LOST CANYON WATERSHED NONPOINT SOURCE POLLUTION CONTROL PLAN

Prepared for:

VILLAGE OF LAKE DELTON, WISCONSIN

QUALITY

♦

INTEGRITY

♦

CREATIVITY

♦

RESPONSIVE

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0 INTRODUCTION

1 BACKGROUND - PROJECT UNDERSTANDING

ie Lost Canyon Watershed is located within the Lake Delton Watershed in the southern p
the Village of Lake Delton. It extends along State Highway (STH) 12 from just no
ady Lane northward to the outlet at Lake Delton. Based on a 1992 lake management
is watershed is currently one of the greatest polluters to Lake Delton. A number of
velopments have been proposed for the Lost Canyon Watershed which will signifi
crease flooding and pollutant loading into the lake. This 1992 study began to addre
oblem of nonpoint source pollution from the Lost Canyon Watershed to Lake Delton.
ll of 1993, the Village of Lake Delton received a Lake Management Grant from the Wis
epartment of Natural Resources (WDNR) to provide a holistic set of alternatives to
aluate the nonpoint source pollution problems to Lake Delton.

2 PURPOSE AND SCOPE OF THE PLAN

ie study area for this project encompasses approximately 1,700 acres. Approximately
this watershed is developed, and is projected to be 80% developed in the next 20 y
ke Delton is already considered nutrient rich (eutrophic) and has experienced an alg
ckweed nuisance for many years. Without stormwater management practices, this con
ll only get worse. It is for this reason that the Village of Lake Delton applied for a
anagement Grant in hopes of providing a plan to control nonpoint source pollution to the
e overall goal for a Nonpoint Source Pollution Control Plan for the Lost Canyon Wat
to contribute to the overall attainment of the resource of Lake Delton which includ
provement of natural habitat, water quality conditions, biological populations and recrea
. The Nonpoint Source Pollution Control Plan for the Lost Canyon Watershed will ev
i make recommendations to:

improving the capacity of the system of storm sewers, swales, ditches, streams, et
make up the stormwater management system;

control erosion, sedimentation and deposition in Lake Delton from the Lost C
Watershed to minimize the need for dredging;

reduce nonpoint source pollution loadings of nutrients, heavy metals and other poll
from the urbanized and developing areas of the watershed

provide an implementation strategy and set priorities for the practices within the stud

3 FORMAT OF THE PLAN

ne remainder of this document is presented in five major sections. A brief description ntent of each section is given below.

Section 2.0 Description of the Project Area

This section provides a general description of the physical parameters of the stud including general location, drainage basins, soils, land use, and drainage patterns. included is existing regulatory ordinances.

Section 3.0: Methods and Assumptions for Determining Nonpoint Pollutant Loads

This section describes the steps used for assessing the present and predicted future no pollution potential of the project area. The base parameters and assumptions used Source Load And Management Model (SLAMM) are also described in this section.

Section 4.0: Methods and Assumptions for Determining Hydrologic Conditions

This section describes the tools used in analyzing the hydrologic conditions in the area. The hydrologic conditions are simulated on a computer model (SEDCAD various recurrence interval rainfall events for both existing and projected future cond

Section 5.0: Recommended Design Criteria

This section outlines criteria for the proper management of stormwater in the Lost C Watershed.

Section 6.0: Storm Water Management Alternatives

This section views different Best Management Practice (BMP) alternatives and de their effectiveness in alleviating drainage and water quality issues.

Section 7.0: Implementation Approach

0 DESCRIPTION OF THE PROJECT AREA

1 GENERAL LOCATION

ıe Lost Canyon Watershed is Located in the Village of Lake Delton and extends out
ɔrporate limits into the Town of Lake Delton. The Village is located in north east Sauk C
South-Central Wisconsin. The project area encompasses approximately 1,700 ac
ainage area to Lost Canyon. Lost Canyon is a scenic 0.8 mile ravine cutting into the
nd stone and conveys flow directly to Lake Delton. This canyon is also home to th
anyon Tours, a horse-drawn carriage ride and Dell View Riding Stable and Stageco
ɔrseback canyon tour. Both are popular tourist attraction.

2 DRAINAGE BASINS

ɔr study purposes, the Lost Canyon Watershed was broken down into 15 sub-basins.
b-basins range in area from 17 to 242 acres. Elevations within the project area vary
out 1,020 feet above mean sea level in the southernmost sub-basin to 832 feet, a diff
188 feet.

3 SOILS

ıe soils in the study area classified in the Sauk County Soil Survey are predominately
ams and loamy sands including the Plainfield loamy sands, Wyocena sandy loams
:henry silty loams. Soils are well drained, medium textured underlain with sandy glac
outwash sand. Shallow or exposed bedrock conditions exist throughout the study are

ils are classified into hydrologic groups to indicate the minimum rate of infiltration ob
bare soil after prolonged wetting. The soils in the watershed consist mostly of Hydr
ɔups A and B. Group A soils have low runoff potential and high infiltration rates (g
ɪn 0.30 in/hr) even when thoroughly wetted. They consist of deep, well to excessively d
ıds or gravels. Group B soils have moderate infiltration rates (0.15-0.30 in/hr)
ɔroughly wetted and consist chiefly of moderately deep to deep, moderately well to
ıined soils with moderately fine to moderately coarse textures.

LAND USE OF THE PROJECT AREA

ɪsent day land uses within the watershed include commercial, low density residential
ırse, open space, woods, highway/roadway, agricultural and farmsteads. Areas were gr
ɔ categories of relatively homogeneous impervious areas. A detailed delineation of lan

1994 LAND USE

Commercail / Business		Farmsteads		Agricultural		Open Space / Undeveloped		Woods		Highway / Roadway		Total
acres	% total	acres	% total	acres	% total	acres	% total	acres	% total	acres	% total	acres
0	0%	0	0%	0	0%	3	17%	14	78%	0	0%	18
0	0%	0	0%	104	45%	8	3%	121	52%	0	0%	232
23	21%	0	0%	18	16%	28	26%	41	38%	0	0%	109
6	22%	0	0%	0	0%	10	35%	11	40%	1	3%	28
8	8%	0	0%	7	7%	64	63%	15	15%	5	5%	101
4	19%	0	0%	0	0%	11	48%	0	0%	8	33%	23
8	7%	17	14%	31	26%	35	29%	21	18%	0	0%	119
0	0%	0	0%	117	89%	0	0%	14	11%	0	0%	131
30	17%	0	0%	0	0%	126	72%	18	10%	0	0%	174
0	0%	0	0%	0	0%	20	28%	0	0%	51	72%	71
9	12%	0	0%	0	0%	45	60%	16	21%	5	7%	75
0	0%	0	0%	27	23%	0	0%	84	71%	0	0%	119
15	12%	0	0%	0	0%	3	2%	92	72%	0	0%	127
28	22%	0	0%	50	39%	50	39%	0	0%	0	0%	128
1	0%	0	0%	123	50%	122	50%	0	0%	0	0%	246
132	8%	17	1%	476	28%	524	31%	447	26%	70	4%	1701

PROJECTED FUTURE LAND USE

Medilum Density Residential		Commercail / Mixed Use *		Commercail / (50% Impervious)		Open Space / Undeveloped		Woods		Highway / Roadway		Total
acres	% total	acres	% total	acres	% total	acres	% total	acres	% total	acres	% total	acres
6	31%	0	0%	0	0%	7	40%	5	29%	0	0%	18
145	62%	0	0%	0	0%	5	2%	82	35%	0	0%	232
4	3%	31	28%	0	0%	37	34%	38	34%	0	0%	109
0	0%	20	71%	0	0%	1	5%	6	20%	1	4%	28
0	0%	74	73%	0	0%	0	0%	22	22%	5	5%	101
0	0%	15	65%	0	0%	0	0%		0%	8	35%	23
56	47%	41	34%	16	14%	0	0%	5	5%	0	0%	119
98	75%	19	15%	9	6%	0	0%	5	4%	0	0%	131
74	43%	66	38%	14	8%	0	0%	10	6%	0	0%	174
0	0%	19	27%	0	0%	0	0%		0%	51	73%	71
0	0%	46	62%	19	26%	0	0%	5	6%	5	6%	75
1	1%	47	40%	58	48%	0	0%	13	11%	0	0%	119
0	0%	0	0%	38	30%	0	0%	19	15%	0	0%	127

llage's projected annexation plan. Table 1 also lists the projected future land uses within
sin.

CURVE NUMBER (CN)

e SCS has evolved a system of curve numbers to estimate runoff production potential. C
nbers are based on soil permeability, land use (cover types) and antecedent mo
nditions. Table 2 provides composite CNs for each subbasin.

WATER RESOURCE CONDITIONS / DRAINAGE PATTERNS

e Lost Canyon Watershed does not contain any surface waters and has no perennial stre
rmwater comprises all of the flow through the canyon, which can be very significan
vy rain. As rain falls on roads, buildings, lawns, etc., the stormwater picks up sedimen
er pollutants from the watershed and deposits them directly into the lake. The dra
terns delineated in Figure 1 are broken down and described below:

Basin 15 (246 ac)

This drainage basin collects stormwater along a flat, heavily vegetated swale a
intermittent stream flowing to the north to Fern Dell Road, east of STH 12.

Basin 14 (128 ac)

This basin contributes to the same intermittent stream which began in Basin 15. The st
flows north from Fern Dell Road and east of STH 12 northwesterly towards the I-9
and STH 12 Interchange.

Basin 13 (127 ac)

This drainage basin is entirely contained in the southwest quadrant of the I-90/94 - ST
Interchange. Drainage pattern flows northerly through the Yellow Thunder Subdivisio
continues underneath I-90/94.

