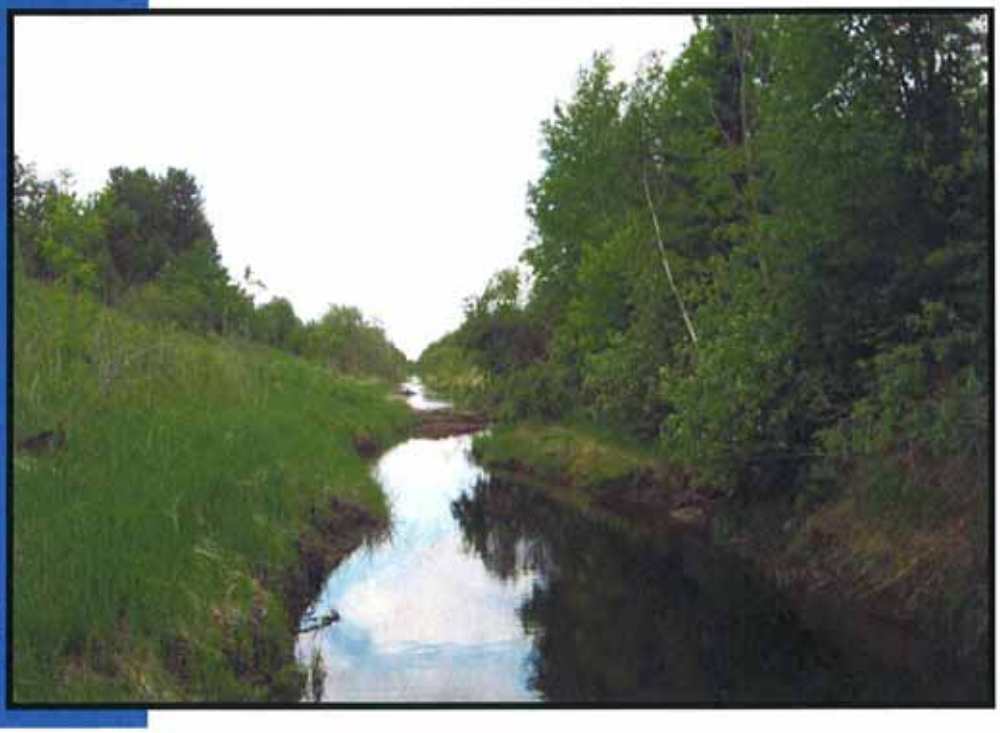
Palmville Flood Damage Reduction and Fen Restoration Project

Engineer's Report

Roseau River Watershed District

July 23, 2007



Prepared by:

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ENGINEER'S REPORT

PALMVILLE FLOOD DAMAGE REDUCTION AND FEN RESTORATION PROJECT

ROSEAU RIVER WATERSHED DISTRICT

July 25, 2007

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

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APPENDICES

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ACRONYMS AND SHORT FORMS

CMP	CORRUGATED METAL PIPE
CN	CURVE NUMBER
DNR	DEPARTMTENT OF NATURAL RESOURCES
EPA	ENVIRONMENTAL PROTECTION AGENCY
FDR	FLOOD DAMAGE REDUCTION
GIS	GEOGRAPHIC INFORMATION SYSTEM
GPS	GLOBAL POSITIONING SYSTEM
HEC	USACE HYDROLOGIC ENGINEERING CENTER
HMS	HYDROLOGIC MODELING SYSTEM
JD	JUDICIAL DITCH
MNDNR	MINNESOTA DEPARTMENT OF NATURAL RESOURCES
NPDES	NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM
NRCS	NATURAL RESOURCES CONSERVATION SERVICE, FORMALLY THE SCS
NRE	NATURAL RESOURCES ENHANCEMENT
NWS	NATIONAL WEATHER SERVICE
R	SCS STORAGE COEFFICIENT
RAS	HEC RIVER ANALYSIS SYSTEM
RCP	REINFORCED CONCRETE PIPE
RRWMA	ROSEAU RIVER WILDLIFE MANAGEMENT AREA

RRWMB	RED RIVER WATERSHED MANAGEMENT BOARD
SCS	SOIL CONSERVATION SERVICE
SS	STEADY STATE CONDITIONS MODELING
T_c	TIME OF CONCENTRATION
USACE	UNITED STATES ARMY CORPS OF ENGINEERS
USDA	UNITED STATES DEPARTMENT OF AGRICULTURE
USS	UNSTEADY STATE CONDITIONS MODELING
WCA	WETLAND CONSERVATION ACT
WSE	WATER SURFACE ELEVATION

1.0 EXECUTIVE SUMMARY

The Palmville Fen is a major wetland area covering approximately 3,000 acres located in the upper watershed of the South Fork of the Roseau River, primarily on land owned and managed by the State of Minnesota Department of Natural Resources. The fen has been degraded by the construction of judicial and county ditch systems over the last one hundred years. Currently, almost all of the incoming water from the 33 square mile (mi^2) drainage area enters the existing channel of the Judicial Ditch 63 (JD 63), where it flows to the South Fork of the Roseau River. The existing conditions only allow minimal amounts of 1-year to 10-year runoff events out of the channel banks as surface flow spilling out into the surrounding fen.

The Palmville project is a flood damage reduction (FDR) and natural resource enhancement (NRE) project. Flood control benefits would be provided to immediate areas downstream, the City of Roseau, and the City of Wannaska. Fen restoration would hopefully be accomplished by encouraging a greater depth and duration of surface and subsurface flow to spill from the main channel and seep into the adjacent fen. The placement of 2 proposed stoplog control structures will also allow flow to continue down the main channel, maintaining the ditches existing capacity for all future flood events. Figure 1 displays the project location.

2.0 INTRODUCTION

The Palmville Flood Damage Reduction and Fen Restoration Project is located in Sections 23, 24, 25 & 26 of Poplar Grove Township and Sections 19, 20, 29 & 30 of Palmville Township in Roseau County, Minnesota. The local area and areas downstream are flood prone, affected by repetitive flooding on a consistent basis. The primary reason for flooding in this area is due to topography. Much of the RRWD basin is the flat ancestral bed of Lake Agassiz, averaging 3 to 5 feet of vertical drop in elevation per mile. When heavy rains fall on this flat area, the land is unable to drain quickly and flooding can result. Compounding the flooding is the fact that there are ridges and steeper topography in some portions of the watershed. These areas drain more quickly, and inundate the flatter lands downstream.

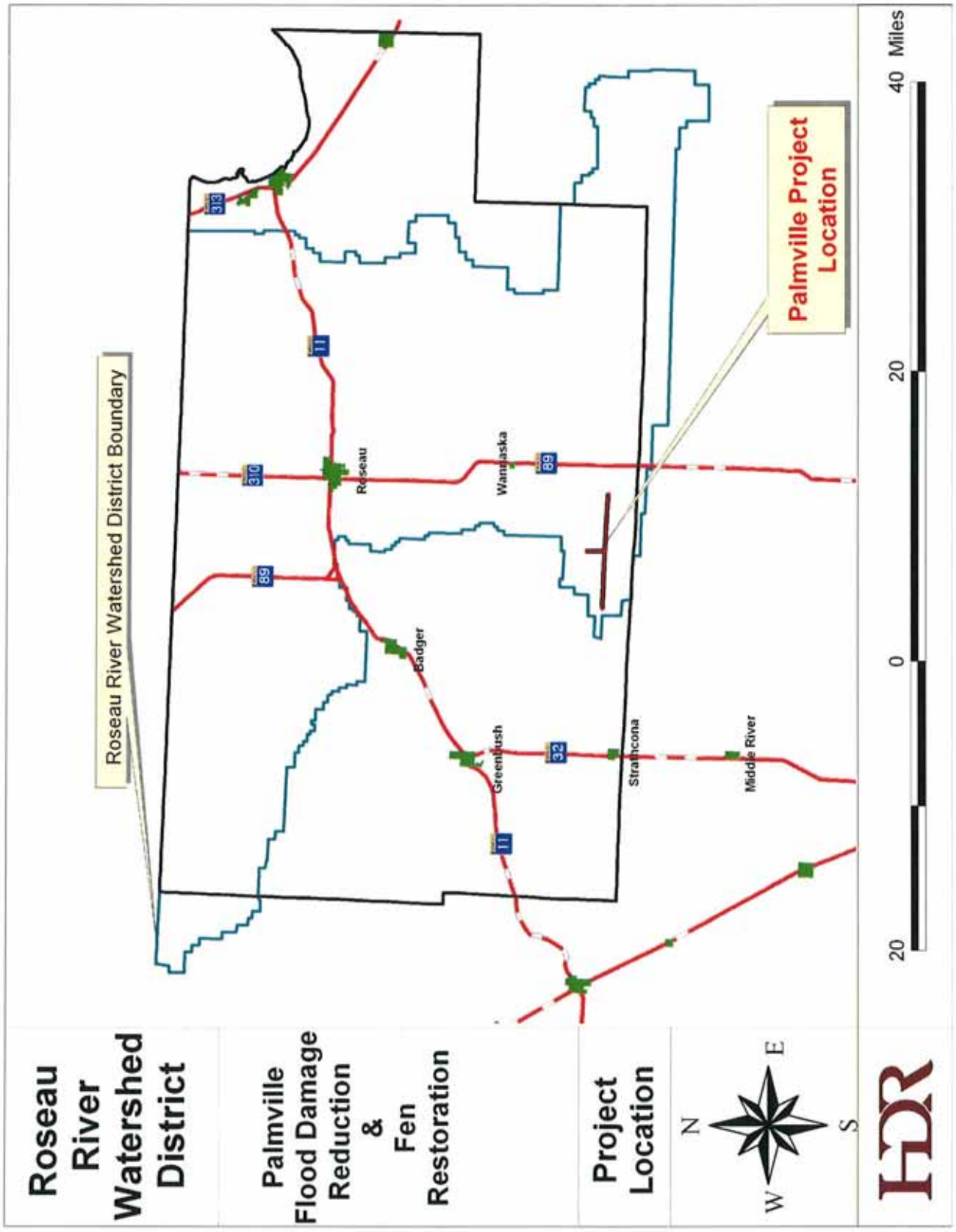
Since settlement of the area, drainage programs have removed nearly 56% of the wetlands of Roseau County. Fens are among the types of wetlands that have been removed or degraded. A fen is a peat-forming wetland that receives nutrients from sources other than precipitation, such as from upslope sources through drainage from

surrounding mineral soils and from groundwater movement. Fens, like bogs, provide important benefits in a watershed, including preventing or reducing the risk of floods, improving water quality, and providing habitat for unique plant and animal communities. Restoration of the Palmville Fen can have benefits for the wildlife in the watershed.

The purpose of the project is to provide local and regional flood control, as well as the environmental benefit of the restoration of the fen. The work to be performed during the construction and operation of this project includes:

1. Placement of 2 stoplog control structures and riprap
2. Access improvements
3. Ditch cleaning and beaver dam removal (ditch maintenance)
4. FDR and NRE monitoring
5. Future modifications, if any, based upon monitoring and Project Team recommendations

FIGURE 1
PROJECT AREA



3.0 SUMMARY OF ACTIVITIES

Flood Damage Reduction Approach

The Roseau River Watershed District's (RRWD) flooding problems will not be solved with the construction of one project at one specific location. Only a comprehensive approach with many types of projects and various water management techniques will be successful in solving the flooding problems in the District. The Red River Flood Damage Reduction Work Group (RRFDRWG) Agreement of December 1998 is the framework for flood damage reduction projects in the Red River Basin. The RRWD works within the guidelines of the mediation process established by the RRFDRWG in the development of potential flood control projects. The purpose of the mediation process was to reach an agreement on long-term solutions for reducing flood damage and ensuring the protection and enhancement of natural resources. The primary focus of this agreement is to balance economic, environmental and social considerations when planning and implementing flood damage reduction and natural resource enhancement projects in the District. The District encourages participation by local, state and federal governments, natural resource agencies, conservation organizations and local citizens in this planning process.

A Project Team was organized and has been meeting monthly to discuss project planning and design elements, starting most recently in 2006. Project team members include:

- TODD MILLER – RRWD Board
- JIM COURNEYA - MPCA
- BRIAN KETRING - Roseau Co. HD
- LAYTON OSLAND - Landowner
- RANDY PRACHAR – DNR Wildlife
- KELLY URBANEK - USCOE
- LEROY CARRIERE – RRWD Board
- GRACIA NELSON – Roseau Co. EMO
- DON BUCKOUT - DNR
- DAN THUL - DNR Waters
- WES PESEK - Landowner
- BRIAN DWIGHT -BWSR
- MIKE LARSON - DNR Fisheries
- BETTY LARSON - Landowner
- STEVE LEE – RRWD Board
- RRWD staff and OTHERS

The project components discussed in this report have been thoroughly discussed by the Project Team, to the extent that consensus has been achieved as an indication of willingness and agreement to participate by the District, State, and Landowners in attendance at the meetings.

