

Total Maximum Daily Load
For Siltation
Fairfield Municipal Reservoir 2
Jefferson County, Iowa

July 2001

Iowa Department of Natural Resources
Water Resources Section

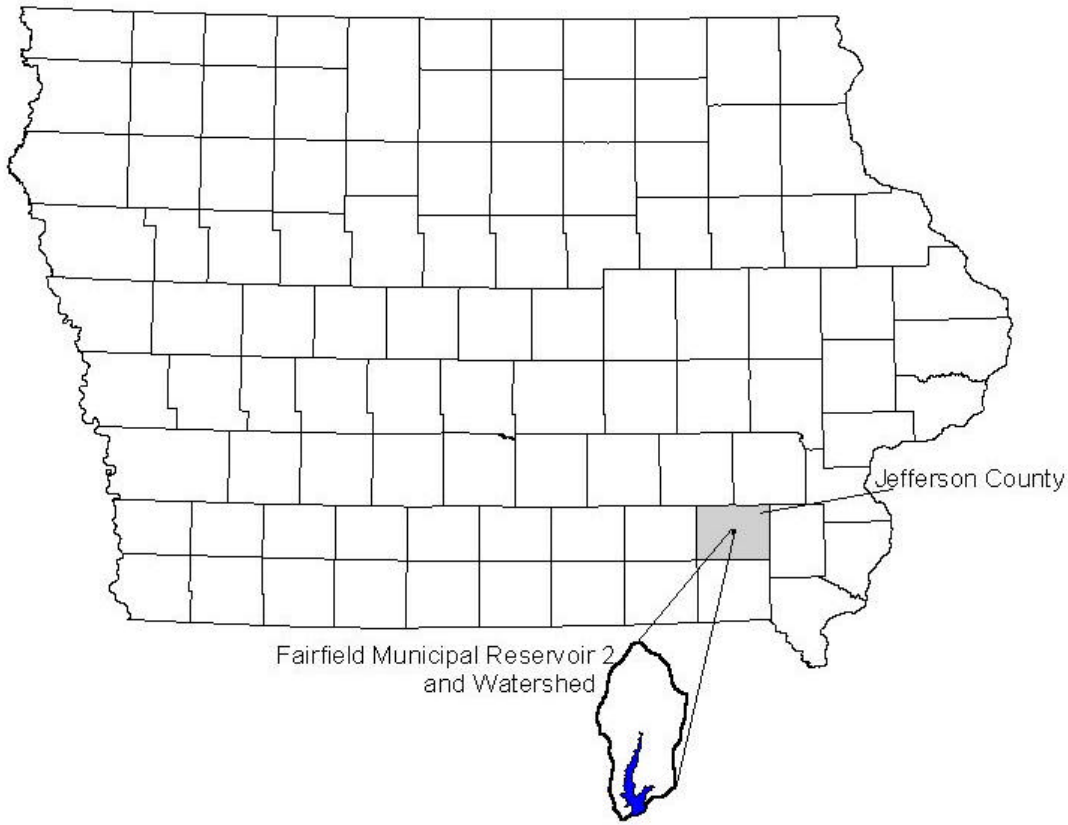


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TMDL for Siltation Fairfield Municipal Reservoir 2 Jefferson County, Iowa

Waterbody Name:	Fairfield Municipal Reservoir 2
IDNR Waterbody ID:	IA 03-SKU-00955-L
Hydrologic Unit Code:	HUC11 07080107040
Location:	Sec. 24 T72N R10W
Latitude:	41 Deg. 01 Min. N
Longitude:	91 Deg. 56 Min W
Use Designation Class:	B(LW) (aquatic life) C (potable water source)
Watershed Area:	596 acres
Lake Area:	54 acres
Major River Basin:	Skunk
Tributaries:	Unnamed intermittent streams
Pollutant:	Siltation
Pollutant Sources:	Agricultural Non Point Sources
Impaired Use:	Aquatic life (habitat)
1998 303d Priority:	High



1. Description of Waterbody and Watershed

Fairfield Municipal Reservoir 2 was built in 1898 and is located in southeastern Iowa, northeast of Fairfield, Iowa. Reservoir 2 is owned by the City of Fairfield. The designated use classes for Reservoir 2 are Class B (LW) (aquatic life) and C (potable water source). Fairfield Municipal Reservoir 2 has a shoreline length of 2.5 miles and a volume of approximately 390 acre-feet (Sperflage, 2000).