Basin 12 (119 ac)

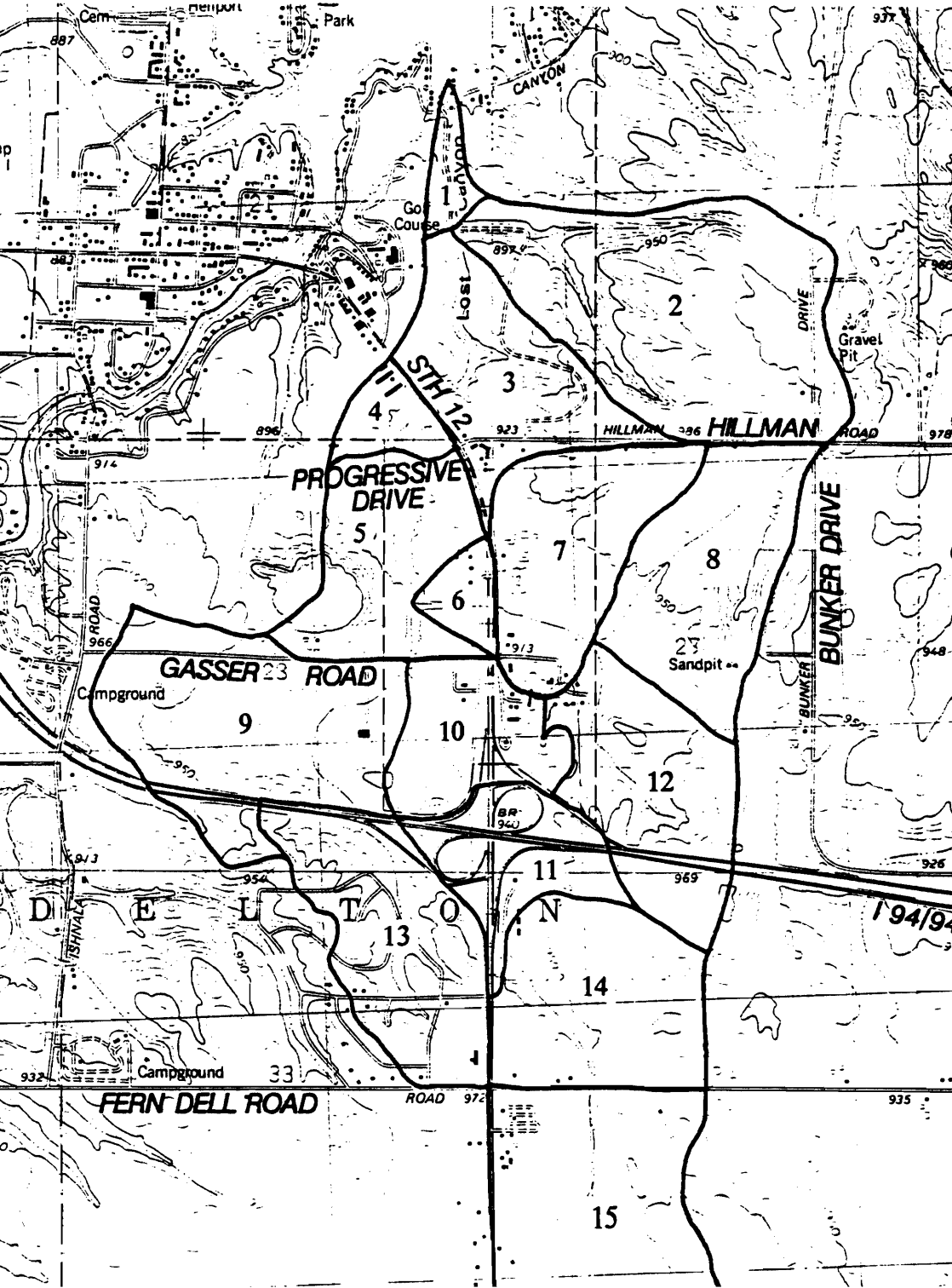
This basin drains an area in the northeast quadrant of the I-90/94 - STH 12 Interch
The intermittent stream draining Basin 12 flows in a northeasterly direction throu
heavily vegetated area.

Table 2

Hydrologic Input Parameters

Lost Canyon Watershed

Sub-basin	Area (acres)	Curve Number (Existing)	Curve Number (Future)	Time of Concentration (Hours)
1	18	61	70	0.17
2	232	60	66	0.65
3	109	65	71	0.63
4	28	72	86	0.25
5	101	72	85	0.61
6	23	71	91	0.24
7	119	71	85	0.51
8	131	71	81	0.54
9	174	71	81	0.44
10	71	60	68	0.54
11	75	60	81	0.54
12	119	52	81	0.57
13	127	46	58	0.92
14	128	64	81	0.75
15	246	57	69	1.5


Park
CANYON
Lost Canyon
Gravel Pit
STH 12
HILLMAN
HILLMAN ROAD
PROGRESSIVE DRIVE
BUNKER DRIVE
GASSER ROAD
Campground
Sandpit
DELTON
FERN DELL ROAD
Campground
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15

Basin 10 (71 ac)

This basin drains an area east of Highway 12 just north of the I-90/94 - STH Interch

Basin 9 (174 ac)

This basin drains an area on the north side of I-90/94 east of Basin 10 including portion of the Wisconsin Dells Greyhound Racing Park. This intermittent stream me to the north where it joins with the flows from Basin 10 at Gasser Road.

Basin 8 (131 ac)

This drainage basin collects water from a largely undeveloped area with a fairly steep (4 percent), dropping over 80 feet in less than one half of one mile. This is the on which drains primarily to the southwest to meet up with a northerly flow from Basi

Basin 7 (119 ac)

Flows from the southeast (Basin 12) and northeast (Basin 8) converge and continue a flat stretch through agricultural fields west towards STH 12.

Basin 6 (23 ac)

This slightly urbanized basin is one of the smallest in the watershed. The basin c stormwater runoff from STH 12 adding to it the flows from Basin 7.

Basin 5 (101 ac)

Drainage patterns involve the convergence of several different flows into and throu Village's largely undeveloped commercial lands and business park. The basin has sl steep slopes which channel runoff to the intermittent stream meandering almost due

Basin 4 (28 ac)

Located between Progressive Drive and STH 12, Basin 4 is the second smallest basin watershed. The basin has moderate slopes flowing northeast towards and under STH

Basin 3 (109 ac)

Basin 1 (18 ac)

This is the northernmost portion of the Lost Canyon watershed. This small basin is with steep picturesque canyon slopes which takes water from the south and east thro canyon to a bay at the south end of Lake Delton.

.7 TIME OF CONCENTRATION (TC)

he time of concentration is an important parameter in estimating peak rates of stor unoff. The shorter the time of concentration a basin has, the greater the peak runo ime of concentrations used in the hydrologic modeling were presented in Table 2.

.8 EXISTING REGULATORY REVIEW

he Village of Lake Delton currently has an enforceable erosion control ordinance (Or o. 9-91-273). The ordinance follows the model construction site erosion control or utlined in the Wisconsin Construction Site Best Management Practice Handbook. By fa f the Sediment in the Lost Canyon Watershed comes from constructions sites.

he Village of Lake Delton also has an enforceable stormwater management or Ordinance No. 12-92-282). This ordinance requires new development to provide a Stor Management Plan and stormwater drainage facilities for any development with land dis ctivity of over 20,000 square feet. No final subdivision plat can be approved and no b ermit can be issued until and unless a Stormwater Management Plan has been review pproved by the Zoning Administrator. Each project is individually reviewed for com ith regulations. Some of the key criteria of the stormwater management ordinance ar elow.

- The controlled release rate of stormwater runoff from all developments describ this section shall not exceed that of the pre-development or undisturbed condition on a 10-year, 24-hour storm.

- Streets, blocks, lots, parks, and other public grounds shall be located and laid such a manner as to minimize the velocity of overland flow and allow ma opportunity for infiltration of stormwater into the ground.

- Detention facilities shall release stormwater at a non-erosive velocity.

0 METHOD AND ASSUMPTIONS FOR DETERMINING NONPOINT POLLUTANT LOADS

1 BACKGROUND INFORMATION

onpoint pollution loadings from the Lost Canyon Watershed were determined usi
isconsin Department of Natural Resources (WDNR) "Source Loading and Manag
odel" (SLAMM). This model was developed by and for the WDNR to be used i
iority Watershed - Nonpoint Source Pollution Abatement Program. SLAMM is u
lculate the annual pollutant loadings for each basin in the Lost Canyon Watershed.
adings are then used to prioritize 'critical' areas by loading rates in tons or pounds pe
ese results help to target areas where Best Management Practices (BMP's) can be pla
hieve maximum reduction of the pollutant loadings to Lake Delton. Pollutants of inte
s study are particulate sediments, nutrients (measured as particulate phosphorous) and
etals (measured as total lead). The model calculates loadings based on several f
cluding :

- Existing and Future Land Uses
- Soils Hydrologic Grouping
- Drainage System
- Existing Drainage Control Practices
- Annual Rainfall
- Street and Roadway Conditions

? PROCEDURE FOR POLLUTANT LOADING ESTIMATION

llutant loading estimation relies on two processes. The first consists of all c
aracteristics of the watershed being placed on one master map file including existin
ure land uses, soil hydrologic grouping, and drainage basins. The second is to create
SLAMM data files specifically tailored to each land use in the Lost Canyon Watershe

escription of all existing and future land use types within the watershed can be fou
ble 1 of Section 2.0. Both existing and future land use delineations were placed on a
a master map for the Lost Canyon Watershed.

Each drainage basin in the study area was then divided into land parcels of varying siz
on 1) hydrologic soil type (A/B or C/D) and 2) land use characteristics.

