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Las Vegas Wash Time-of-Travel Study

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This study estimated travel time for the Las Vegas Wash (Wash) and compared the results with previous travel time measurements. Travel times were measured using a fluorescent Rhodamine WT 20 dye. Dye concentration was collected at 10 sampling sites using multiprobe dataloggers with Rhodamine sensors. The raw data were corrected for background measurements of Rhodamine concentration and analyzed to determine travel times and velocities. The average travel time for water through the Wash between Vegas Valley Drive and Site S8 located near the Las Vegas Marina boat launch was 14.23 hours. For the reach between the confluence of the Wash with discharges from the Clark County Water Reclamation District's (CCWRD) Central and Advanced Wastewater Treatment Facilities and the Northshore Road bridge, the travel time was approximately 9.6 hours. The average velocity of water in the Wash was one mile per hour. Compared with travel times from previous studies, the travel time observed in this study is an intermediate value between the travel time observed in 1980 and the time observed in 1986, indicating that construction of weirs and vegetation establishment over the last 15 years has slowed the average velocity of water in the Wash and increased the travel time.

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Acronyms and Abbreviations

Acronym or Abbreviation	Definition
cfs	cubic feet per second
CCWRD	Clark County Water Reclamation District
Confluence	Site S2 The location immediately downstream of the points at which the Clark County Water Reclamation District (CCWRD) Wastewater Treatment Facility and the CCWRD Advanced Wastewater Treatment Plant discharge treated wastewater to the Wash
mi/hr	miles per hour
msl	mean sea level
ppb	Parts per billion. Equivalent to µg/L
Reclamation	U.S. Department of the Interior, Bureau of Reclamation
SNWA	Southern Nevada Water Authority
µg/L	Micrograms per liter. Equivalent to parts per billion
Wash	Las Vegas Wash

Executive Summary

The purpose of this study was to estimate travel time for the Las Vegas Wash (Wash) and to compare the results with previous travel time measurements. Travel times were measured through a dye tracer study using Rhodamine WT 20 fluorescent dye. Dye concentration was collected at 10 sampling sites using battery-powered Eureka TDX multiprobe dataloggers fitted with Turner Designs Cyclops Rhodamine sensors, with measurements recorded at one minute intervals. The raw data were corrected for background measurements of Rhodamine concentration and analyzed to determine travel times and velocities for the entire length of the study area and for individual reaches within the Wash.

The average travel time for water through the Wash between Vegas Valley Drive and Site S8 located near the Las Vegas Marina boat launch (14.33 miles downstream from the dye input and 2.72 miles below the full pool level of Lake Mead) was 14.23 hours. For the reach between the Confluence of the Wash with discharges from the Clark County Water Reclamation District's (CCWRD) Central and Advanced Wastewater Treatment Facilities (8.85 miles above the full pool elevation of Lake Mead) and the Northshore Road bridge (0.9 miles above Lake Mead's full pool elevation), the travel time was approximately 9.6 hours.

The average velocity of water in the Wash during this study was one mile per hour. Compared with travel times from previous studies, the travel time observed in 2015 is an intermediate value between the travel times observed in 1980 and 1986, indicating that construction of weirs and vegetation establishment over the last 15 years has slowed the average velocity of water in the Wash and increased the travel time.

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Introduction

Study Overview and Purpose

The purpose of this study was to estimate the travel time of water through the Las Vegas Wash (Wash) and to compare the results with previous travel time measurements. The Wash is a natural channel used to convey urban stormwater runoff and wastewater treatment plant effluent from the Las Vegas Valley to the Las Vegas Bay of Lake Mead. Prior to urban development in the Valley, the Wash was an intermittent desert channel with small areas of wetlands. Changes in the hydrologic regime of the Wash due to population growth in the Valley caused the flow to transition from ephemeral to perennial and resulted in the growth and expansion of wetlands. Later, as population growth continued, channel erosion led to downcutting that resulted in groundwater drainage and subsequent wetland decline. Since 2000, 19 grade control structures have been installed to protect the Wash from further erosion and to restore and enhance habitat along the Wash. This study investigated travel times of water through the Wash from Vegas Valley Drive to Lake Mead. By comparing travel time results from this study to travel times measured by previous studies, and analyzing travel times through various reaches of the Wash, we can increase understanding of the effectiveness of these restoration efforts.

Study Background

History of the Las Vegas Wash

The Wash is a stormwater runoff and treated wastewater discharge channel in the Las Vegas Valley (Valley). As described in the Las Vegas Wash Comprehensive Adaptive Management Plan, or CAMP (Las Vegas Wash Coordination Committee, 1999), prior to the settlement of the Valley, the Wash was an ephemeral stream that conveyed stormwater runoff and groundwater flow to the Colorado River. As settlement in the Valley increased beginning in the 1950s, urban runoff and the addition of wastewater treatment plant discharges into the Wash caused it to begin flowing continuously and led to the formation of ponds, wetlands, and riparian habitat. As flows continued to increase due to ongoing development, erosion and headcutting began to occur, exacerbated by flood flows from storm events. Wetlands created by the earlier shift to perennial flows decreased in extent and were replaced by invasive tamarisk.

Figure 1. Location of Homestead Weir prior to weir construction and restoration, showing evidence of significant downcutting and erosion.

