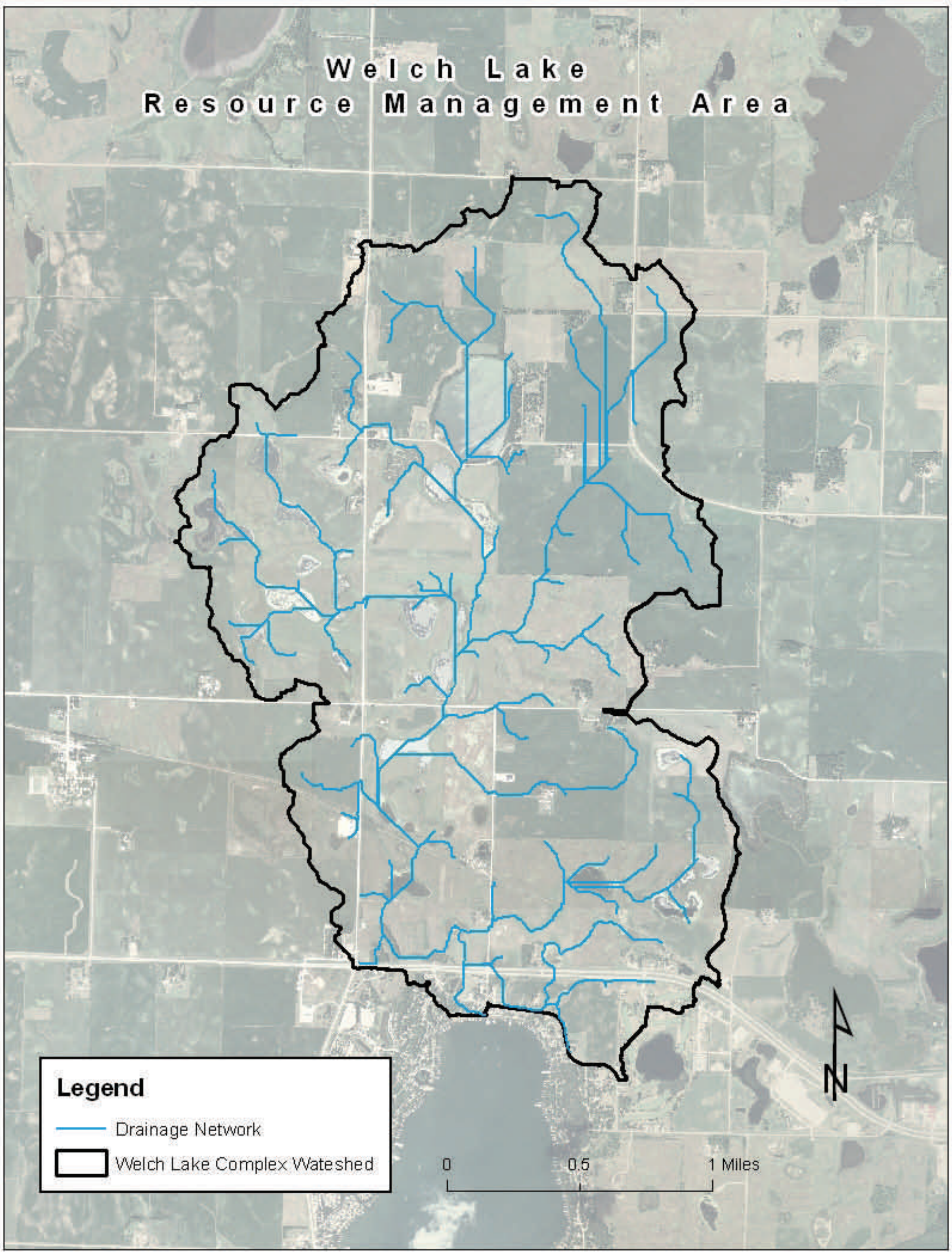


Figure 1.40 Welch Lake Resource Management Area

Welch Lake Complex Wetland Prioritization

Wetland ID	Flows into	Flows into	Flows into	Flows into	Flows into	Wetland Size (acres)	Watershed Size (acres)	Watershed to Wetland Ratio	GIS/RUSLE Priority
718	737	Lake				12.1	484.1	40.1	1
705	718	737	Lake			82.5	336.9	4.1	2
827	Lake					4.9	131.4	27.0	3
580	705	718	737	Lake		1.6	34.5	21.7	4
662	705	718	737	Lake		8.7	71.1	8.2	5
783	Lake					2.3	63.5	27.6	6
777	783	Lake				3.3	54.0	16.2	7
838	824	827	Lake			11.6	62.0	5.3	8
709	705	718	737	Lake		1.9	28.3	14.6	9
646	Lake					16.1	40.1	2.5	10
616	Lake					6.1	74.4	12.3	11
690	Lake					3.3	38.6	11.5	12
715	709	705	718	737	Lake	4.5	13.6	3.0	13
823	838	824	827	Lake		4.8	37.1	7.8	14
644	Lake					7.2	19.3	2.7	15
826	Lake					1.1	65.4	61.1	16
764	777	783	Lake			1.6	16.7	10.6	17
679	662	705	718	737	Lake	1.7	10.7	6.3	18
924	942	Lake				1.0	45.8	45.8	19
740	737	Lake				3.1	58.6	18.9	20
829	826	Lake				2.3	20.3	8.8	21
833	824	827	Lake			0.3	10.1	32.5	22
842	829	826	Lake			0.5	35.4	72.2	23
871	Lake					0.4	8.1	20.7	24
801	827	Lake				0.9	6.9	7.7	25
804	801	827	Lake			0.6	4.1	6.4	26
893	Lake					1.5	8.5	5.5	27
678	690	Lake				0.4	3.9	9.4	28
675	Lake					1.0	33.8	32.8	29
892	Lake					0.3	1.7	6.6	30

Table 1.8 Wetland restoration priorities for the Welch Lake watershed. GIS priority rankings are based on a combination of erosion rates and size of watershed draining to each wetland (wetlands having watershed to wetland area ratios greater than 75:1 are excluded).

