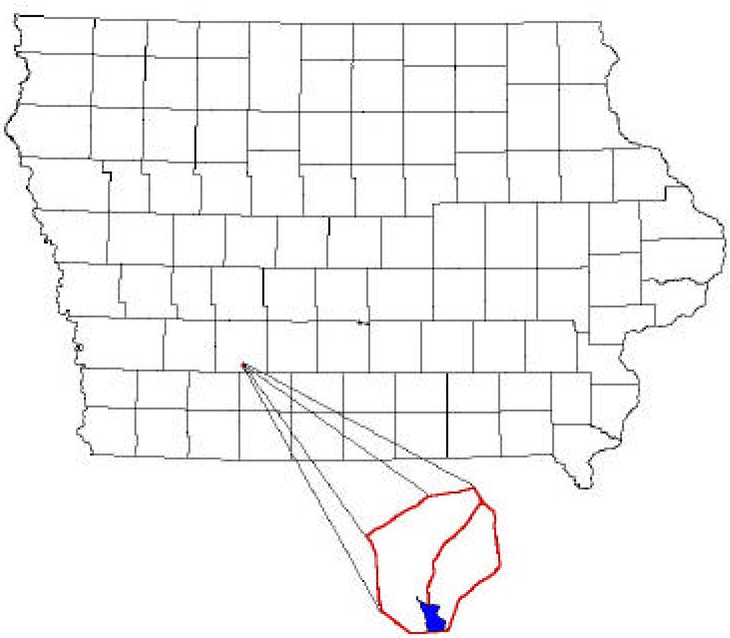
Total Maximum Daily Load
For Siltation
Orient Lake
Adair County, Iowa

July 2001

Iowa Department of Natural Resources
Water Resources Section

TMDL for Siltation
Orient Lake
Adair County, Iowa

Waterbody Name:	Orient Lake
IDNR Waterbody ID:	IA 05-NOD-00485-L
Hydrologic Unit Code:	HUC11 10240010030
Location:	Sec. 20, T74N, R31W
Latitude:	41 Deg. 12 Min. N
Longitude:	94 Deg. 26 Min W
Use Designation Class:	A (primary contact recreation) B(LW) (aquatic life) C (potable water source)
Watershed Area:	595 acres
Lake Area:	Approx. 24 acres
Major River Basin:	Southern Iowa River Basin
Tributaries:	Unnamed intermittent streams
Receiving Water Body:	E. Nodaway River
Pollutant:	Siltation
Pollutant Sources:	Agricultural Nonpoint
Impaired Use:	B (LW) (aquatic life)
1998 303d Priority:	Low



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1. Description of Waterbody and Watershed

Orient Lake is located in southwestern Iowa about 1 mile southwest of Orient, Iowa. Orient Lake was built in 1970 by the city of Orient as a source of potable water for the city. It has a surface area of approximately 24 acres, a mean depth of 6 feet, and a maximum depth of 12 feet.

Orient Lake is owned by the City of Orient and has been leased to the Adair County Conservation Board since 1974. The recreational portions have been developed and managed by the Board. Orient Lake has the designated uses of Class A (primary contact recreation), Class B(LW) (aquatic life) and Class C (potable water source). Although the lake is designated for primary contact recreation, there is not a swimming beach. The lake provides facilities for fishing, boating, camping, picnicking and hiking. In a survey conducted in the mid-1990's, park use was estimated at approximately 12,000 visits per year. The Adair Conservation Board reports that use has continued to increase, and is higher now. They also report that 2000 was a record year for park use. The City of Orient discontinued use of Orient Lake as a source of potable water on November 5, 1993.

The Orient Lake watershed has an area of approximately 595 acres and has a watershed-to-lake ratio of 25:1.

Table 1. Land use in Orient watershed (2001).

Landuse	Area in Acres	Percent of Total Area
Cropland	474	80
Pasture	10	2
CRP	31	5
Other (roads, etc)	80	13
Total	595	100

Topography of the watershed varies from gently to strongly sloping to steep (2-14%) prairie-derived soils developed from loess, pre-Wisconsin till, or pre-Wisconsin till-derived paleosols. Sharpsburg, Shelby, and Adair soils (DSC-DNR, 1991). Nearly level to moderately sloping (0-9%) prairie-derived soils developed from loess or pre-Wisconsin till-derived paleosols. Sharpsburg, Macksburg, Winterset, and Clarinda soils.

Average rainfall in the area is 33 inches/year, with the greatest monthly amount (5.5 inches) occurring in June.