Beginning in the late 1970s, government agencies, stakeholders, and community groups began efforts to manage the Wash and control erosion. Meanwhile, development in the Valley and along the Wash continued, including the construction of the Northshore Road Bridge in 1978. Temporary grade control structures were installed starting in the mid-1980s and the Clark County Wetlands Park was established in the early 1990s. Construction of Lake Las Vegas in the 1990s required the Wash flow to be routed through two large (84 inch) pipelines beneath the lake, and in 1994, the City of Henderson began discharging treated wastewater to the Wash at Pabco Road where the first permanent grade control structure was completed in 2000. In 2000, the CAMP was adopted, which contained 44 recommendations for managing the Wash. In 2003, a Capital Improvement Plan proposing construction of 21 grade control structures was developed that describes channel bed stabilization, channel bank protection, revegetation, and studies and support programs for protection and enhancement of the Wash. To date, 19 of the planned grade control structures have been constructed on the Wash between its confluence with discharges from the Clark County Water Reclamation District’s (CCWRD) Central and Advanced Wastewater Treatment Facilities (Confluence) and where it is piped beneath Lake Las Vegas. An additional 2 structures are planned for construction by 2019.

Figure 2. Homestead Weir in 2014. The weir was completed in 2011 and is constructed from rock rip rap, allowing water to flow through the structure. Riparian vegetation planted on the weir and along the banks of the Wash upstream also contributes to channel stabilization.

Previous Studies

Previous studies have documented travel times in the Wash. The first documented dye study was performed in November 1980 by Brown and Caldwell using Rhodamine WT dye. That study reported a travel time of 18.2 hours for the dye peak between the Confluence and Lake Mead at a surface elevation of 1203.68 ft above mean sea level (msl), a distance of approximately 9.2 mi (Brown and Caldwell, 1982). Between reaches of the Wash, travel times varied depending on the condition of the channel. The dye peak traveled from the Confluence to Pabco Road in approximately 7 hours through mainly dirt channel, and passed through a series of ponds and marshes below Pabco Road in approximately 6 hours. Below the ponds and marshes, the channel contained headcuts and erosion, and travel time from the marshes to Northshore Road bridge was approximately 3 hours. From Northshore Road to Lake Mead the travel time was approximately 40 minutes.

Following the 1980 dye study, in November and December 1986, Roline and Sartoris performed a dye study with Rhodamine dye. The study measured a travel time of 5.75 hours from the Confluence to the bridge on Northshore Road, a distance of approximately 8.2 miles (Roline & Sartoris, 1986). The study measured a travel time of 2.75 hours between the Confluence and Pabco Road and 3 hours between Pabco Road and Northshore Road.

A September 2002 dye tracer study over 5.5 miles of the Wash between Pabco Road and Northshore Road measured a travel time of 3.25 hours using Rhodamine WT and fluorescein dyes (Leising, 2003).

Table 1. Summary of travel times in hours found by previous studies

	Travel Time (hours)		
Reach	**Brown and Caldwell, 1982**	**Roline and Sartoris, 1986**	**Leising, 2003**
Confluence to Pabco Road	7	2.75	N/A
Pabco Road to Northshore Road	10.5	3	3.5

Study Area

The Study Area was the Wash between Vegas Valley Drive and the Las Vegas Bay of Lake Mead. Along the length of the Wash there were nine sampling locations, with a tenth site located at the Pabco Gypsum plant intake structure in Las Vegas Bay of Lake Mead. Sites S1-S7 were located in the Wash above Lake Las Vegas. Site S8 was located in the Wash below Lake Las Vegas and the Northshore Road bridge, 2.72 miles below the full pool level of Lake Mead (1221.4 ft above msl). At the time of the study, the surface elevation of Lake Mead was 1080.91 ft above msl. Flows in the Wash measured by USGS on 12/29/2015 averaged 39 cfs near the dye input at Vegas Valley Drive, 309 cfs at Pabco Road, 340 cfs at Three Kids Wash, and 306 cfs below Lake Las Vegas (Figure 3).

