

MIRROR LAKE SEDIMENT & NUTRIENT REDUCTION STUDY REPORT  
MIRROR LAKE MANAGEMENT DISTRICT  
Lake Delton, Wisconsin

*Prepared For:*  
Mirror Lake Management District  
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*Prepared On:*  
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vierbicher  
planners | engineers | advisors



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# 2010 MIRROR LAKE SEDIMENT & NUTRIENT REDUCTION STUDY REPORT

## I. Introduction

The Mirror Lake Management District completed a major lake improvement project in 2008 that included substantial navigational dredging and construction of a sediment and nutrient trap in the lake. Grants from The Wisconsin Department of Natural Resources (DNR) were used to fund that project.

After that project the Mirror Lake District applied for another grant from DNR's Lake Management Program to investigate other tributary sources of sediment and nutrients to the lake. This subsequent project developed recommendations to reduce the inflow of sediment and nutrients to help further improve the water quality of Mirror Lake. This project provided detail to Mirror Lake's existing lake management plan by indentifying and refining engineering solutions to reduce erosion in heavily developed steep shoreline sub-watersheds.

Mirror Lake is about 137 acres in size and is an impoundment of Dell Creek. The lake provides fish and wildlife habitat, flood protection, and recreational opportunities for local residents and the public. Public access to the lake is abundant with 7 public access sites providing more than 30 parking spaces for vehicles.

Significant erosion is taking place within developed sub-watersheds primarily along the northern portion of the lake (see appendix). This severe erosion is cutting deep gullies along the steep shoreline and the deposited sediment is filling in the lake shore. The transport of sediment and nutrients along these gullies is damaging littoral habitat and creating turbid water in the remainder of the lake.

This studies primary focus is to evaluate these sub-watersheds and develop engineering approaches to help reduce the amount of sediment and nutrients entering the lake. This report identifies Best Management Practices (BMPs) such as storm water detention facilities, check dams and buffer zones that if implemented will help reduce gully erosion.

The steep slopes along eroding gullies are identified on maps and the watershed draining to these gullies are delineated so that surface water runoff patterns and affected environmentally sensitive areas could be identified more easily. Watershed pollution sources were also evaluated using the Source Loading And Management Model (SLAMM). This assessment was used to set a priority ranking of the eroding gullies and to develop a feasibility analysis of potential sub-watershed pollution controls. In some gullies constructing structural engineering solutions did not apply because not enough area was available. The area available was unsuited for construction or the property owner was unwilling to participate.

## II. Project Results

### Grant Administration –

Vierbicher assisted the Mirror Lake Management District with grant administration including aligning our work tasks with grant approved activities, and then completing grant reimbursement requests, and writing this final grant report.



### **Agency Coordination –**

Representatives from Vierbicher, Sauk County Land Conservation and Mirror Lake Management District met in the Sauk County Land Conservation Office on October 12, 2009 to review the scope of the project, and discuss issues that need to be addressed. Subsequent meetings with county staff were held to complete project work items such as review of the final construction plans for specific BMPs.

### **Regulatory Coordination –**

Through conversations between Vierbicher and the Sauk County Land Conservation Staff, coordination with the appropriate regulatory agency staff was completed. Because the proposed BMP projects were outside regulated shoreline areas or above the ordinary high water line no additional permits were necessary to implement the proposed best management practices at the Hutchinson, Steinhoff and Peterson Sites. However, as implementation takes place at other sites such as R & G Inc., or when sediment deltas are removed additional permits may be required.

### **Prepare Base Map –**

A base map and detailed plans were prepared for the project area showing topography, property ownership, existing improvements within the sub-watersheds, areas of significant erosion, environmentally sensitive areas such as wetlands and steep slopes, shoreline sediment deposits and other important physical features (See Appendix). In addition, the county prepared plans for BMPs in gullies in area 5 and 7 for R&G Inc.

### **Sub-watershed Analysis –**

A sub-watershed analysis using SLAMM was used to develop plans for improvements to reduce erosion and the amount of sediment and nutrients entering the lake. The sub watershed improvements evaluated in this step included SLAMM techniques to compare the existing case where no controls are in place, as to the proposed BMPs such as upstream storm water detention, reinforced stream banks, and check dams.



### Gully Sediment Deposition (Tons/Year) Into Mirror Lake

Gully	Property Owner	Watershed Size (Acres)	Land Use	Tons/Year (No Controls)	Tons/Year W/Controls	Feasibility	Rank
1	Garry, Herbst, Halwax	50	Wooded	0.3	No Controls	Unwilling owner	6
2	Hutchison, Steinhoff	14	Residential	0.18	.12	Yes	4
3	Peterson	9	Residential	0.05	.02	Yes	3
4	Reifsteck	30	Residential	0.23	No Controls	Unwilling Owner	5
5	R & G Inc.	17	Campground	0.2	.04	Yes	2
6	R & G Inc.	6	Campround	0.04	No Controls	Too Steep	7
7	R & G Inc.	20	Campground	0.21	.04	Yes	1
8	Pine Cove Condominium Development	3	Residential	0.02	No Controls	Too Small	8

Total	Reduction:	Percent
Deposition:	(ton/year)	Reduction
Acres	(Ton/Year)	
<b>Totals:</b>	<b>149</b>	<b>1.23</b>
	<b>.42</b>	<b>34%</b>

#### Conceptual Plans –

Conceptual plans of BMPs to reduce the amount of sediment and nutrients entering the lake were developed and presented at the Mirror Lake Management District meeting on October 8<sup>th</sup>, 2009. Designs were coordinated with the Sauk County Land Conservation to complete project review and approvals. In each sub-watershed where improvements were feasible, budgets, time lines and responsible parties were identified for project implementation. Some sites were too steep (Gully 6), too small (Gully 8) or had unwilling owners (Gully 1 & 4) so were not feasible to implement BMPs.