2. Applicable Water Quality Standards

The State of Iowa does not have numeric water quality standards for siltation. In the 1986 Department of Natural Resources (DNR) biennial water quality 305(b) report the fishable uses (Class B) for Orient Lake were assessed as partially supported due to excessive sediment from agricultural sources, based on the best professional judgement of DNR Fisheries staff. This assessment was based on information collected during the 1984-1985 period. That assessment of partially supporting of Class B (LW) has continued to be used in subsequent biennial reports. Excess sediment impacts 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 causes 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 macro invertebrates.

3. Water Quality Conditions

Various Water Quality studies have been conducted at Orient Lake, measuring general physical parameters often related to water clarity such as total suspended solids, Secchi Disk depth, chlorophyll a, and turbidity. Table 3, Appendix I provides a summary of pertinent data collected during these studies. Several of the studies have characterized the lake as being turbid. Data on Secchi depth as shown in Appendix I substantiate the observations that turbidity is high (Secchi depth is consistently less than 1 meter). Turbidity is often a result of excess sediment, and contributes to the negative impact on the aquatic life uses. In addition to excessive sediment, turbidity can also result from algal growth caused by excess nutrient loading. Appendix I data also show elevated chlorophyll and phosphorus values. Because phosphorus is often bound with soil particles, its loading is closely related to sediment delivery. With the sediment delivery reduction, a corresponding phosphorus loading reduction is expected which may help the algal situation. However, because these relationships are complex and include factors such as light penetration, data from future monitoring will continue to assess not only sediment-related parameters, but nutrients and chlorophyll as well.

The primary impact of sediment at Orient Lake is interference with reproduction and growth of fish and other aquatic life. Excessive sediment deposition has lead to the lake being assessed as not meeting water quality standards.

The studies conducted include the Clean Lakes Classification Study by Iowa State University (ISU) (1979, 1990); the Iowa Lakes Study University of Iowa Hygienic Laboratory (UHL) in 1986; and again a herbicides study by UHL in 1995. Currently, in-lake water monitoring will be completed as part of the Iowa Lakes Survey, which includes sampling three times per year for each of the field seasons 2000 – 2005.

4. Desired Endpoint

The listing of Orient Lake is based on narrative criteria. There are no numeric criteria for siltation applicable to Orient Lake or its sources in Chapter 61 of the Iowa Water Quality Standards (IAC, 1996). Since excessive sediment deposition has impacted this water body, the endpoint needs to include both sediment loads to the lake and measurement of the aquatic life within the lake. Therefore, this TMDL will incorporate two endpoints.

The first endpoint will deal with direct deposition of eroded sediment delivered to the lake. A direct measure of the sediment load is difficult, 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. The sediment delivery to Orient Lake was estimated based on the time at which the impairment was first noted in 1985. Estimates used “Predicting Rainfall Erosion Losses, The Revised Universal Soil Loss Equation (RUSLE)” Section I, Erosion Prediction (USDA/NRCS 2000) for sheet and rill erosion; and “Erosion and Sediment Delivery Procedure”, Section I, Erosion Protection (USDA/NRCS 1998) for the sediment delivery factors. Pertinent calculations can be found in Appendix II and in Section 7.2. These two calculations are generally accepted in the agricultural community as simple and straightforward methods for determining gross erosion and its resultant delivery to a body of water. Using landuse and practices supplied by the Adair County Soil and Water Conservation District (Lundstedt, 2001), it is estimated that average loss was 10 tons/acre/year in 1985. This results in an estimated sediment load to the lake of 2,320 t/y. Note Table 2 in Section 7.2.

Endpoint number one for Orient Lake is to reduce the gross erosion rate from fields in the watershed to “T” and thereby reduce the corresponding delivery to the lake. “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-SCS, 1990). There are no significant contributions of sediment from gullies, streambeds, or shorelines to be considered. Reducing the erosion rate to T from fields in the Orient Lake watershed is expected to result in the protection of aquatic life by eliminating the adverse effects of excessive sediment loading to Orient Lake. 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 sediment delivery endpoints in Table 2 were calculated using the Erosion and Sediment Delivery Procedure, Section I, Erosion Protection (USDA/NRCS, 1998). Endpoint values incorporating an erosion factor T, calculated from these delivery predictions, are in tons of sediment delivered per year. The resultant endpoint for this TMDL for Orient Lake will be 1,112 tons/year.