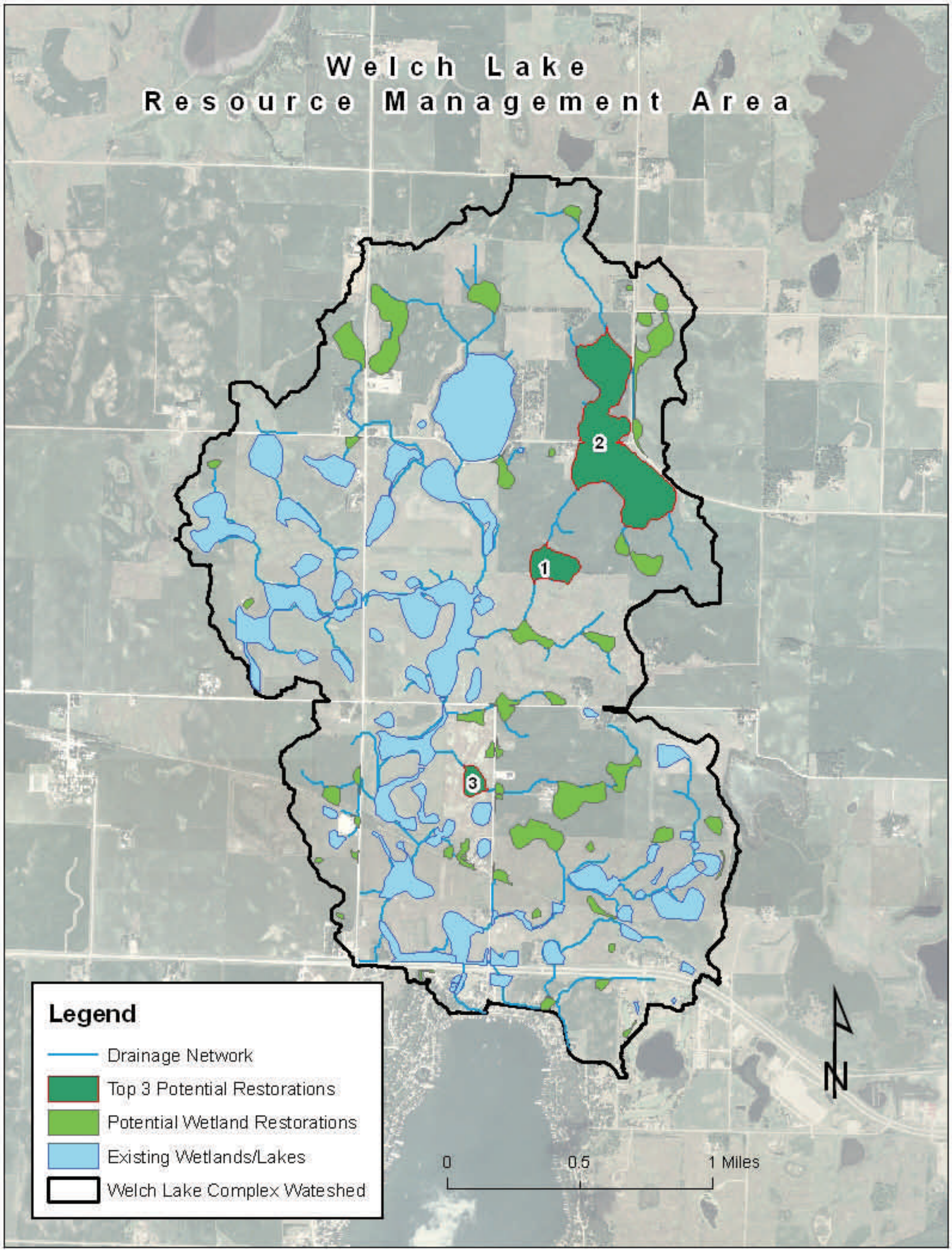


Figure 1.41 Welch Lake Priority Wetland Restoration Sites

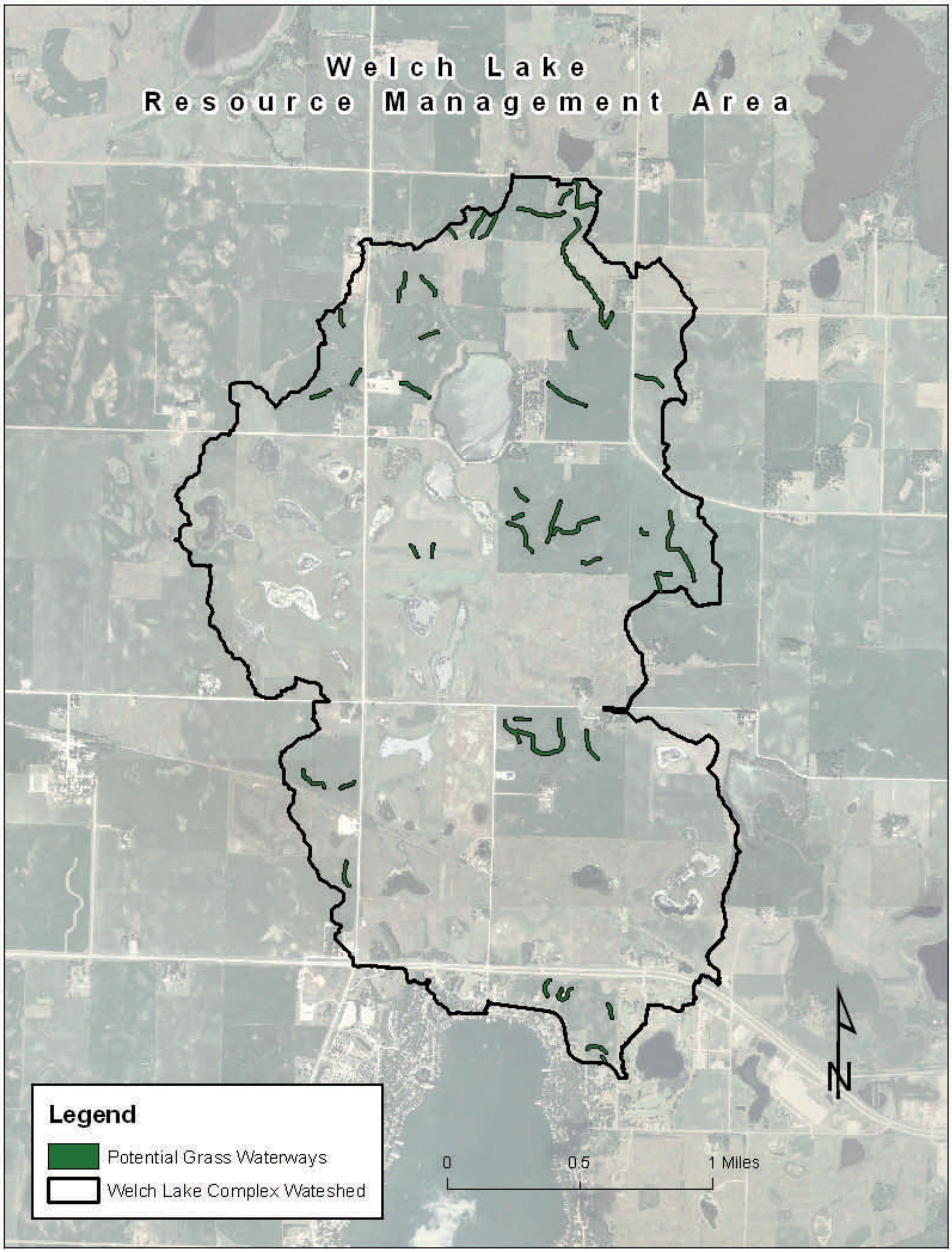


Figure 1.42 Welch Lake Ephemeral Gullies

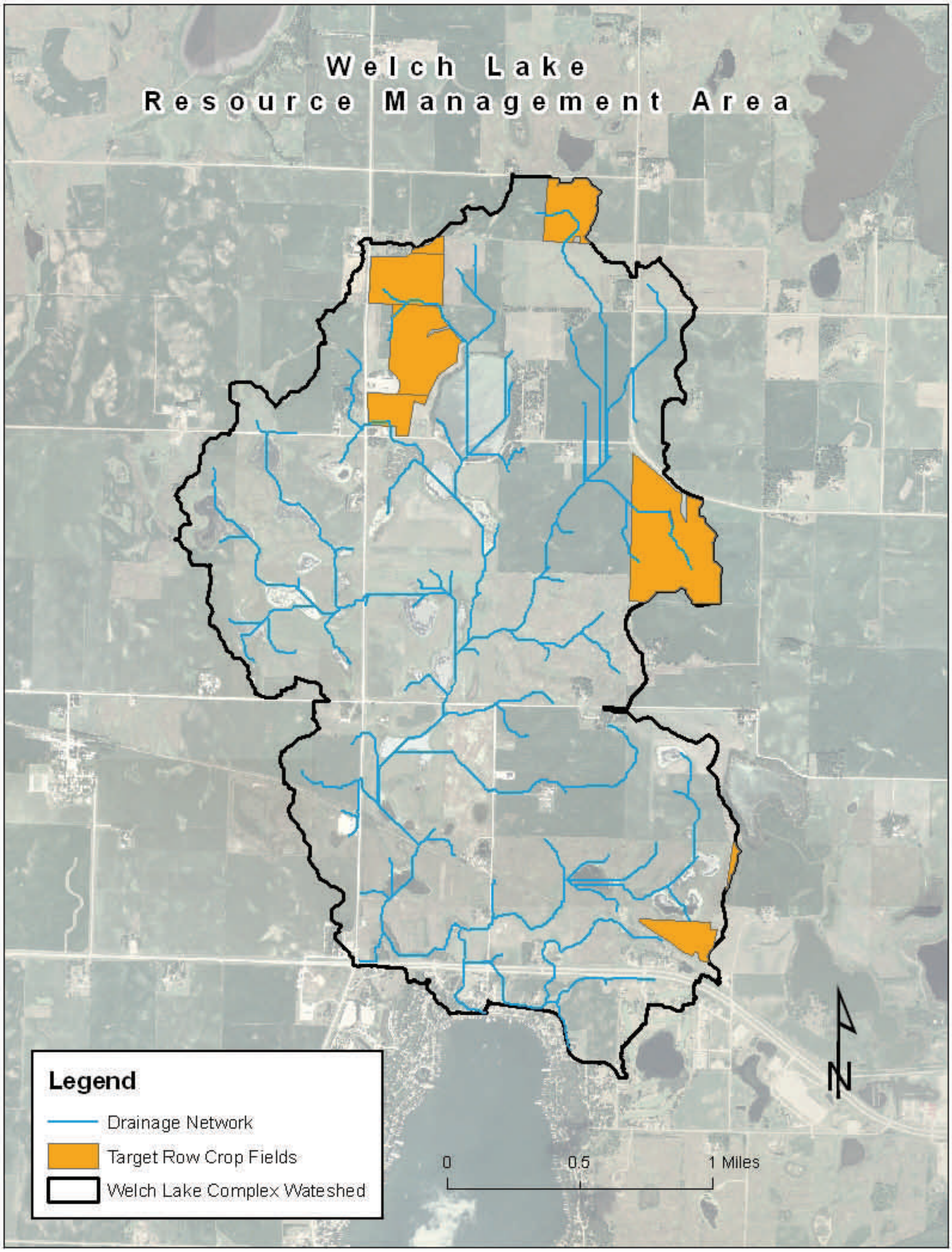


Figure 1.43 Welch Lake Target Row Crop Fields

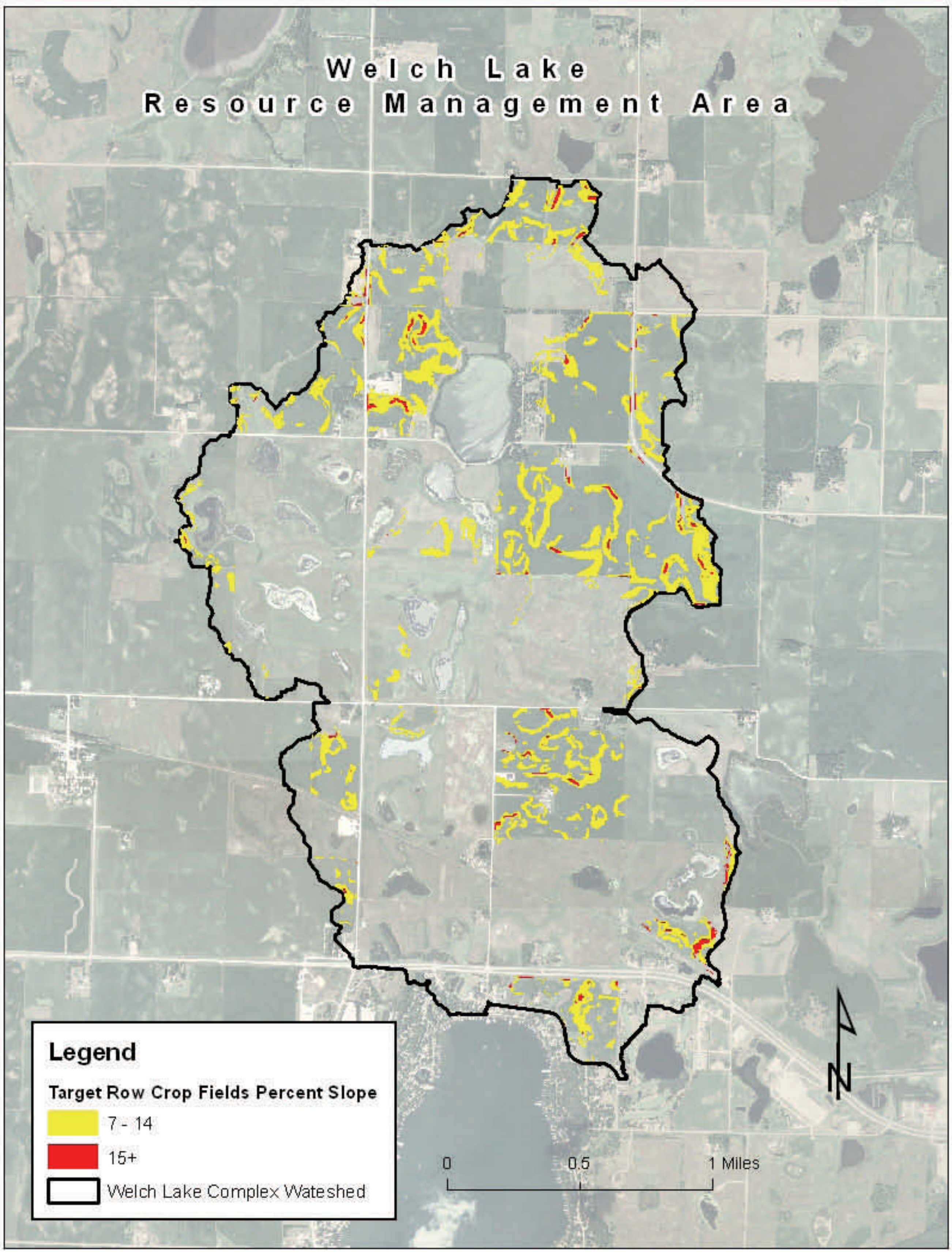


Figure 1.44 Welch Lake Target Row Crop Slopes

CENTER LAKE WATERSHED

Watershed Information:

Lake Size	Total Watershed	Watershed Direct	Watershed Indirect	Watershed Lakes	Direct RMA	Indirect RMA	Impaired
280 ac	892 ac	612 ac	n/a	15	1	n/a	Yes

Lakes in the watershed of Center Lake: None

RMA's that drain to Lower Gar Lake

Direct

Center Lake RMA

Impairment for Center Lake: Center Lake was impaired on the 2008 303 (d) list approved by EPA in 2010. Center Lake is impaired due to pH for both recreational primary contact and aquatic life. In the assessment documents for the 303 (d) report the cause of the pH impairment is linked to internal nutrient cycling. A TMDL has not been written for Center Lake's impairments and it does not show up on the Iowa DNR Water Quality Improvement Plan Schedule that goes out to 2014.

***Objective* –** To remove the impairments of pH for recreational primary contact and aquatic life designations. To protect the lakes Center Lake drains into directly and indirectly from getting a similar impairment caused by nutrients. Any work done in the Center Lake Watershed will assist with other lakes that Center Lake drains to indirectly.

Center Lake Resource Management Area (RMA)

Objective – Restore and maintain Center Lake to a clear water system. The sediment reductions in this RMA will assist with the target reduction of phosphorus in Upper Gar Lake (3,300 pounds per year) and Lower Gar Lake (6,100 per year) in accordance with their specific approved TMDL's.

Description – Center Lake has undergone many hydrological changes since the pioneers first settled the Iowa Great Lakes. The reduction of wetlands and the switch from prairies to farmland has left this watershed very degraded. The shift from natural drainage to a mostly urban sprawl has drastically increased the volume of water entering Center Lake via storm sewers. This huge influx of unfiltered water has a dramatic and negative impact on the water quality of the system. The sediment reductions in this RMA will assist with the target reduction of phosphorus in Upper Gar Lake (3,300 pounds per year) and Lower Gar Lake (6,100 per year) in accordance with their specific approved TMDL's.

Center Lake and its watershed represent nearly 18% of the watershed of West Okoboji Lake. When healthy, the shallow wetland complex and lake making up this watershed provide important protection to West Okoboji Lake. These areas also provide critical fishery and wildlife habitats. A holistic approach is needed to restore ecological health and water quality to this complex. A combination of both watershed and lake management practices is needed to reach the project objective. Sediment, nutrients, and water volume loadings from the watershed should be reduced utilizing a prioritized plan through augmentation of existing landowner conservation programs, easements, public acquisitions, alternative lakeshore practices, and improved storm sewer system.

Restoration of the lake to a clear water system can be accomplished through processes designed to mitigate watershed alterations and the introduction of common carp. A fish barrier system should be installed at the new outlet to prevent fish migrating up to Center Lake from West Okoboji, and options should be discussed for the removal of existing carp populations in Center Lake.

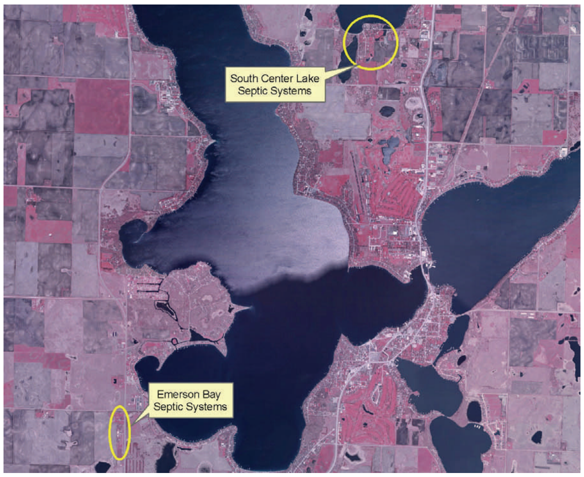
Restoration Planning Components

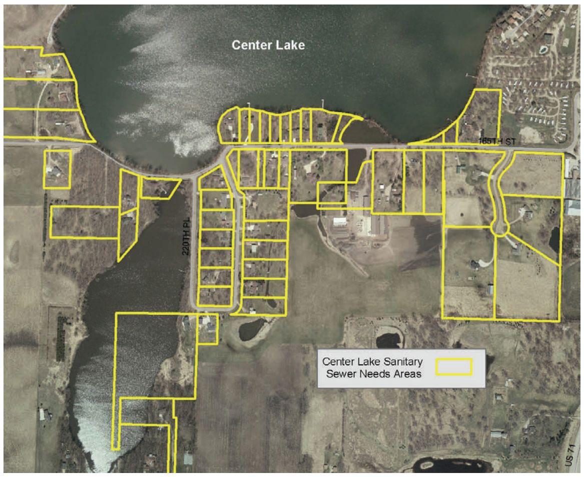
<u>Watershed Practices</u>

Prioritized Sub-watershed (Figure 1.45)

Septic System Renovation

- Meet with the 43 residential lot owners individual
- Work with landowners, Iowa Great Lakes Sanitary District, Iowa DNR, City of Spirit Lake and County Sanitarian for best option to reduce bacteria reaching West Okoboji.
- Best option is to connect all lots up to sanitary sewer district and require a new main to be installed.
- Create a joint septic system to control nutrients from getting into Center Lake.
- Work with individuals landowners to get septic systems up to date and functioning to keep nutrients out of Center Lake





Structural Sediment Trapping

- Analysis has identified two priority wetland restorations in this sub-watershed (Figure 1.46).
- These wetland restorations have the potential to effectively intercept 367 acres (11% of the priority sub-watershed) of primarily agricultural runoff (Table 1.9).
- In lieu of restoration of these priority wetland areas, analysis has identified several locations for sediment retention basins or constructed wetlands.
- Restoration of these wetlands can reduce sediment by 660 tons per year.

Gully Management

- 2.5 miles of ephemeral gully erosion has been identified within agricultural fields (Figure 1.47).
- By installing grassed waterways within each of these ephemeral gullies, 24 acres of upland habitat can be created and sediment loss from these areas significantly reduced.
- Construction of these grassed waterways can reduce 264 tons of sediment per year.

Highly Erodible Fields—Conservation Tillage

- 13 agricultural fields devoted to row crop production exceed sediment loss thresholds (Figure 1.48).
- These fields, totaling 320 acres, account for 50% of the sediment loss within the targeted watershed.
- Conservation tillage on these acres can reduce 640 tons of sediment per year.

Highly Erodible Fields—Permanent Vegetation

- Sediment loss can be reduced on 123 acres of row cropped fields by implementing alternative practices (i.e. permanent vegetation, sediment basins, and reduced tillage) where field slope is greater than seven percent.
- Eight acres have been identified and should have alternate land practices implemented because their slope is greater than 15% (Figure 1.48).
- Permanent vegetation on these slopes can reduce 703 tons of sediment per year.

Nutrient Management

- A total of 695 acres are currently being utilized for the production of corn and soybeans within the targeted watershed of Sandbar Slough.
- A nutrient and pesticide management plan should be set up with each individual landowner to ensure that over application and runoff of nutrients and pesticides is minimized.
- A plan should also be put into place to protect field tile intakes from excessive nutrients and sediment.
- Rock tile intakes with an additional 50 foot vegetative buffer should be discussed and implemented at all tile intake locations within the sub-watershed.

<u>Shoreline and Island Restoration</u>

Shoreline restoration is needed to reduce sediment re-suspension in Center Lake. There is an estimated 1,500 ft of linear shoreline that can be restored with upland prairie vegetation and in-lake native aquatic plants. In addition, there is an additional estimated .25 acres of the island area that can be restored in the same manner.

<u>Lake Restoration</u>

Proper in lake management begins by controlling the movement of water and fish in/out of Center Lake. A new fish barrier (Figure 1.36) should be installed at the newly constructed outlet and water control structure. Because extensive shoreline development exists, a long term drawdown is unlikely. However, the water level should be lowered and maintained to around 6-inches below the ordinary high water level. If the lake home-owners association agrees, the lake should be lowered an additional 6-inches for a brief period of time during and/or after a large scale rough fish removal. This time when the lake is low will stimulate shoreline vegetation and firm up near shore bottom sediments. This time of lower maintained water level could occur after a natural drought time to minimize the impact on lakeshore owners.

Pollution Reduction

Center Lake does not have a TMDL assigned to it, but it is listed on the State's List of Impaired Waters (303 (d) list. In order to ensure the Lake and its watershed are sustainable for future years this plan requires a 273 pound reduction of phosphorous per year to be removed. This Management Plan will help meet that 273 pound goal with a reduction in phosphorous coming from the restored priority wetlands, stopping the ephemeral gullies using grassed waterways and sediment basins, conservation tillage, vegetative cover, and nutrient and pest management. In addition, rock tile intakes and vegetation around the intakes will ensure an adequate reduction of phosphorous and associated sediment. In lake vegetation will also use nutrients that are currently in the water table and prevent them from being released back into the water column and reused for algae production.