SLAMM data files rely on a number of sub-files to compute pollutant loadings. F
rainfall, runoff source areas and pollutant data were selected to best represent site conditi
pollutant characteristics of the watershed to predict annual pollutant loading rates. Rain
for 1982 was used in the SLAMM model as suggested by the WDNR because it is cor
o represent a typical year of rainfall.

Each land use was broken down by contributing source areas such as streets, parking lots
andscaped areas and so on. Source areas were further refined to reflect the percent of
onnected impervious areas (DCIA) where needed. These are source areas which drai
r less directly to the streets. All other areas are considered to be non-DCIA and typicall
o grassed areas. Street parking density, roadway drainage type (swales, curbs, etc.) a
treet sweeping practices were also considered. All of the above information was compil
set of files created for both sandy (A/B) soil types and clayey (C/D) soil types un
ossible land uses.

All of the data files were run using SLAMM Version 6.1 to analyze for particulate
sediments), particulate phosphorous, and total lead loadings. The model reports the res
ediments in tons per year and phosphorus and lead in pounds per year. These calculati
eported as statistical average pollutant loadings for a typical year of rainfall.

hese results were then tabulated and added to the watershed parcel spreadsheet. A routi
reated to calculate loadings where criteria matched for each subbasin based on its ind
haracteristics. These loadings were then summed by subbasin to assess current and
nticipated loading rates.

ediment loadings to Lake Delton were also calculated using RUSLE (Revised Univers
oss Equation) which computed erosion and sedimentation based on flow velocities and
olumes (i.e. runoff energy). This method was used with the watershed model SEDCAD
ed the actual erodibility of soil, slope of the basin, land cover and flow length to
mpute erosion and sedimentation rates for existing areas with a more rural setting.

3 NONPOINT SOURCE IMPACTS

s rain falls on rooftops, roads, lawns and parking lots, stormwater runoff picks up po
ch as sediments, nutrients, pesticides, road salt, and bacteria. These pollutants can co
increased turbidity, algae blooms, macrophyte growths and unsafe swimming conditi

oncentrations may reach the point where they can be toxic or a health hazard to human quatic organisms.

.4 ESTIMATED POLLUTION LOADINGS

stimated pollutant loadings for each subbasin are summarized in Table 3. Nearly hal onpoint source pollutants originate in three Subbasins - 3, - 9 and - 14. In each c ubbasins commercial property makes up 17 percent to 22 percent of the total area (Ta

ubbasin 6 has the highest rate of pollutant loadings. This is due to the high percent ubbasin which is either commercially developed and in Highway 12. Subbasins with hig f pollutant loadings which are considered critical are Subbasins 3, 4, 6, 9, 11, 13 Figure 2). These subbasins have estimated loading rates which are above the average atershed. Average pollutant loading rates for the Lost Canyon Watershed would be con gnificant when compared to other urban watersheds.

otal pollutant loadings and loading rates are expected to increase dramatically as the wa evelops. Table 4 summarizes predicted future nonpoint source pollutant loadings. Su hich are not currently critical sources of nonpoint source pollutants will become cri evelopment occurs (Figure 3). Figure 4 shows the most critical increases in nonpoint llutant loadings which are highlighted in Table 5. This increase in nonpoint source po adings will have a noticeable and adverse impact on the water quality in Lake M herefore, it is important that proper Best Management Practices are constructed fo isting and future development.

5 BACTERIA IN STORMWATER RUNOFF

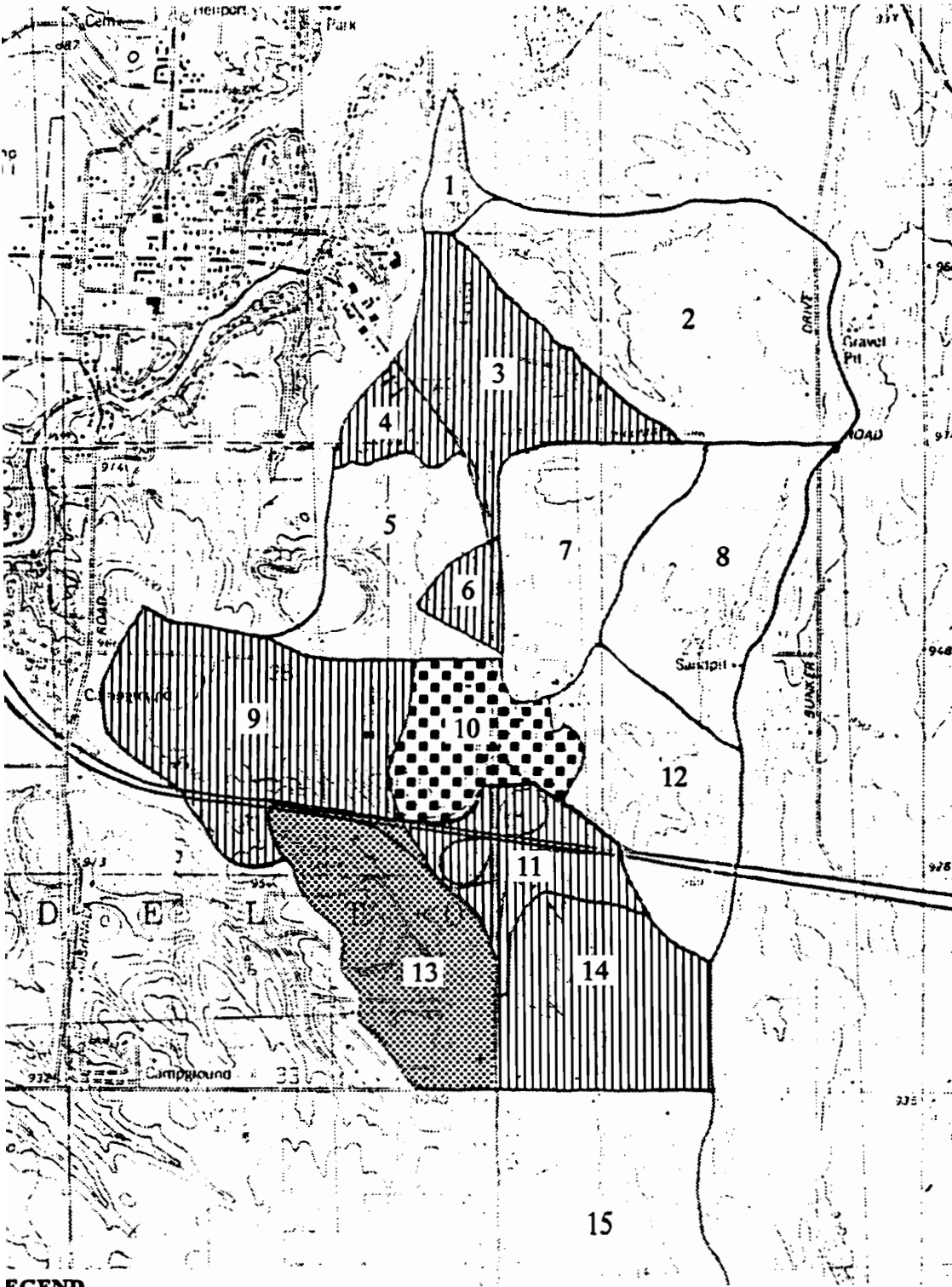
mples taken by the U.S. Environmental Protection Agency (EPA) and the Wisconsi dicate that bacteria levels in stormwater runoff often cause surface water bodies to exc PA water quality standard, which is 200 fecal coliforms per 100 ml or less, duri mediately after storm events. This is particularly a problem in lakes and slow-moving d streams. In highly publicized events during 1993 and 1994, stormwater runoff was high bacteria levels that resulted in beach closings and threaten drinking water supplie e coast of Lake Michigan from Sheboygan to Kenosha.

ne presence of bacteria in stormwater runoff in itself may not be a concern. Howeve ed as an indicator of the potential presence of pathogens that would be a risk to human cteria is present anywhere there are warm blooded animals, both domestic and wildl here there is decomposing organic matter. Of most concern are sources which contain d

is difficult to estimate, with any reliability, the bacteria levels that will be in sto
ınoff because of the variability of site specific conditions and the weather. Samplin
ɛriod of time is the only way to identify and quantify a problem. Sampling and te
ıtside the scope of this study, therefore, this investigation will focus on estima
:ductions of sediments, heavy metals and phosphorous (nutrients). However, recomme
ɔr reducing nonpoint source pollution in the Lost Canyon Watershed will also help
ıcteria levels in the stormwater runoff from the Lost Canyon Watershed.

