams slowed releases from many of the wasteways. Beavers constructed dams most nights in the Sabinal wasteway and nearly triggered channel drying near RM 137.5 during early-September.

Large rainstorms that brought a significant spike in flows rewetted the channel in both reaches by late-September. The final day of intermittency was September 28 and September 22 in the San Acacia and Isleta Reaches, respectively. Provisional flow data from the San Acacia gauge reported a spike in mean daily flow to 866 cfs on September 28 and mean daily discharge peaked at 3,700 cfs on October 7. Reported mean daily discharge (provisional) at the Bosque Farms gage reached 102 cfs when sustained channel rewetting began on September 22. Mean daily discharge recorded at the Bosque Farms gauge continued to rise over the next couple weeks, peaking at 3,430 cfs on October 7.

Table 2. Summary of RiverEyes channel drying observations in the San Acacia Reach during 2017.

San Acacia Reach				
Month	**Total Number of Intermittent Days**	**Maximum Length (RM)**	**Mean Length (RM)**	**Standard Deviation (RM)**
Jul	23	15.72	7.15	5.60
Aug	12	9.44	2.36	3.39
Sep	28	21.31	14.91	6.57
Oct	0	0.00	0.00	0.00
Grand Total	**63**	**21.31**	**7.89**	**7.41**

Table 3. Summary of RiverEyes channel drying observations from the Isleta Reach during 2017.

Isleta Reach				
Month	**Total Number of Intermittent Days**	**Maximum Length (RM)**	**Mean Length (RM)**	**Standard Deviation (RM)**
Jul	0	0.00	0.00	0.00
Aug	0	0.00	0.00	0.00
Sep	14	2.28	0.70	0.82
Oct	0	0.00	0.00	0.00
Grand Total	**14**	**2.28**	**0.22**	**0.56**

DISCUSSION

Drying Trends

Drying patterns vary to some degree each year, but 2017 seems unique, especially in the San Acacia Reach, for two reasons: 1) absence of pumping except for the southern boundary at BDA; and, 2) formation of a sediment plug in the active channel at BDA. In reviewing RiverEyes data from previous years (e.g. SWCA 2015), it appears pumping from the Low-Flow Conveyance Channel at BDA's north boundary had promoted channel re-wetting for a certain distance downstream of the pump location before flows went subsurface upstream of the southern refuge boundary. In 2017, however, the BDA north boundary pumps were not utilized so the channel through the upper segment of the refuge dried in a more consistent pattern with channel segments upstream of the north boundary.

Spring runoff during 2017 delivered higher volumes of water than the basin had seen for more than a decade. A sediment plug formed in the main channel through BDA, and the plug reduced the water conveyance capacity through the active channel by diverting water from the channel into the east and west floodplain. While it appears the plug was most perched between RM 79 to 81 (most of the flow was naturally pushed to over bank areas on either side of the river through this section), the sediment plug's effect on channel gradient and downstream flow impacted drying patterns between approximately RM 84 and the south boundary pump site at RM 73.8. RiverEyes crews documented specific locations where water spilled from the active channel into the overbank on both sides of the river primarily between RM 84 and RM 81. Water lost to these flow paths sometimes dictated the upstream end of drying.

Due to waterlogged conditions and dense vegetation, it was difficult to discern where, or if, this water returned to the main channel as surface flow. During July and August 2017, flow paths originating near the north refuge boundary carried water through the westside floodplain all the way down to the south boundary pump channel where water eventually spilled back into the active channel.

Multiple drainage channels also re-entered the active channel and returned flow to the main channel on the east side of the river. Two drainage channels from the east overbank, at RM 79.15 and RM 76.17, were especially pronounced and influential on the downstream extent of drying. During the first three days that drying was detected, the downstream drying extent remained at the outfall of the RM 79.15 drainage path. When that side channel dried, the drying extended downstream about three miles to the next major channel from the east overbank at RM 76.17. As flows diminished from drainage outfall at RM 76.17, drying rapidly (within a day or less) extended more than three miles to about 300 feet upstream of the south boundary pump site at RM 73.86. The downstream extent of drying then remained at the southern BDA boundary until the river rewetted.

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