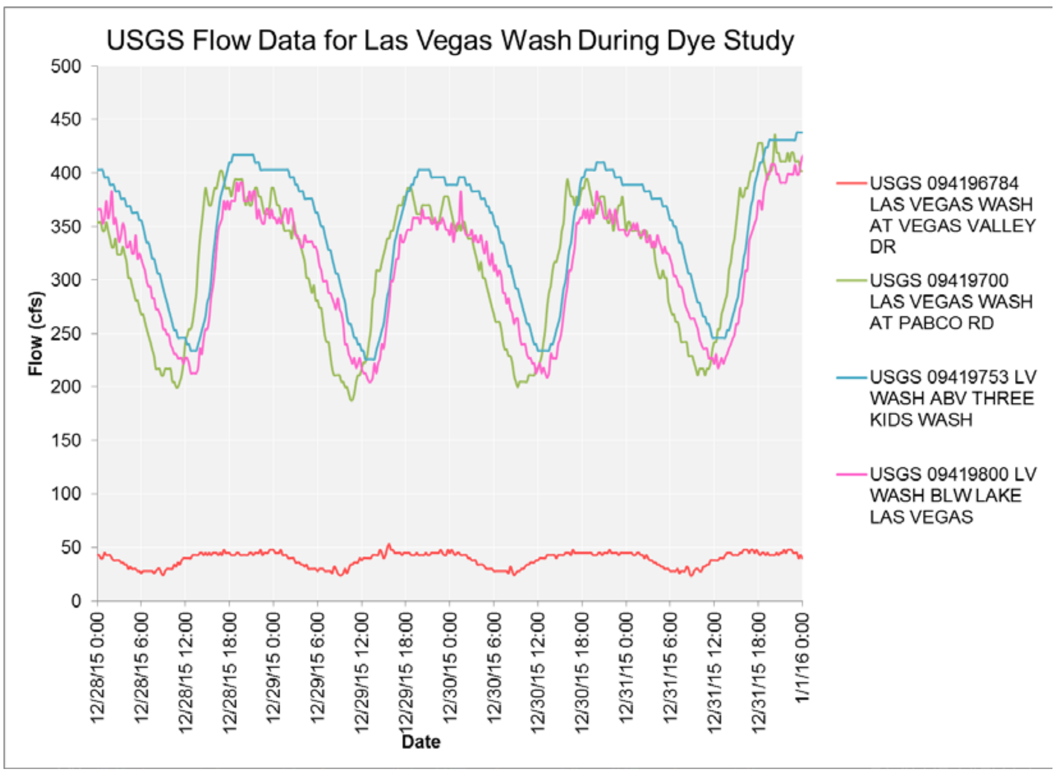

Figure 3. Flows at USGS gages along the Las Vegas Wash during the dye study.

Figure 4. Wash Study area and sampling locations

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Methods

Sampling and data analysis methods were adapted from chapters A9 and A12 of Techniques of Water-Resources Investigations of the United States Geological Survey (Kilpatrick & Wilson, 1989; Wilson, Cobb, & Kilpatrick, 1986).

Data Collection and Sampling

In-situ dye concentration data were collected at the 10 sensor sites (Table 2,Figure 4) using battery-powered multiprobes consisting of Eureka TDX dataloggers with Turner Designs Cyclops Rhodamine sensors. The probes contained sensors for water temperature and depth in addition to Rhodamine.

Table 2. Multiprobe sampling locations

Name	Description	Latitude	Longitude	Distance from input (miles)
DYE INPUT	LW11.1	36.13608	-115.03784	0.00
S1	LW10.8, between LW11.1 and CLVWTF	36.13089	-115.0348	0.40
S2	LW8.85 at USGS Wasteway Gage. (CCWRD Confluence)	36.10836	-115.02251	2.13
S3	DU Wetlands #1 Weir	36.09535	-115.01114	3.38
S4a	Above Upper NarrowsWeir	36.09008	-114.99582	4.45
S4b	Below Upper Narrows Weir	36.08993	-114.99541	4.51
S5	LW5.5 above Historic Lateral Weir	36.08939	-114.97785	5.66
S6	Lower Narrows Weir	36.09352	-114.96003	6.83
S7	Fire Station Weir	36.10195	-114.93674	8.38
S8	Vacant Las Vegas Bay Marina Launch Ramp	36.12052	-114.86018	14.33
S9	Pabco Gypsum Intake Structure in Lake Mead	36.119961	-114.83652	15.90

Prior to installation, the Cyclops sensors were calibrated using a one-point calibration against a known 100 parts per billion (ppb) standard of Rhodamine WT. The standard was prepared with raw water taken from the Wash on the day of calibration (December 7, 2015) following recommended preparation instructions from the sensor manufacturer (Turner Designs).

The multiprobes were installed on December 28, 2015, the day before the dye input. All multiprobes were installed in housings made from perforated 2-inch diameter PVC tubing. One end of the tubing was sealed with a glued cap, and the other end was covered with a removable slide-on cap. A hole in each removable cap allowed a zip tie or wire to be attached to the cap and the housing to ensure the cap would not come off while the sensor was in the water. Each PVC housing was attached to two 4-foot lengths of rebar driven into the streambed of the Wash channel (Figure 5). The multiprobe located at site S9, the Pabco Gypsum intake structure in Lake Mead, was attached with a rope to the intake structure.

Rhodamine concentration, water temperature, and water depth data were collected at 1-minute sampling intervals at each sampling site for the duration of the study. The probes at sites S1 and S2 were removed on the day of the dye input some hours after the dye was visually observed to have passed those locations. The probes at sites S3 through S8 were removed on January 4, 2016. The probe at site S9 was removed on January 8, 2016.

Figure 5. Eureka TDX Multiprobe in protective PVC pipe housing installed at site S2.

17 grab samples were collected at the City of Henderson water intake, located at the Saddle Island Intake Structure, between 1/1/2016 and 1/4/2016. These samples were stored in bottles and transported to Reclamation's Lower Colorado Regional Laboratory for analysis on 1/6/2016. The samples were analyzed on 1/7/2016 using one of the calibrated multiprobes. No measureable concentration of Rhodamine was observed in any of the samples from this intake.

Samples were requested from the Southern Nevada Water Authority (SNWA) intake located near the mouth of the Las Vegas Bay of Lake Mead. However, SNWA staff declined to provide samples for analysis.

Dye Input

At 9:06 AM on 12/29/2015, 2 liters of Rhodamine WT 20 dye were discharged into the Wash below Vegas Valley Drive (approximately 11.1 miles above full pool elevation of Lake Mead, at 36.13608, -115.038 decimal degrees). The dye volume was determined using the dosage formula (Kilpatrick & Wilson, 1989) to achieve a concentration of 10 µg/L approximately 7.5 miles downstream of the input location, which enabled compliance with the discharge permit (State of Nevada, Division of Environmental Protection Permit NVG000001) maximum concentration of 10 µg/L at all intake locations. Two Reclamation staff members manually dumped the dye linearly along the center third of the Wash channel. The dye was visually observed at the input point until 9:15 AM (Figure 6). A video of the dye input can be viewed at https://www.youtube-nocookie.com/embed/h232qQiGUCo?list=PL97E2B161CFD30D5B&showinfo=0.

