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WASTEWATER FACILITY PLAN
FOR

BIG FLOYD LAKE
DETROIT TOWNSHIP
BECKER COUNTY, MINNESOTA

JANUARY 1998

Prepared By

Widseth Smith Nolting & Assoc., Inc.
Project No. 470A473

WIDSETH SMITH NOLTING

ENGINEERS • ARCHITECTS • LAND SURVEYORS • ENVIRONMENTAL SERVICES

216 South Main
P.O. Box 458
Crookston, MN 56716
218-281-6522
FAX: 218-281-6545

2000 Industrial Park Rd. S.
P.O. Box 2720
Baxter, MN 56425
218-829-5117
Fax: 218-829-2517

2504 Aga Drive
Alexandria, MN 56308
320-762-8149
FAX: 320-762-0263

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DETROIT TOWNSHIP

Chair:	John Tigges
Clerk:	Ray Windschitl
Supervisor:	Eugene Pavelko
	Curtis Weldon

BY

Widseth Smith Nolting & Assoc., Inc.
2504 Aga Drive
Alexandria, Minnesota 56308

WSN Project No. 470A473

I hereby certify that this report was prepared by me or under my direct supervision and that I am a duly Registered Professional Engineer under the laws of the State of Minnesota.

Timothy E. Bayerl — Jan. 5, 1998 — 17651

Timothy E. Bayerl, P.E. — Date — Reg. No.

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I. EXECUTIVE SUMMARY

This wastewater facility plan was prepared at the request of the Detroit Township Board of Supervisors. In this report alternatives are considered for collection and treatment of wastewater on the south and east sides of Big Floyd Lake (Figure 1). The Township also requested preparation of a Water System Feasibility Study which has been completed as a separate report.

At present all structures in the study area are served by Individual Sewage Treatment Systems (ISTS). Most of the existing ISTS are not in compliance with current standards. In many locations it is difficult or impossible to site an acceptable ISTS.

The proposed project is to construct a standard gravity collection system and a stabilization pond wastewater treatment facility. Final treatment and disposal of wastewater is proposed to be by rapid infiltration. The estimated project cost is:

Collection System	$1,902,000
Treatment Facility	945,000
	$2,847,000

The project area contains approximately 242 properties. The project cost per user is estimated at $11,765. Monthly user costs could be as high as $100 depending on available financing. The Township Median Household Income (MHI) is ~~$28,750~~ $25,927. Two percent of the MHI is ~~$48~~ $43 per month, indicating that the project needs a grant of approximately 50 percent to be affordable.

One alternative not addressed in this report is the potential for connection to the City of Detroit Lakes. It is recommended that the potential for connection to the City be investigated prior to proceeding with the project selected herein to insure that the best option is constructed.

Funding for this project potentially could be obtained from the State of Minnesota Department of Trade and Economic Development (DTED). The state revolving loan (SRL) program and the wastewater infrastructure fund (WIF) administered by the Public Facilities Authority (PFA), division of DTED, are the potential funding sources. It is recommended that the Township submit application for SRL and WIF funds.

II. INTRODUCTION

A. PURPOSE

This preliminary engineering report has been prepared at the request of Detroit Township. In this report alternatives are considered for central collection and treatment of wastewater from the developed areas around the south and east sides of Big Floyd Lake. The planning area is shown as Figure 1.

Detroit Township is proposing the establishment of a Subordinate Service District for the purpose of sanitary sewer and water service around the portion of Big Floyd Lake in the planning area. Sanitary sewer collection and wastewater treatment is addressed in this report. A separate report, prepared concurrently, addresses water service and supply.

B. SCOPE

The wastewater facility plan is intended to present in one source all data and analysis pertinent to the determination of the best wastewater collection and treatment alternative. The purpose of this wastewater facility plan is to analyze all reasonable alternatives for wastewater collection and treatment, provide estimated costs for construction and operation of feasible alternatives, select and recommend the "best" alternative. The apparent "best" alternative is selected based on cost, environmental considerations, ability of the owner to implement the alternative, and public input.

C. CURRENT SITUATION

The lakeshore within the study area is nearly fully developed. Development consists of both seasonal and year around residences.

The existing residences are served by individual sewage treatment systems (ISTS). Many of the existing ISTS are not in compliance with current standards. Soil conditions and/or high groundwater precludes installation of standard onsite systems on many lots, forcing installation of more costly above-grade systems. Also, many lots are small and locating a proper ISTS is difficult or impossible.

The Becker County Environmental Services office provided a summary of the status of existing ISTS. The summary is included as Appendix B. There are a total of 219 lakeshore properties with 38 undetermined systems (assumed nonconforming), 17 known nonconforming systems, and 30 with holding tanks, for a total of 85 nonconforming systems. Of the 219 lakeshore properties, 8 are empty lots, making 211 the total number of lakeshore properties with structures. The number of lakeshore properties with nonconforming ISTS is 85 of 211 or 40.3 percent.

In 1996, the Pelican River Watershed District retained A.W. Research Laboratories (AWRL) to use low altitude remote sensing imagery to identify and evaluate existing conditions around Big Floyd Lake relating to failing ISTS. The AWRL report is included as Appendix C. Of 333 shoreline residences observed (some outside the planning area of this project) AWRL determined the following:

	#OF RESIDENCES	%OF RESIDENCES
Inadequate Septic Setback	196	59
Non-complying Lot Size	289	8
Inadequate Depth to Groundwater	256	77
New Addition	1	0
Privy or Cesspool	4	1
Straight Pipe	1	0
Observed Influence Seen in Lake or Lawn	175	53
Possible Septic Effluent	0	0
Any Septic Problem (all of the above)	309	93
Possible Point Source	11	3

As noted in the table, 93% of the residences have a problem of some type with their ISTS.

III. FACILITY PLANNING

A. PLANNING AREA

The planning area consists of the shoreland area on the south and east sides of Big Floyd Lake. Also included is developed property adjacent to the shoreland area. The planning area is shown on Figure 1.

B. PLANNING PERIOD

The planning period is 20 years. Twenty years is typically used for sizing and design of a central wastewater system. The basic assumption used for this study is that we expect areas served by the central wastewater collection system to saturate during the next 20 years. That is, facilities would be sized for complete lakeshore development and some second tier development in the area served.

C. FORECAST OF FLOW AND LOADING

The forecast of wastewater flow is typically based on existing and a projected design population. For this study, however, the number of existing users times a unit design flow rate has been used to estimate existing flow. Design flow was projected based on

available empty space suitable for development, plus the existing flow determination. This method was selected because many of the users are seasonal, and it is difficult to obtain accurate population data for the planning area.

At present there are approximately 242 residential structures within the planning area. Space for additional development is rather restricted. We estimate that the potential total for the planning area is 285 structures. The twenty year design flow is therefore based on 285 residential structures. The average wet weather design flow per residential structure is 200 gallons per day. The average wet weather design flow is as follows:

Present Average Flow = 242 x 200 gpd = 48,400 gpd
Design Average Flow = 285 x 200 gpd = 57,000 gpd

Additional detail regarding the determination of design flow is contained in Appendix A.

The wastewater produced is exclusively from domestic sources and therefore the expected composition is that of typical domestic wastewater. The anticipated concentration is approximately 250 mg/l Biochemical Oxygen Demand (BOD), 280 mg/l Total Suspended Solids (TSS), and 5 mg/l Total Phosphorus.

Based on the design average wet weather flow of 57,000 gpd, the wastewater treatment facility should be designed for the following organic loading.

BOD	119 lbs/day
TSS	133 lbs/day
Total Phosphorus	2.4 lbs/day

IV. COLLECTION SYSTEM ALTERNATIVES

A. INTRODUCTION

A sewage collection system is needed for a community wastewater treatment facility. Three alternative collection systems are analyzed herein.

B. ALTERNATIVE 1
GRAVITY SYSTEM

A gravity collection system is the most commonly used system. It typically consists of 4" diameter service pipes from the properties draining to 8" diameter (minimum) main line sewers in the street area. Sewage flow is by gravity to lift stations that are used when needed to pump the sewage to other gravity main line sewers or the treatment facility.

The gravity collection system proposed for Big Floyd Lake is shown on the drawings

included with this report. The cost of a gravity collection system is estimated at $1,902,000. A detailed cost estimate is provided as Table 1.

C. ALTERNATIVE 2 VACUUM SYSTEM

A vacuum station maintains a vacuum in the collection lines. When the sewage from one or several homes fills the storage pit, a valve opens, and the sewage and air rush into the collection line toward the vacuum station. Pumps in the vacuum station transfer the sewage to a treatment system. Power is required only at the vacuum station. The vacuum system is economical where many homes are served, or in areas with high excavation costs and lift stations. The system requires a professional operator.

AIRVAC Vacuum Sewer Systems has provided a preliminary design and cost estimate for the Big Floyd Lake project. The AIRVAC proposal is included as Appendix D. Other costs in addition to these by AIRVAC include surface restoration, engineering, and administrative. Table 2 shows the total estimated cost for the vacuum sewer system to be estimated at $1,888,000.

D. ALTERNATIVE 3 SMALL DIAMETER PRESSURE SYSTEM

Sewage is first pretreated by a grinder pump and then forced through small diameter pipes to a conventional gravity sewer or to the treatment facility. The pressure pipes can normally be installed at less depth than gravity sewers saving on initial cost. The system is sometimes cost effective where conventional sewers are costly due to scattered development or high groundwater. Central management is required.

For the Big Floyd Lake project, use of grinder pumps and small diameter pressure sewers is considered for areas served by lift stations #1, 2, 4, 5 and 6 (see drawings). The small diameter pressure sewer would discharge to the gravity sewer flowing to lift station #3 which pumps to the proposed treatment facility. The estimated cost for this alternative is $2,072,000 as shown on Table 3.

E. EVALUATION OF ALTERNATIVES

Ranking based on estimated cost:

1.	Vacuum Sewer	$1,888,000
2.	Gravity Sewer	$1,902,000
3.	Pressure Sewer	$2,072,000

Cost estimates are intended to convey a general and approximate picture of the cost which will probably be incurred in carrying out the proposed work. Cost can vary widely depending upon many factors such as weather, economic conditions, size of project, and the work load of available contractors. Actual costs can only be determined by bidding the project.

Both the vacuum sewer system and the small diameter pressure sewer system are significantly more costly and difficult to operate than is the convential gravity sewer system. In addition, the vacuum sewer system air valves are a proprietary item with only one source of supply. The vacuum system or pressure system would only be recommended over the gravity system if it were significantly (25% or more) less costly. Therefore, use of a conventional gravity sewer system is recommended.

It is estimated that for the gravity sewer system dewatering will be a significant cost. The cost of dewatering is included in the $25.00 per lineal foot cost for the 8" diameter sanitary sewer. At present, limited information is available for estimating dewatering cost. Soil borings should be conducted as one of the first steps during project design. If soil borings or other analysis indicate that dewatering costs will be significantly higher than presently estimated, reconsideration of the vacuum sewer system or pressure sewer system should be initiated.

V. TREATMENT FACILITY ALTERNATIVES

A. INTRODUCTION

There are several wastewater treatment technologies that are feasible for this project. The two major categories are mechanical treatment plants and stabilization pond systems. Mechanical treatment plants normally have a continuous discharge to surface water. Stabilization ponds commonly have a controlled discharge, releasing water only during selected spring and fall discharge periods. Stabilization ponds can also be followed by land application by spray irrigation, or rapid infiltration basins.

Big Floyd Lake discharges to Little Floyd Lake which discharges to the Pelican River. The Pelican River flows southward a few miles and then discharges to Detroit Lake. A river is normally an acceptable receiving stream for a wastewater treatment facility, however, the discharge standards for the Pelican River are very stringent because it discharges to Detroit Lake. The stringent discharge standards and anticipated public opposition essentially eliminate any wastewater treatment facility proposal with a surface water discharge. Only the wastewater treatment facility alternatives without a surface water discharge are addressed further in this report.

B. ALTERNATIVE 1
STABILIZATION POND AND SPRAY IRRIGATION

Stabilization ponds are shallow basins used for primary and secondary treatment of wastewater. Conditions are generally aerobic, however, these ponds do operate in a facultative manner. Treatment is provided by settling of solids and reduction of BOD by bacterial activity. Dissolved oxygen for aerobic bacterial metabolism is furnished by oxygen transfer between the air and water surface, and by photosynthetic algae.

Hydraulic detention time of 210 days is generally used in northern Minnesota. The stabilization pond is designed to have a 2 foot minimum depth and a 6 foot maximum depth. The storage depth of four feet (2' to 6') times the pond area must provide the 210 days storage. The average design wet weather flow of 57,000 gpd times 210 days requires 9.2 acres water area for the Big Floyd Lake project. The pond system would be constructed of two cells. One primary cell and one secondary cell. The primary cell would be 2/3 of the total water area or 6.1 acres, and the secondary cell 1/3 of the total area or 3.1 acres.

Stabilization pond design must also insure a maximum 5-day biochemical oxygen demand (BOD5) loading of 22 pounds per acre per day at a mean operating depth in the primary cells. It has been determined that the design year total organic loading is 119 pounds of BOD5 per day. A stabilization pond system with primary pond surface area of 5.4 acres will comply with the standards for organic loading. To provide adequate secondary treatment and efficient operation during discharge, the secondary pond(s) are required to have a capacity of at least one-third the total hydraulic capacity of the pond system. This would require a secondary pond of 2.7 acres. This would give a total pond size of 8.1 acres. Since this area is less than the area calculated for hydraulic detention, the hydraulic detention size controls, and the total water area required is 9.2 acres.

The stabilization pond must have a liner to limit leakage to protect groundwater and meet State of Minnesota requirements. The liner can be either a soil (clay) which restricts seepage or a synthetic material (such as PVC or HDPE). Review of soils information from the U.S. Department of Agriculture Natural Resources Conservation Service (Appendix E) indicates that clay soils suitable for a liner are not available in the proposed stabilization pond area. Therefore, it is assumed that a synthetic liner will be needed.

Final treatment and disposal of the wastewater will by land application. Land application will be accomplished by spray irrigation using a center pivot irrigator. Generally 12 to 15 inches of water can be irrigated per year in Minnesota on high water using crops such as alfalfa. The required irrigation area for this project is approximately 60 acres. The proposed site for the stabilization pond and spray irrigator is shown on Figure 2. The estimated cost is $1,170,000 and is presented in Table 4.

C. ALTERNATIVE 2
STABILIZATION POND AND RAPID INFILTRATION

The general design parameters for the stabilization pond are the same as for Alternative 1 above, except that the winter storage period can be shorter for a system using rapid infiltration for final treatment and disposal. Also, the stabilization pond must only provide primary treatment. For this alternative, two primary cells would be constructed, that are large enough to provide approximately 160 days winter storage and a BOD5 loading of 22 pounds per acre per day or less. Storage of 160 days at 57,000 gpd requires 7.0 acres water area. Two cells of 3.5 acres each are proposed. The BOD5 loading of 119 lbs/day would be 17 lbs/acre/day.

In Rapid Infiltration (RI) land treatment, most of the applied wastewater percolates through the soil, and the treated effluent drains naturally to surface waters or joins the ground water. The wastewater is applied to moderately and highly permeable soils (such as sands and loamy sands), by spreading in basins or by sprinkling, and is treated as it travels through the soil matrix. Vegetation is not usually planned, but there are some exceptions, and emergence of weeds and grasses usually does not cause problems.

The proposed site for the stabilization pond and RI land treatment is shown on Figure 3. The estimated cost is $945,000 and is detailed on Table 5.

D. EVALUATION OF ALTERNATIVES

To evaluate the alternatives, estimated annual operation, maintenance and replacement (O, M&R) costs were estimated in addition to the initial capital costs of planning, design and construction. Estimated O, M&R costs are presented as Table 6.

For Alternative 1, stabilization pond and spray irrigation, the total initial capital cost including the gravity collection system is $3,072,000. As indicated on Table 8, the estimated equivalent annual project cost is $325,000. For Alternative 2, stabilization pond and RI, the total initial capitol cost including collection is $2,847,000. The estimated equivalent annual project cost is $302,000.

VI. INDIVIDUAL SEWAGE TREATMENT SYSTEMS

Existing individual sewage treatment systems could be upgraded to current standards as an alternative to a community collection and treatment system. Soil conditions and high groundwater force installation of more costly above-grade systems at many locations. Many lots are small and locating a proper ISTS is difficult or impossible. This is especially true of Floyd Lake Point and Paradise Point.

The alternative for ISTS and cluster systems for Floyd Lake Point and Paradise Point is

presented as Table 9. For Floyd Lake Point and Paradise Point small diameter pressure collection systems are proposed. The collection systems would pump sewage off the confined point areas to locations where room for treatment drainfields is available. Individual systems are proposed for all other properties. Some individual systems could be standard in-ground systems and some would need to be above-grade (mound) systems. In many locations there is not room for the ISTS on the lakeshore lot and a site on an adjoining property must be used. In many locations the ISTS would be located across the roadway on a backlot.

The actual cost for each ISTS will vary considerably for each property. For the economic analysis, an average cost of $8,700 has been used for each ISTS. The $8,700 figure is the retail installation cost estimated by the Minnesota Pollution Control Agency for research completed at Lake Washington in LeSueur County.

In Table 10, the equivalent annual cost for individual and cluster sewage treatment systems is calculated. The estimated equivalent annual project cost is $250,500. This is approximately 17% less than the $302,000 equivalent annual cost estimated for the lowest cost community collection and treatment option (Table 8).

Remaining on ISTS systems might be somewhat less costly than a community system, but also is less desirable for the following reasons.

- Some of the setback requirements for septic systems and buildings would not be addressed.
- Although supposedly adequately treated, effluent from many of the ISTS would still enter Big Floyd Lake.
- The potential failure rate for ISTS is relatively high.
- Finding suitable locations for second and third generation drainfields will become successively more difficult.

VII. PLAN SELECTION

A. SELECTED PLAN

The selected plan for the collection system is to construct Alternative 1 - Standard Gravity Collection System. This alternative is the most common and most proven type of collection system. It also has the lowest annual operation and maintenance cost.

The selected plan for the treatment facility is to construct Alternative 2 - Stabilization Pond and Rapid Infiltration. This alternative has the lowest initial project cost and the

lowest annual operation, maintenance and replacement cost.

B. ENVIRONMENTAL IMPACTS OF SELECTED PLAN

The selected plan will have a positive environmental impact within the planning area. Construction of the project will significantly reduce the potential for groundwater and surface water contamination within and around the planning area by eliminating non-conforming ISTS. The project will provide protection for Big Floyd Lake. The lake presently has high water quality and is used for swimming, boating, and fishing.

The sanitary sewer collection system and treatment facility will be designed to meet Minnesota Pollution Control Agency (MPCA) requirements as well as the Great Lakes Upper Mississippi River Board of State Public Health and Environmental Managers (GLUMRB-Ten States Standards) requirements. Meeting these requirements will provide adequate protection of the environment.

This project will require a State Disposal System (SDS) permit from the MPCA. An Environmental Assessment Worksheet (EAW) will be required to obtain the SDS permit. The SDS permit must be obtained prior to the construction start. During the EAW process, environmental issues will be addressed by appropriate governmental agencies.

C. ESTIMATED COST OF SELECTED PLAN

The estimated cost of the proposed project is:

Collection System	$1,902,000
Treatment Facility	945,000
	$2,847,000

Detailed cost estimates are presented in tables within this report. Cost estimates are intended to convey a general and approximate picture of the cost which will probably be incurred in carrying out the proposed work. Cost can vary widely depending upon many factors such as weather, economic conditions, size of project, and the work load of available contractors. Actual costs can only be determined by bidding the project.

D. ESTIMATED COST PER USER

Number of Users =	242
Estimated Cost/User = $2,847,000/242 =	$11,765
O,M&R Cost/User = $22,500/242 =	$93.00 per year

The township will need obtain financing for the estimated project cost of $2,847,000.

The project could be funded by a general obligation bond or possibly by a low interest loan from the State of Minnesota Public Facilities Authority (PFA) - State Revolving Loan Program.

Assume that a 20 year general obligation bond would have an interest rate of 6 percent and compare that with a PFA low interest loan of 3 percent. Assume that 1 percent would be added to each interest rate and that the cost would be assessed for a 20 year period.

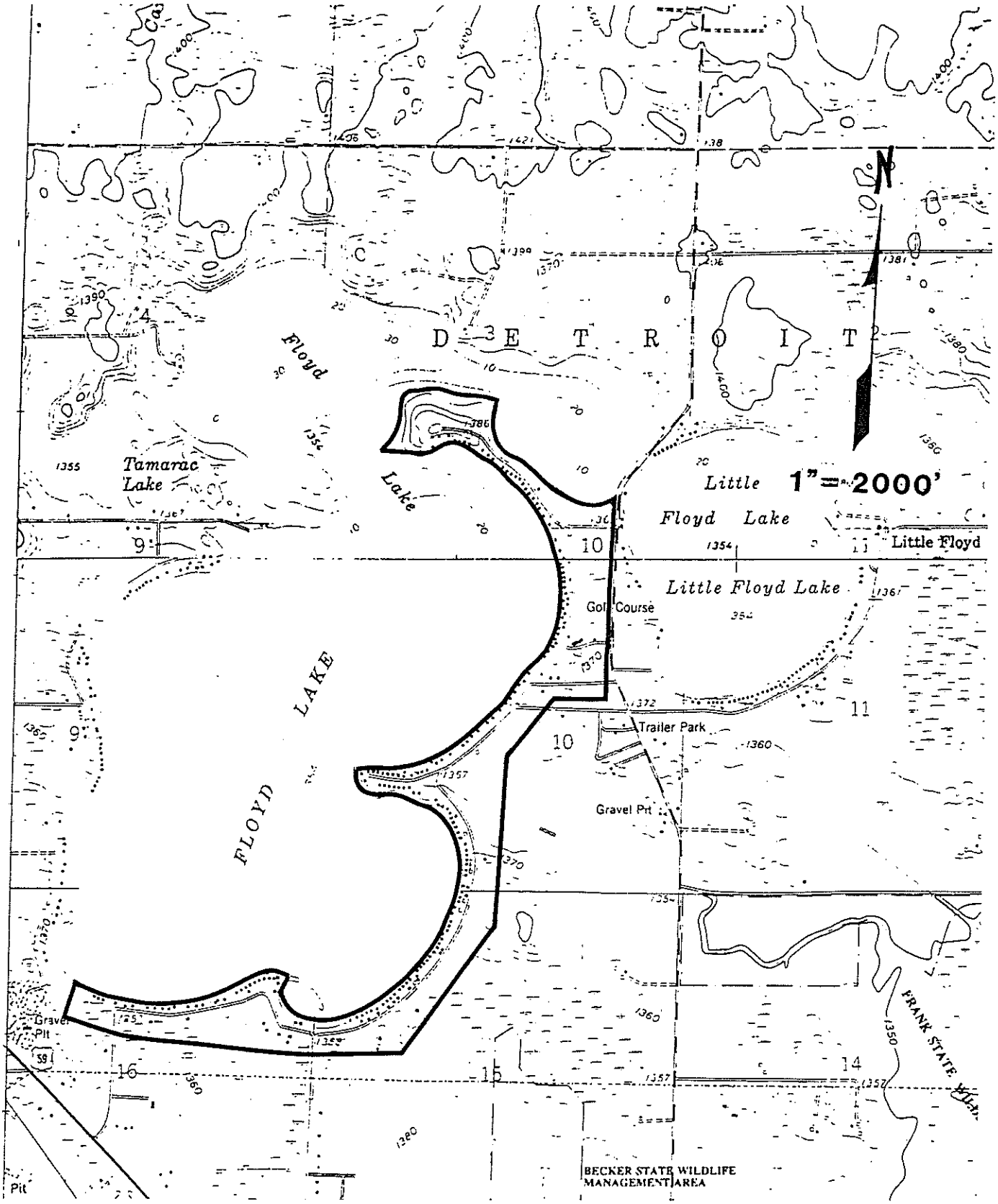
	4% Assessment	7% Assessment
Assessment Amount	$11,765	$11,765
Capital Recovery Factor	0.07358	0.09439
Annual Assessment Payment	$ 866	$1,110
Annual O,M&R Cost	$ 93	$93
Total Cost/User	$ 959/year	$1,203/year
	$ 79.92/month	$100.25/month

A cost of 1.5 to 2.0 percent of the Median Household Income (MHI) is considered affordable for a wastewater collection/treatment system. The MHI for Detroit Township is ~~$28,750~~ $25,927 per year. A cost of ~~$36.00~~ 32.40 to ~~$48.00~~ 43.20 per month (1.5 to 2.0%) is considered affordable.

The estimated user cost of $80 to $100 per month is about double the affordable rate based on the MHI. The project is eligible for a low interest loan thru the state revolving loan program as well as a forgiven loan (grant) from the state Wastewater Infrastructure Fund.

VIII. PUBLIC PARTICIPATION

The Big Floyd Lake Association has been involved in initiating this facility plan study and has been involved throughout the development of this report. A preliminary draft of this report was presented at the regularly scheduled Detroit Township meeting on December 2, 1997. The final report was presented at the January 6, 1998 meeting. No specific notice was made to the public. A formal public hearing is planned for April - May 1998 and will be incorporated as part of this facility plan after it is held.