The second endpoint for this TMDL will be achieved when the fishery of Orient Lake 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 in either 2001 or 2002. The DNR Fisheries Bureau will conduct an assessment of Orient Lake in accordance with the Statewide Biological Sampling Plan protocol (Larscheid, 2001) by the end of the 2002 season to characterize the condition of aquatic life. IDNR Fisheries Bureau is using this protocol to help develop benchmarks for fishery integrity in Iowa lakes. Sampling techniques for these surveys are outlined in “Standard Gear and Techniques for Fisheries Surveys in Iowa”, 1995. This assessment will include growth, size structure, body condition, relative abundance, and species.

Orient Lake will not be considered restored until the Phase II endpoint is achieved. If the aquatic life endpoint is achieved prior to the sediment delivery endpoint, then the level of conservation practices implemented at the time of the assessment may become the baseline for the watershed. If however, after a reasonable time following the completion of the sediment delivery practices the aquatic life use has not been restored, then further study and practices may be necessary.

5. Loading Capacity

The Iowa DNR has determined that reducing the gross erosion rate from fields in the watershed to T will enable the lake to meet water quality standards. “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-SCS, 1990). The erosion factor T in Orient Lake watershed is 4.79 t/a/y. Using an average delivery rate of 39% (from (USDA/NRCS, 1998)) yields a 1.9 t/a/y sediment delivery to the lake at T. This totals 1,112 tons/year for the entire watershed on an annual basis.

6. Pollutant Sources

Water quality in Orient Lake is influenced only by non-point sources. There are no point source discharges in the watershed. Nonpoint source pollution is caused by material transported to the lake by runoff from the watershed. Gully, streambank/streambed, sheet and rill, and shoreline erosion can contribute significantly to poor water quality and deterioration of the lake. There is no gully or streambank/streambed erosion in the Orient Lake watershed. There has been shoreline stabilization conducted around the lake, and therefore the contribution from this source is minimal. Although all land within a watershed contributes to sediment runoff, the main source of this pollutant in the Orient Lake watershed is sheet and rill erosion from agricultural fields.

7. Pollutant Allocation

7.1 Point Sources

There are no point source discharges within the Orient Lake watershed, so the Wasteload Allocation established under this TMDL is zero.

7.2 Non-Point Sources

Production agriculture dominates the watershed of Orient Lake. Non-point source erosion accounts for almost all sediment entering the lake. There are no gullies present in the watershed. Streambank/streambed erosion is not a factor, and shoreline erosion stabilization has been conducted, eliminating a contribution from that source.

Sediment delivery estimates were determined by using the Erosion and Sediment Delivery Procedure, Section I, Erosion Protection (USDA/NRCS, 1998). The following equation was used to calculate sediment delivery to Orient Lake:

Sediment Delivery (t/y) = Drainage Area x Gross Erosion Rate x SDR x Gully Factor

Where: Drainage Area is the subwatershed in acres
Gross Erosion is 4.79 Tons/acre/year (T)
SDR is the Sediment Delivery Rate = 39%
(Taken from Chart 1, "Estimated Sediment Delivery for Landform Regions" using drainage area in acres. (USDA/NRCS, 1998))
Gully Factor is determined by the activity in the watershed:
(When no gullies are present this factor is 1)

Calculations were made for each subwatershed using this sediment delivery equation. A trap efficiency of 90% was calculated for the portion of the lake protected by the silt dam on the northwest side of the lake. The sediment deliveries for each subwatershed were added together to obtain the total sediment delivery to Orient Lake. The Load Capacity to support the endpoint in this TMDL is 1,112 tons/year of sediment delivered to Orient Lake. A reduction in total sediment delivered from 1985 levels will improve water quality by allowing the lake to "maintain a balanced community normally associated with lake-like conditions" (IAC, 1996).

There are two subwatersheds within in the Orient Lake watershed. Figure 1 in Appendix III shows the boundaries of each. The only structure is a 1.5-acre silt pond/walkway constructed on the northwest arm of Orient Lake.

Table 2 shows, by subwatershed, the 1985 prediction of sediment delivery and the Load Capacity representing a reduction to T.

Table 2. Sediment delivery to Orient Lake (T/Y).

Subwatershed	Acres	1985 Sediment Delivery	Load Capacity
I	388	1,513	725
II	207	807	387
Total	595	2,320	1,112

7.3 Load Allocation and Margin of Safety

An implicit margin of safety is recognized by virtue of the fact that the aquatic life use must be restored to Orient Lake. The use of the dual endpoints of 1) sediment load reduction and 2) aquatic life assessment assures that the uses will be restored regardless of the accuracy of the sediment delivery endpoint. Failure to achieve water quality standards will trigger review and probable revision of the TMDL, allocations, and/or further sediment source management approaches.