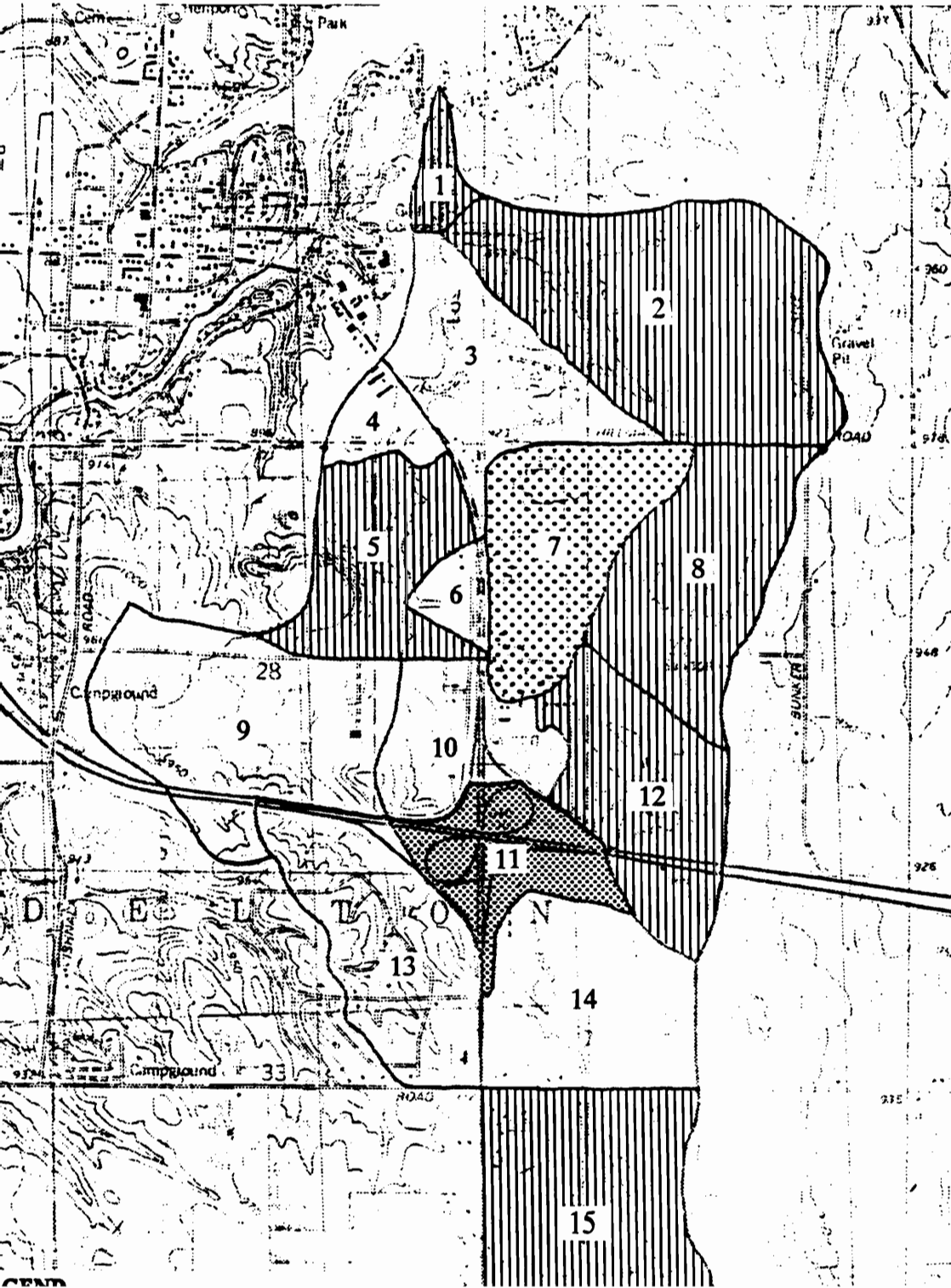
CRITICAL BASIN IDENTIFICATION
Existing Non-Point Source Pollutant Loadings

POLLUTANT							
Sediment		Lead		Zinc		Phosphorous	
(tons/year)	lbs/ac/yr	(lbs/year)	lbs/ac/yr	(lbs/year)	lbs/ac/yr	(lbs/year)	lbs/ac/yr
0.0	2.80	0.1	0.003	0.1	0.003	0.1	0.007
0.3	2.80	0.7	0.003	0.7	0.003	1.6	0.007
11.2	204.95	60.0	0.549	33.6	0.308	47.8	0.438
3.3	233.40	18.3	0.653	11.5	0.410	15.3	0.547
5.0	99.71	34.0	0.336	20.4	0.201	28.2	0.278
3.6	311.96	30.0	1.306	20.0	0.868	24.7	1.074
4.6	76.71	23.6	0.198	13.1	0.110	20.1	0.169
0.3	3.88	0.5	0.004	0.6	0.005	1.4	0.010
15.0	172.07	80.3	0.461	41.5	0.238	62.8	0.361
3.2	90.21	42.8	0.603	29.4	0.414	34.8	0.491
5.1	136.36	32.0	0.425	17.3	0.229	24.9	0.331
0.6	10.36	2.1	0.018	1.8	0.015	3.7	0.031
8.4	131.59	44.6	0.351	23.2	0.183	37.7	0.297
14.5	227.09	75.4	0.589	48.8	0.381	64.9	0.507
0.9	7.25	3.7	0.015	2.6	0.011	4.1	0.017
76.0	1,711.15	448.1	5.515	264.4	3.378	372.1	4.564
	114.08		0.368		0.225		0.304


1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
Gravel Pit
Campground

CRITICAL BASIN IDENTIFICATION
Future Non-Point Source Pollutant Loadings

POLLUTANT							
Sediment		Lead		Zinc		Phosphorous	
(tons/year)	lbs/ac/yr	(lbs/year)	lbs/ac/yr	(lbs/year)	lbs/ac/yr	(lbs/year)	lbs/ac/yr
0.3	37.59	1.3	0.073	1.5	0.081	2.2	0.122
8.4	72.59	33.2	0.143	36.9	0.159	55.1	0.237
15.5	283.36	83.2	0.762	45.7	0.418	66.0	0.604
10.0	716.67	55.5	1.981	31.6	1.129	44.0	1.573
37.0	730.92	208.1	2.056	111.5	1.101	161.1	1.592
8.8	761.86	58.7	2.554	35.6	1.548	46.8	2.037
28.1	471.81	148.3	1.246	81.1	0.682	124.1	1.043
15.5	237.22	76.4	0.583	50.0	0.382	77.6	0.593
40.9	470.43	216.3	1.243	119.3	0.686	181.1	1.041
8.9	251.89	74.8	1.053	43.0	0.606	57.7	0.813
28.3	752.51	158.2	2.101	74.0	0.983	117.0	1.553
37.1	623.88	204.9	1.722	90.8	0.763	149.5	1.256
14.1	222.70	75.3	0.593	33.7	0.265	61.2	0.482
53.9	841.60	299.2	2.337	127.8	0.999	215.0	1.680
17.4	141.35	87.4	0.355	41.4	0.168	83.7	0.340
324.4	6,616.40	1780.6	18.801	924.1	9.970	1442.3	14.965
	441.09		1.253		0.665		0.998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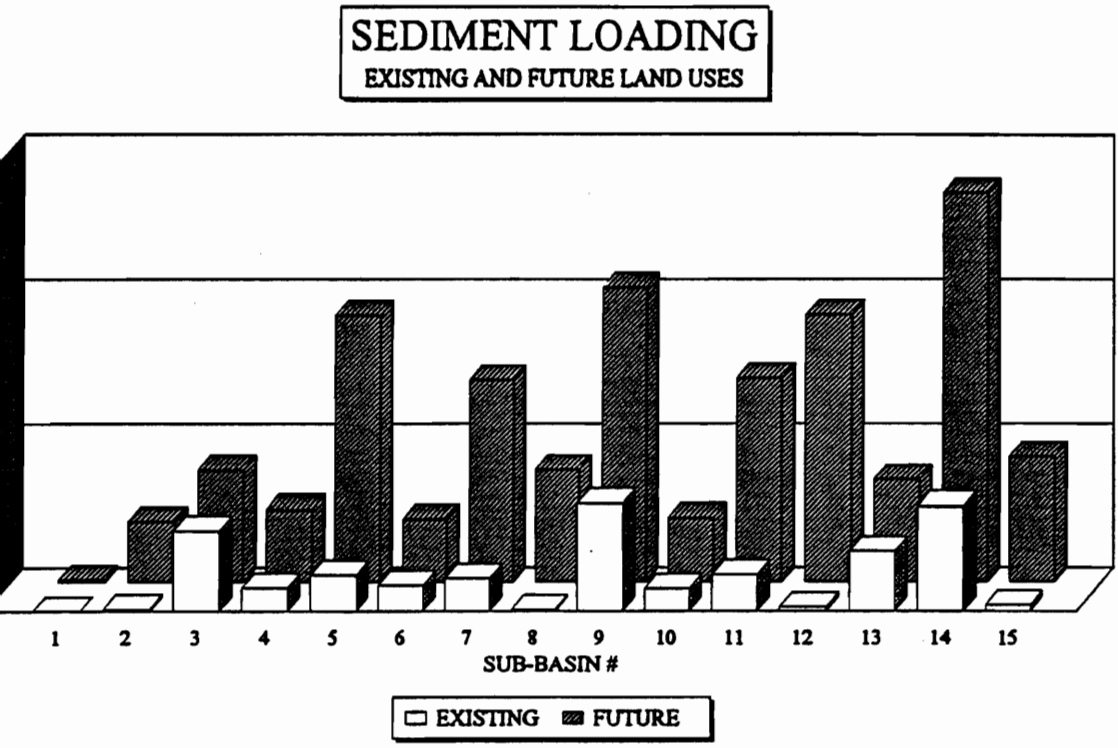
ROAD
D E L T O N