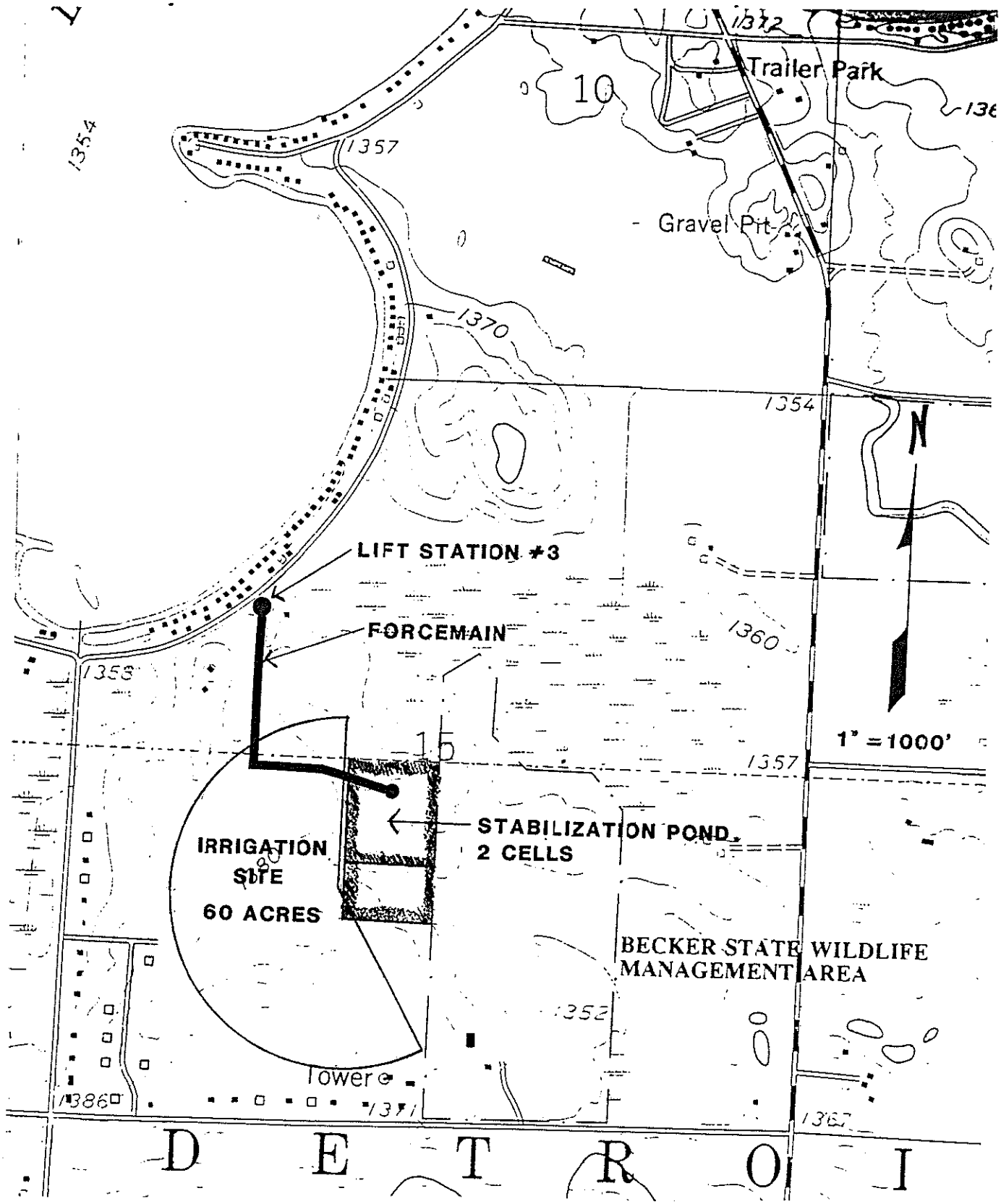


PLANNING AREA

DETROIT TOWNSHIP

WSN #470A473

FIGURE 1

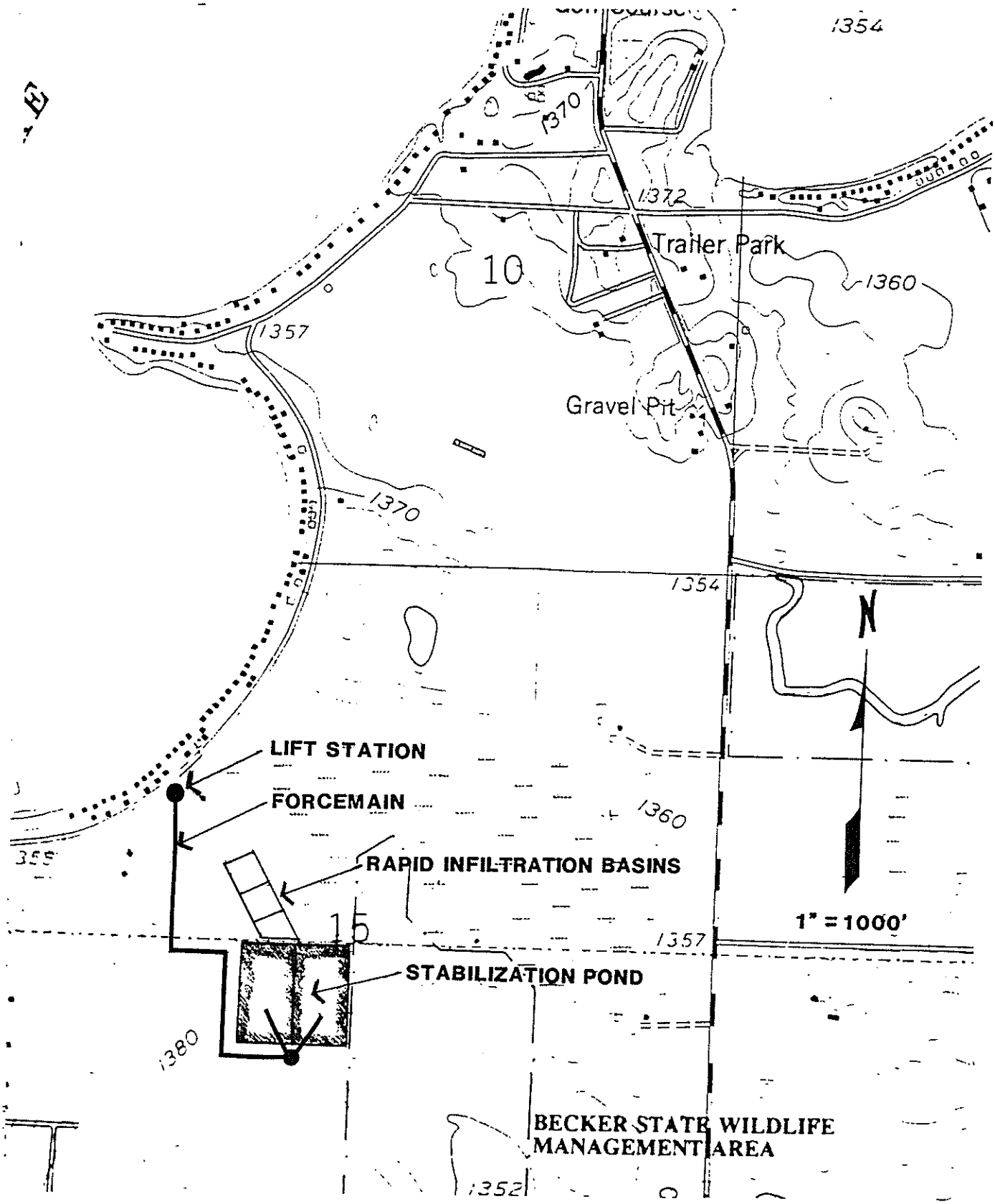


W.W.T.F. SITE PLAN

STABILIZATION POND AND SPRAY IRRIGATION

WSN #470A473

FIGURE 2



W.W.T.F. SITE PLAN

STABILIZATION POND WITH RAPID INFILTRATION

WSN #470A473

FIGURE 3

LIFT STATION AND FORCEMAIN SCHEMATIC

FLOYD LAKE – DETROIT TOWNSHIP

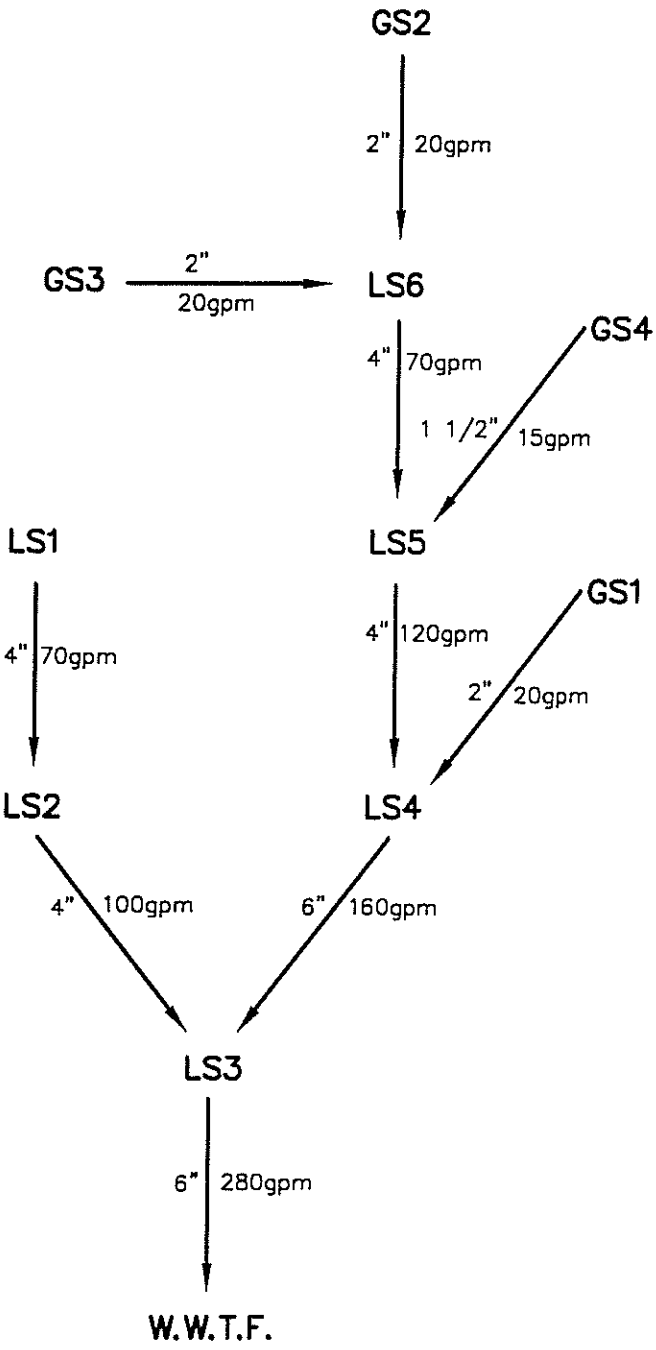


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FIGURE 4

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TABLE 1

DETROIT TOWNSHIP
GRAVITY SANITARY SEWER COLLECTION SYSTEM

COST ESTIMATE

Item Description	Quantity	Unit	Unit Cost	Amount
8" Sanitary Sewer	16,350	LF	$25.00	$408,750.00
Manholes	55	EACH	1500.00	82,500.00
Wyes	285	EACH	100.00	28,500.00
Services	9,400	LF	15.00	141,000.00
Lift Station	6	EACH	40,000.00	240,000.00
Grinder Station	4	EACH	20,000.00	80,000.00
Forcemain 1 1/2" & 2"	1,800	LF	8.00	14,400.00
Forcemain 4" & 6"	7,000	LF	12.00	84,000.00
Air Release MH	3	EACH	3,000.00	9,000.00
Bit Street Repair	37,000	SY	9.00	333,000.00
Gravel Street Repair	800	CY	12.00	9,600.00
Seeding	10	ACRE	1,000.00	10,000.00
Estimated Construction Cost				$1,440,750.00
Contingencies (15%)				$216,250.00
Engineering - Basic Services (7.5%)				108,000.00
- Construction (7.5%)				108,000.00
Legal, Fiscal and Administrative (2%)				29,000.00
TOTAL ESTIMATED PROJECT COST				$1,902,000.00

TABLE 2

DETROIT TOWNSHIP
VACUUM SANITARY SEWER COLLECTION SYSTEM

COST ESTIMATE

Item Description	Quantity	Unit	Unit Cost	Amount
Vacuum Collection System	1	LS	$766,450.00	$766,450.00
Vacuum Station	1	LS	240,000.00	240,000.00
Bit Street Repair	37,000	SY	9.00	333,000.00
Gravel Street Repair	800	CY	12.00	9,600.00
Seeding	10	Acre	1,000.00	10,000.00
Dewatering	5,000	LF	10.00	50,000.00
Estimated Construction Cost				$1,409,050.00
Contingencies (15%)				$210,950.00
Engineering - Basic Services (8.5%)				120,000.00
- Construction (8.5%)				120,000.00
Legal, Fiscal and Administrative (2%)				28,000.00
TOTAL ESTIMATED PROJECT COST				$1,888,000.00

TABLE 3

DETROIT TOWNSHIP
SMALL DIAMETER PRESSURE SEWER
COLLECTION SYSTEM

COST ESTIMATE

Item Description	Quantity	Unit	Unit Cost	Amount
1 1/2" Pressure Sewer	3200	LF	$ 12.00	$ 38,400.00
2" Pressure Sewer	2900	LF	15.00	43,500.00
3" Pressure Sewer	4800	LF	18.00	86,400.00
4" Pressure Sewer	5500	LF	22.00	121,000.00
8" Gravity Sewer	2900	LF	25.00	72,500.00
Manholes	9	Each	1,500.00	13,500.00
Wyes	40	Each	100.00	4,000.00
4" Gravity Service	1400	LF	15.00	21,000.00
Lift Station	1	Each	50,000.00	50,000.00
Pressure Sewer Service Lateral Connection	120	Each	100.00	12,000.00
Grinder Pump Station	120	Each	7,000.00	840,000.00
Bit Street Repair	25000	SY	9.00	225,000.00
Gravel Street Repair	800	CY	12.00	9,600.00
Seeding	10	Acre	1,000.00	10,000.00
Estimated Construction Cost				$1,546,900.00
Contingencies (15%)				$232,100.00
Engineering - Basic Services (8.5%)				131,000.00
- Construction (8.5%)				131,000.00
Legal, Fiscal and Administrative (2%)				31,000.00
TOTAL ESTIMATED PROJECT COST				$2,072,000.00

TABLE 4

DETROIT TOWNSHIP

STABILIZATION POND WITH SPRAY IRRIGATION

COST ESTIMATE

Mobilization	$20,000.00
Forcemain to Pond Site	30,000.00
Excavation and Embankment	140,000.00
Synthetic Liner	250,000.00
Random Riprap	95,000.00
Control Structures and Piping	70,000.00
Fencing	10,000.00
Seeding	10,000.00
Tractor and Mower	30,000.00
Portable Emergency Generator	20,000.00
Irrigation Pump Station	60,000.00
Center Pivot Irrigator	60,000.00
Miscellaneous	10,000.00
Estimated Construction Cost	$805,000.00
Contingencies (15%)	121,000.00
Land for Pond Site and Irrigator (120 acres)	100,000.00
Engineering - Basic Services (8.5%)	68,000.00
- Construction (7.5%)	60,000.00
Legal, Fiscal and Administrative (2%)	16,000.00
	$1,170,000.00

TABLE 5

DETROIT TOWNSHIP

STABILIZATION POND WITH RAPID INFILTRATION

COST ESTIMATE

Mobilization	$20,000.00
Forcemain to Pond Site	30,000.00
Excavation and Embankment	150,000.00
Synthetic Liner	200,000.00
Random Riprap	80,000.00
Control Structures and Piping	100,000.00
Fencing	10,000.00
Seeding	10,000.00
Tractor and Mower	30,000.00
Portable Emergency Generator	20,000.00
Monitoring Wells	20,000.00
Miscellaneous	10,000.00
Estimated Construction Cost	$680,000.00
Contingencies (15%)	102,000.00
Land for Pond Site and RI (40 acres)	40,000.00
Engineering - Basic Services (8.5%)	58,000.00
- Construction (7.5%)	51,000.00
Legal, Fiscal and Administrative (2%)	14,000.00
	$945,000.00

TABLE 6

DETROIT TOWNSHIP
ESTIMATED OPERATION, MAINTENANCE AND REPLACEMENT COSTS

COST ESTIMATE

	Pond and Spray Irrigation	Pond and Rapid Infiltration
Salaries and Wages	$10,000	$10,000
Utilities (Electricity)	$5,000	$3,500
Materials and Equipment	$1,500	$1,500
Maintenance	$1,500	$1,000
Replacement	$2,000	$1,500
Collection System	$2,000	$2,000
NPDES Testing	$1,500	$2,000
Miscellaneous	$1,000	$1,000
TOTAL O, M&R COST	$24,500	$22,500

TABLE 7

DETROIT TOWNSHIP
ESTIMATED 20 YEAR SALVAGE VALUES

COST ESTIMATE

	Pond and Spray Irrigation	Pond and Rapid Infiltration
LAND-Permanent	$100,000	$40,000
40 Year Items WWTF	$52,000	$52,000
30 Year Items WWTF	$40,000	$37,000
40 Year Items - Collection System	$365,000	$365,000
Total 20 Year Salvage Value	$557,000	$494,000

TABLE 8

DETROIT TOWNSHIP
EQUIVALENT ANNUAL COST SUMMARY

COST ESTIMATE

Assumed Interest Rate 8.00%

		Pond and Spray Irrigation	Pond and Rapid Infiltration
Estimated Project Cost: Gravity Collection System		$1,902,000	$1,902,000
Treatment Facility		1,170,000	945,000
		$3,072,000	$2,847,000
ADD Present Worth of Annual O,M&R Costs			
O,M&R Costs (from Table 6)	$24,500	$22,500	
Present Worth of Annual O,M&R Costs	x 9.818	x 9.818	
over 20 year design life		$241,000	221,000
SUBTRACT			
Total 20 Year Salvage Value	$557,000	494,000	
(from TABLE 7)	x 0.2145	x 0.2145	
Present Value of 20 Year Salvage Value		(119,000)	(106,000)
Estimated Present Worth		$3,194,000	$2,962,000
Equivalent Annual Project Cost (x0.10185)		$325,000	$302,000

TABLE 9

DETROIT TOWNSHIP
INDIVIDUAL AND CLUSTER SEWAGE TREATMENT SYSTEMS

COST ESTIMATE

I. CLUSTER SYSTEMS

Assume small diameter pressure sewer collection of Floyd Lake Point and Paradise Point with remote septic tank and drainfield located off the point areas.

A.	Floyd Lake Point (approximately 20 residences)	
	Collection	$117,500
	Septic Tanks and Drainfields	70,500
		$118,000
B.	Paradise Point (approximately 40 residences)	
	Collection	$252,000
	Septic Tanks and Drainfields	141,000
		$393,000
	Total Estimated Construction Cost	$581,000
	Contingencies (15%)	87,000
	Engineering - Basic Services (8.5%)	49,000
	- Construction (7.5%)	44,000
	Legal, Fiscal and Administrative (2%)	12,000
	TOTAL ESTIMATED COST	$773,000

II. ISTS

Assume all others are served by individual sewage treatment systems. Based on Becker County information, approximately 40% of the remaining 180 homes are not in compliance. 180 x 0.4 = 72 residences. MPCA research for mound systems indicates an average cost of $8,700 each.

72 ISTS @ $8,700 each =	$626,400
TOTAL ESTIMATED PROJECT COST =	$1,399,400

TABLE 10

DETROIT TOWNSHIP
INDIVIDUAL AND CLUSTER SEWAGE TREATMENT SYSTEMS
EQUIVALENT ANNUAL COST SUMMARY

COST ESTIMATE

Assumptions:

1. Cluster collection systems have 20 year life.
2. Cluster and ISTS treatment systems have 10 year life.
3. Annual operation and maintenance cost for each residence is $100 per year or $24,200 per year for the total (242 systems)
4. Interest Reate = 8.00%

Estimated Initial Project Cost	$1,399,400
Add Present Worth of Annual O&M Cost $24,200 x 9.818 =	$237,600

Add Present Worth of Expenditure for System Replacement in 10 years.

1.	Floyd Lake Point =	$70,500
2.	Paradise Point=	141,000
3.	180 ISTS @ $8,700 each=	1,566,000
		$1,777,500
	$17,777,500 x 0.4632 =	$823,000
Estimated Present Worth		$2,460,000
Equivalent Annual Project Cost (x 0.10185)		$250,500

APPENDIX A

WASTEWATER FACILITIES PLAN
DETROIT TOWNSHIP, MINNESOTA
FLOYD LAKE WWTF
WSN #470A473

DETERMINATION OF DESIGN FLOWS

(A.) For determination of peak hourly wet weather design flow: (PHWW)

(1)	Present peak hourly dry weather flow		121,000
(2)	Present peak hourly flow during high groundwater period (no runoff)		121,000
(3)	Present peak hourly dry weather flow (Same as (1))	(-)	121,000
(4)	Present peak hourly infiltration	(=)	0
(5)	Present peak hourly flow during high groundwater period and runoff at point of greatest distance between Curves Y & Z		121,000
(6)	Present hourly flow during high groundwater (no runoff) at same time of day as (5) measurement	(-)	121,000
(7)	Present peak hourly inflow	(=)	0
(8)	Present peak hourly inflow adjusted for a 5 year - 1 hour rainfall event		0
(9)	Present peak hourly infiltration (Same as (4))		0
(10)	Peak hourly infiltration cost effective to eliminate	(-)	0
(11)	Peak hourly infiltration after rehab (where rehab cost effective)	(=)	0
(12)	Present peak hourly adjusted inflow (Same as (8)		0
(13)	Peak hourly inflow cost effective to eliminate	(-)	0
(14)	Peak hourly inflow after rehab (where rehab cost effective)	(=)	0
(15)	Population increase times 2.5 (peaking factor)		21,500
(16)	Peak hourly flow from planned industrial increase		0
(17)	Estimated peak hourly flow from future unidentified industries		0
(18)	Peak hourly flow from other future increases		0
(19)	Peak hourly wet weather design flow (1+11+14+15+16+17+18)		142,500

(B.) For determination of peak instantaneous wet weather design flow: (PIWW)

(20)	Peak hourly wet weather design flow (same as (19))		142,500
(21)	Present peak hourly inflow adjusted for a 5 year 1 hour rainfall event (same as (8))	(-)	0
(22)	Present peak inflow adjusted for a 25 year-1 hour rainfall event	(+)	0
(23)	Peak instantaneous wet weather design flow	(=)	142,500

(C.) For determination of average dry weather design flow: (ADW)

(24)	Present average dry weather flow		48,400
(25)	Population increase	(+)	8,600
(26)	Average flow form planned industrial increase	(+)	0
(27)	Estimated average flow from other future unidentified industries	(+)	0
(28)	Average flow from other future increases	(+)	0
(29)	Average dry weather design flow	(=)	57,000

(D.) For determination of average wet weather design flow (30 day average for mechanical plant and 180 day average for controlled discharge ponds): (AWW)

(30)	Present average dry weather flow		48,400
(31)	Average infiltration after rehab (where rehab cost effective)	(+)	0
(32)	Average inflow after rehab (where rehab cost effective)	(+)	0
(33)	Population increase	(+)	8,600
(34)	Average flow from planned industrial increase	(+)	0
(35)	Estimated average flow from other future unidentified industries	(+)	0
(36)	Average flow from other future increases	(+)	0
(37)	Average wet weather design flow (30+31+32+33+34+35+36)	(=)	57,000

DETROIT TOWNSHIP
FLOW DETERMINATION WORKSHEET

1) Present Peak Hourly Dry Weather Flow

It is estimated that the peak hour flow will be 2.5 times the average daily flow. The present average daily flow is estimated at 48,400 GPD (See No. 24)

Therefore the Peak Hour Flow = 2.5 x 48,400
= 121,000 gpd

2) Present Peak Hourly flow during High Groundwater Period

Same as No. 1.

15) Population Increase

See #25 below (Use 8,600)
8,600 x 2.5 = 21,500 gpd

24) Present Average Dry Weather Flow

The existing users are all residential, except for the golf club house. The number of users by area is approximately as follows:

	Existing Structures	Potential Total including vacant lots
1. Willow Haven, Modern Acres and Brolin Beach	46	55
2. Floyd Lake Beach	65	75
3. Floyd Lake Point and Oakridge Area	50	65
4. Clark's Grove Area	37	40
5. Paradise Point	44	50
	242	285

Use design flow of 200 gpd per structure.

Existing ADW Flow = 242 x 200 gpd = 48,400 gpd

Potential ADW of Service Area = 285 x 200 gpd = 57,000 gpd

Potential Flow Increase = 57,000 - 48,400 = 8,600 gpd

25) Population Increase

The potential flow increase from population increase is 8,600 gpd as indicated in #24. The increase is equivalent to 43 homes or approximately 100 people at 2.33 per household.

APPENDIX B

COUNTY OF BECKER

Environmental Services
Dan A. Holm, Administrator

829 Lake Avenue • P.O Box 787
Detroit Lakes, MN 56502-0787 • Fax 218-846-7266

September 5, 1997

Timothy Bayerl, P.E.
Widseth, Smith & Nolting
2504 Aga Drive
Alexandria, MN 56308

RE: Detroit Township
Floyd Lake Sanitary Sewer Study
WSN #470A473

Dear Mr. Bayerl:

Enclosed please find the new information for Floyd Lake Sanitary Sewer Study and plat maps. I'm sorry that the first batch of information was incorrect, either I wrote down the wrong ending point or was given the wrong ending point.

The total number of properties we have are 219. All properties are lakeshore, I understand that the Lake Association has included some non-lakeshore properties in the study.

Total Number of Properties	219
Number of undetermined systems	38
Number of nonconforming systems	17
Number of holding tank systems	30
Number of tank/drainfield systems	126
Number of tank/drainfield systems that are known mounds	31
Number of known vacant lots	8

Some of the undetermined systems could be failed systems. These systems could have seepage into the ground but none evident to the surface.

All the nonconforming systems are failed systems. These systems have seepage into the ground but none evident to the surface.

All the holding tank systems are confined to such a system because of well setback infringements - drainfields could possibly be installed if all wells were drilled wells or relocated.

During this study, the distance separation from the bottom of the drainfield to the water table was not checked. If the distance was checked on each tank/drainfield system, there is a possibility that a number of systems could fail.