8. Seasonal Variation

It is expected that the majority of all erosion in the Orient Lake watershed occurs in the spring and early summer during periods of high rainfall when vegetative cover may be reduced. This TMDL recognizes that sediment loading and transport varies substantially from year to year as well as seasonally. In addition, sediment impacts are felt over longer timeframes, and predictions regarding those impacts can only be assessed over multi-year periods. Therefore, the Load Allocations in this document are appropriate when expressed as an average per year.

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 a two-phase implementation strategy to improve water quality at Orient Lake.

There are two parts to addressing the water quality issues involved at Orient Lake. The primary impact of sediment at Orient Lake is interference with reproduction and growth of fish and other aquatic life. Habitat degradation as a result of excess sediment contributes to the lake being assessed as not meeting water quality standards. Phase I of this TMDL reduces the sediment delivery to the lake. This will stop the continuing negative impact to the lake. Phase II includes the restoration of the fishery to a level that fully supports the Class B aquatic life uses.

Phase I: Field investigations to determine landuses, cropping patterns, fertilizer use, conservation practices, livestock operations, and gully erosion were made in early 2001 by the local Soil and Water Conservation District (SWCD) office. Over the last fifteen years numerous conservation practices have been implemented in the Orient watershed. Virtually all the row cropland has been terraced. Highly erodible land has been placed in CRP or pasture. Grassed waterways have been added to the areas on the north and east sides of the lake, and a 1.5 acre silt pond has been added to the northwest arm of lake. Within the park, trees have been planted on the north, east and west sides to address the “considerable” wind action noted in earlier studies. Using this information, RUSLE calculations were made. The gross erosion prediction calculated using present land use and current practices is 1 ton/acre/year. This results in 232 tons/year being delivered to the lake before the silt pond. The 1.5-acre silt pond is 90% efficient for the subwatershed it protects, which reduces the load on that arm from 151 t/y to 15 t/y. The total load to the lake is now approximately 96 t/y, well below the 1,112 t/y sediment load endpoint.

In further support of Phase I, the Iowa DNR Fisheries has applied for grants from Clean Water Act Section 319 to construct a sediment control structure on the northeast arm of Orient Lake. If approved, construction will be completed in 2001. Construction projects funded by Section 319 grants are subject to the provisions of the Endangered Species Act. Any projects within the watershed that utilize federal funds will consider any endangered species.

Phase II: The DNR Fisheries Bureau will conduct an assessment of Orient Lake in accordance with the Statewide Biological Sampling Plan protocol (Larscheid, 2001) by the end of the 2002 season to characterize the condition of aquatic life. Sampling techniques for these surveys are outlined in "Standard Gear and Techniques for Fisheries Surveys in Iowa", 1995. This assessment will include growth, size structure, body condition, relative abundance, and species.

10. Public Participation

Public meetings regarding the procedure and timetable for developing the Orient Lake TMDL were held on January 17, 2001, in Des Moines, Iowa; and on February 1, 2001 in Orient, Iowa. Another meeting was held in Orient June 11, 2001 to discuss the draft document. Comments received, where appropriate, have been incorporated into this document.

11. References

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12. Appendix I

Table 3 . Summary of Pertinent Data Collected During Water Quality Studies of Orient Lake

Study Year	**Total Suspended Solids***	**Turbidity***	**Chlorophyll a***	**Secchi Disc Depth***	**Phosphorus***
1979		7.2 JTU	44.8 mg/m3	0.8 m	91.8 mg/m3
1987	22 – 62 mg/l		14 – 53 ug/l	0.3 - 0.6 m	0.09-0.19 mg/l
1990	28.4 mg/l		32.6 mg/m3	0.6 m	0.151 mg/l
1995	(These parameters were not measured in this study.)				
2000	34.6 mg/l		22 ug/l	0.6 m	0.322 mg/l

*mean

Note that units were reported differently during some studies. No attempt has been made to convert the values to consistent units. The express purpose of this table is to present available data and to demonstrate whether trends can be seen, not to indicate that any exist.

13. Appendix II

PREDICTING RAINFALL EROSION LOSSES THE REVISED UNIVERSAL SOIL LOSS EQUATION (RUSLE)

The equation is expressed as follows: A = RKLSCP where:

A = average annual soil loss from inter-rill (sheet) and rill erosion caused by rainfall and its associated overland flow expressed in tons/ac/yr,

R = the factor for climatic erodibility,
K = the factor for soil erodibility measured under a standard condition,
L = the factor for slope length,
S = the factor for slope steepness,
C = the factor for cover-management, and
P = the factor for support practices.