Fairfield Municipal Reservoir 2 is a standby source of potable water for the City of Fairfield. The Reservoir is also used for fishing, picnicking and boating and a trail system is being constructed around the lake. Fairfield Municipal Reservoir 2 is used frequently by local residents for these activities.

The Fairfield Municipal Reservoir 2 watershed has an area of approximately 596 acres and a watershed to lake ratio of 11:1. Land use data for the Fairfield Municipal Reservoir 2 watershed was collected in November 2000 by the Iowa Department of Agriculture and Land Stewardship, Division of Soil Conservation, and the Iowa Department of Natural Resources staff. The landuse and associated areas for the watershed are shown in Table 1.

Table 1. Landuse in the Fairfield Municipal Reservoir 2 watershed (November, 2000).

Land Use	Acres	Percent
Row crop	474	80%
Forest	47	8%
Grass / Hay	30	5%
CRP	37	6%
Roads, Farmsteads, etc.	8	1%
Total	596	100%

The watershed of Fairfield Municipal Reservoir 2 is dominated by agricultural row crop uses. The remainder of the landuse is forest or grassland. Thirty-seven acres of row crop land were enrolled in the Conservation Reserve Program after the 2000 harvest. This reduced the percent of row crop acres in the watershed from 86% to 80%.

Topography of the watershed varies from level to gently sloping (0-14%). Soils of the watershed were developed from glacial till or loess and include Mahaska, Otle, Clarinda, and Taintor. These soils are moderately well to poorly drained and the permeability varies from moderate to very slow. These types of soils present slight to moderate erosion hazards (USDA-NRCS, 1999)

Average rainfall in the area is 36 inches/year, with the greatest monthly amount (5.1 inches) occurring in July.

2. Applicable Water Quality Standards

The State of Iowa does not have numeric water quality standards for siltation. In 1992, the fishable uses (Class B) were assessed as partially supporting based on the best professional judgement of DNR Fisheries staff. The reservoir has not been reassessed since 1992, rather the assessment of partially supporting of Class B (LW) has continued to be used. The impacts of excess sediment is impairing the Class B(LW) designated use by altering the physical and chemical characteristics of the lake so that a balanced community normally associated with lake-like conditions is not maintained (IAC 567-61.3(1)b(7)). The altering of the physical and chemical characteristics are causing impairments of the following beneficial uses: 1) aquatic

habitat; 2) spawning, reproduction and development; and, 3) sport fishing. In addition, siltation reduces food supplies by smothering benthic macroinvertebrates.

3. Water Quality Conditions

The water quality of Fairfield Reservoir 2 has not been well documented. As part of the Fairfield Lakes Water Quality Project, water samples were collected monthly from the lake from June 1998-July 2000 (Sperflage, 2000). This analysis was determined by field test methods and included turbidity, pH, total alkalinity, and total hardness (Sperflage, 2000).

4. Desired Endpoint

The listing of Fairfield Municipal Reservoir 2 is based on narrative criteria. There are no numeric criteria for siltation applicable to Fairfield Municipal Reservoir 2 or its sources in Chapter 61 of the *Iowa Water Quality Standards* (Iowa, 1996). Therefore, an appropriate endpoint needs to be determined. The endpoint needs to include both sediment load to the lake as well as a measurement of the aquatic life within the lake. Therefore, this TMDL will incorporate an endpoint for sediment delivery to the lake, and an endpoint for the fishery of the lake.

The first endpoint is to address the deposition of sediment delivered to the lake. A direct measure of the sediment load is difficult to make, given seasonal variability and actual measurement tools. Acceptable estimates using established soil loss equations can be made to predict the erosion rates in the watershed, and subsequent delivery to the lake. An estimate of the gross erosion and sediment delivery to Fairfield Municipal Reservoir 2 based on the time at which the lake was listed as impaired was calculated using the Revised Universal Soil Loss Equation (RUSLE). The potential gross erosion in the Fairfield Municipal Reservoir 2 watershed when the waterbody was listed as impaired (1992 landuse and practices) is estimated at 5,724 tons/year (Table 2, Appendix I). An average delivery rate of 36% (Chart 1, USDA-NRCS, 1998) yields an estimated 1992 sediment delivery to the reservoir of 2,078 tons/year (Table 2, Appendix I).

The first endpoint for this TMDL is to reduce gross erosion from fields in the watershed to "T". "T is an estimate of the maximum average annual rate of erosion by wind or water that can occur without affecting crop productivity over a sustained period" (USDA-NRCS, 1999). Reducing the erosion rate to T from fields in the Fairfield Municipal Reservoir 2 watershed is expected to result in the protection of aquatic life by eliminating the adverse effects of excessive sediment loading to the reservoir. This target load reduction is a reasonable initial estimate of needed reductions because it will result in an average rate of deposition in the lake low enough to minimize the impact on aquatic life.