#### Review Plans –

Engineered construction plans were presented at Mirror Lake District Meetings on October 8<sup>th</sup> and on December 12<sup>th</sup>, 2009 with the Mirror Lake Management District Members, Mirror Lake Association Members, Mirror Lake State Park Staff, and landowners in attendance. In addition the County Land Conservation Department reviewed all construction plans.

#### Plans, Specifications and an Engineers Opinion of Probable Cost –

Complete engineering designs of the BMPs were completed which included; construction plans, specifications and an engineer's opinion of the probable costs. (See Appendix)

#### Funding Review –

Funding for the construction of the BMPs will be provided through the Dell Creek Priority Watershed Project, and the Mirror Lake Management District. Future projects maybe funded solely by the Lake Management District if cost/benefits justify the project and no other sources of funding are available.



## **Sediment & Nutrient Reduction and Removal-**

As a result of this project, BMPs were designed for Gullies 2,3,5 & 7 to reduce sediment and nutrient inflow to the lake. However, substantial sediment deposits are located along the ends of gullies along Mirror Lake. Dredging activities could remove these sediment deposits through mechanical/barge dredging (long reach excavator, barge, quad axel dump trucks, etc.) or by hydraulic suction dredging. Dredging would also remove nutrients which have been transported in the sediment to Mirror Lake. The sediment would be removed to upland areas such as the existing dredge spoil sites within Mirror Lake State Park.

On March 1<sup>st</sup> & July 27<sup>th</sup>, 2010 sediment surveys were completed. Multiple gullies of interest were surveyed to estimate sediment volume (See Appendix). An average of 475 cubic yards of sediment was found at each gully and approximately 3,330 cubic yards of sediment was found in the seven gullies surveyed. Dredging is estimated to cost approximately \$30.00 per cubic yard, and a total of about \$100,000 will be required to remove the 3,330 cubic yards. Permits will be required with the Wisconsin Department of Natural Resources, the United States Army Corp of Engineers, and Sauk County. Obtaining these permits will require six months and maybe longer if a lake drawdown is necessary to reach accumulated material. Because these seven gully sites are widely distributed along the lake and no nearby disposal sites are readily available the hydraulic dredge option was not a feasible alternative.

We recommend that sediment accumulated in the seven gullies surveyed be removed by mechanical methods. Where possible such as at the R&G Inc. sites access from the shore should be considered as well as finding nearby upland areas for disposal of the material. For the remaining sites where water based access and remote spoil disposal is required obtaining a bid price from qualified contractors will help determine if removing the remaining material is economically feasible.