Figure 4
Sediment and Phosphorous Loadings



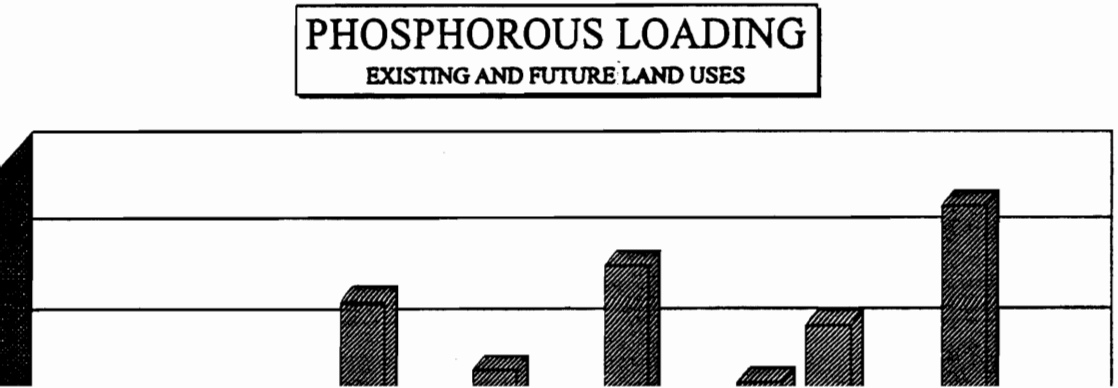
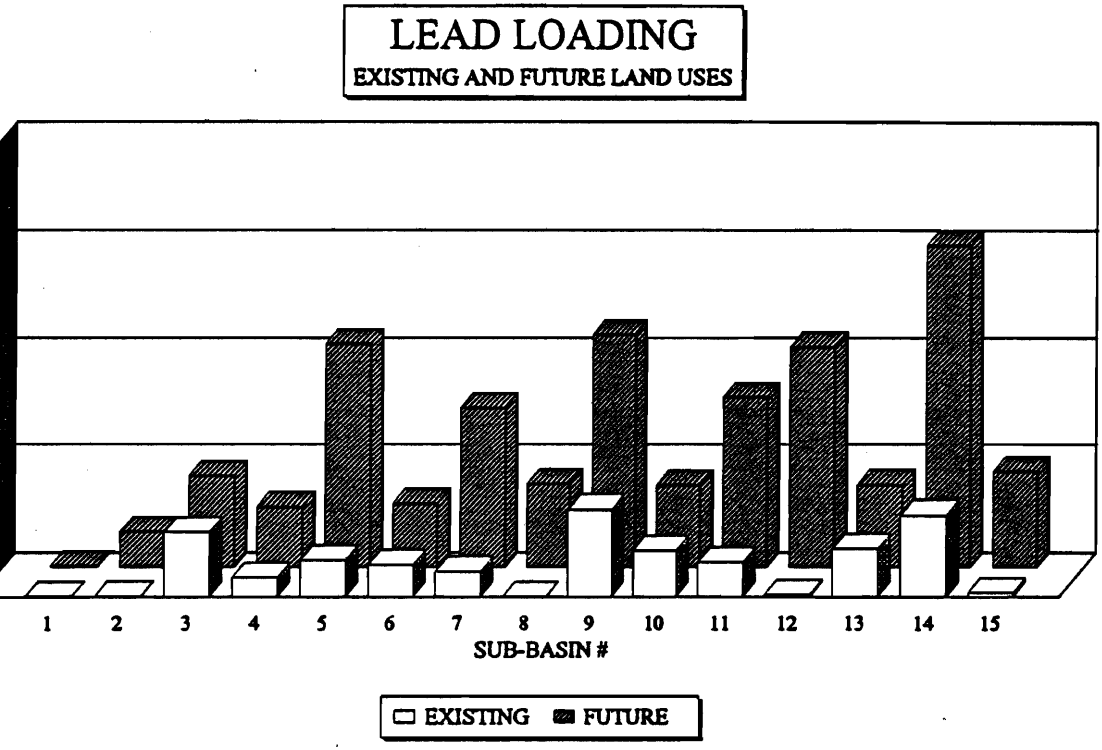
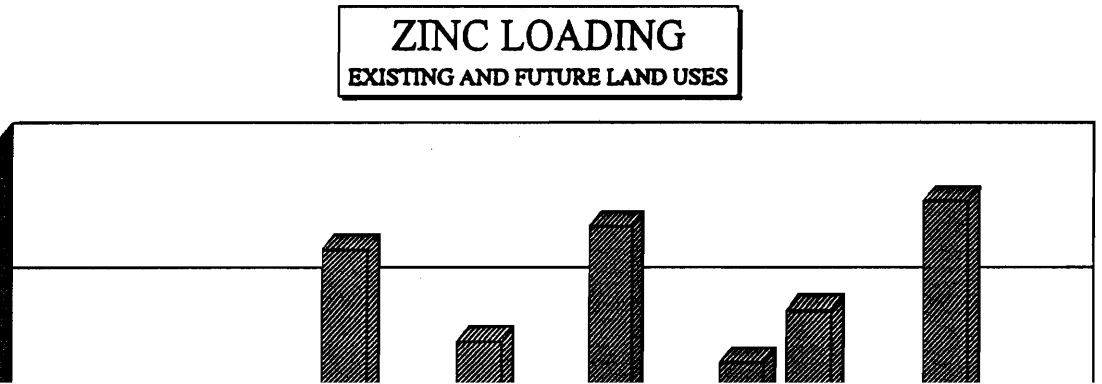


Figure 4 (cont.)
Lead and Zinc Loadings





FUTURE NON-POINT SOURCE POLLUTANT LOADINGS

Projected Increase Over Present Loading Rates

	POLLUTANT											
	Sediment			Lead			Zinc			Phosphorous		
	lbs/ac/yr	% Increase	(lbs/year)	lbs/ac/yr	% Increase	(lbs/year)	lbs/ac/yr	% Increase	(lbs/year)	lbs/ac/yr	% Increase
3	37.59	1342%	1.3	0.073	2423%	1.5	0.081	2693%	2.2	0.122	1740%
4	72.59	2593%	33.2	0.143	4761%	36.9	0.159	5302%	55.1	0.237	3390%
5	283.36	138%	83.2	0.762	139%	45.7	0.418	136%	66.0	0.604	138%
0	716.67	307%	55.5	1.981	304%	31.6	1.129	276%	44.0	1.573	288%
0	730.92	733%	208.1	2.056	612%	111.5	1.101	547%	161.1	1.592	572%
8	761.86	244%	58.7	2.554	195%	35.6	1.548	178%	46.8	2.037	190%
1	471.81	615%	148.3	1.246	628%	81.1	0.682	619%	124.1	1.043	618%
5	237.22	6120%	76.4	0.583	14675%	50.0	0.382	8374%	77.6	0.593	5749%
9	470.43	273%	216.3	1.243	269%	119.3	0.686	288%	181.1	1.041	288%
9	251.89	279%	74.8	1.053	175%	43.0	0.606	147%	57.7	0.813	166%
3	752.51	552%	158.2	2.101	495%	74.0	0.983	428%	117.0	1.553	470%
1	623.88	6021%	204.9	1.722	9787%	90.8	0.763	4962%	149.5	1.256	4056%
1	222.70	169%	75.3	0.593	169%	33.7	0.265	145%	61.2	0.482	162%
9	841.60	371%	299.2	2.337	397%	127.8	0.999	262%	215.0	1.680	332%
4	141.35	1950%	87.4	0.355	2390%	41.4	0.168	1599%	83.7	0.340	2024%
4	6,616.40		1780.6	18.801		924.1	9.970		1442.3	14.965	
	441.09			1.253			0.665			0.998	

basins where the pollutant loadings increase more than five times (500%) that of existing (1994) conditions.

0 METHOD AND ASSUMPTIONS FOR DETERMINING HYDROLOGIC - HYDRAULIC CONDITIONS

1 BACKGROUND INFORMATION

ıe runoff and sedimentology model SEDCAD+ was used to analyze the hydrologic/hy nditions of the project area. SEDCAD+ was developed by the University of Kennuck mputes both runoff volumes, flows and sediment loadings. The program was also dev assist in design of storm water conveyance and detention facilities.

EDCAD+ simulated hydrographs for each basin. subwatersheds and combing and routin ows, SEDCAD+ determined peak stormwater discharges throughout the drainage system put data includes area, soil types, and flow path information as described in Section 2

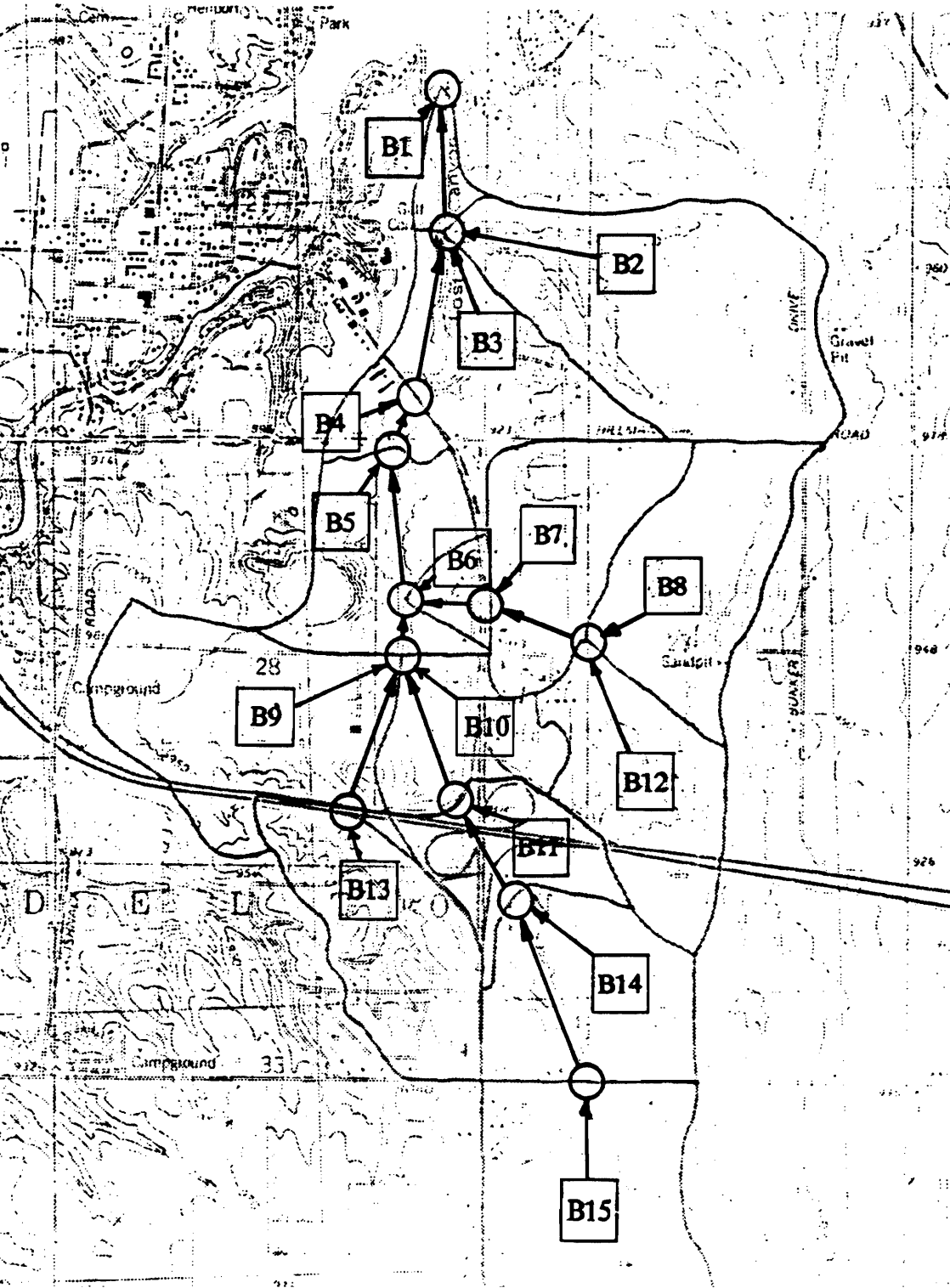
ıe schematic of the SEDCAD+ model in Figure 5 shows the order in which the ocessed the calculations. The model has the capability to determine peak runoff rates a provide design criteria for Best Management Practices (BMPs).