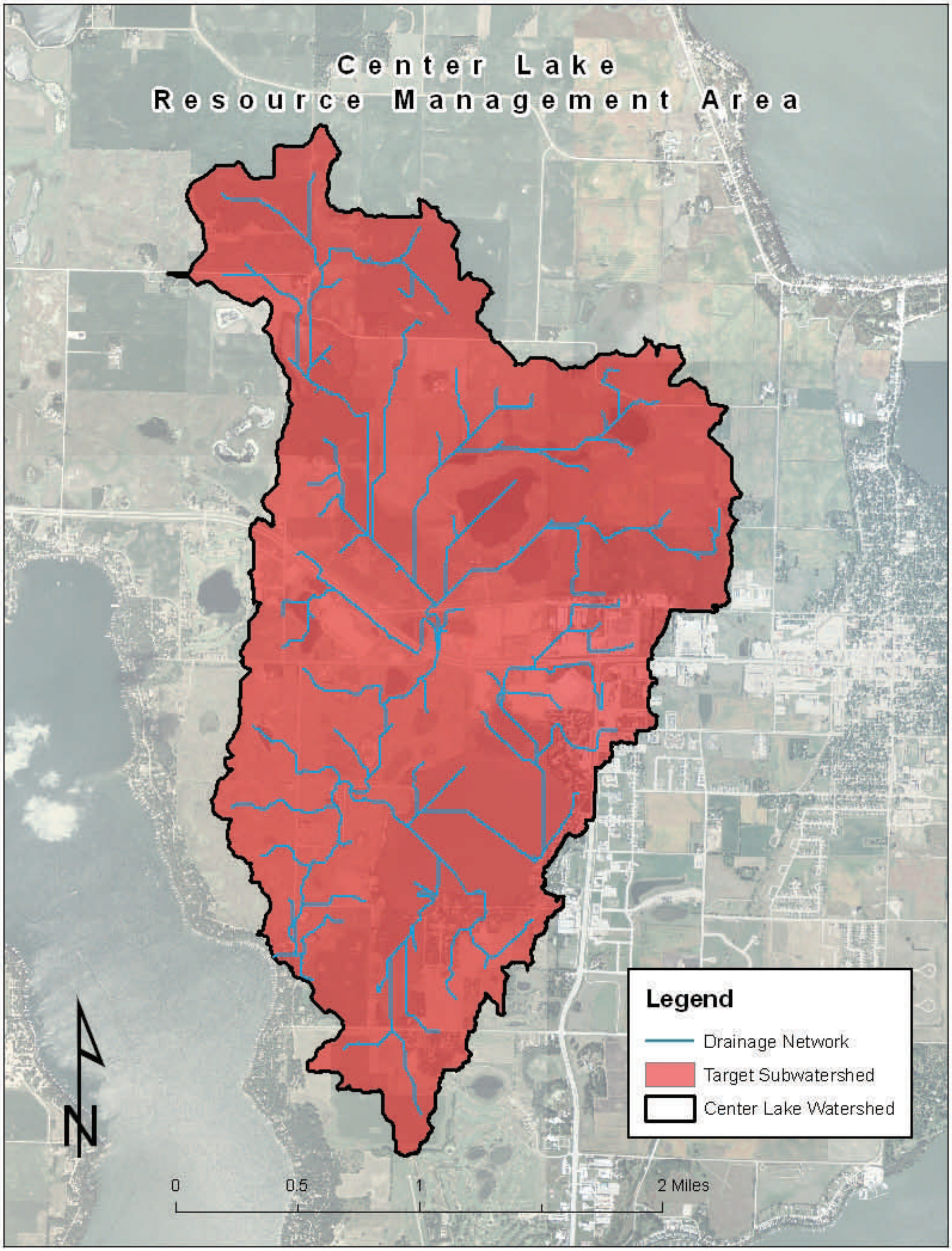


Figure 1.45 Center Lake Resource Management Area

Center Lake Watershed Wetland Prioritization

Wetland ID	Flows into	Flows into	Flows into	Flows into	Flows into	Flows into	Flows into	Wetland Size (acres)	Watershed Area (acres)	Watershed to Wetland Ratio	GIS/ RUSLE Priority
762	985	Lake						58.3	210.7	3.6	1
1018	1031	1025	1035	1043	Lake			21.5	89.2	4.1	2
1298	Lake							20.2	77.9	3.9	3
1069	Lake							0.6	42.3	71.7	4
784	985	Lake						1.5	49.3	31.8	5
797	762	985	Lake					11.7	81.3	7.0	6
966	985	Lake						15.4	103.6	6.7	7
1124	Lake							3.5	31.7	9.0	8
983	Lake							0.6	30.2	54.9	9
903	985	Lake						2.5	17.6	7.0	10
968	Lake							1.2	18.3	15.1	11
769	784	985	Lake					8.5	22.3	2.6	12
959	966	985	Lake					2.3	66.0	28.2	13
1240	Lake							0.4	24.8	65.2	14
1118	1124	Lake						1.7	15.1	9.1	15
1254	1240	Lake						1.7	19.3	11.2	16
1201	Lake							4.0	23.6	6.0	17
1052	1031	1025	1035	1043	Lake			0.3	24.7	72.7	18
1099	Lake							0.6	25.1	39.8	19
996	1018	1031	1025	1035	1043	Lake		1.2	12.4	10.4	20
1048	Lake							0.9	15.9	17.1	21
781	784	985	Lake					0.8	10.3	13.2	22
1015	1018	1031	1025	1035	1043	Lake		1.1	15.8	14.9	23
1172	Lake							0.6	10.7	17.8	24
883	985	Lake						6.0	17.3	2.9	25
1186	1201	Lake						0.6	9.5	14.9	26
1082	Lake							0.3	18.0	53.0	27
1023	Lake							0.6	8.9	16.1	28
1249	1254	1240	Lake					0.8	8.2	10.7	29
1179	1172	Lake						1.9	5.5	3.0	30
932	968	Lake						0.9	3.7	4.4	31
991	996	1018	1031	1025	1035	1043	Lake	0.6	5.2	9.4	32
1268	1249	1254	1240	Lake				0.9	4.5	4.8	33
879	985	Lake						0.9	4.3	4.8	34
1047	1046	Lake						1.0	3.3	3.3	35

Table 1.9 Wetland restoration priorities for the Center Lake watershed. GIS priority rankings are based on a combination of erosion rates and size of watershed draining to each wetland (wetlands having watershed to wetland area ratios greater than 75:1 are excluded).

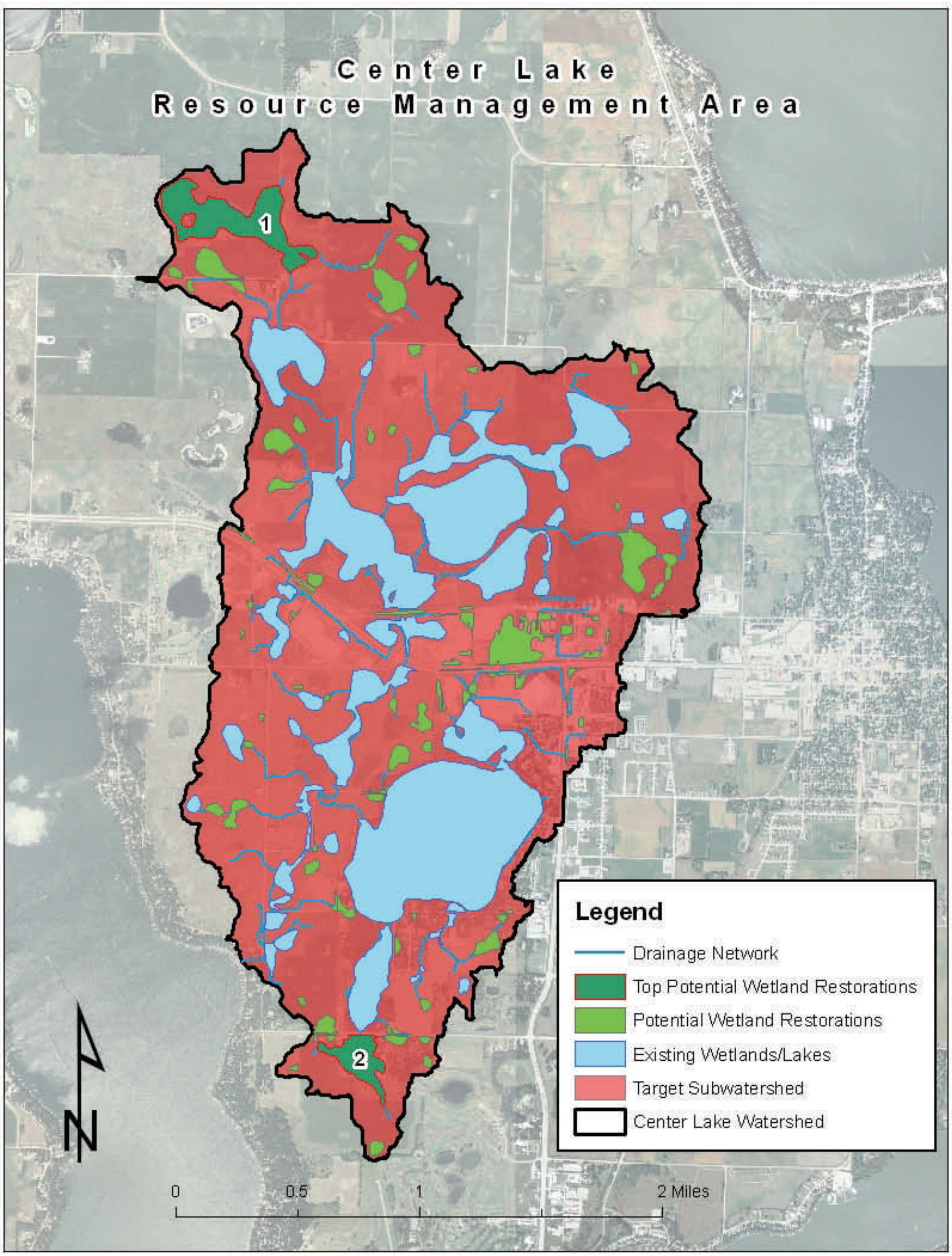


Figure 1.46 Center Lake Priority Wetland Restoration Sites

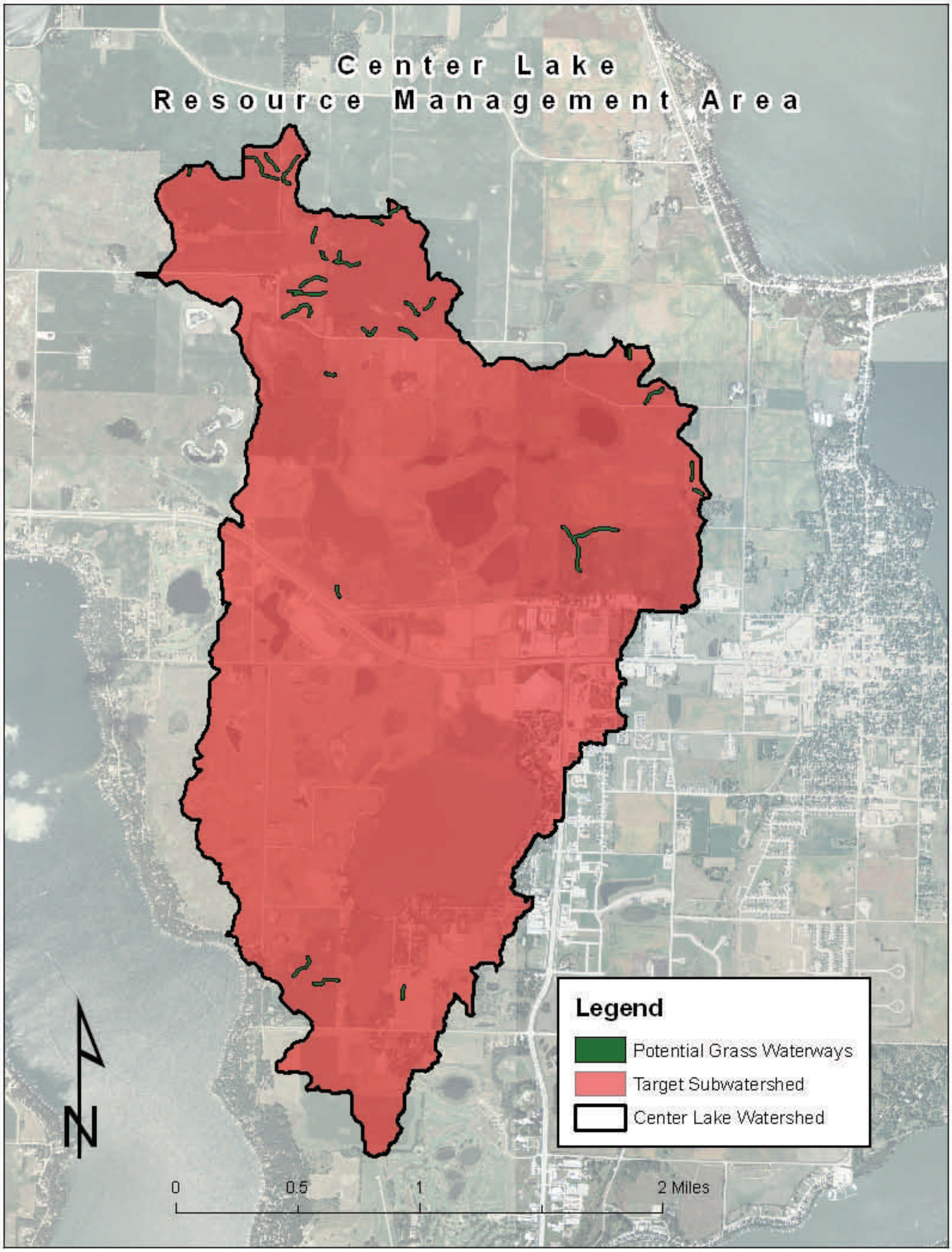


Figure 1.47 Center Lake Ephemeral Gullies

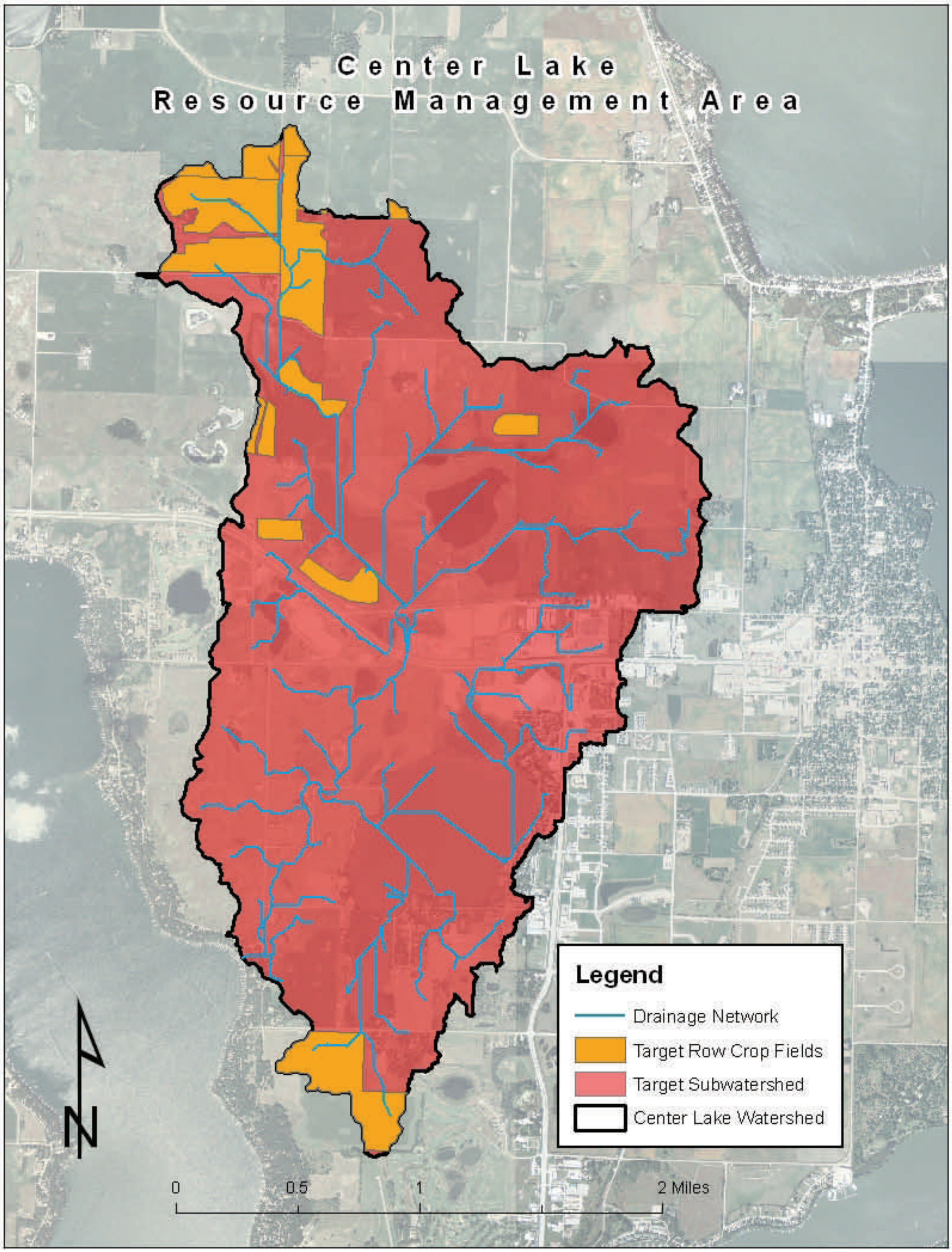


Figure 1.48 Center Lake Target Row Crop Fields

BIG SPIRIT LAKE WATERSHED

Watershed Information:

