Distribution, Late Summer Feeding Habits, and Effects of Dam Building on Stream Width and Depth by Beaver (Castor canadensis) at Walnut Creek National Wildlife Refuge

Senior Research Seminar
by
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INTRODUCTION

Beavers (*Castor canadensis*) are a species that were native to most of Iowa before settlement by the colonists in the 1860's. They occurred along streams and waterways and are said to have been abundant (Bowles, 1975). The beaver population suffered a severe decline in the late 1800's and early 1900's, almost becoming extinct. This was due to hunting and trapping of the beavers for several different reasons. One of the main reasons was that beaver pelts could be sold to fur traders and then made into hats. Beavers were also killed because they were seen as a nuisance. By building dams they flooded potential farmland. In the mid 1900's beavers began to be reintroduced into Iowa and are now relatively common once again.

Beavers have a large impact on their environment. They modify a stream's morphology and hydrology by cutting down trees and building dams (Doucet, 1993). According to Doucet, beavers cut down trees which are successively larger in diameter in direct relation to the distance they are from their lodge. Beavers also cut down more trees in areas of higher density and fewer trees in areas of lower density. In doing this they cause an expansion of wetland area, an elevation of the watertable, and the accumulation of organic compounds that change the biochemical processes of the

waterway. These processes include the decomposition cycle and the rate at which it occurs, changes in the way nutrients cycle through the ecosystem, and sedimentation which can affect the soils of the riparian areas. Along with this, beaver activity affects the course, size, and swiftness of a waterway and can eventually influence the biotic community's composition and diversity.

It is important to know, and be able to predict, which sites are preferable to beavers for building dams. Many studies have been done to determine the most favorable sites. Beier and Barrett (1988), concluded that several factors prove favorable for dam building. These include relatively flat stream bed gradient, wider and deeper streams, and gentler banks (Beier and Barrett, 1988). A high density of herbaceous vegetation may also be important (Howard and Larson, 1985).

STUDY SITE

Walnut Creek National Wildlife Refuge (WCNWR) is a tract of land which covers approximately 5000 acres as of April 1994. The Refuge is part of the National Wildlife Refuge System, which is operated by the United States Department of the Interior, Fish and Wildlife Service. The Refuge includes large plots of oak-hickory woodland as well as grazed pastureland and abandoned cropland. It

also contains Walnut Creek and its tributaries running approximately through the center of the Refuge. The purpose of the Refuge is to restore the area to the habitats which were dominant before settlement by the Euro-Americans in the 1860's. These habitats include tallgrass and midgrass prairie, oak-hickory woodland and savanna, and riparian wetland communities (Hamilton and Roelle, 1993).

The restoration of the communities will involve restoring native animal life. Although there are no actual records of the animal life present before settlement, fairly accurate data has been gathered through research at museums as well as by reading old journals and accounts written by the people who settled the land. Studying undisturbed ecosystems can provide us with an idea of the species which occurred in these habitats.

The methodology for the restoration of the Refuge is still being planned. Much observation and recording of data must be done in order to determine the best course of action. My research provides information that will help to develop that plan, especially as it applies to beaver.

METHODS

The first step in my research was to determine what the survey team from Iowa State University had done. They had walked Walnut Creek and all of its tributaryies within the Refuge except for those in the topographic maps 2, 3, 7, 15, 16, 24, 38, 43, 47, 48, and 69 (Figure 1). After talking with Pauline Drobney and the head of the ISU research team, I decided not to do a walking survey in the areas of maps 7, 9, 15, 16, and 24. This left me with the areas in maps 2, 3, 7, 38, 43, 47, and 47 (Figure 2). I did the walking survey of these areas to look for any signs of beaver activity and any unknown dams. After looking at the areas in the sections 38, 43, 44, and 48 I decided not to survey them because the stream bed had obviously been dry for some time. Herbaceous vegetation had overgrown the stream beds: areas that didn't have grass had a dry and cracked soil surface. The area in map number 44, which was listed as part of the creek bed, was surrounded by corn fields and looked more like a drainage ditch for excess runoff caused by heavy rainfall. While walking the creek I looked for tracks near the water as well as any kind of branch or tree which looked like it could have been chewed on by beaver.

The second step was to locate the dams mapped by the Iowa State University team. These ocurred in maps 18, 19, 39, 45, and

89 (Figure 1). After locating them, I did a survey of the banks, looking for beaver scat, scent mounds, tracks, and any type of tree cutting. I also counted the number of trees in an area 75 feet above the dam to 25 feet below the dam, identified each tree by species, and measured the diameter of each tree.

Lastly, I measured the stream width and depth at 5, 10, and 20 foot intervals above and below the dam. Stream depth was measured using a meter stick attached to a pole (Figure 3). On the end of the meter stick was a plastic bowl top to prevent the stick from sinking into the mud. While standing on the bank I stretched the pole over the water to the approximate center and then lowered it until it hit bottom. Stream width was measured with a tape measure, one person standing on each bank holding the tape measure.

RESULTS

The first dam I located was in the area shown on topographic map number 45 (Figure 4). The dam was approximately seven meters across and one meter tall. It was in the shape of a crescent moon with the concave side facing upstream. This dam seemed to be well built and in good repair. The banks on both sides of the dam were densely forested and had a large amount of herbaceous cover on the banks. The banks were steep and around five feet high. The

predominant tree in the area was Ashleaf Maple (*Acer negundo*).

The second dam I found was in the area shown on topographic map number eighteen (Figure 5). This dam was approximately .4 meters tall and 2.5 to 3 meters wide, again shaped like a crescent. This dam was not in very good repair. A lot of water was flowing over it and through cracks in it. This may account for the fact that there was not a pond formed upstream from the dam. One bank was densely forested and the other had trees right next to the bank but then became empty farmland. There was a large amount of herbaceous vegetation on and near the banks. The banks were steep and about eight feet tall.

The third site was in the area shown on topographic map number nineteen (Figure 6). The Iowa State University team had marked this as a dam during their survey. The dam was large enough to cause a pool to form upstream. Due to the fact that there wasn't any mud or grasses packed against the jammed trees and that the water was flowing freely through the dam I concluded that if this actually had been a dam it had been abandoned. Therefore I did not survey the banks around it. I did find one dead tree which had been partially chewed near the dam. The dam looked as if a log had fallen across the stream and the beavers had unsuccessfully tried to make a dam using it.

The final site, which was located in the area shown on map 39

(Figure 7), contained dam number 3 which was the largest and best built dam. A cottonwood tree approximately 5 1/2 feet in diameter had fallen across the river. The beavers built the dam against the log. The water above the dam did not form a pool, although there was a narrow channel that seemed to be fairly deep. The area below the dam had a large pool. This was also the only place where I saw any signs of beaver living quarters. A bank den was built right next to the dam on the upstream side. The entryway had been built from branches but the main part of the den was in the bank. I also found a large amount of fresh scat around and on the dam. There was a tree stand on one side of the dam, but the trees were not densely packed, the main species being Honey Locust (*Gleditsia triacanthos*). There was also much tall herbaceous material all along the banks and in the trees. The banks were steep and approximately six feet from the top to the water level.

