SEEPAGE, SOIL, AND SEDIMENT DATA FOR SELECTED CANALS, WIND RIVER FEDERAL IRRIGATION PROJECT, WYOMING, 1990-91

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CONVERSION FACTORS AND ABBREVIATIONS

Multiply	By	To obtain
acre-foot per year (acre-ft/yr)	1,233	cubic meter
cubic foot per second (ft^3/s)	0.02832	cubic meter per second
inch (in)	25.4	millimeter
foot (ft)	0.3048	meter
mile (mi)	1.609	kilometer
ton	0.9072	megagram

Temperature can be converted to degrees Fahrenheit (°F) or degrees Celsius (°C) as follows:

$$°F = 9/5\ (°C) + 32$$

$$°C = 5/9\ (°F - 32)$$

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Kirk A. Miller

ABSTRACT

Seepage and soil data are presented for four reaches of three canals and sediment data are presented for three stream and canal pairs on the Wind River Federal Irrigation Project (WRFIP). The WRFIP is located in the west-central and south-central parts of the Wind River Indian Reservation in central Wyoming. Data presented in this report were collected by the U.S. Geological Survey as part of a cooperative study with the Shoshone and Northern Arapahoe Tribes and the U. S. Bureau of Indian Affairs.

The seepage data consist of gains and losses computed from measured discharges at the upstream and downstream ends of selected canal study reaches and at diversions on the study reaches. Discharge measurements were made on Dinwoody Canal (May and August 1990, and May 1991), Dry Creek Canal (July and August 1990, and May 1991), and Ray Canal (May and August 1990).

The soil data consist of physical properties of soil samples collected at points along the study reaches. These soil data include sample structure, particle-size distribution, texture, and bulk density. Soil sample data are presented for two sites on Dinwoody Canal, two sites on Dry Creek Canal, and three sites on Ray Canal.

The sediment data consist of suspended-sediment concentration, computed suspended-sediment and bedload discharge, and bedload particle-size distribution of samples collected at sites on selected stream and canal pairs. Sediment samples were collected at sampling sites on Dry Creek and Dry Creek Canal (July and August 1990, and May 1991), Little Wind River and Subagency Canal (July 1990 and May 1991), and Wind River and Johnstown Canal (July and August 1990).

INTRODUCTION

The Wind River Federal Irrigation Project (WRFIP) is in the west-central and south-central parts of the Wind River Indian Reservation in central Wyoming (fig. 1). The WRFIP consists of distinct diversion units in which about 170,000 acre-ft/yr of water is diverted from streams and distributed through a network of about 90 mi of canals each year (Donald Crook, U.S. Bureau of Indian Affairs, oral commun., 1989). Most of the canals on the WRFIP are constructed in soil, rock, and other unconsolidated materials and are unlined. Losses of irrigation water because of seepage through these materials are known to exist (McGreevy and others, 1969; Hurlbut,

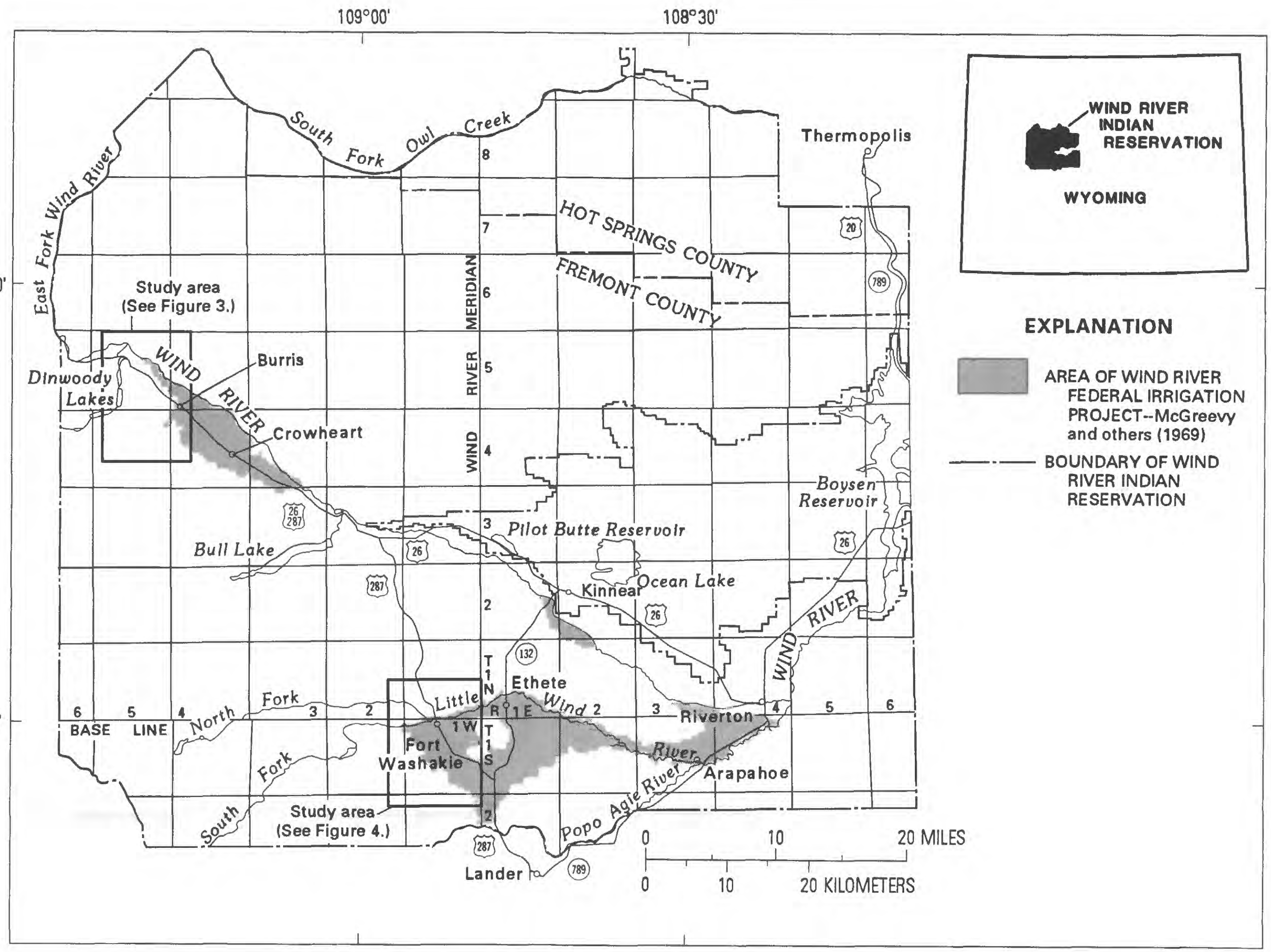

Figure 1.--Location of study areas and Wind River Federal Irrigation Project.

Kersich & McCullough Consulting Engineers, 1975); however, the magnitude of these losses has not been determined. WRFIP water managers need seepage loss data for management of the existing project and for use in the design of future irrigation projects.

Many streams that supply irrigation water to the WRFIP transport sediment. This sediment is deposited in some canals with flow velocities slower than the flow velocities in the streams from which irrigation water was diverted. The sediment must be dredged from the canals to maintain their efficiency. WRFIP water managers need sediment-transport data for representative streams and associated canals to use in the design of future diversions.

A reconnaissance of the WRFIP was made to select data collection reaches and sites. Four canal study reaches were selected for collecting seepage data. Sites on three stream and canal pairs were selected for collecting sediment data. Seepage and sediment data were collected between March 1990 and May 1991. The study was conducted by the U.S. Geological Survey (USGS) in cooperation with the Shoshone and Northern Arapahoe Tribes and the U.S. Bureau of Indian Affairs.