2 CURRENT HYDROLOGIC-HYDRAULIC CONDITIONS

sults of the modeling and historical records reveals drainage concerns within the study .e most common reason for flooding in the Lost Canyon Watershed is simply that culve dersized and are unable to convey the flows cause stormwater to back up and flood ad operty. The Lost Canyon conveyance system was analyzed for its ability to convey m the 2, 10, 25, 50 and 100-year recurrence intervals. Estimated flows at selected loc oughout the study area are summarized in Table 6. Existing and future deficiencies rmwater management system are described in the following sections.

Existing Conditions

- The private culvert (42" CMP) in Basin 4 leading to a 6' x 4' concrete box c under STH 12 just north of Progressive drive is undersized and is obstructe debris causing flooding upstream.
- Culvert under old service road in Basin 10 directly north of interchange has coll This temporarily offers some detention and relief on downstream structures (Cu through Kennel Club and under Gasser Road).
- Culvert (36" CMP) between Kennel Club Inn and Suites and Wisconsin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Campground
Campground
Gravel Pit
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Table 6

CALCULATED FLOWS FOR LOCATIONS IN THE LOST CANYON WATERSHED

Existing Conditions

Location	Contributing Watersheds	Return Period 2-year (cfs)	10-year (cfs)	25-year (cfs)	50-year (cfs)
Lake Delton	1-15	80	205	350	420
tream of Progressive Drive	5-15	90	310	400	525
vnstream of Interchange	11, 14, 15	15	75	105	140
under HWY 12 North of Gasser Rd.	7, 8, 12	65	205	256	340

Proposed Future Conditions

Location	Contributing Watersheds	Return Period 2-year (cfs)	10-year (cfs)	25-year (cfs)	50-year (cfs)
ake Delton	1-15	265	455	605	850
ream of Progressive Drive	5-15	325	700	840	1,015
nstream of Interchange	11, 14, 15	80	205	240	300
under HWY 12 North of Gasser Rd.	7, 8, 12	220	465	550	670

- Culvert (60" CMP) under STH 12 (Basin 7) would be exceeded for the 50 and 10 events.

Future Conditions

All concerns listed in the existing conditions above apply including:

- Existing Detention facility just south of Progressive drive is undersized
- Increased flows are expected to create scouring and erosion throughout the cany

RECOMMENDED DESIGN CRITERIA

NTRODUCTION

: is a growing awareness that land use decisions affect stormwater management needs
iwater management needs and decisions, in turn, affect land use decisions. Cu
iwater management studies, such as this one and the Spring Brook Bay Watershed Plan
rtant first steps to addressing the stormwater management needs of these two a
lopments and planned developments south of Progressive Drive, along both sid
way 12, have helped to focus on the specific needs of these areas. Highlighted ar
to provide safe passage for both large and small storms to protect the environment a
ort the quality of life for commercial, residential, and tourist trade of Lake Delton
rehensive stormwater management system is necessary to convey stormwater safely thr
ost Canyon Watershed to Lake Delton. The selected stormwater management system
nmodate existing and future commercial, residential, and recreational interests in the
ent manner possible and with minimum disruption to commercial interests of this ar

d, often unplanned, peripheral development has frequently been the source of n
icts with long established waterways. In watersheds, like Lost Canyon, that do not
nial streams, development tends to forget to plan for the inevitable flooding that will o
ings are often constructed too close to the waterway or constructed across the water
ng safe passage and future capacity expansions difficult and costly. Once areas have
, or even partially developed, there is often little that can be done to alleviate
ems. However, toward the peripheries of the developed areas, where development pre
t beginning, it is still possible to influence where development occurs, how close it wi
iting stormwater passage areas, and the type of service that will be required to
ng and future facilities.

ptimize the level of control or services provided, recommendations incorporate
tment Train" that is depicted in Figure 8-1. The concept of the Treatment Train incl
ore simple less costly source controls as well as the more traditional structural cont
proposed recommendations will enable the Village of Lake Delton to protect the
y in Lake Delton by reducing nonpoint source pollutant loadings in stormwater runo

SOURCE CONTROLS

called "Housekeeping Measures", source controls are procedures or activities that pre
duce the amount of stormwater coming into contact with potential pollutant sources. So
ols for the Village of Lake Delton range from informing the public on proper u

rcing erosion control standards. The Uniform Dwelling Code (UDC), established
R 20-25 and ILHR 50-25 and WDNR's NR-216 require erosion control measu
truction sites. Village inspectors are currently enforcing State erosion control stanc
nter-agency agreement is being developed which will clarify the rolls of the City, W
DILHR. It is estimated that the control of erosion from construction site should r
nent loadings to Lake Delton by as much as 20 tons per acre per year (approximate
: yards per acre).

5.2.2 Stormwater Management Ordinance

void the expense of correcting future stormwater management problems, the Village s
ıte its stormwater management ordinance. The ordinance should require standard
ess both the quantity and quality of stormwater runoff. The Village could use the
el ordinance being developed by the DNR for stormwater management. The ordinance
ify which projects would need to get a stormwater permit, would there be any project
ld be exempted from needing to get a stormwater permit, what information wou
ired to be submitted, and who may prepare the information submitted in the p
ication (i.e. does the permit have to be prepared by a Registered Professional Engi
ordinance should contain enforcement measures, such as penalties, fines or stop
rs, for violation of the ordinance. One of the most important policy decision which s
ncluded is the issue of maintenance. Maintenance of stormwater facilities is often
ed which causes nothing but trouble for the local municipal government. In the ordi
should be provisions for: the dedication of a maintenance easement; establishing wh
legal responsibility to preputial maintain any structures; a maintenance plan and pe
ıot properly maintaining the facilities.

5.2.3 Public Education

objective of public education is to make individuals aware of the problems caus
mwater runoff and the measures that they can take to minimize the harmful ef
iences must first be identified. There are at least three audiences in the Village of
on, the business community, the general public, and school age children. A ta
sage should be developed for each audience.

City should consider developing basic informational materials such as, brochures, dis
shows, etc., that are specific to the Village of Lake Delton's stormwater manag
ram. It may include the preparation of articles for the local news paper or the Village
r.

mational signs along area water ways would compliment the stenciling. Signs could ed
ɔublic about water quality issues. Topics which could be included are nonpoint s
tion sources, causes for and general information about the fish advisory, citizen poll
ɛntion techniques, and recognition of the implementation of best management practic

ic education program of the Village's recycling program will benefit the Vill
ıwater program by providing instruction for the proper disposal of vehicle oil, antifr
izers, pesticides, old paint and other house hold hazardous wastes that often fine thei
area water ways.

Village would be encouraged to develop a comprehensive program targeting school
lren. This approach has been very successful in getting participation in the recy
rams. In addition to classroom materials, audio visual materials could also be devel
ɔrtable, interpretive water quality display could be part of the comprehensive progra

5.2.4 Maintenance

tine maintenance cleaning of streets, ditches, swales, and storm sewers is essentia
cing the amount of pollutants accumulated on Village streets, ditches and sewers tha
ashed into area water ways. The Village does not adequately clean streets and ditch
fficantly reduce nonpoint source pollution. Site specific improvements to the Vill
ation/maintenance program include, weekly sweeping of Village streets and parking l
nercial areas and routine cleaning of ditches and storm sewers on a three to four year c

5.2.5 Spills and Illicit Connections

Village should review established procedures for responding to the spill of poten
rdous materials. The review should evaluate whether adequate measures would be
prevented pollution of storm sewers ditches and Lake Delton.

Village should establish an inspection program of all drainage facilities to locate
nate all non-stormwater discharges which are not properly permitted.