After compiling a list of the tree species at each dam site (Table 1) I performed an analysis of variance (Table 1A). This showed a significant difference in the number of trees at each dam site ($p=0.027$). Therefore, the number of trees I found at each site varied from what would be expected in random test sites.

I ran an analysis of variance test to determine if stream depth varied among the three sites (Table 2 and 2A). The tests showed that there was no significant variance between stream depth

above or below the dam at any of the sites. There was a trend for stream depth to be deeper at the point above and closest to the dam. I did the same test for stream width (Table 3 and 3A). The results of this test showed that there was no significant difference between stream width above or below the dams.

Although I did find a few tree stumps, none of the stumps I found appeared to have been cut that year. They were grey and dead, with no remaining bark or wood chips at the base. At dam number one I found one tree stump and one partially cut tree. At dam number 2 I found one partially chewed dead stump. At dam number three I found three stumps. At the site in topographic map number 39 (Figure 8), where no dam was located, I found two trees which had recently been gnawed on, but I did not find any stumps.

DISCUSSION

"In order to simulate natural wetland biology...in wetland restoration, careful consideration must be given to site selection...site preparation...methods of establishing wetland vegetation, and methods for maintenance of the wetland after it is established" (Thompson, 1993). If managed properly, beavers can be very important and useful tools in obtaining the desired goals of

wetland and riparian restoration. Therefore it is important to know as much about their influence on the Refuge as possible.

My study was a preliminary study to locate beaver activity and dams, as well as to gather data which can later be used to predict sites of beaver activity. The three beaver dams were located in similar areas. The most noticeable characteristic of all three was the abundance of herbaceous vegetation. Jenkins (1981) states, "Beavers prefer herbaceous food vegetation over woody forage during seasons when herbaceous food is available and the increased likelihood of colonization in reaches with herbaceous plants may reflect this fact". I began my study thinking that beavers preferred woody vegetation, but was surprised at how few trees I found which were felled or gnawed on. My results showed that at all three sites the number of saplings was very low. There also was a low number of tree stumps and chewed trees, which supports the theory that the beavers were eating herbaceous material. At dam number three there was a high density of elderberry bushes (*Sambucus canadensis*). I found an abundance of fresh scat containing elderberry seeds at this location and concluded that this was a main food staple for the beavers at this dam.

Herbaceous material is therefore an important consideration in managing beaver populations at Walnut Creek. Diater and McCabe (1989), found that heavy grazing by livestock eliminates food

supplies and appropriate building materials necessary for beavers. Thus, herbaceous vegetation should be encouraged as a useful resource for managing the future beaver population at the Refuge.

My results showed that stream depth and width were similar for all three dam sites. This may also be another important factor for predicting future dam sites. The average stream depth above the dams was 46.778 centimeters and the average width was 482.222 centimeters. The average stream depth below the dams was 28.667 and the average width was 431.111. "Deep and wide streams are important because a higher volume channel offers more escape cover, more secure sites for underwater food caches, and a more reliable source of water for impoundments, especially during drought years" (Howard and Larson, 1985).

There are many benefits to restoring riparian areas, including aesthetic, educational, recreational, and financial purposes. Riparian habitats are important in maintaining the water table through recharge and discharge. They also act as a barrier and a filter between aquatic and terrestrial areas. Riparian communities help prevent the erosion caused by channelization by slowing the speed of the water and providing areas suitable for aquatic plant growth. They serve to retain and remove nutrients as well as

provide a place for wildlife and fish populations. Restoration helps to revive the food chain and lastly serves as a place for recreation and education (Thompson, 1992).

Beavers may be of great assistance in achieving the goals of Walnut Creek National Wildlife Refuge. "Areas abandoned by beavers may produce fertile habitats for grasslands" (Lizzaralde, 1993). This may be useful in restoring the native tallgrass prairie in the northern parts of the Refuge. Beavers may also help to revegetate a site by carrying seeds in their fur or clearing an area of trees which would allow other species to take hold in that area. Lastly, beavers have a large impact on an area because of the trees they cut down. This is of importance because it may alter the species composition of riparian ecosystems which may lead to changes in ecosystem functioning.

ACKNOWLEDGEMENTS

I would like to thank Walnut Creek National Wildlife Refuge for the use of the Refuge and their maps. I would like to give a special thanks to Pauline Drobney who oversaw my work at the Refuge and spent time giving me advice on my proposal and methods of research. I would like to thank my dad, Rod Roland, and Dave Elfvin for accompanying me to the Refuge on many occasions. I

would also like to thank Dr. Stuart Allison for overseeing my project and coordinating my work with the Refuge.

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Figure 2 - Current and expected boundaries of the refuge; index of topographic maps

Figure 3 - Diagram of the device used to measure stream depth

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Figure 5 - Topographic map 18; site where dam 2 was found

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Figure 7 - Topographic map 89; site where dam 3 was found

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Table 1 - Tree type, common and scientific names, key to abbreviations, and tree diameter at each site