Purpose and Scope

This report presents seepage, soil, and sediment data collected for selected canal study reaches on the WRFIP. The seepage data consist of net gains or losses in discharge computed from measured discharges at the upstream and downstream ends of selected canal study reaches and at diversions on the study reaches. The soil data consist of physical properties of soil samples collected at points along the study reaches. These soil data include sample structure, particle-size distribution, texture, and bulk density. The sediment data consist of suspended-sediment concentration, computed suspended-sediment and bedload discharge, and bedload particle-size distribution.

The scope of this report precluded interpretation of the data. Streamflow discharge data and computed net gains or losses in discharge are presented for Dinwoody Canal (May and August 1990, and May 1991), Dry Creek Canal (July and August 1990, and May 1991), and Ray Canal (May and August 1990). Soil samples are presented for two sites on Dinwoody Canal, two sites on Dry Creek Canal, and three sites on Ray Canal. Suspended-sediment concentration, bedload particle-size distribution data, and computed suspended-sediment and bedload discharge are presented for sampling sites on Dry Creek and Dry Creek Canal (July and August 1990, and May 1991), Little Wind River and Subagency Canal (July 1990 and May 1991), and Wind River and Johnstown Canal (July and August 1990).

Acknowledgments

Appreciation is extended to the Wind River Environmental Quality Commission and the U.S. Bureau of Indian Affairs. Personnel from each of these agencies provided valuable information and assistance during the course of this study. Also appreciated is the assistance provided by Joseph F. Meyer, U.S. Bureau of Land Management, who provided information and assistance on data-collection and analysis techniques for soil samples.

DATA COLLECTION

A reconnaissance of the WRFIP was made during March and April 1990 to identify four canal reaches for investigating seepage losses and sites on three stream and canal pairs for investigating sediment transport. Reconnaissance and selection of the study reaches and sites involved personnel from the Wind River Environmental Quality Commission, U.S. Bureau of Indian Affairs, and USGS.

Seepage and Soil Data Collection

Seepage and soil data were collected for four canal study reaches on the WRFIP. The study reaches were chosen on the basis of one or more of the following criteria: (1) apparent seepage losses from the canal, (2) representative surficial geology, (3) number of diversions and inflows, and (4) discharge-measurement suitability.

Continuous-record and partial-record gaging stations were used to monitor canal stage during discharge measurements. Existing continuous gaging stations were used or, if needed, partial-record gaging stations were established at the upstream and downstream ends of the study reaches. Partial-record gaging stations consisted of strip-chart recorders on stilling wells with 10-in. floats. Canal stage was monitored to verify that steady-state flow conditions existed.

Seepage data for the canal study reaches consist of net gains or losses in discharge computed from measured discharges. Discharge measurements were made on the canal study reaches during May, July, and August 1990, and May 1991. Discharge was measured with a current meter according to standard USGS methods (Buchanan and Somers, 1969). Discharge measurements were made at the upstream and downstream ends and select intermediate sites of the study reaches. Discharge was measured for all active diversions except for those in which flow was too small to measure using standard USGS methods, or in which discharge measured by earlier seepage investigations determined the flow to be less than the accuracy of the total canal discharge. When discharge was not measured for the latter two reasons, the discharge is reported as "not measured" (nm) in table 1 at back of report. All diversions from canals as well as potential inflow sites were inspected to verify their status (active or inactive) before discharge measurements were made. Measured discharge at each site is reported to 3 significant figures in this report. Exceptions were discharges less than 1 ft^3/s which were reported to the nearest hundredth. Gain or loss in discharge for a study reach is computed as the difference between discharge measured at successive downstream sites less measured discharges for any active diversions in the study reach. Overall net gain or loss in discharge by date and study reach was calculated after the measured discharge at each site was rounded to be consistent with the least accurate measurement.

Gains or losses in discharge presented in this report might be in error due to inaccuracies in discharge measurements. The accuracy of an individual discharge measurement is affected by the condition of the measuring equipment, the physical characteristics of the measuring section, the accuracy of the depth measurements, and other factors (Rantz and others, 1982, p. 179). A qualitative rating of accuracy is assigned to the measurement by the hydrographer who made the measurement. This rating represents the cumulative errors associated with the aforementioned factors. All discharge measurements made during this study were rated good or better (an error less than +/- 5 percent). Therefore, net gains or losses of discharge less than 5 percent of the least accurate measurement for any given set of measurements should be qualified.

Soil data consist of physical properties of soil samples collected at sites along the canal study reaches where the channel was stable. Soils in the study reaches were sampled during October 1990. Loose surface material and debris were removed prior to sampling (about 0.15 ft). Most soil samples were collected as a 2-in.-diameter vertical core by using bed-material sampler US BMH-53 (see Edwards and Glysson, 1988, for a description of the sampler and its limitations). Depth interval sampled represents the total length of core collected. Some soil samples containing high percentages of sand and (or) water had to be collected with a spade. A minimum of four vertical-core samples were collected at each site--two from the "built-up" canal wall (designated "W" samples) and two or three from the canal bottom (designated "B" samples) (fig. 2). At each soil-sampling site, sample W1 was a vertical core collected near the approximate operating water level of the canal. Sample W2 was collected below sample W1 using the same corehole except in cases where sloughing occurred in the corehole. In those cases, the site was excavated down to the depth of sample W1 before collecting sample W2. Similarly, samples B1 and B2 (and B3 at one site) were collected in the canal bottom. A duplicate sample was collected and analyzed to provide an indicator of soil variability at two sites. Soil structure, when present, and a qualitative moisture content were noted onsite for each sample. Sand-silt-clay size fractions (smaller than 2.0 mm) and clod bulk density (where possible) were determined for each sample according to standard U.S. Department of Agriculture methods (Kelli Belden, University of Wyoming, Department of Plant Soil and Insect Sciences, Soil Testing Laboratory, oral commun., 1992; also, see U.S. Department of Agriculture, 1951, p. 225, for definitions of soil terms). Soil textures were determined from particle-size distribution data according to the standard soil texture classification scheme (U.S. Department of Agriculture, 1951, p. 205).

Sediment-Data Collection

Sites on three stream and canal pairs were chosen for sediment-data collection on the WRFIP. The sites were chosen on the basis of one or more of the following criteria: (1) apparent sediment transport or deposition, (2) suitability of the site for sediment sampling, (3) suitability of the site for discharge measurement, and (4) cooperator interest.

Suspended-sediment and bedload samples were collected for each sampling section during July and August 1990, and May 1991. Sampling sections were established at each study site on the stream upstream of the diversion, and on the canal downstream of the diversion. Suspended-sediment samples were collected using the equal-width-increment (EWI) method (Edwards and Glysson, 1988, p. 61). Bedload samples were collected using the single equal width increment (SEWI) method (Edwards and Glysson, 1988, p. 98). Duplicate samples were collected at most sampling sections. Discharge was measured with a current meter at most sampling sections. Discharge was determined from stage-discharge ratings at established streamflow-gaging stations where available. Suspended-sediment concentration and bedload particle-size distribution for each sample were determined by the USGS Wyoming District Sediment Laboratory in Cheyenne, Wyoming according to standard USGS methods (Guy, 1969). Suspended-sediment discharge was computed by multiplying suspended-sediment concentration, in milligrams per liter, times stream discharge, in cubic feet per second, times the conversion factor 0.0027. Suspended-sediment concentration and computed discharge values for duplicate suspended-sediment samples were summed and the mean values reported. Values of discharge computed from duplicate bedload samples were reported separately because of the variability in bedload discharge (Edwards and Glysson, 1988, p. 92). Bedload discharge was computed using the total cross-section method (Edwards and Glysson, 1988, p. 103).