The concept of a "Palmville Project" is decades old. Flood damage reduction has been discussed at the watershed and state level on numerous occasions, usually centering

around development of some sort of flood control impoundment with embankments and a control gate. Most recently, the RRWD renewed planning efforts for a project in the Palmville area after floods devastated the watershed and the City of Roseau in June 2002. The State Legislature appropriated specific funding for engineering and construction, which is administered through a grant from the DNR FDR grant program.

The overall goals for the RRWD include:

Flood Damage Reduction (FDR) Goals

- Provide 100-year flood protection for the City of Roseau and rural homesteads in the district.
- Provide 10-year flood protection for agricultural lands.
- Reduce flood damage to roads and crossings.
- Reduce drought damages.
- Preserve ground water supply and recharge areas.

Natural Resource Enhancement (NRE) Goals

- Protect, restore, enhance and manage lakes and streams in the RRWD to support sustainable aquatic communities.
- Manage wetland and upland habitats to support sustainable wildlife communities.
- Preserve, protect and restore unique natural resource communities and other features in the watershed.
- Increase and promote outdoor recreational activities related to fish, wildlife and other natural resources in the watershed.
- Improve water quality in the RRWD.

The Palmville Flood Damage Reduction and Fen Restoration Project will contribute to several of these RRWD goals.

4.0 GEOTECHNICAL DISCUSSION

The soils data discussed in this report was obtained from the United States Department of Agriculture (USDA) Natural Resource Conservation Service (NRCS) and the Minnesota Agriculture Experimentation Station's "Soil Survey of Roseau County, Minnesota."

The soils that are located in the Project Area are listed in Table 1; Table 1 displays the Soil type in the project location, the square feet and acreage of each soil type and the overall percentage of the soil type throughout the project area. Figure 2 displays the NRCS Soil Survey Data at the Palmville Site.

TABLE 1
PALMVILLE SOIL TYPES

Symbol	Name	Area (sq. ft.)	Area (acre)	Percentage of Total Area (%)
111	Hangaard Sandy Loam	595,427	13.67	0.34%
116	Redby Loamy Fine Sand	3,452,633	79.26	1.95%
117	Cormant Loamy Fine Sand	2,762,311	63.41	1.56%
145	Enstrom loamy sand	258,732	5.94	0.15%
187	Haug Muck	1,843,187	42.31	1.04%
205	Karlstad Loamy Sand	3,964,468	91.01	2.24%
383	Percy Loam	4,285,115	98.37	2.42%
384	Percy Mucky Loam	811,340	18.63	0.46%
435	Syrene Sandy Loam	919,798	21.12	0.52%
439	Strathcona Fine Sandy Loam	2,837,422	65.14	1.60%
481	Kratke Fine Sandy Loam	1,102,257	25.30	0.62%
482	Grygla Loamy Fine Sand	1,724,046	39.58	0.97%
540	Seelyeville Muck	19,163,848	439.94	10.83%
541	Rifle Mucky Peat	57,875,655	1,328.64	32.69%
543	Markey Muck	17,101,751	392.60	9.66%
544	Cathro Muck	10,941,713	251.19	6.18%
547	Deerwood Muck	13,587,150	311.92	7.68%
563	Northwood Muck	8,316,750	190.93	4.70%
565	Eckvoll Loamy Fine Sand	1,494,344	34.31	0.84%
712	Rosewood Fine Sandy Loam	91,084	2.09	0.05%
794	Clearriver Loamy Fine Sand	245,288	5.63	0.14%
1144	Strathcona and Kratke Soils (depressionable)	605,007	13.89	0.34%
1191	Sahkahtay Sandy Loam	430,901	9.89	0.24%
1401	Grygla Mucky Loam Fine Sand	1,787,940	41.05	1.01%
1807	Cathro Muck - Ponded	3,244,427	74.48	1.83%
1808	Markey Muck - Ponded	8,766,057	201.24	4.95%
1327b	Karlstad - Marquette Complex	3,483,257	79.96	1.97%
48b	Hiwood Fine Sand	5,327,126	122.29	3.01%
Total Area		177,019,034	4,063.80	100.00%

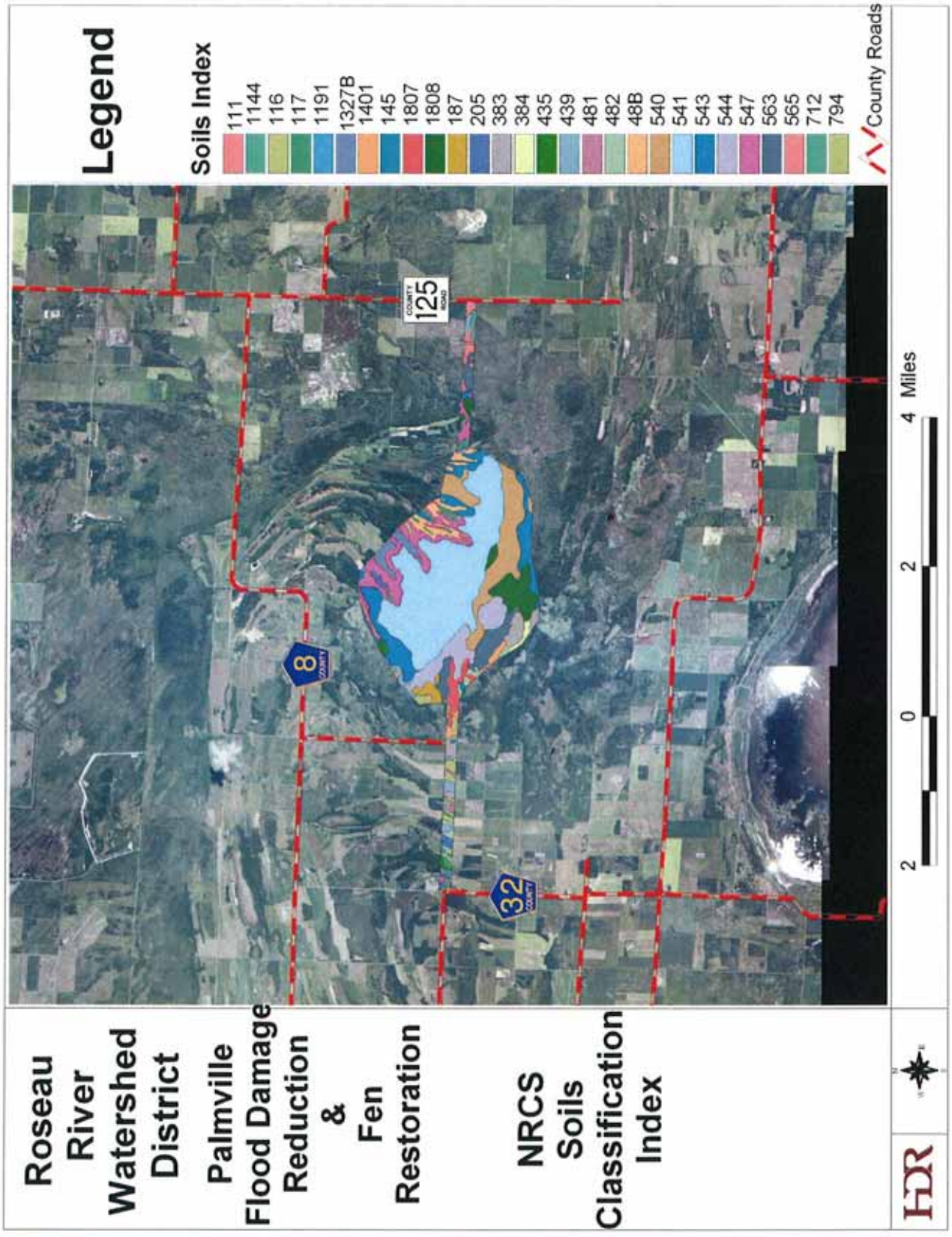
The soils located at the Project site are primarily Rifle Mucky Peat, shown in Table 1 as being over 32% of the Project area. Rifle Mucky Peat, as classified by the NRCS, consists of a very deep, poorly drained soils, formed in organic deposits more than 51 inches thick in bogs and depressionable areas. These soils have moderately rapid permeability. Slopes range from 0 to 2%.

The Project site also contains ridges of sand where the control structures will be placed. The ridges contain three different types of sand, Redby Loamy Fine Sand, Cormant

Loamy Fine Sand and Hiwood Fine Sand. The Redby Series and the Cormant Series consists of very deep, poorly drained soils that formed in glacial lacustrine or outwash sediments on glacial lake plains. These soils have rapid permeability and slopes that range from 0%-3%. The Hiwood series consists of very deep, moderately well drained soils that formed in sandy glacial lacustrine or outwash sediments on glacial lake plains or outwash plains. Permeability is rapid. Slopes range from 0 to 12 percent.

The Engineering Properties of the soils are located in Appendix B.

FIGURE 2
NRCS SOILS MAP



5.0 DESIGN ALTERNATIVES

Three distinct types of design alternatives were explored as possibilities for the Project. Each alternative is a form of hydraulic structure that would provide potential operational changes in the ditch, enhancing FDR and potentially improving the fen. Each alternative was modeled in unsteady HEC-RAS to better simulate flood storage and attenuation, and then compared with the existing conditions based upon each alternative's ability to inundate the wetland, to document duration of inundation and water surface elevation.

Figure 3 displays the existing features of the Palmville site. Some items of note are the locations of the existing structures. Existing land uses in the basin consists of agricultural lands, gravel pits, forested areas and wetlands. Figure 4 shows current land use in the Palmville area.

- **Alternative 1—Replace Existing Culverts with 36" CMPs**

Alternative 1 is the option of replacing the two existing 60" CMP with 2-36" CMP. After replacement, riprap would be installed. The goal of this alternative would be to cause flow restrictions, forcing the water surface elevations to rise and spill out of the channel temporarily while allowing flow to continue down the main channel.

- **Alternative 2—Replace Existing Culverts with Fixed Crest Weirs**

Alternative 2 consists of replacing the two existing 60" CMP with fixed crest weirs set at an elevation about half the channel depth, or "channel half full". This option would impound water to the elevation of the top of the weirs as well as spill the water out of the channel into the fen during runoff events. During extremely high flow, water would be able to spill over the weirs and continue down the main channel.

- **Alternative 3—Replace Existing Culverts With 2 Gated Control Structures with Stoplogs**

Alternative 3 consists of replacing the two existing 60" CMP with 2 CMP gated control structures. The control structures would enable the District to dictate the permanent pool elevation with stoplogs, thereby affecting the elevation of the water depth in the fen during runoff events. Three variations on this Alternative are evaluated in this report:

1. No permanent pool (ditch empty)
2. Stoplogs set at about half the ditch depth (ditch half full ~3.5 feet)
3. Stoplogs set at full ditch depth (ditch full ~ 7 feet)

Figure 5 displays an example of the Gated Control Structure.