The potential gross erosion from fields in the Fairfield Municipal Reservoir 2 watershed is 2,704 tons/year at "T" (Table 3, Appendix I). An average delivery rate of 36% (Chart 1, USDA-NRCS, 1998) would yield 973 tons/year (1.6 t/a/y) of sediment delivered to the lake at T (Table 3, Appendix I). Therefore, the desired endpoint for sediment delivery to the reservoir is 973 tons/year.

The second endpoint for this TMDL will be achieved when the fishery of Fairfield Municipal Reservoir 2 is determined to be fully supporting the Class B aquatic life uses. This determination will be accomplished through an assessment conducted by the DNR Fisheries Bureau by 2002. This assessment will be in accordance with the Statewide Biological Sampling Plan protocol (Larscheid, 2001). This protocol is currently being used to develop benchmarks

for the fishery of Iowa's lakes. The results from the Fairfield Municipal Reservoir 2 assessment will be compared with the benchmarks being developed. These assessments will include age, growth, size structure, body condition, relative abundance, and species.

Fairfield Municipal Reservoir 2 will not be considered restored until the second endpoint is achieved. If the aquatic life endpoint is achieved prior to the sediment delivery endpoint, then the level of land practices may be maintained at a level at or above those in place at the time of the assessment. If however, after a reasonable time following the completion of the sediment delivery practices the aquatic life has not been restored, then further study and practices may be necessary.

5. Loading Capacity

"T is an estimate of the maximum average annual rate of erosion by wind or water that can occur without affecting crop productivity over a sustained period" (USDA-NRCS, 1999). The average "T" factor for the Fairfield Reservoir 2 watershed is 4.6 t/y. If the fields in the watershed were farmed at "T", the sediment delivery to the reservoir would be 973 tons/year. Reducing the amount of sediment delivered to the lake should improve the overall water quality of the reservoir, and restore the lake to water quality standards.

6. Pollutant Sources

Water quality in Fairfield Municipal Reservoir 2 is influenced only by nonpoint sources. There are no point source discharges in the watershed.

Fairfield Reservoir 2 was assessed as partially supporting of the Class B (LW) use in 1992 due to siltation. Since this assessment, three watershed projects have worked with landowners to improve the land management and conservation practices in the watershed. Soil losses in the watershed averaged 10.9 tons/acre/year of sediment on row crop acres not protected by terraces (Dave White, District Conservationist). When the 1992 assessment was made the majority of the row crop ground was benefiting from reduced tillage, but there were very few, if any, terraces in place in the watershed. The estimated sediment delivery to the lake at the time of the assessment was 2,078 tons/year.

Field investigations to determine current landuses, cropping patterns, fertilizer use, conservation practices, livestock operations, gully erosion and shoreline erosion were made in May 2000. Agricultural row crop production is the primary landuse in this watershed (80%). Conservation practices in place in the watershed include terraces, grass waterways, contour cropping, no till, minimum till, organic farming, and nutrient and chemical management. There are no animal feeding operations in the watershed.

During the field investigations in May 2000, one small minimally active gully was located on the west side of the reservoir. The majority of this gully is covered with vegetation. There is very little erosive activity in this gully, and sediment delivery to the lake from this gully is minimal. There is also some minimal shoreline erosion in Fairfield Municipal Reservoir 2. These two sources are considered minimal, and neither were used in the sediment delivery calculations.

7. Pollutant Allocation

7.1 Point Sources

There are no point source discharges within the Fairfield Reservoir 2 watershed. Therefore, the Wasteload Allocation established under this TMDL is zero.

7.2 Non-Point Sources

The non-point source discharges are originating from sheet and rill erosion. Gross sheet and rill erosion was calculated for the watershed using the Revised Universal Soil Loss Equation (RUSLE) and sediment delivery to Fairfield Municipal Reservoir 2 was determined using the erosion and sediment delivery worksheet (USDA-NRCS, 1998). These calculations are shown in Appendix I. When Fairfield Municipal Reservoir 2 was listed as impaired, the estimated average sediment delivery was 2,078 tons per year (3.5 tons/acre/year). The desired endpoint is 973 t/y. The Load Allocation established under this TMDL is 973 tons per year delivered to the lake from the watershed.