Table 1A - ANOVA comparing number of trees at each site

Table 2 - Number of trees at each dam site

Table 2A - Chi-Square analysis of number of trees at each site

Table 3 - Stream depth at different distances above and below each dam site

Table 3A - ANOVA comparing stream depths between dam sites

Table 4 - Stream width at different distances above and below each dam site

Table 4A - ANOVA comparing stream widths between dam sites

Figure 1

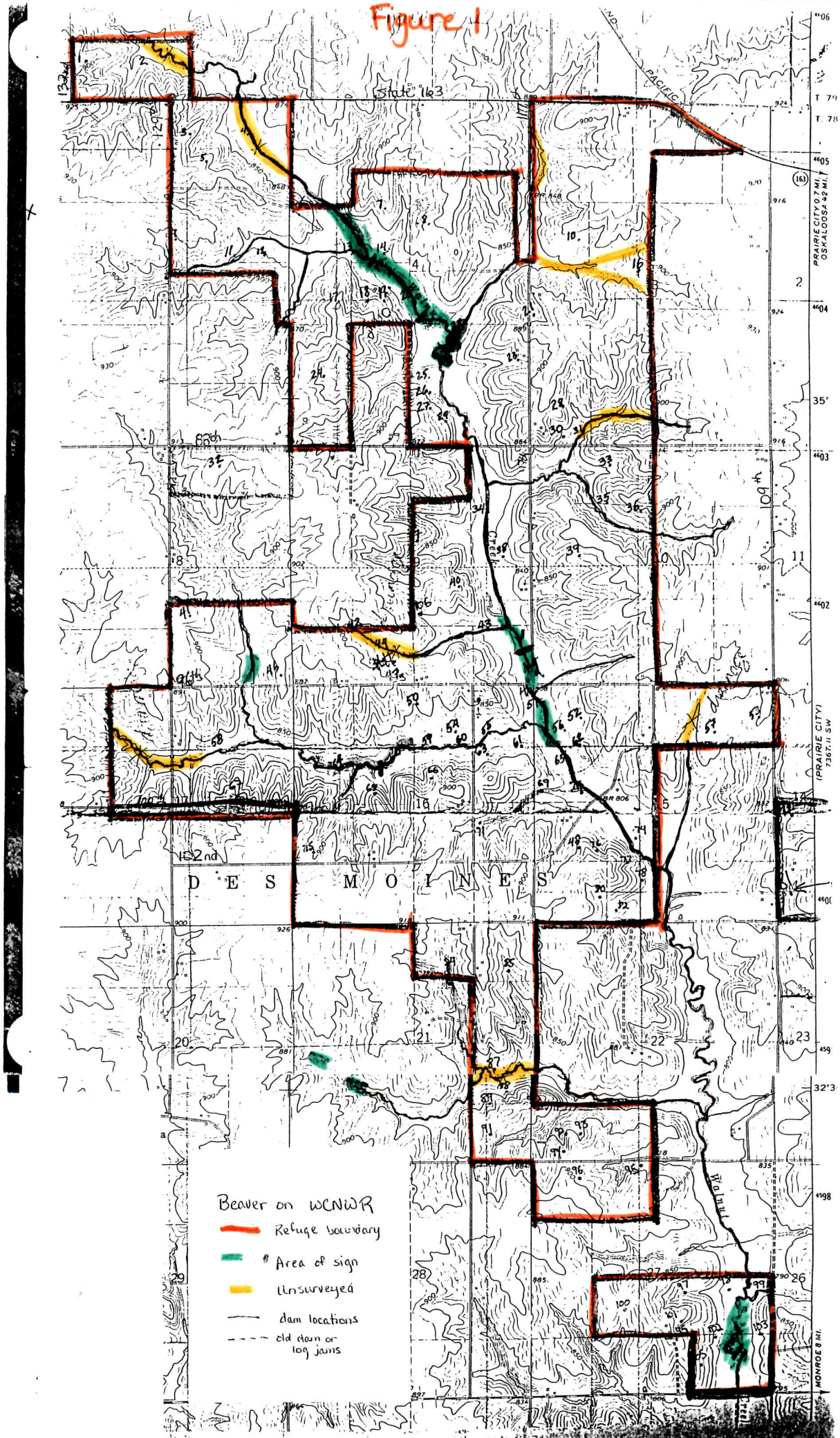
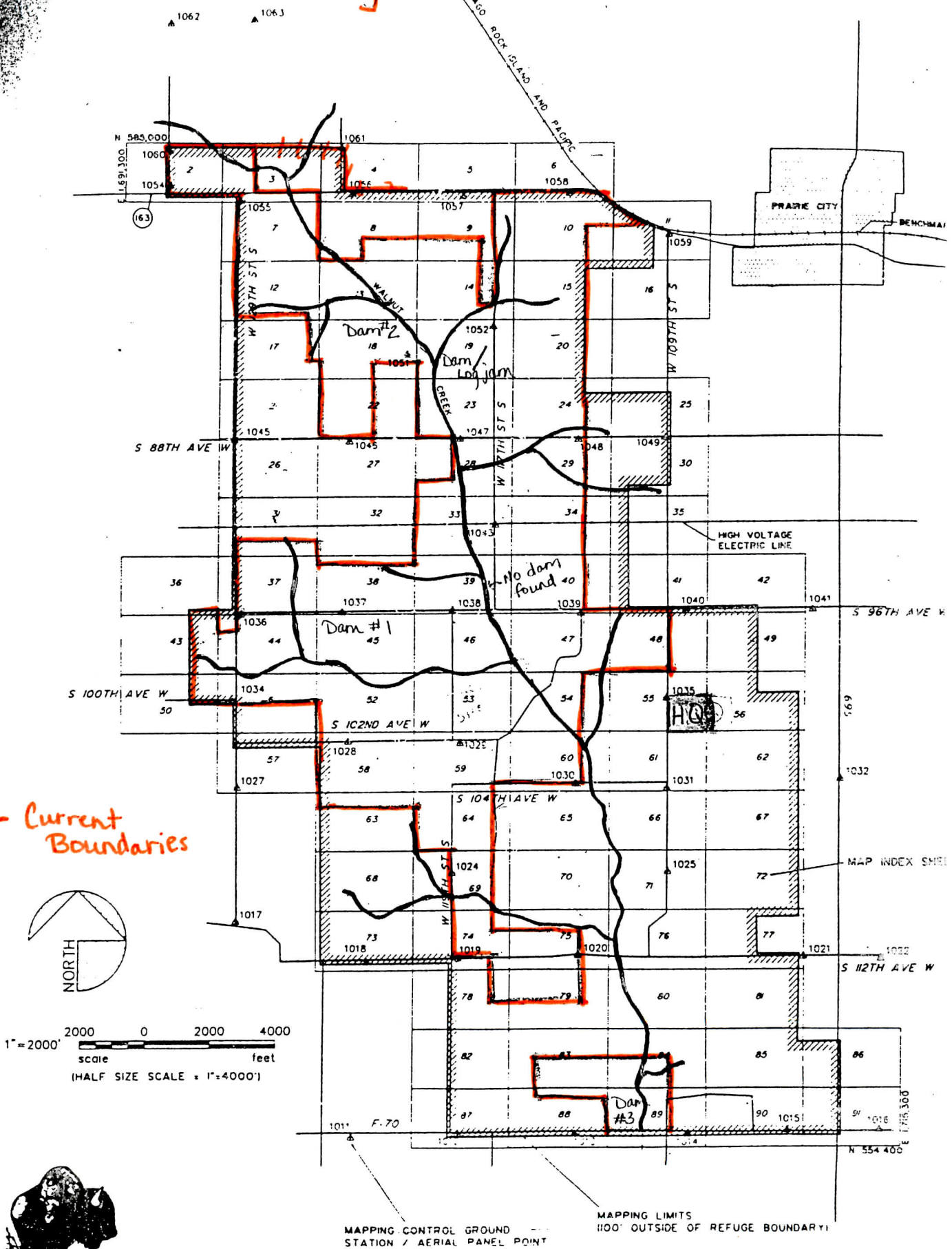

State 163
PACIFIC
PRAIRIE CITY 0.7 MI.
OSKALOOSA 42 MI.
(PRAIRIE CITY)
7367 II SW
MONROE 8 MI.
DES MOINES
Beaver on WCNWR
Refuge boundary
Area of sign
Unsurveyed
dam locations
old dam or log jams

Figure #2



– Current Boundaries

NORTH

1" = 2000' 2000 0 2000 4000
scale feet
(HALF SIZE SCALE = 1"=4000')

MAPPING CONTROL GROUND STATION / AERIAL PANEL POINT

MAPPING LIMITS (100' OUTSIDE OF REFUGE BOUNDARY)

