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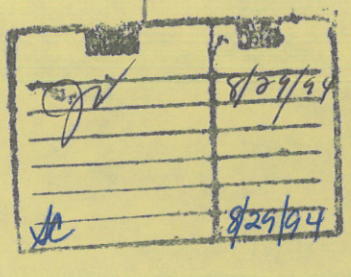


BA/WTR
CO20.00.30
Mail Stop 60189

AUG 2 9 1994

Memorandum

To: Chief, Water Rights Branch, Division of Engineering, Region 6 (60190)

From: Refuge Hydrologist, Water Resources Division, Region 6

Subject: August 1-2, 1994 Trip Report for Arapaho National Wildlife Refuge (NWR), Colorado

Ken Bottle and I met with Refuge staff and Eric Wagner, the local Water Commissioner, on Monday August 1, 1994. We discussed the status of water measurement on the Refuge. The Refuge has approximately 70 ponds that are filled by a complex network of canals. Earlier in the year, in an exercise to determine which projects would be eliminated if severe budget shortages occur, the Refuge had identified cutting back their water measurement efforts. To assist in alleviation of this work load we were investigating use of electronic monitors on their flumes. We also wanted to put additional flumes on the few unmeasured canals.

After much discussion, the Refuge staff decided that electronic monitors would prevent staff from discovering beaver dams, trash, or other impediments in the canals. They concluded that weekly readings of flumes guarantees better water management.

The conversion of private agricultural water rights to current Refuge owned water rights and continued development of wetlands in the Private Lands Program raises the question of possible downstream depletions. The Water Commissioner described the results of several independent studies that conclude the consumptive use is only 10 inches near Walden. Eric Wagner, the Water Commissioner said he would send copies of this work to us. These results will be useful for Section 7 Consultations for possible wetland development.

Eric Wagner also suggested that the Service do a study comparing consumptive use of wetlands versus irrigated hay meadows (historic use of majority of the water rights). He offered the Refuge a lysimeter to begin the work. I later spoke to the State water engineer in Steamboat Springs, Kent Holt, who has the lysimeters. His consumptive use study requires 30 minutes of work a week to maintain a lysimeter and a collocated weather station. A National Weather

Service weather station requires a substantial commitment (daily observations) unless we purchase automated equipment. Kent said that this data becomes very valuable in Colorado Water Courts.

Eric had another concern; he has operated the Walden Weather Station for the past 17 years, and would like to retire from this duty. He assured us, that in a comparison study of weather between Walden and the Refuge, the two sites were so similar that it would not damage the historic record by moving the site to the Refuge. He pointed out that many Refuges perform this duty.

The following morning Gene Patten, the Project Leader, took us to sites that do not have water measurement devices. We measured three sites for flume installation. Attached are Ken Bottle's hydraulic analysis for sizing the flumes. I will order the flumes.

Two of the three proposed flumes would measure flows on the Midland Ditch. The first flume would be placed approximately 74 feet upstream of an old wooden flume in the ditch. The flume would measure flows coming from private property just upstream of Refuge land. At the site of the first proposed flume, there are two water rights. The first water right is for 5 cfs and belongs to the Refuge, the second water right is for 6.5 cfs and belongs to a landowner just downstream of Refuge land (Anderson). The second proposed flume would be placed on Anderson's property approximately 180 feet downstream of Refuge land. This flume would serve two purposes. First, the flume would show the amount of water diverted by the Refuge (by subtracting the gage reading from the reading of the first flume). Second, the flume measurements would show the amount of flow Anderson is receiving. We would have preferred to place the second flume on Refuge land just before entering Anderson's property, however the channel characteristics near the property fence were inappropriate for the flume.

The third flume would be placed on the Hubbard 2 Ditch. It should be noted that the proposed flume on Hubbard 2 would actually measure flows entering Hubbard 4. The Hubbard 2 Ditch changes into the Hubbard 4 Ditch when it passes underneath a County road. The flume would be placed at a point on Hubbard 2 that is downstream of all structures and takeouts. The site for the Hubbard 2/4 flume was chosen partly for ease of reading the flume gage. The Hubbard 2/4 flume will be sized for the bankfull level of the channel. The flume will measure all of the flow into Hubbard 4 although the Refuge's water right for Hubbard 4 is only 2 cfs. As with the proposed flumes on the Midland Ditch, measurement of all flow through Hubbard 4 is needed because all of the water flowing through the ditches is beneficially used by the Refuge, and should be documented.

We also measured the discharge under the bridge next to the Refuge to check the rating table (see attached results). We may need to do another calibration curve for this site after the County replaces the bridge with a two lane bridge next summer, unless Walden's Water Commissioner plans to do it again.

There seems to be an excellent working relation between the State and the Refuge on water issues. It is also apparent that the staff at Arapaho NWR is very knowledgeable and dedicated to water management.