Figure 6. Input site (corresponding to site LW11.1 used for ongoing water quality monitoring of the Wash) following dye input.

Data Analysis

Data from each multiprobe were downloaded and saved as separate Microsoft Excel (xlsx) files. After initial data quality control and processing, the data files were saved as comma separated variable (csv) files and imported into the R statistical computing environment (R Development Core Team, 2008). There, the data were further processed to remove datapoints recorded while the sensors were out of the water and to correct for background readings of Rhodamine concentration. Although no Rhodamine dye was present in the Wash prior to the dye input, turbidity can be read by the Rhodamine sensor as fluorescence. To correct for background readings, the average value of Rhodamine measured by each sensor between zero and 12 hours prior to the dye input was subtracted from its measured Rhodamine concentration. The background Rhodamine concentration averaged 0.63 micrograms per liter (µg/L) and ranged from 0.31 µg/L at site S9 to 1.04 µg/L at site S8 with an average standard deviation of 0.066 µg/L (Figure 7). The concentrations of Rhodamine measured at sites S1 to S8 are shown in Figure 8.

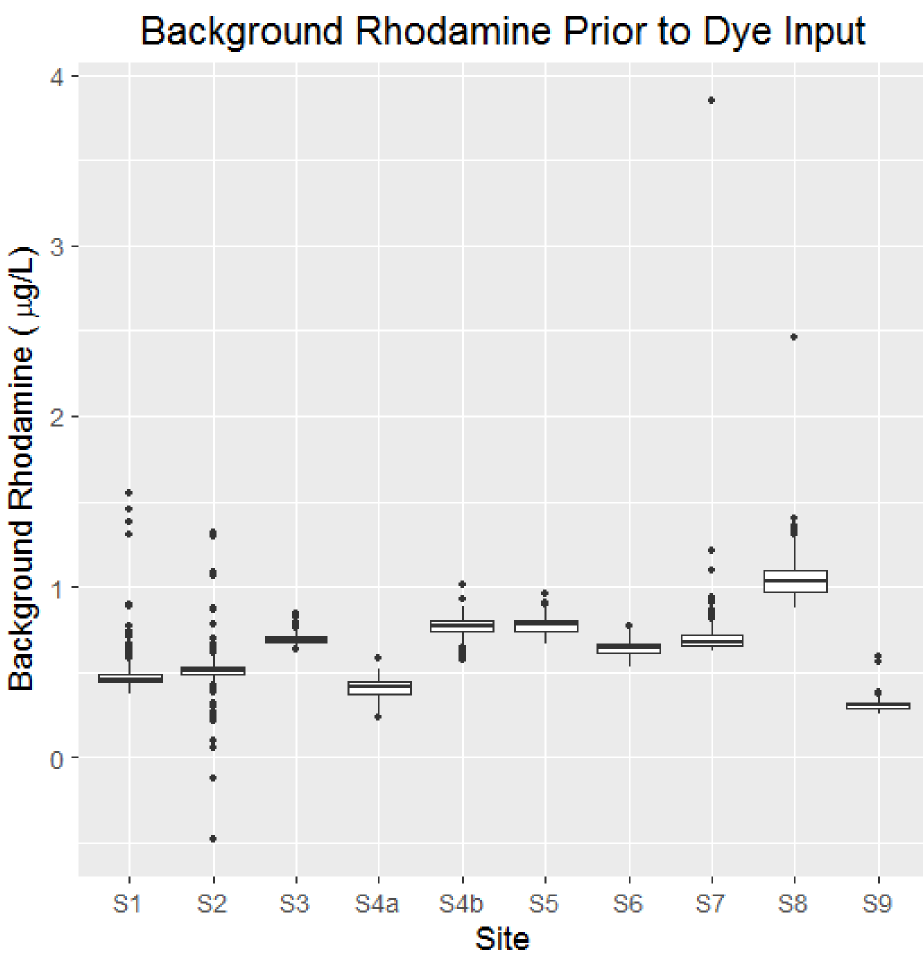

Figure 7. Background Rhodamine (turbidity) concentrations at each site for 12 hours prior to dye input.