Walnut Creek
National Wildlife Refuge – Prairie Learning Center

Figure # 2 cont

Legend

	Concrete	▲806.5	Aerial Panel Point
800	Contour, Index		Bridge
800	Contour, Index Approximate		Building
800	Contour, Index Depression		Bush Outline
800	Contour, Index Depression Approximate	) (	Culvert
	Contour, Intermediate	ΔFH	Fire Hydrant
	Contour, Intermediate Approximate	OFP	Flagpole
	Contour, Intermediate Depression		Grid Tick
	Contour, Intermediate Depression Approximate	OL.O.	Located Object
	Cultivated Field	— L.O.	Located Object
	Fence Line		Luminary
	Guard Rail		Pole
	Unidentified Line on Ground	▣RS	Railroad Signal
	Median		Sign
	Pipe	OSilo	Silo
	Railroad	×801.2	Spot Elevation
	Road, Highway/Edge Pavement		Swamp or Marsh
	Rock/Rip Rap Outline		Swamp or Marsh Outline
	Trail or Edge of Dirt/Gravel Road	T	Tank
	Wall		Tree, Conifer
	Wall, Retaining		Tree, Deciduous
	Water		Tree Outline
	Boundaries of Refuge currently	WELL	Well

NOTES

1. Mapping is prepared on the following datums:

   A. Horizontal Datum/Coordinate System: Horizontal datum is based on NAD 83 geodetic and the Iowa State Plane coordinate system (south zone). Project was controlled from use of Station "DYER". DYER lies at latitude (north) 41°24'39.03919" and longitude (west) of 93°16'17.28230". Coordinate base as shown is a State Plane Coordinate System (SPCS) MODIFIED. Geodetic positions were developed on forty-six (46) ground Stations. These forty-six (46) Stations in turn were converted to the SPCS. A combined factor was then developed to modify the coordinate base as follows:

      1. Ellipsoid (sea level) factor - An average project site elevation of 850 feet was utilized. This factor is 0.99996413.

      2. The grid scale factor - This factor was based on a project site average latitude (north) of 41°33'57.5". This factor is 0.9999686.

      The combined factor is:

E.F.	x	G.F.	=	Combined Factor
0.99996413	x	0.9999686	=	0.9999327

      Reciprocal value of the combined factor was multiplied times the SPCS coordinates to derive the SPCS (modified) values.

   B. Vertical Datum: Vertical datum is based on a National Geodetic Survey (NGS) benchmark known as Y4. This first order; standard USC&GS brass disk set in concrete is located in Prairie City, Iowa and described as follows:

      0.4 mile east along the Chicago, Rock Island & Pacific Railway from Prairie City, Jasper County. 550 feet east of a street crossing near a schoolhouse, 75 feet east of a powerline pole at a curve in the row of poles, and 41 feet north of the centerline of the track. A standard disk, stamped "926.130 Y 4 1930" and set in the top of a concrete post.

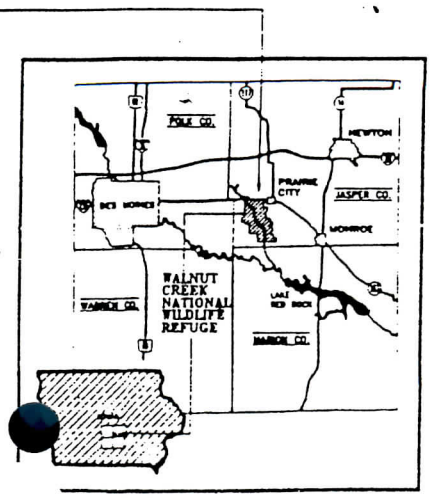
2. Aerial flight data gathered from black and white photography flown November 13, 1991. Photography extended 200 ft. outside of refuge boundary

3. Mapping limits extend 100 feet outside the refuge boundary

4. Mapping is digitized in AutoCAD format, Version 10.

5. Mapping contour interval is 2'.

6. Global Positioning Satellite surveying was utilized for this project to determine the geodetic position, i.e. latitude and longitude, of forty-six ground stations. Four days of observations utilizing four (4) satellite receivers with a minimum of four (4) sessions per day resulted in 111 baseline observations. Each session being one to two hours in duration. A least squares adjustment was performed constrained to the "fixed" geodetic position of station "DYER". Geodetic positions were then converted to SPCS modified as stated above.