# Appendix

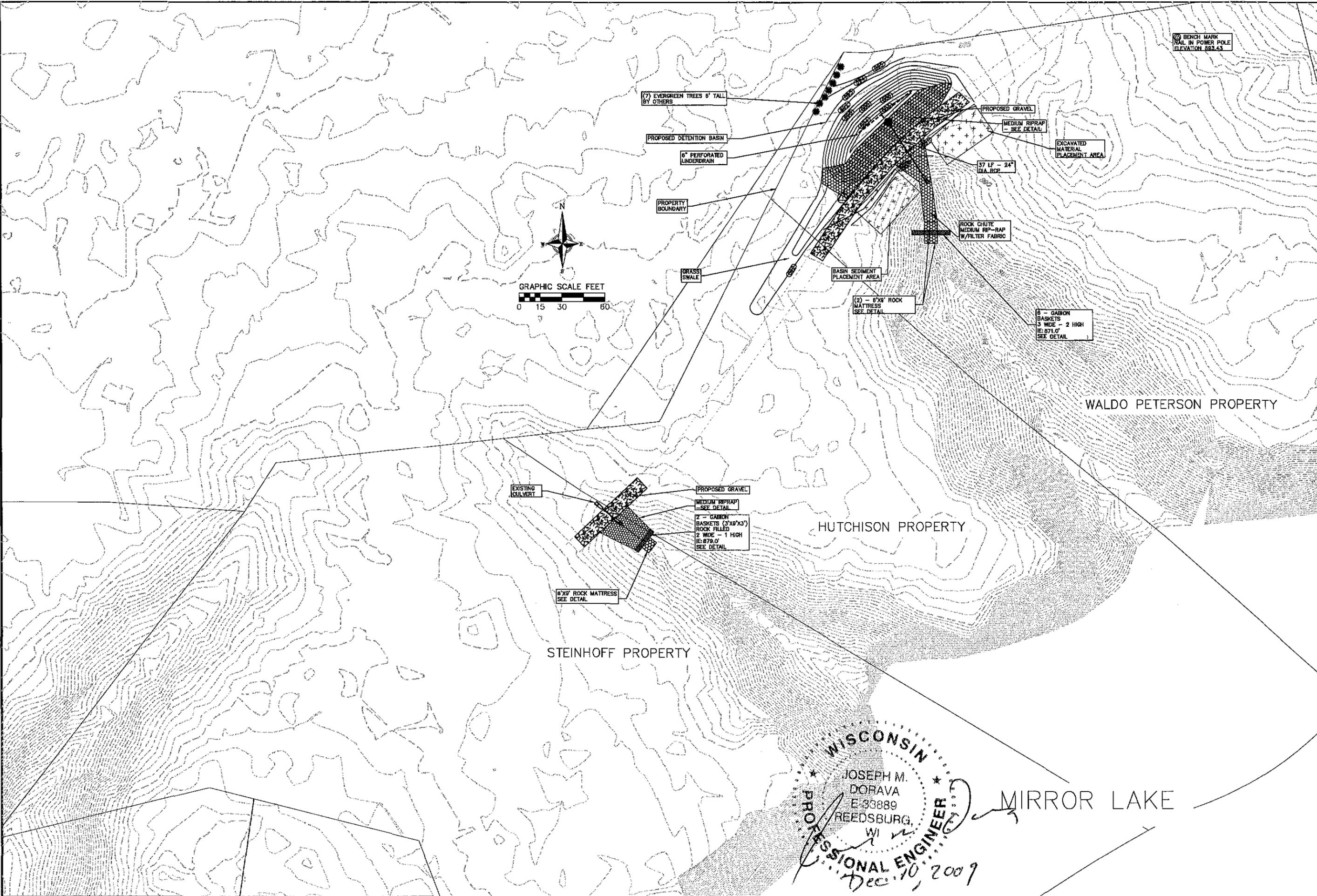


**MIRROR LAKE OVERALL  
 EROSION AND NUTRIENT REDUCTION  
 PROJECT LOCATION  
 SAUK COUNTY, WI**

REVISIONS	NO.	DATE	REMARKS

SCALE: AS SHOWN  
 DATE: JANUARY 2010  
 DRAFTER: NPFA  
 CHECKED: JOOR  
 PROJECT NO.: 026086775  
 SHEET: 1 OF 1  
 DWG. NO.: No.

10 Dec 2009 9:24a R:\Mirror Lake 026086775 Grant Application 2009\Civil 3D\Waldo Peterson Site.dwg by: npfa ©2009 Vierbicher Associates, Inc.



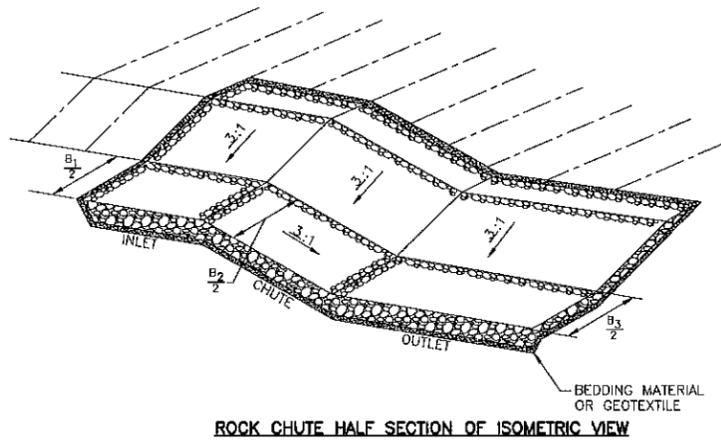
WISCONSIN PROFESSIONAL ENGINEER  
 JOSEPH M. DORAVA  
 E-33889  
 REEDSBURG, WI  
 Dec 10, 2009

**vierbicher** planners | engineers | advisors  
 REEDSBURG - MADISON - PRAIRIE DU CHIEN  
 400 Viking Drive Reedsburg, Wisconsin 53979  
 Phone: (608) 524-4468 Fax: (608) 524-0218

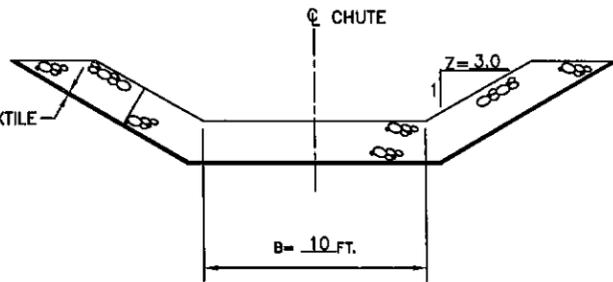
**Detention Basin**  
 Mirror Lake Management District  
 Waldo Peterson & Steinhoff/Hutchison Properties  
 Lake Delton, Wisconsin

REVISIONS	NO.	DATE	REMARKS
1	12/01/09		REVISIONS

SCALE: AS SHOWN  
 DATE: November 2009  
 DRAFTER: NPFA  
 CHECKED: JDR  
 PROJECT NO.: 026086775  
 SHEET: 1 OF 4  
 DWG. NO.: NO