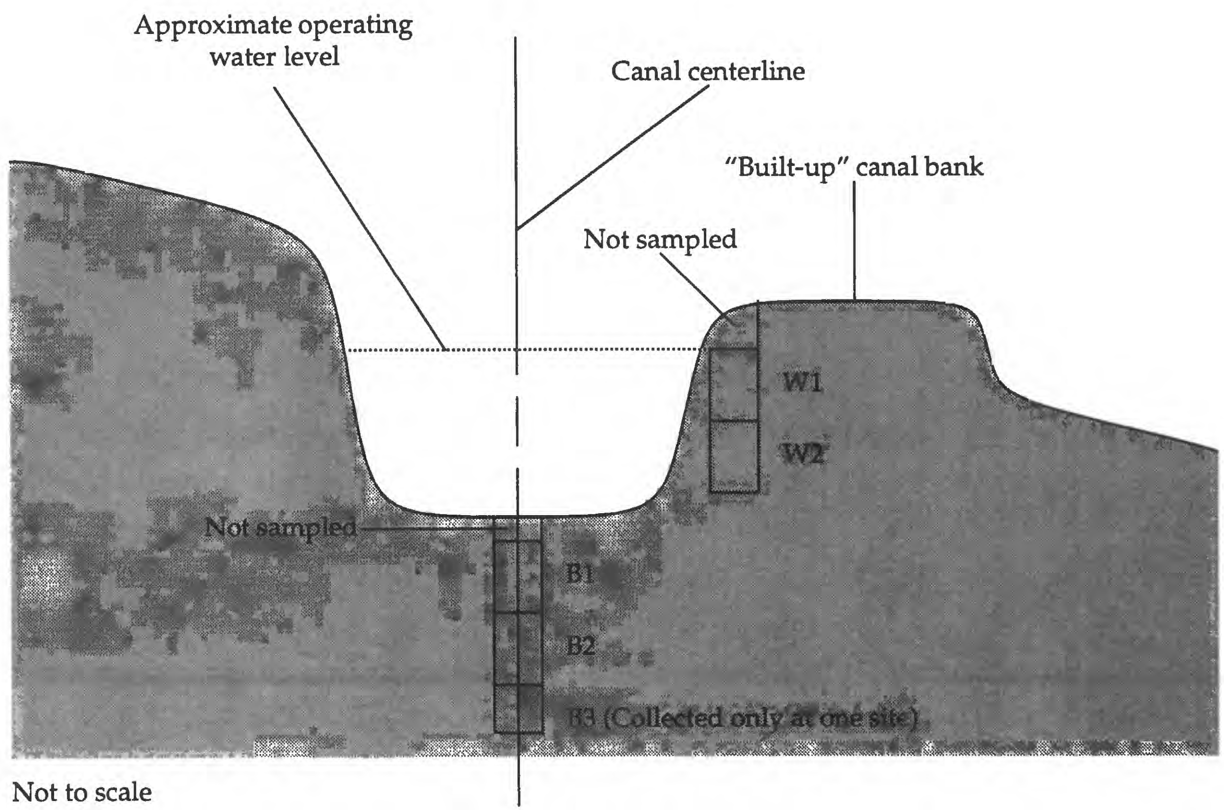

Figure 2.--Schematic of canal cross section showing relative positioning of soil samples.

SEEPAGE AND SOIL DATA FOR SELECTED CANALS

Canal study reaches were selected for the collection of seepage and soil data. The study reaches are reaches of Dinwoody Canal, Dry Creek Canal, and Ray Canal.

Dinwoody Canal

The study reach selected on Dinwoody Canal begins at a partial-record gaging station (DIN-1) about 600 ft downstream from the diversion from Dinwoody Lake and ends at a partial-record gaging station (DIN-4) installed about 0.8 mi upstream of Dry Creek (fig. 3). The study reach is about 9.8 canal mi long. Dinwoody Canal was constructed to provide supplemental water other established irrigation areas. Thus, no diversions are in the study reach. No inflows were observed along the study reach of Dinwoody Canal during each seepage investigation.

Discharge-measurement and soil-sampling sites and geology for the study reach are shown in figure 3. Selected physical properties of soil samples are presented in table 1 at back of report. Measured discharge and gains or losses in discharge between discharge-measurement sites are presented in table 2 at back of report.

Dry Creek Canal

The study reach selected on Dry Creek Canal begins at the continuous-record gaging station (DRY-1) about 200 ft downstream from the diversion from Dry Creek and ends at a partial-record gaging station (DRY-2) installed about 1.6 mi downstream from Lateral-11C (fig. 3; the measurement site on Lateral-11C is designated LAT-11C). The study reach is about 3.7 canal mi long. Several diversions in the study reach were active during the seepage investigations; of which Lateral-11C was the only diversion with measurable flow. The remaining diversions were shut off during the seepage investigations. No inflows were observed along the study reach of Dry Creek Canal during each seepage investigation.

Discharge-measurement and soil-sampling sites and geology for the study reach are shown in figure 3. Selected physical properties of soil samples are presented in table 1 at back of report. Measured discharge and gains or losses in discharge between discharge-measurement sites are presented in table 2 at back of report.

Upper Ray Canal

Ray Canal diverts water from the South Fork Little Wind River. The study reach referred to in this report as upper Ray Canal consists of the reach of Ray Canal beginning at the continuous-record gaging station (URAY-1) about 160 ft downstream from the diversion from the South Fork Little Wind River and ending at a partial-record gaging station (URAY-2) installed about 100 ft downstream from Trout Creek Road (fig. 4). The study reach is about 1.4 canal mi long. During the seepage investigations, four diversions in the study reach were active; three of which had measurable flow on May 30, 1990: Lateral-2C, Lateral-6C, and Turnout-63 (fig. 4; measurement sites on each of the previous diversions are designated LAT-2C, LAT-6C, and TO-63). Diversion flows into Lateral-6C and Turnout-63 were not measurable on August 1 or August 15, 1990. No irrigation return flow or additional inflows were observed along the study reach of upper Ray Canal during each seepage investigation.