AREA MAP
N T S

REVISION	STATUS	DATE	DESCRIPTION	BY

PROJECT

SHEET TITLE — INDEX SHEET

PREPARED BY

DATE	DESIGNED	DRAWN	CHECKED	DRAWING NO	
					1 of 9

Figure #3

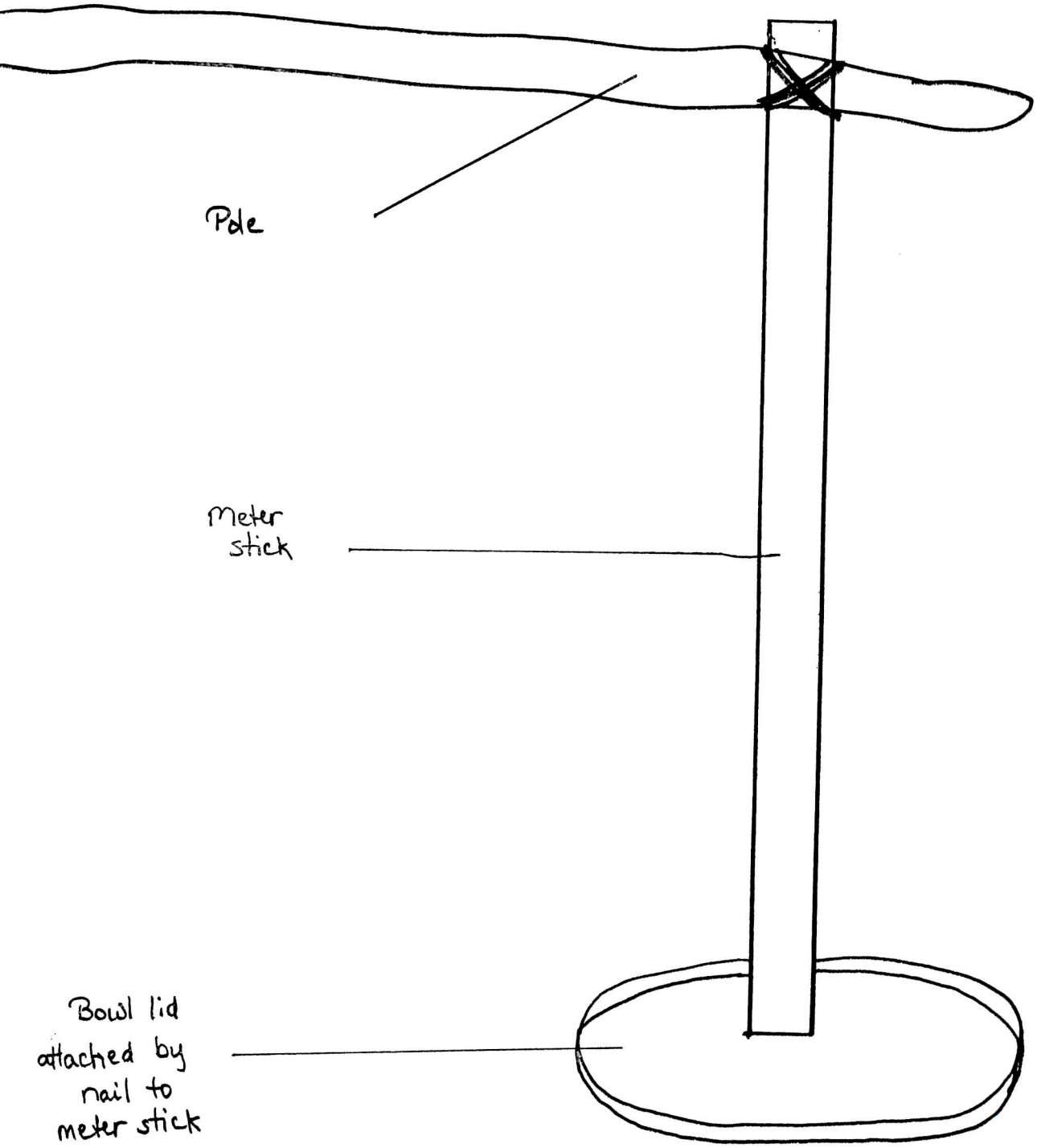
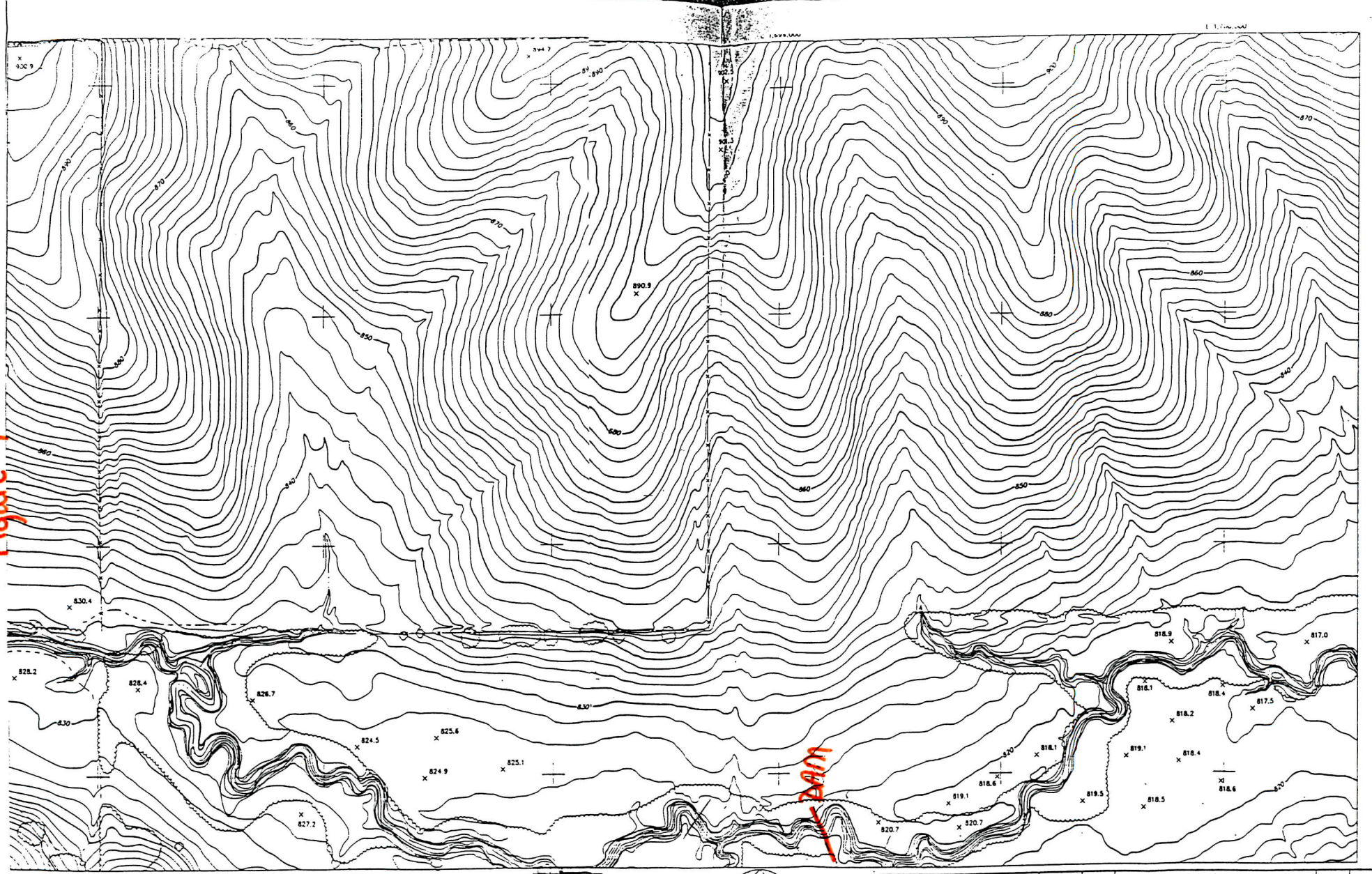
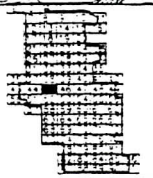
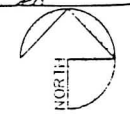


Figure 4







1"=100'