7.3 Margin of Safety

The margin of safety for this TMDL is implicit. The dual endpoints for this TMDL assures that that the aquatic life uses will be restored regardless of the accuracy of the sediment delivery endpoint. Failure to achieve water quality standards will result in review of the TMDL, allocations, and/or sediment management approaches and probable revision. In addition, calculations were made using conservative estimates. RUSLE uses conservative calculations to calculate the gross erosion.

8. Seasonal Variation

This TMDL accounts for seasonal variation by recognizing that (1) sediment loading varies substantially by season and between years, and (2) sediment impacts are felt over multi-year timeframes. Sediment loading and transport are predictable only over long timeframes. Moreover, in contrast to pollutants that cause short-term beneficial use impacts and are thus sensitive to seasonal variation and critical conditions, the sediment impacts in this watershed occur over much longer time scales. For these reasons, the longer timeframe (tons per year) used in this TMDL is appropriate.

It is expected that the majority of all erosion occurring in the Fairfield Reservoir 2 watershed occurs in the spring during periods of higher rainfall and in the fall after crops have been harvested and the ground is left uncovered (Sperfslage, 2000).

9. Implementation

The Iowa Department of Natural Resources recognizes that an implementation plan is not a required component of a Total Maximum Daily Load. However, the IDNR offers the following implementation strategy as a guide to improve water quality in Fairfield Municipal Reservoir 2.

This TMDL is being designed as a Phased TMDL with two Phases. Phase One of this TMDL is to reduce the amount of sediment delivered to the reservoir so that the Load Allocation is met. Phase Two is to reassess the fishery of the reservoir to determine if aquatic life impairments continue to exist.

The watershed of Fairfield Municipal Reservoir 2 is primarily agricultural and varies from level to gently sloping. Row crop accounts for 80% of the landuse in the watershed. Three watershed management projects have been sponsored by the Iowa Department of Agriculture and Land Stewardship, Division of Soil Conservation and the Jefferson County Soil and Water Conservation District, beginning in 1990. The most recent project began in April 1998 and was completed in September 2000. These projects worked with landowners to improve the management of the land and to improve water quality by reducing overland runoff and sediment

and nutrient delivery to the lake. These projects used cost share funds and incentives to construct terraces and promote on ground practices.

All cropland acres in the watershed follow a USDA-NRCS plan and are usually a corn-bean rotation. Approximately 85 acres are consistently no-tilled, 67 acres now organically farmed, and the remainder of the cropland is minimum tilled (~30% residue left after planting).

During the watershed projects, approximately 20,000 feet of terraces have been constructed. There has also been a general reduction in fertilizers and long-lived herbicides, with fertilizer management now complete on 203 acres. In addition, there are approximately 2,000 feet of grass waterways in the watershed (Sperfslage, 2000).

Shoreline erosion is present, but not extensive, in Fairfield Municipal Reservoir 2. The Fairfield Lakes Water Quality Project addressed this erosion by placing riprap along selected portions of the eroding areas of shoreline (approximately 300 feet). In addition, willow stake plantings have been established to control bank sloughing in areas of the shoreline where it is not accessible to place riprap (approximately 425 feet of shoreline).

Very little of the Fairfield Municipal Reservoir 2 watershed still needs to have conservation measures implemented. There are approximately 21 acres on the west side of the lake that would benefit from the construction of terraces. This land is currently contour farmed using minimum till practices. This tract may be developed for residential housing, therefore it is unlikely that terraces will be constructed. Another 62 acres northwest of the reservoir would benefit from the construction of terraces. This land is currently organically farmed and minimum tilled.

Any future development in the watershed should ensure that erosion control practices are in place during construction, septic systems and leach fields are adequately designed and do not discharge to the lake, and future storm water runoff is adequately controlled to reduce sediment delivery to the lake.

The Fairfield Municipal Reservoir 2 currently has many best management practices and erosion control structures in place. With these conservation measures accounted for, the sediment delivery to the reservoir is estimated to be 764 tons/year (1.3 t/a/y) based on the RUSLE and the erosion and sediment delivery worksheet (USDA-NRCS, 1998) (Table 4, Appendix I). This equates to a 63% reduction in sediment delivery to the reservoir. Current conservation practices have already reduced sediment delivery to Fairfield Municipal Reservoir 2, and attained the desired endpoint of 973 tons per year.

Phase Two will be completed by the Fisheries Bureau of the Iowa Department of Natural Resources. The fishery at Fairfield Municipal Reservoir 2 will be surveyed by December 2002 to assess the Class B uses.

10. Public Participation

Public meetings were held in Des Moines and Fairfield regarding the proposed TMDL for siltation for Fairfield Municipal Reservoir 2 on January 17 and January 25, 2001. A second public meeting was held in Fairfield on June 13, 2001. Any comments received will be reviewed and given consideration and, where appropriate, incorporated into the TMDL.