AREA CONTROLS

rcement of the Village's Erosion Control and stormwater management Ordinances w
foundation of the area controls implemented by the Village. It has been estimate
ous investigations that erosion from construction sites has historically contributed over
e total sediment loadings to Wisconsin's rivers and lakes. Enforcement of the er

include a series of check dams constructed to slow stormwater runoff flowing thr
ow swales. The system should be designed to treat the "First Flush" of pollutants wa
uring the first few minutes of a rain event. The ":First Flush" typically refers to pollu
ined in the runoff from the first 1.5 inches of rainfall. The combination of check dam
tation would slow stormwater runoff and allow particles to settle and be filtered b
tation. Area controls would be effective, inexpensive practice that could be incorpo
the site development in areas such as the Village's Business park.

development should be required to construct stormwater management facilities to h
ncreases in runoff rates, volumes and pollutant loadings. Criteria and standards shou
d to existing building codes that require new develop to construct on-site facilities to
First Flush" (runoff from the first 1.5" rainfall) and contain the peak runoff rate for th
and 100-year storm events to predevelopment conditions. Structural controls could
a swales and check dams to on-site detention ponds. The controls will ensure
lopment pays its own way. Village residents will therefore, avoid paying for rebui
ing Village facilities to accommodate development. However, as an alternative to requ
ite facilities, the Village could collect a fee or an assessment from new developmen
ld pay for their share of over-sized facilities.

DEVELOPMENT AND REGIONAL CONTROLS

proposed stormwater management ordinance should not only apply to the developme
idual sites but should also apply to larger new developments and existing development,
residential subdivision or the Village's business park. Development and regional cor
e use of the economy of scale to optimize on-site area controls and larger system con
s recommended that large developments such as the business park require
ant"/property owner to landscape their properties to detain the "First Flush". The or
ities would help contain spills and would provide partial treatment of stormwater ru
ollection systems of swales and storm sewers would be designed to convey runo
egically placed regional detention ponds. Detention ponds should be designed to re
o 80 percent of sediments contained in stormwater runoff. Detention ponds shou
gned as a landscaped water features that improves stormwater quantity and provides
ction, similar to the detention area north of Progressive Drive. Detention ponds sh
e ever possible, be designed as off-line facilities so that they are unaffected large
s.

onal controls are strategically located and sized to achieve flooding and water quality
ughout the watershed. Regional facilities can offer an economy-of-scale for reducti
tants, flood protection, reduction of maintenance, and increase system reliability

ration is a practice that is most effectively used as an Area Control of nonpoint s
tion. On occasion, infiltration has been used on a Development or Regional ba
rge groundwater supplies. Infiltration facilities should be designed with a safety fact
2) to account for clogging by the accumulation of fine soil particles (silts and clays).
d be designed to drain within a 72 hour period (the average time between storms ev
ottom of the infiltration facility and the top of bed rock or the top of the water table s
parated by at least three feet of soil. Keeping infiltration basins vegetated helps to e
performance of the facilities. Infiltration should be routinely cleaned to ma
eability and remove pollutants. Strict procedures to control spills of potentially haza
rials would have to be enforced by the Village in areas where infiltration is used.

CORRIDOR PRESERVATION

idor preservation is one means of coordinating stormwater management planning with
lanning and development. Its goal is to prohibit, or at least minimize, development in
h are likely to be required to meet stormwater management needs in the future. These
de: lands adjacent to existing stormwater conveyance areas which are projected to re
city expansion; areas which might be needed to construct entirely new channels or co
erve neighborhoods or commercial developments; and land needed for stormw
tion/detention facilities.

n corridors are preserved in advance, negative land use and social impacts, as well a
of stormwater management improvements, are minimized. However, when land i
rved for future needs, disruption of residences and businesses is a frequent result, an
of obtaining the land and/or constructing alternate stormwater conveyance facilities
nwater detention facilities is very likely to be considerably higher. At times, the ne
ovement cannot even be made because the disruption and cost would be too great.

idor preservation should be undertaken now. Public opinion (private and public se
nt studies, and the Village's efforts to deal with ongoing development issues and co
stormwater management all intensely focus the need for additional or expanded stormw
gement facilities. Planned development within the watershed makes it mandatory to
fe, efficient, and economical means of managing stormwater in this area. It is espe
rtant in areas such as the Lost Canyon Watershed south of Progressive Drive on bot
nd west side of Highway 12, as well as in the Spring Brook Watershed, and the wate
ing through the Pizza Pub area.

5.6.1 Problems with Implementing Corridor Preservation

go a long way toward establishing corridors and detention/retention facility sites
:ing stormwater management--land use conflicts.

5.6.2 Methods of Corridor Preservation

e are several techniques that can be used to preserve corridors for future storm
ıgement construction:

Purchase of Land and Interest in Land - The outright purchase of land for future us
ɔe done where there is no question as to the final facility location.

Official Mapping - A technique short of land acquisition is the official mapping of f
stormwater management corridors and sites. When planning, the Village has the stat
ıuthority to prepare plans and maps showing the approximate location and size of f
stormwater corridors and detention/retention facilities. The purpose of the map is to in
the public and land developers which areas may be required for future conveyance
detention of stormwater in order to prevent development from taking place in the corr

Developer Dedications - It would be appropriate for the Village to build into
subdivision ordinance the right to require developers and individuals to dedicate a po
of their land for necessary stormwater management improvements. This technique is
to acquire land for the construction of stormwater conveyance facilities, as well as to c
the needed right-of-way for facility expansions. Dedications or payment in lie
construction could then be used to require developers to set aside land in appropriate a
or if a regional solution is desired, payment in lieu of a land set aside so that a reg
solution which might be constructed more efficiently could be constructed to resolve i
for the area.

5.6.3 Village of Lake Delton's role

Village of Lake Delton should develop a corridor preservation master plan after evalu
ıeed for corridor preservation. Indicated in the plan would be the type of improver
ued and when, and the plan should propose a method of monitoring future develop
ns to ensure that the preservation needs are being met to the extent possible. Specifi
Village should:

Be an advocate for corridor preservation efforts;

- Raise the issue with local developers and landowners

- What new stormwater management facilities will be needed?
- Where is it possible to keep development out of the right-of-way needed for f stormwater management purposes?
- Develop a map showing those areas where preservation efforts should be undert
- Monitor development pressure and give priority for corridor preservation effo those areas where development pressure is the greatest.

Develop corridor preservation strategies:

- Where it is determined that future stormwater management expansions will be nece and where corridor preservation is still possible, map the needs and work extraterritorial government officials seeking better cooperation.

Monitor and document the progress of preservation efforts.

FLOOD CONTROL CRITERIA

atersheds, like Lost Canyon, that do not have perennial streams, development patterns rget to plan for the inevitable disaster that a flood will bring. Previous discussion s nportance of preserving the natural drainage corridors. it is recommended that these na age corridors, sometimes referred to as the "Primary Drainage System", be sized to co or store the runoff from a 100-year storm event. The "Primary Drainage System" i Canyon Watershed is delineated in Figure 1 on the USGS 7 1/2 minute quadrangle ma oken blue line (intermittent stream).

e are three constraints in the primary system, the 42" private culvert leading to High orth of Progressive Drive, the 60" east-west culvert under Highway 12 north of G and the culverts under the I-90/94 Interchange. It is recommended that regional dete s should be constructed at each of these locations to attenuate flood flows to the capa e existing culverts.

DRAINAGE

stormwater collection system of swales, culverts, and storm sewers from subdivision idual developments should be sized to handle the 10-year storm. The Village's exi water regulations are for the most part adequate for this criteria. Storm sewers and di n are major collectors, should be sized for a larger design storm such as the 25-year s

STORMWATER MANAGEMENT ALTERNATIVES

ently, Lost Canyon Watershed is only approximately 15 percent developed. This
:ver is projected to be mostly developed in the near future. Current drainage and
ty problems currently exist. It is therefore recommended that the facilities in Figure
lled to help alleviate these potentially hazardous future stormwater problems, protec
r quality of Lake Delton, and help to create a safe and aesthetically pleasing area.
ıe recommended facilities are multi-purpose water quality, drainage and flood co
tures. Recommended alternatives are listed below:

1. Regional Detention - Located in the infield of the southwest quadrant of I-9
Interchange and south of the interchange. Purpose is to alleviate the impact of f
stormwater flows originating south of the interstate. This basin would requ
maximum storage of 48 acre-ft. in order to attenuate the post-development 100
storm from runoff conditions to that of pre-development (existing) conditions.
recommended that this facility be designed for flood control only. Stormwater qu
should be addressed by constructing Best Management practices designed for
development or group of developments (Area Controls).

2. Conveyance - Open channel to convey 100-year stormwater north from the inte
along the west side of STH 12 to new culvert south of Aire Vista Motel and w
existing greenway. In order to convey the future conditions, a trapezoidal gr
swale would be required with a bottom width of 5 feet and a depth of 5 feet wit
side slopes. These are the minimum dimensions of the primary drainage corrido
the Lost Canyon Watershed. As a grassed drainage corridor, there is the advanta
the channel functioning to filter and settle pollutants carried by stormwater runo

3. Regional Detention - Located east of STH 12. The purpose is to alleviate the ir
of stormwater from future development originating in the northeast quadrant of I-9
Interchange east to Bunker Road. These basins (-7, -8 and -12) would requ
maximum storage of 75 acre-ft. in order to attenuate the 100-year storm to a flov
can be safely handled by the 60" CMP under STH 12 can convey. Significant inc
in pollutant loadings are predicted from future development in this drainage area.
facility can be designed as a regional water quality and flood control detention b
An alternative would be to design the facility for flood control only. Howeve
Village would then have to adopt the policy requiring each development in the dra
basin to construct their own facility to treat the "First Flush".