100 0 100 200

feet

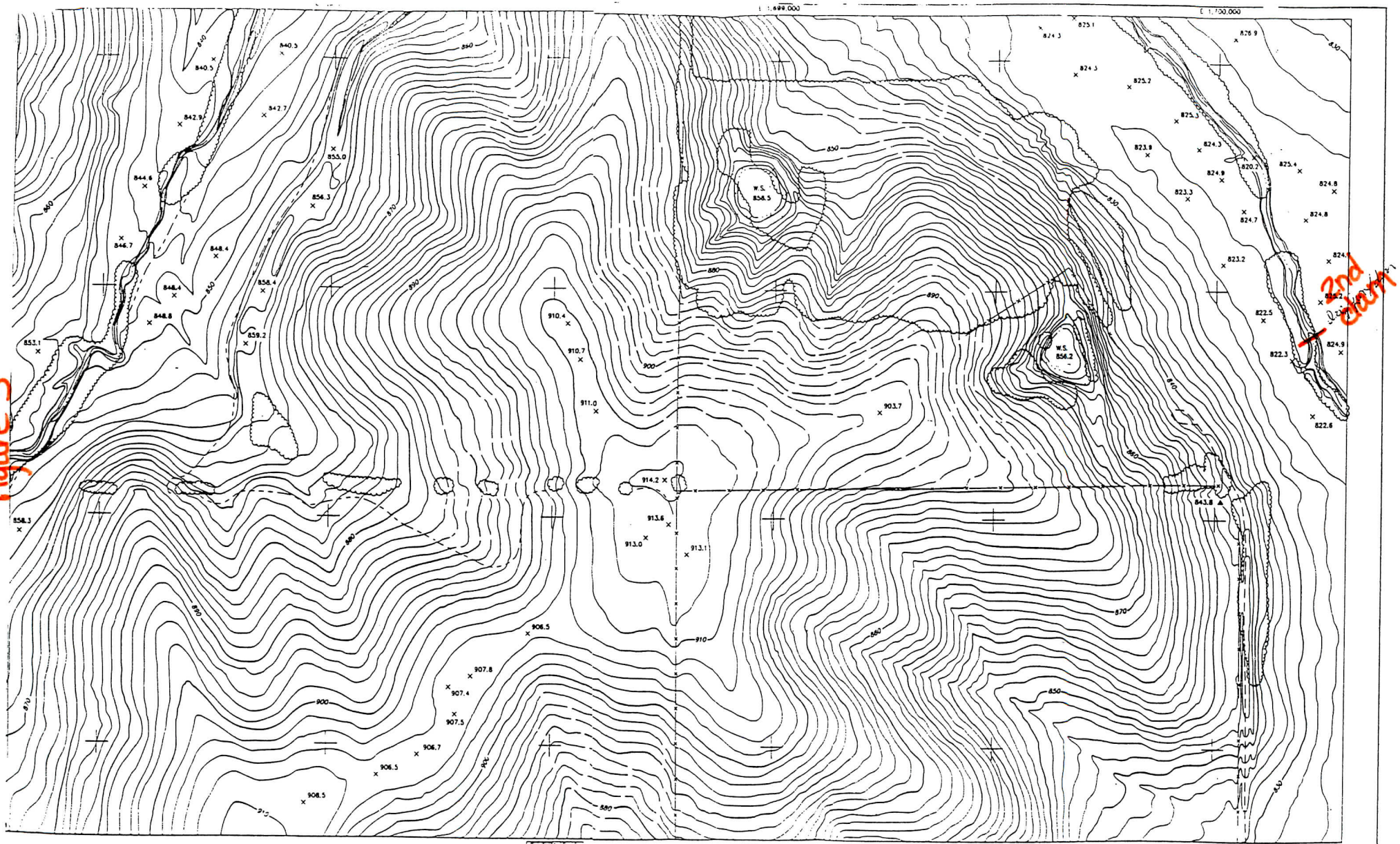
INTERVAL 2 FEET

REVISION	STATUS	DATE	DESCRIPTION	BY
PROJECT				
SHEET TITLE				
PREPARED BY				
DATE	DESIGNED	DRAWN	CHECKED	DRAWING NO

Walnut Creek

45 of 91

Figure 5



Walnut Creek

Wildlife Refuge - Prairie Learning Cen

REVISION	STATUS	DATE	DESCRIPTION	BY
PROJECT				
SHEET TITLE				
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Figure 6

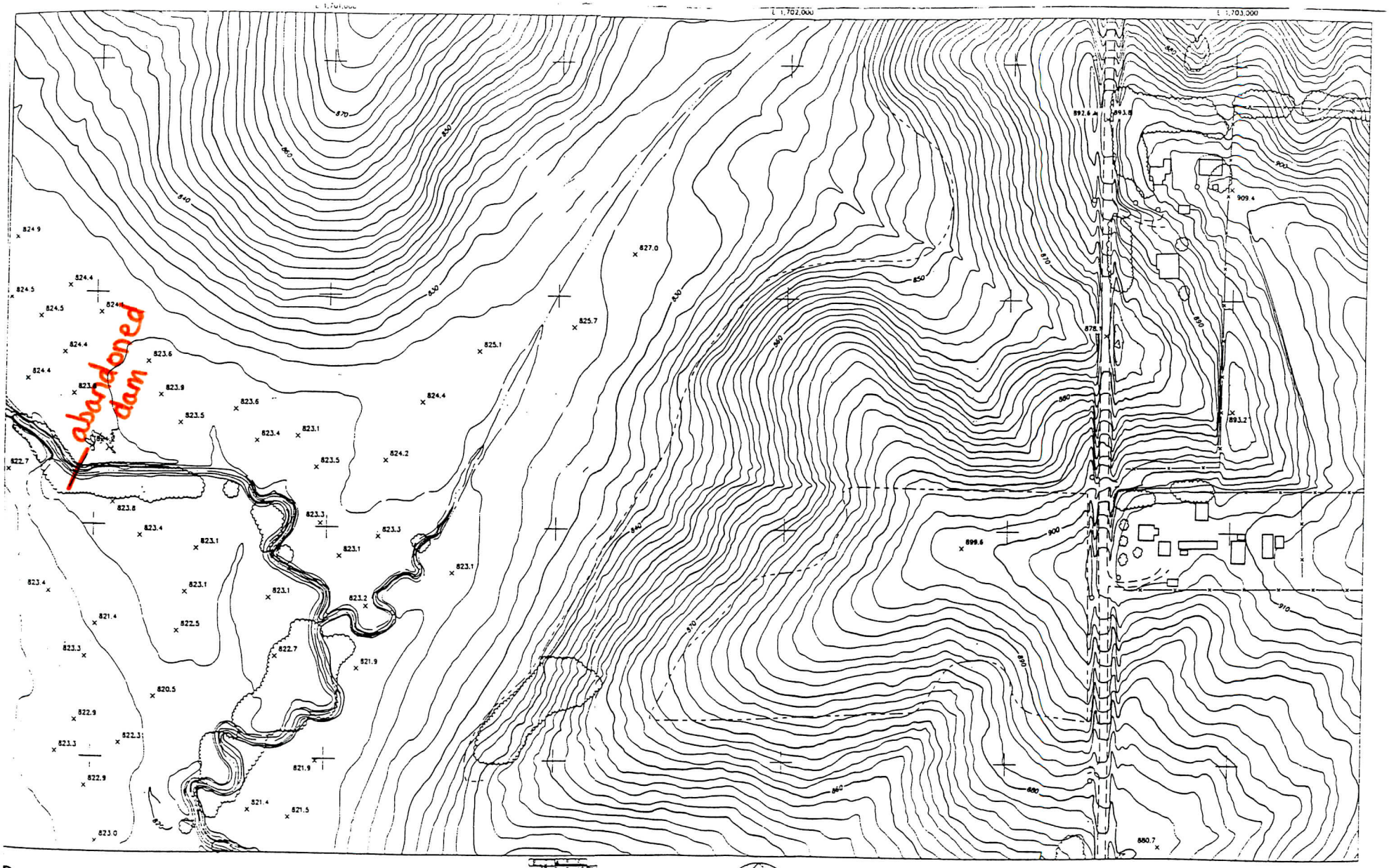

abandoned dam
E 1,702,000
E 1,703,000
NORTH
CONTOUR INTERVAL 2 FEET
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Figure 7