Lake Size	Total Watershed	Watershed Direct	Watershed Indirect	Watershed Lakes	Direct RMA	Indirect RMA	Impaired
5,684 ac	45,661 ac	14,399 ac	25,578 ac	9	4	3	Yes

Lakes that Drain to Big Spirit Lake:

Direct
Loon Lake
Little Spirit Lake
East Hottes Lake

Indirect
Clear Lake
West Hottes Lake
Pearl Lake
Grovers Lake

RMA's to Big Spirit Lake:

Direct
Sandbar Slough RMA
Hales Slough RMA
Reeds Run RMA
Templar Lagoon RMA

Indirect
Loon Lake RMA
Little Spirit RMA
Hottes/ Marble RMA

Impairment for Big Spirit Lake: Big Spirit Lake was impaired as part of the 2008 303 (d) Impaired Waterways list by the Iowa DNR. The impairment is due to bacteria determined by beach monitoring activities. The bacteria readings that caused the impairment are specific to the monitoring done at Marble Beach Camp ground on the west shore of Big Spirit Lake. It does not show up on the Iowa DNR Water Quality Improvement Plan Schedule that goes out to 2014.

Objective – To remove Big Spirit Lake bacteria impairments and keep the lake from becoming impaired from turbidity due to sediment loading or algae. Work done within the Big Spirit Lake Watershed to keep the lake from becoming impaired for turbidity or nuisance algae blooms will assist with impairments on Upper and Lower Gar Lakes.

Sandbar Slough Resource Management Area (RMA)

Objective – Restore and maintain Sandbar Slough to a clear water system. The sediment reductions in this RMA will assist with the target reduction of phosphorus in Upper Gar Lake (3,300 pounds per year) and Lower Gar Lake (6,100 per year) in accordance with their specific approved TMDL's.

Description – Sandbar Slough has undergone many hydrological changes since the pioneers first settled the Iowa Great Lakes. The reduction of wetlands and the switch from prairies to farmland has left this watershed very degraded. Active grazing along the shoreline and direct access of cattle to the slough has further degraded this system.

The Sandbar Slough watershed represents nearly 23% of the watershed of Big Spirit Lake. When healthy, the shallow wetland complex making up the Sandbar watershed provides important watershed protection to Big Spirit Lake. These areas also provide critical fishery and wildlife habitats. A holistic approach is needed to restore ecological health and water quality to this complex. A combination of both watershed and lake management practices is needed to reach the project objective.

Sediment, nutrients, and water volume loadings from the watershed should be reduced utilizing a prioritized plan through augmentation of existing landowner conservation programs, easements, and public acquisitions. Restoration of the lake to a clear water system can be accomplished through processes designed to mitigate watershed alterations and the introduction of common carp. To simulate natural drought conditions, managed water level draw downs are needed to stimulate growth of emergent aquatic vegetation and reduce or eliminate common carp populations.

Restoration Planning Components

<u>Watershed Practices</u>

Prioritized Sub-watershed (Figure 1.49)

Structural Sediment Trapping

- Analysis has identified five priority wetland restorations in this sub-watershed (Figure 1.50).
- These wetland restorations have the potential to effectively intercept 3,340 acres (64% of the priority sub-watershed) of primarily agricultural runoff (Table 1.10).
- In lieu of restoration of these priority wetland areas, analysis has identified several locations for sediment retention basins or constructed wetlands.
- Restoration of these wetlands can prevent a total of 6,012 tones of sediment per year from reaching the lake.

Gully Management

- 27 miles of ephemeral gully erosion has been identified within agricultural fields (Figure 1.51).
- By installing grassed waterways within each of these ephemeral gullies, 240 acres of upland habitat can be created and sediment loss from these areas significantly reduced.
- Construction of grassed waterways on these gullies can reduce the sediment moving to the lake by 2,640 tons.

Highly Erodible Fields—Conservation Tillage

- 33 agricultural fields devoted to row crop production exceed sediment loss thresholds.
- These fields, totaling 2,084 acres, account for 50% of the sediment loss within the targeted watershed.
- Conservation tillage on these acres can reduce sediment by 4,166 tons per year.

Highly Erodible Fields—Permanent Vegetation

- Sediment loss can be reduced on 262 acres of row cropped fields by implementing alternative practices (i.e. permanent vegetation, sediment basins, and reduced tillage) where field slope is greater than seven percent.
- Twelve acres have been identified and should have alternate land practices implemented because their slope is greater than 15% (Figure 1.52).

- Planting a permanent vegetation on these slopes will reduce the sediment from these slopes of 1,442 tons per year.

Nutrient Management

- A total of 4,018 acres are currently being utilized for the production of corn and soybeans within the targeted watershed of Sandbar Slough.
- A nutrient and pesticide management plan should be set up with each individual landowner to ensure that over application and runoff of nutrients and pesticides is minimized.
- A plan should also be put into place to protect field tile intakes from excessive nutrients and sediment.
- Rock tile intakes with an additional 50 foot vegetative buffer should be discussed and implemented at all tile intake locations within the sub-watershed.

Lake Restoration

Proper in lake management begins by controlling the movement of water and fish in/out of Sandbar Slough. A new fish barrier (Figure 1.53) and water control structure should be constructed between Sandbar Slough and Big Spirit Lake to help control the movement of common carp into the slough. An electric water control structure and drain pipe should be placed at the outlet of the slough to allow for periodic draw downs that mimic historic drought conditions that are no longer occurring due to watershed changes. These water level fluctuations will allow managers to control fisheries populations and promote natural and diverse vegetation communities that benefit both fisheries and wildlife interests.

Once control structures are in place, an initial extended drawdown should occur in order to firm up near shore bottom sediments and promote extensive plant growth before water levels are allowed to return. This drawdown will also allow managers to apply chemical treatments to completely eliminate any existing fishery. Once water levels are allowed to return, natural fish communities should reintroduce themselves to the system via the outlet to the lake. Supplemental stocking of advanced northern pike fingerlings right after water levels return would help intercept any young common carp that move into the system immediately after renovation. A long term management plan should be developed between fish and wildlife professionals that outline the criteria and plan for dewatering this basin in order to maintain a balanced ecosystem.

Pollution Reduction

Big Spirit Lake does not have a TMDL assigned to it, but in order to ensure the Lake and its watershed are sustainable for future years this plan requires a 1,500 pound reduction of phosphorous per year to be removed. This Management Plan will help meet that 1,500 pound goal with a reduction in Phosphorous coming from the restored priority wetlands, stopping the ephemeral gullies using grassed waterways and sediment basins, conservation tillage, vegetative cover, and nutrient and pest management. In addition, rock tile intakes and vegetation around the intakes will ensure an adequate reduction of phosphorous and associated sediment. The total reduction in phosphorous from the Sandbar Slough RMA is 600 pounds of phosphorous.

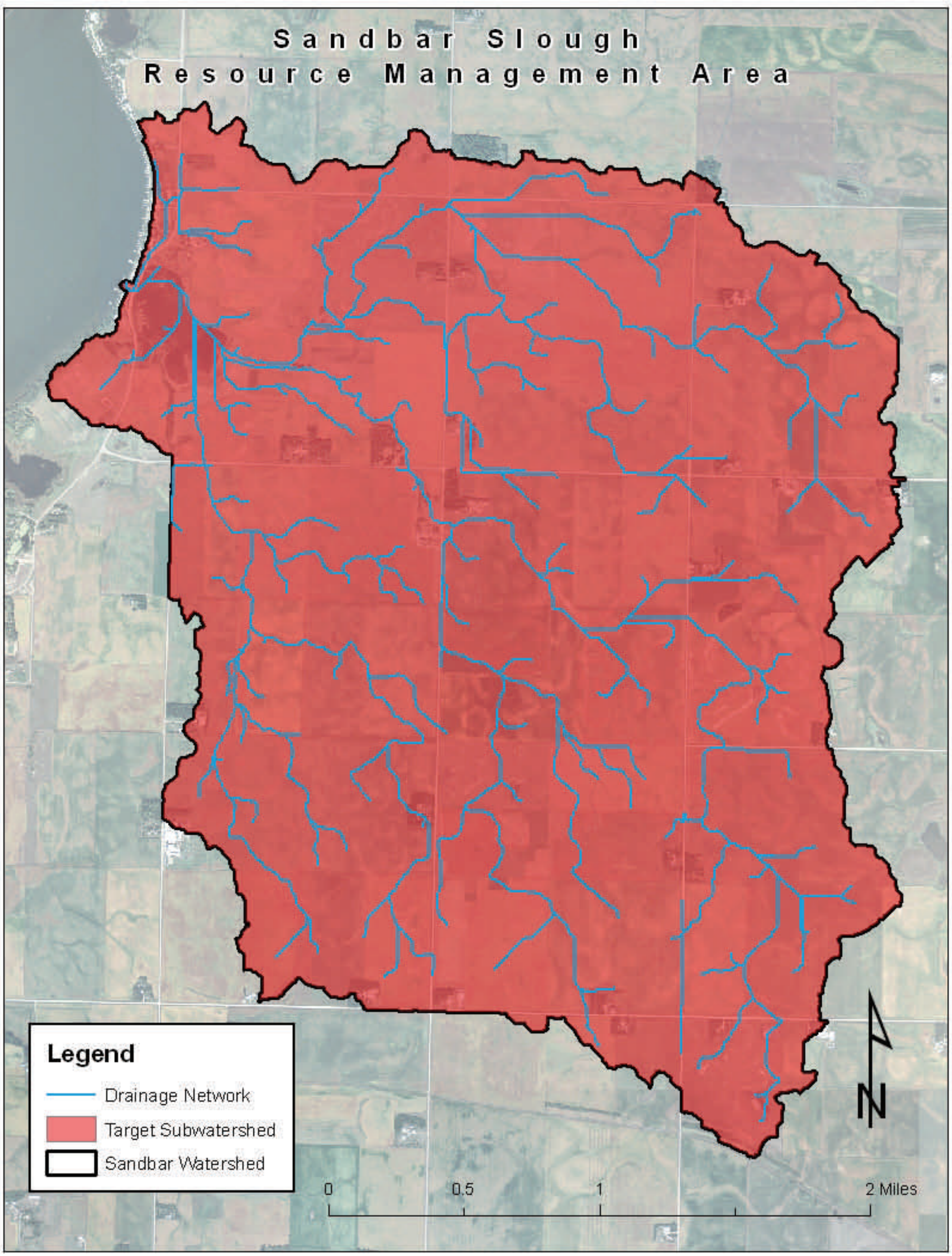


Figure 1.49 Sandbar Slough Resource Management Area

Sandbar Slough Watershed Wetland Prioritization

Wetland ID	Flows into	Flows into	Flows into	Flows into	Flows into	Flows into	Flows into	Wetland Size (acres)	Watershed Size (acres)	Watershed to Wetland Ratio	GIS/RUSLE Priority
665	596	Lake						120.6	947.9	7.9	1
532	528	549	Lake					75.1	1,221.9	16.3	2
749	713	698	665	596	Lake			32.2	354.8	11.0	3
559	550	532	528	549	Lake			20.5	346.3	16.9	4
582	559	550	532	528	549	Lake		36.6	184.4	5.0	5
702	689	Lake						4.5	222.3	49.4	6
547	539	532	528	528	549	Lake		7.1	196.5	27.8	7
604	582	559	550	532	528	549	Lake	34.3	69.0	2.0	8
785	642	612	596	Lake				18.4	138.9	7.5	9
600	543	545	532	528	549	Lake		46.0	81.8	1.8	10
600	543	545	532	528	549	Lake		46.0	81.8	1.8	10
574	547	539	532	528	549	Lake		9.4	97.4	10.4	12
760	724	702	689	Lake				18.8	76.8	4.1	13
800	749	713	698	665	596	Lake		3.8	85.2	22.1	14
819	800	749	713	698	665	596	Lake	6.9	74.8	10.8	15
531	549	Lake						3.6	76.2	21.3	16
533	532	528	549	Lake				4.9	73.4	14.9	17
523	531	549	Lake					2.3	55.4	24.4	18
585	574	547	539	532	528	549	Lake	1.8	64.2	34.9	19
527	Lake							6.4	157.9	24.7	20
513	527	Lake						7.9	145.4	18.4	21
518	523	531	549	Lake				9.1	39.4	4.3	22
739	749	713	698	665	596	Lake		6.8	24.3	3.6	23
556	547	539	532	528	549	Lake		1.6	65.8	40.9	24
735	642	612	596	Lake				7.2	47.1	6.5	25
688	Lake							1.1	41.6	38.2	26
703	688	Lake						9.8	29.8	3.1	27
772	760	724	702	689	Lake			0.4	25.5	70.9	28
763	719	Lake						13.8	56.8	4.1	29
778	785	642	612	596	Lake			11.5	28.9	2.5	30

Table 1.10 Wetland restoration priorities for the Sandbar Slough watershed. GIS priority rankings are based on a combination of erosion rates and size of watershed draining to each wetland (wetlands having watershed to wetland area ratios greater than 75:1 are excluded).