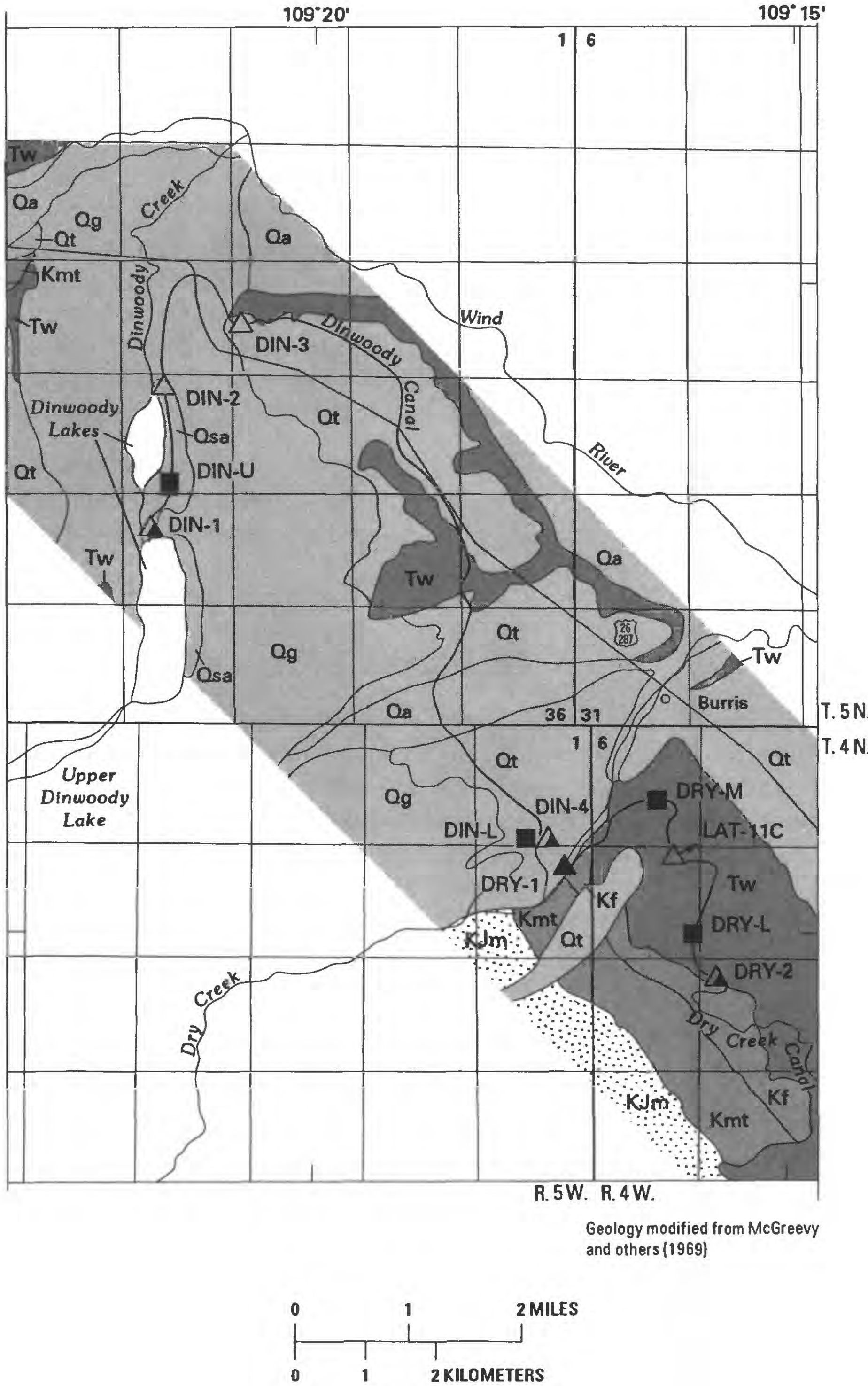

Figure 3.--Geology and location of soil-sampling and discharge-measurement sites on the Dinwoody Canal and Dry Creek Canal study reaches.

EXPLANATION

QUATERNARY	Qa	ALLUVIUM OF FLOODPLAINS AND RELATED TERRACES
	Qsa	SLOPE WASH AND ALLUVIUM
	Qt	TERRACE AND PEDIMENT DEPOSITS
	Qg	GLACIAL DEPOSITS
TERTIARY	Tw	WIND RIVER FORMATION
CRETACEOUS	Kf	FRONTIER FORMATION
	Kmt	MOWRY AND THERMOPOLIS SHALES
CRETACEOUS AND JURASSIC	KJm	CLOVERLY AND MORRISON FORMATIONS

———	CONTACT--*Approximately located*
———	CANAL STUDY REACH
DRY-M ■	SOIL-SAMPLING SITE AND SITE IDENTIFICATION
DRY-1 ▲	CONTINUOUS-RECORD GAGING STATION AND SITE IDENTIFICATION--*Discharge-measurement site*
DIN-4 △	PARTIAL-RECORD GAGING STATION AND SITE IDENTIFICATION--*Discharge-measurement site*
DIN-3 △	DISCHARGE-MEASUREMENT SITE AND SITE IDENTIFICATION
LAT-11C △	DISCHARGE-MEASUREMENT SITE AND SITE IDENTIFICATION--*Lateral or turnout diversion from canal*

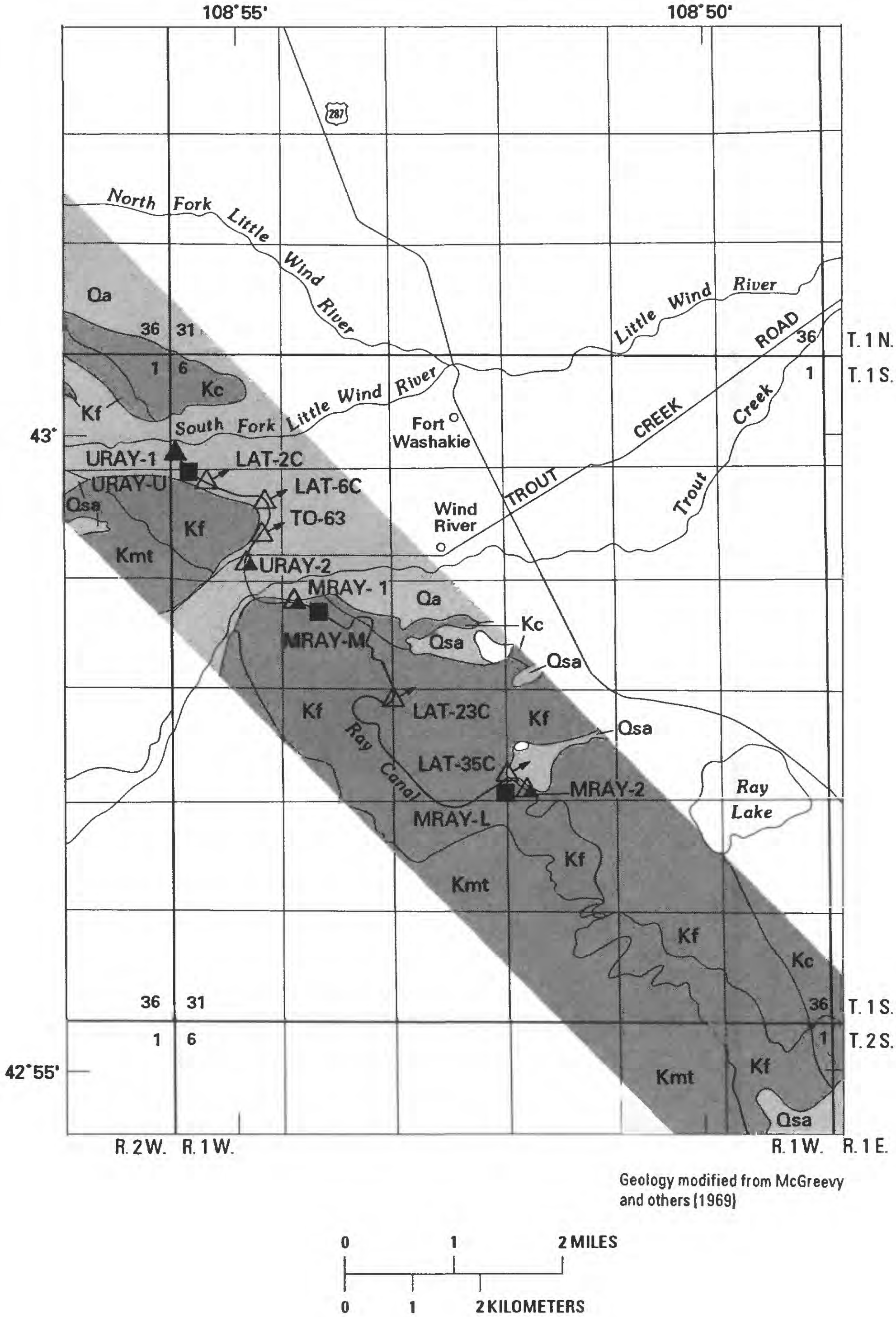

Figure 4.--Geology and location of soil-sampling and discharge-measurement sites on the Upper and Middle Ray Canal study reaches.