FIGURE 3
SITE MAP

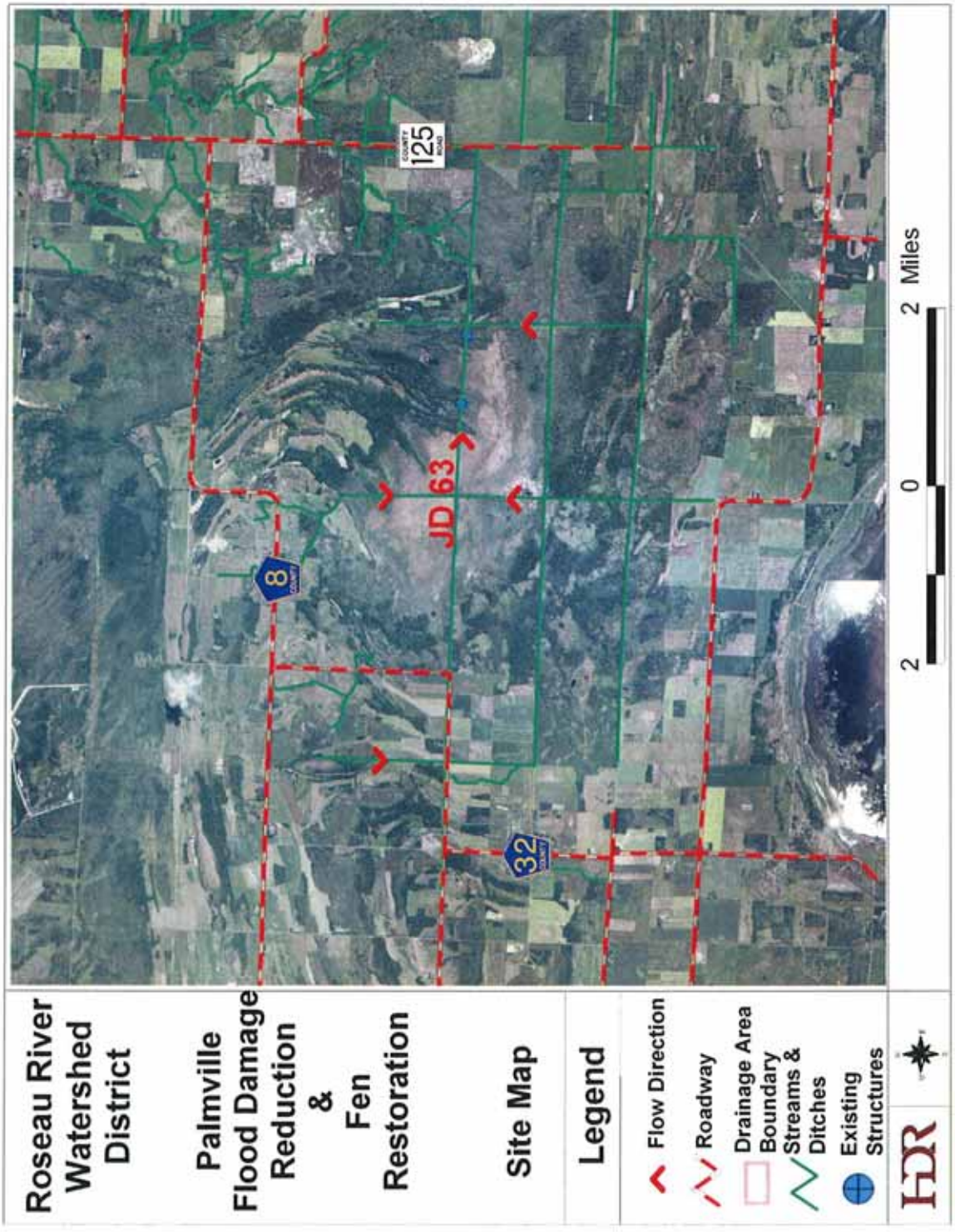


FIGURE 4
PALMVILLE LAND USE

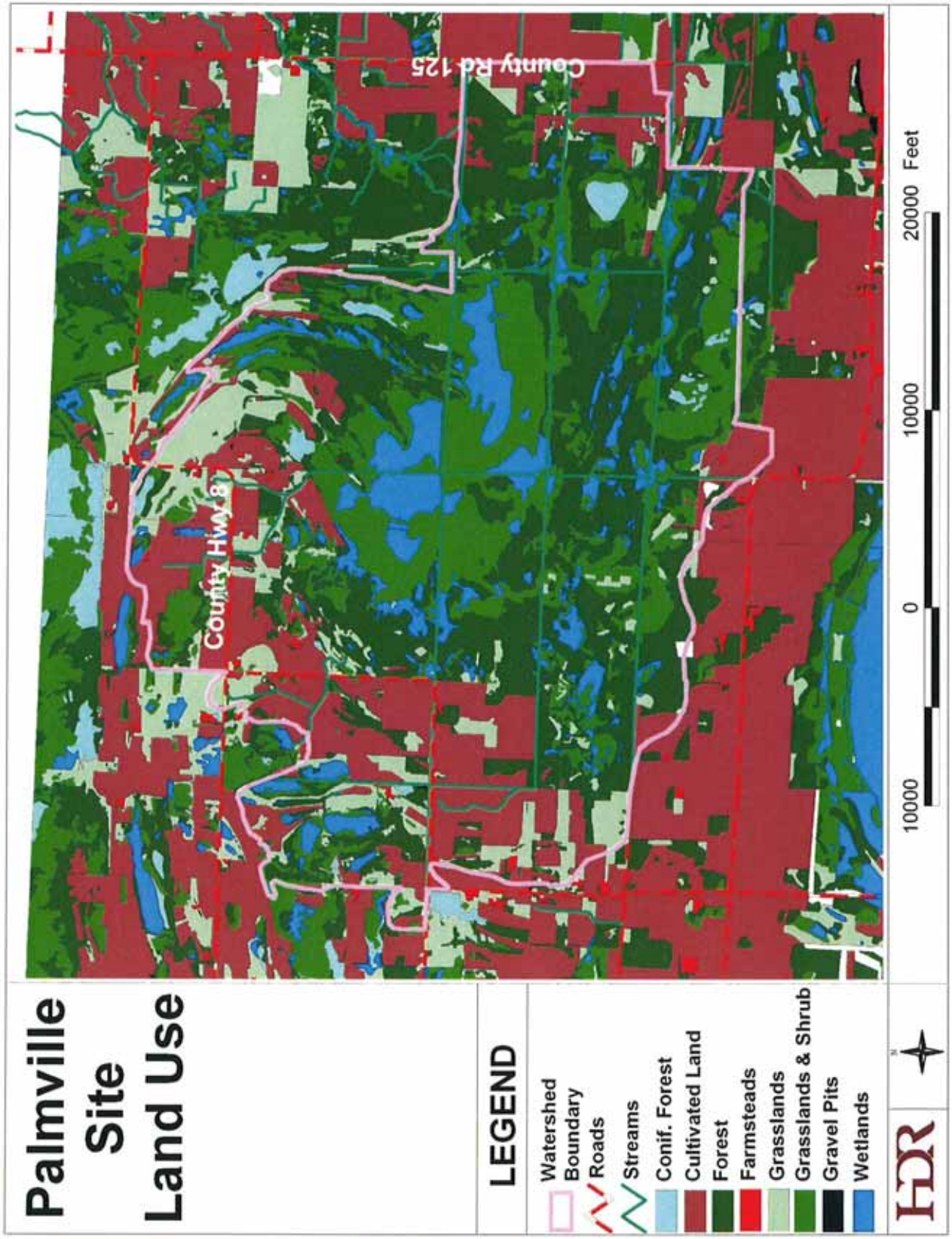
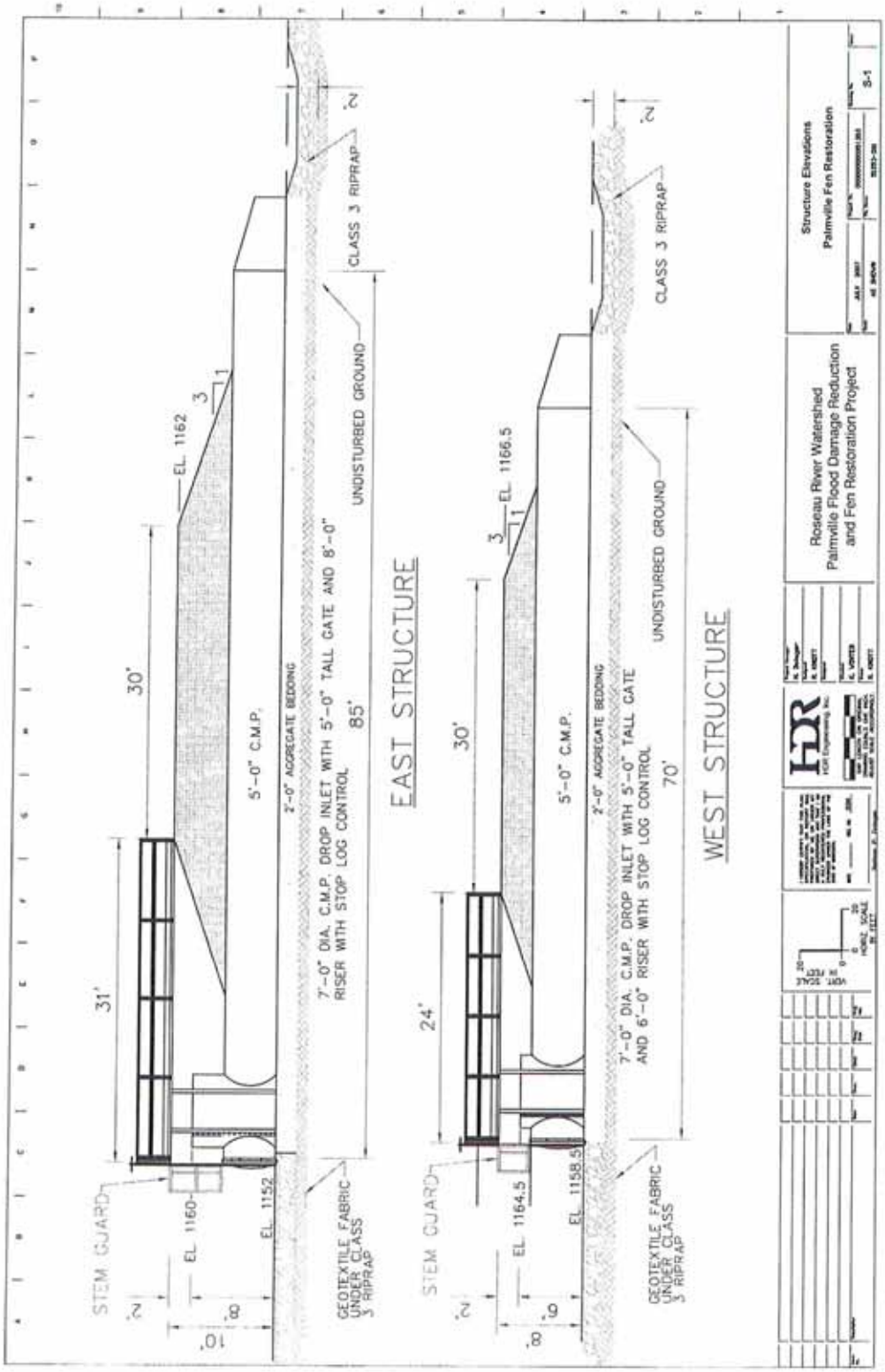


FIGURE 5
GATED CONTROL STRUCTURE



6.0 HYDROLOGY

The Palmville site has a drainage area of approximately 33 mi^2. Currently the water from a runoff event enters and exits the site along J.D. 63, where it is carried downstream to the South Fork of the Roseau River, and eventually makes its way to the Red River of the North. Figure 6 displays the delineated watershed for the project location. The United States Army Corps of Engineers (US ACE) Hydraulic Engineering Center's Hydrologic Modeling System (HEC-HMS) was used to determine the hydrologic data for this site. HEC-HMS provided the inflow hydrographs used during the modeling of the site in HEC-RAS.

A rainfall-runoff model of the Roseau River basin was developed by the Roseau River Water District ("District Model"). The District Model uses the HEC-1 software to simulate both spring run-off conditions as well as standard SCS loss methods. For further analysis for this report, the District Model was imported into the more recent HEC-HMS software.

The 100-year storm events were obtained from the Rainfall Frequency Atlas of the Midwest (Huff and Angel, 1992). All results presented in this document refer to a Spring 10 day runoff event. Table 2 displays the event precipitation; Table 3 displays the HMS Parameters used. Figure 6 shows a comparison of the peak discharges of the Roseau River at Roseau and JD 63. The routed peak flow from the Palmville area likely coincides quite closely with the peak of the Roseau River in the City of Roseau.