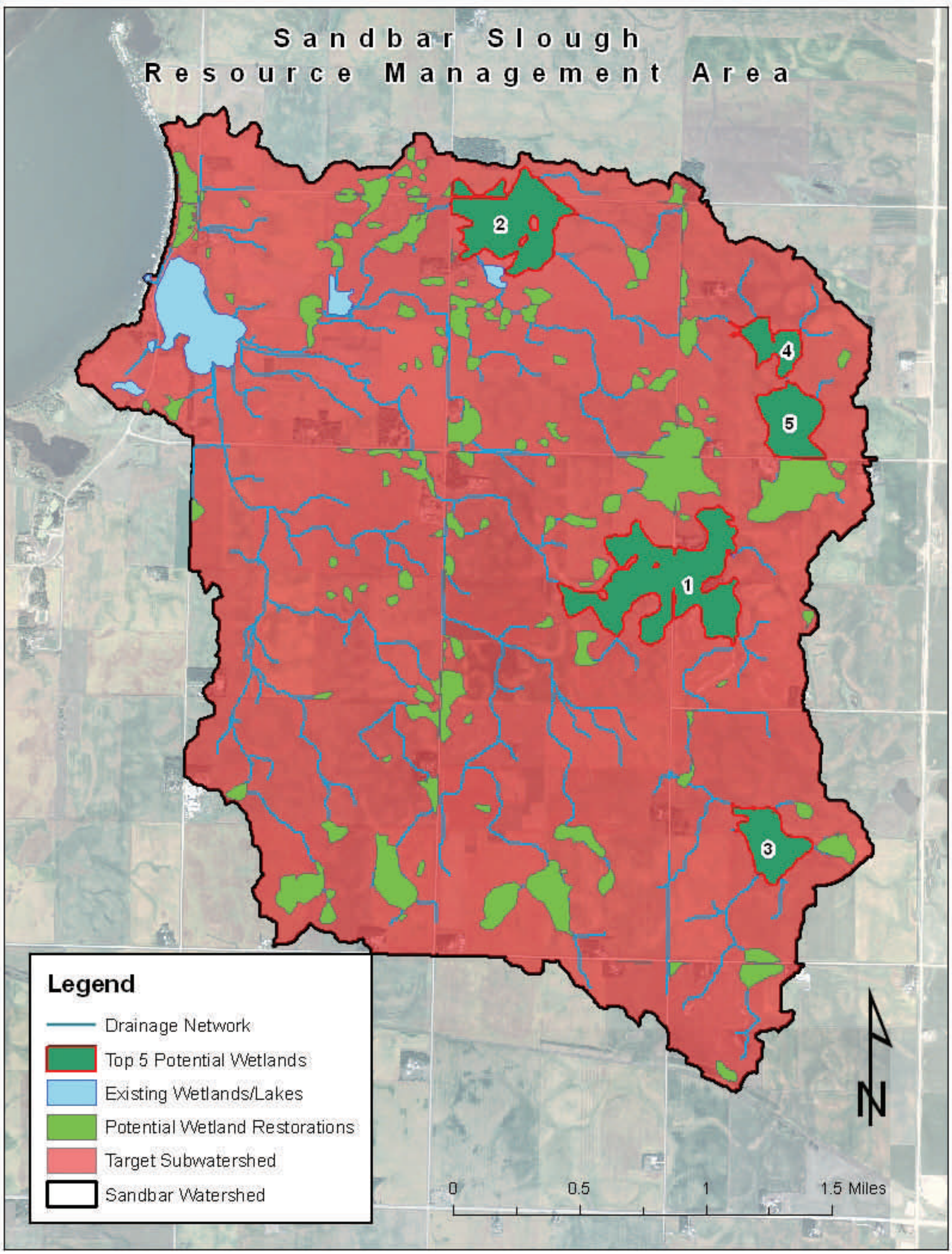


Figure 1.50 Sandbar Slough Priority Wetland Restorations

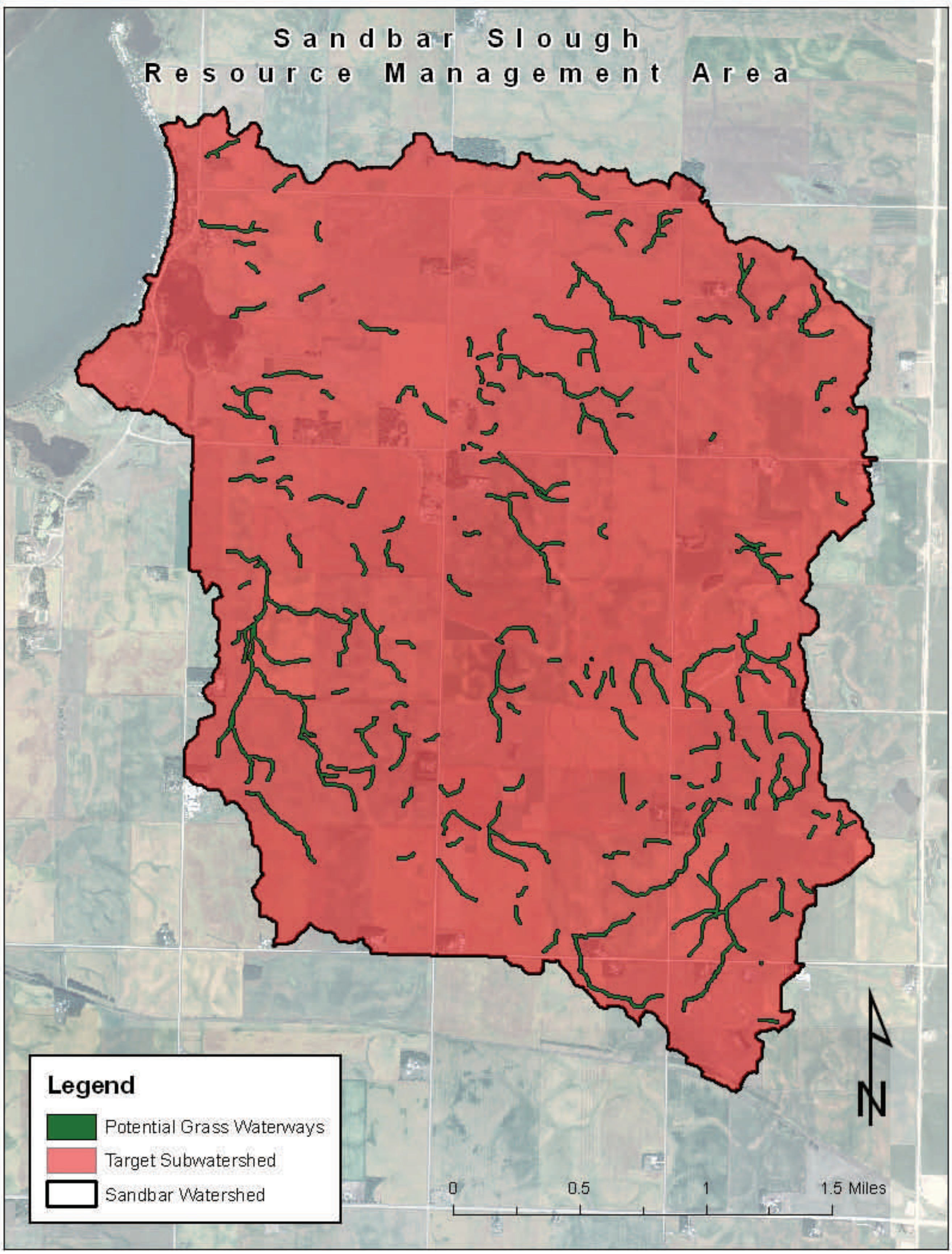


Figure 1.51 Sandbar Slough Ephemeral Gullies

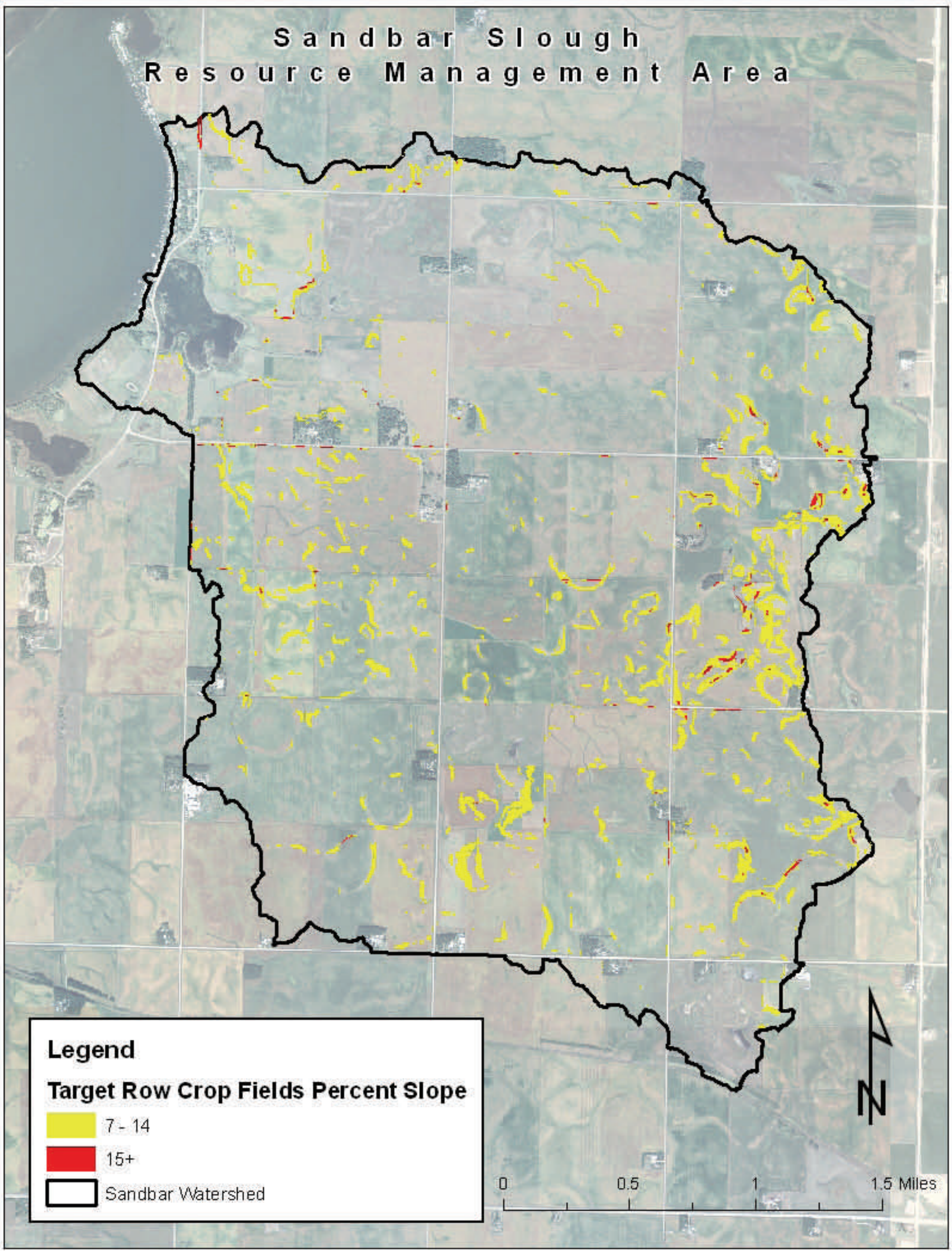


Figure 1.52 Sandbar Slough Target Row Crop Slopes

Figure 1.53 Sandbar Slough Fish Barrier Location

Hales Slough Resource Management Area (RMA)

Objective **–** Restore and maintain Hales Slough to a clear water system. The sediment reductions in this RMA will assist with the target reduction of phosphorus in Upper Gar Lake (3,300 pounds per year) and Lower Gar Lake (6,100 per year) in accordance with their specific approved TMDL's.

Description **–** Major changes in hydrology within the watershed of this complex along with the introduction of common carp have led to slow degradation of water. Submersed aquatic vegetation has nearly disappeared within Hales Slough.

Hales Slough and its associated watershed represent approximately 3% of the watershed of Big Spirit Lake. When healthy, this wetland complex provides important watershed protection to Big Spirit Lake. These areas also provide critical fishery and wildlife habitats. A holistic approach is needed to restore ecological health and water quality to this complex. A combination of both watershed and lake management practices is needed to reach the project objective.

Sediment, nutrients, and water volume loadings from the watershed should be reduced utilizing a prioritized plan through augmentation of existing landowner conservation programs, easements, and public acquisitions. Restoration of the lake to a clear water system can be accomplished through processes designed to mitigate watershed alterations and the introduction of common carp.

Restoration Planning Components

<u>Watershed Practices</u>

Prioritized Sub-watershed (Figure 1.54)

Structural Sediment Trapping
- Analysis has identified two priority wetland restorations in this sub-watershed (Figure 1.55).
- These wetland restorations have the potential to effectively intercept 90 acres (18% of the priority sub-watershed) of primarily agricultural runoff (Table 1.11).
- In lieu of restoration of these priority wetland areas, analysis has identified several locations for sediment retention basins or constructed wetlands.
- Restoring these wetlands will reduce sediment delivery by 162 tons.

Gully Management
- 4 miles of ephemeral gully erosion has been identified within agricultural fields (Figure 1.56).
- By installing grassed waterways within each of these ephemeral gullies, 35 acres of upland habitat can be created and sediment loss from these areas significantly reduced.
- Construction of these grassed waterways will reduce sediment delivery by 385 tons per year.

Highly Erodible Fields—Conservation Tillage
- Six agricultural fields devoted to row crop production exceed sediment loss thresholds (Figure 1.57).
- These fields, totaling 263 acres, account for 50% of the sediment loss within the targeted watershed.
- Conservation tillage on these acres will reduce sediment by 526 tons per year.

Highly Erodible Fields—Permanent Vegetation
- Sediment loss can be reduced on 27 acres of row cropped fields by implementing alternative practices (i.e. permanent vegetation, sediment basins, and reduced tillage) where field slope is greater than seven percent.
- A bit over one more acre has been identified and should have alternate land practices implemented because their slope is greater than 15% (Figure 1.58).
- Planting permanent vegetation on these acres will reduce 146 tons of sediment per year.

Nutrient Management
- A total of 445 acres are currently being utilized for the production of corn and soybeans within the targeted watershed of Hales Slough.
- A nutrient and pesticide management plan should be set up with each individual landowner to ensure that over application and runoff of nutrients and pesticides is minimized.

- A plan should also be put into place to protect field tile intakes from excessive nutrients and sediment.
- Rock tile intakes with an additional 50 foot vegetative buffer should be discussed and implemented at all tile intake locations within the sub-watershed.

Outside Prioritized Sub-watershed (Figure 1.54)

Structural Sediment Trapping

- Analysis has identified one priority wetland restoration in this portion of the sub-watershed (Figure 1.55).
- This wetland restoration has the potential to effectively intercept 60 acres (8% of the Hales Slough sub-watershed) of primarily agricultural runoff.
- In lieu of restoration of these priority wetland areas, analysis has identified several locations for sediment retention basins or constructed wetlands.
- These wetland restorations can prevent 108 tons per year of sediment.

Gully Management

- 465 feet of ephemeral gully erosion has been identified within agricultural fields (Figure 1.59).
- By installing grassed waterways within each of these ephemeral gullies, 1 acre of upland habitat could be created and sediment loss from these areas significantly reduced.
- Construction of grassed waterways on these acres will reduce 11 tons per year of sediment.

Highly Erodible Fields—Conservation Tillage

- One agricultural field devoted to row crop production exceeds sediment loss thresholds (Figure 1.60).
- This field, totaling 9.5 acres, account for 25% of the sediment loss within this portion of the watershed.
- A total of 19 tons of sediment can be prevented by using conservation tillage on these acres.

Highly Erodible Fields—Permanent Vegetation

- Sediment loss can be reduced on five acres of row cropped fields by implementing alternative practices (i.e permanent vegetation, sediment basins, reduced tillage) where field slope is greater than seven percent.
- 0.34 acres have been identified and should have alternate land practices implemented because their slope is greater than 15% (Figure 1.61).
- By planting permanent vegetation on these acres 23.74 tons of sediment can be stopped before it reaches the lake.

Nutrient Management

- A total of 43 acres are currently being utilized for the production of corn and soybeans within the second priority portion of the watershed for Hales Slough.
- A nutrient and pesticide management plan should be set up with each individual landowner to ensure that over application and runoff is minimized.
- A plan should also be put into place to protect field tile intakes from excessive nutrients and sediment.
- Rock tile intakes with an additional 50 foot vegetative buffer should be discussed and implemented at all tile intake locations within the sub-watershed.