There is no indication that there is non-domestic wastewater.

If there is any other information we can furnish you, please contact me.

Sincerely,

Debi Moltzan

Debi Moltzan,
Zoning Secretary / Field Inspector

cc: Floyd Lake File

APPENDIX C

DATE: January 16, 1996

TO: Pelican River Watershed District
Richard Hecock
803 Roosevelt Avenue, Suite 100
Detroit Lakes, MN 56502

SUBJECT: FINAL REPORT OF THE AERIAL SURVEY OF WASTEWATER TREATMENT FACILITIES FOR BIG FLOYD LAKE

FROM: Gordon Johnson
Don R. Hickman
Alan W. Cibuzar
A.W. Research Laboratories
717 Laurel Street
Brainerd, MN 56401
(218) 829-7974 Fax (218) 829 1316

TABLE OF CONTENTS

EXECUTIVE SUMMARY

In June 1996, the Pelican River Watershed District contacted A.W. Research Laboratories (AWRL) for assistance in evaluating and identifying existing or potential sources of water pollution due to failing septic systems and point sources around Big Floyd Lake. In response to this request, AWRL conducted an aerial survey of wastewater treatment facilities using remote sensing equipment.

A.W. Research Laboratories (AWRL) has used low altitude remote sensing imagery to identify nutrient and toxic conditions in lakes since 1974. The use of remote sensing (aerial imagery) is invaluable for lake management because it quickly and economically summarizes complex environmental conditions. These dramatic aerial images demonstrate environmental conditions to lay people in a format that is easily understood, and becomes a tool for lakeshore residents to gain a better awareness of their effect on the environment, and with that awareness an increased willingness to rectify problems.

The actual overflights of Big Floyd Lake were completed over two dates July 31 and October 28, 1996. Next, the infrared and visible slides were correlated to geographic maps, and analyzed for wastewater treatment facilities which have degraded water quality. This analysis includes identification of point and non-point septic source pollution, as well as potential point sources such as streams, ditches, and straight pipes.

The following table presents the number and percentage of the residences analyzed that exhibit possible wastewater treatment problems on Big Floyd Lake:

	# OF RESIDENCES	% OF RESIDENCES
Inadequate Septic Setback	196	59
Non-complying Lot Size	28	8
Inadequate Depth to Groundwater	256	77
New Addition	1	0
Privy or Cesspool	4	1
Straight Pipe	1	0
Observed Influence Seen in Lake or Lawn	175	53
Possible Septic Effluent	0	0
Any Septic Problem (all of the above)	309	93
Possible Point Source	11	3

INTRODUCTION

Big Floyd Lake provides a scenic environment for its residents and visitors, along with unspoiled habitat for a broad diversity of wildlife and fish. The homes and cabins along the lake's shoreline and many islands provide valued seasonal and year-round lakeside living. The beauty and recreational environment that Big Floyd Lake provides are a prime reason that families and individuals have invested in their lakeshore property. In recognizing the importance of this resource, the Pelican River Watershed District contacted A.W. Research Laboratories (AWRL) in June 1996 for assistance in evaluating and identifying existing or potential sources of water pollution due to failing wastewater treatment facilities. In response to this request, AWRL conducted an aerial survey of wastewater treatment facilities using remote sensing equipment.

A.W. Research Laboratories (AWRL) has used low altitude remote sensing imagery to identify nutrient and toxic conditions in lakes since 1974. The use of remote sensing (aerial imagery) is invaluable for lake management because it quickly and economically summarizes complex environmental conditions. These dramatic aerial images demonstrate environmental conditions to lay people in a format that is easily understood, and becomes a tool for lakeshore residents to gain a better awareness of their effect on the environment, and with that awareness an increased willingness to rectify problems.

Additional advantages of the aerial perspective are that: 1) it allows the user to see things that would be obscured from the ground perspective, and 2) the visual image record can be reviewed using standard protocols to detect evidence of conditions that the user is interested in. Since this review can take place in a controlled laboratory situation it is more consistent than field review.

On a technical level, an aerial survey of wastewater treatment facilities provides a low altitude oblique view of shorelines; photographed in the visible and infrared range, recorded on 35mm slides of every 300 to 500 feet of lakeshore. Oblique imaging allows an image analyst to "see beneath trees and shrubs", and to view both vertical embankments and horizontal land surfaces at the same time. For nonpoint source pollution detection an aerial survey is a successful methodology because a comprehensive view is provided of the lake, streams, wetlands and adjacent upland area.

METHODOLOGY

During the first phase of the aerial survey, A.W. Research Laboratories' Remote Sensing System recorded the shoreline of Big Floyd Lake using both visible and near infrared 35 mm slide film from a Lake Buccaneer Seaplane. The actual overflights were completed over two dates: July 31 and October 28, 1996.

Next, the infrared and visible slides were correlated to geographic maps, and analyzed for wastewater treatment facilities which have deteriorated water quality. This analysis also includes identification of point and non-point septic source pollution, as well as potential point sources such as streams, ditches, and straight pipes.

Finally, in the analysis section of this report, all observed problems with wastewater treatment facilities, as well as point sources, are identified along with a brief description of the type of observed problem.

ANALYSIS CRITERIA

The focus of this study was to evaluate the effect of water pollutants associated with wastewater treatment facilities related to shoreline development along Big Floyd Lake. The criteria for the slide analysis used to evaluate the possible effect each property is having on water quality are listed below:

Wastewater influences:

*residences that appear to be built before 1974, because these are more likely to have outdated or non-compliant septic systems;
*lots that appear to be less than 20,000 square feet, because lots of this size are less likely to have the area needed for a modern drain field;
*property with an elevation of ten feet or less above the lake level, because these lots are unlikely to meet minimum separation from groundwater to adequately treat wastewater;
*residences that are very large or have been recently remodeled, in order to evaluate whether on-site wastewater systems have been upgraded to meet current demands of the home or structure;
*property that has very healthy or dense aquatic vegetation in the near shore area, since this suggests a local source of nutrient loading;
*evidence of animal wastes, since these are clearly associated with potential nutrient or bacterial loading if not properly managed.

Point sources:

*evidence of a creek or ditch on the property, since these can contribute pollutants from other portions of the watershed;
*culverts within 100 feet of the shoreline;
*hoses or "straight pipes" within 100 feet of the shoreline.

The magnitude of problems associated with the findings listed above is influenced by many factors, and cannot be accurately assessed without direct on-site evaluations and sampling. Several of these influential factors are listed below, along with the known information concerning each factor:

1. **The number of residences on the lake.**

   333 residences in 8.4 miles of analyzed shoreline.

   The shoreland jurisdiction requires a minimum lot width of 100 feet at the ordinary high water level, and a minimum lot area of 20,000 square feet. Our survey found that the average lot on Little Floyd Lake has a shoreline of 133 feet/lot. Since this average is barely above the minimum size requirements, it emphasizes the high density of development around this lake.

2. **The number of structures on each lot that generate sewage.**

   Unknown.

3. **The number of residences that are inhabited all year.**

   Unknown.

4. **Second tier development of lots.**

   None.

5. **Hydrogeologic sensitivity of the area.**

   At least a portion of approximately 66% of the map positions on ~~Little~~ Big Floyd Lake are less than ten feet above the elevation of the lake, creating a high risk of ground water contamination. Specifically, in low laying areas it is almost impossible to avoid discharging inadequately treated effluent to groundwater (and therefore the lake) unless wastewater is pumped uphill for treatment, whether a mound or other type of above-ground systems are used.

There were 11 locations that indicated a possible point source of pollution. These locations were areas in a yard or near a road that indicated a point source.

Factors that determine the seriousness of identified point sources include:

1. the number of point source occurrences;
2. how often they flow;
3. the volume they contribute;
4. what pollutants they contribute;
5. their concentration, and subsequent loading they contribute.

To respond to the information gathered by the aerial survey, AWRL recommends the following actions by the Pelican River Watershed District:

1. All sites with likely on-site wastewater treatment facility problems should be inspected, and a plan developed to upgrade non-conforming facilities.

2. Wells should be sampled in areas that have a low elevation to determine if the aquifer is being contaminated.

3. Conduct a fecal monitoring program for the lake during the summer months.

4. Conduct site-specific soil evaluations in order to better understand the area's soil chemistry. Given the density of development in this area we should expect even more problems associated with phosphorus discharges. A basic evaluation could take random soil core samples from three to four drain fields with different soil types, and test for aluminum and iron to see if these elements are binding the phosphorus.

5. Verification of the existence and flow of inlets and outlets, along with the sampling to determine chemical content or concentration.

6. Incorporate the information gathered in step 5 into a hydrologic and nutrient Mass Balance analysis.

7. Analyze the slides to identify other (non-wastewater) influences or land use practices which may have enhanced or degraded water quality.

1996 LAKE DATA SUMMARY OF BIG FLOYD LAKE

Number of shoreline residences observed:	333
Estimated miles of shoreline analyzed	8.4
Average number of lots per mile	40
Average footage of shoreline per dwelling	133

In all cases where number of dwellings are presented it should be recognized that these statistics are estimates. Heavy tree cover, high density developments, or other factors create difficulties in distinguishing homes from outbuildings.

ANALYSIS SECTION

USER GUIDE

In characterizing the observations and interpretations of the evaluation of the aerial images, a summary table has been prepared for each slide or image. This table refers to each slide by its "map position", followed by a list of general comments (which would pertain to all residences within the photo), and by comments directly associated with each home or building.

The Map Position number listed in the summary table corresponds to the number drawn on the topographical map, and also to the number listed on the corresponding slides. There are at least two slides for each Map Position; a visible slide and an infrared slide, each representing the same area on the ground. On occasion there are more than one visible or infrared slide for a Map Position. This is usually done at the judgment of the pilot in order to ensure overlap of each set of slides, and that adequate views of all structures within a position are clearly distinguishable. In these instances a letter code is added to the Map Position number, and the text in the analysis refers to which slide is being used for the analysis.

There are frequently as many as five residences discussed at each Map Position. Residences are discussed from left to right as they are located on the slide. Because length of shoreline in each slide will overlap (50-100 feet) the next slide, some residences may be pictured twice. However, despite this overlap, each residence is only analyzed once. If one has trouble locating which residence is the first one analyzed in a particular slide, one may have to look at the previous slide to figure out which residence was the last one analyzed on that slide. Any general comments that refer to all residences are presented at the beginning of the Map Position discussion, followed by specific comments for each individual residence. Situations recommended for investigation are listed in the summary table.

It is the intent that the "investigation" section of the summary table be used as the basis for developing ground truthing plans and priorities. "Ground truthing" is essentially an on-site verification of concerns identified in the examination of the aerial images. One of the most effective uses of the aerial survey data is when a trained "ground truther" presents the slides and analysis to the property owner of each residence. Together these parties can identify whether concerns identified in the slides are significant.

getting the full value of the study. The two most common options for obtaining a person to perform the ground truthing are listed below:

1. A lake association can hire a person under contract.

2. One or more members of the lake association could perform the ground truthing, either under contract or under other mutually agreeable arrangements.

AWRL can be retained to provide training for either of the options previously mentioned. Training is important to ensure that the ground truthing results in accurate and complete documentation of the lakeshore situation. Also, the ground truthing experience should be cooperative and educational rather than threatening to the lakeshore owner.

A proposal outlining the costs of the ground truthing or ground truth training can be submitted to the Pelican River Watershed District upon request.

6

DEFINITIONS

"IR" refers to infrared.

It is important to remember that there may be more than one residence at every Map Position, so that pollution sources may be associated with one or multiple homes within that position. The color coded map on page 8 illustrates all map positions along with a color coded listing of the category of potential pollution source identified for that position. The colors may be interpreted using the following key:

1. Any problem with wastewater treatment	Red
2. All possible point sources	Green
3. No problems with on-site wastewater disposal detected	Black

The undeveloped map positions were not analyzed, and were marked with black.

The map gives the user a quick assessment of where and what the pollutant sources are, based on the conditions which were observed at each map position. For instance, the map positions colored in red illustrate that there is at least one suspected wastewater treatment influence based on the criteria outlined in the Analysis Criteria section on page 3.

7

MAP POSITION
1

Map positions one through four should be investigated for soil type. The dense growth of aquatic vegetation throughout this entire area is a likely indicator of failing septic system(s).

1B

Light colored residence with a dark colored roof.

Investigate:

- the performance and compliance of past and present septic systems. The wispy blue area along the shoreline by the beach area (seen as blue in IR slide 1B) may be a surfactant, which is a likely indicator of a failing septic system, or it could be a result of the large amount of runoff contributed by this area.

Dark colored residence with a dark colored roof.

Investigate:

- the location, as well as the performance and compliance of past and present septic systems. The circular patterns in the lakeside lawn (seen as bright red in IR slide 1B) are likely indicators of a failing septic system.

MAP POSITION
2

Map positions one through four should be investigated for soil type. The dense growth of aquatic vegetation throughout this entire area is a likely indicator of failing septic system(s).

Light colored residence with a light colored roof.

Investigate:

- the performance and compliance of past and present septic systems. The dense growth of aquatic vegetation throughout this entire area is a likely indicator of failing septic system(s).

Large dark colored residence with a dark colored roof.

Investigate:

- the performance and compliance of past and present septic systems. The dense growth of aquatic vegetation throughout this entire area is a likely indicator of failing septic system(s).

MAP POSITION
3

Map positions one through four should be investigated for soil type. The dense growth of aquatic vegetation throughout this entire area is a likely indicator of failing septic system(s).

Light colored residence with a light colored roof and a sandy beach.

Investigate:

- the performance and compliance of past and present septic systems. The dense growth of aquatic vegetation throughout this entire area is a likely indicator of failing septic system(s).

Light colored residence with a light colored roof and a dark colored lakeside deck.

Investigate:

- the performance and compliance of past and present septic systems. The dense growth of aquatic vegetation throughout this entire area is a likely indicator of failing septic system(s).

Dark colored residence with a dark colored roof and a purple trampoline.

Investigate:

- the performance and compliance of past and present septic systems. The dense healthy aquatic vegetation along the shoreline (seen as bright red in the IR slide) is a likely indicator of a failing septic system. Alternatively, this may be a result of nutrient laden runoff from the two lakeside gardens.

MAP POSITION
4

Map positions one through four should be investigated for soil type. The dense growth of aquatic vegetation throughout this entire area is a likely indicator of failing septic system(s).

Greyish residence with a greyish roof.

Investigate:

- the location, as well as performance of past and present septic systems with respect to septic system setback regulations from the ordinary high water level and neighboring wells.

Dark colored residence in the trees with a dark colored roof.

Investigate:

- the possible hose extending into the lake in front of the steps leading down to the beach to determine whether it is discharging into the lake.

MAP POSITION
5

Light colored residence with a light colored roof and a blue dock.

Investigate:

- the location, as well as performance of past and present septic systems with respect to septic system setback regulations from the ordinary water level and neighboring wells.

Red residence with a white roof.

Investigate:

- the location, as well as performance of past and present septic systems with respect to septic system setback regulations from the ordinary high water level and neighboring wells. The healthy vegetation in the lake along the shoreline under the trees (seen as bright red in the IR slide) is a likely indicator of a failing septic system. Alternatively, this could be a result of nutrient laden runoff from the flower beds along shoreline and/or runoff from the cleared lot.

The cleared lot with a truck parked at it.

Investigate:

- If this lot is used for seasonal camping. Ensure proper disposal of all wastewater.

Dark colored residence with a dark colored roof and a blue pontoon boat.

Investigate:

- the location, as well as performance of past and present septic systems with respect to septic system setback regulations from the ordinary high water level and neighboring wells.

MAP POSITION
6

Two tone (blue and white) residence with a light colored roof.

Investigate:

- the location, as well as performance of past and present septic systems with respect to septic system setback regulations from the ordinary high water level and neighboring wells;
- the trench extending into the lake. The trail extending from the residence to the trench (seen as red in the IR slide) may be the location of a pipe or a possible drainage trench.

Dark colored residence with a dark colored roof.

Investigate:

- the location, as well as performance of past and present septic systems with respect to septic system setback regulations from the ordinary high water level.

White residence.

Investigate:

- the performance and compliance of past and present septic systems with respect to the age of the residence, as well as verify compliance of proper disposal of the RV's septic.

MAP POSITION
7

Point source.

Investigate:

- the source, nutrient concentration and flow of water from the point source draining the wetland. The very healthy vegetation throughout the wetland, as well as at the mouth of the point source may be the result of nutrient laden runoff from the upstream agricultural fields (seen in the extra IR slide).

Recommendations:

- Conduct a year long hydraulic and nutrient budget of the point source.

MAP POSITION
8

Five residences; from the light colored residence with a dark colored roof and attached garage, to the brown residence with a light colored roof and a dark colored garage.

Investigate:

- the location, as well as the performance and compliance of past and present septic systems, with respect to septic system setback regulations from the ordinary high water level. In addition, proximity of the septic system to neighboring wells and of the ground surface to the water table should be investigated.

MAP POSITION
9

Four residences; from the flagpole to the big sandy beach.

Investigate:

- the location, as well as the performance and compliance of past and present septic systems, with respect to septic system setback regulations from the ordinary high water level. In addition, proximity of the septic system to neighboring wells and of the ground surface to the water table should be investigated;
- the possible hoses; one which is located below the flag pole, and the other which is on the north corner of the property associated with the last residence, to determine whether either hose is discharging into the lake.

MAP POSITION
10

Three large tan residences.

Investigate:

- the location, as well as the performance and compliance of past and present septic systems, with respect to septic system setback regulations from the ordinary high water level. In addition, proximity of the septic system to neighboring wells and of the ground surface to the water table should be investigated.

MAP POSITION
11

Small red residence with a light colored roof.

Investigate:

- the location, as well as performance of past and present septic systems with respect to septic system setback regulations from the ordinary high water level and neighboring wells;

Large dark colored residence with a flat roof.

Investigate:

- the possible hose extending into the lake between the "U" shaped dock below the steps leading down to the lake to determine whether it is discharging into the lake.

MAP POSITION
12

Light colored residence with a light colored roof and a brick chimney.

No problems with on-site wastewater disposal were detected.

Residence with a green dock and a pontoon boat.

No problems with on-site wastewater disposal were detected.

Residence in the trees with a green dock and an overturned boat on shore.

Investigate:

- the performance and compliance of past and present septic systems. The apparent bloom along the shoreline may be cladophora, an algae that is indicative of high levels of phosphorus. The bloom is seen as bright red in the IR slide, and is a likely indicator of a failing septic system.

MAP POSITION
13

The two larger light colored residences with light colored roofs.

Investigate:

- the location, as well as performance of past and present septic systems with respect to septic system setback regulations from the ordinary high water level and neighboring wells.

The dark colored residence in the trees with no docks.

Investigate:

- the performance and compliance of past and present septic systems. The dense healthy aquatic vegetation along the shoreline (seen as red in the IR slide) is a likely indicator of a failing septic system.

MAP POSITION
14

Blue residence with a blue dock.

No problems with on-site wastewater disposal were detected.

The light colored and red residence with a dark colored roof, along with the light colored residence with a light colored roof and a lakeside deck.

Investigate:

- the location, as well as performance of past and present septic systems with respect to septic system setback regulations from the ordinary high water level. The bright red area in the IR slide along shoreline between these two residences may be cladophora, an algae which is indicative of high phosphorus levels, and is a likely indicator of a failing septic system(s).

Large white residence with a long reddish colored dock.

Investigate:

- the location, as well as performance of past and present septic systems with respect to septic system setback regulations from the ordinary high water level.

MAP POSITION
15

Brown residence with a brown roof.

No problems with on-site wastewater disposal were detected.

Dark colored residence in the trees with a tan colored roof.

No problems with on-site wastewater disposal were detected.

Dark colored residence in the trees with a light colored roof.

Investigate:

- the location, as well as performance of past and present septic systems with respect to septic system setback regulations from the wetland area.

MAP POSITION
16

No problems with on-site wastewater disposal were detected.

MAP POSITION
17

The lot with the two parked campers.

Investigate:

- the method used for wastewater treatment. It is probable that they are using an outhouse.

Light colored residence with a light colored roof and an overturned boat on shore.

Investigate:

- the location, as well as performance of past and present septic systems with respect to septic system setback regulations from the ordinary high water level and neighboring wells.

Light colored residence with a light colored roof with a "L" shaped dock.

Investigate:

- the location, as well as performance of past and present septic systems with respect to septic system setback regulations from the ordinary high water level and neighboring wells;
- the possible hose extending into the lake next to the dock to determine whether it is discharging into the lake.

Two residences in the trees with tan colored roofs.

Investigate:

- the location, as well as performance of past and present septic systems with respect to septic system setback regulations from the ordinary high water level and neighboring wells.

MAP POSITION
18

Residence in the trees with a light colored roof and a "L" shaped dock.

Investigate:

- the location, as well as performance of past and present septic systems with respect to septic system setback regulations from the ordinary high water level and neighboring wells.

Barn style residence with a straight dock.

Investigate:

- the location, as well as performance of past and present septic systems with respect to septic system setback regulations from the ordinary high water level and neighboring wells. The patch of healthy grass between the residence and the road (seen as red in the IR slide) is a likely indicator of a failing septic system.

Residence with the "L" shaped dock with two jet skis parked at it.

Investigate:

- the location, as well as performance of past and present septic systems with respect to septic system setback regulations from the ordinary high water level and neighboring wells.

Multi-layered residence with a straight dock and paved driveway.

Investigate:

- the location, as well as performance of past and present septic systems with respect to septic system setback regulations from the ordinary high water level and neighboring wells. The healthy vegetation in the lake in front of this residence (seen as red in the IR slide) is a likely indicator of a possible failing septic system.

Lot with a boat house.

Investigate:

- the land uses of this lot, and confirm the method used for wastewater disposal. The healthy grass in the lawn adjacent to the boat house on the northeast side is a likely indicator of a failing septic system (if applicable).

Residence in the trees with a "L" shaped dock.

No problems with on-site wastewater disposal were detected.

MAP POSITION
19

Residence with a canoe on shore.

Investigate:

- the location, as well as performance of past and present septic systems with respect to septic system setback regulations from the ordinary high water level and neighboring wells.

Residence in the trees with no dock.

Investigate:

- the location, as well as performance of past and present septic systems with respect to septic system setback regulations from the ordinary high water level and neighboring wells.

Bluish residence with a "L" shaped dock.

Investigate:

- the location, as well as performance of past and present septic systems with respect to septic system setback regulations from the ordinary high water level and neighboring wells.

Light colored residence with a slide on the beach.

Investigate:

- the location, as well as performance of past and present septic systems with respect to septic system setback regulations from the ordinary high water level and neighboring wells. The rectangular shaped patch of healthy grass in the lawn behind the residence near the road (seen as bright red in the IR slide) is a likely indicator of a failing septic system.

MAP POSITION
20

Red residence with a white roof.

Investigate:

- the location, as well as performance of past and present septic systems with respect to septic system setback regulations from the ordinary high water level and neighboring wells.

Light colored residence with a light colored roof.

Investigate:

- the location, as well as performance of past and present septic systems with respect to septic system setback regulations from the ordinary high water level and neighboring wells.

Red residence with a dark colored roof.

Investigate:

- the location, as well as performance of past and present septic systems with respect to septic system setback regulations from the ordinary high water level and neighboring wells.

Yellow residence with a flat light colored roof.

Investigate:

- the location, as well as performance of past and present septic systems with respect to septic system setback regulations from the ordinary high water level.

MAP POSITION
21

Dark colored residence with a white flat roof and a "L" shaped red dock.

Investigate:

- the location, as well as performance of past and present septic systems with respect to septic system setback regulations from the ordinary high water level and neighboring wells.

Dark colored residence in the trees with a dark colored roof and a small stralght dock.

Investigate:

- the location, as well as performance of past and present septic systems with respect to septic system setback regulations from the ordinary high water level and neighboring wells.

Residence in the trees near the shoreline with a light colored roof.

Investigate:

- the location, as well as performance of past and present septic systems with respect to septic system setback regulations from the ordinary high water level and neighboring wells.

Residence further inland with a dark colored roof and a large lakeside deck.

No problems with on-site wastewater disposal were detected.

Light colored "U" shaped residence with a long paved driveway.

Investigate:

- the location, as well as performance of past and present septic systems with respect to septic system setback regulations from the ordinary high water level and neighboring wells.

Small dark colored residence near the shoreline.

Investigate:

- the location, as well as performance of past and present septic systems with respect to septic system setback regulations from the ordinary high water level and neighboring wells;
- and verify compliance of proper disposal of the RV's septic.

White residence with the white deck and a sandy beach area.

Investigate:

- the location, as well as performance of past and present septic systems with respect to septic system setback regulations from the ordinary high water level. The algae on the rocks along shoreline (seen as red in the IR slide) may be cladophora, an algae that is indicative of high phosphorus levels, and is a likely indicator of a failing septic system.

MAP POSITION
22

Light colored residence with a red deck.

No problems with on-site wastewater disposal were detected.

Three other residences.

Investigate:

- the location, as well as the performance and compliance of past and present septic systems, with respect to septic system setback regulations from the ordinary high water level and neighboring wells and close proximity of the ground surface to the water table. The dense narrow band along with a circular spot of dark vegetation along this shoreline is a likely indicator of a failing septic system(s).

MAP POSITION
23

No problems with on-site wastewater disposal were detected.

MAP POSITION
24

No problems with on-site wastewater disposal were detected.

MAP POSITION
25

No problems with on-site wastewater disposal were detected.

MAP POSITION
26

No problems with on-site wastewater disposal were detected.

MAP POSITION
27

No problems with on-site wastewater disposal were detected.

MAP POSITION
28

No problems with on-site wastewater disposal were detected.

MAP POSITION
29

White residence with a dark colored roof.
Investigate:
- the performance and compliance of past and present septic systems with respect to the likely proximity of ground surface to the water table.

MAP POSITION
30

No problems with on-site wastewater disposal were detected.