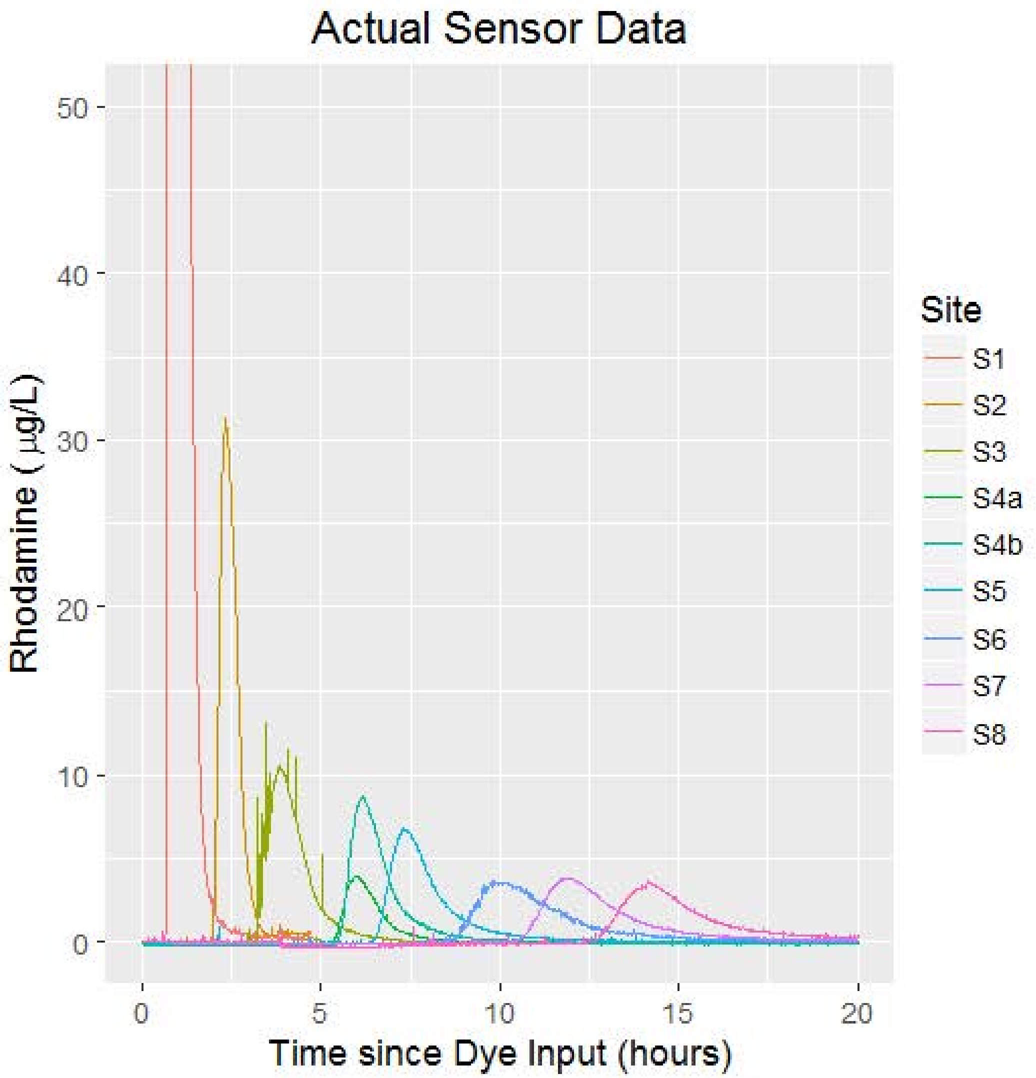

Figure 8. Rhodamine concentrations measured at sites S1 through S8 corrected for background concentration.

After removing the background concentration, data for site S9 were eliminated from further analysis because no measurable Rhodamine concentration was detected. A loess smooth (Cleveland, Gross, & Shyu, 1992) was applied to the Rhodamine concentrations measured at sites S1 through S8, and the timing of the peak, center of mass, leading and trailing edge were calculated on the smoothed data for each site. The peak was defined as the time when the maximum dye concentration was observed. The centroid was calculated as the time when half of the dye had passed the site. The leading and trailing edges were calculated as the first and last measurements equal to 10% of the peak value, respectively. The duration of dye presence was calculated as the difference between the times of the trailing and leading edges. The time between peak observations for each site was calculated as the difference in time between each site's peak and the previous site's peak. The average velocity was calculated as the total distance divided by the time to the peak. The average reach velocity was calculated as the time between peaks divided by the distance between sites demarcating the reach.

Results

Travel Time for Las Vegas Wash

Travel times for Sites S1-S8 are tabulated in Table 3 and shown in Figure 9 and Figure 10. The travel time from the dye input to Site S8 represents the overall travel time for the Wash. Site S8 was located 14.33 miles from the dye input and 2.72 miles below the full pool level of Lake Mead during this study. The time for the dye peak to travel from the input site to site S8 was 14.23 hours. The centroid of the dye pulse passed at 16.78 hours. The leading edge of the dye reached site S8 after 12.82 hours, and the trailing edge passed at 18.60 hours after the dye input. Dye was present at site S8 for a duration of 5.78 hours.

Travel times for sites between the input and S8 (S1-S7) represent travel times for intermediate reaches of the Wash. The travel times and duration of dye presence generally increased with distance downstream. The dye peak at site S1 was observed at 0.83 hours and at site S7 was observed at 11.9 hours after dye input. The duration of dye presence ranged from 0.63 hours at site S1 to 5.17 hours at site S7. This is indicative of dispersion of the dye laterally along the Wash length. The centroid generally reached each sampling site after the peak, and the time between the peak and centroid generally got longer with distance downstream, also indicating dispersion. For example, the centroid occurred at 0.16 hours after the peak for site S1 and 1.79 hours after the peak for site S7. Upstream dispersion (after the peak) appeared to dominate, with the average time between the peak and the trailing edge lasting three times longer than the time between the peak and the leading edge.

An anomaly was noted in the travel time data for site S4a. The time to peak aligned with the pattern expected based on the other sites, but the centroid occurred approximately 3 hours earlier than the peak for this site, in contrast to other sites where the centroid occurred after the peak. The Rhodamine concentrations for this site were also lower than expected based on the measurements at other sites. After further examination of the data, no explanation for these anomalies could be determined.