Lake Restoration

Proper in lake management begins by controlling the movement of water and fish in/out of Hales Slough. A new fish barrier should be constructed at the outlet of Hales Slough in order to prevent the movement of common carp into the slough (Figure 1.62).

Once the fish barrier is in place, a chemical treatment should be applied during late fall in order to eliminate any adult carp still remaining in the slough. The following spring, natural fish communities will return to spawn via the natural connection to Big Spirit Lake. A long term management plan should be developed between fish and wildlife professionals that outline the criteria and plan for chemically controlling the fishery in order to maintain a balanced ecosystem.

Pollution Reduction

Big Spirit Lake does not have a TMDL assigned to it, but in order to ensure the Lake and its watershed are sustainable for future years this plan requires a 1,500 pound reduction of phosphorous per year to be removed. This Management Plan will help meet that 1,500 pound goal with a reduction in Phosphorous coming from the restored priority wetlands, stopping the ephemeral gullies using grassed waterways and sediment basins, conservation tillage, vegetative cover, and nutrient and pest management. In addition, rock tile intakes and vegetation around the intakes will ensure an adequate reduction of phosphorous and associated sediment. The total reduction in phosphorous from the Hales Slough RMA is 300 pounds of phosphorous.

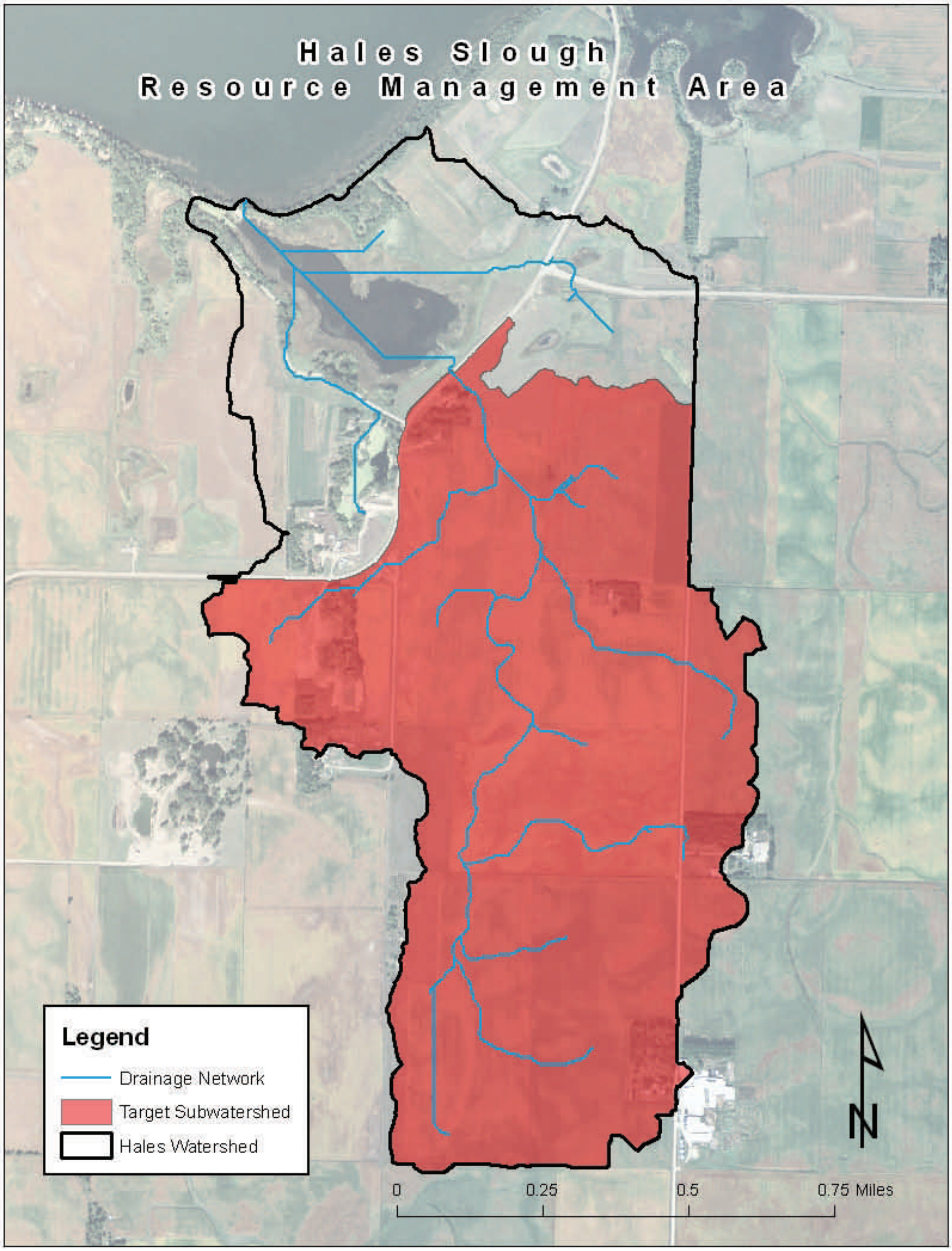


Figure 1.54 Hales Slough Resource Management Area

Hales Slough Watershed Wetland Prioritization

Wetland ID	Flows into	Flows into	Flows into	Flows into	Flows into	Flows into	Wetland Size (acres)	Watershed Size (acres)	Watershed to Wetland Ratio	GIS/RUSLE Priority
721	615	Lake					11.5	28.4	2.5	1
592	Lake						0.9	58.7	63.8	2
625	615	Lake					1.1	49.5	45.9	3
650	625	615	Lake				8.8	39.6	4.5	4
666	615	Lake					4.3	21.9	5.1	5
710	615	Lake					1.1	21.1	18.7	6
636	650	625	615	Lake			2.1	22.0	10.3	7
627	592	Lake					2.9	7.5	2.6	8
680	663	666	615	Lake			0.3	15.5	51.7	9
590	Lake						1.3	4.6	3.6	10
605	615	Lake					1.2	6.4	5.4	11
656	636	650	625	615	Lake		1.5	4.3	2.9	12
595	615	Lake					0.7	3.4	4.6	13
659	615	Lake					1.9	5.3	2.8	14
653	650	625	615	Lake			2.2	5.0	2.3	15
663	666	615	Lake				0.3	1.6	5.3	16
626	627	592	Lake				0.6	4.3	7.2	17
661	656	636	650	625	615	Lake	0.4	1.2	3.1	18
664	659	615	Lake				0.7	2.5	3.6	19

Table 1.11 Wetland restoration priorities for the Hales Slough Lake watershed. GIS priority rankings are based on a combination of erosion rates and size of watershed draining to each wetland (wetlands having watershed to wetland area ratios greater than 75:1 are excluded).