MAP POSITION
31

Large dark colored residence with a dark colored roof.
Investigate:
- the performance and compliance of past and present septic systems. The dense healthy vegetation along the entire shoreline (seen as red in the IR slide) is a likely indicator of a failing septic system;
- the trench extending from the residence to the lake. This may be a drainage ditch/point source.

MAP POSITION
32

No problems with on-site wastewater disposal were detected.

Investigate:
- the source, nutrient concentration and flow of water from the possible point source seen on the south side of the wetland.

Recommendations:
- Conduct a year long hydraulic and nutrient budget of the possible point source.

MAP POSITION
33

Tan colored residence.
Investigate:
- the location, as well as the performance and compliance of the past and present septic systems. The healthy grass in the lawn on the north side of the residence with a plume of healthy grass extending from this location to the lake (seen as red in the IR slide) is a likely indicator of a failing septic system.

MAP POSITION
34

No problems with on-site wastewater disposal were detected.

MAP POSITION
35

No problems with on-site wastewater disposal were detected.

Point source
Investigate:
- the source, nutrient concentration and flow of water from the point source.

Recommendations:
- Conduct a year long hydraulic and nutrient budget of the point source.

MAP POSITION
36

No problems with on-site wastewater disposal were detected.

MAP POSITION
36X

Investigate:
- the exact location lake as well as the extent of influence these dumps have on the lake

MAP POSITION
37

Small red residence or cabin.
Investigate:
- the performance and compliance of past and present septic systems with respect to the likely proximity of ground surface to the water table.

MAP POSITION
38

No problems with on-site wastewater disposal were detected.

MAP POSITION
40

Light colored residence with a rock rip-rap shoreline.

No problems with on-site wastewater disposal were detected.

MAP POSITION
41

41
Two residences, one dark colored the other light colored.
Investigate:
- the performance and compliance of past and present septic systems with respect to the likely proximity of ground surface to the water table.

Dark colored residence in the trees further inland.

No problems with on-site wastewater disposal were detected.

MAP POSITION
42

Red residence.
Investigate:
- the performance and compliance of past and present septic systems. The dense area of dark vegetation along the shoreline (seen in the IR slide) on the west side of the dock is a likely indicator of a failing septic system.

Smaller light colored residence.

No problems with on-site wastewater disposal were detected.

MAP POSITION
43

Two residences, one reddish the other yellow.
Investigate:
- the performance and compliance of past and present septic systems with respect to the likely proximity of ground surface to the water table. The area of healthy grass on the east side of the yellow residence's lake side lawn (seen as red in the IR slide) is a likely indicator of a failing septic system.

MAP POSITION
44

No problems with on-site wastewater disposal were detected.

MAP POSITION
45

No problems with on-site wastewater disposal were detected.

Point source.
Investigate:
- the source, nutrient concentration and flow of water from the point source.

Recommendations:
- Conduct a year long hydraulic and nutrient budget of the point source.

MAP POSITION
46

No problems with on-site wastewater disposal were detected.

MAP POSITION
47

Yellow residence.
Investigate:
- the performance and compliance of past and present septic systems with respect to the likely proximity of ground surface to the water table.

MAP POSITION
48

No problems with on-site wastewater disposal were detected.

MAP POSITION
49

No problems with on-site wastewater disposal were detected.

Big Floyd-Little Floyd Channel.
Investigate:
- the source, nutrient concentration and flow of water from the point source.

Recommendations:
- Conduct a year long hydraulic and nutrient budget of the point source.

MAP POSITION
50

Three mobile homes.
Investigate:
- the performance and compliance of past and present septic systems with respect to the likely proximity of ground surface to the water table.

MAP POSITION
51

Two residences on the northeast side of the road.
Investigate:
- the performance and compliance of past and present septic systems with respect to the likely proximity of ground surface to the water table.

MAP POSITION
52

White residence with the dock.
Investigate:
- the location, as well as the performance and compliance of past and present septic systems, with respect to septic system setback regulations from the ordinary high water level and the proximity of the ground surface to the water table.

MAP POSITION
53

No problems with on-site wastewater disposal were detected.

MAP POSITION
54

No problems with on-site wastewater disposal were detected.

MAP POSITION
55

No problems with on-site wastewater disposal were detected.

MAP POSITION
56

Dark colored residence.

No problems with on-site wastewater disposal were detected.

MAP POSITION
57

No problems with on-site wastewater disposal were detected.

MAP POSITION
58

Light colored residence with a dark colored roof.

No problems with on-site wastewater disposal were detected.

MAP POSITION
59

Two residences at this map position.

No problems with on-site wastewater disposal were detected.

MAP POSITION
60

Four residences two reddish and two white.

Investigate:

- the location, as well as the performance and compliance of past and present septic systems, with respect to septic system setback regulations from the ordinary high water level. In addition, proximity of the septic system to neighboring wells and of the ground surface to the water table should be investigated.

MAP POSITION
61

Two residences, the first one with the blue roll-a-dock.

Investigate:

- the location, as well as the performance and compliance of past and present septic systems, with respect to septic system setback regulations from the ordinary high water level. In addition, proximity of the septic system to neighboring wells and of the ground surface to the water table should be investigated.

Two residences on top of the hill, the first with a boat house and the other with steep stairs leading down to the lake.

Investigate:

- the performance and compliance of past and present septic systems. The dense area of dark vegetation along the shoreline (seen in all slides) is a likely indicator of a failing septic system(s).

MAP POSITION
62

62A
Dark colored residence with a dark colored roof on top of the hill.

No problems with on-site wastewater disposal were detected.

If not already in place, a small community type wastewater treatment system is likely the most efficient and economical method of controlling wastewater discharges. Wells in this area should be sampled because high residential density increases risk of well contamination.

62B
Nine residences; the first one has a flat black roof, and the last one is greenish colored next to a large dark colored residence with greenhouse style windows. There are also two guest cabins or second tier development located behind the third residence from the left of this slide.

Investigate:

- the location, as well as the performance and compliance of past and present septic systems, with respect to septic system setback regulations from the ordinary high water level. In addition, proximity of the septic system to neighboring wells and of the ground surface to the water table should be investigated. The dense line or area of dark vegetation along this entire shoreline is a likely indicator of failing septic system(s).

MAP POSITION
63

Four residences, from the residence with the "V" shaped beach area down to the red residence.

Investigate:

- the location, as well as the performance and compliance of past and present septic systems, with respect to septic system setback regulations from the ordinary high water level. In addition, proximity of the septic system to neighboring wells and of the ground surface to the water table should be investigated. The dense line or area of dark vegetation along this entire shoreline is a likely indicator of failing septic system(s).

MAP POSITION
64

Four residences, from the light colored residence with a light colored roof to the dark colored residence with a light colored slanted roof.

Investigate:

- the location, as well as the performance and compliance of past and present septic systems, with respect to septic system setback regulations from the ordinary high water level. In addition, proximity of the septic system to neighboring wells and of the ground surface to the water table should be investigated. The dense line or area of dark vegetation along this entire shoreline is a likely indicator of failing septic system(s).

MAP POSITION
65

Four residences, from the white residence with a dark colored roof and a checkerboard patio to the small square white residence with a light colored roof.

Investigate:

- the location, as well as the performance and compliance of past and present septic systems, with respect to septic system setback regulations from the ordinary high water level. In addition, proximity of the septic system to neighboring wells and of the ground surface to the water table should be investigated. The dense line or area of dark vegetation along this entire shoreline is a likely indicator of failing septic system(s).

MAP POSITION
66

Four residences; from the rectangular white residence to the blue residence.

Investigate:

- the location, as well as the performance and compliance of past and present septic systems, with respect to septic system setback regulations from the ordinary high water level. In addition, proximity of the septic system to neighboring wells and of the ground surface to the water table should be investigated. The dense line or area of dark vegetation along this entire shoreline is a likely indicator of failing septic system(s).

MAP POSITION
67

Map positions 67-70 are likely influenced by the golf course which is located up-gradient from the subject properties. Golf courses are commonly associated with accelerated use of fertilizers and pesticides. Using a mobile home as an index for distance, it appears that the subject shoreline ranges from 100-150 feet from the golf course. This distance is unlikely to be adequate to mitigate the effects of turf management activities associated with golf course operations. A likely example of golf course influences may be observed in slide #67B as an algae bloom seen in the golf course water hazard.

Eight residences, from the light colored residence with a possible guest cabin down to the residence in the trees with a dark colored roof and a green roll-a-dock.

Investigate:

- the location, as well as the performance and compliance of past and present septic systems, with respect to septic system setback regulations from the ordinary high water level. In addition, proximity of the septic system to neighboring wells and of the ground surface to the water table should be investigated. The dense line or area of dark vegetation along this entire shoreline is a likely indicator of failing septic system(s).

MAP POSITION
68

See golf course general comments listed under Map Position 67.
If not already in place, a small community type wastewater treatment system is likely the most efficient and economical method of controlling wastewater discharges. Wells in this area should be sampled because high residential density increases risk of well contamination.

Four residences, dark colored, mobile home, turquoise, and a light colored residence.

Investigate:

- the location, as well as the performance and compliance of past and present septic systems, with respect to septic system setback regulations from the ordinary high water level. In addition, proximity of the septic system to neighboring wells and of the ground surface to the water table should be investigated. The dense line or area of dark vegetation along this entire shoreline is a likely indicator of failing septic system(s).

MAP POSITION
69

See golf course general comments listed under Map Position 67.
If not already in place, a small community type wastewater treatment system is likely the most efficient and economical method of controlling wastewater discharges. Wells in this area should be sampled because high residential density increases risk of well contamination.

Yellow residence.

Investigate:

- the performance and compliance of past and present septic systems, with respect to the likely proximity of ground surface to the water table. The dense circular area of dark vegetation (seen in the IR slide) at the end of the dock is a likely indicator of a failing septic system.

Three residences; from the white residence with a red garage to the residence in the trees with a red dock.

Investigate:

- the location, as well as the performance and compliance of past and present septic systems, with respect to septic system setback regulations from the ordinary high water level. In addition, proximity of the septic system to neighboring wells and of the ground surface to the water table should be investigated. The dense line or area of dark vegetation along this entire shoreline is a likely indicator of failing septic system(s).

MAP POSITION
70

See golf course general comments listed under Map Position 67.
If not already in place, a small community type wastewater treatment system is likely the most efficient and economical method of controlling wastewater discharges. Wells in this area should be sampled because high residential density increases risk of well contamination.

Eight residences; from the dark colored residence with a long narrow garage to the second tier residence which is behind the large white two story residence with a dark colored roof.

Investigate:

- the location, as well as the performance and compliance of past and present septic systems, with respect to septic system setback regulations from the ordinary high water level. In addition, proximity of the septic system to neighboring wells and of the ground surface to the water table should be investigated. The dense line or area of dark vegetation along this entire shoreline is a likely indicator of failing septic system(s).

MAP POSITION
71

A small community type wastewater treatment system should be implemented if not already in place, a small community type wastewater treatment system is likely the most efficient and economical method of controlling wastewater discharges. Wells in this area should be sampled because high residential density increases risk of well contamination.

Two small light colored residences with light colored roofs.

Investigate:

- the location, as well as the performance and compliance of past and present septic systems, with respect to septic system setback regulations from the ordinary high water level. In addition, proximity of the septic system to neighboring wells and of the ground surface to the water table should be investigated. The dense line or area of dark vegetation along this entire shoreline is a likely indicator of failing septic system(s).

Dark colored residence with a dark colored roof.

Investigate:

- the location, as well as the performance and compliance of past and present septic systems, with respect to septic system setback regulations from the ordinary high water level and the proximity of the ground surface to the water table. The dense vegetation out from the shoreline is a likely indicator of failing septic system(s).

Dark colored residence with a light colored roof.

Investigate:

- the location, as well as the performance and compliance of past and present septic systems, with respect to septic system setback regulations from the ordinary high water level. In addition, proximity of the septic system to neighboring wells and of the ground surface to the water table should be investigated. The dense vegetation out from the shoreline is a likely indicator of failing septic system(s).

The narrow white residence along with the white residence with a red garage and small guest cabin along the shoreline.

Investigate:

- the performance and compliance of past and present septic systems for all living quarters, with respect to the likely proximity of ground surface to the water table. The dense vegetation out from the shoreline is a likely indicator of failing septic system(s).

MAP POSITION
72

Two light colored residences with light colored roofs.

Investigate:

- the performance and compliance of past and present septic systems with respect to the likely proximity of ground surface to the water table. The two narrow bands of vegetation in the lake in front of each residence are a likely indicator of failing septic system(s).

The four residences which are further inland and along the road appear to have been built on very low elevation, suggesting a minimal separation from ground water. If this is true, than many land uses -- from lawn maintenance to wastewater discharge -- are likely to have a direct influence on the lake.

MAP POSITION
73

Brown residence.

Investigate:

- the performance and compliance of past and present septic systems with respect to the likely proximity of ground surface to the water table. The narrow band of vegetation in the lake in front of the residence is a likely indicator of a failing septic system.

The three light colored residences with white, blue, and green docks.

Investigate:

- the location, as well as the performance of past and present septic systems with respect to septic system setback regulations from the ordinary high water level and neighboring wells and the proximity of the ground surface to the water table. The dense patches of dark vegetation in between the docks are a likely indicator of failing septic system(s).

Dark colored residence in the trees with a red dock.

Investigate:

- the performance and compliance of past and present septic systems with respect to the likely proximity of ground surface to the water table. The two dense patches of dark vegetation on each side of the dock are likely indicators of failing septic system(s).

Twelve mobile homes.

Investigate:

- the type of wastewater treatment system utilized by this trailer park. No signs of existing on-site wastewater treatment capacity are visible in this image. Specifically, no aeration pipes, sewage lagoons, or other signs of conventional wastewater treatment technology were apparent in the slides, so it is questionable as to whether this development has wastewater treatment which is compliant with state/county codes and regulations. The proximity of the wetland immediately adjacent to the trailer park exacerbates this concern since any wastewater facility which fails will likely discharge into Big Floyd Lake with a minimal amount of treatment.

Main building or residence associated with the trailer park.

Investigate:

- the performance and compliance of past and present septic systems. The area of healthy grass in the lawn on the south side of the main building or residence is a likely indicator of a failing septic system.

MAP POSITION
74

"L" shaped light colored residence.

Investigate:

- the location, as well as the performance and compliance of past and present septic systems with respect to the proximity of the ground surface to the water table. The dense patch of dark vegetation in the lake in front of this residence is a likely indicator of a failing septic system.

The old foundation seen in the slide taken this fall.

Investigate:

- past and present land use, if there was a septic system associated with this old foundation ensure proper abandonment.

Light colored residence with a "L" shaped roll-a-dock.

Investigate:

- the performance and compliance of past and present septic systems with respect to the likely proximity of ground surface to the water table. The narrow band of vegetation in the lake in front of the residence is a likely indicator of a failing septic system.

MAP POSITION
75

New residence under construction.

Investigate:

- the performance and compliance of past and present septic systems with respect to the likely proximity of ground surface to the water table. The circular patch of vegetation in the lake in front of the residence is a likely indicator of a failing septic system.

Three residences, two dark colored with a yellow residence in between them.

Investigate:

- the location, as well as the performance of past and present septic systems with respect to septic system setback regulations from the ordinary high water level and neighboring wells and the proximity of the ground surface to the water table. The dense patches of dark vegetation in between the docks are likely indicators of failing septic system(s).

MAP POSITION
76

If not already in place, a small community type wastewater treatment system is likely the most efficient and economical method of controlling wastewater discharges. Wells in this area should be sampled because high residential density increases risk of well contamination.

Five residences; from the red "barn" style residence to the residence with the flat dark colored roof.

Investigate:

- the location, as well as the performance of past and present septic systems with respect to septic system setback regulations from the ordinary high water level and neighboring wells and the proximity of the ground surface to the water table. The dense patches of dark vegetation in between the docks are likely indicators of failing septic system(s).

Two mobile homes across the road.

Investigate:

- the location, as well as the performance of past and present septic systems with respect to the proximity of the ground surface to the water table. The white mobile home appears to have a mound system behind it. Investigate whether or not it is used by both mobile homes. If not, investigate what type of wastewater treatment system is used for the blue mobile home. The very healthy grass in the lawn below the mound (seen as bright reed in the IR slide) is very typical of a failing mound system.

MAP POSITION
77

If not already in place, a small community type wastewater treatment system is likely the most efficient and economical method of controlling wastewater discharges. Wells in this area should be sampled because high residential density increases risk of well contamination.

Two light colored residences, the first rectangular shaped and the second is "L" shaped.

Investigate:

- the location, as well as the performance of past and present septic systems with respect to septic system setback regulations from the ordinary high water level and neighboring wells and the proximity of the ground surface to the water table. The dense patch of dark vegetation in the lake in front of these two residences is a likely indicator of a failing septic system(s).

The dark colored residence and yellow residence.

Investigate:

- the location, as well as the performance and compliance of past and present septic systems, with respect to septic system setback regulations from the ordinary high water level. In addition, proximity of the septic system to neighboring wells and of the ground surface to the water table should be investigated.

Light colored residence with a dark colored roof.

This residence has a mound system (seen in slide 77B) which appears to meet all regulatory requirements. This type of system is generally recommended in areas of low elevation in preventing septic seepage into the ground water.

MAP POSITION
78

Because of the high residential density along this entire point, -- Map Positions 78-82 -- a small community type wastewater treatment system is likely the most efficient and economical method of controlling wastewater discharges. Wells in this area should be sampled because high residential density increases risk of well contamination.

Reddish residence along with the light colored residence with the boat house.

Investigate:

- the performance and compliance of past and present septic systems with respect to the likely proximity of ground surface to the water table.

New residence under construction.

Investigate:

- whether the septic system has been properly upgraded to meet the needs of the larger residence. In the slide dated 7-31-96 this was a small (one to two bedroom) residence. In the slide dated 10-28-96 it is almost three times larger, with possibly four bedrooms.

Yellow residence with a dark colored roof.

Investigate:

- the performance and compliance of past and present septic systems with respect to the likely proximity of ground surface to the water table.

MAP POSITION
79

Because of the high residential density along this entire point, -- Map Positions 78-82 -- a small community type wastewater treatment system is likely the most efficient and economical method of controlling wastewater discharges. Wells in this area should be sampled because high residential density increases risk of well contamination.

Four residences; from the red residence to the light colored residence with the shed next to a cement patio near the lake.

Investigate:

- the location, as well as the performance and compliance of past and present septic systems, with respect to septic system setback regulations from the ordinary high water level. In addition, proximity of the septic system to neighboring wells and of the ground surface to the water table should be investigated.

MAP POSITION
80

Because of the high residential density along this entire point, -- Map Positions 78-82 -- a small community type wastewater treatment system is likely the most efficient and economical method of controlling wastewater discharges. Wells in this area should be sampled because high residential density increases risk of well contamination.

Four residences; from the tan residence with a dark colored roof to the residence at the end of the point with a light colored roof.

Investigate:

- the location, as well as the performance and compliance of past and present septic systems, with respect to septic system setback regulations from the ordinary high water level and the proximity of the ground surface to the water table.

MAP POSITION
81

Because of the high residential density along this entire point, -- Map Positions 78-82 -- a small community type wastewater treatment system is likely the most efficient and economical method of controlling wastewater discharges. Wells in this area should be sampled because high residential density increases risk of well contamination.

Tan colored residence on top of the hill.

No problems with on-site wastewater disposal were detected.

Mobile home.
Investigate:
- the location, as well as the performance and compliance of past and present septic systems, with respect to septic system setback regulations from the ordinary high water level and the proximity of the ground surface to the water table.

Light colored two story residence with a flat roof.
Investigate:
- the performance and compliance of past and present septic systems with respect to the likely proximity of ground surface to the water table.

MAP POSITION
82

Because of the high residential density along this entire point, -- Map Positions 78-82 -- a small community type wastewater treatment system is likely the most efficient and economical method of controlling wastewater discharges. Wells in this area should be sampled because high residential density increases risk of well contamination.

Ten residences; from the reddish residence with the terraced landscaping on the lakeside of the residence seen in slide 82A to the Light colored residence in the small bay with a "L" shaped dock seen in slide 82B.
Investigate:
- the location, as well as the performance and compliance of past and present septic systems, with respect to septic system setback regulations from neighboring wells and the proximity of the ground surface to the water table. The dense plumes of dark vegetation near the shore in front of both the first three residences, as well as the last three residences are likely indicators of failing septic system(s).

MAP POSITION
83

83A
Four residences; from the residence in the trees with a light colored roof and the landscaping along the shoreline to the small light colored residence with a "L" shaped dock.
Investigate:
- the location, as well as the performance of past and present septic systems with respect to septic system setback regulations from neighboring wells. The dense band of dark vegetation along the shoreline in front of these four residences is a likely indicator of a failing septic system(s).

83B
Light colored residence in the trees with a dark colored roof.
Investigate:
- the performance and compliance of past and present septic systems with respect to the likely proximity of ground surface to the water table.

Light colored residence with a side walk back to a possible guest cabin.
Investigate:
- the location, as well as the performance and compliance of past and present septic systems, with respect to septic system setback regulations from the ordinary high water level and the proximity of the ground surface to the water table.

Dark colored residence with a steep peaked roof.
Investigate:
- the location, as well as the performance and compliance of past and present septic systems, with respect to septic system setback regulations from the ordinary high water level. In addition, proximity of the septic system to neighboring wells and of the ground surface to the water table should be investigated.

MAP POSITION
84

84A
Small square light colored residence in the trees with a "U" shaped dock along with the larger light colored residence.

Investigate:

- the location, as well as the performance and compliance of past and present septic systems, with respect to septic system setback regulations from the ordinary high water level. In addition, proximity of the septic system to neighboring wells and of the ground surface to the water table should be investigated. The dense band of dark vegetation along the shoreline, as well as the larger patch next to the dock of the larger residence are likely indicators of failing septic systems.

84B
Red residence.

Investigate:

- the performance and compliance of past and present septic systems with respect to the likely proximity of ground surface to the water table.

Blue residence further inland along the road.

Investigate:

- the performance and compliance of past and present septic systems with respect to the likely proximity of ground surface to the water table.

Three residences; from the blue residence with a short red dock to the residence with a "L" shaped dock and a half circle sandy fire pit area along the shoreline.

Investigate:

- the location, as well as the performance and compliance of past and present septic systems, with respect to septic system setback regulations from the ordinary high water level. In addition, proximity of the septic system to neighboring wells and of the ground surface to the water table should be investigated. The dense band of dark vegetation along the shoreline is a likely indicator of failing septic system(s).

MAP POSITION
85

The red residence, yellow residence, and the greyish residence.

Investigate:

- the location, as well as the performance and compliance of past and present septic systems, with respect to septic system setback regulations from the ordinary high water level. In addition, proximity of the septic system to neighboring wells and of the ground surface to the water table should be investigated. The dense band of dark vegetation along the shoreline is a likely indicator of failing septic system(s).

Five residences; from the dark colored residence with a light colored roof and green dock to the light colored residence with the "L" shaped dock just before the straight red dock.

Investigate:

- the location, as well as the performance and compliance of past and present septic systems, with respect to septic system setback regulations from the ordinary high water level. In addition, proximity of the septic system to neighboring wells and of the ground surface to the water table should be investigated.

MAP POSITION
86

The four residences with the four straight red docks in a row.

Investigate:

- the location, as well as the performance and compliance of past and present septic systems, with respect to the proximity of the ground surface to the water table. The dense patches of dark vegetation around the docks are likely indicators of failing septic system(s).

Three residences, the white residence, red residence, and the Dark colored residence with a dark colored roof.

Investigate:

- the location, as well as the performance and compliance of past and present septic systems, with respect to the proximity of the ground surface to the water table.

MAP POSITION
87

Six residences; from the light colored steep roofed residence to the light colored residence with the three different level four sided roofs which includes one second tier residence.

Investigate:

- the location, as well as the performance and compliance of past and present septic systems, with respect to the proximity of the ground surface to the water table.

MAP POSITION
88

Six residences, from the blue residence with the new garage under construction down to the large blue residence with a blue garage.

Investigate:

- the location, as well as the performance and compliance of past and present septic systems, with respect to the proximity of the ground surface to the water table.

MAP POSITION
89

Long narrow residence with a dark colored roof.

Investigate:

- the location, as well as the performance and compliance of past and present septic systems, with respect to septic system setback regulations from the ordinary high water level. In addition, proximity of the septic system to neighboring wells and of the ground surface to the water table should be investigated.

Six residences; from the light colored residence with a rectangular cement driveway to the pink colored residence with a red canoe on shore (seen as yellow in the IR slides).

Investigate:

- the location, as well as the performance and compliance of past and present septic systems, with respect to the proximity of the ground surface to the water table.

MAP POSITION
90

four residences; from the small light colored residence with the two story garage/guests cabin to the light colored residence, which is adjacent to the open lot with a dark colored shed.

Investigate:

- the location, as well as the performance and compliance of past and present septic systems, with respect to the proximity of the ground surface to the water table.

Nine residences; from the dark colored residence with the dark red roof down to the public access.

Investigate:

- the location, as well as the performance and compliance of past and present septic systems, with respect to the proximity of the ground surface to the water table. The dense area of dark vegetation out from shore in front of these residences as well as up to the shoreline at the last three residences are likely indicators of failing septic systems.

MAP POSITION
91

Three residences; from the two story residence with an attached garage down to the residence with the near flat roof.

Investigate:

- the location, as well as the performance and compliance of past and present septic systems, with respect to septic system setback regulations from the ordinary high water level and the proximity of the ground surface to the water table.

Point source or drainage ditch seen on the map along the road.

Investigate:

- the existence, source, nutrient concentration and flow of water from the possible point source.

Recommendations:

- Conduct a year long hydraulic and nutrient budget of the point source if applicable.

MAP POSITION
92

Two residences in the trees on the south side of this bay, before the bend in the road.

Investigate:

- the location, as well as the performance and compliance of past and present septic systems, with respect to septic system setback regulations from the ordinary high water level and the proximity of the ground surface to the water table.

