3 Data Presentation

ADCP Velocity and Direction Profile Measurements

Plates 9-14 are representative time history plots of the ADCP velocity and direction data obtained during the data collection periods. The orientations of the directions of flow in the plots are all downstream. The left and right sides of the plots are the left- and right-descending banks, respectively. The flow directions were 90 deg to the orientation of the range.

Maximum magnitudes of velocities within the main river ranged from 0.20 to 1.16 m/sec. It should be noted that these magnitudes are for the background (no river traffic effects) levels near the channel of the main river. With the exception of those ranges positioned in the inlets to the backwater or side channels, no ADCP velocity measurements were made in the remote off-channel areas (back-water and side channels). The observed maximum velocity magnitudes for the ADCP measurements are summarized below:

Main River Channel Maximum ADCP Velocity Magnitude, m/sec

Location	Date	R1.0	R2.0	R3.0	R5.0
Pool 8	10/95	1.04	N/A	1.07	N/A
	09/96	0.22	N/A	0.7	N/A
Pool 26	11/95	1.13	N/A	N/A	1.13
	07/96	1.16	N/A	N/A	1.13
	09/96	0.55	N/A	N/A	0.79
La Grange	07/96	N/A	0.79	0.76	0.85
	09/96	N/A	0.49	0.52	0.52

N/A = not a main river channel velocity range location.

Significant discharges existed during the October-November 1995 data collection effort at Pools 8 and 26. All the monitored flows for Pools 26 and La Grange are below the 50-percent duration flow and therefore do not reflect the full range of high, medium, and low flows. Discharges over the entire study period ranged from 248 to 1,438 cu m/sec. No significant eddies or unusual flow patterns were observed at any of the data collection ranges.

Fixed-Depth Velocity Measurements

Representative time histories of the fixed-depth velocity meter recordings during the data collection periods illustrating tow passage events and the effects on the current magnitudes near the channel boundary limit in the main river and the off-channel monitoring locations are shown in Plates 15-30. Average magnitudes of current speeds within the channel borders of the main river ranged from 0.10 to 0.47 m/sec. It should be noted that these magnitudes are for the background (prior to a river traffic event) levels near the channel of the main river. Average magnitudes of current speeds within the off-channel areas (backwater and side channels) ranged from 0.10 to 0.60 m/sec. The observed maximum and average velocity magnitudes for the fixed-depth current meters from each data collection site are summarized in the Tables 2-5.

Direction of travel, loading, and barge configurations play a part in the overall effect of changes in velocity magnitude and flow direction. Upbound tows and downbound tows passing within close proximity to the current meters in the main river create totally different effects on velocity readings. Upbound tows have a tendency to increase the longitudinal velocity magnitude near the channel border, whereas downbound tows will have the opposite effect. Loaded tows that are upbound were observed to increase the longitudinal velocities near the channel border by a factor of 2 in wide channels, such as Pool 26, and by a factor of as much as 4 in narrow channels, such as La Grange Pool. The decrease in velocities caused by downbound loaded barges within the narrow channels were accompanied with a change in flow direction that ranged from 180 to 200 deg. Plate 24 illustrates the effects of both a downbound and upbound towboat. From Table 10, the direction of travel and time of arrival of the boats at Range 5 can be determined. The upbound vessel (Boat B04) arrived at 10:16 a.m., and the downbound vessel (Boat B05) arrived at 11:00.

The observed net increase or decrease in velocity magnitudes is relatively short term in duration, depending on the length of the entire vessel and the time required to pass the instrument location. The duration of the changes in velocity magnitudes and flow direction ranged from 1.5 min to 5 min.

Velocity instruments located in the off-channel areas displayed varied effects due to the tow passage, from no effect at all to slight changes in background velocity magnitudes. The most significant effect was observed in the off-channel areas in the La Grange Pool study area. Plates 27-30 represent tow passage

effects in a small tributary (low-flow outfall slough) and a side channel around an island, respectively.

Water-Surface Waves and Drawdown Measurements

The variation of water-surface waves due to wind and navigation traffic observed during the various data collection efforts is shown in the representative time history plots (Plates 31-44).

The values of maximum wave height for upbound and downbound vessels did not differ significantly. The range of maximum wave heights from barge traffic varied between 0.06 and 0.12 m. The largest wave heights observed (0.24 - 0.30 m) were produced by recreational boat traffic on the Illinois River and are shown in Plate 44. The maximum measured drawdown produced by passing barge traffic, 0.2 m, occurred in the main channel at the La Grange Pool study area. The combination of the narrow channel width and shallow depth at the study site contributed to the significance of the drawdown effect.