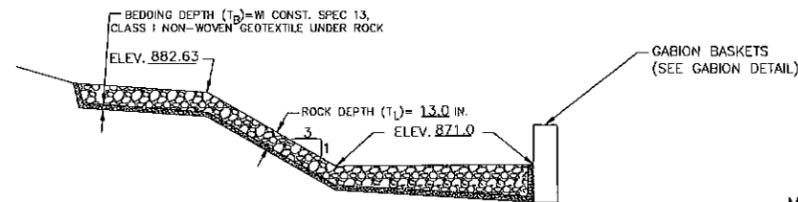
ROCK CHUTE HALF SECTION OF ISOMETRIC VIEW



CROSS SECTION OF CHUTE (AT CENTER)

BEDDING MATERIAL REQUIREMENTS

A GEOTEXTILE MEETING THE REQUIREMENTS OF WISCONSIN CONSTRUCTION SPECIFICATION 13 SHALL BE USED IN LIEU OF BEDDING.



ROCK CHUTE PROFILE ALONG CENTERLINE

MEDIUM RIP-RAP - GRADATION OF ROCK

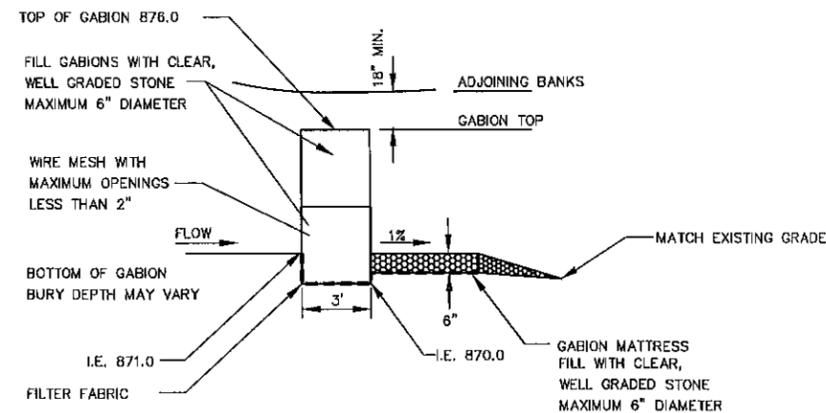
PERCENT PASSING BY WEIGHT	SIZE (INCHES)
100	12-16
85	10.4-14.4
50	8-12
10	6.4-10.4

HEAVY RIP-RAP - GRADATION OF ROCK

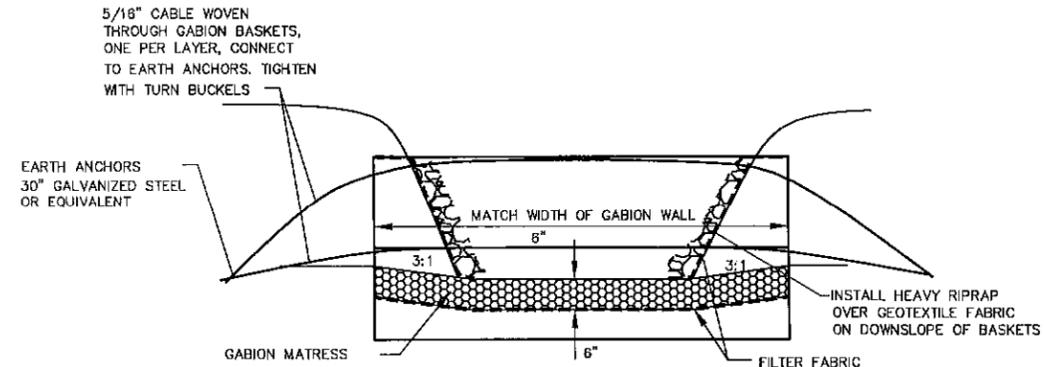
PERCENT PASSING BY WEIGHT	SIZE (INCHES)
100	18-24
85	15.6-21.6
50	12-18
10	9.6-15.6

REFER TO NRCS WISCONSIN CONSTRUCTION SPECIFICATIONS

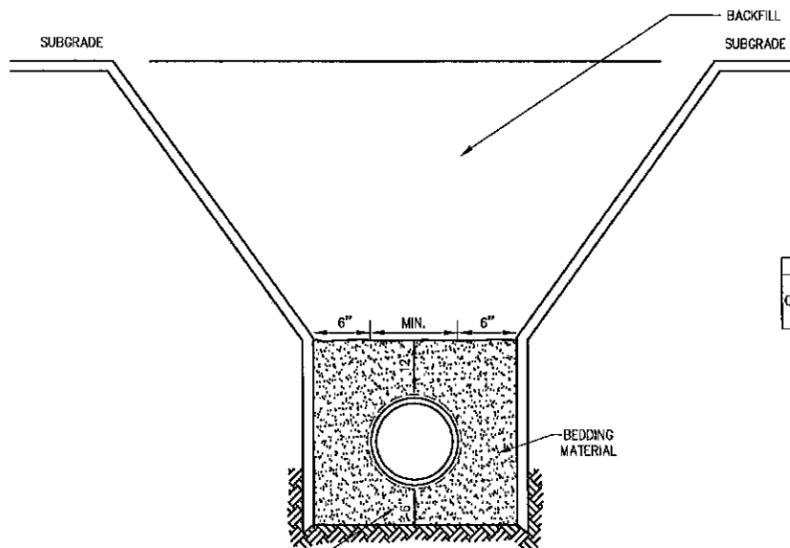
- #1 CLEARING
- #2 EXCAVATION
- #3 EARTH FILL
- #9 ROCK RIPRAP
- #13 GEOTEXTILES
- #15 PLASTIC PIPE CONDUITS
- #17 WIRE MESH GABIONS AND MATTRESSES