TABLE 2
HYDROLOGIC DATA SUMMARY

Event	Precipitation (inches)
10-Year, 10-Day	5.74
25-Year, 10-Day	6.79
50-Year, 10-Day	7.65
100-Year, 10-Day	8.31

TABLE 3
HMS PARAMETERS

Sub-Basin	Drainage Area (sq mi)	SCS Runoff Curve No.	Time of Concentration (Hours)	Storage Co-efficient (Hours)
		10-Day		
A	3.79	62	6.98	19.54
B	2.45	63	9.62	26.94
C	1.27	60	7.06	19.77
D	4.44	54	15.4	43.18
E	1.25	57	11.52	24.19
F	2.93	48	16.27	22.78
G	2.69	47	6.25	13.13
H	2.9	47	7.84	16.46
I	1.29	45	5.11	16.67
J	7.65	62	13.89	45.30
K	2.36	62	7.85	25.61

FIGURE 6
PEAK DISCHARGE COMPARISSON OF ROSEAU RIVER AT ROSEAU AND JD 63

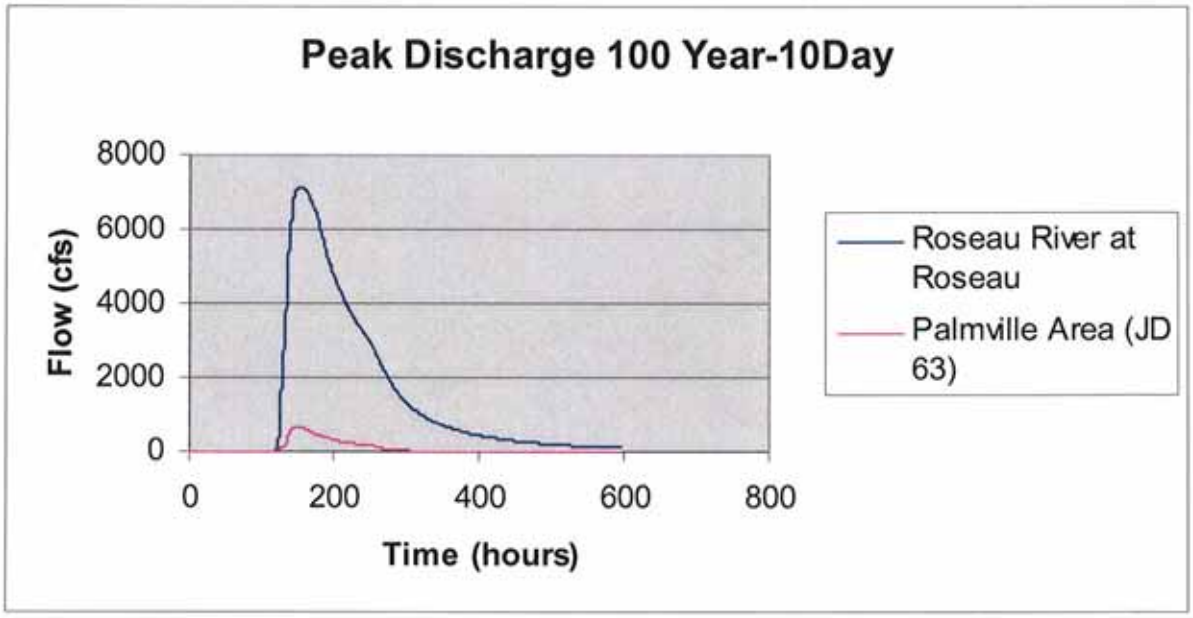
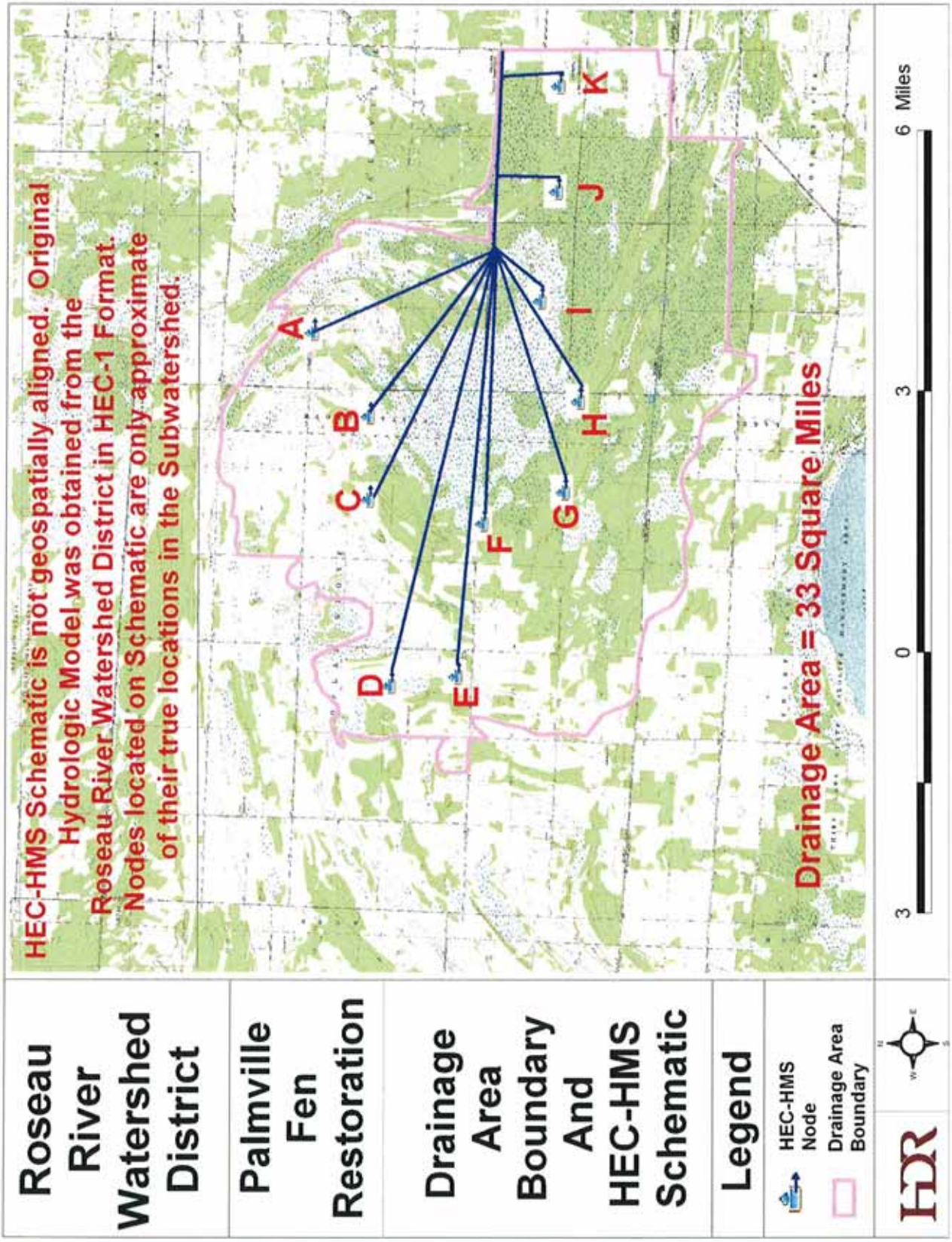


FIGURE 7
DRAINAGE AREA BOUNDARY AND HEC-HMS SCHEMATIC



7.0 HYDRAULICS

The site was modeled using both Steady State (SS) and Unsteady State Conditions (USS). Table 4 shown below displays the peak discharges used during the SS analysis.

TABLE 4
HEC-HMS PEAK FLOWS

Event	Peak Flow (cfs)	Total Runoff Volume (ac-ft)
10-Year, 10-Day	267	2088
25-Year, 10-Day	423	3012
50-Year, 10-Day	557	3826
100-Year, 10-Day	672	4489

Survey data was collected on November 15th of 2006 by HDR Engineering, Inc. The survey data collected helped develop the cross sections used in the RAS model. Figure 8 displays an example of a cross section in the RAS model. Figure 9 demonstrates the channel profile.

FIGURE 8
PALMVILLE HEC-RAS CROSS SECTION

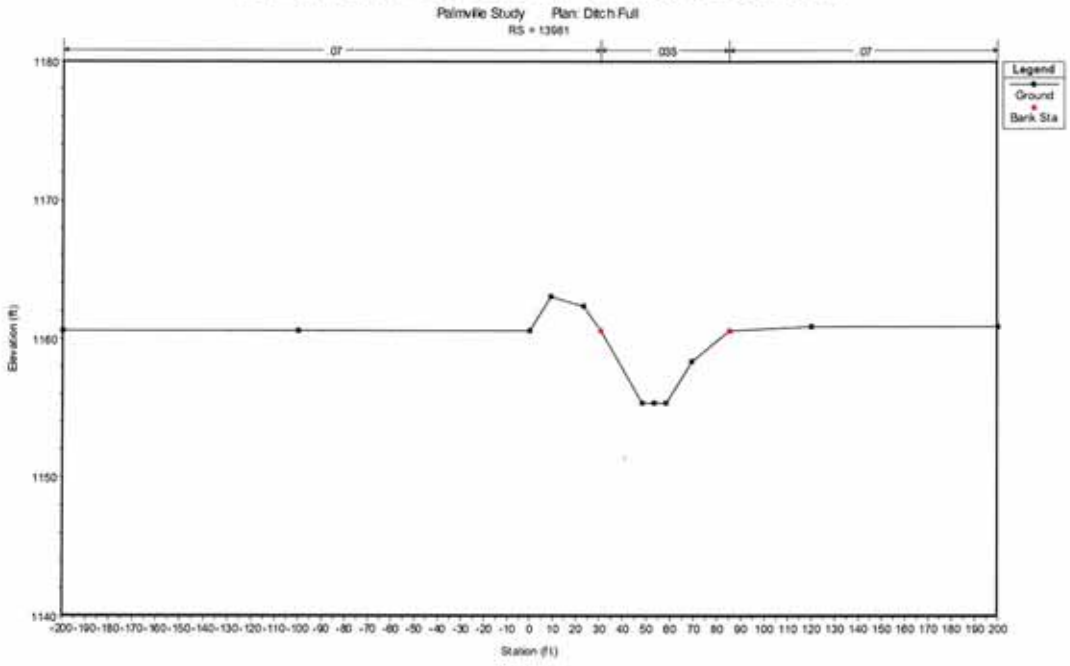
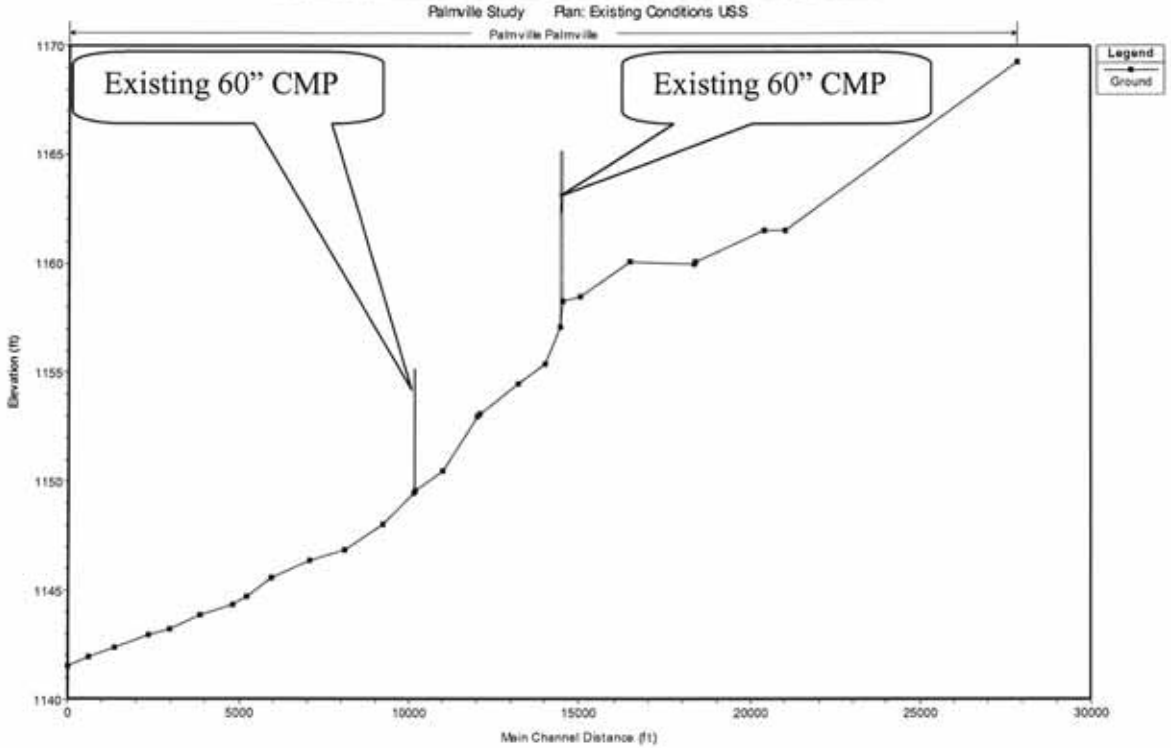


FIGURE 9
PALMVILLE HEC-RAS DITCH PROFILE



During the course of the modeling Alternatives 1-3 were investigated for their performance with both the SS and USS conditions. The average WSE between the two existing structure locations was used to identify the ability of each alternative to inundate the wetland, and the duration of the inundation. The fen pool depth elevation along with the duration of the overbank flooding is listed in Table 5 below. Figure 10 shows the profile of the water surface elevation with respect to the south overbank of the proposed conditions. Figure 11 demonstrates the theoretical route of surface flow for the simulated events.