/s/ JANA VARNER

cc: ARD-RW (60130)
Project Leader, Arapaho NWR (65520)

bcc: WTR rdg fl
Ofcl fl WTR
RD
WTR:JLVarner:8-29-94

ARAPAHO NWR | FLUMES | 8-24-94

MIDLAND DITCH – 73.5' UPSTREAM OF WOODEN FLUME

Q (SUM of REMAINING WATER RIGHTS) = 11.5 cfs

y_n = 1.165', b = 2.6', TOP of BANK = 1.66'

TOP WIDTH = 6, – 4.5 = 1.5

1' WINGWALLS

USING THE BOR WATER MEASUREMENT MANUAL:

FLUME SIZE	Ha (ft)	Loss (L)	DEPTH UPSTREAM (y_n+L)
12"	2.00'	.80	1.965
24"	1.265'	.50	1.665, O.K. → USE "FLUME

Hb = (.7)(1.265) = .886'

Wingwalls? = 30" flume / 1 foot

MIDLAND DITCH – APPROXIMATELY 180' DOWNSTREAM of REFUGE/ANDERSON PROPERTY FENCE

Q = 11.5 cfs

y_n = 1.045', b = 6.5', TOP of BANK = 1.62'

Top width @ 1.5' depth = 14.36'

FLUME SIZE	Ha (ft)	Loss (L, ft)	DEPTH UPSTREAM (y_n+L)
24"	1.23	.50	1.55', O.K.
36"	0.95	.35	1.40', O.K.

14.36 – 4.5 = 9.86'

5' WINGWALLS

FLUME RANGE 1/3 to 1/2 BOTTOM WIDTH (b) ∴ USE 30" FLUME

Hb = (.7)(~1.09) = .763'

HUBBARD 3/4 – 175' DOWNSTREAM of LAST STRUCTURE in HUBBARD 2 DITCH

Q (BASED on BANK-FULL) = 15.0 cfs

y_n = 1.01, b = 5.0', TOP of BANK = 2.12'

FLUME SIZE	Ha (ft)	Loss (L, ft)	DEPTH UPSTREAM (y_n+L)
24"	1.50	0.58	1.59' O.K.
36"	1.15	0.45	1.46 O.K. ⇒ USE 24" FLUME

Hb = (.7)(1.50) = 1.05'

Top width at 2' = 10.8'

10.8' – 3.96' = 6.84'

3.5' WINGWALLS

Arapaho NWR stream next to headquarters 8/02/94
Downstream from gage and old bridge

Gage Height = 0.57

distance	width	depth	velocity	area	discharge
1.4					
5	2.80	0.90	0.04	2.52	0.10
7	2.00	1.05	0.08	2.10	0.17
9	2.00	1.50	0.04	3.00	0.12
11	2.00	1.50	0.07	3.00	0.21
13	2.00	1.90	0.10	3.80	0.38
15	2.00	1.95	0.10	3.90	0.39
17	2.00	2.00	0.09	4.00	0.36
19	2.00	2.00	0.14	4.00	0.56
21	2.00	1.85	0.04	3.70	0.15
23	3.50	1.60	0.00	5.60	0.00
28					
				35.62	2.44 CFS

Down stream of CMP
(looking upstream)

↖ Burr Drain ↗

upstream of CMP
48" CMP

Midland Flume,
which will be replaced
soon

↑ Ish + Baldwin Ditch ⟶

With the River in the foreground, Ken + Gene are standing on the Rt. Bank near the turn out. very small water right, that Gene may transfer,

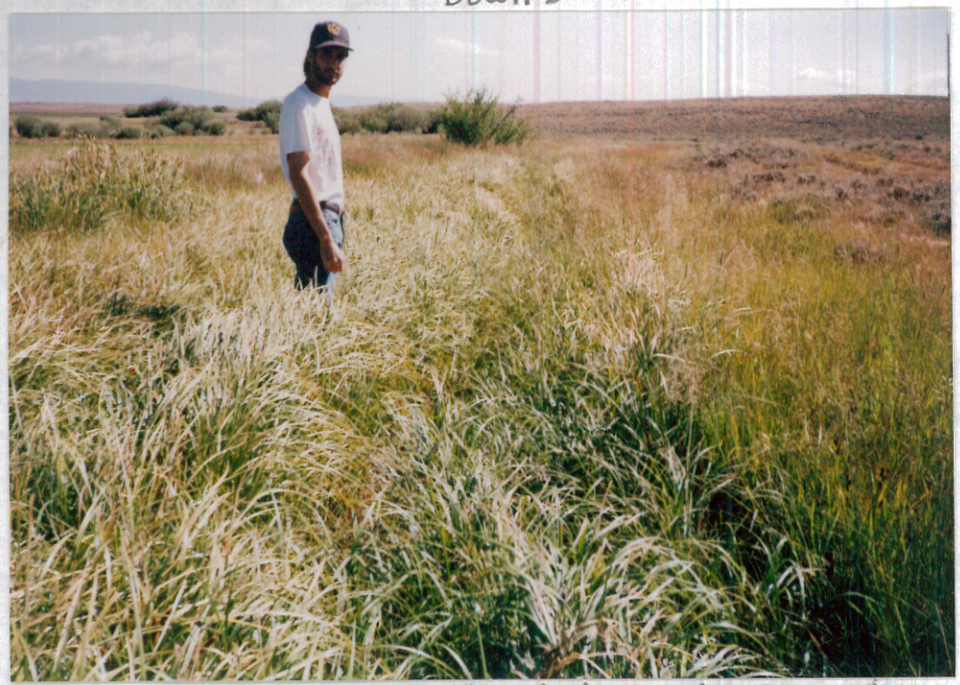
Upstream

Ditch recently cleaned,

← Midland Ditch ↑ Downstream↑

Downstream from the tape is an old wooden flume that will be removed.

Down stream



↑Midland Ditch on Phillip Anderson's property →

upStream ←

↑ Hubbard Ditch #4/#2
EAST side of Highway #12 →