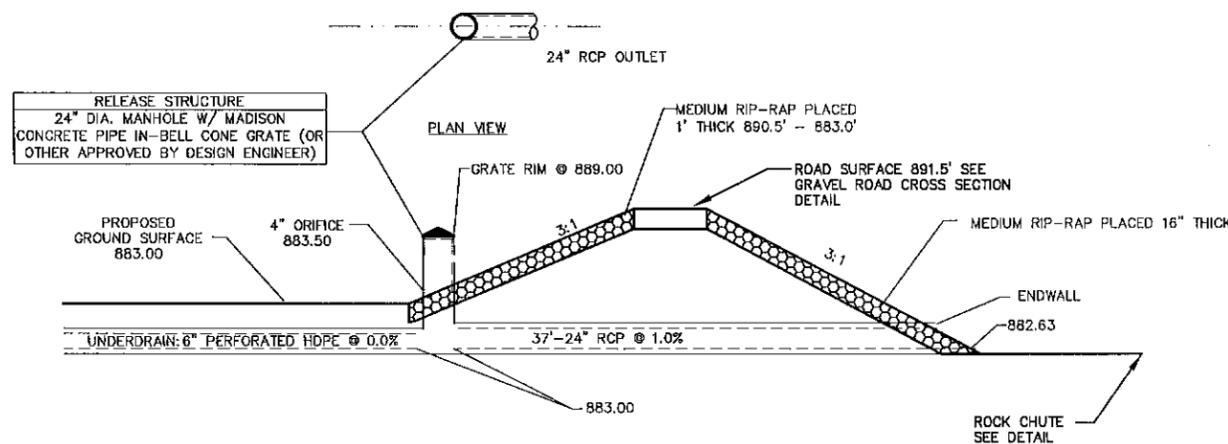
GABION DETAIL (NOT TO SCALE)



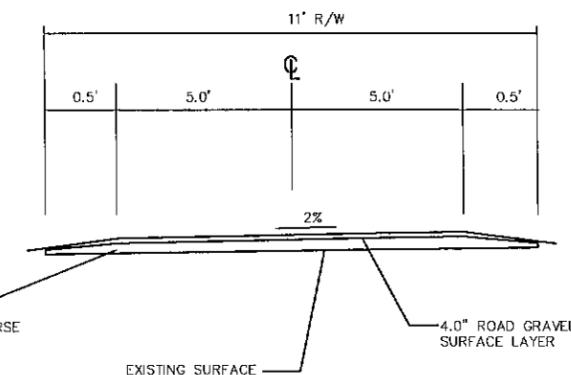
GABION MATTRESS (NOT TO SCALE)



STANDARD TRENCH SECTION (NOT TO SCALE)



BASIN 1: OUTFALL STRUCTURE (NOT TO SCALE)



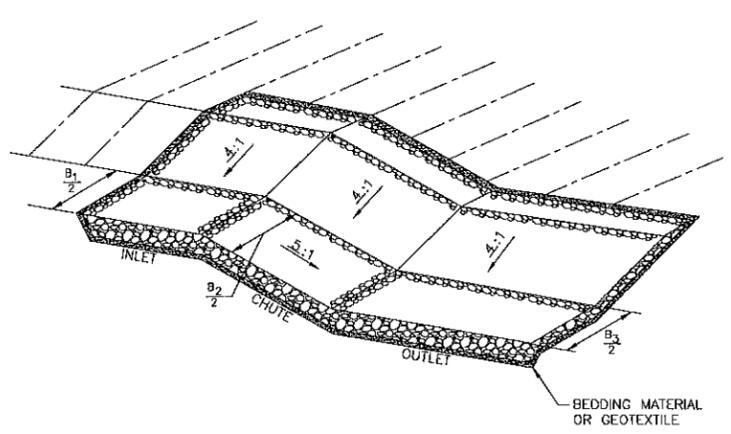
GRAVEL ROAD TYPICAL SECTION

REVISIONS	NO.	DATE	REMARKS

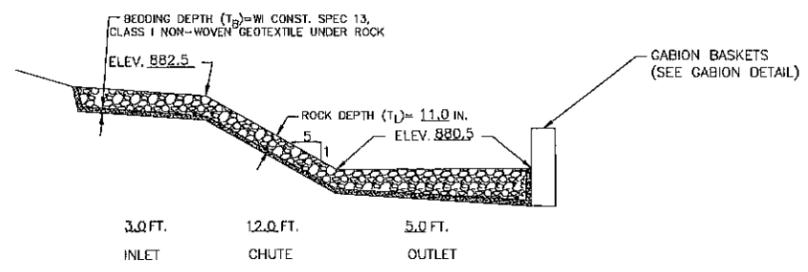
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DATE: November 2009  
DRAFTER: NPFA  
CHECKED: JDR  
PROJECT NO.: 026086775  
SHEET: 2 OF 4  
DWG. NO.: NO