Example calculation from Orient Watershed:

A= ?	
R= 160	rainfall factor
K= 0.26	erodibility factor (by soil type)
LS= 1.25	length / slope
C= 0.39	cropping factor
P= 0.1	practice factor (ex: 90% reduction, therefore 10% of load)

A= (160) (0.26) (1.25) (0.39) (0.1)
= 2.028 t/a/y
= 2.0 t/a/y

14. Appendix III

Figure 1
Orient Lake Subwatersheds

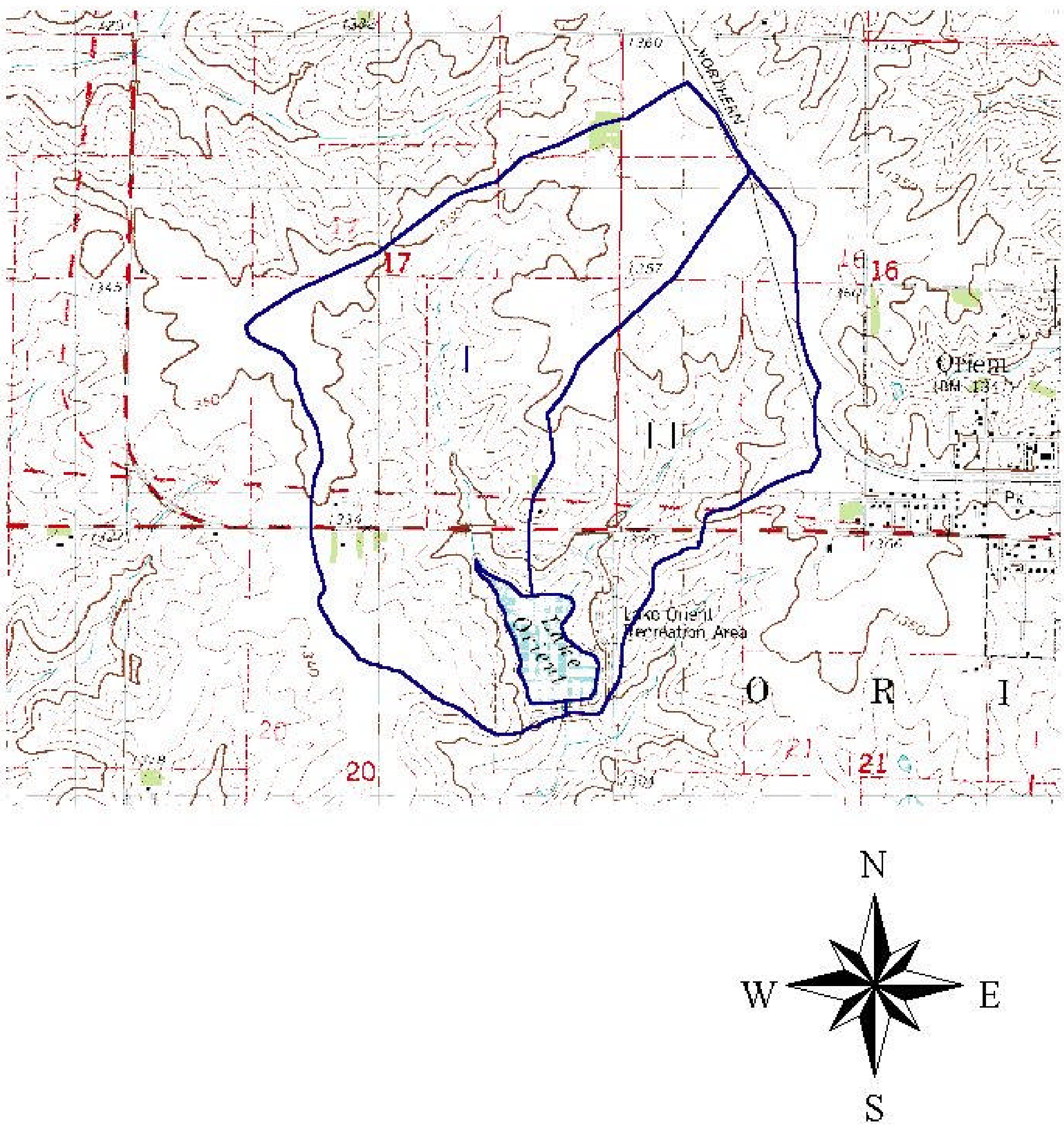

Figure 2
Orient Watershed