FIGURE 10
PALMVILLE HEC-RAS SIMULATION PROFILE OF PROPOSED CONDITIONS 100 YEAR- 10 DAY

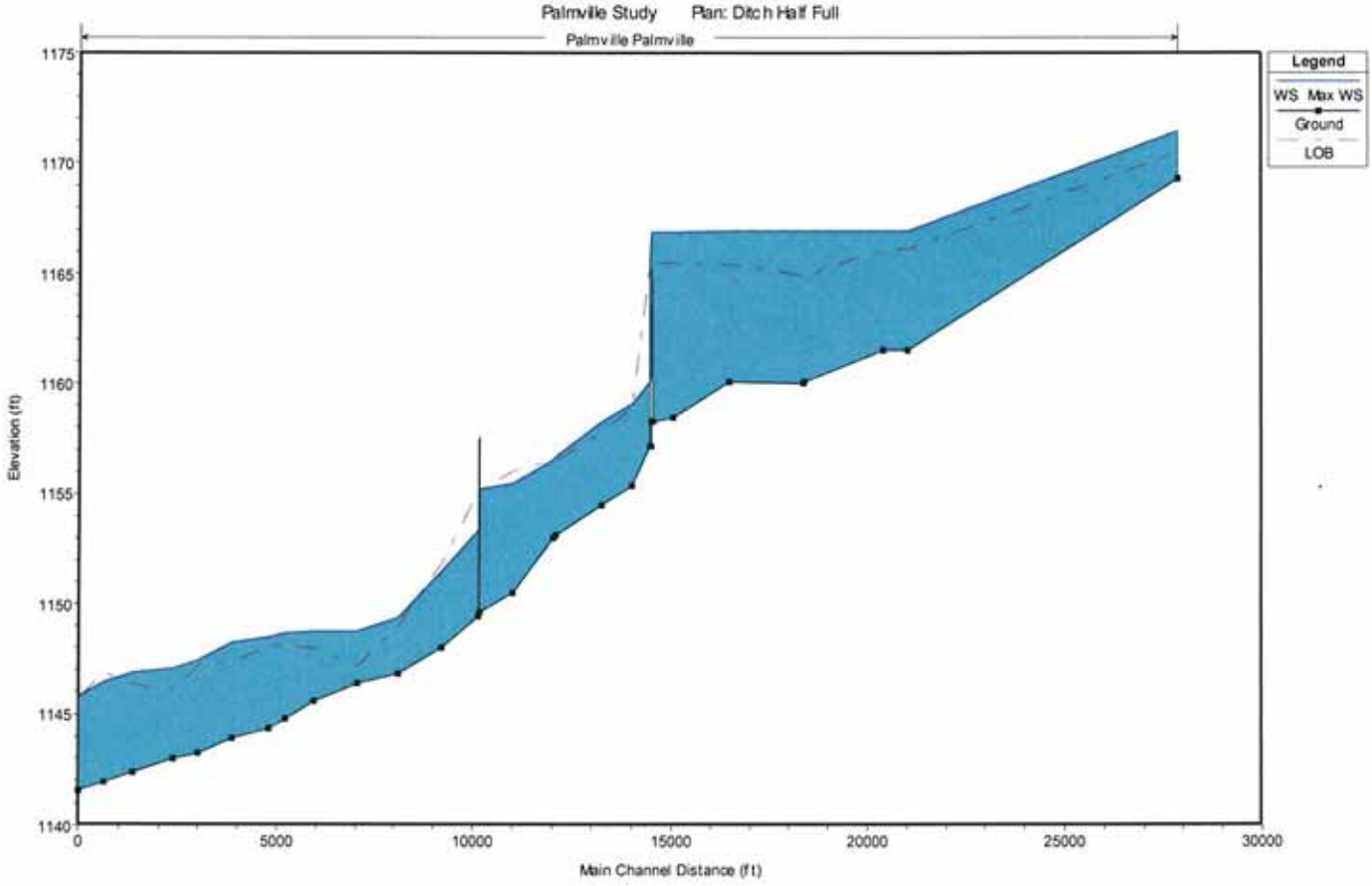


FIGURE 11
PALMVILLE POTENTIAL FLOW PATH

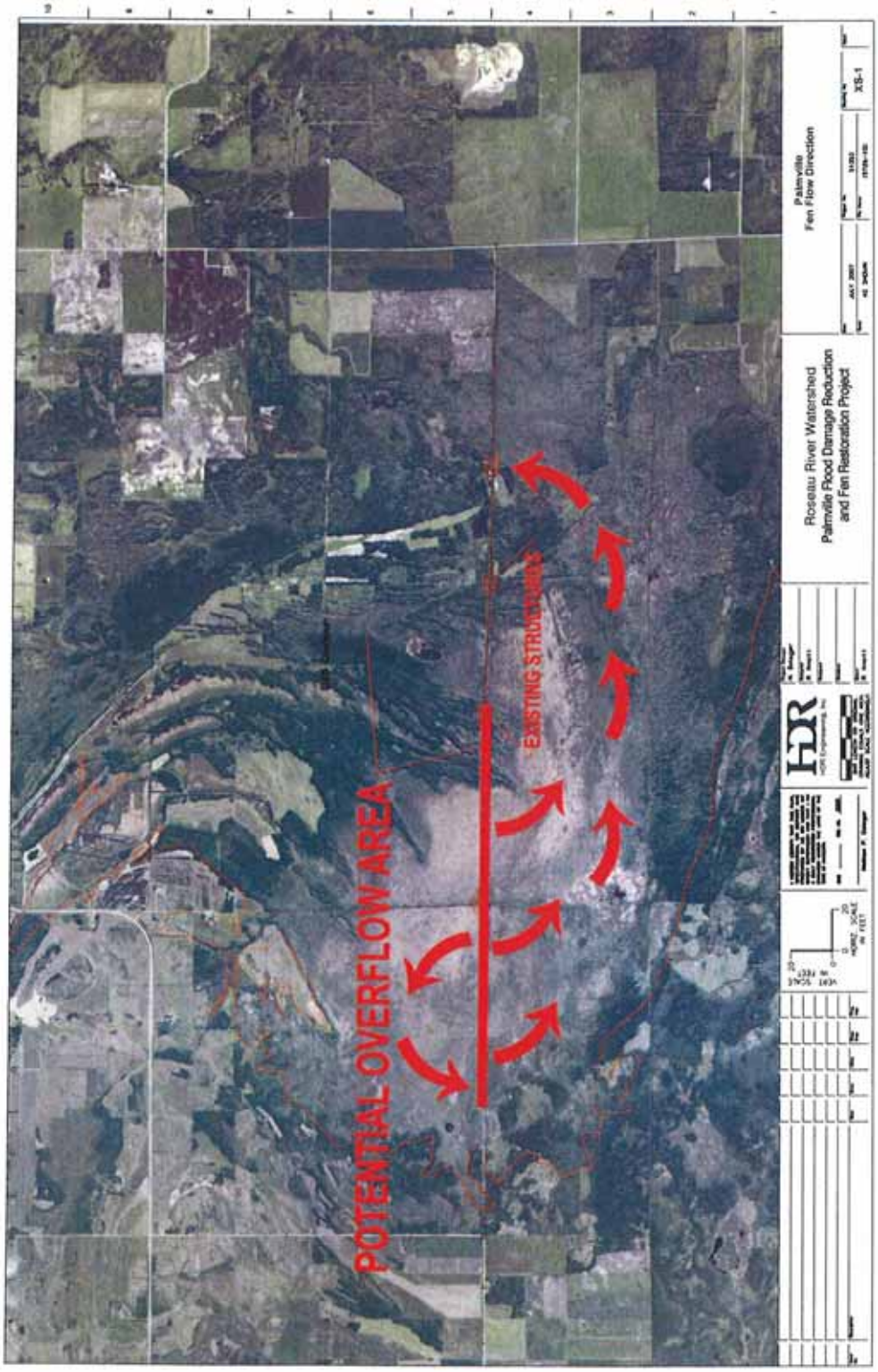


TABLE 5
SIMULATION RESULTS

	Alternative	10-Year Event		100-Year Event	
		Duration (Hours)	Fen Pool Depth (feet)	Duration (Hours)	Fen Pool Depth (feet)
--	Existing Conditions	47	0.11	161	1.18
1	36 inch CMP	107	0.46	241	1.36
2	½ Channel Weirs	97	0.32	253	1.47
3-1	Gated Structure (Ditch Empty)	47	0.11	161	1.18
3-2	Gated Structure (Ditch ½ Full)	97	0.32	253	1.47
3-3	Gated Structure (Ditch Full)	98	0.33	326	1.76

Figures 12 to 17 show the inflow vs. outflow of each alternative respectively. Inflow is represented by inflow on the west end of the project; outflow is represented by outflow on the east end of the project.