alnut Creek

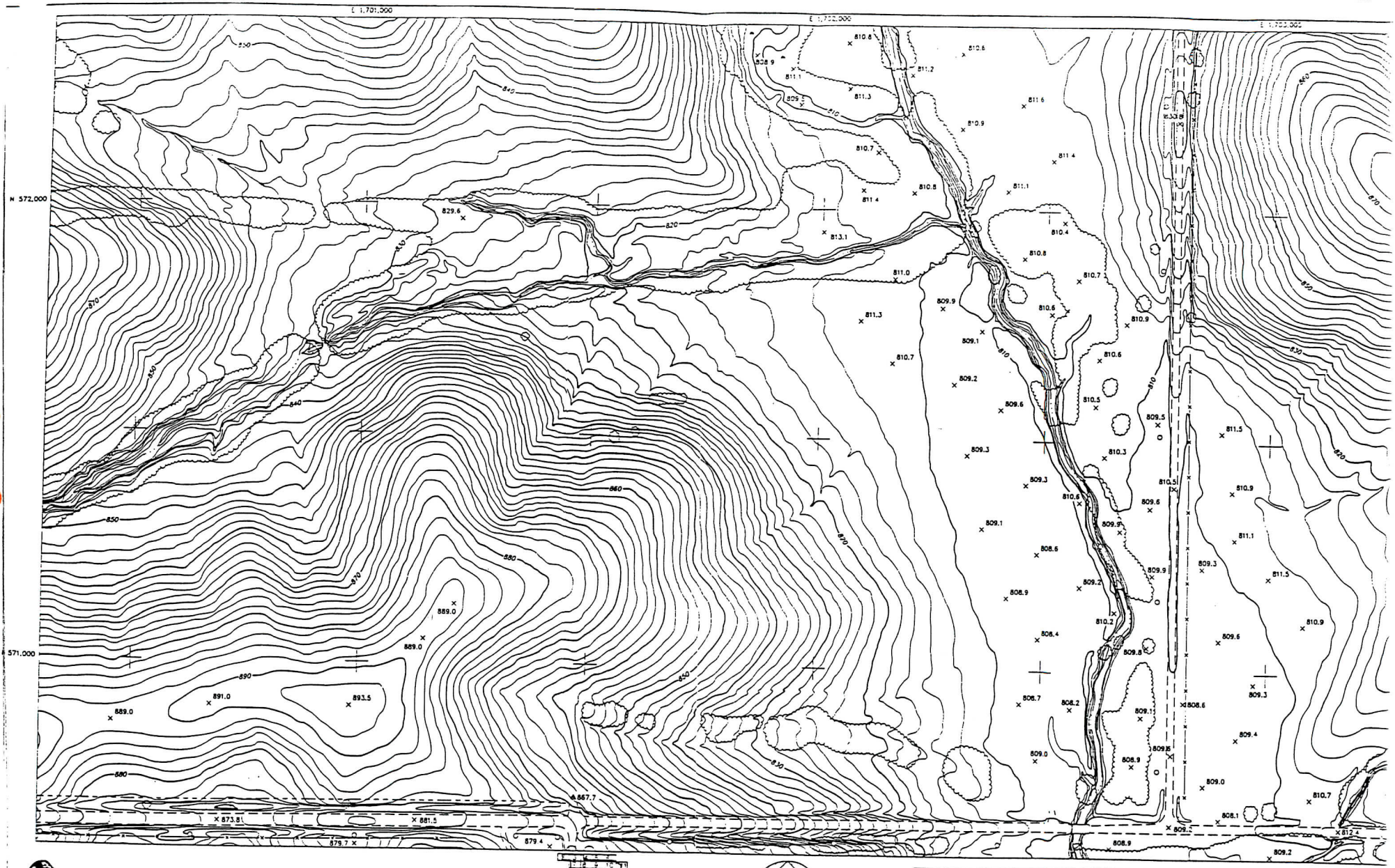
NORTH

1"=100' 100 0 100 200 feet

CONTOUR INTERVAL 2 FEET

REVISION	STATUS	DATE	DESCRIPTION	BY
PROJECT				
SHEET TITLE				
PREPARED BY				
DATE	DESIGNED	DRAWN	CHECKED	DRAWING NO.

Figure 8



Walnut Creek

National Wildlife Refuge – Prairie Learning Center

TABLE 1

	dam site	tree type	diameter (cm)
	Y_1		X_1
1	one	gr ash	2.2
2	one	gr ash	14.4
3	one	am elm	42.9
4	one	am elm	28.0
5	one	am elm	18.8
6	one	am elm	20.4
7	one	am bass	19.0
8	one	am bass	24.3
9	one	am bass	36.9
10	one	ash map	13.0
11	one	ash map	26.2
12	one	ash map	30.2
13	one	ash map	41.0
14	one	ash map	44.5
15	one	ash map	43.1
16	one	ash map	30.3
17	one	ash map	34.9
18	one	ash map	29.4
19	one	ash map	47.2
20	one	ash map	31.5
21	one	ash map	31.0
22	one	ash map	29.6
23	one	ash map	15.3
24	one	ash map	18.9
25	one	ash map	16.7
26	one	ash map	8.6
27	two	shaghick	3.3
28	two	silmaple	43.0
29	two	gr ash	16.4
30	two	am elm	16.1
31	two	am elm	23.0
32	two	wh mul	14.0
33	two	wh mul	48.7
34	two	wh mul	18.1
35	two	am bass	32.0
36	two	ash map	38.6
37	two	ash map	36.3
38	two	ash map	33.8
39	two	ash map	23.5
40	two	ash map	19.4
41	two	s will	29.8
42	three	locust	19.2
43	three	locust	28.7

	dam site	tree type	diameter (cm)
	Y_1		X_1
44	three	locust	17.6
45	three	locust	5.1
46	three	locust	16.5
47	three	locust	16.8
48	three	locust	21.4
49	three	locust	26.3
50	three	locust	15.6
51	three	silmaple	28.1
52	three	silmaple	36.6
53	three	gr ash	20.3
54	three	am bass	21.1
55	three	am bass	19.7
56	three	am bass	30.4
57	three	am bass	12.3
58	three	cottonwood	102.2

TABLE 1 Con't

Tree Species, Common Names, and Abbreviations

Honey locust	- *Gleditsia triacanthos*	- locust
Shagbark Hickory	- *Carya ovata*	- shaghick
Common Cottonwood	- *Populus deltoides*	- cottonwood
Silver maple	- *Acer saccharinum*	- silmaple
Green Ash	- *Fraxinus pennsylvanica*	- gr ash
American Elm	- *Ulmus americana*	- am elm
White Mulberry	- *Morus alba*	- wh mul
American Basswood	- *Tilia americana*	- am bass
Ashleaf Maple	- *Acer negundo*	- ash map
Sandbar Willow	- *Salix exigua*	- s will

tree diameter

TABLE 1A

One Factor ANOVA X 1 : dam site Y 1 : diameter (cm)

Analysis of Variance Table

Source:	DF:	Sum Squares:	Mean Square:	F-test:
Between groups	2	12.418	6.209	.027
Within groups	55	12692.145	230.766	p = .9735
Total	57	12704.563		

Model II estimate of between component variance = -11.982

One Factor ANOVA X 1 : dam site Y 1 : diameter (cm)

Group:	Count:	Mean:	Std. Dev.:	Std. Error:
one	26	26.858	11.752	2.305
two	15	26.4	12.389	3.199
three	17	25.759	21.052	5.106

One Factor ANOVA X 1 : dam site Y 1 : diameter (cm)

Comparison:	Mean Diff.:	Fisher PLSD:	Scheffe F-test:	Dunnett t:
one vs. two	.458	9.871	.004	.093
one vs. three	1.099	9.495	.027	.232
two vs. three	.641	10.784	.007	.119

TABLE 2

	dam	distance	site	depth (cm)
1	above	five	one	77
2	above	five	two	50
3	above	five	three	60
4	above	ten	one	63
5	above	ten	two	39
6	above	ten	three	41
7	above	twenty	one	49
8	above	twenty	two	15
9	above	twenty	three	27
10	below	five	one	23
11	below	five	two	10
12	below	five	three	61
13	below	ten	one	17
14	below	ten	two	16
15	below	ten	three	54
16	below	twenty	one	15
17	below	twenty	two	11
18	below	twenty	three	51