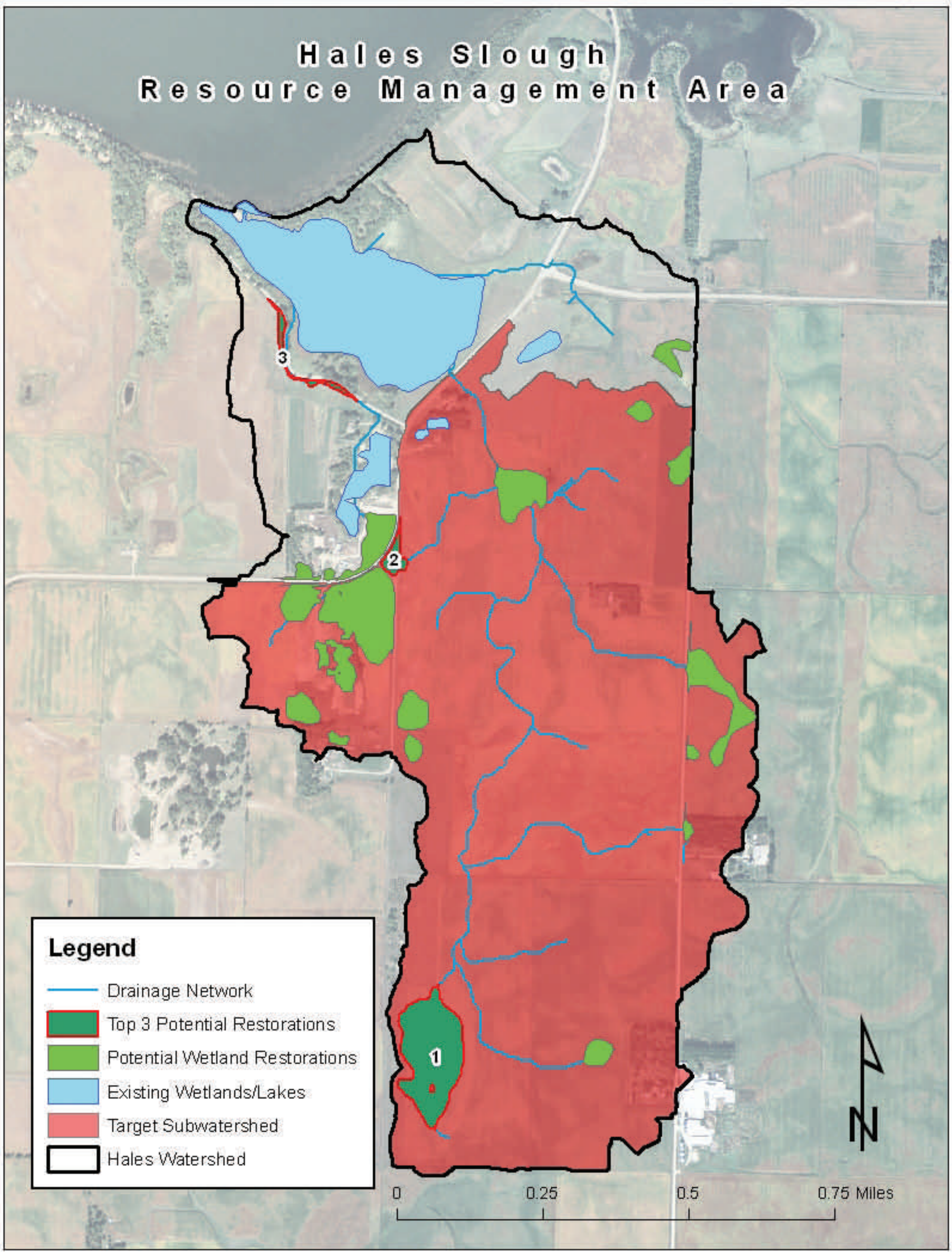


Figure 1.55 Hales Slough Priority Wetland Restorations

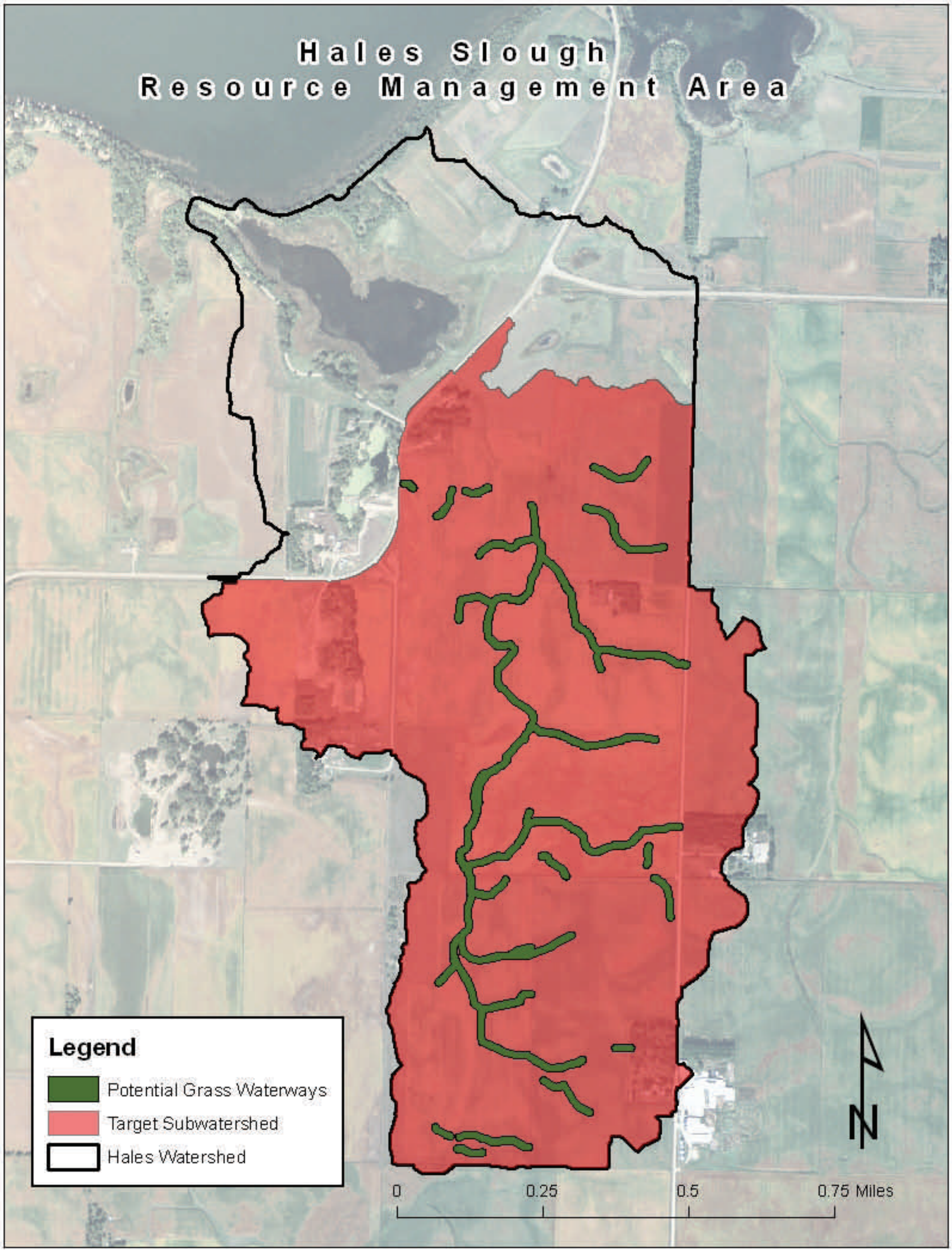


Figure 1.56 Hales Slough Ephemeral Gullies

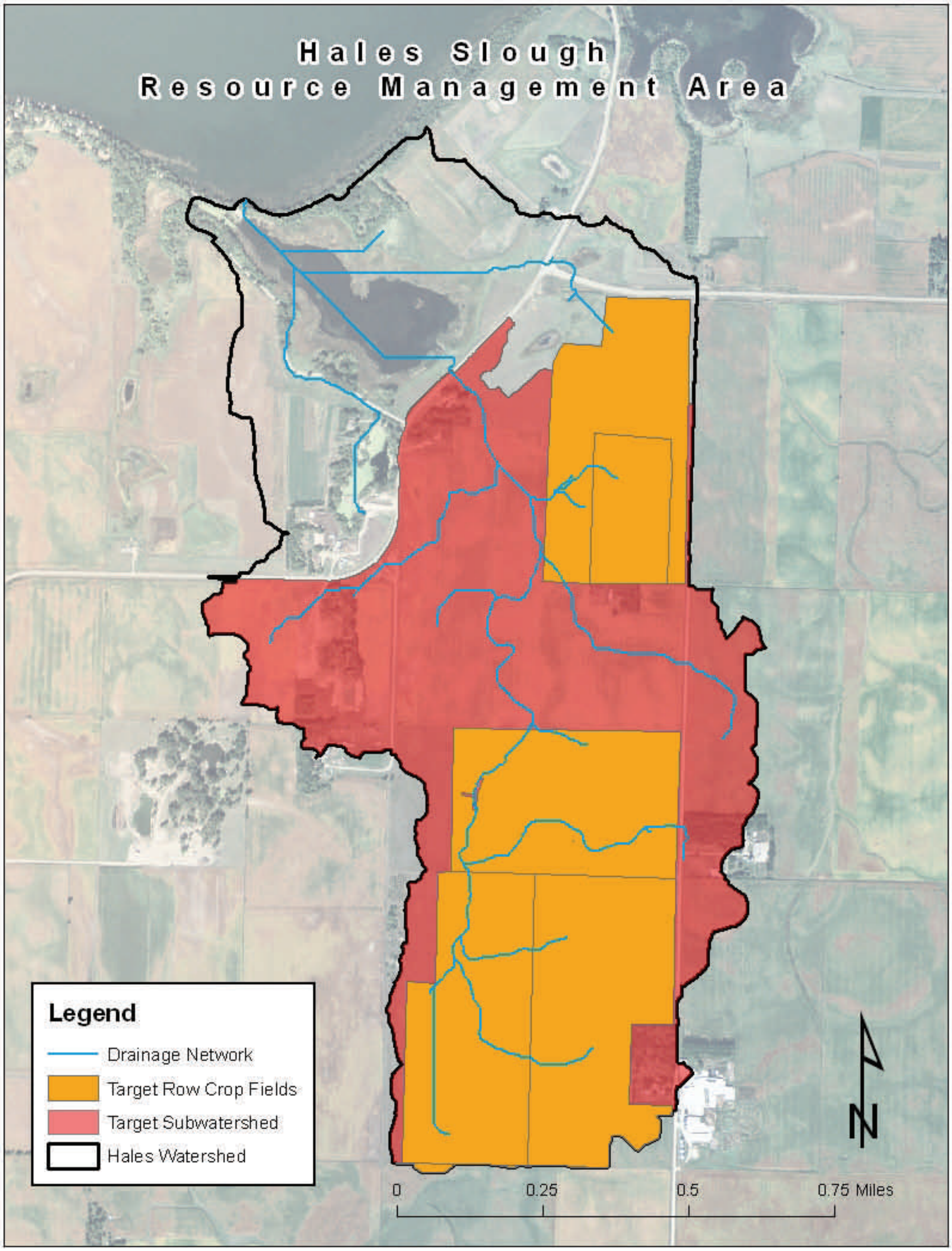


Figure 1.57 Hales Slough Target Row Crop Fields

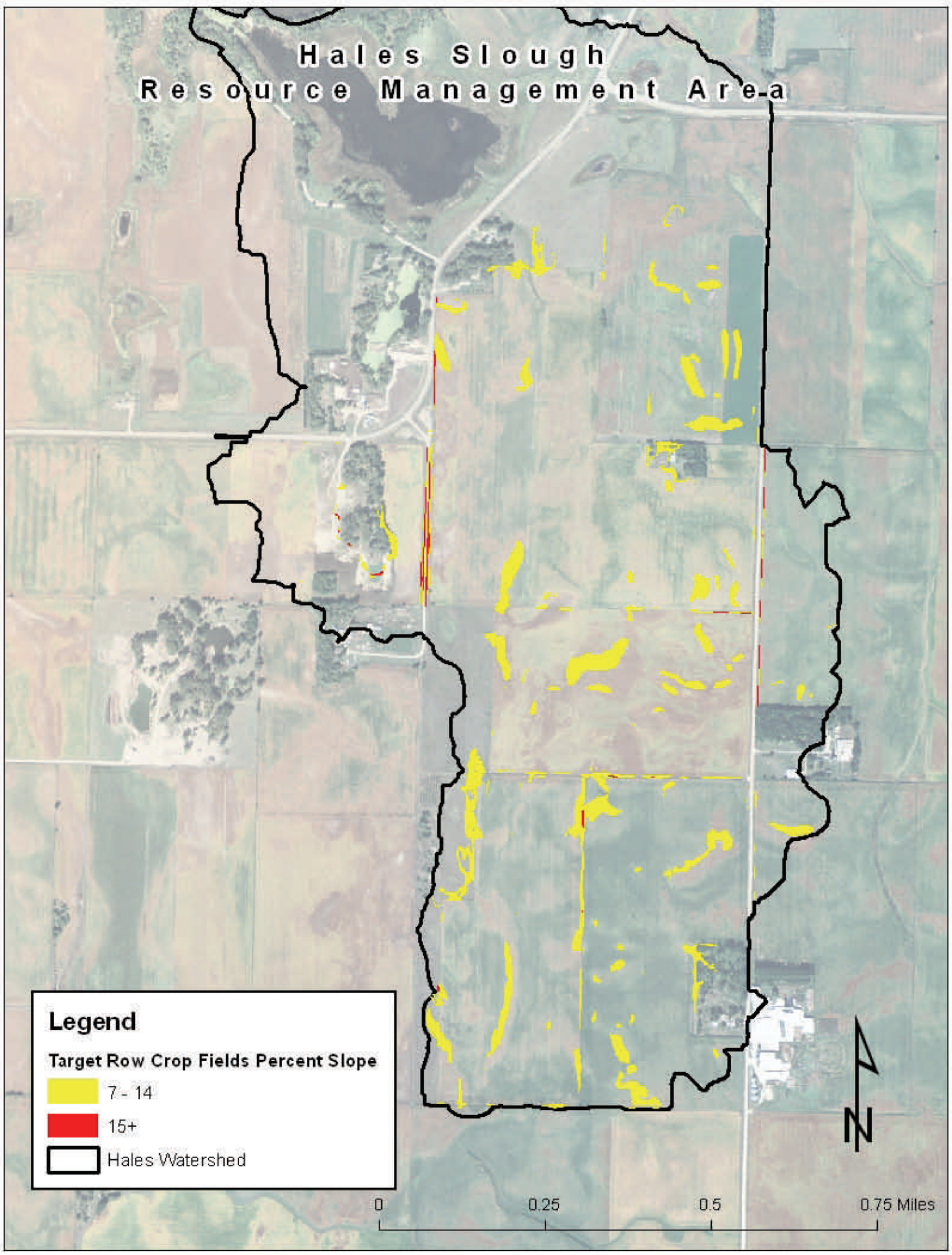


Figure 1.58 Hales Slough Target Row Crop Slopes

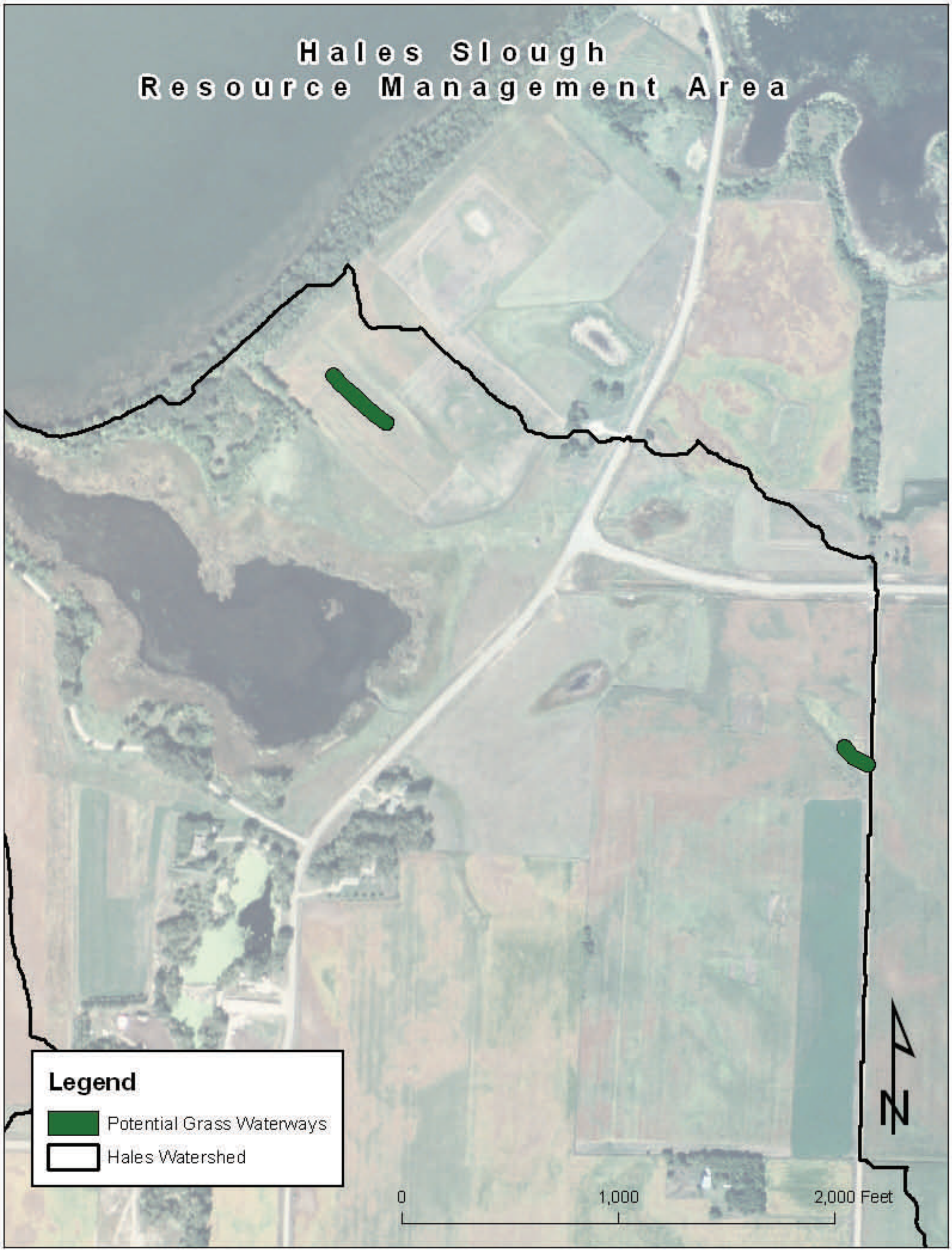


Figure 1.59 Hales Slough Ephemeral Gullies

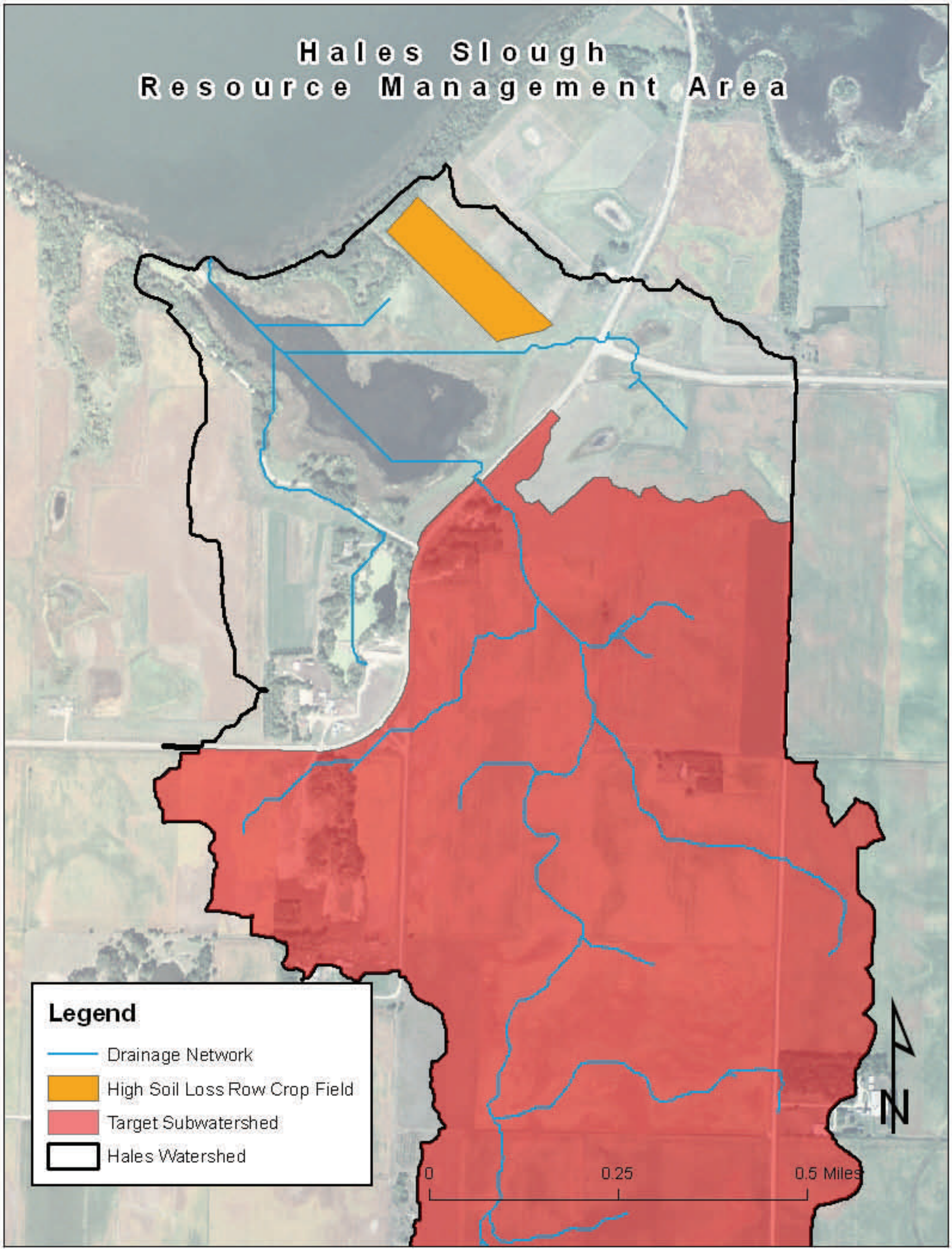


Figure 1.60 Hales Slough Target Row Crop Fields

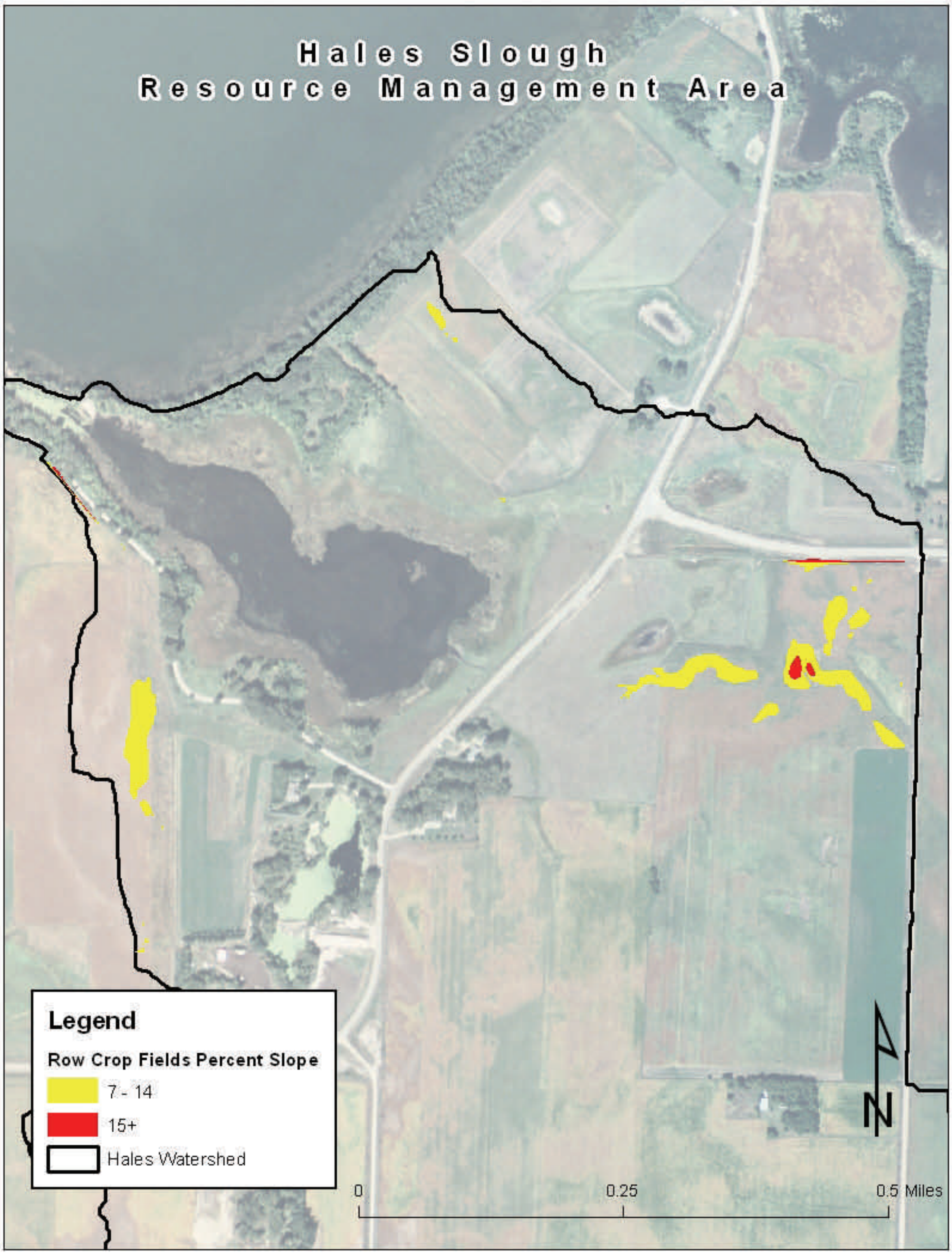


Figure 1.61 Hales Slough Target Row Crop Slopes

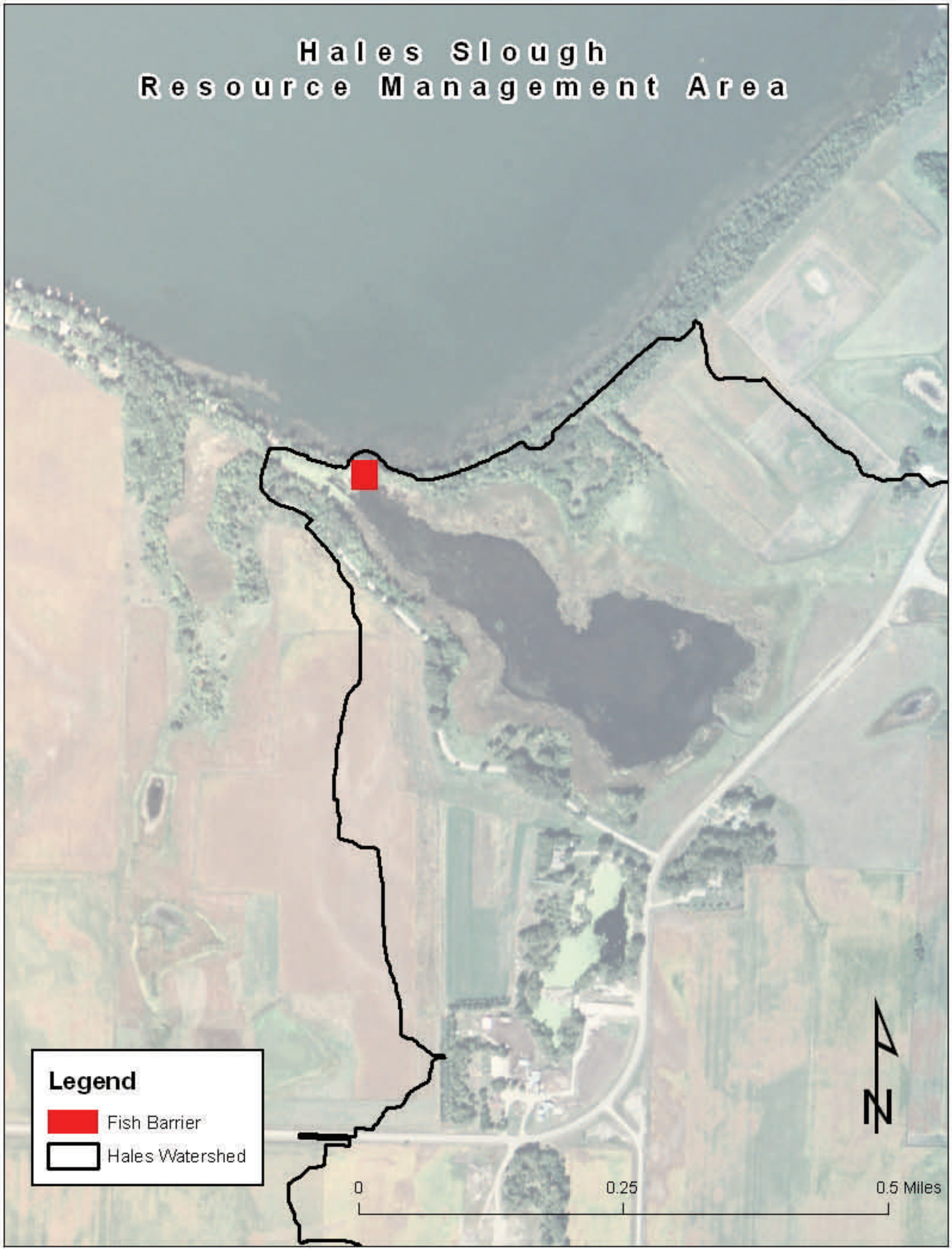


Figure 1.62 Hales Slough Fish Barrier Location

Reeds Run Resource Management Area (RMA)

Objective – Prevent heavy sediment loaded water reaching Big Spirit Lake via Reeds Run ephemeral stream. The sediment reductions in this RMA will assist with the target reduction of phosphorus in Upper Gar Lake (3,300 pounds per year) and Lower Gar Lake (6,100 per year) in accordance with their specific approved TMDL's.

Description – The Reeds Run watershed has undergone many hydrological changes in the past 100 years. The reduction of wetlands and the switch from prairies to farmland has left this watershed very degraded. This watershed represents approximately 7% of the watershed of Big Spirit Lake. Originally a long series of pothole wetlands provided important watershed protection to Big Spirit Lake and provided critical wildlife habitat. A holistic approach is needed to restore ecological health and water quality to this area. A combination of both watershed and wetland restoration practices is needed to reach the project objective.

Sediment, nutrients, and water volume loadings from the watershed should be reduced utilizing a prioritized plan through augmentation of existing landowner conservation programs, easements, and public acquisitions.

Restoration Planning Components

<u>Watershed Practices</u>

Prioritized Sub-watershed (Figure 1.63)

Structural Sediment Trapping

- Analysis has identified three priority wetland restorations in this sub-watershed (Figure 1.64).
- These wetland restorations have the potential to effectively intercept 950 acres (60% of the priority sub-watershed) of primarily agricultural runoff (Table 1.12).
- In lieu of restoration of these priority wetland areas, analysis has identified several locations for sediment retention basins or constructed wetlands.
- Restoration of these wetlands can reduce up to 1,710 tons of sediment per year.

Gully Management

- Five miles of ephemeral gully erosion has been identified within agricultural fields (Figure 1.65).
- By installing grassed waterways within each of these ephemeral gullies, 45 acres of upland habitat can be created and sediment loss from these areas significantly reduced

Highly Erodible Fields—Conservation Tillage

- 20 agricultural fields devoted to row crop production exceed sediment loss thresholds (Figure 1.66).
- These fields, totaling 687 acres, account for 50% of the sediment loss within the targeted watershed.

Highly Erodible Fields—Permanent Vegetation

- Sediment loss can be reduced on 79 acres of row cropped fields by implementing alternative practices (i.e. permanent vegetation, sediment basins, and reduced tillage) where field slope is greater than seven percent.