FIGURE 12
EXISTING CONDITIONS INFLOW/OUTFLOW HYDROGRAPH 100-YEAR EVENT

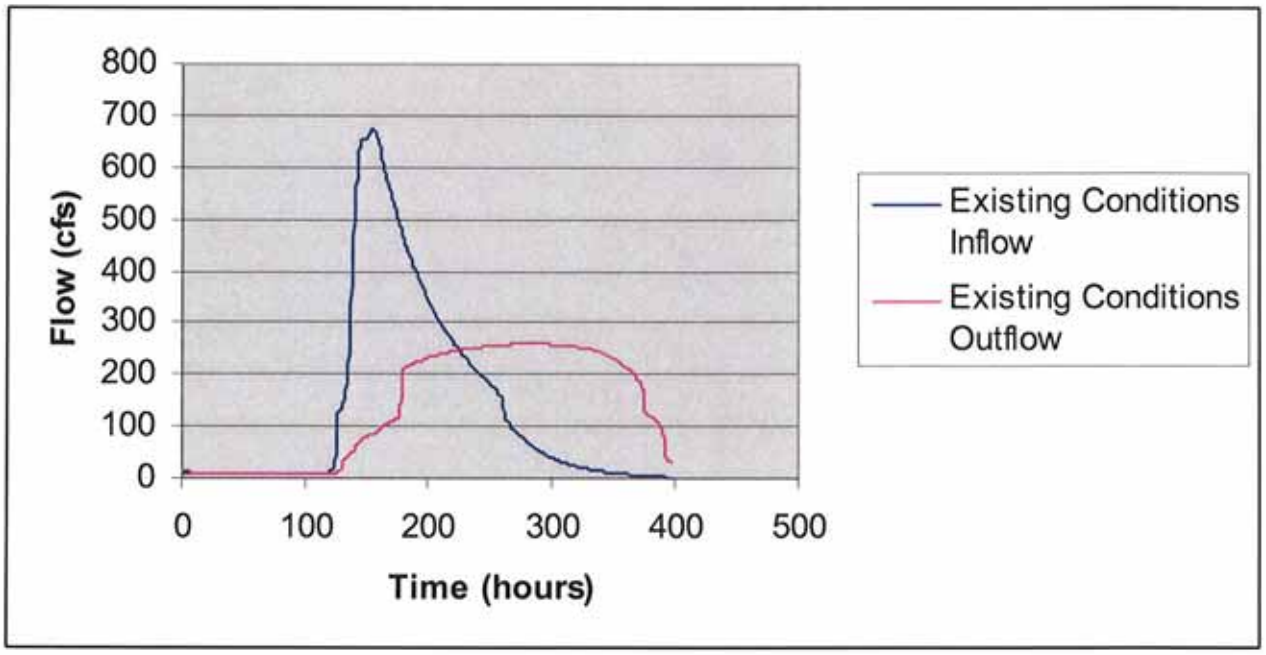


FIGURE 13
36" CMP INFLOW/OUTFLOW HYDROGRAPH 100-YEAR EVENT

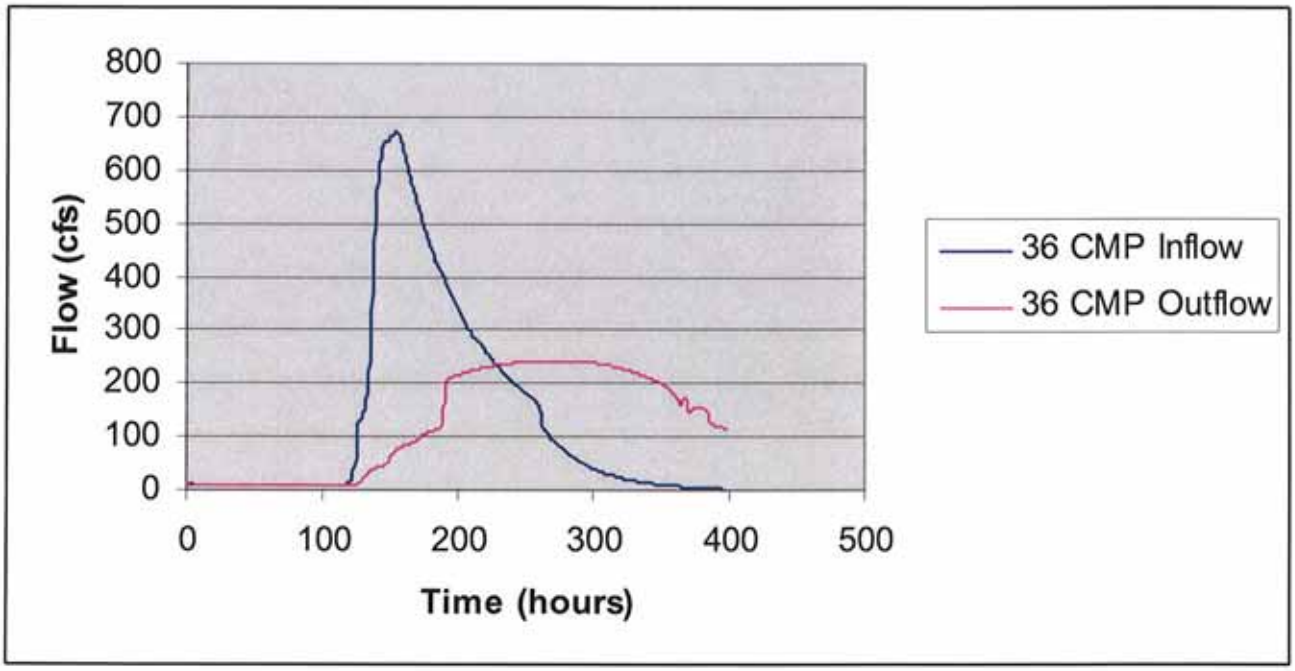


FIGURE 14
½ CHANNEL WEIRS INFLOW/OUTFLOW HYDROGRAPH 100-YEAR EVENT

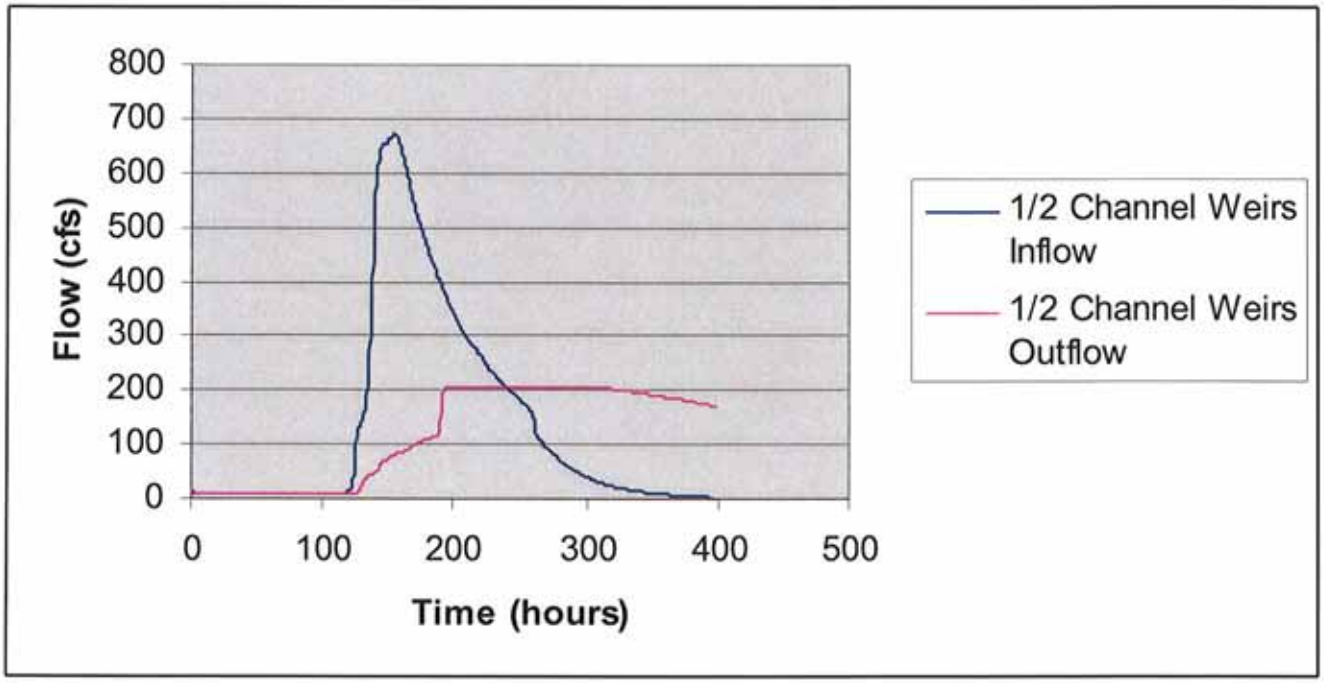


FIGURE 15
GATED CONTROL STRUCTURE (DITCH EMPTY) INFLOW/OUTFLOW HYDROGRAPH 100-YEAR EVENT

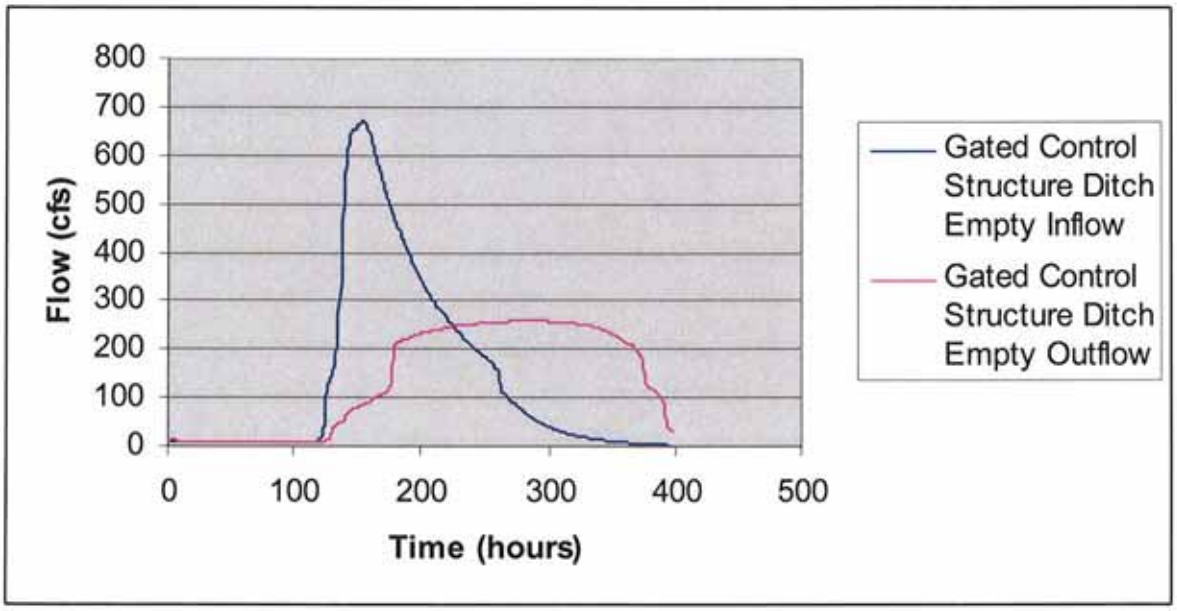


FIGURE 16
GATED CONTROL STRUCTURE (DITCH ½ FULL) INFLOW VS OUTFLOW HYDROGRAPH 100-YEAR EVENT

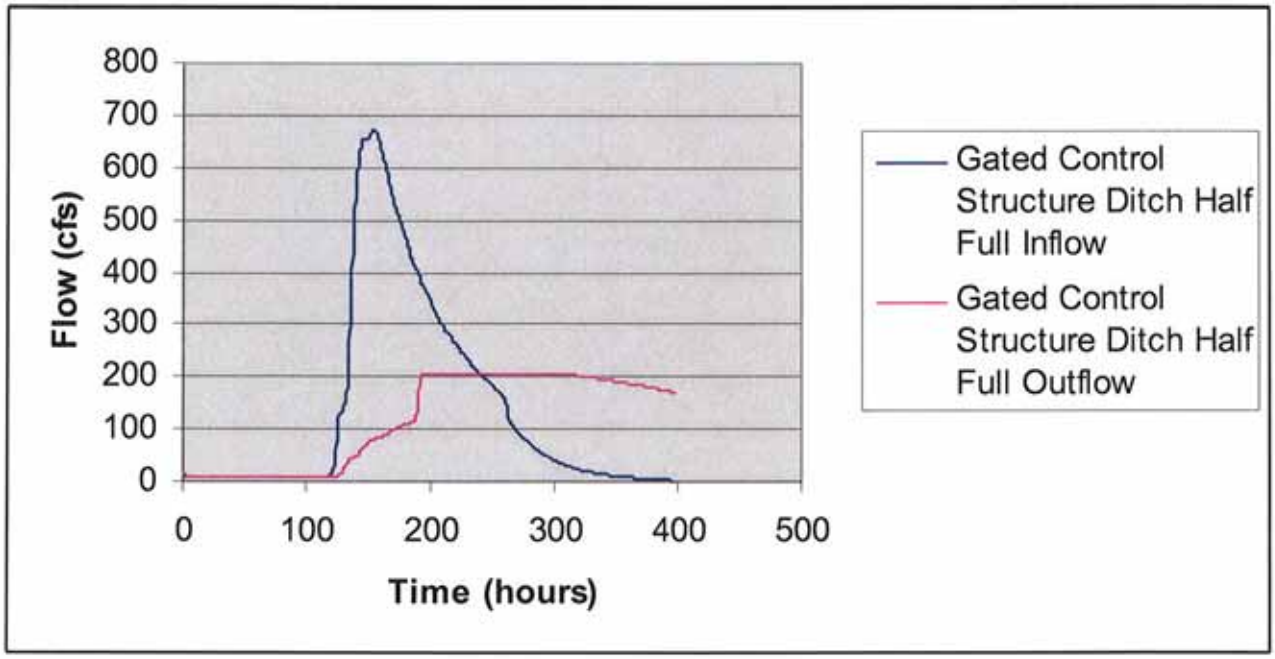


FIGURE 17
GATED CONTROL STRUCTURE (DITCH FULL) INFLOW VS OUTFLOW HYDROGRAPH 100-YEAR EVENT

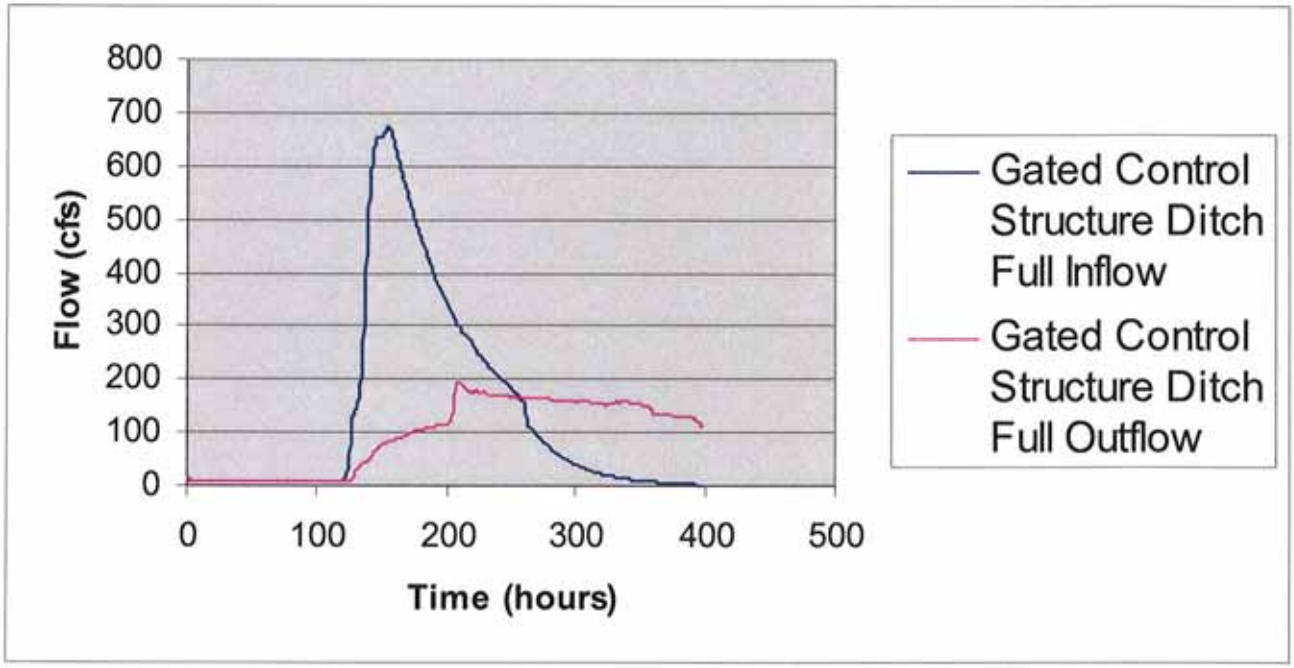


TABLE 6
FLOOD DAMAGE REDUCTION BENEFITS

	Alternative	Peak Outflow Reduction					
		10-Year Event (cfs)	10 – Year Net (cfs)	Peak Delay (Hr)	100-Year Event (cfs)	100 – Year Net (cfs)	Peak Delay (Hr)
--	Existing Conditions	73.55	N/A	N/A	411.73	N/A	N/A
1	36 inch CMP	78.53	4.98	25	427.9	16.17	-9
2	½ Channel Weirs	76.53	2.98	12	464.19	52.46	-82
3-1	Gated Structure (Ditch Empty)	73.55	0	0	411.73	0	0
3-2	Gated Structure (Ditch ½ Full)	76.53	2.98	12	464.19	52.46	-82
3-3	Gated Structure (Ditch Full)	80.12	6.57	9	475.33	63.6	-73

8.0 DISCUSSION OF RESULTS

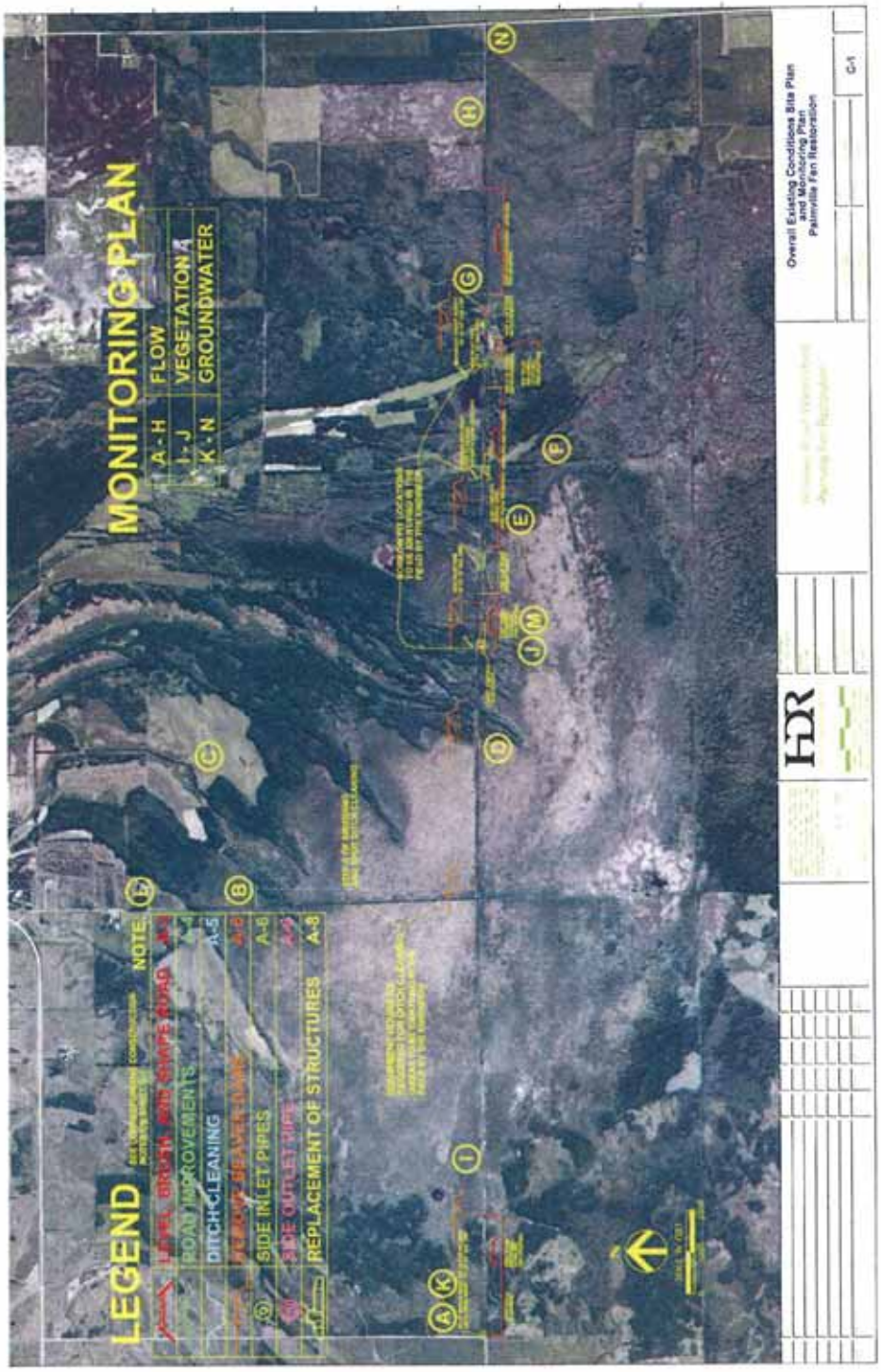
As demonstrated in Tables 5 and 6 and Figures 12 through 17 there is substantial attenuation of inflows entering the fen, even under existing conditions. Alternatives 1-3 increase this attenuation modestly for more frequent events such as the 10 year 10 day storm, and increase peak flow reduction compared to existing conditions up to 64 cfs for the 100 year 10 day event (Alternative 3-3). This effect is caused by forcing the water in the ditch above natural ground and out into the fen on a more frequent basis at a deeper depth and longer duration. For a 10 year event, the peak is delayed a few hours by the proposed alternatives. For a 100 year event, the peak is lowered and actually occurs several days earlier, primarily because the peak is reduced, and the upper portion of the hydrograph is removed earlier on the rising limb of the hydrograph. In terms of timing with the Roseau River in the City of Roseau, both the peak flow reduction and +/- peak delays move the contributing portion of flow from the Palmville area further away from the peak at Roseau.

Movement of the increased floodwaters out into the Fen area is expected to occur much like that shown in Figure 11. Based upon topography, water from the Fen does and will continue to discharge back into JD 63 in the vicinity of McKinock Creek. No additional flooding from surface or groundwater sources is expected to occur on private lands, either upstream or downstream of the proposed structures and Fen restoration. Figure 19 depicts land ownership in the area.

9.0 MONITORING OF FDR, FEN REST. & ENV. IMPACTS

Documentation is necessary to measure FDR and successful restoration of the fen. Monitoring will be based on: vegetative inventories, groundwater monitoring (piezometers), water quality data, and flow monitoring. A formal monitoring plan will be developed in collaboration with the RRWD, DNR, PCA, and the Project Team. The suggested elements of a monitoring plan are shown in Figure 18.

FIGURE 18
FEN MONITORING PLAN