The data from the water-level recorders in the main river were used as a reference for comparison with the data from the other off-channel locations in order to estimate water-level differences between the main river and off-channel reaches of the study areas. This comparison illustrated that minimum wave effects were observed in the off-channel areas at all the study sites ranging from 0.0 to 0.02 m. Plates 6 and 7 illustrate the most notable effects, which were measured in a side-channel location (Sugar Creek Island) on the Illinois River near ranges R4 and R5. Physically, this side channel was relatively short in length, in close proximity to the main channel, and connected to the main river at both ends. The maximum recorded drawdown in this side channel was 0.14 m as shown in Plate 42. Maximum wave heights in the side channel during tow passage were less than 0.05 m. The maximum wave heights observed in the off-channel monitoring locations due to vessel traffic on the main river ranged from no change above background level to 0.06 m. During the study periods, no sustained winds occurred that could produce significant wind waves.

Suspended-Sediment Concentration Measurements

General observations on the suspended-sediment concentrations for both background data and changes due to navigation traffic through the study areas indicated some general trends occurring. Plates 45-89 are typical representative plots of suspended-sediment levels during background observations and increases during barge-tow events. The observed mean background suspended-sediment concentrations for the data collection periods ranged from 19.9 to 225 and 19.9 to 135 mg/L for the main channel and off-channel monitoring locations, respectively.

Following tow passage events, the increases in suspended-sediment concentrations in the main river ranged from no change above background levels to 400 mg/L. Pulsing of the sediment plume after a tow passage, particularly a loaded tow in the upbound direction, was found to occur at all three sites. This pulsing can be defined by sharply increasing and decay of sediment-concentration levels followed by multiple smaller increases and decays. The pulses following the tow passage may exist in the main river channel for periods of time varying from 20 to 60 min before suspended-sediment concentrations return to ambient levels. An example of this is shown in Plates 78-80.

In the off-channel monitoring locations, the changes in suspended-sediment concentrations ranged from no increase above background levels to 330 mg/L. In general, suspended-sediment concentration values at the profile locations within the backwater inlets connected to the main river indicate no significant increases due to tows passing the inlets to the off-channel areas. The majority of sediments resuspended by the navigation traffic appeared to remain in the main river channel. The Sugar Creek Island side channel entrance site, La Grange Pool, experienced some of the most significant responses due to tow passage as shown in Plates 84-86. A significant increase in suspended-sediment concentration level in the near-surface measurement zone generally occurred following an upbound tow passage. Downbound tows did not raise the concentrations above the measured background levels. These increases, however, also displayed some of the pulsing characteristics discussed earlier. These high levels of suspended sediment could possibly be due to a combination of the sediment plume from the passing vessel and the resuspension of nearshore sediments from the vessel drawdown and waves.

Grain-Size Distribution of Bottom Materials

In addition to suspended-sediment concentration, bottom-material sediment samples were analyzed to determine representative ranges of grain sizes typical of both the main river channels and off-channel locations in each study area. All samples were composed of medium to fine sand, silt, and clay. The La Grange Pool samples from the main river contained some shell and fragments. The median diameter (d_{50}) grain size of bed material for the Mississippi River in Pool 26 ranged from 0.38 to 0.58 mm and from 0.16 to 0.50 mm within the main channel and off-channel locations, respectively. For Pool 8 of the Mississippi River, the d_{50} grain size of bed material ranged from 0.43 to 0.48 and 0.26 to 0.46 mm within the main and off-channel locations, respectively. La Grange Pool main channel bed material d_{50} grain sizes ranged from 0.07 to 0.42 mm, whereas, the off-channel bed material d_{50} grain size ranged from 0.08 to 0.18 mm. Plates 90-96 are representative gradation curves of the bed material for each study area.

Vessel Traffic Characteristics

Tables 6-12 present the field observations made of navigation vessel characteristics from each of the data collection sites. The information includes the total number of barge-tows that transited each site, loading, configuration of barges, estimated length, direction of travel, vessel speed, sailing line, and vessel identification. A total of 69 vessel traffic events were recorded during the various trips to the study sites. Vessels during the study periods varied from small recreational vessels to large tow configurations of three barges wide by five long.