EXPLANATION

QUATERNARY
- Qa — ALLUVIUM OF FLOODPLAINS AND RELATED TERRACES
- Qsa — SLOPE WASH AND ALLUVIUM

CRETACEOUS
- Kc — CODY SHALE
- Kf — FRONTIER FORMATION
- Kmt — MOWRY AND THERMOPOLIS SHALES

CONTACT--Approximately located

CANAL STUDY REACH

MRAY-L ■ SOIL-SAMPLING SITE AND SITE IDENTIFICATION

URAY-1 ▲ CONTINUOUS-RECORD GAGING STATION AND SITE IDENTIFICATION--Discharge-measurement site

MRAY-2 ◭ PARTIAL-RECORD GAGING STATION AND SITE IDENTIFICATION--Discharge-measurement site

LAT-35C △ DISCHARGE-MEASUREMENT SITE AND SITE IDENTIFICATION--Lateral or turnout diversion from canal

Discharge-measurement and soil-sampling sites and geology for the study reach are shown in figure 4. Selected physical properties of soil samples are presented in table 1 at back of report. Measured discharge and gains or losses in discharge between discharge-measurement sites are presented in table 2 at back of report.

Middle Ray Canal

The study reach referred to in this report as middle Ray Canal consists of the reach of Ray Canal beginning at a partial-record gaging station (MRAY-1) installed about 0.5 mi downstream from Trout Creek and ending at a partial-record gaging station (MRAY-2) installed about 1,000 ft downstream from Lateral-35C (fig. 4; the measurement site on Lateral-35C is designated LAT-35C). The study reach is about 5.0 canal mi long. During the seepage investigations, two diversions in the study reach were active: Lateral-23C and Lateral-35C (fig. 4; measurement sites on each of the previous diversions are designated LAT-23C and LAT-35C). There was no flow in Lateral-23C on August 1 or August 15, 1990. Between Lateral-23C and Lateral-35C, the study reach traverses two ephemeral creeks, which could provide inflow to the canal. No inflows were observed along the study reach of middle Ray Canal during each seepage investigation.

Discharge-measurement and soil-sampling sites and geology for the study reach are shown in figure 4. Selected physical properties of soil samples are presented in table 1 at back of report. Measured discharge and gains or losses in discharge between discharge-measurement sites are presented in table 2 at back of report.

SEDIMENT DATA FOR SELECTED STREAM AND CANAL PAIRS

Sediment data were collected at the following stream and canal pairs: Dry Creek and Dry Creek Canal, the Little Wind River and Subagency Canal, and the Wind River and Johnstown Canal. The location of the sediment-sampling sites on each of these streams and canals is shown in figure 5.

Dry Creek and Dry Creek Canal

Sediment samples were collected from a sampling section on Dry Creek (site 1, fig. 5) and on Dry Creek Canal (site 2, fig. 5). The sampling section on Dry Creek was in a riffle about 1,000 ft upstream of the Dry Creek Canal headworks. Potential sampling sections closer to the diversion were investigated. Sample collection at these sections was not possible during normal operating flow. The sampling section on Dry Creek Canal was in a riffle about 100 ft downstream from the headworks.

Flow in Dry Creek, upstream of the diversion to Dry Creek Canal, is supplemented by discharge from Dinwoody Canal, about 0.5 mi upstream of the diversion. The Dry Creek Canal headworks incorporate a low-head diversion dam. The dam results in a pool on Dry Creek immediately upstream of the headworks. Flow in Dry Creek enters the diversion pool directly across from the headworks. Sediment was observed in suspension through the length of the pool during data-collection activities.

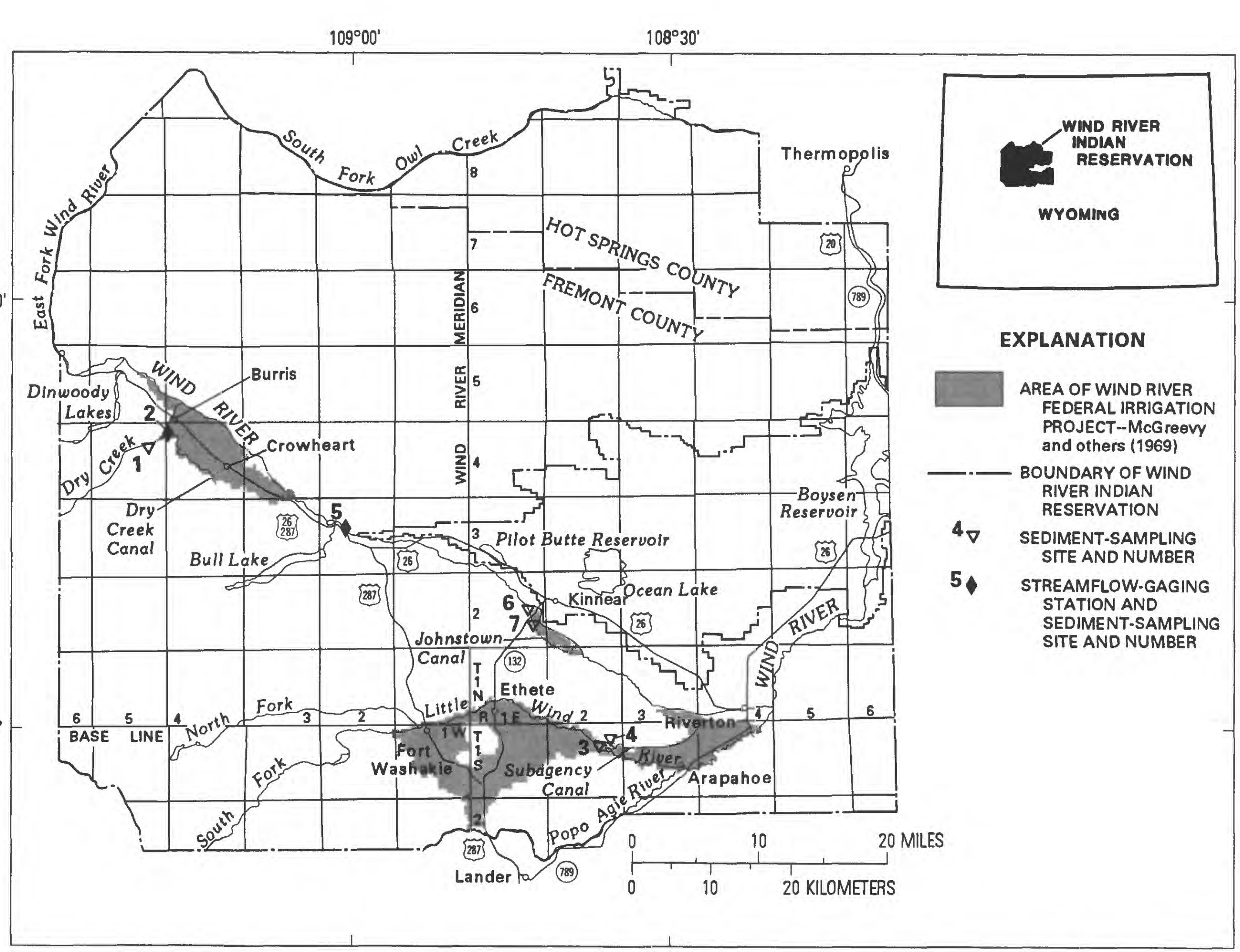

Figure 5.--Location of sediment-sampling site and number.