REVISIONS	NO.	DATE	REMARKS

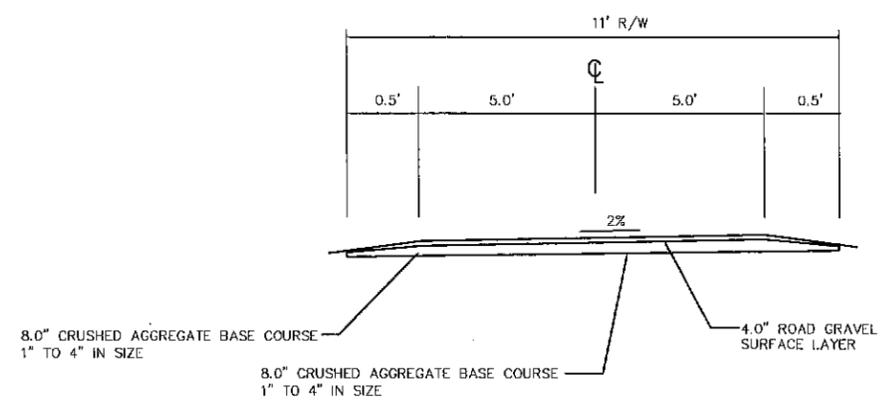
SCALE: NTS  
 DATE: November 2009  
 DRAFTER: NPFA  
 CHECKED: JDOOR  
 PROJECT NO.: 026086775  
 SHEET: 3 OF 4  
 DWG. NO.: NO



**ROCK CHUTE HALF SECTION OF ISOMETRIC VIEW**



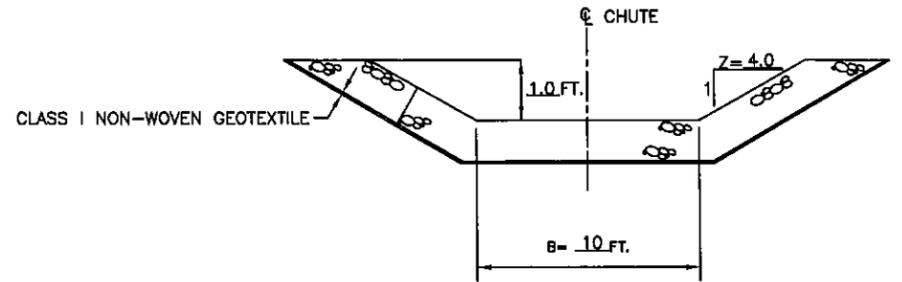
**ROCK CHUTE PROFILE ALONG CENTERLINE**



**GRAVEL ROAD TYPICAL SECTION**

REFER TO NRCS WISCONSIN CONSTRUCTION SPECIFICATIONS

- #1 CLEARING
- #2 EXCAVATION
- #3 EARTH FILL
- #9 ROCK RIPRAP
- #13 GEOTEXTILES
- #15 PLASTIC PIPE CONDUITS
- #17 WIRE MESH GABIONS AND MATTRESSES

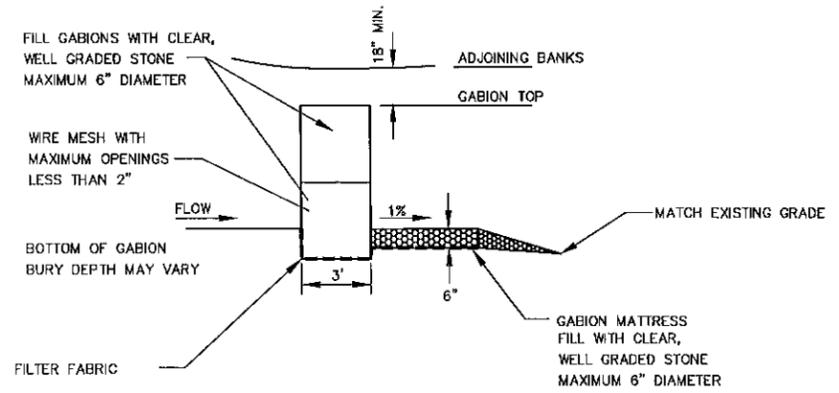


**CROSS SECTION OF CHUTE (AT CENTER)**

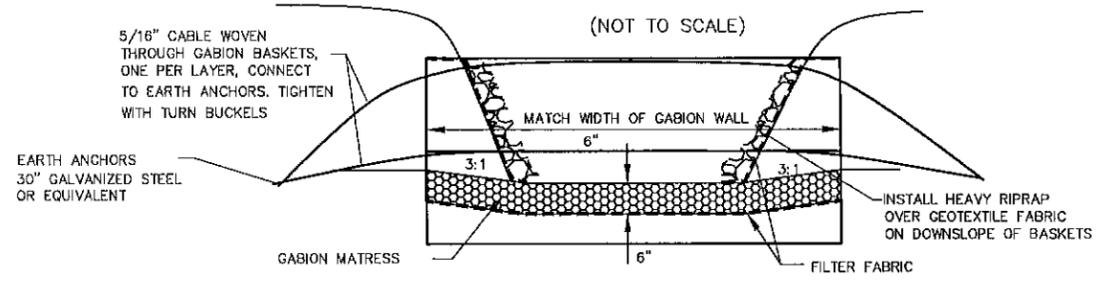
**BEDDING MATERIAL REQUIREMENTS**

A GEOTEXTILE MEETING THE REQUIREMENTS OF WISCONSIN CONSTRUCTION SPECIFICATION 13 SHALL BE USED IN LIEU OF BEDDING.