- Three acres have been identified and should have alternate land practices implemented because their slope is greater than 15% (Figure 1.67).
- Construction of grassed waterways on these acres can prevent 495 tons of sediment per year.

Nutrient Management

- A total of 1300 acres are currently being utilized for the production of corn and soybeans within the targeted watershed of Reeds Run.
- A nutrient and pesticide management plan should be set up with each individual landowner to ensure that over application and runoff of nutrients and pesticides is minimized.
- A plan should also be put into place to protect field tile intakes from excessive nutrients and sediment.
- Rock tile intakes with an additional 50 foot vegetative buffer should be discussed and implemented at all tile intake locations within the sub-watershed.

Pollution Reduction

Big Spirit Lake does not have a TMDL assigned to it, but in order to ensure the Lake and its watershed are sustainable for future years this plan requires a 1,500 pound reduction of phosphorous per year to be removed. This Management Plan will help meet that 1,500 pound goal with a reduction in Phosphorous coming from the restored priority wetlands, stopping the ephemeral gullies using grassed waterways and sediment basins, conservation tillage, vegetative cover, and nutrient and pest management. In addition, rock tile intakes and vegetation around the intakes will ensure an adequate reduction of phosphorous and associated sediment. The total reduction in phosphorous from the Reeds Run RMA is 300 pounds of phosphorous.

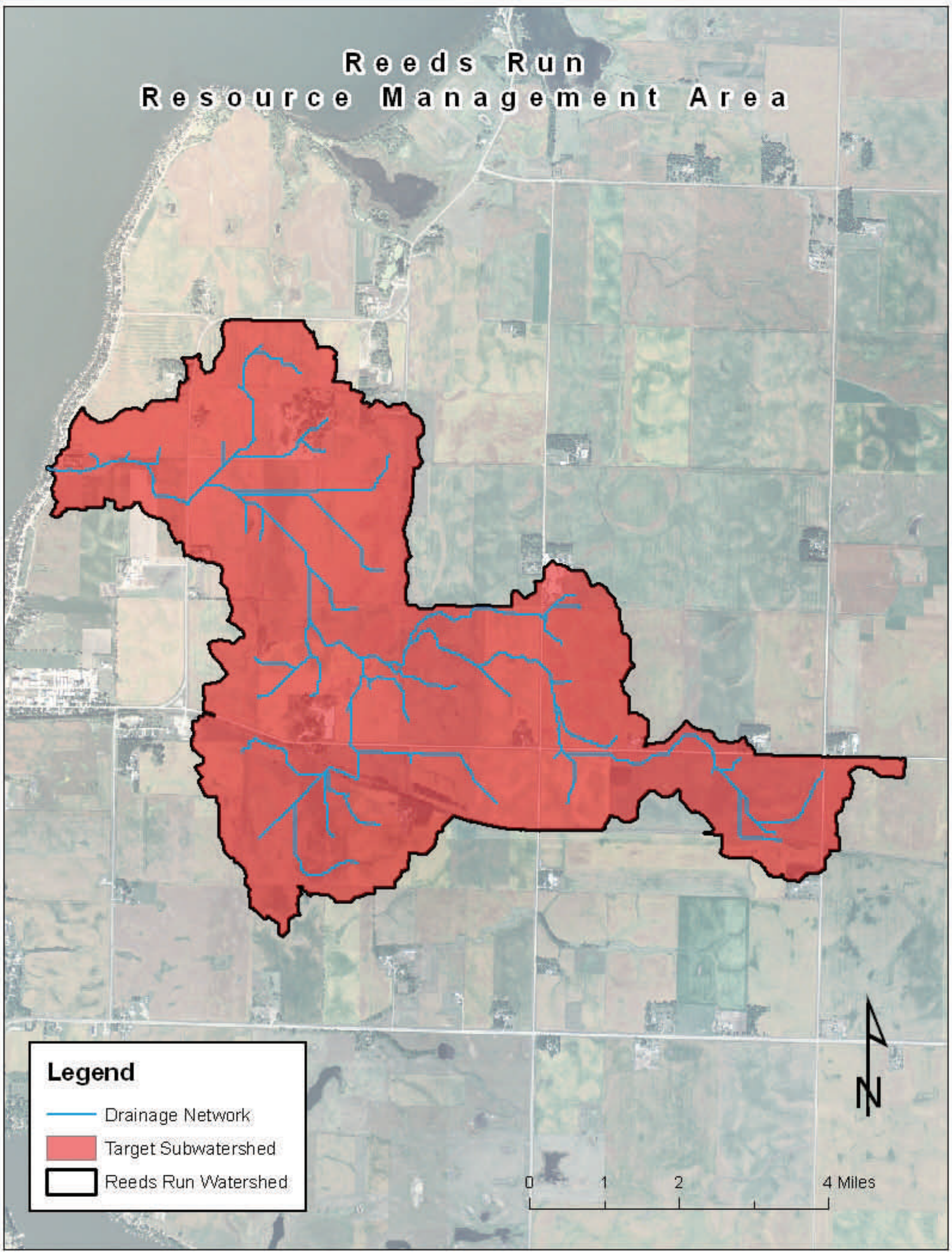


Figure 1.63 Reeds Run Resource Management Area

Reeds Run Watershed Wetland Prioritization

Wetland ID	Flows into	Flows into	Flows into	Flows into	Flows into	Flows into	Flows into	Wetland Size (acres)	Watershed Size (acres)	Watershed to Wetland Ratio	GIS/RUSLE Priority
733	Lake							200.6	1,262.3	6.3	1
787	733	Lake						11.2	386.6	34.6	2
808	787	733	Lake					8.3	316.9	38.4	3
809	759	733	Lake					6.9	219.7	31.8	4
884	808	787	733	Lake				73.6	155.7	2.1	5
839	790	802	809	759	733	Lake		27.9	105.4	3.8	6
757	733	Lake						6.9	54.3	7.9	7
730	733	Lake						7.1	51.4	7.2	8
843	839	790	802	809	759	733	Lake	3.1	21.8	7.0	9
830	808	787	733	Lake				4.2	22.7	5.4	10
818	839	790	802	809	759	733	Lake	1.1	17.1	15.4	11
682	Lake							1.2	9.0	7.7	12
677	Lake							0.7	5.3	7.2	13
693	Lake							1.9	7.0	3.6	14
660	733	Lake						2.2	8.4	3.8	15
815	809	759	733	Lake				0.6	7.6	12.3	16
711	733	Lake						0.6	6.8	10.6	17
676	Lake							0.9	4.0	4.5	18
814	830	808	787	733	Lake			1.4	2.1	1.5	19
789	757	733	Lake					1.0	6.5	6.7	20
805	809	759	733	Lake				0.6	1.6	2.6	21
774	765	733	Lake					0.6	6.3	9.7	22
765	733	Lake						0.5	9.5	19.7	23
796	789	757	733	Lake				1.2	3.4	2.9	24
695	733	Lake						0.4	2.1	4.7	25
704	695	733	Lake					0.7	0.8	1.0	26
791	787	733	Lake					1.9	4.4	2.3	27
793	791	787	733	Lake				0.4	1.3	3.6	27

Table 1.12 Wetland restoration priorities for the Reeds Run watershed. GIS priority rankings are based on a combination of erosion rates and size of watershed draining to each wetland (wetlands having watershed to wetland area ratios greater than 75:1 are excluded).