* The residence in the trees with the long light colored "L" shaped dock, seen in slide 92A.

Investigate:

- the location, as well as the performance and compliance of past and present septic systems, with respect to septic system setback regulations from the ordinary high water level and the proximity of the ground surface to the water table. The very large dense plume of dark vegetation extending from the shoreline in front of this residence is a likely indicator of a failing septic system.

Three residences (seen in slide 92C); from the small light colored residence with a straight light colored dock to the light colored residence with a pontoon boat on shore under a blue tarp.

Investigate:

- the location, as well as the performance and compliance of past and present septic systems, with respect to septic system setback regulations from the ordinary high water level and the proximity of the ground surface to the water table.

MAP POSITION
93

Light colored residence with a light colored roof.

Investigate:

- the location, as well as the performance and compliance of past and present septic systems, with respect to septic system setback regulations from the ordinary high water level and neighboring wells and proximity of the ground surface to the water table. The dense area of dark vegetation between the two red docks is a likely indicator of a failing septic system(s).

Two light colored residences, the first with a dark colored roof and the second with a light colored roof.

Investigate:

- the location, as well as the performance and compliance of past and present septic systems, with respect to septic system setback regulations from the ordinary high water level and neighboring wells and close proximity of the ground surface to the water table.

Three residences, a light colored residence with a dark colored roof, a mobile home and a bluish residence with a blue "L" shaped dock.

Investigate:

- the location, as well as the performance and compliance of past and present septic systems, with respect to septic system setback regulations from the ordinary high water level. In addition, proximity of the septic system to neighboring wells and of the ground surface to the water table should be investigated. The dense patches of dark vegetation in the lake in front of these residences and the unusual patches of healthy grass in the lake side lawn of the mobile home, as well as around the walkway of the bluish residence are likely indicators of failing septic system(s).

Three second tier residences located behind the three previously mentioned residences seen in slide 93B.

Investigate:

- the performance and compliance of past and present septic systems with respect to the likely proximity of ground surface to the water table.

MAP POSITION
94

Small light blue residence with a light colored roof.

Investigate:

- the performance and compliance of past and present septic systems with respect to the likely proximity of ground surface to the water table.

Six residences, from the blue residence with a dark colored roof down to the Light colored "L" shaped residence with a light colored roof.

Investigate:

- the location, as well as the performance and compliance of past and present septic systems, with respect to septic system setback regulations from the ordinary high water level and neighboring wells and close proximity of the ground surface to the water table. The dense patches of dark vegetation in the lake in front of these residences are likely indicators of failing septic system(s).

MAP POSITION
95

Five residences; from the small residence in the trees with an RV parked behind it down to the red residence with a square cement pad or patio along the shoreline.

Investigate:

- the location, as well as the performance and compliance of past and present septic systems, with respect to septic system setback regulations from the ordinary high water level and neighboring wells and close proximity of the ground surface to the water table. The dense areas of dark vegetation in the lake in front of each residence is a likely indicator of a failing septic system;
- and verify compliance of proper disposal of the RV's septic system located at the first residence.

Three residences just before the open lot.

Investigate:

- the location, as well as the performance and compliance of past and present septic systems, with respect to septic system setback regulations from the ordinary high water level and the proximity of the ground surface to the water table. The dense band of dark vegetation along the shoreline in this area is a likely indicator of failing septic systems.

MAP POSITION
96

Four residences; from the light colored residence with a blue trampoline to the light colored residence with a light colored roof.

Investigate:

- the location, as well as the performance and compliance of past and present septic systems, with respect to septic system setback regulations from the ordinary high water level and the proximity of the ground surface to the water table. The dense band of dark vegetation along the shoreline in this area, along with the mound system with a plume of healthy grass extending along the driveway of the first residence (seen as bright red in the IR slide) are likely indicators of failing septic system(s).

MAP POSITION
97

The reddish square residence, light colored residence with a dark colored roof, and a small light colored residence with a small blue dock.

Investigate:

- the location, as well as the performance and compliance of past and present septic systems, with respect to septic system setback regulations from the ordinary high water level and neighboring wells for the first two residences and the proximity of the ground surface to the water table for all three. The dense band of dark vegetation along the shoreline is a likely indicator of failing septic system(s).

MAP POSITION
98

Small dark blue residence.

Investigate:

- the location, as well as the performance and compliance of past and present septic systems, with respect to septic system setback regulations from the ordinary high water level and the proximity of the ground surface to the water table. The dense band of dark vegetation along the shoreline is a likely indicator of a failing septic system.

Large red residence possibly an apartment building.

Investigate:

- the location, as well as the performance and compliance of past and present septic systems, with respect to septic system setback regulations from the ordinary high water level and the proximity of the ground surface to the water table. The dense band of dark vegetation along the shoreline along with an even darker mass of emergent vegetation (seen as red in the IR slide) are likely indicators of a failing septic system.

Turquoise colored residence with a dark colored roof.

Investigate:

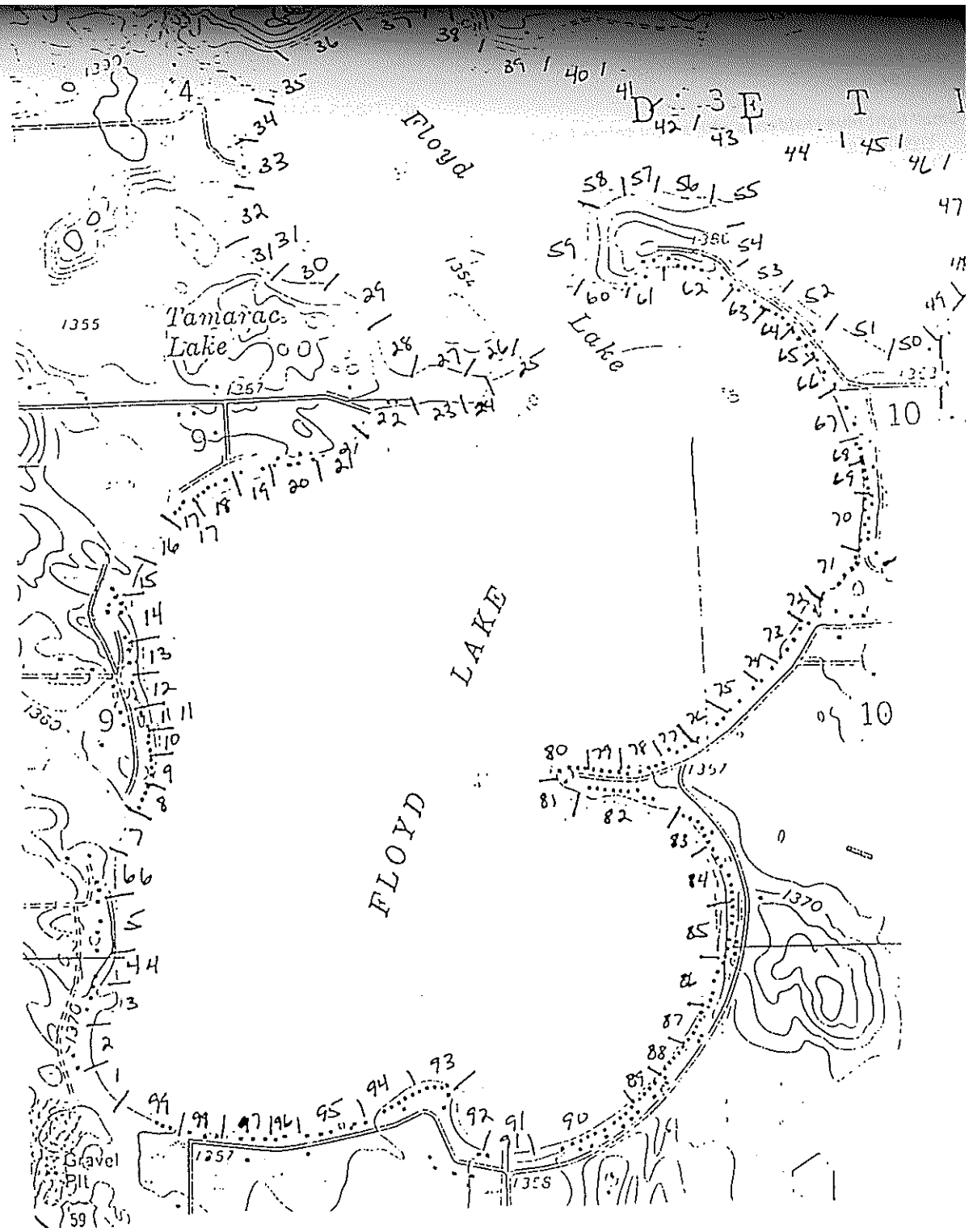
- the location, as well as the performance and compliance of past and present septic systems, with respect to septic system setback regulations from the ordinary high water level and the proximity of the ground surface to the water table. The dense band of dark vegetation along the shoreline is a likely indicator of a failing septic system;
- and verify compliance of proper disposal of the RV's septic system.

MAP POSITION
99

The last five residences.

Investigate:

- the location, as well as the performance and compliance of past and present septic systems, with respect to septic system setback regulations from the ordinary high water level and the proximity of the ground surface to the water table. On the roadside of the second residence the grass appears to be uncommonly healthy (seen as bright red in the IR slide). In addition, on the lakeside of the house located on the right hand side of the slide dark patches of vegetation (dark red in the IR slide) are apparent beginning at the end of the dock. These may be due to overfertilization of the lawns, failing septic systems, or may be associated with runoff from the agricultural fields visible in the upper right hand corner of the slide.



DISCUSSION AND CONCLUSIONS

Big Floyd Lake is located in Becker County, Minnesota, and is classified as a General Development lake. ~~Two~~ Eight and ~~two~~ four tenths miles of shoreline were included in this study. Ninety percent of the residences on Big Floyd Lake met one or more of the criteria on page 3 for likely wastewater influence. Indeed, failed or inadequate wastewater treatment could easily result in significant degradation of water quality in Big Floyd Lake. However, this investigation made no effort to compare the relative impacts of wastewater treatment to other influences.

Other influences that may have an impact on the water quality of Big Floyd Lake include "non-point runoff" such as: runoff from residences closer than the legal setback limit to the lake, runoff from yards (fertilizers), runoff from roads, shoreline erosion, and possible hazardous waste or toxic areas.

Possible point sources that were identified in this study may also have a very large impact on water quality depending on the land uses associated with their drainages. Point sources are a direct conduit of nutrient sources to lakes which can be easily quantified by taking water samples and flow measurements at different times of the year.

A spread sheet was prepared to help the Pelican River Watershed District prioritize which wastewater treatment influences are the most important. The spread sheet consists of 14 columns that are labeled with common problems associated with wastewater treatment facilities. Listed below are the names of each of the 14 columns, along with a description of their content:

- **Map position**, two columns which identify the map position that is being addressed;
- **Notes**, describes the characteristics of each map position;
- **Septic setback**, residences which have any wastewater treatment facility that appears to be located closer than 50 feet to the ordinary high water level or neighboring wells;
- **Non-complying lot size**, lots that appear to be less than 20,000 square feet in size;
- **Ground water**, lots that appear to be ten feet or less in elevation above surface water;
- **New addition**, residences that appear to have a new addition, which should be investigated for adequacy septic upgrade;
- **Privy or cesspool**, residences which appear to be using an outhouse or cesspool for wastewater treatment;
- **Straight pipe**, any pipe or hose which does not appear to be used for lawn watering;
- **Influence seen in lake or lawn**, algae blooms or dense vegetative growths in the lake as well as patterns of unusually healthy vegetation in lawns which appear to be a by-product of failing wastewater treatment facilities;
- **Possible septic effluent**, any area that appears to have raw sewage seeping into the lake;
- **Any septic problem**, this summary column reflects the total number of residences which appear to have any of the above listed problems;
- **Possible point source**, any stream, ditch, culvert, pipe or hose.

The following table presents the number and percentage of residences that exhibit the previously mentioned wastewater treatment problems.

BIG FLOYD LAKE

	# OF RESIDENCES	% OF RESIDENCES
Septic Setback	196	59
Non-complying Lot Size	28	8
Groundwater	256	77
New Addition	1	0
Privy or Cesspool	4	1
Straight Pipe	1	0
Influence Seen In Lake or Lawn	175	53
Possible Septic Effluent	0	0
Any Septic Problem	309	93
Possible Point Source	11	3

The magnitude of problems associated with the findings listed above is influenced by many factors, and cannot be accurately assessed without direct on-site evaluations and sampling. Several of these influential factors are listed below, along with the known information concerning each factor:

1. the number of residences on the lake that are developed.
   333 residences in 8.4 miles of analyzed shoreline.

   The shoreland jurisdiction requires a minimum lot width of 100 feet at the ordinary high water level, and a minimum lot area of 20,000 square feet. Our survey found that the average lot on Little Floyd Lake has a shoreline of 133 feet/lot. Since this average is barely above the minimum size requirements, it emphasizes the high density of development around this lake.

2. the number of structures on each lot that generate sewage.

3. The number of residences that are inhabited all year.

   Unknown.

4. Second tier development of lots.

   None.

5. Hydrogeologic sensitivity of the area.

   At least a portion of approximately 66% of the map positions on Little Floyd Lake are less than ten feet above the elevation of the lake, creating a high risk of ground water contamination. Specifically, in low laying areas it is almost impossible to avoid discharging inadequately treated effluent to groundwater (and therefore the lake) unless wastewater is pumped uphill for treatment, whether a mound or other type of above-ground systems are used.

There were 11 locations that indicated a possible point source. These locations were areas in a yard or near a road that indicated a point source.

Factors that determine the seriousness of point sources include:

1. the number of point source occurrences;
2. how often they flow;
3. the volume they contribute;
4. what pollutants they contribute;
5. their concentration, and subsequent loading they contribute.

To estimate the magnitude of nutrient loading actually occurring from the point sources one would need to know each of the variables listed above.

RECOMMENDATIONS

To respond to the information gathered by the aerial survey, AWRL recommends the following actions by the Pelican River Watershed District:

1. All sites with likely on-site wastewater treatment facility problems should be inspected, and a plan developed to upgrade non-conforming facilities.

2. Wells should be sampled in areas that have a low elevation to determine if the aquifer is being contaminated.

3. Conduct a fecal monitoring program for the lake during the summer months.

4. Conduct site-specific soil evaluations in order to better understand the area's soil chemistry. Given the density of development in this area we should expect even more problems associated with phosphorus discharges. A basic evaluation could take random soil core samples from three to four drain fields with different soil types, and test for aluminum and iron to see if these elements are binding the phosphorus.

5. Verification of the existence and flow of inlets and outlets, along with the sampling to determine chemical content or concentration.

6. Incorporate the information gathered in step 5 into a hydrologic and nutrient Mass Balance analysis.

7. Analyze the slides to identify other (non-wastewater) influences or land use practices which may have enhanced or degraded water quality.

APPENDIX D

WALDOR PUMP
& EQUIPMENT CO.
9700 HUMBOLDT AVE. SO.
MINNEAPOLIS, MN 55431
PHONE (612) 884-5394 **FAX (612) 884-3239**

October 7, 1997

Timothy E. Bayerl, PE
Widseth, Smith Nolting and Associates
Alexandria, MN

Fax # : 320/762-0263

RE: Detroit Township Water/Sanitary Sewer Study
Airvac System

Dear Tim:

Attached is the Airvac letter with cost estimates and maps.

The originals have been mailed to you today.

Thank you for the opportunity to submit an Airvac proposed layout.

Please contact John Lally or myself if you have any questions.

Cordially,

WALDOR PUMP AND EQUIPMENT

Matt Waldor
President

MW/pm

Attachments: Airvac Letter, (2) Cost Estimate Sheets, (2) maps

AIRVAC®
Vacuum Sewer Systems

AIRVAC, INC.
4217 N. Old U.S. 31, P.O. Box 528
Rochester, Indiana 46975 U.S.A.

Mr. Matt Waldor
Waldor Pump and Equipment Co.
9700 Humboldt Ave. So.
Minneapolis, Mn 55431

Re: Floyd Lake, Minnesota
Preliminary Vacuum Sewer Estimate

Dear Mr. Waldor:

Following you will find the recently completed preliminary estimate and layout for the Floyd Lake area near Detroit Lakes, Minnesota. A few comments may be helpful in understanding our estimate and layout.

We located the Vacuum Collection Station at the site where you indicated on your USGS map of the area. Although the exact location was hard to pinpoint on the plat map, we assumed that it was a particular triangular shaped lot within the boundaries of Gov't Lot #6. If that proves incorrect, moving the station one way or another does not appear to affect the project greatly as the line sizes would remain the same.

We were able to serve the entire area with 6" and 4" vacuum sewers. The line to the south of the Vacuum Collection Station has capacity for additional flow within the 6" pipe. However, the north line, which we are calling Line 'A', has limited growth as most of the homes within the service area are on this line. We assumed approximately 174 of the present 242 homes to be on this north line. If this is very far off, or if the future growth is primarily to be on Line 'A', then perhaps we will need to make some of this line 8" pipe.

Airvac's Design Criteria limits the length of 4" pipe on each branch or main to 2000 ft. If you intend to extend the south line, Line 'B', to the west at the south end of Floyd Lake, then perhaps that line should be 6" diameter pipe also, eliminating or limiting the 4" pipe.

We noticed from the few elevations on the USGS map that it appears that many of the homes on the north end of Line 'A', Paradise Point and Clark's Grove Subdivision in particular, were on the lake's edge and the road was at a higher elevation. This elevation difference is in some instances as much as 15 to 20 ft. In order to serve this area we will need to run the vacuum main along the shoreline in this area to avoid excessive "lift" from the vacuum valve pit to the sewer main if the main were placed along the roadway. Once we travel further south with the vacuum main we will follow the roads, as we prefer to do. Although the exact point is not known, we expect this to be in the area of Hermanson Shores or County Rd. 131. Obviously, easements will be required

Telephone (219) 223-3980 Fax (219) 223-5566

for this crossing as well as running along the shoreline as mentioned above. There is one hill on Line 'A', a short distance (1000-1500 ft.) north of the Vacuum Collection Station where a deeper cut may be required to avoid excessive static lift losses. This is noted on the map we are sending. Some of the line sizes are only preliminary estimates. We used our best guess to try to determine where expansion could or would take place. Once we have more accurate maps and information these can be changed.

We feel the area can be well served by vacuum sewers if the Sewer District is willing to follow the shore where mentioned and make the deep cut as mentioned. The Cost Estimate was figured based upon the 242 connections presently. Future connections on this network will reduced the per connection cost somewhat from the present $4,159.

We used an installed cost of $15 and $12 per foot for the 6" and 4" vacuum sewers. If you have other information concerning local costs you wish to use please adjust as needed. The Crossover connection you see on the Cost Estimate is the 3" line from the Valve Pit Package to the main or branch sewer. The Division Valves, or Isolation Valves if you prefer, are resilient wedge gate or plug valves placed in the lines at strategic points such as branch connections to help the operator troubleshoot the system, make tie-ins, and monitor the sytem.

We used a fairly common number of 2 homes per valve pit for purposes of this estimate. Once we have aerial views of the area with homes we can place the valve pit packages more exactly. We assumed approximately 87 Valve Pit Packages on Line 'A' and 34 on Line 'B', with 5 added to each line for contingencies, such as very long gravity lines, etc. Once again, additional information will clarify that number, but we suspect that to be very close based on past experience.

Airvac will provide a field representative during the construction phase of the project. It is estimated that his services will be required for approximately 21 weeks, based on the amount of vacuum sewer and number of valve pits to be installed. The Portable Vacuum Pump (testing) shown on the Cost Estimate is a trailer mounted vacuum pump, gasoline engine driven, which is used by the contractor to test the line as it is installed. This can be re-purchased by Airvac or is often turned over to the owner upon completion of the project.

The Vacuum Station includes the equipment supplied by Airvac and other miscellaneous items necessary to maintain the building. The Equipment refers generally to the collection tank, vacuum pumps, sewage pumps, control panel, and valves and piping mounted on a steel skid ready for hook-up and operation. We have included $25,000 for a generator, if required. Many sewer districts or municipalities do not have a dedicated generator but share with other utilities on a portable unit. If that is the case, this item may be deleted. The building is estimated to be a fairly modest structure, approximately 24 x 30 ft. size, with

textured block face. It would have a metal landing and stairs leading down to the basement where the equipment is located. Obviously, personal preferences play a large role in determining the size and appearance of the building.

One item which we sometimes include and omitted here is the Force Main. We are unsure what the length of such a line would be, although we suspect it would be 4" ductile iron. The Force Main and several other items, both large and small, need to be added to the estimate. We have attempted to estimate only the collection portion of the project. Among other things these items are restoration, permits, fees, easements, land acquisition and numerous other costs.

We are sure you will have many questions once you have had time to study this layout and estimate. Feel free to call either myself or Mr. Al Johnson any time to discuss this or other projects.

Sincerely,
AIRVAC, INC.

Denny Moss
Sr. Project Engineer

cc: Al Johnson, Midwest Regional Sales Mgr.
Tampa office
file

Floyd Lake, Minnesota
Connections 242
Equiv # Conn 242

COST ESTIMATE
Station # 1

INSTALLED COST-COLLECTION SYSTEM

QUANTITY	DESCRIPTION		UNIT PRICE	TOTAL PRICE
14,200 lf	6" Vacuum Sewer	@	15.00 /lf	213,000
6,050 lf	4" Vacuum Sewer	@	12.00 /lf	72,600
131 ea	Crossover Connections	@	400.00 /ea	52,400
6 ea	6" Division Valve	@	900.00 /ea	5,400
4 ea	4" Division Valve	@	750.00 /ea	3,000
131 ea	AIRVAC Valves *	@	2,800.00 /ea	366,800
1 set	Special Tools	@	3,000.00 /set	3,000
3%	Spare Parts	@		11,000
21 wks	AIRVAC Field Rep	@	1,250.00 /wk	26,250
1 ea	Portable Vacuum Pump (Testing)	@	13,000.00 /ea	13,000
			COLLECTION SYSTEM COST	$766,450

Includes Fiberglass Pit, Cast Iron Cover w/ Frame, Breather and 55 Gallon Holding Tank

INSTALLED COST-VACUUM STATION

Equipment		105,000
Equipment Installation		30,000
Station Wiring, Piping, Etc		20,000
Motor-generator set		25,000
Building		60,000
	VACUUM STATION COST	$240,000

TOTAL INSTALLED COST	$1,006,450
EQUIV # CONNECTIONS	242
COST PER CONNECTION	$4,159

06-Oct-97

Floyd Lake, Minnesota

# VALVES	131
# CONNECTIONS	242
EQUIV # CONN	242

ANNUAL O&M ESTIMATE
Station # 1

LABOR

Item	Labor effort		Quantity				Annual Labor
Vacuum Station	365 hrs/yr/station	x	1 station			=	365 hrs/yr
Piping	60 hrs/yr/system	x	1 system			=	60 hrs/yr
Valves	1 hrs/yr/valve	x	131 valves			=	131 hrs/yr
							556 hrs/yr
					Hourly rate	x	$15 /hr
					Overhead factor	x	1.75
							$14,595 /yr
						ROUND TO:	$14,600 /yr

POWER

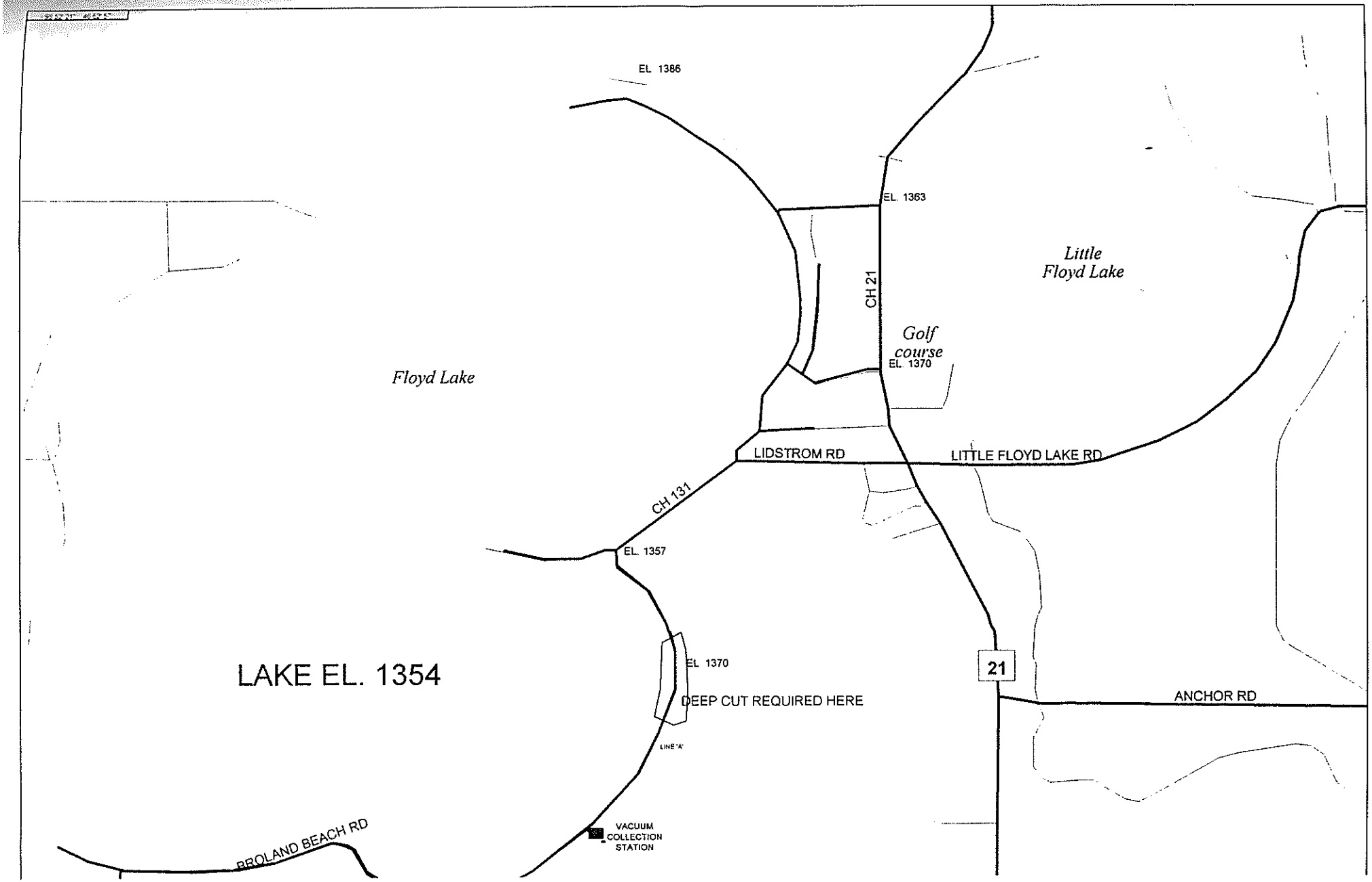
Item	Unit cost		Equiv # conn		Duration		Annual Power
Vacuum Station	$1.25 mo/conn	x	242 conn	x	12 mo	=	$3,630 /yr
						ROUND TO:	$3,600 /yr