Table 3. Travel times in hours

Site	Distance from input (miles)	Time to Peak (hours)	Centroid (hours)	Leading Edge (hours)	Trailing Edge (hours)	Duration (hours)	Peak to Centroid (hours)
S1	0.40	0.83	0.99	0.72	1.35	0.63	0.16
S2	2.13	2.33	2.55	2.03	3.03	1.00	0.21

Site	Distance from input (miles)	Time to Peak (hours)	Centroid (hours)	Leading Edge (hours)	Trailing Edge (hours)	Duration (hours)	Peak to Centroid (hours)
S3	3.38	3.90	3.92	3.15	5.42	2.27	0.02
S4a	4.45	5.98	2.84	5.42	7.55	2.13	-3.15
S4b	4.51	6.15	6.21	5.57	7.95	2.38	0.06
S5	5.66	7.37	8.37	6.60	9.68	3.08	1.00
S6	6.83	10.00	11.60	8.80	14.22	5.42	1.60
S7	8.38	11.90	13.69	10.70	15.87	5.17	1.79
S8	14.33	14.23	16.78	12.82	18.60	5.78	2.55

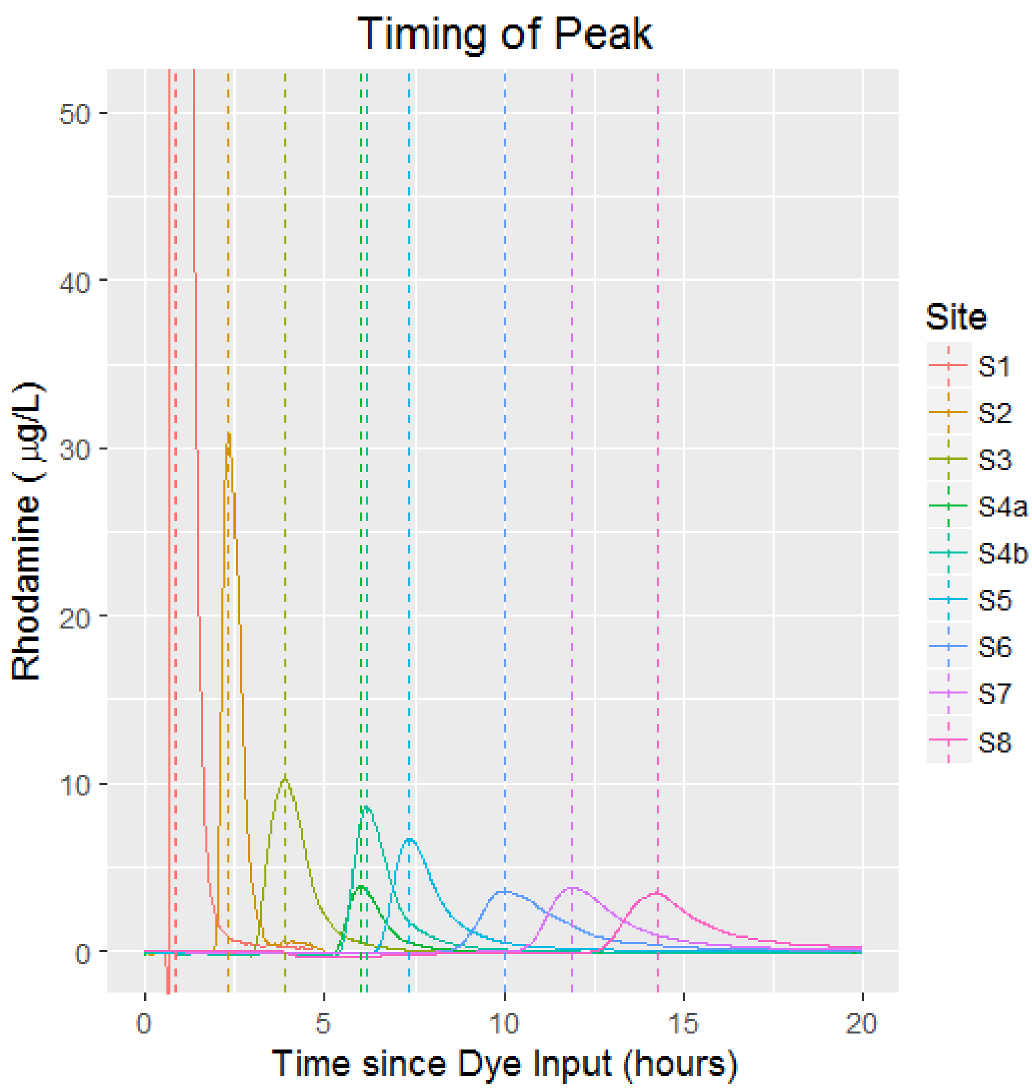

Figure 9. Timing of dye peak for Sites S1 to S8. The peak for each site is indicated by a vertical dashed line.