Suspended-sediment concentration and discharge, bedload discharge, and bedload particle-size data for the Dry Creek and Dry Creek Canal study site are presented in table 3 at back of report.

Little Wind River and Subagency Canal

Sediment samples were collected from a sampling section on the Little Wind River (site 3, fig. 5) and on the Subagency Canal (site 4, fig. 5). The sampling section on the Little Wind River was at the downstream end of a riffle, near the upstream end of the diversion pool, and about 300 ft upstream of the Subagency Canal headworks. Suitable sampling sections closer to the diversion did not exist. The sampling section on Subagency Canal was at the downstream end of a riffle about 150 ft downstream from the headworks.

The Subagency Canal headworks incorporate a low-head diversion dam, which results in a large pool on the Little Wind River upstream from the headworks. Fluvial-sediment deposits were observed in the diversion pool near the headworks.

Suspended-sediment concentration and discharge, bedload discharge, and bedload particle-size data for the Little Wind River and Subagency Canal study site are presented in table 3 at back of report.

Wind River and Johnstown Canal

Sediment samples were collected from a sampling section on the Wind River (site 6, fig. 5) and on Johnstown Canal (site 7, fig. 5). The sampling section on the Wind River was about 300 ft upstream of the Johnstown Canal headworks at the upstream end of a riffle. No other suitable sampling sections closer to the diversion existed because of the braided channel of the Wind River between the sampling section and the headworks. The sampling section on Johnstown Canal was about 300 ft downstream from the headworks in a riffle.

The Johnstown Canal headworks are on the right bank of the Wind River. Part of the river nearest the headworks has been channelized to direct water toward the headworks. The canal headworks are nearly perpendicular to the direction of flow in the river.

Suspended-sediment and bedload samples were collected July 31 and August 2, 1990. The samples were collected in conjunction with a regulated sediment-flushing flow of the diversion dam on the Wind River about 15 river mi upstream of the sampling section on the Wind River. Two sets of samples were collected July 31. The initial samples were collected prior to the flushing flow. River stage was monitored using a temporary staff gage at the sampling section on the river. The second set of samples was collected during the estimated peak stage of the Wind River during the flushing flow. A third set of samples was collected on August 2 after the Wind River had attained a constant-discharge condition following the flushing flow. The discharge of the Wind River was assumed to be constant on the basis of the continuous-stage record from a streamflow-gaging station (station 06227600, Wind River near Kinnear, not shown in fig. 5) about 1 mi downstream of the sampling section on the Wind River. Because Johnstown Canal diverts from only part of the Wind River, bedload samples from the river were collected in four equal-width increments (quarters) of the river.

Sediment samples also were collected at a second section on the Wind River at station 06225500 (Wind River near Crowheart, site 5, fig. 5) on August 2, 1990. This sampling section is not part of the study site; however, samples were collected at this section to provide sediment-transport data for the river upstream of the diversion dam.

Suspended-sediment concentration and discharge, bedload discharge, and bedload particle-size data for Wind River near Crowheart and for the Wind River and Johnstown Canal study site are presented in table 3 at back of report. Bedload discharge and distribution by quarter for the Wind River above Johnstown Canal are presented in table 4 at back of report.

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Table 1.--*Measured discharge and computed gain or loss of discharge in selected irrigation canal study reaches, Wind River Federal Irrigation Project, 1990-91*

[ft^3/s, cubic feet per second; na, not applicable; --, not measured]

Site identification	Distance downstream from diversion (canal miles)	Discharge[4] Measured (ft^3/s)	Computed gain(+) or loss (-) (ft^3/s)	Measured (ft^3/s)	Computed gain(+) or loss (-) (ft^3/s)	Measured (ft^3/s)	Computed gain(+) or loss (-) (ft^3/s)
Dinwoody Canal							
		May 31, 1990		August 16, 1990		May 9, 1991	
DIN-1[1]	0.1	143	na	180	na	62.5	na
DIN-2	1.6	140	-3	--	na	--	na
DIN-3	3.6	135	-5	--	na	--	na
DIN-4	9.9	122	-13	157	-23	43.9	-19
Overall net gain(+) or loss (-)			-21		-23		-19
Dry Creek Canal							
		July 27, 1990		August 16, 1990		May 8, 1991	
DRY-1[2]	0.0	146	na	183	na	52.7	na
LAT-11C	2.1	38.9	na	30.1	na	0	na
DRY-2	3.7	112	+ 5	154	+ 1	50.2	- 2
Overall net gain(+) or loss (-)			+ 5		+ 1		- 2
Upper Ray Canal							
		May 30, 1990		August 1, 1990		August 15, 1990	
URAY-1[3]	0.0	263	na	163	na	163	na
LAT-2C	.4	3.38	na	1.85	na	1.79	na
LAT-6C	1.1	2.86	na	--	na	--	na
TO-63	1.2	.03	na	--	na	--	na
URAY-2	1.4	233	-24	163	+ 2	149	-12
Overall net gain(+) or loss (-)			-24		+ 2		-12

Table 1.--*Measured discharge and computed gain or loss of discharge in selected irrigation canal study reaches, Wind River Federal Irrigation Project, 1990-91--Continued*

		Discharge[4]					
Site identification	Distance downstream from diversion (canal miles)	Measured (ft^3/s)	Computed gain(+) or loss (-) (ft^3/s)	Measured (ft^3/s)	Computed gain(+) or loss (-) (ft^3/s)	Measured (ft^3/s)	Computed gain(+) or loss (-) (ft^3/s)
			Middle Ray Canal				
		May 30, 1990		August 1, 1990		August 15, 1990	
MRAY-1	1.8	202	na	143	na	127	na
LAT-23C	4.4	2.19	na	0	na	0	na
LAT-35C	6.6	4.25	na	.39	na	4.51	na
MRAY-2	6.8	174	-22	140	- 3	116	- 6
Overall net gain(+) or loss (-)			-22		- 3		- 6

[1]U.S. Geological Survey partial-record gaging station Dinwoody Canal (station 432302109215601).

[2]U.S. Geological Survey continuous-record gaging station Dry Creek Canal at headgate, near Burris, Wyo. (station 06222510).

[3]U.S. Geological Survey continuous-record gaging station Ray Canal at headworks, near Fort Washakie, Wyo. (station 06228510).

[4]Measured discharge at each site is reported to 3 significant figures. Exceptions are discharges less than 1 ft^3/s which are reported to the nearest hundredth. Gain or loss in discharge for a study reach is computed as the difference between discharge measured at successive downstream sites less measured discharges for any active diversions in the study reach. Overall net gain or loss in discharge by date and study reach was calculated after the measured discharge at each site was rounded to be consistent with the least accurate measurement.