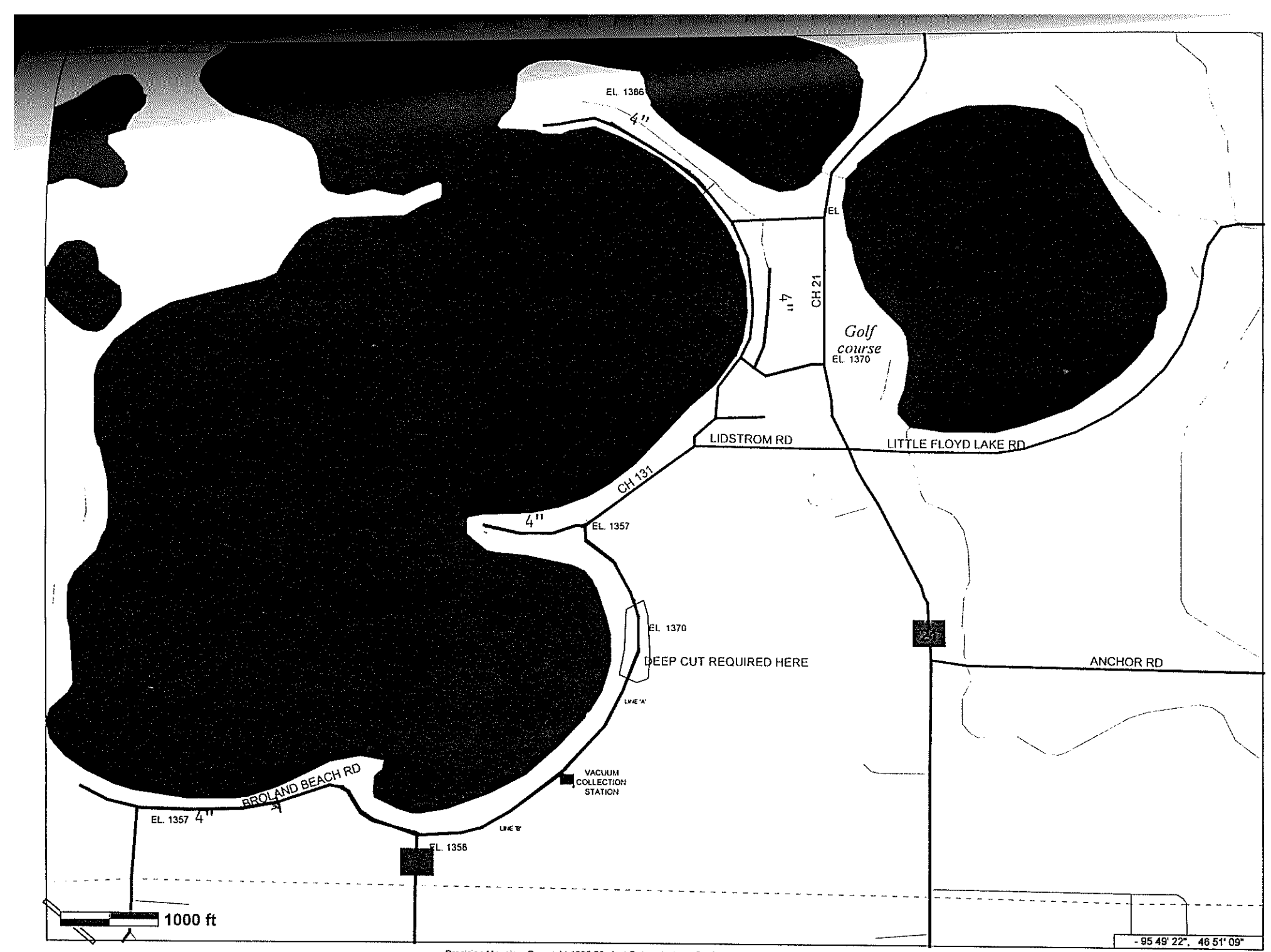
EQUIPMENT REPLACEMENT

Item	Replacement cost		Useful life		Quantity		Annual R&R
VACUUM STATION							
Vacuum Pumps	$15,500 /ea	/	15 years	x	2 pumps	=	$2,067 /yr
Sewage Pumps	$5,000 /ea	/	15 years	x	2 pumps	=	$667 /yr
Collection Tank	$12,500 /ea	/	25 years	x	1 ea	=	$500 /yr
Control Panel	$17,000 /ea	/	20 years	x	1 ea	=	$850 /yr
Misc. Equip	$2,500 /ea	/	15 years	x	1 ea	=	$167 /yr
							$4,250 /yr
						ROUND TO:	$4,300 /yr
VACUUM VALVES							
Vacuum Valves	$17.50 /ea	/	10 years	x	131 valves	=	$229 /yr
Controller	$35.00 /ea	/	5 years	x	131 valves	=	$917 /yr
Misc. Parts	$12.50 /ea	/	10 years	x	131 valves	=	$164 /yr
							$1,310 /yr
						ROUND TO:	$1,300 /yr

SUMMARY

LABOR	$14,600 /yr
POWER	$3,600 /yr
EQUIPMENT REPLACEMENT (STATION)	$4,300 /yr
EQUIPMENT REPLACEMENT (VALVES)	$1,300 /yr
	$23,800 /yr
EQUIVALENT # CONNECTIONS	242 conn
ANNUAL COST PER CONNECTION	$98.35 /yr/conn


EL. 1386
EL. 1363
CH 21
Little
Floyd Lake
Golf
course
EL. 1370
Floyd Lake
LIDSTROM RD
LITTLE FLOYD LAKE RD
CH 131
EL. 1357
LAKE EL. 1354
EL. 1370
DEEP CUT REQUIRED HERE
21
ANCHOR RD
LINE 'A'
VACUUM
COLLECTION
STATION
BROLAND BEACH RD

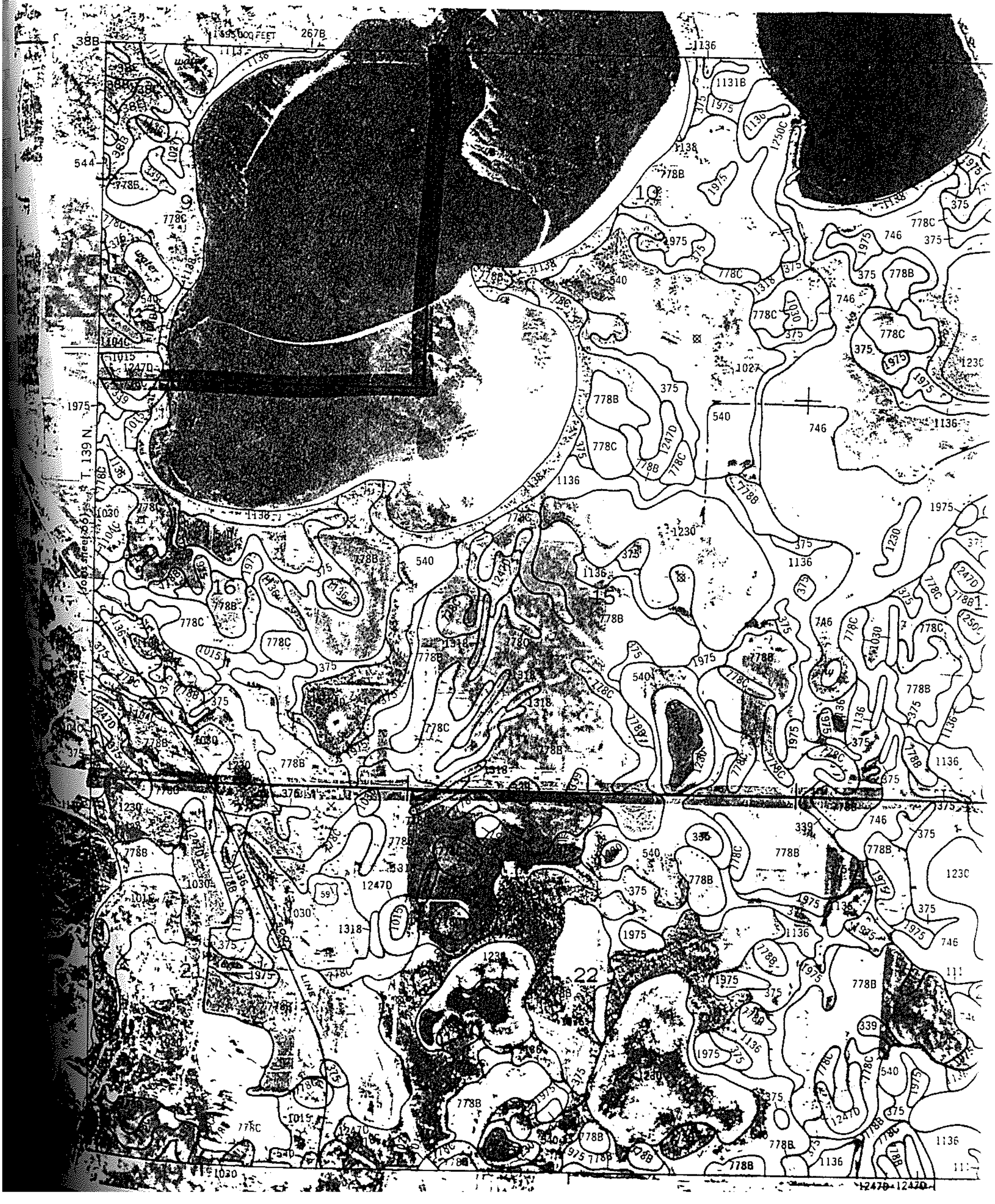


APPENDIX E

SOIL MAP LEGEND

Soils list

Map symbol	Soil name
38B	Waukon loam, 2 to 8 percent slopes
38C	Waukon loam, 8 to 15 percent slopes
38E	Waukon loam, 15 to 30 percent slopes
180	Gonvick loam
339	Fordville loam
375	Forada loam
540	Seelyeville muck
541	Rifle mucky peat
544	Cathro muck
746	Haslie muck
765	Smiley loam
778B	Dorset-Corliss complex, 1 to 6 percent slopes
778C	Dorset-Corliss complex, 6 to 12 percent slopes
1015	Udipsamments, cut and fill land
1030	Pits, gravel-Udipsamments complex
1104B	Waukon-Dorset complex, 1 to 8 percent slopes
1104C	Waukon-Dorset complex, 8 to 15 percent slopes
1113	Haslie, Seelyeville, and Cathro soils, ponded
1129	Lindaas silty clay loam, morainic
1131B	Verndale-Abbeylake complex, 1 to 6 percent slopes
1136	Nidaros muck
1138	Rushlake and Hangaard soils, lake beaches
1230	Haslie and Nidaros soils, ponded
1247D	Corliss-Dorset complex, 12 to 20 percent slopes
1250C	Abbeylake-Verndale complex, 6 to 12 percent slopes
1318	Darnen loam
1825B	Seelyeville muck, seepland, 1 to 10 percent slopes
1975	Oylen sandy loam


1 395 000 FEET
T. 139 N.
9
10
15
16
22
water
LINE
38B
267B
544
778B
778C
1136
1131B
1975
1250C
375
746
540
1027
1030
1104C
1015
1247D
1230
1318
339
59
1138

NONTECHNICAL SOILS DESCRIPTION REPORT

Soils list

Map Symbol	Soil name and description
38B	Waukon loam, 2 to 8 percent slopes Major management factors: Water erosion. Major crops grown are alfalfa and corn. Where slopes are short and irregular, erosion and runoff can be minimized by using tillage practices that leave crop residues on the soil surface. Where slopes are long and smooth, erosion and runoff can be minimized by contour farming, stripcropping or terracing. Grassed waterways can be installed to carry surface runoff water from the field without causing gullying. Inclusions: Moderately well drained Gonvick soils on lower lying positions. Poorly drained Flom soils in drainageways and on low lying positions. Very poorly drained Quam and Cathro soils in depressions. Seams or pockets of sand and gravel. Soils that have a sandy loam, fine sandy loam, or clay loam surface layer. Waukon soil and similar soils: 85 to 98 percent; Contrasting inclusions: 2 to 15 percent; Landform and position on the landform: Convex slopes on moraines. Shape of areas: Irregular; Size of areas: 3 to 80 acres; Typical profile: 0 to 5 inches - very dark gray, loam; 5 to 10 inches - dark brown, fine sandy loam; 10 to 23 inches - dark yellowish brown, clay loam; 23 to 35 inches - light yellowish brown, calcareous, loam; 35 to 60 inches - light olive brown, calcareous, loam; Depth: Very deep; Drainage class: Well drained; Permeability: moderate; Available water capacity: high; Organic matter content: moderate; Surface runoff: medium; Depth to water table: Greater than 6 feet. Land capability classification: 2e; Woodland ordination symbol: 4L; Windbreak suitablility group: 3.
38C	Waukon loam, 8 to 15 percent slopes

Map Symbol	Soil name and description
	Major management factors: Water erosion. Major crops grown are alfalfa and corn. Where slopes are short and irregular, erosion and runoff can be minimized by using tillage practices that leave crop residues on the soil surface. Where slopes are long and smooth, erosion and runoff can be minimized by contour farming, stripcropping or terracing. Grassed waterways can be installed to carry surface runoff water from the field without causing gullying. Inclusions: Poorly drained Flom soils in drainageways and on low lying positions. Very poorly drained Quam and Cathro soils in depressions. Seams or pockets of sand and gravel. Soils that have a sandy loam, fine sandy loam, or clay loam surface layer. Waukon soil and similar soils: 85 to 98 percent; Contrasting inclusions: 2 to 15 percent; Landform and position on the landform: Convex slopes on moraines. Shape of areas: Irregular; Size of areas: 3 to 80 acres; Typical profile: 0 to 4 inches - very dark gray, loam; 4 to 7 inches - dark grayish brown, sandy loam; 7 to 15 inches - dark brown, clay loam; 15 to 28 inches - dark brown, clay loam; 28 to 33 inches - olive brown, loam; 33 to 60 inches - light olive brown, calcareous, loam; Depth: Very deep; Drainage class: Well drained; Permeability: moderate; Available water capacity: high; Organic matter content: moderate; Surface runoff: rapid; Depth to water table: Greater than 6 feet. Land capability classification: 3e; Woodland ordination symbol: 4L; Windbreak suitability group: 3.
[illegible]E	Waukon loam, 15 to 30 percent slopes Inclusions: Poorly drained Flom soils in drainageways and on footslopes. Very poorly drained Quam and Cathro soils in depressions. Seams or pockets of sand and gravel. Soils that have a sandy loam, fine sandy loam, or clay loam surface layer.

NONTECHNICAL SOILS DESCRIPTION REPORT

Soils list

Map Symbol	Soil name and description
	Waukon soil and similar soils: 85 to 98 percent; Contrasting inclusions: 2 to 15 percent; Landform and position on the landform: Convex slopes on moraines. Shape of areas: Irregular; Size of areas: 3 to 50 acres; Typical profile: 0 to 4 inches - very dark gray, loam; 4 to 8 inches - dark grayish brown, loam; 8 to 19 inches - dark yellowish brown, clay loam; 19 to 60 inches - light olive brown, calcareous, loam; Depth: Very deep; Drainage class: Well drained; Permeability: moderate; Available water capacity: high; Organic matter content: moderate; Surface runoff: very rapid; Depth to water table: Greater than 6 feet. Land capability classification: 7e; Woodland ordination symbol: 4R; Windbreak suitability group:3. Major management factors: Steep slopes.
180	Gonvick loam Major management factors: tilth. Major crops grown are alfalfa and corn. Organic matter content and tilth can be maintained by returning crop residues to the soil. Inclusions: Well drained Forman soils on higher lying positions. Poorly drained Flom soils on lower lying positions. Soils that have a loam surface layer. Soils that lack an accumulation of clay in the subsoil.

NONTECHNICAL SOILS DESCRIPTION REPORT

Soils list

Map Symbol	Soil name and description
	Gonvick soil and similar soils: 85 to 98 percent; Contrasting inclusions: 2 to 15 percent; Landform and position on the landform: Nearly level and slightly convex areas on moraines. Shape of areas: Irregular; Size of areas: 3 to 25 acres; Typical profile: 0 to 7 inches - black, clay loam; 7 to 11 inches - black, clay loam; 11 to 18 inches - dark grayish brown, clay loam; 18 to 23 inches - dark grayish brown, mottled, clay loam; 23 to 44 inches - light olive brown, mottled, calcareous, clay loam; 44 to 60 inches - light olive brown, mottled, calcareous, clay loam; Depth: Very deep; Drainage class: Moderately well drained; Permeability: Moderate or high; Available water capacity: high; Organic matter content: high; Surface runoff: slow; Depth to water table: 2.5 to 4 feet. Land capability classification: 2e; Woodland ordination symbol: 4A; Windbreak suitability group: 1.
339	Fordville loam Major management factors: Wind erosion, groundwater contamination. Reduce the risk of soil blowing by planting field windbreaks and by maintaining crop residues on the soil surface. Carefully control the use and application of fertilizers, herbicides and insecticides to reduce the risk of groundwater contamination. Inclusions: Well drained Darnen soils on similar positions. Soils that have a silt loam surface layer. Soils that have sand and gravel at depths of less than 20 inches. Soils that contain less than 15 percent coarse fragments in the underlying material.

NONTECHNICAL SOILS DESCRIPTION REPORT

Soils list

Map Symbol	Soil name and description
	Fordville soil and similar soils: 90 to 98 percent; Contrasting inclusions: 2 to 10 percent; Landform and position on the landform: Concave, plane and slightly convex slopes on outwash plains and valley trains; Slope range: 0 to 4 percent; Shape of areas: Irregular; Size of areas: 3 to 25 acres; Typical profile: 0 to 10 inches - black, loam; 10 to 17 inches - very dark gray, loam; 17 to 28 inches - dark brown, loam; 28 to 36 inches - dark yellowish brown, coarse sand; 36 to 60 inches - light yellowish brown, calcareous, gravelly coarse sand; Depth: Very deep; Drainage class: Well drained; Permeability: upper part - moderate; below 28 inches - rapid; Available water capacity: moderate; Organic matter content: Moderate or high; Surface runoff: slow; Depth to water table: Greater than 6 feet. Land capability classification: 2e; Windbreak suitability group: 6.
175	Forada loam Major management factors: Soil wetness, groundwater contamination. Major crops grown are oats, barley and corn. Maintain existing drainage systems to remove excess water in the root zone and to provide a proper moisture content for tillage. Select plants that will tolerate wetness in the root zone. Carefully control the use and application of fertilizers, herbicides and insecticides to reduce the risk of groundwater contamination. Inclusions: Moderately well drained Osakis soils on higher lying positions. Very poorly drained Forada soils in depressions. Soils that have a loam surface layer. Soils that have sand and gravel at depths of less than 20 inches.

NONTECHNICAL SOILS DESCRIPTION REPORT

Soils list

Map Symbol	Soil name and description
	Forada soil and similar soils: 90 to 98 percent; Contrasting inclusions: 2 to 10 percent; Landform and position on the landform: Low lying, nearly level areas on outwash plains; Slope range: 0 to 2 percent; Shape of areas: Irregular; Size of areas: 3 to 80 acres; Typical profile: 0 to 7 inches - black, sandy loam; 7 to 14 inches - very dark gray, sandy loam; 14 to 22 inches - dark grayish brown, mottled, sandy loam; 22 to 40 inches - light brownish gray, coarse sand; 40 to 60 inches - light brownish gray, calcareous, gravelly coarse sand; Depth: Very deep; Drainage class: Poorly drained; Permeability: upper part - moderately rapid; below 22 inches - rapid; Available water capacity: low; Organic matter content: Moderate or high; Surface runoff: slow; Depth to water table: 1 to 3 feet. Land capability classification: 2w; Windbreak suitability group: 2.
540	Seelyeville muck Major management factors: Ponding, soil wetness, subsidence. Inclusions: Poorly drained Vallers, Shooker, Epoufette and Forada soils on higher lying positions. Soils that have a mucky peat surface layer. Soils that have more than 10 inches of hemic materials throughout the profile. Soils that have limnic sediments or mineral sediments underlying the organic sediments at depths of less than 51 inches.

NONTECHNICAL SOILS DESCRIPTION REPORT

Soils list

Map Symbol	Soil name and description
	Seelyeville soil and similar soils: 95 to 98 percent; Contrasting inclusions: 2 to 5 percent; Landform and position on the landform: Depressions on moraines, till plains, outwash plains, lakeplains, drumlins and on floodplains; Slope range: 0 to 1 percent; Shape of areas: Irregular; Size of areas: 10 to 200 acres; Typical profile: 0 to 24 inches - very dark gray, muck; 24 to 48 inches - very dark gray, muck; 48 to 60 inches - black, muck; Depth: Very deep; Drainage class: Very poorly drained; Permeability: moderately rapid; Available water capacity: Very high; Organic matter content: Very high; Surface runoff: poor; Depth to water table: +2 to 2 feet. Special Characteristics: This soil is subject to ponding. Land capability classification: 4w drained, 6w undrained; Woodland ordination symbol: 3W; Windbreak suitability group: 2(0) drained; 10 undrained.
541	Rifle mucky peat This soil is very poorly drained. Permeability is moderate or moderately rapid. Available water capacity and organic matter content are very high. Depth to the water table ranges from 1 foot below the surface to 1 foot above. Land capability classification: 6W. Woodland ordination symbol: 3W.
544	Cathro muck Major management factors: Soil wetness, ponding, subsidence. Maintain existing drainage systems to remove excess water in the root zone and to remove water ponded following spring snowmelt and water ponded following heavy rains. Select plants that will tolerate wetness in the root zone. Inclusions: Poorly drained Vallers and Shooker soils on higher lying positions. Soils that have a mucky peat surface layer. Soils that have organic layers more than 51 inches thick or less than 16 inches thick. Soils that are dominantly hemic organic materials.

NONTECHNICAL SOILS DESCRIPTION REPORT

Soils list

Map Symbol	Soil name and description
	Haslie soil and similar soils: 95 to 98 percent; Contrasting inclusions: 2 to 5 percent; Landform and position on the landform: Depressions on till plains, moraines and outwash plains; Slope range: 0 to 1 percent; Shape of areas: Irregular; Size of areas: 10 to 100 acres; Typical profile: 0 to 12 inches - very dark gray, muck; 12 to 26 inches - very dark gray, muck; 26 to 48 inches - black, muck; 48 to 60 inches - dark gray, mucky silt loam (coprogeneous earth); Depth: Very deep; Drainage class: Very poorly drained; Permeability: Moderately rapid in organics and slow in the coprogeneous earth; Available water capacity: Very high; Organic matter content: Very high; Surface runoff: ponded; Depth to water table: 0 to 1 foot; Special Characteristics: This soil is subject to ponding. Land capability classification: 4w drained, 6w undrained; Woodland ordination symbol: 2W; Windbreak suitability group: 2(0) drained, 10 undrained.
165	Smiley loam Major management factors: Soil wetness. Major crops grown are alfalfa and corn. Maintain existing drainage systems to remove excess water in the root zone and to provide a proper moisture content for tillage. Select plants that will tolerate wetness in the root zone. Inclusions: Moderately well drained Gonvick soils on higher lying positions. Very poorly drained Cathro and Quam soils in depressions. Soils that have a sandy clay loam, loam, sandy loam or fine sandy loam; Soils that lack an accumulation of clay in the subsoil layer.