11. References

Iowa. 1996. *Iowa Administrative Code 567, Chapter 61, Iowa Water Quality Standards*.

Larscheid, Joe. Statewide Biological Sampling Plan, July 2001.

Sperflage, Thomas J. Fairfield Lakes Water Quality Project – Final Report. September 2000.

USDA-NRCS. 1998. Field Office Technical Guide Notice No. IA-198. "Erosion and Sediment Delivery Procedure", Section I, Erosion Protection.

USDA-NRCS. 1999. United States Department of Agriculture, Natural Resource Conservation Service. 1999. Soil Survey of Jefferson County, Iowa, Parts I and II.

APPENDIX I

1992 Gross Erosion from the Fairfield Municipal Reservoir 2 watershed

Sheet and Rill Erosion (determined using RUSLE (USDA-NRCS, 1998))

Rainfall x Soil Erodability x Length-Slope x Conservation Practice x Practice Factor = Soil Loss

Cropland with no terraces

$$175 \times .37 \times 1.25 \times 1.0 \times .135 = 10.9 \text{ tons/year}$$

Grass/hay

$$175 \times .37 \times 1.25 \times 1.0 \times .025 = 2 \text{ tons/year}$$

Forest

$$175 \times .37 \times 1.25 \times 1.0 \times .037 = 3 \text{ tons/year}$$

Table 2. 1992 Sediment Delivery to Fairfield Municipal Reservoir 2

Sediment delivery using 1992 Landuse and Conservation practices

Landuse	Acres	Gross Erosion Rate (t/a/y)*	Potential Gross Erosion (tons)	SDR	Sediment Delivered (tons)
Row crop	511	10.9	5,570	36%	2,005
Grass/hay	30	2	60	36%	22
Forest	47	3	94	36%	51
Total			5,724		2,078

Table 3. Sediment delivery at "T"

Landuse	Acres	Average "T"	Potential Gross Erosion at "T"	SDR	Sediment Delivered at "T"
Reservoir 2 Watershed	588	4.6 t/a/y	2,704 t/y	36%	973 t/y

Current Gross Erosion from the Fairfield Municipal Reservoir 2 watershed

Sheet and Rill Erosion (determined using RUSLE (USDA-NRCS, 1998))

Rainfall x Soil Erodability x Length-Slope x Conservation Practice x Practice Factor = Soil Loss

Cropland with no terraces

$$175 \times .37 \times 1.25 \times 1.0 \times .135 = 10.9 \text{ tons/year}$$

Cropland with terraces

$$175 \times .37 \times 1.25 \times .7 \times .08 = 4.5 \text{ tons/year}$$

Grass/hay

$$175 \times .37 \times 1.25 \times 1.0 \times .025 = 2 \text{ tons/year}$$

Forest

$$175 \times .37 \times 1.25 \times 1.0 \times .037 = 3 \text{ tons/year}$$

CRP

$$175 \times .37 \times 1.25 \times 1.0 \times .012 = 1 \text{ tons/year}$$

Table 4. Current Sediment Delivery to Fairfield Municipal Reservoir 2

Sediment delivery using 2001 Landuse and Conservation practices

Landuse	Acres	Gross Erosion Rate (t/a/y)*	Potential Gross Erosion (tons)	SDR	Sediment Delivered (tons)
Row crop (not terraced)	83	10.9	905	36%	326
Row crop (terraced)	391	4.5	1,760	20%	352
CRP	37	1	37	36%	13
Grass/Hay	30	2	60	36%	22
Forest	47	3	141	36%	51
Total Delivery per year (tons)			2,903		764

Potential Gross Erosion (tons/year) = Acres * Gross Erosion Rate (tons/acre/year)

Sediment Delivery (tons/year) =

$$\text{Acres} * \text{Gross Erosion Rate (tons/acre/year)} * \text{Sediment Delivery Rate}$$

* Gross erosion rates in the Fairfield Reservoir 2 watershed were obtained from the local NRCS office and were determined using RUSLE.

The Sediment Delivery Ratio (SDR) was obtained from the Erosion and Sediment Delivery Worksheet, (USDA-NRCS, 1998) and is based on the drainage area of the watershed, watershed shape, topography, channel density, channel characteristics, and type of drainage.

Erosion and sediment delivery calculations do not include eight acres of roads, farmsteads, etc. in the Fairfield Municipal Reservoir 2 watershed.

Fairfield Municipal Reservoir 2 and watershed