Table 2.--*Selected physical properties of soil samples from sites on selected irrigation canal study reaches, Wind River Federal Irrigation Project, 1990*

[ft, feet; mm, millimeter; g/cm^3, grams per cubic centimeter; --, no data]

Site and sample identification[1]	Depth interval sampled (feet below land surface)	Onsite sample description	Onsite sample structure	Distribution of particle sizes[2] smaller than 2.0 mm (percentage by weight)[3]			Texture	Clod bulk density (g/cm^3)
				Sand	Silt	Clay		
			Dinwoody Canal					
DIN-U-W1	0.15 - 0.85	Tan; dry; with cobbles[4]	Crumb	89.8	5.5	4.7	Sand	1.74
DIN-U-W2	0.85 - 1.30	Dry; with gravel	No structure	92.4	4.1	3.6	Sand	--
DIN-U-B1	0.15 - 0.55	Orange-tan; slightly moist	Crumb to blocky	83.1	16.8	.1	Loamy sand	1.89
DIN-U-B1D	0.15 - 0.55	(duplicate of DIN-U-B1)		85.1	14.8	.1	Sand	1.66
DIN-U-B2	0.55 - 1.50	Tan; slightly moist	Blocky	45.2	40.0	14.8	Loam	1.84
DIN-L-W1S	0.10 - 0.60	Light tan; dry	Crumb	60.8	21.1	18.1	Sandy loam	1.71
DIN-L-W2S	0.60 - 1.30	Light tan and buff; moist	Blocky	54.3	20.4	25.2	Sandy clay loam	1.74
DIN-L-B1	0.15 - 0.70	Brown; slightly moist	Subangular blocky	26.8	25.9	47.2	Clay	1.43
DIN-L-B2	0.70 - 0.90	Dark brown; slightly moist	Crumb	55.1	28.2	16.7	Sandy loam	1.49
DIN-L-B3	0.90 - 1.30	Dark brown to grey-brown; moist to dry	Blocky (moist) to platy (dry)	18.2	43.7	38.1	Silty clay loam	1.54
			Dry Creek Canal					
DRY-M-W1S	0.10 - 1.00	Buff-light tan; dry; caliche top	Crumb to subangular blocky	69.5	12.3	18.2	Sandy loam	1.80
DRY-M-W2S	1.00 - 1.80	Buff and light tan; dry	Platy-subangular blocky	72.8	5.0	22.2	Sandy clay loam	2.08

Table 2.--*Selected physical properties of soil samples from sites on selected irrigation canal study reaches, Wind River Federal Irrigation Project, 1990--Continued*

Site and sample identification[1]	Depth interval sampled (feet below land surface)	Onsite sample description	Onsite sample structure	Distribution of particle sizes[2] smaller than 2.0 mm (percentage by weight)[3]			Texture	Clod bulk density (g/cm^3)
				Sand	Silt	Clay		
			Dry Creek Canal--Continued					
DRY-M-B1	0.15 - 0.85	Medium tan; slightly moist	Granular	74.5	10.3	15.2	Sandy loam	1.78
DRY-M-B2	0.85 - 1.00	Slightly moist; with large cobbles[4]	Granular	77.7	8.3	14.0	Sandy loam	1.58
DRY-L-W1S	0.10 - 1.00	Light tan to brown; slightly moist	Granular to blocky	66.0	19.3	14.7	Sandy loam	1.58
DRY-L-W2S	1.00 - 2.00	Greenish-grey to dark grey; slightly moist	Platy to subangular blocky	31.0	53.2	15.8	Silt loam	1.92
DRY-L-B1	0.10 - 0.70	Grey brown; slightly moist	Crumb to subangular blocky	51.6	36.9	11.5	Sandy loam	1.67
DRY-L-B2	0.70 - 1.05	Grey brown, greenish-tint; slightly moist	Crumb to subangular blocky	50.4	39.6	10.0	Loam	1.61
			Upper Ray Canal[5]					
URAY-U-W1	0.10 - 1.00	Tan to light brown; moist	(6)	33.8	35.3	30.9	Clay loam	1.58
URAY-U-W2	1.00 - 1.60	Light brown to buff; moist	(6)	37.1	30.3	32.6	Clay loam	1.64
URAY-U-B1S	0.25 - 1.25	With gravel; wet	No structure	94.9	2.8	2.3	Sand	--
URAY-U-B2S	1.25 - 1.50	Buff; wet	(6)	41.1	36.3	22.6	Loam	1.93
URAY-U-B2DS	1.25 - 1.50	(duplicate of URAY-U-B2)	(6)	50.9	28.6	20.5	Loam	1.94

Table 2.--*Selected physical properties of soil samples from sites on selected irrigation canal study reaches, Wind River Federal Irrigation Project, 1990--Continued*

Site and sample identification[1]	Depth interval sampled (feet below land surface)	Onsite sample description	Onsite sample structure	Distribution of particle sizes[2] smaller than 2.0 mm (percentage by weight)[3] Sand	Silt	Clay	Texture	Clod bulk density (g/cm³)
			Middle Ray Canal					
MRAY-U-W1S	0.10 - 1.10	Brown; moist	Granular to subangular blocky	57.9	18.2	23.9	Sandy clay loam	1.98
MRAY-U-W2S	1.10 - 2.10	Brown; moist	Subangular blocky	57.4	14.7	27.9	Sandy clay loam	1.95
MRAY-U-B1	0.10 - 0.85	Dark tan; moist	Granular to blocky	61.1	16.3	22.7	Sandy clay loam	1.77
MRAY-U-B2	0.85 - 1.20	Light brown; slightly moist	Blocky	59.8	19.2	21.0	Sandy clay loam	1.76
MRAY-U-B3	1.20 - 1.40	Tan; slightly moist	Granular	78.5	8.5	13.0	Sandy loam	1.36
MRAY-L-W1	0.05 - 0.70	Light brown; moist	Blocky	52.1	20.9	27.0	Sandy clay loam	1.51
MRAY-L-W2	0.70 - 1.20	Rust-tan; moist	Subangular blocky to blocky	40.8	21.9	37.3	Clay loam	1.58
MRAY-L-B1	0.05 - 0.70	Black brown to grey; wet	Crumb with few blocky peds[7]	67.7	16.0	16.3	Sandy loam	1.92
MRAY-L-B2	0.70 - 1.30	Tan-black to orange-tan; wet	Crumb to subangular blocky	63.7	15.1	21.1	Sandy clay loam	1.50

[1]Site and sample identification, consisting of two parts, are as follows: (1) soil-sampling site, for example, DIN-U (see fig. 3 and 4), and (2) sample identification, for example, W1 (see fig. 2). Duplicate samples are designated by a "D" appended to the end of the sample identification. Samples collected with a spade are designated by an "S" appended to the end of the sample identification.

[2]Particle sizes are as follows: Sand, 2 - 0.5 mm; Silt, 0.5 - 0.002 mm; Clay, less than 0.002 mm (U.S. Department of Agriculture, 1951, p. 209).

[3]Total percentage by weight of sand-silt-clay size fractions for some samples does not equal 100 percent because of small differences resulting from rounding.

[4]Cobbles in the interval sampled were not collected in the sample.

[5]Lenses of sand and gravel over 1 ft thick and of undetermined areal extent were observed in the canal bottom and walls between URAY-1 and Lateral-6C.

[6]Not able to assess because of high water content.

[7]Ped is defined as "an individual soil aggregate" (U.S. Department of Agriculture, 1951, p. 225).