NONTECHNICAL SOILS DESCRIPTION REPORT

Soils list

Map Symbol	Soil name and description
	Smiley soil and similar soils: 90 to 98 percent; Contrasting inclusions: 2 to 10 percent; Landform and position on the landform: Drainageways and low lying nearly level areas on moraines. Slope range: 0 to 2 percent; Shape of areas: Irregular; Size of areas: 3 to 20 acres; Typical profile: 0 to 13 inches - very dark gray, silt loam; 13 to 18 inches - very dark grayish brown, mottled, silty clay loam; 18 to 26 inches - dark grayish brown, mottled, clay loam; 26 to 47 inches - light olive brown, mottled, calcareous, loam; 47 to 60 inches - light olive brown, mottled, calcareous, loam; Depth: Very deep; Drainage class: Poorly drained; Permeability: moderate; Available water capacity: high; Organic matter content: moderate; Surface runoff: very slow; Depth to water table: 1 - 3 feet. Land capability classification: 2w drained; 4w undrained; Windbreak suitability group: 2.
778B	Dorset-Corliss complex, 1 to 6 percent slopes
	DORSET: This soil is well drained. Permeability in the upper part is moderately rapid. Available water capacity is low. Organic matter content is moderate or high. Depth to the water table is greater than 6 feet. Land capability classificatoin: 3S. Woodland ordination symbol: 2A. Permeability in the lower part is rapid. CORLISS: This soil is excessively drained. Permeability is rapid. Available water capacity is very low. Organic matter content is moderately low or moderate. Depth to the water table is greater than 6 feet. Land capability classification: 4S. Woodland ordination symbol: 6S.
778C	Dorset-Corliss complex, 6 to 12 percent slopes

NONTECHNICAL SOILS DESCRIPTION REPORT

Soils list

Map Symbol	Soil name and description
	Major management factors: Droughtiness, water erosion, groundwater contamination. Major crops grown are oats, barley and wheat. Because of the limited available water capacity, crops that tolerate droughty conditions are best suited. Moisture can be conserved by using tillage practices that leave crop residues on the soil surface. Erosion and runoff can be minimized by using tillage practices that leave crop residues on the soil surface. Grassed waterways can be installed to carry surface runoff water from the field without causing gullying. Carefully control the use and application of fertilizers, herbicides and insecticides to reduce the risk of groundwater contamination. Inclusions: Excessively drained Sandberg soils on similar positions. Soils that have a fine sandy loam surface layer. Soils that contain less than 15 percent coarse fragments in the underlying material. Dorset-Corliss: 90 to 98 percent; Contrasting inclusions: 2 to 10 percent; Landform and position on the landform: Convex slopes on outwash plains and valley trains; Shape of areas: elongated; Size of areas: 3 to 25 acres; Typical profile: 0 to 7 inches - very dark gray, sandy loam; 7 to 14 inches - dark yellowish brown, sandy loam; 14 to 25 inches - yellowish brown, gravelly coarse sand; 25 to 60 inches - light yellowish brown, calcareous, gravelly coarse sand; Depth: Very deep; Drainage class: Well drained; Permeability: upper part - moderately rapid; below 14 inches - rapid; Available water capacity: low; Organic matter content: Moderate or high; Surface runoff: medium; Depth to water table: Greater than 6 feet. Land capability classification: 4e; Woodland ordination symbol: 2A; Windbreak group: 6G.
1015	Udipsamments, cut and fill land

NONTECHNICAL SOILS DESCRIPTION REPORT

Soils list

Map Symbol	Soil name and description
	This mapping unit consist of reclaimed gravel pits and other disturbed areas in sandy and gravelly materials. Individual areas are irregular in shape and range from 3 to 300 acres in size. On reclaimed gravel pit areas, topsoil is often stockpiled prior to mining of the gravel deposits. Following mining operations the topsoil is returned to the site. The topsoil that is retuned is quite variable in depth and composition. The underlying material is variable from location to location. Land leveling in the vicinity of Detroit Lakes accounts for much of the acreage of this mapping unit. Large areas were leveled for the creation of the industrial park area. Several other areas were leveled for housing developments. Soil properties such as permeability, runoff, available water capacity, reaction, organic matter content and seasonal high water table are variable and require on-site investigation.
1030	Pits, gravel-Udipsamments complex
	This mapping unit consists of open excavations from which sand and gravel deposits are being removed, and from inactive gravel pits that are beginning to revegetate themselves. Individual areas are irregular in shape and range from 3 to 300 acres in size. Pits are usually within areas of Sandberg, Arvilla, Dorset, Mahtomedi or Sugarbush soils. Gravel and sand deposits have been removed leaving an open pit. In some areas the topsoil has been stockpiled around the edge of the pit to be used as topsoil when the gravel pit is reclaimed for other uses.
1104B	Waukon-Dorset complex, 1 to 8 percent slopes
	Major management factors: Waukon soil - Water erosion. Dorset soil - Droughtiness, wind erosion. Major crops grown are alfalfa and corn. Erosion and runoff can be minimized by using tillage practices that leave crop residues on the soil surface. Grassed waterways can be installed to carry surface water runoff water from the field without causing gullying. The Dorset component is droughty due to its limited available water capacity. Crops that tolerate droughty conditions are best suited.

NONTECHNICAL SOILS DESCRIPTION REPORT

Soils list

Map Symbol	Soil name and description
	Inclusions: Moderately well drained Gonvick and Oylen soils on lower lying positions. Poorly drained Smiley soils on lower lying positions. Very poorly drained Quam and Cathro soils in depressions. Soils that have a clay loam or fine sandy loam surface layer. Soils formed in sandy sediments. Waukon soil and similar soils: 50 to 70 percent; Dorset soil and similar soils: 20 to 40 percent; Contrasting inclusions: 2 to 20 percent; These two soils occur as areas so intricately mixed that mapping them seperately was not practical; Landform and position on the landform: Convex slopes on moraines; Shape of areas: Irregular; Size of areas: 5 to 50 acres; Typical profile: Waukon: 0 to 4 inches - very dark gray, loam; 4 to 9 inches - dark grayish brown, fine sandy loam; 9 to 17 inches - dark brown, clay loam; 17 to 28 inches - light yellowish brown, calcareous, loam; 28 to 60 inches - light yellowish brown, calcareous, loam; Dorset: 0 to 8 inches - very dark gray, sandy loam; 8 to 14 inches - dark brown, sandy loam; 14 to 35 inches - light yellowish brown, calcareous, gravelly coarse sand; 35 to 60 inches - yellowish brown, calcareous, gravelly coarse sand; Depth: Very deep; Drainage class: Well drained; Permeability: Waukon-moderate; Dorset-moderately rapid in the upper part and rapid below 14 inches. Available water capacity: Waukon-high; Dorset-low; Organic matter content: Waukon-moderate; Dorset-moderate or high; Surface runoff: Waukon-medium; Dorset-slow; Depth to water table: Greater than 6 feet. Land capability classification: Waukon-2e; Dorset-4e; Woodland ordination symbol: Waukon-4L; Dorset-2A; Windbreak suitability group: Waukon-3; Dorset-6G.
1104C	Waukon-Dorset complex, 8 to 15 percent slopes

NONTECHNICAL SOILS DESCRIPTION REPORT

Soils list

Map Symbol	Soil name and description
	Major management factors: Waukon soil - Water erosion. Dorset soil - Droughtiness, water erosion. Major crops grown of this soil are alfalfa and corn. Erosion and runoff can be minimized by using tillage practices that leave crop residues on the soil surface. Grassed waterways can be installed to carry surface water runoff water from the field without causing gullying. The Dorset component is droughty due to its limited available water capacity. Crops that tolerate droughty conditions are best suited. Inclusions: Moderately well drained Gonvick and Oylen soils on lower lying positions. Poorly drained Smiley soils on lower lying positions. Very poorly drained Quam and Cathro soils in depressions. Soils that have a clay loam or fine sandy loam surface layer. Soils formed in sandy sediments. Waukon soil and similar soils: 50 to 70 percent; Dorset soil and similar soils: 20 to 40 percent; Contrasting inclusions: 2 to 20 percent; These two soils occur as areas so intricately mixed that mapping them seperately was not practical; Landform and position on the landform: Convex slopes on moraines; Shape of areas: Irregular; Size of areas: 5 to 40 acres; Typical profile: Waukon: 0 to 8 inches - very dark grayish brown, loam; 8 to 21 inches - dark brown, clay loam; 21 to 33 inches - light yellowish brown, calcareous, loam; 33 to 60 inches - light olive brown, calcareous, loam; Dorset: 0 to 7 inches - very dark gray, sandy loam; 7 to 16 inches - dark brown, sandy loam; 16 to 35 inches - yellowish brown, calcareous, gravelly coarse sand; 35 to 60 inches - light yellowish brown, calcareous, gravelly coarse sand; Depth: Very deep; Drainage class: Well drained; Permeability: Waukon-moderate; Dorset-moderately rapid in the upper part and rapid below inches. Available water capacity: Waukon-high; Dorset-low; Organic matter content: Waukon-moderate; Dorset-moderate or high; Surface runoff: Waukon-rapid; Dorset-medium; Depth to water table: Greater than 6 feet. Land capability classification: Waukon-3e; Dorset-6e; Woodland ordination symbol: Waukon-4L; Dorset-2A; Windbreak suitability group: Waukon-3; Dorset-6G.
413	Haslie, Seelyeville, and Cathro soils, ponded

Map Symbol	Soil name and description
	Inclusions: Poorly drained Hangaard and Vallers soils on edges of the depressions. Soils underlain by mineral sediments at depths of less than 51 inches. Haslie soil and similar soils: 0 to 90 percent; Seelyeville soil and similar soils: 0 to 90 percent; Cathro soil and similar soils: 0 to 90 percent; Contrasting inclusions: 2 to 10 percent; These three soils occur in depressions that are normally ponded with water and mapping them seperately was not practical due to their inaccessibility; Landform and position on the landform: Depressions on moraines, outwash plains and lakeplains; Shape of areas: Irregular; Size of areas: 5 to 200 acres; Typical profile: Haslie: 12 inches to 0 - water; 0 to 18 inches - dark reddish brown, mucky peat; 18 to 45 inches - black, muck; 45 to 60 inches - light brownish gray, calcareous, mucky silt loam (coprogeneous earth); Typical profile: Cathro: 12 inches to 0 - water; 0 to 8 inches - black, muck; 8 to 24 inches - very dark grayish brown, calcareous, mucky silt loam (coprogeneous earth); 24 to 60 inches - gray, calcareous, mucky silt loam (coprogeneous earth); Typical profile: Seelyeville: 36 inches to 0 - water; 0 to 54 inches - black, muck; 54 to 60 inches - dark gray, calcareous, mucky silt loam (coprogeneous earth); Depth: Very deep; Drainage class: Very poorly drained; Permeability: Haslie-moderately rapid over slow; Cathro & Seelyeville-moderate; Available water capacity: Haslie & Cathro-very high; Seelyeville-high; Organic matter content: Very high; Surface runoff: ponded; Depth to water table: 3 feet above to 1 feet below the surface. Land capability classification: Haslie-6w; Cathro-6w; Seelyeville-6w.
1129	Lindaas silty clay loam, morainic

Map Symbol	Soil name and description
	Major management factors: Soil wetness, clay content. Major crops grown are wheat, barley and soybeans. Maintain existing drainage systems to remove excess water in the root zone and to provide a proper moisture content for tillage. Select plants that will tolerate wetness in the root zone. Perform tillage operations only when the soil is at the proper moisture content to reduce compaction and prevent clod formation. Inclusions: Moderately well drained Bygland soils on higher lying positions. Very poorly drained Dovray soils in depressions. Soils that have a silt loam, clay loam or silty clay loam surface layer. Soils that lack an accumulation of clay in the subsoil. Lindaas soil and similar soils: 90 to 98 percent; Contrasting inclusions: 2 to 10 percent; Landform and position on the landform: Low lying, nearly level areas on lakeplains and moraines; Slope range: 0 to 2 percent. Shape of areas: Irregular; Size of areas: 3 to 70 acres; Typical profile: 0 to 8 inches - black, silty clay; 8 to 14 inches - black, silty clay; 14 to 20 inches - very dark grayish brown, clay; 20 to 29 inches - dark grayish brown, mottled, clay; 29 to 60 inches - grayish brown, mottled, calcareous, silty clay; Depth: Very deep; Drainage class: Poorly drained; Permeability: slow; Available water capacity: high; Organic matter content: High or very high; Surface runoff: slow; Depth to water table: 1 - 3 feet; Special Characteristics: Lindaas soils when mapped adjacent to Peever and Naytahwaush soils have 1 to 4 percent rock fragments throughout. Land capability classification: 2w; Windbreak suitability group: 2.
1131B	Verndale-Abbeylake complex, 1 to 6 percent slopes

Map Symbol	Soil name and description
	VERNDALE: This soil is well drained. Permeability in the upper part is moderately rapid. Permeability in the middle part is moderate. Permeability in the lower part is rapid. Available water capacity is low. Organic matter content is moderate. Depth to the water table is greater than 6 feet. Land capability classificatoin: 3S. ABBEYLAKE: This soil is excessively drained. Permeability is rapid. Available water capacity is low. Organic matter content is moderately low or moderate. Depth to the water table is greater than 6 feet. Land capability classification: 4S. Woodland ordination symbol: 6S.
1136	Nidaros muck Major management factors: Ponding, soil wetness, subsidence. Inclusions: Poorly drained Forada, Epoufette and Hangaard soils on higher lying positions. Soils that have a mucky peat surface layer. Soils that have organic sediments more than 50 inches thick. Nidaros soil and similar soils: 95 to 98 percent; Contrasting inclusions: 2 to 5 percent; Landform and position on the landform: Depressions in outwash plains, valley trains and on floodplains; Slope range: 0 to 1 percent; Shape of areas: Irregular; Size of areas: 3 to 50 acres; Typical profile: 0 to 31 inches - black,muck; 31 to 42 inches - black,loam; 42 to 49 inches - dark gray,sandy loam; 49 to 60 inches - gray, calcareous,coarse sand; Depth: Very deep; Drainage class: Very poorly drained; Permeability: upper part - moderately rapid; below 31 inches - rapid; Available water capacity: Very high; Organic matter content: Very high; Surface runoff: poor; Depth to water table: 1 foot above to 1 foot below the surface; Special Characteristics: This soil is subject to ponding. Land capability classification: 4w drained, 6w undrained; Woodland ordination symbol: 2W; Windbreak suitability group: 2(0).
1138	Rushlake and Hangaard soils, lake beaches

Map Symbol	Soil name and description
	Inclusions: Excessively drained Sandberg and Menahga soils on higher lying positions. Very poorly drained Markey soils on lower lying positions. Soils that have a coarse sand, sand, loamy coarse sand, loamy sand or fine sandy loam surface layer. Soils that contain less than 10 percent coarse fragments throughout. Rushlake soil and similar soils: 0 to 90 percent; Hangaard soil and similar soils: 0 to 90 percent; Contrasting inclusions: 2 to 25 percent; These two soils occur as areas so variable that mapping them individually was not practical. Some areas consist of both soils and other areas consist of one or the other soil; Landform and position on the landform: Nearly level and slightly convex slopes on lake beaches; Slope range: Rushlake-0 to 3 percent; Hangaard-0 to 2 percent. Shape of areas: elongated; Size of areas: 5 to 40 acres; Typical profile: Rushlake: 0 to 7 inches - black, loamy sand; 7 to 19 inches - brown, coarse sand; 19 to 60 inches - light brownish gray, mottled, calcareous, gravelly coarse sand; Typical profile: Hangaard: 0 to 12 inches - black, sandy loam; 12 to 21 inches - grayish brown, sand; 21 to 30 inches - dark brown, mottled, coarse sand; 30 to 60 inches - grayish brown, mottled, calcareous, gravelly coarse sand; Depth: Very deep; Drainage class: Rushlake-moderately well drained; Hangaard-poorly drained; Permeability: rapid; Available water capacity: low; Organic matter content: Rushlake-moderate; Hangaard-high; Surface runoff: slow; Depth to water table: Rushlake-3 to 5 feet; Hangaard-1 to 3 feet. Land capability classification: Rushlake-4s; Hangaard-4w; Windbreak suitability group: Rushlake-5; Hangaard-2. Major management factors: Rushlake soil - Droughtiness. Hangaard soil - Soil wetness.
1330	Haslie and Nidaros soils, ponded

NONTECHNICAL SOILS DESCRIPTION REPORT

Soils list

Map Symbol	Soil name and description
	Haslie-Nidaros: This soil is very poorly drained. Permeability in the upper part is moderate or moderately rapid. Permeability in the lower part is slow. Available water capacity and organic matter content are very high. Land capability classification: 8W.
1247D	Corliss-Dorset complex, 12 to 20 percent slopes
	CORLISS: This soil is excessively drained. Permeability is rapid. Available water capacity is low. Organic matter content is moderately low or moderate. Depth to the water table is greater than 6 feet. Land capability classification: 6E. Woodland ordination symbol: 6R. DORSET: This soil is well drained. Permeability in the upper part is moderately rapid. Permeability in the lower part is rapid. Available water capacity is low. Organic matter content is moderate or high. Depth to the water table is greater than 6 feet. Land capability classification: 6E. Woodland ordination symbol: 2R.
1250C	Abbeylake-Verndale complex, 6 to 12 percent slopes
	ABBEYLAKE: This soil is excessively drained. Permeability is rapid. Available water capacity is low. Organic matter content is moderately low or moderate. Depth to the water table is greater than 6 feet. Land capability classification: 4S. Woodland ordination symbol: 6S. VERNDALE: This soil is well drained. Permeability in the upper part is moderately rapid. Permeability in the middle part is moderate. Permeability in the lower part is rapid. Available water capacity is low. Organic matter content is moderate. Depth to the water table is greater than 6 feet.
1318	Darnen loam
	Inclusions: Well drained Fordville soils on similar positions. Poorly drained Lakepark soils on lower lying positions. Soils that have a loam, sandy loam or clay loam surface layer.

NONTECHNICAL SOILS DESCRIPTION REPORT

Soils list

Map Symbol	Soil name and description
	Darnen soil and similar soils: 90 to 98 percent; Contrasting inclusions: 2 to 10 percent; Landform and position on the landform:concave and plain slopes on outwash plains and moraines. Slope range: 0 to 3 percent; Shape of areas: elongated; Size of areas: 3 to 20 acres; Typical profile: 0 to 8 inches - black, silt loam; 8 to 39 inches - black, silt loam; 39 to 53 inches - dark brown, silty clay loam; 53 to 60 inches - dark yellowish brown, silty clay loam; Depth: Very deep; Drainage class: Well drained; Permeability: moderate; Available water capacity: high; Organic matter content: high; Surface runoff: medium; Depth to water table: Greater than 6 feet. Land capability classification: 1; Windbreak suitability group: 3.
1825B	Seelyeville muck, seepland, 1 to 10 percent slopes
	Inclusions: Poorly drained Vallers and Forada soils on the edges of the map unit. Soils that have a mucky peat surface layer.
	Seelyeville soil and similar soils: 95 to 98 percent; Contrasting inclusions: 2 to 5 percent; Landform and position on the landform: Gently sloping organics under hydrostatic pressure on moraines and outwash plains; Shape of areas: Irregular; Size of areas: 3 to 80 acres; Typical profile: 0 to 20 inches - very dark gray, calcareous, muck (mixed organic and coprogeneous earth); 20 to 55 inches - dark olive gray, calcareous, muck (mixed organic and coprogeneous earth); 55 to 60 inches - dark gray, calcareous, muck (mixed organic and coprogeneous earth); Depth: Very deep; Drainage class: Very poorly drained; Permeability: moderately rapid; Available water capacity: Very high; Organic matter content: Very high; Surface runoff: slow; Depth to water table: 0 to 2 feet. Land capability classification: 6w.
1975	Oylen sandy loam

Map Symbol	Soil name and description
	Major management factors: Droughtiness, wind erosion, groundwater contamination. Because of the limited available water capacity, crops that tolerate droughty conditions are best suited. Moisture can be conserved by using tillage practices that leave crop residues on the soil surface. Reduce the risk of soil blowing by planting field windbreaks and by maintaining crop residues on the soil surface. Carefully control the use and application of fertilizers, herbicides and insecticides to reduce the risk of groundwater contamination. Inclusions: Poorly drained Forada soils on lower lying positions. Soils that have a coarse sandy loam or fine sandy loam surface layer. Soils that lack an accumulation of clay in the subsoil. Oylen soil and similar soils: 90 to 98 percent; Contrasting inclusions: 2 to 10 percent; Landform and position on the landform: Nearly level and slightly convex areas on outwash plains; Slope range: 0 to 3 percent. Shape of areas: Irregular; Size of areas: 3 to 60 acres; Typical profile: 0 to 10 inches - black, sandy loam; 10 to 13 inches - very dark gray, sandy loam; 13 to 22 inches - dark brown, sandy clay loam; 22 to 33 inches - dark yellowish brown, sand; 33 to 52 inches - dark yellowish brown, mottled, coarse sand; 52 to 60 inches - light brownish gray, mottled, calcareous, coarse sand; Depth: Very deep; Drainage class: Moderately well drained; Permeability: upper part - moderately rapid; below 22 inches - rapid; Available water capacity: low; Organic matter content: moderate; Surface runoff: slow; Depth to water table: 2 to 5 feet. Land capability classification: 3s; Windbreak suitability group: 8.

PHYSICAL PROPERTIES OF SOILS

Soils list

(Entries under "Erosion factors--T" apply to the entire profile. Entries under "Wind erodibility group" and "Wind erodability index" apply only to the surface layer)

Map symbol and soil name	Depth	Clay	Moist bulk density	Permeability	Available water capacity	Shrink-swell potential	Organic matter	Erosion factors			Wind erodibility group	Wind erodibility index
								K	Kf	T		
	In	Pct	g/cc	In/hr	In/in		Pct					
38B:												
Waukon	0-9	12-27	1.40-1.60	0.60-2.00	0.20-0.24	Moderate	2.0-6.0	0.24	0.24	5	6	48
	9-20	18-35	1.40-1.60	0.60-2.00	0.15-0.19	Moderate	0.0-0.5	0.32	0.32			
	20-60	18-30	1.45-1.65	0.60-2.00	0.15-0.19	Low	0.0-0.5	0.32	0.32			
38C:												
Waukon	0-8	12-27	1.40-1.60	0.60-2.00	0.20-0.24	Moderate	2.0-6.0	0.24	0.24	5	6	48
	8-20	18-35	1.40-1.60	0.60-2.00	0.15-0.19	Moderate	0.0-0.5	0.32	0.32			
	20-60	18-30	1.45-1.65	0.60-2.00	0.15-0.19	Low	0.0-0.5	0.32	0.32			
38E:												
Waukon	0-7	12-27	1.40-1.60	0.60-2.00	0.20-0.24	Moderate	2.0-6.0	0.24	0.24	5	6	48
	7-26	18-35	1.40-1.60	0.60-2.00	0.15-0.19	Moderate	0.0-0.5	0.32	0.32			
	26-60	18-30	1.45-1.65	0.60-2.00	0.15-0.19	Low	0.0-0.5	0.32	0.32			
180:												
Gonvick	0-12	10-27	1.30-1.45	0.60-2.00	0.20-0.22	Moderate	2.0-5.0	0.24	0.24	5	6	48
	12-34	22-35	1.35-1.50	0.20-2.00	0.15-0.19	Moderate	1.0-3.0	0.32	0.32			
	34-60	18-35	1.40-1.65	0.60-2.00	0.15-0.19	Low	0.0-0.5	0.32	0.32			
339:												
Fordville	0-10	18-25	1.20-1.30	0.60-2.00	0.18-0.20	Low	3.0-7.0	0.24	0.24	4	6	48
	10-17	18-30	1.25-1.40	0.60-2.00	0.18-0.21	Moderate	1.0-4.0	0.28	0.28			
	17-28	15-30	1.25-1.45	0.60-6.00	0.12-0.18	Low	0.0-2.0	0.28	0.28			
	28-60	0-5	1.60-1.80	6.00-60.00	0.03-0.06	Low	0.0-0.5	0.10	0.17			
375:												
Forada	0-14	10-22	1.20-1.40	0.60-2.00	0.20-0.22	Low	5.0-9.0	0.24	0.24	4	5	56
	14-22	8-18	1.30-1.50	0.60-6.00	0.12-0.19	Low	0.5-1.0	0.28	0.28			
	22-60	0-5	1.50-1.70	6.00-20.00	0.02-0.10	Low	0.0-0.5	0.15	0.17			
440:												
Seelyeville	0-24	---	0.10-0.25	0.20-6.00	0.35-0.45		25-99	---	---	3	2	134
	24-60	---	0.10-0.25	0.20-6.00	0.35-0.45		25-99	---	---			
441:												
Rifle	0-14	---	0.20-0.35	0.60-6.00	0.48-0.58		75-99	---	---	3	5	56
	14-60	---	0.08-0.20	0.60-6.00	0.48-0.58		25-99	---	---			

PHYSICAL PROPERTIES OF SOILS--Continued

Soils list

Map symbol and soil name	Depth	Clay	Moist bulk density	Permeability	Available water capacity	Shrink-swell potential	Organic matter	Erosion factors			Wind erodibility group	Wind erodibility index
								K	Kf	T		
	In	Pct	g/cc	In/hr	In/in		Pct					
544:												
Cathro----------	0-8	---	0.28-0.45	0.20-6.00	0.45-0.55		60-85	---	---	2	2	134
	8-22	---	0.15-0.30	0.20-6.00	0.35-0.45		60-85	---	---			
	22-60	10-30	1.50-1.70	0.20-2.00	0.11-0.19	Low	1.0-5.0	0.20	0.24			
746:												
Haslie----------	0-8	---	0.10-0.30	0.60-6.00	0.35-0.48		60-90	---	---	1	2	134
	8-43	---	0.10-0.30	0.60-6.00	0.35-0.48		60-90	---	---			
	43-60	18-35	0.10-0.50	0.06-0.60	0.18-0.24	Moderate	6.0-20	0.28	0.28			
765:												
Smiley----------	0-13	8-20	1.20-1.50	0.60-2.00	0.20-0.24	Low	2.0-5.0	0.24	0.24	5	5	56
	13-26	18-35	1.35-1.60	0.60-2.00	0.15-0.19	Moderate	0.5-2.0	0.24	0.24			
	26-47	16-32	1.40-1.70	0.60-2.00	0.14-0.19	Low	0.0-0.5	0.24	0.24			
	47-60	16-32	1.40-1.70	0.60-2.00	0.14-0.19	Low	0.0-0.5	0.24	0.24			
778B:												
Dorset----------	0-10	4-18	1.40-1.55	2.00-6.00	0.13-0.15	Low	3.0-5.0	0.20	0.20	4	3	86
	10-20	10-18	1.45-1.65	2.00-6.00	0.12-0.19	Low	1.0-2.0	0.28	0.28			
	20-24	5-10	1.55-1.65	6.00-20.00	0.06-0.10	Low	0.0-0.5	0.10	0.17			
	24-60	0-5	1.55-1.65	6.00-20.00	0.02-0.04	Low	0.0-0.5	0.10	0.15			
Corliss----------	0-5	2-10	1.40-1.60	6.00-20.00	0.10-0.12	Low	1.0-3.0	0.15	0.15	5	2	134
	5-13	0-10	1.50-1.65	6.00-20.00	0.03-0.10	Low	0.0-0.5	0.10	0.15			
	13-60	0-5	1.50-1.65	6.00-20.00	0.02-0.06	Low	0.0-0.5	0.10	0.15			
778C:												
Dorset----------	0-9	4-18	1.40-1.55	2.00-6.00	0.13-0.15	Low	3.0-5.0	0.20	0.20	4	3	86
	9-15	10-18	1.45-1.65	2.00-6.00	0.12-0.19	Low	1.0-2.0	0.28	0.28			
	15-18	5-10	1.55-1.65	6.00-20.00	0.06-0.10	Low	0.0-0.5	0.10	0.17			
	18-60	0-5	1.55-1.65	6.00-20.00	0.02-0.04	Low	0.0-0.5	0.10	0.15			
Corliss----------	0-5	2-10	1.40-1.60	6.00-20.00	0.10-0.12	Low	1.0-3.0	0.15	0.15	5	2	134
	5-60	0-5	1.50-1.65	6.00-20.00	0.02-0.06	Low	0.0-0.5	0.10	0.15			
1015:												
Udipsamments----	0-14	1-15	1.50-1.70	2.00-20.00	0.05-0.10	Low	0.0-0.5	0.15	0.15	5	2	220
	14-60	1-10	1.50-1.70	6.00-20.00	0.05-0.08	Low	---	0.10	0.10			
	60-80	1-10	1.50-1.70	>20.00	0.03-0.05	Low	---	0.05	0.10			
1910:												
Pits.												