MEDIUM RIP-RAP -- GRADATION OF ROCK		HEAVY RIP-RAP -- GRADATION OF ROCK	
PERCENT PASSING BY WEIGHT	SIZE (INCHES)	PERCENT PASSING BY WEIGHT	SIZE (INCHES)
100	12-16	100	18-24
85	10.4-14.4	85	15.6-21.6
50	8-12	50	12-18
10	6.4-10.4	10	9.6-15.6



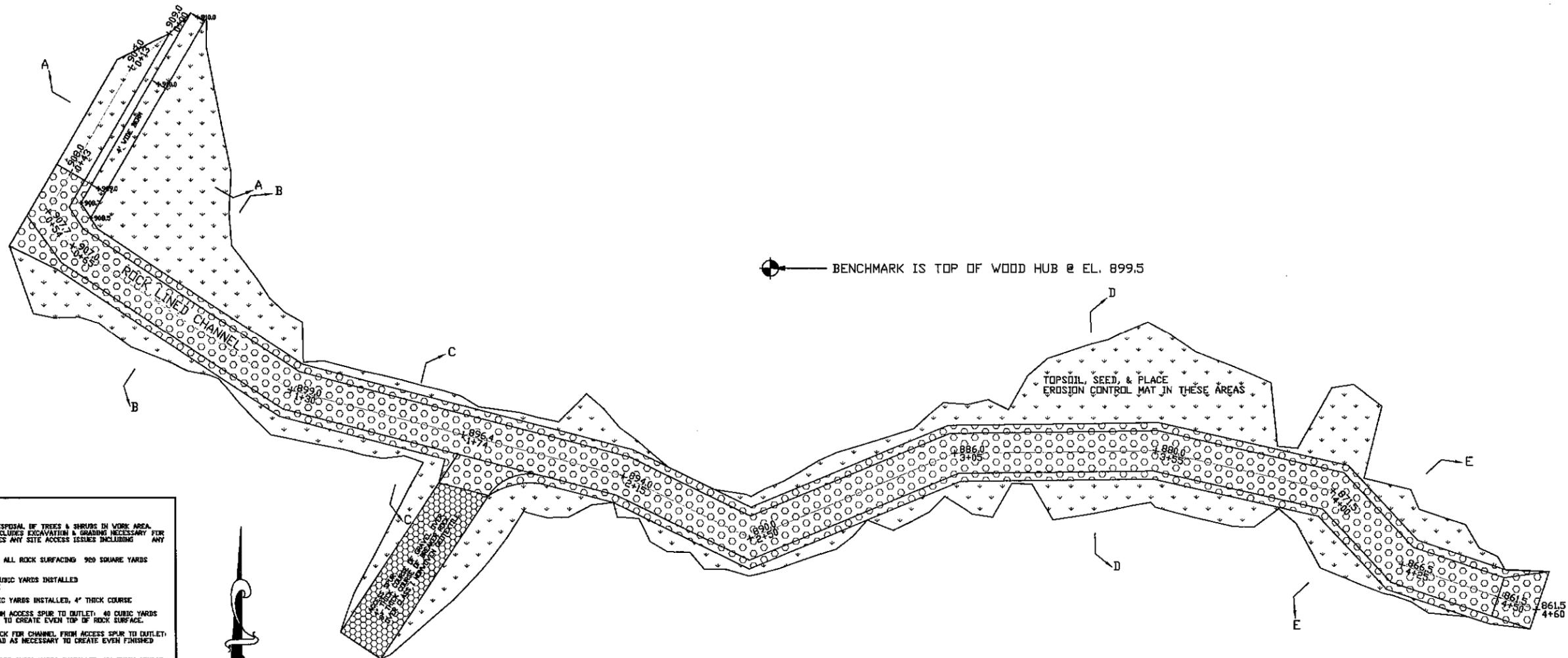
**GABION DETAIL (NOT TO SCALE)**



**GABION MATTRESS (NOT TO SCALE)**



# PLAN VIEW



## CONSTRUCTION NOTES

SITE PREP: LUMP SUM  
 SITE PREP INCLUDES REMOVAL & DISPOSAL OF TREES & SHRUBS IN WORK AREA. VERIFY DISPOSAL WITH LANDOWNER. INCLUDES EXCAVATION & GRADING NECESSARY FOR INSTALLATION OF ROCK LINING. INCLUDES ANY SITE ACCESS ISSUES INCLUDING ANY REPAIRS OF ACCESS ROADS.

CLASS I NON-WOVEN GEOTEXTILE UNDER ALL ROCK SURFACING. 900 SQUARE YARDS INSTALLED.