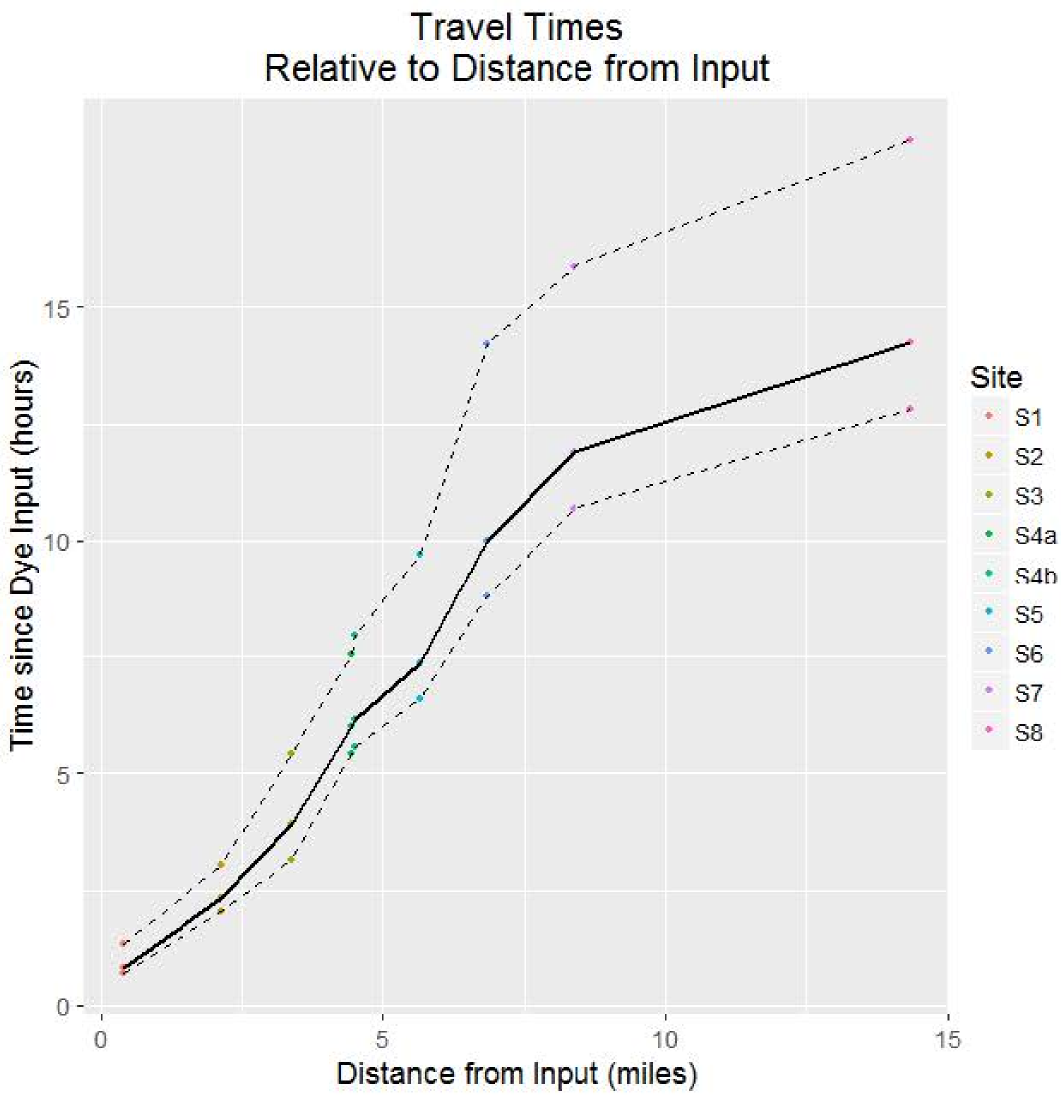

Figure 10. Travel times for sites S1 to S8 plotted against distance downstream. The solid line represents the peak, the lower dashed line represents the leading edge, and the higher dashed line represents the trailing edge.

Velocity

On average, dye traveled at 1 mile per hour (mi/hr) through the Wash from the input to site S8. Reach velocities were generally less than 1 mi/hr, except for the reach between S7 and S8, which had a velocity of 2.55 mi/hr. The reach between S7 and S8 includes the portion of the Wash that is piped beneath Lake Las Vegas and the portion of the Wash downstream of Lake Las Vegas that has not been the focus of recent restoration efforts.

The slowest velocity, 0.35 mi/hr, was observed in the reach between sites S4a and S4b, which were located directly on the upstream and downstream edges of the recently constructed Upper Narrows weir (completed in 2013). This indicates that the weir is slowing the water velocity as it passes through the weir structure itself.

Based on the times between the dye peaks at S4a and S4b, the retention time for the Upper Narrows weir is approximately 0.17 hours (10 minutes)

Table 4. Reach velocities.

Reach	Distance (miles)	Time between Peaks (hours)	Average Reach Velocity (mi/hr)
Input -S1	0.40	0.83	0.48
S1-S2	1.73	1.50	1.15
S2-S3	1.25	1.57	0.80
S3-S4a	1.07	2.08	0.51
S4a-S4b	0.06	0.17	0.35
S4b-S5	1.16	1.22	0.95
S5-S6	1.16	2.63	0.44
S6-S7	1.55	1.90	0.82
S7-S8	5.96	2.33	2.55

Comparison to Other Studies

The Brown and Caldwell dye tracer study (Brown and Caldwell, 1982) measured a travel time of 17.5 hours between the Confluence and Northshore Road bridge, while Roline and Sartoris found a travel time of 5.75 hours for the same reach, indicating significant changes in channel morphology between the two studies. This finding is supported by the results of Leising in 2003, who found a similar travel time result as Roline and Sartoris for the Pabco to Northshore Road reach. Estimating travel times to Pabco and Northshore Roads using the time to the peak for the nearest sampling sites, the current study found an estimated travel time of 9.6 hours from the Confluence (site S2) to Northshore Road (site S7), with a 4.45 hour travel time for the reach from the Confluence to Pabco Road (average of sites S4b and S5), and 5.15 hours from Pabco Road to Northshore Road (Table 5).

Table 5. Summary of travel times in hours found by previous studies. Reclamation travel times were estimated from the peaks for Sites S2 (Confluence), the average of S4b and S5 (upstream and downstream of Pabco Road), and S7 (upstream of Northshore Road).