TABLE 2A

ANOVA Table for depth (cm)

	DF	Sum of Squares	Mean Square	F-Value	P-Value
dam	1	1476.056	1476.056	3.821	.0743
distance	2	1067.444	533.722	1.382	.2884
dam * distance	2	520.778	260.389	.674	.5279
Residual	12	4635.333	386.278		

Means Table for depth (cm)
Effect: dam * distance

	Count	Mean	Std. Dev.	Std. Err.
above, five	3	62.333	13.650	7.881
above, ten	3	47.667	13.317	7.688
above, twenty	3	30.333	17.243	9.955
below, five	3	31.333	26.502	15.301
below, ten	3	29.000	21.656	12.503
below, twenty	3	25.667	22.030	12.719

Interaction Bar Plot for depth (cm)
Effect: dam * distance
Error Bars: ± 1 Standard Error(s)

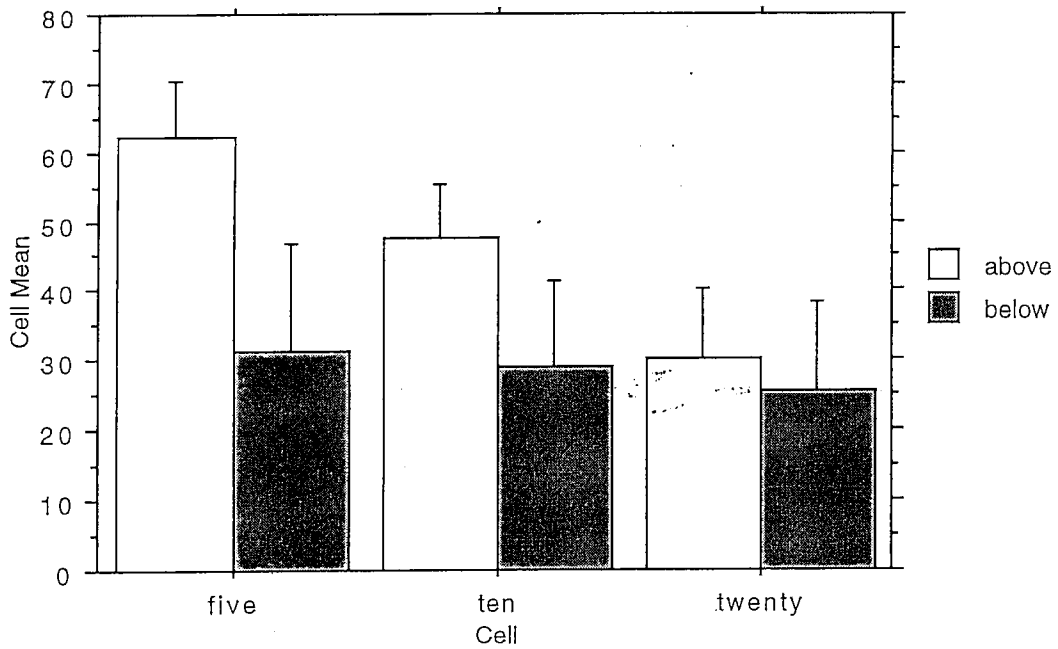


TABLE 3

	dam	distance	site	width (cm)
1	above	five	one	730
2	above	five	two	250
3	above	five	three	700
4	above	ten	one	640
5	above	ten	two	330
6	above	ten	three	580
7	above	twenty	one	610
8	above	twenty	two	190
9	above	twenty	three	310
10	below	five	one	40
11	below	five	two	130
12	below	five	three	1220
13	below	ten	one	110
14	below	ten	two	150
15	below	ten	three	930
16	below	twenty	one	190
17	below	twenty	two	200
18	below	twenty	three	910

TABLE 2A

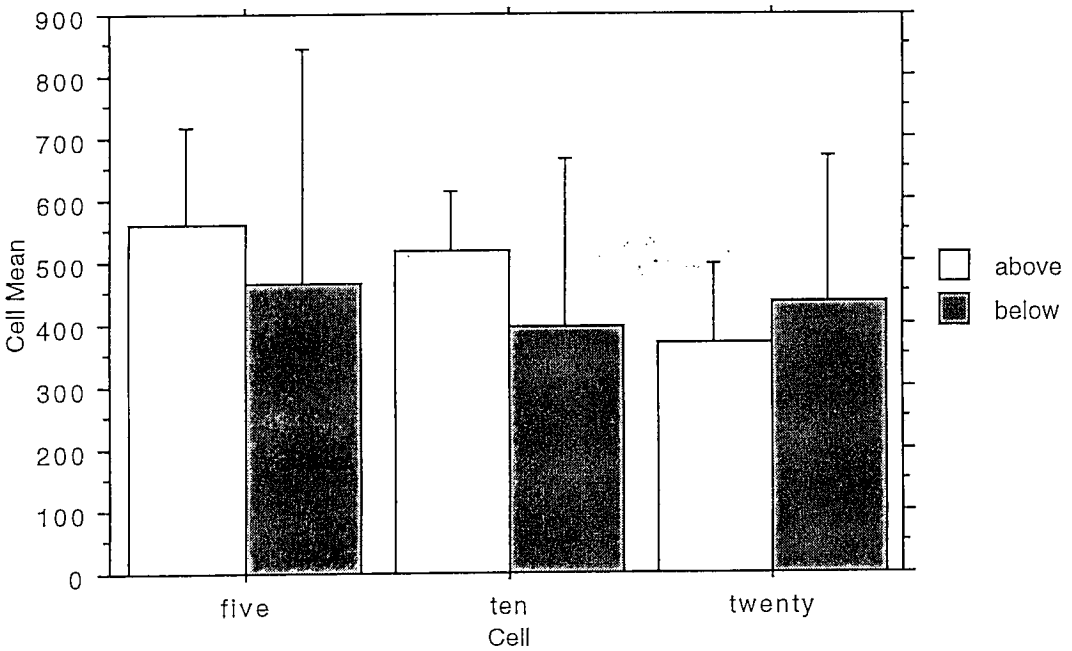
ANOVA Table for width (cm)

	DF	Sum of Squares	Mean Square	F-Value	P-Value
dam	1	11755.556	11755.556	.073	.7911
distance	2	36300.000	18150.000	.113	.8939
dam * distance	2	29877.778	14938.889	.093	.9117
Residual	12	1923466.667	160288.889		

Means Table for width (cm)
Effect: dam * distance

	Count	Mean	Std. Dev.	Std. Err.
above, five	3	560.000	268.887	155.242
above, ten	3	516.667	164.418	94.927
above, twenty	3	370.000	216.333	124.900
below, five	3	463.333	656.836	379.224
below, ten	3	396.667	462.313	266.917
below, twenty	3	433.333	412.836	238.351

Interaction Bar Plot for width (cm)
Effect: dam * distance
Error Bars: ± 1 Standard Error(s)



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