Table 3.--*Suspended-sediment concentration and discharge, bedload discharge, and bedload particle-size data for selected streams and associated irrigation canals, Wind River Federal Irrigation Project, 1990-91*

[°C, degrees Celsius; ft^3/s, cubic feet per second; d, day; mg/L, milligrams per liter; mm, millimeter; --, no data; nm, no material]

Date	Sample-collection time	Water temperature[1] (°C)	Instantaneous discharge[1] (ft^3/s)	Average[2] suspended-sediment concentration (mg/L)	Sediment discharge: Average[2] suspended-sediment (tons/d)	Sediment discharge: Bedload (tons/d)	Bedload, percent finer than indicated particle diameter[3] (mm): 0.062	0.125	0.250	0.500	1.00	2.00	4.00	8.00	16.0	32.0
Site 1 - Dry Creek above Dry Creek Canal, near Burris, Wyo. (station 432020109174001)																
7/27/90	1115	14.5	224	4	2.4	0.98	0.3	0.9	3	36	70	90	100	nm	nm	nm
	1205	14.5	224	4	2.4	1.1	0	.4	2	28	58	83	98	100	nm	nm
8/17/90	1200	17.5	192	6	3.1	.11	0	2	4	32	62	84	100	nm	nm	nm
	1245	17.5	192	6	3.1	.07	0	0	9	37	68	91	100	nm	nm	nm
5/08/91	1130	8.5	54	12	1.8	.05	0	1	3	28	75	97	100	nm	nm	nm
	1200	8.5	54	12	1.8	.01	0	0	0	43	79	93	100	nm	nm	nm
Site 2 - Dry Creek Canal at headgate, near Burris, Wyo. (station 06222510)																
7/27/90	1330	16.0	146	5	2.0	.82	.1	.3	1	15	37	62	83	94	100	nm
	1430	16.0	146	5	2.0	2.7	0	.1	.6	12	40	68	86	94	100	nm
8/17/90	1400	17.0	180	5	2.4	.65	.1	.3	1	16	44	76	100	nm	nm	nm
	1420	17.0	180	5	2.4	1.0	.1	.2	.6	11	31	62	89	100	nm	nm
5/08/91	1330	11.0	53	12	1.7	.13	.5	2	5	38	74	92	100	nm	nm	nm
	1400	11.0	53	12	1.7	.12	.5	2	4	32	73	91	100	nm	nm	nm

Table 3.--*Suspended-sediment concentration and discharge, bedload discharge, and bedload particle-size data for selected streams and associated irrigation canals, Wind River Federal Irrigation Project, 1990-91--Continued*

Date	Sample-collection time	Water temperature[1] (°C)	Instantaneous discharge[1] (ft^3/s)	Average[2] suspended-sediment concentration (mg/L)	Sediment discharge: Average[2] suspended-sediment (tons/d)	Sediment discharge: Bedload (tons/d)	Bedload, percent finer than indicated particle diameter[3] (mm): 0.062	0.125	0.250	0.500	1.00	2.00	4.00	8.00	16.0	32.0
Site 3 - Little Wind River above Subagency Canal, near Arapahoe, Wyo. (station 425931108370201)																
7/04/90	1030	--	419	37	42	12	0.2	0.3	2	26	65	97	100	100	nm	nm
5/07/91	1130	13.5	82	100	22	0	nm	nm	nm	nm	nm	nm	nm	nm	nm	nm
	1155	13.5	82	100	22	0	nm	nm	nm	nm	nm	nm	nm	nm	nm	nm
Site 4 - Subagency Canal at headworks, near Arapahoe, Wyo. (station 425934108365301)																
7/04/90	1230	--	108	49	14	.01	0	9	18	36	64	82	100	nm	nm	nm
	1320	--	108	49	14	.19	1	3	7	23	49	75	100	nm	nm	nm
5/07/91	1215	14.0	30	112	9.1	0	nm	nm	nm	nm	nm	nm	nm	nm	nm	nm
	1245	14.0	30	112	9.1	0	nm	nm	nm	nm	nm	nm	nm	nm	nm	nm
Site 5 - Wind River near Crowheart, Wyo. (station 06225500)																
8/02/90	1020	18.5	1,560	25	105	15	0	.1	2	24	68	82	83	84	85	100
	1120	18.5	1,560	25	105	21	.1	.1	1	27	76	88	90	91	91	100

Table 3.--*Suspended-sediment concentration and discharge, bedload discharge, and bedload particle-size data for selected streams and associated irrigation canals, Wind River Federal Irrigation Project, 1990-91--Continued*

Date	Sample-collection time	Water temperature[1] (°C)	Instantaneous discharge[1] (ft^3/s)	Average[2] suspended-sediment concentration (mg/L)	Sediment discharge: Average[2] suspended-sediment (tons/d)	Sediment discharge: Bedload (tons/d)	Bedload, percent finer than indicated particle diameter[3] (mm): 0.062	0.125	0.250	0.500	1.00	2.00	4.00	8.00	16.0	32.0
Site 6 - Wind River above Johnstown Canal, near Kinnear, Wyo. (station 430906108434901)																
7/31/90	1120	17.0	628	268	454	410	0.0	0.0	1	26	92	100	100	100	nm	nm
7/31/90	1227	16.5	1,810	1,070	5,230	1,100	.2	.5	4	29	91	100	100	100	nm	nm
8/02/90	1030	18.0	554	60	90	120	.1	.1	2	26	81	98	100	100	nm	nm
	1115	18.0	554	60	90	270	.1	.1	1	27	83	98	100	100	nm	nm
Site 7 - Johnstown Canal at headworks, near Kinnear, Wyo. (station 430902108434101)																
7/31/90	0950	17.0	23	99	6.2	6.0	0	.3	2	37	98	100	100	nm	nm	nm
	1100	17.0	23	99	6.2	5.1	0	.2	3	44	99	100	100	nm	nm	nm
7/31/90	1200	16.5	36	815	79	16	0	.7	4	34	98	100	100	100	nm	nm
	1215	16.5	36	815	79	9.2	0	.9	4	44	98	100	100	100	nm	nm
8/02/90	1100	18.0	21	34	1.9	3.4	0	.3	2	45	99	100	100	100	nm	nm

[1]Measurements of temperature and discharge were made once per site visit but are applicable for both sampling times.

[2]Average of values for two samples collected per site visit.

[3]The number of significant figures does not indicate the accuracy of bedload data, but is used to show the relative percentage in each particle-size range.

Table 4.--*Bedload discharge and particle-size distribution by river cross-section quarter, Wind River above Johnstown Canal, near Kinnear, Wyoming (station 430906108434901), Wind River Federal Irrigation Project, 1990*

[°C, degrees Celsius; mm, millimeter; nm, no material]

Date	Time	Water temper-ature (°C)	River cross-section quarter	Bedload discharge[1] (tons/day)	Bedload, percent finer than indicated particle diameter[2] (mm)							
					0.062	0.125	0.250	0.500	1.00	2.00	4.00	8.00
7/31/90	1120	17.0	Right	100	0	0	0	11	86	99	100	100
			Right-center	260	0	0	2	33	94	100	100	nm
			Left-center	46	0	0	1	24	92	100	100	nm
			Left	0	nm	nm	nm	nm	nm	nm	nm	nm
7/31/90	1227	16.5	Right	520	0.1	0.3	2	19	89	99	100	nm
			Right-center	520	.1	.3	3	36	92	100	100	nm
			Left-center	92	.1	.8	4	41	98	99	100	100
			Left	4.4	1	7	27	75	92	98	100	nm
8/02/90	1030	18.0	Right	58	0	0	.5	11	69	96	100	100
			Right-center	58	0	0	2	39	92	99	100	100
			Left-center	1.6	0	0	.6	65	98	100	100	nm
			Left	0	nm	nm	nm	nm	nm	nm	nm	nm
8/02/90	1115	18.0	Right	120	0	0	.8	17	77	98	100	100
			Right-center	150	0	0	2	33	88	98	100	100
			Left-center	5.8	.1	.2	5	65	98	99	100	100
			Left	0	nm	nm	nm	nm	nm	nm	nm	nm

[1]The sums of the bedload discharge for four quarters do not equal bedload discharge values in table 3 because of small differences resulting from rounding.

[2]The number of significant figures does not indicate the accuracy of bedload data, but is used to show the relative percentage in each particle-size range.

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