PHYSICAL PROPERTIES OF SOILS--Continued

Soils list

Map symbol and soil name	Depth	Clay	Moist bulk density	Permeability	Available water capacity	Shrink-swell potential	Organic matter	Erosion factors			Wind erodibility group	Wind erodibility index
								K	Kf	T		
	In	Pct	g/cc	In/hr	In/in		Pct					
1030 (con.):												
Udipsamments	0-14	1-15	1.50-1.70	2.00-20.00	0.05-0.10	Low	0.0-0.5	0.15	0.15	5	2	220
	14-60	1-10	1.50-1.70	6.00-20.00	0.05-0.08	Low	---	0.10	0.10			
	60-80	1-10	1.50-1.70	>20.00	0.03-0.05	Low	---	0.05	0.10			
1104B:												
Waukon	0-9	12-27	1.40-1.60	0.60-2.00	0.20-0.24	Moderate	2.0-6.0	0.24	0.24	5	6	48
	9-17	18-35	1.40-1.60	0.60-2.00	0.15-0.19	Moderate	0.0-0.5	0.32	0.32			
	17-60	18-30	1.45-1.65	0.60-2.00	0.15-0.19	Low	0.0-0.5	0.32	0.32			
Dorset	0-8	4-18	1.40-1.55	2.00-6.00	0.13-0.15	Low	3.0-5.0	0.20	0.20	4	3	86
	8-14	10-18	1.45-1.65	2.00-6.00	0.12-0.19	Low	1.0-2.0	0.28	0.28			
	14-60	0-5	1.55-1.65	6.00-20.00	0.02-0.04	Low	0.0-0.5	0.10	0.15			
1104C:												
Waukon	0-8	12-27	1.40-1.60	0.60-2.00	0.20-0.24	Moderate	2.0-6.0	0.24	0.24	5	6	48
	8-21	18-35	1.40-1.60	0.60-2.00	0.15-0.19	Moderate	0.0-0.5	0.32	0.32			
	21-60	18-30	1.45-1.65	0.60-2.00	0.15-0.19	Low	0.0-0.5	0.32	0.32			
Dorset	0-7	4-18	1.40-1.55	2.00-6.00	0.13-0.15	Low	3.0-5.0	0.20	0.20	4	3	86
	7-16	10-18	1.45-1.65	2.00-6.00	0.12-0.19	Low	1.0-2.0	0.28	0.28			
	16-60	0-5	1.55-1.65	6.00-20.00	0.02-0.04	Low	0.0-0.5	0.10	0.15			
1113:												
Haslie	0-20	---	0.10-0.30	0.60-6.00	0.35-0.48		60-90	---	---	1	8	---
	20-60	18-35	0.10-0.50	0.06-0.60	0.18-0.24	Moderate	6.0-20	0.28	0.28			
Seelyeville	0-18	---	0.10-0.25	0.20-6.00	0.35-0.45		25-99	---	---	3	8	---
	18-60	---	0.10-0.25	0.20-6.00	0.35-0.45		25-99	---	---			
Cathro	0-23	---	0.28-0.45	0.20-6.00	0.45-0.55		60-85	---	---	2	8	---
	23-60	10-30	1.50-1.70	0.20-2.00	0.11-0.22	Low	1.0-5.0	---	---			
1129:												
Lindaas	0-14	27-35	1.10-1.30	0.60-2.00	0.14-0.17	Moderate	4.0-7.0	0.28	0.28	5	7	38
	14-29	35-60	1.20-1.40	0.06-0.20	0.10-0.14	High	2.0-4.0	0.32	0.32			
	29-60	25-40	1.20-1.50	0.20-0.60	0.11-0.15	Moderate	0.5-1.0	0.32	0.32			
1131B:												
Werndale	0-12	7-12	1.50-1.70	2.00-6.00	0.13-0.17	Low	2.0-4.0	0.20	0.20	3	3	86
	12-16	7-18	1.60-1.70	0.60-2.00	0.14-0.18	Low	0.5-1.0	0.24	0.24			
	16-35	2-6	1.45-1.60	6.00-20.00	0.06-0.08	Low	0.0-0.5	0.10	0.10			
	35-60	0-4	1.45-1.60	6.00-20.00	0.02-0.06	Low	0.0-0.5	0.10	0.10			

PHYSICAL PROPERTIES OF SOILS--Continued

Soils list

Map symbol and soil name	Depth	Clay	Moist bulk density	Permeability	Available water capacity	Shrink-swell potential	Organic matter	Erosion factors			Wind erodibility group	Wind erodibility index
								K	Kf	T		
	In	Pct	g/cc	In/hr	In/in		Pct					
1131B (con.):												
Abbeylake	0-7	2-10	1.40-1.60	6.00-20.00	0.10-0.12	Low	1.0-3.0	0.15	0.15	5	2	134
	7-22	0-10	1.50-1.65	6.00-20.00	0.03-0.11	Low	0.0-0.5	0.10	0.10			
	22-60	0-3	1.50-1.65	6.00-20.00	0.03-0.08	Low	0.0-0.5	0.10	0.10			
1136:												
Nidaros	0-31	---	0.15-0.45	0.20-6.00	0.35-0.45		55-85	---	---	2	2	134
	31-49	8-35	1.50-1.80	0.60-2.00	0.13-0.22	Low	5.0-15	0.24	0.24			
	49-60	0-4	1.40-1.65	6.00-20.00	0.03-0.08	Low	0.0-0.5	0.10	0.15			
1138:												
Rushlake	0-7	3-10	1.50-1.70	6.00-20.00	0.10-0.12	Low	0.5-4.0	0.17	0.17	5	2	134
	7-60	1-10	1.50-1.70	6.00-20.00	0.02-0.10	Low	0.0-0.5	0.05	0.10			
Hangaard	0-13	8-18	1.25-1.45	2.00-6.00	0.10-0.14	Low	3.0-8.0	0.20	0.20	5	3	86
	13-60	2-10	1.50-1.70	6.00-40.00	0.02-0.04	Low	0.0-0.5	0.10	0.15			
1230:												
Haslie	0-18	---	0.10-0.30	0.60-6.00	0.35-0.48		60-90	---	---	1	8	---
	18-60	18-35	0.10-0.50	0.06-0.60	0.18-0.24	Moderate	6.0-20	0.28	0.28			
Nidaros	0-38	---	0.15-0.45	0.20-6.00	0.35-0.45		55-85	---	---	2	8	---
	38-54	8-35	1.50-1.80	0.60-2.00	0.13-0.22	Low	5.0-15	0.20	0.24			
	54-60	0-4	1.40-1.65	6.00-20.00	0.03-0.08	Low	0.0-0.5	0.10	0.15			
1247D:												
Corliss	0-9	2-10	1.40-1.60	6.00-20.00	0.10-0.12	Low	1.0-3.0	0.15	0.15	5	2	134
	9-16	0-10	1.50-1.65	6.00-20.00	0.03-0.10	Low	0.0-0.5	0.10	0.15			
	16-60	0-5	1.50-1.65	6.00-20.00	0.02-0.06	Low	0.0-0.5	0.10	0.15			
Dorset	0-9	4-18	1.40-1.55	2.00-6.00	0.13-0.15	Low	3.0-5.0	0.20	0.20	4	3	86
	9-17	10-18	1.45-1.65	2.00-6.00	0.12-0.19	Low	1.0-2.0	0.28	0.28			
	17-25	5-10	1.55-1.65	6.00-20.00	0.06-0.10	Low	0.0-0.5	0.10	0.17			
	25-60	0-5	1.55-1.65	6.00-20.00	0.02-0.04	Low	0.0-0.5	0.10	0.15			
1250C:												
Abbeylake	0-9	2-10	1.40-1.60	6.00-20.00	0.10-0.12	Low	1.0-3.0	0.15	0.15	5	2	134
	9-16	0-10	1.50-1.65	6.00-20.00	0.03-0.11	Low	0.0-0.5	0.10	0.10			
	16-60	0-3	1.50-1.65	6.00-20.00	0.03-0.08	Low	0.0-0.5	0.10	0.10			

PHYSICAL PROPERTIES OF SOILS--Continued
Soils list

Map symbol and soil name	Depth	Clay	Moist bulk density	Permeability	Available water capacity	Shrink-swell potential	Organic matter	Erosion factors			Wind erodibility group	Wind erodibility index
								K	Kf	T		
	In	Pct	g/cc	In/hr	In/in		Pct					
1250C (con.):												
Verndale	0-8	7-12	1.50-1.70	2.00-6.00	0.13-0.17	Low	2.0-4.0	0.20	0.20	3	3	86
	8-14	7-18	1.60-1.70	0.60-2.00	0.14-0.18	Low	0.5-1.0	0.24	0.24			
	14-28	2-6	1.45-1.60	6.00-20.00	0.06-0.08	Low	0.0-0.5	0.10	0.10			
	28-60	0-4	1.45-1.60	6.00-20.00	0.02-0.06	Low	0.0-0.5	0.10	0.10			
1318:												
Darnen	0-56	18-27	1.25-1.40	0.60-2.00	0.18-0.20	Low	4.0-8.0	0.24	0.24	5	6	48
	56-60	18-30	1.40-1.60	0.60-2.00	0.15-0.19	Moderate	1.0-2.0	0.28	0.28			
1825B:												
Seelyeville	0-60	---	0.10-0.25	0.20-6.00	0.35-0.45		25-99	0.10	0.10	3	8	---
1975:												
Oylen	0-13	7-12	1.50-1.70	2.00-6.00	0.12-0.16	Low	2.0-4.0	0.20	0.20	3	3	86
	13-22	7-18	1.60-1.70	0.60-2.00	0.12-0.18	Low	0.5-2.0	0.24	0.24			
	22-52	2-6	1.45-1.60	6.00-20.00	0.03-0.08	Low	0.0-0.5	0.10	0.10			
	52-60	0-4	1.45-1.60	6.00-20.00	0.03-0.07	Low	0.0-0.5	0.05	0.10			

PHYSICAL PROPERTIES OF SOILS

Endnote -- PHYSICAL PROPERTIES OF SOILS

This report shows estimates of some characteristics and features that affect soil behavior. These estimates are given for the major layers of each soil in the survey area. The estimates are based on field observations and on test data for these and similar soils.

CLAY as a soil separate consists of mineral soil particles that are less than 0.002 millimeter in diameter. In this report, the estimated clay content of each major soil layer is given as a percentage, by weight, of the soil material that is less than 2 millimeters in diameter. The amount and kind of clay greatly affect the fertility and physical condition of the soil. They determine the ability of the soil to adsorb cations and to retain moisture. They influence shrink-swell potential, permeability, plasticity, the ease of soil dispersion, and other soil properties. The amount and kind of clay in a soil also affect tillage and earthmoving operations.

MOIST BULK DENSITY is the weight of soil (ovendry) per unit volume. Volume is measured when the soil is at field moisture capacity, the moisture content at 1/3 bar moisture tension. Weight is determined after drying the soil at 105 degrees C. In this report, the estimated moist bulk density of each major soil horizon is expressed in grams per cubic centimeter of soil material that is less than 2 millimeters in diameter. Bulk density data are used to compute shrink-swell potential, available water capacity, total pore space, and other soil properties. The moist bulk density of a soil indicates the pore space available for water and roots. A bulk density of more than 1.6 can restrict water storage and root penetration. Moist bulk density is influenced by texture, kind of clay, content of organic matter, and soil structure.

PERMEABILITY refers to the ability of a soil to transmit water or air. The estimates indicate the rate of downward movement of water when the soil is saturated. They are based on soil characteristics observed in the field, particularly structure, porosity, and texture. Permeability is considered in the design of soil drainage systems, septic tank absorption fields, and construction where the rate of water movement under saturated conditions affects behavior.

AVAILABLE WATER CAPACITY refers to the quantity of water that the soil is capable of storing for use by plants. The capacity for water storage is given in inches of water per inch of soil for each major soil layer. The capacity varies, depending on soil properties that affect the retention of water and the depth of the root zone. The most important properties are the content of organic matter, soil texture, bulk density, and soil structure. Available water capacity is an important factor in the choice of plants or crops to be grown and in the design and management of irrigation systems. Available water capacity is not an estimate of the quantity of water actually available to plants at any given time.

SHRINK-SWELL POTENTIAL is the potential for volume change in a soil with a loss or gain of moisture. Volume change occurs mainly because of the interaction of clay minerals with water and varies with the amount and type of clay minerals in the soil. The size of the load on the soil and the magnitude of the change in soil moisture content influence the amount of swelling of soils in place. Laboratory measurements of swelling of undisturbed clods were made for many soils. For others, swelling was estimated on the basis of the kind and amount of clay minerals in the soil and on measurements of similar soils. If the shrink-swell potential is rated moderate to very high, shrinking and swelling can cause damage to buildings, roads, and other structures. Special design is often needed. Shrink-swell potential classes are based on the change in length of an unconfined clod as moisture content is increased from air-dry to field capacity. The change is based on the soil fraction less than 2 millimeters in diameter. The classes are "Low," a change of less than 3 percent; "Moderate," 3 to 6 percent; and "High," more than 6 percent. "Very high," greater than 9 percent, is sometimes used.

PHYSICAL PROPERTIES OF SOILS

Endnote -- PHYSICAL PROPERTIES OF SOILS--Continued

ORGANIC MATTER is the plant and animal residue in the soil at various stages of decomposition. In report J, the estimated content of organic matter is expressed as a percentage, by weight, of the soil material that is less than 2 millimeters in diameter. The content of organic matter in a soil can be maintained or increased by returning crop residue to the soil. Organic matter affects the available water capacity, infiltration rate, and tilth. It is a source of nitrogen and other nutrients for crops.

EROSION FACTOR K indicates the susceptibility of the whole soil (including rocks and rock fragments) to sheet and rill erosion by water. Factor K is one of six factors used in the Universal Soil Loss Equation (USLE) to predict the average annual rate of soil loss by sheet and rill erosion in tons per acre per year. The estimates are based primarily on percentage of silt, sand, and organic matter (up to 4 percent) and on soil structure and permeability. Values of K range from 0.05 to 0.69. The higher the value, the more susceptible the soil is to sheet and rill erosion by water.

EROSION FACTOR Kf is like EROSION FACTOR K but it is for the fine-earth fraction of the soil. Rocks and rock fragments are not considered.

EROSION FACTOR T is an estimate of the maximum average annual rate of soil erosion by wind or water that can occur without affecting crop productivity over a sustained period. The rate is in tons per acre per year.

WIND ERODIBILITY GROUPS are made up of soils that have similar properties affecting their resistance to wind erosion in cultivated areas. The groups indicate the susceptibility of soil to wind erosion. Soils are grouped according to the following distinctions:

1. Coarse sands, sands, fine sands, and very fine sands. These soils are generally not suitable for crops. They are extremely erodible, and vegetation is difficult to establish.

2. Loamy coarse sands, loamy sands, loamy fine sands, loamy very fine sands, and sapric soil material. These soils are very highly erodible. Crops can be grown if intensive measures to control wind erosion are used.

3. Coarse sandy loams, sandy loams, fine sandy loams, and very fine sandy loams. These soils are highly erodible. Crops can be grown if intensive measures to control wind erosion are used.

4L. Calcareous loams, silt loams, clay loams, and silty clay loams. These soils are erodible. Crops can be grown if intensive measures to control wind erosion are used.

4. Clays, silty clays, noncalcareous clay loams, and silty clay loams that are more than 35 percent clay. These soils are moderately erodible. Crops can be grown if measures to control wind erosion are used.

PHYSICAL PROPERTIES OF SOILS

Endnote -- PHYSICAL PROPERTIES OF SOILS--Continued

5. Noncalcareous loams and silt loams that are less than 20 percent clay and sandy clay loams, sandy clays, and hemic soil material. These soils are slightly erodible. Crops can be grown if measures to control wind erosion are used.

6. Noncalcareous loams and silt loams that are more than 20 percent clay and noncalcareous clay loams that are less than 35 percent clay. These soils are very slightly erodible. Crops can be grown if ordinary measures to control wind erosion are used.

7. Silts, noncalcareous silty clay loams that are less than 35 percent clay, and fibric soil material. These soils are very slightly erodible. Crops can be grown if ordinary measures to control wind erosion are used.

8. Soils that are not subject to wind erosion because of coarse fragments on the surface or because of surface wetness.

The WIND ERODIBILITY INDEX is used in the wind erosion equation (WEQ). The index number indicates the amount of soil lost in tons per acre per year. The range of wind erodibility index numbers is 0 to 300.

WATER FEATURES

Soils list

Map symbol and soil name	Hydrologic group	Flooding			High water table and ponding				Maximum ponding depth
		Frequency	Duration	Months	Water table depth	Kind of water table	Months	Ponding duration	
					Ft				Ft
38B:									
Waukon	B	None	---	---	>6.0	---	---	---	---
38C:									
Waukon	B	None	---	---	>6.0	---	---	---	---
38E:									
Waukon	B	None	---	---	>6.0	---	---	---	---
180:									
Gonvick	B	None	---	---	2.5-3.5	Apparent	Nov-Jun	---	---
339:									
Fordville	B	None	---	---	>6.0	---	---	---	---
375:									
Forada	B/D	None	---	---	0.5-1.5	Apparent	Oct-Jun	---	---
540:									
Seelyeville	A/D	None	---	---	-1.0-0.5	Apparent	Oct-Jun	---	1.0
541:									
Rifle	A/D	None	---	---	-1.0-1.0	Apparent	Nov-Jun	---	1.0
544:									
Cathro	A/D	None	---	---	-1.0-0.5	Apparent	Oct-Jun	---	1.0
746:									
Haslie	A/D	None	---	---	-1.0-0.5	Apparent	Nov-Jul	---	1.0
765:									
Smiley	B/D	None	---	---	0.5-1.5	Apparent	Apr-Jul	---	---
778B:									
Dorset	B	None	---	---	>6.0	---	---	---	---
Corliss	A	None	---	---	>6.0	---	---	---	---
778C:									
Dorset	B	None	---	---	>6.0	---	---	---	---
Corliss	A	None	---	---	>6.0	---	---	---	---

WATER FEATURES--Continued
Soils list

Map symbol and soil name	Hydrologic group	Flooding: Frequency	Flooding: Duration	Flooding: Months	High water table and ponding: Water table depth	High water table and ponding: Kind of water table	High water table and ponding: Months	High water table and ponding: Ponding duration	High water table and ponding: Maximum ponding depth
					Ft				Ft
1015:									
Udipsamments	A	None	---	---	>6.0	---	---	---	---
1030:									
Pits.									
Udipsamments	A	None	---	---	>6.0	---	---	---	---
1104B:									
Waukon	B	None	---	---	>6.0	---	---	---	---
Dorset	B	None	---	---	>6.0	---	---	---	---
1104C:									
Waukon	B	None	---	---	>6.0	---	---	---	---
Dorset	B	None	---	---	>6.0	---	---	---	---
1113:									
Haslie	D	None	---	---	-3.0-0.0	Apparent	Jan-Dec	---	3.0
Seelyeville	D	None	---	---	-3.0-0.0	Apparent	Jan-Dec	---	3.0
Cathro	D	None	---	---	-4.0-0.5	Apparent	Jan-Dec	---	4.0
1129:									
Lindaas	C/D	None	---	---	1.0-3.0	Apparent	Oct-Jul	---	---
1131B:									
Verndale	B	None	---	---	>6.0	---	---	---	---
Abbeylake	A	None	---	---	>6.0	---	---	---	---
1136:									
Nidaros	A/D	None	---	---	-1.0-0.5	Apparent	Oct-Jun	---	1.0
1138:									
Rushlake	A	None	---	---	2.5-3.5	Apparent	Jan-Dec	---	---
Hangaard	A/D	None	---	---	0.5-1.5	Apparent	Apr-Jul	---	---

WATER FEATURES--Continued
Soils list

Map symbol and soil name	Hydrologic group	Flooding: Frequency	Flooding: Duration	Flooding: Months	High water table and ponding: Water table depth	High water table and ponding: Kind of water table	High water table and ponding: Months	High water table and ponding: Ponding duration	High water table and ponding: Maximum ponding depth
					Ft				Ft
1230:									
Haslie	D	None	---	---	-3.0-0.0	Apparent	Jan-Dec	---	3.0
Nidaros	D	None	---	---	-3.0-0.0	Apparent	Jan-Dec	---	3.0
1247D:									
Corliss	A	None	---	---	>6.0	---	---	---	---
Dorset	B	None	---	---	>6.0	---	---	---	---
1250C:									
Abbeylake	A	None	---	---	>6.0	---	---	---	---
Verndale	B	None	---	---	>6.0	---	---	---	---
1318:									
Darnen	B	None	---	---	>6.0	---	---	---	---
1825B:									
Seelyeville	D	None	---	---	0.0-2.0	Apparent	Jan-Dec	---	---
1975:									
Oylen	B	None	---	---	2.0-5.0	Apparent	Oct-Jun	---	---

WATER FEATURES

Endnote -- WATER FEATURES

This report gives estimates of various soil water features. The estimates are used in land use planning that involves engineering considerations.

Hydrologic soil groups are used to estimate runoff from precipitation. Soils not protected by vegetation are assigned to one of four groups. They are grouped according to the infiltration of water when the soils are thoroughly wet and receive precipitation from long-duration storms. The four hydrologic soil groups are:

Group " A". Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

Group "B". Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group "C". Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group "D". Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a permanent high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

If a soil is assigned to two hydrologic groups in this report, the first letter is for drained areas and the second is for undrained areas. Flooding, the temporary inundation of an area, is caused by overflowing streams, by runoff from adjacent slopes, or by tides. Water standing for short periods after rainfall or snowmelt is not considered flooding, nor is water in swamps and marshes. This report gives the frequency and duration of flooding and the time of year when flooding is most likely. Frequency, duration, and probable dates of occurrence are estimated.

Frequency is expressed as "None", "Rare", "Occasional", and "Frequent". "None" means that flooding is not probable; "Rare" that it is unlikely but possible under unusual weather conditions; "Occasional" that it occurs, on the average, once or less in 2 years; and "Frequent" that it occurs, on the average, more than once in 2 years.

Duration is expressed as "Very brief" if less than 2 days, "Brief" if 2 to 7 days, "Long" if 7 to 30 days, and "Very long" if more than 30 days. The information is based on evidence in the soil profile, namely thin strata of gravel, sand, silt, or clay deposited by floodwater; irregular decrease in organic matter content with increasing depth; and absence of distinctive horizons that form in soils that are not subject to flooding. Also considered are local information about the extent and levels of flooding and the relation of each soil on the landscape to historic floods.

WATER FEATURES

Endnote -- WATER FEATURES--Continued

Information on the extent of flooding based on soil data is less specific than that provided by detailed engineering surveys that delineate flood-prone areas at specific flood frequency levels.

High water table (seasonal) is the highest level of a saturated zone in the soil in most years. The depth to a seasonal high water table applies to undrained soils. The estimates are based mainly on the evidence of a saturated zone, namely grayish colors or mottles in the soil. Indicated in this report are the depth to the seasonal high water table; the kind of water table, that is, "Apparent", "Artesian", or "Perched"; and the months of the year that the water table commonly is high. A water table that is seasonally high for less than 1 month is not indicated in this report.

An "Apparent" water table is a thick zone of free water in the soil. It is indicated by the level at which water stands in an uncased borehole after adequate time is allowed for adjustment in the surrounding soil.

An "Artesian" water table exists under a hydrostatic beneath an impermeable layer. When the impermeable layer has been penetrated by a cased borehole, the water rises. The final level of the water in the cased borehole is characterized as an artesian water table.

A "Perched" water table is water standing above an unsaturated zone. In places an upper, or "Perched", water table is separated from a lower one by a dry zone. Only saturated zones within a depth of about 6 feet are indicated.

Ponding is standing water in a closed depression. The water is removed only by deep percolation, transpiration, evaporation, or a combination of these processes.

This report gives the depth and duration of ponding and the time of year when ponding is most likely. Depth, duration, and probable dates of occurrence are estimated.

Depth is expressed as the depth of ponded water in feet above the soil surface. Duration is expressed as "Very brief" if less than 2 days, "Brief" if 2 to 7 days, "Long" if 7 to 30 days, and "Very long" if more than 30 days. The information is based on the relation of each soil on the landscape to historic ponding and on local information about the extent and levels of ponding.