9.1 VEGETATIVE INVENTORY

Fens may contain a wide variety of vegetation. The project's effectiveness will be monitored by the presence, extent, and change of such fauna and flora over time. Table 7 listed below displays vegetation typically found in fens. The DNR is responsible for leading this monitoring effort.

TABLE 7
VEGETATION TYPICALLY FOUND IN FENS

Common name	Scientific name
beak-rush	*Rhynchospora capillacea*
beaked sedge	*Carex rostrata*
bog bedstraw	*Galium labradoricum*
bog birch	*Betula pumila*
bog willow	*Salix pedicellaris*
bogbean	*Menyanthes trifoliata*
brook lobelia	*Lobelia kalmii*
bull sedge	Carex lanuginosa
bulrush	*Scirpus* spp.
cattails	*Typha* spp.
common boneset	*Eupatorim perfoliatum*
flat-topped white aster	*Aster umbellatus*
fringed gentian	*Gentianopsis crinata*
Grass of Parnassus	*Parnassia glauca*
inland sedge	*Carex interior*
large arrow grass	Triglochin maritimum
marsh fern	Thelypteris thelypteroides
marsh-marigold or cowslip	*Caltha palustris*
Muhly or barnyard grass	*Muhlenbergia glomerata*
narrow-leaved fringed gentian	*Gentianopsis procera*
northern bog violet	Viola nephrophylla
Olney's bulrush	*Scirpus americanus*
purple-stemmed aster	*Aster puniceus*
reedgrass (common reed)	Phragmites australis
sage or hoary willow	*Salix candida*
sensitive fern	*Onoclea sensibilis*
small arrow grass	*Triglochin palustre*
spotted Joe-Pye-Weed	*Eupatoriadelphus maculatus*
swamp saxifrage	*Saxifraga pensylvanica*
tall cottongrass	*Eriophorum angustifolium*
upright sedge	*Carex stricta*
valerian	*Valeriana edulis*
water sedge	*Carex aquatilis*
yellow monkey flower	*Mimulus glabratus*

9.2 PIEZOMETERS/POTENTIAL GROUNDWATER IMPACTS

Piezometers can be used to measure the ground water levels. This will help determine lateral groundwater flow throughout the fen. Directional piezometers may also be used to determine directionality. The RRWD is responsible for monitoring these levels in selected locations.

9.3 WATER QUALITY

Water quality, specifically total phosphorus, ortho phosphorus, nitrite, nitrate, total suspended solids, temperature, conductivity, pH, dissolved oxygen, and turbidity can be monitored to assess changes that occur over time that may impact the fen's restoration. The PCA has indicated a willingness to provide monitoring equipment and expertise to assist with water quality monitoring.

9.4 FLOW MONITORING

Water flows and rainfall will be monitored at upstream and downstream locations to assess the FDR effectiveness of the project over time. Typically, a rating curve will be developed for each monitoring site, where a permanent stage recorder will be installed to measure flows over time that will correspond to rainfall monitoring data in the area. The RRWD will lead the flow monitoring efforts.

9.5 ENVIRONMENTAL CONSEQUENCES

This project is not expected to cause significant negative environmental consequences. Restoration of the fen will improve water quality, habitat potential, and flood reduction benefits. Any additional inundated area is expected to be contained within State property.

10.0 LAND OWNERSHIP

The project will be contained with in the lands currently owned by the State of Minnesota. Please see Figure 19 for land ownership information.

FIGURE 19
LAND OWNERSHIP

11.0 COST ESTIMATE

Table 8 shows an estimate of the most probable cost.