4. Regional Detention - Located south of Progressive Drive in existing greenw

. Detention/Channel and Culvert Improvements - West side of STH 12 to Progre Drive. The purpose of this facility would be to supplement the storage of the l regional facility south of Progressive Drive. This facility is too close to the wel Progressive Drive to be suitable as a water quality facility.

. Detention Dam - Located east of Highway 12 in Lost Canyon. The main purpo this facility is protecting the water quality in Lake Delton by reducing the sedi transported through the canyon.

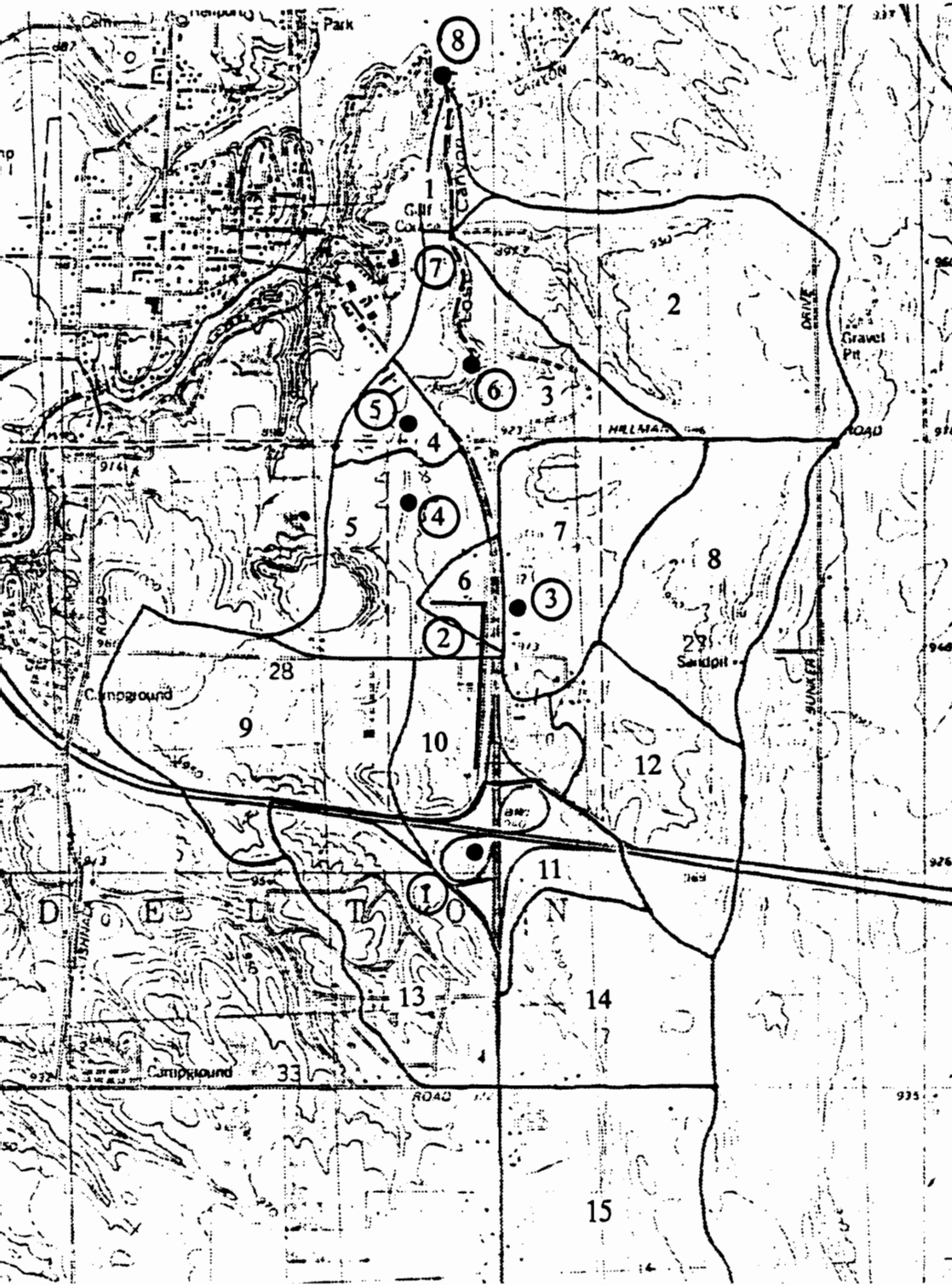
. Channel Stabilization - Located north of the detention dam described in item 6 a and continuing north to Lake Delton. Purpose is to reduce erosion and sedi transport to the Lake.

. Dredging - Lost Canyon Bay. Purpose is to remove accumulated sediments. Pos maintenance dredging.

xisting 42" CMP on the upstream side of STH 12, north of Progressive Drive, is gr sized. It would be unrealistic for the Village to construct the required 190 acre-ft reg tion basin (Recommendation -4) to prevent predicted flooding and overtopping of STH olution should include the following elements:

- regional detention;
- increase the private culvert capacity leading to the box culvert under STH 112;
- channel stabilization in Lost Canyon;
- development of a site plan for the area between Progressive Drive and Gasser R and
- floodproofing of the concessionaire in Lost Canyon.

ry preliminary estimate of costs for these solutions could range from $1,000,0 0,000. Coordination and negotiation with the affected landowners, the Village an along with the required engineering goes beyond the limits of this investigation. How s a critical issue which must be addressed by the Village as soon as possible.


Park
Canyon
Gulch
Gravel Pit
DRIVE
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Campground
Sandpit
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) IMPLEMENTATION APPROACH

1 COSTS

sts for the recommended alternatives are presented in Table 7. Estimated costs inclu
rcent for engineering and 25 percent for contingencies. Land acquisition is included
st estimates. It was assumed that the average per acre cost for land is $8,000. Constr
ould be phased to coincide with development and availability of funding.

2 PRIORITY WATERSHED

ık County has filed an application with the DNR requesting that the Dell Creek Wate
included in the States Priority Watershed Program. Based on verbal comments fro
NR, there is reason to be optimistic that the Dell Creek Watershed will be selected. Ass
watershed is selected this year (1994), the Village may be able to apply for grants st
1995 to assist with the implementation of facilities that are designed to improve the
ality of stormwater runoff from existing development. Total amount of the grants th
llage may be eligible for is approximately $250,000 to $400,000.

3 PROJECT PRIORITY

e two most critical recommendations identified in Figure 6 are stormwater detention
WDB)-3 and -4. SWDB-3 is in a subbasin for which a major development is planned.
important to have the necessary infrastructure in place to mitigate the impact of incr
noff volumes and added pollutant loadings. SWDB-4 is a partially constructed facility
tical for storing and treating stormwater runoff from commercial lands and the business

commendations -5, -6 and -7 are also eligible for partial funding through DNR's Pr
atershed Program. However, their timing is not critical. Construction of SWDB-1 shou
ed to coincide with the development of Subbasins 14 and 15. Construction c
ommended channel improvement (Recommendation - 2) should be completed at the same
the reconstruction of the traffic alignment of the frontage roads. Table 8 summariz
ggested priorities of the recommended improvements.

. IMPLEMENTATION PLAN

suggested implementation schedule is presented in Table 9. The schedule covers onl
rs of 1994 through 1996. This schedule and the priority for implementing the rema
ommendations may change as development occurs.

TABLE 7

Estimated Project Costs

oject umber*	Description	Estimated Cost
1.	I-90/94 Detention Basin	$1,045,000
2.	Channel Reconstruction	730,000
3.	Regional Detention Cost w/STH 12	1,800,000
4.	Regional Detention south of Progressive Drive	N/A
5.	Detention north of Progressive Drive	150,000
6.	Lost Canyon Detention Dam	160,000
7.	Lost Canyon Channel Stabilization	22,000
8.	Dredging Lost Canyon Bay	20,000
9.	Annual Maintenance Dredging	20,000
Total		$3,947,000

From Figure 6

A Cost estimates not available

TABLE 8

Suggested Priority
Recommended Improvements

iority	Project Number*	Project
1	9	Lost Canyon Bay Dredging
2	3	Regional Detention East of Highway 12
3	4	Regional Detention South of Progressive D
4	5	Detention North of Progressive Drive
5	6	Lost Canyon Detention Dam
6	7	Lost Canyon Channel Stabilization
7	8	Maintenance Dredging
8	2	Channel Reconstruction
9	1	I-90/94 Detention Basin

From Figure 6

TABLE 9

Suggested Implementation Plan

994

Implementation of stormwater utility billing system.
Adopt ordinance establishing a system of impact fees and special assessments.
Preliminary design of the detention basin and greenway corridor south of Progressive
Adopt zoning regulations to set aside land for regional detention basins.
Apply for Dell Creek Watershed designation as a priority watershed.
Complete dredging of Lost Canyon Bay.

995

Preliminary design for detention basin east of Highway 12 (SWDA-3).
Modify zoning to include detention basin and greenway corridor in industrial park so
Progressive Drive.
Acquire land for SWDA-4.
Complete design plans and specifications for SWDA-4.

996

Construction of SWDA-4.
Prepare plans and specifications for SWDA-3.
Acquire land for SWDA-3.
Acquire land for SWDA-5.

TABLE 10

Recommendations 3 and 4

ecommendation No. 3 - SWDA east of Highway 12

Land acquired through dedication by developers.
50% special assessment based on a per acre basis.
50% impact fees based on impact fees.
User Fees/General Fund will front revenue that will eventually be collected by assessments and impact fees.

ecommendation No. 4 - SWDA South of Progressive Drive

50% DNR Local Assistance Grant.
25% special assessment based on a per acre basis.
25% impact fees based on impervious area.
User Fees/General Fund will front revenue that will eventually be collected by assessments and impact fees.

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