	Travel Time (hours)			
Reach	**Brown and Caldwell, 1982**	**Roline and Sartoris, 1986**	**Leising, 2003**	**Reclamation, 2015 (estimated)**
Confluence (S2) to Pabco Road (S4b/S5)	7	2.75	N/A	4.45
Pabco Road (S4b/S5) to Northshore Road (S7)	10.5	3	3.5	5.15
Confluence (S2) to Northshore Road (S7)	17.5	5.75	N/A	9.6

Discussion and Conclusion

This study has shown that the average travel time for water through the Wash between Vegas Valley Drive and Site S8 located near the Las Vegas Bay Marina boat launch (14.33 miles downstream from the dye input and 2.72 miles below the full pool level of Lake Mead) was 14.23 hours. For the reach between the Confluence and Northshore Road, the travel time was approximately 9.75 hours. The average velocity of water in the Wash is 1 mi/hr, with reach velocities ranging from 0.35 to 2.55 mi/hr. Travel time was slowest through weirs and fastest through Reach S7-S8, where the Wash is piped underneath Lake Las Vegas and travels through the channel from Northshore Road to the Las Vegas Bay. Some erosion control features have been installed in the channel between Northshore Road to the Las Vegas Bay, but the efforts have not been as extensive as in the upstream reaches.

Compared to previous measurements of travel time, the travel time measured in December 2015 is greater than the value observed by Roline and Sartoris in 1985, but less than the value observed by Brown and Caldwell in 1980. This indicates that the grade control structures installed since 2000 have had the intended effect of increasing travel times through the Wash. Because the flow regime in the Wash has changed since 1980 due to increasing population, restoration efforts may not result in future travel times that are the same as previously measured values. However, as evidenced by the travel times between sites S4a and S4b, the weirs are performing as expected in slowing the movement of water through the Wash. Along with the weirs, vegetation is also likely contributing to slowing the water flow and retaining sediment.

Over time, riparian vegetation plantings can be expected to grow and develop, further enhancing the detention of water and increasing travel times. The additional weirs anticipated in the Capital Improvement Plan can also be expected to further slow the water travel times. To monitor changes in travel time as additional weirs and restoration projects are completed and existing vegetation and wetlands mature, it is recommended that the travel time study be repeated at least once in the next five years. The Rhodamine discharge permit obtained for this study is effective through October 11, 2020 and the sensors and dataloggers can be reused.

The techniques used in this study to measure travel time through the Wash can also be applied to other streams to gauge impacts of riparian restoration efforts, such as construction of grade control structures, installation of large woody debris, riparian plantings, construction of backwater rearing ponds, and remeandering. Changes in travel time could also be used as an indicator of erosion risk, potential for water quality impacts, and habitat availability.

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Supporting Data Sets

The following datasets and analysis files are associated with this final report:

Description	Excel and CSV files containing the raw and processed sensor data collected and used for the study
Folder Name and File Path	ibr3lcrfp001\div\d2000\com2600\water quality\las vegas wash\dye study \ Final Report\Supporting Datasets\Sensor Data
Point of Contact Name, Email, and Phone	Allison Danner, adanner@usbr.gov, 702-293-8331 Becky Blasius, bblasius@usbr.gov, 702-293-8109

Description	Excel and CSV files containing the raw and processed sensor data collected and used for the study
Keywords	Eureka TDX datalogger, Turner Designs Cyclops Rhodamine sensor, Travel Time, Retention Time, Dye Study, Dye Tracer
File Size	38.1 MB

Description	R Files used for analyzing data
Folder Name and File Path	ibr3lcrfp001\div\d2000\com2600\water quality\las vegas wash\dye study \ Final Report\Supporting Datasets\R Analysis
Point of Contact Name, Email, and Phone	Allison Danner, adanner@usbr.gov, 702-293-8331 Becky Blasius, bblasius@usbr.gov, 702-293-8109
Keywords	R, RStudio, Travel Time, Dye Study, Dye Tracer
File Size	7.13 MB

Description	Excel files used for analyzing data for the study, including sensor data and USGS data
Folder Name and File Path	ibr3lcrfp001\div\d2000\com2600\water quality\las vegas wash\dye study \ Final Report\Supporting Datasets\Excel Analysis
Point of Contact Name, Email, and Phone	Allison Danner, adanner@usbr.gov, 702-293-8331 Becky Blasius, bblasius@usbr.gov, 702-293-8109
Keywords	Excel, USGS, Travel Time, Retention Time, Dye Study, Dye Tracer
File Size	4.03 MB

Description	Excel files used for analyzing USGS data for this study and for previous studies
Folder Name and File Path	ibr3lcrfp001\div\d2000\com2600\water quality\las vegas wash\dye study \ Final Report\Supporting Datasets\USGS Data
Point of Contact Name, Email, and Phone	Allison Danner, adanner@usbr.gov, 702-293-8331 Becky Blasius, bblasius@usbr.gov, 702-293-8109
Keywords	Excel, USGS, Travel Time, Dye Study, Dye Tracer
File Size	20.0 MB

Description	ArcGIS files used to generate the study area map
Folder Name and File Path	ibr3lcrfp001\div\d2000\com2600\water quality\las vegas wash\dye study \ Final Report\Supporting Datasets\GIS Data
Point of Contact Name, Email, and Phone	Katherine Zander, kzander@usbr.gov, 702-293-8523 Becky Blasius, bblasius@usbr.gov, 702-293-8109
Keywords	ArcGIS, Dye Study, Dye Tracer
File Size	0.98 MB