TABLE 8
CONCEPTUAL COST (IN 2007 DOLLARS)

Item	Quantity	Unit	Unit Cost	Cost
MOBILIZATION - FALL 2007	1	LS	$ 5,000.00	$5,000.00
MOBILIZATION - WINTER 2007/2008	1	LS	$ 5,000.00	$5,000.00
MOBILIZATION - SPRING/SUMMER 2008	1	LS	$ 5,000.00	$5,000.00
LEVEL AND SHAPE SPOIL - 12'	8,015	LF	$ 2.00	$16,030.00
LEVEL AND SHAPE SPOIL - 6'	10,270	LF	$ 2.50	$25,675.00
ACCESS IMPROVEMENTS	2,800	LF	$ 10.00	$28,000.00
DITCH CLEANING - 3 CY BACKHOE	40	HR	$ 150.00	$6,000.00
BEAVER DAM REMOVAL	8	EACH	$ 300.00	$2,400.00
BRUSHING	10	ACRE	$ 5,000.00	$50,000.00
SALVAGE 60" CMP	85	LF	$ 14.00	$1,190.00
GATED CONTROL STRUCTURE - CMP	2	EACH	$ 100,000.00	$200,000.00
24" CM PIPE CULVERT	317	LF	$ 30.00	$9,510.00
24" GS PIPE APRON	22	EACH	$ 300.00	$6,600.00
RIPRAP CLASS 3	440	CY	$ 75.00	$33,000.00
EROSION CONTROL BLANKET, CATEGORY 1	900	SY	$ 8.00	$7,200.00
SEEDING	15.0	ACRE	$ 250.00	$3,750.00
SEED MIXTURE 250	1,050	POUND	$ 9.00	$9,450.00
MULCH MATERIAL TYPE 1	30.0	TON	$ 200.00	$6,000.00
DISC ANCHORING	15.0	ACRE	$ 50.00	$750.00
COMMERCIAL FERTILIZER, ANALYSIS 22-5-10	1.50	TON	$ 800.00	$1,200.00
Subtotal				$421,755.00
Engineering and Administration		25 %		$105,438.75
Materials Testing (Construction)				$5,000.00
Contingencies		10 %		$42,176.00
Total Construction				**$574,370.00**

12.0 PERMITTING

12.1 STATE ENVIRONMENTAL REVIEW

Minnesota Rules Chapter 4410 does not require the preparation of an Environmental Assessment Worksheet (EAW). The mandatory preparation of an EAW (Minnesota Rules 4410.4300, subpart 24) is necessary for "construction of a dam with an upstream drainage area of 50 square miles or more" or "permanent impoundment of water creating additional water surface of 160 or more acres." The Project has a drainage area of 33 square miles and will not impound more than 160 acres. "No stream diversion" (subpart 26) will result from the Project and no public waters (subpart 27) are impacted.

12.2 SECTION 404 OR SECTION 10

A site inspection and meeting has been held with USACE permitting authorities regarding the proposed project. It is understood that a permit may be required from the USACE, which could include a review of operational parameters such as wetland inundation, bounce, flood frequency and water depth in addition to wetland impacts from the construction footprint. However, the project has been designed to avoid new impacts, thus it is hoped the Project may be eligible for a General Permit or a determination of no jurisdiction. Construction will not begin until all permits are received.

12.3 MINNESOTA DEPARTMENT OF NATURAL RESOURCES

An MnDNR Protected Water Permit, in accordance with Minnesota Rules 6115.015, is not required, as no protected waters will be affected.

12.4 WETLAND CONSERVATION ACT (WCA)

Meetings have been held with WCA permitting authorities regarding the proposed project (DNR and BWSR). It is understood that an individual wetland permit may be required from the local government unit (LGU - DNR), which could include a review of operational parameters such as wetland inundation, bounce, flood frequency and water depth in addition to wetland impacts from the construction footprint. However, the project has been designed to avoid new impacts, thus it is hoped the Project may be eligible for an exemption, General Permit, or a determination of no jurisdiction. Construction will not begin until all permits are received.

12.5 NPDES REQUIREMENTS

A storm water permit is required for the construction of this project. The permittee must develop a storm water pollution prevention plan (SWPPP) to address their storm water discharges from the site. Each regulated party determines the appropriate pollution preventions practices, or best management practices to minimize pollution for the specific site. The final engineering plans for the project will address the SWPPP for the site by means of seeding, mulch, fiber rolls, filter fabric and rip rap.

12.6 ROSEAU COUNTY HIGHWAY DEPARTMENT

Judicial Ditch 63 is administered by Roseau County. The proposed Project requires the review and approval of the ditch authority under Statute 103E.227. The RRWD will petition the County Board for approval and operation of the Project.

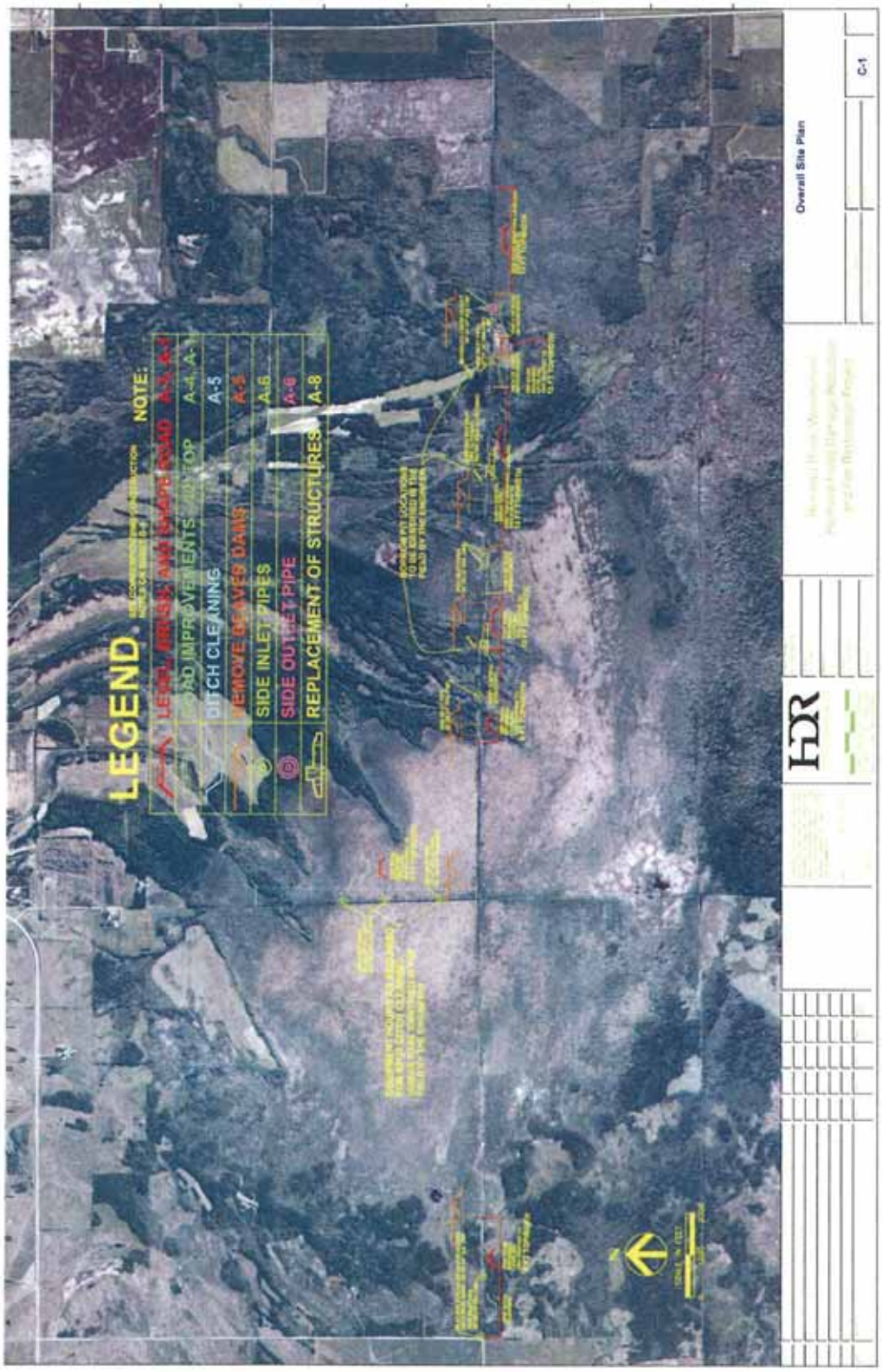
13.0 RECOMMENDATIONS

The hydrologic and hydraulic data indicates that the project should help reduce downstream peak flows. The timing of flood peaks discharging from JD 63 should also be attenuated. The benefit of constructing the Project is the cumulative reduction in flood flows in the City of Roseau and the improvement in agricultural protection downstream. Additional benefits include potential restoration of the fen. The Palmville Flood Damage Reduction Project and Fen Restoration Project can be characterized as follows:

- Phase 1 - Installation of 2 control structures, with initial stoplogs set at "ditch ½ full" ~ 3.5 feet, in accordance with Project Team recommendations and concurrence
- Phase 1 - Ditch system maintenance to include spot cleaning and beaver dam removal
- Phase 1 - Ditch system access improvements and maintenance
- Phase 1 - Erosion Control
- Phase 2 - FDR and NRE Monitoring
- Phase 3 – Corrective Actions, if any, based upon monitoring results and Project Team recommendations and concurrence. This may include stoplog additions or removals (raising or lowering starting water surface elevation), gate operation, or other changes as deemed appropriate.

Figure 20 outlines the proposed work. It is recommended that the RRWD approve Phases 1 and 2 for immediate implementation. Phase 3 will be addressed going forward in an effort by all involved parties to evaluate and make changes in stoplog levels or other operation parameters that are in the best interest of the Project and all involved parties, including private landowners.

FIGURE 20
OVERALL SITE PLAN



APPENDIX A
REFERENCES

1. JOR Engineering—
   - ❖ Some of the preliminary Engineering work was provided to the Roseau River Watershed District by JOR Engineering including the HEC-1 Model, along with GIS Images; those images were used and adapted for purposes of this report.

2. Natural Resources Conservation Service. Soil Survey Geographic (SSURGO) database for Roseau County, Minnesota. USDA: Fort Worth, TX, 2006.

3. Brady, Nyle. The Nature and Properties of Soils. Macmillian: New York, 1990. 10th ed.

4. Huff, Floyd and James Angel. Rainfall Frequency Atlas of the Midwest. Midwestern Climate Center: Champaign, IL, 1992.

5. State of Minnesota. Minnesota Wetlands Conservation Plan, Version 1.0, Minnesota Department of Natural Resources: St. Paul, Minnesota, 1997.

6. United States Environmental Protection Agency . Description of Fens. URL: *http://www.epa.gov/owow/wetlands/types/fen.html, February 22, 2006.*

APPENDIX B
SOIL PROPERTIES

Engineering Properties (MN)

Roseau County, Minnesota

[Absence of an entry indicates that data were not estimated]

Map symbol and soil name	Hydro-logic group	Depth	USDA texture	Classification		Fragments		Percent passing sieve number--				Liquid limit	Plasticity index
				Unified	AASHTO	>10 inches	3-10 inches	4	10	40	200		
		In				Pct	Pct					Pct	
48B:													
Hiwood	A	0-3	Fine sand	SC-SM, SM	A-2, A-3	0	0	100	95-100	80-96	5-25	---	NP
		3-22	Fine sand, loamy sand, sand	SC-SM, SM	A-2, A-3	0	0	100	95-100	80-95	5-20	---	NP
		22-80	Fine sand, sand	SP, SP-SM	A-2, A-3	0	0	100	95-100	80-96	1-12	---	NP

USDA Natural Resources Conservation Service

Tabular Data Version: 5
Tabular Data Version Date: 11/28/2006

This report shows only the major soils in each map unit

Page 1

Engineering Properties (MN)

Roseau County, Minnesota

[Absence of an entry indicates that data were not estimated]

Map symbol and soil name	Hydrologic group	Depth	USDA texture	Classification		Fragments		Percent passing sieve number--				Liquid limit	Plasticity index
				Unified	AASHTO	>10 inches	3-10 inches	4	10	40	200		
		In				Pct	Pct					Pct	
116:													
Redby	B	0-3	Loamy fine sand	SM	A-2, A-3	0	0	100	95-100	85-95	5-25	0-20	NP-3
		3-28	Fine sand, sand	SM, SW-SM	A-2, A-3	0	0	100	95-100	80-95	5-35	0-20	NP-3
		28-80	Fine sand, sand	SP, SP-SM	A-2, A-3	0	0	100	95-100	80-95	2-12	0-14	NP
117:													
Cormant	A/D	0-6	Loamy fine sand	SM, SP-SM	A-2, A-3, A-4	0	0	100	100	60-100	5-40	0-14	NP
		6-80	Fine sand, loamy fine sand, sand	SM, SP, SP-SM	A-2, A-3	0	0	100	100	75-100	1-20	0-14	NP

Engineering Properties (MN)

Roseau County, Minnesota

[Absence of an entry indicates that data were not estimated]

Map symbol and soil name	Hydrologic group	Depth	USDA texture	Classification		Fragments		Percent passing sieve number--				Liquid limit	Plasticity index
				Unified	AASHTO	>10 inches	3-10 inches	4	10	40	200		
		In				Pct	Pct					Pct	
541:													
Rifle, map 16-22	A/D	0-8	Mucky peat	PT	A-8	0	0	100	100	100	95-100	---	---
		8-60	Mucky peat	PT	A-8	0	0	100	100	100	95-100	---	---