BREAKER ROCK FOR ACCESS SPUR: 10 CUBIC YARDS INSTALLED BY THICK COURSE, 1" TO 4" IN SIZE.

ROAD GRAVEL FOR ACCESS SPUR: 7 CUBIC YARDS INSTALLED, 4" THICK COURSE.

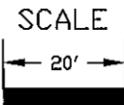
BREAKER ROCK FOR CAPPING RIPRAP FROM ACCESS SPUR TO OUTLET: 40 CUBIC YARDS INSTALLED. SPREAD AS NECESSARY TO CREATE EVEN TOP OF ROCK SURFACE.

ROAD GRAVEL FOR CAPPING BREAKER ROCK FOR CHANNEL FROM ACCESS SPUR TO OUTLET: 50 CUBIC YARDS INSTALLED. SPREAD AS NECESSARY TO CREATE EVEN FINISHED SURFACE.

120'-6" ROCK RIPRAP CHANNEL LINING: 255 CUBIC YARDS INSTALLED, 12" THICK COURSE GRADATION IS AS FOLLOWS:

ROCK SIZE (INCHES)	% PASSING BY WEIGHT
12	100
9	65-95
4	25-50
3	5-20
1	0-5

TOPSOILING & SEEDING: 0.4 ACRES (ALL DISTURBED AREAS)  
 EROSION CONTROL MAT: 1506 SQUARE YARDS INSTALLED (ALL DISTURBED AREAS)  
 CLASS I, TYPE B KIDPORE  
 ALL GRADES 2:1 OR FLATTER UNLESS OTHERWISE INDICATED.  
 ROCK LINED CHANNEL SHALL HAVE 10' FLATT BOTTOM WITH 2:1 SIDE SLOPES WITH 1' LINED DEPTH MINIMUM.  
 PROJECT COMPLETION SHOULD BE PRIOR TO MID-MAY SO AS NOT TO INTERFERE WITH CAMPING SEASON. VERIFY WITH LANDOWNER.



LANDOWNER: CAMP DELTON INC.	
PROJECT: ROCK LINED WATERWAY	
DATE: 12-04-09	DESIGNED BY: JJV
SHEET ____ OF ____	CHECKED BY:

# PLAN VIEW

## CONSTRUCTION NOTES

SITE PREP: LUMP SUM  
 SITE PREP INCLUDES REMOVAL & DISPOSAL OF ANY TREES IN WORK AREA. VERIFY DISPOSAL WITH LANDOWNER. INCLUDES EXCAVATION & GRADING NECESSARY FOR INSTALLATION OF GABION STRUCTURE. INCLUDES ANY SITE ACCESS ISSUES INCLUDING ANY REPAIRS OF ACCESS ROADS. SITE ACCESS WILL BE VIA PROPOSED ROCK LINED CHANNEL. SEE INCLUDED PLANS.

4" DIA. SCHEDULE 40 PVC DRAWDOWN PIPE: 40 LINEAR FEET INSTALLED, (INCLUDES FITTINGS)

4" DIA. SCHEDULE 40 PVC RISER PIPE FOR DRAWDOWN: 1 EACH INSTALLED, (INCLUDES END CAP ON TOP)

GABION BASKETS: 120 CUBIC YARDS

INCLUDES ASSEMBLY, INSTALLATION, AND ROCK FILL. ROCK FILL TO BE PREDDOMINANTLY 4 TO 8 INCHES IN SIZE. GABION STRUCTURE IS COMPOSED OF THE FOLLOWING:

- ONE 30'X27'X1.5' FOUNDATION GABION COURSE
- ONE 39'X9'X1.5' GABION COURSE
- ONE ADDITIONAL 6'X3'X1.5' GABION COURSE FOR KEYING ABOVE COURSE INTO GROUND
- ONE MORE ADDITIONAL 3'X3'X1.5' GABION COURSE FOR KEYING ABOVE COURSE INTO GROUND
- ONE 42'X6'X1.5' GABION COURSE
- ONE ADDITIONAL 3'X3'X1.5' GABION COURSE FOR KEYING ABOVE COURSE INTO GROUND
- ONE 48'X6'X1.5' GABION COURSE
- ONE ADDITIONAL 3'X3'X1.5' GABION COURSE FOR KEYING ABOVE COURSE INTO GROUND
- ONE 51'X3'X1.5' GABION COURSE
- ONE 21'X3'X1.5' WEIR GABION COURSE
- ONE 15'X3'X1.5' WEIR GABION COURSE
- TWO 18'X3'X1.5' STILLING BASIN SIDE GABION COURSES
- ONE 21'X3'X1' STILLING BASIN END GABION COURSE

2" WASHED ROUNDED STONE AROUND PERFORATED RISER: 1.5 CUBIC YARDS INSTALLED

D50=6" ROCK RIPRAP APRON: 6 CUBIC YARDS INSTALLED

GRADATION IS AS FOLLOWS:

ROCK SIZE (INCHES)	% PASSING BY WEIGHT
12	100
9	60-85
6	25-50
3	5-20
1	0-5

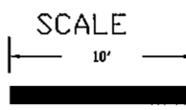
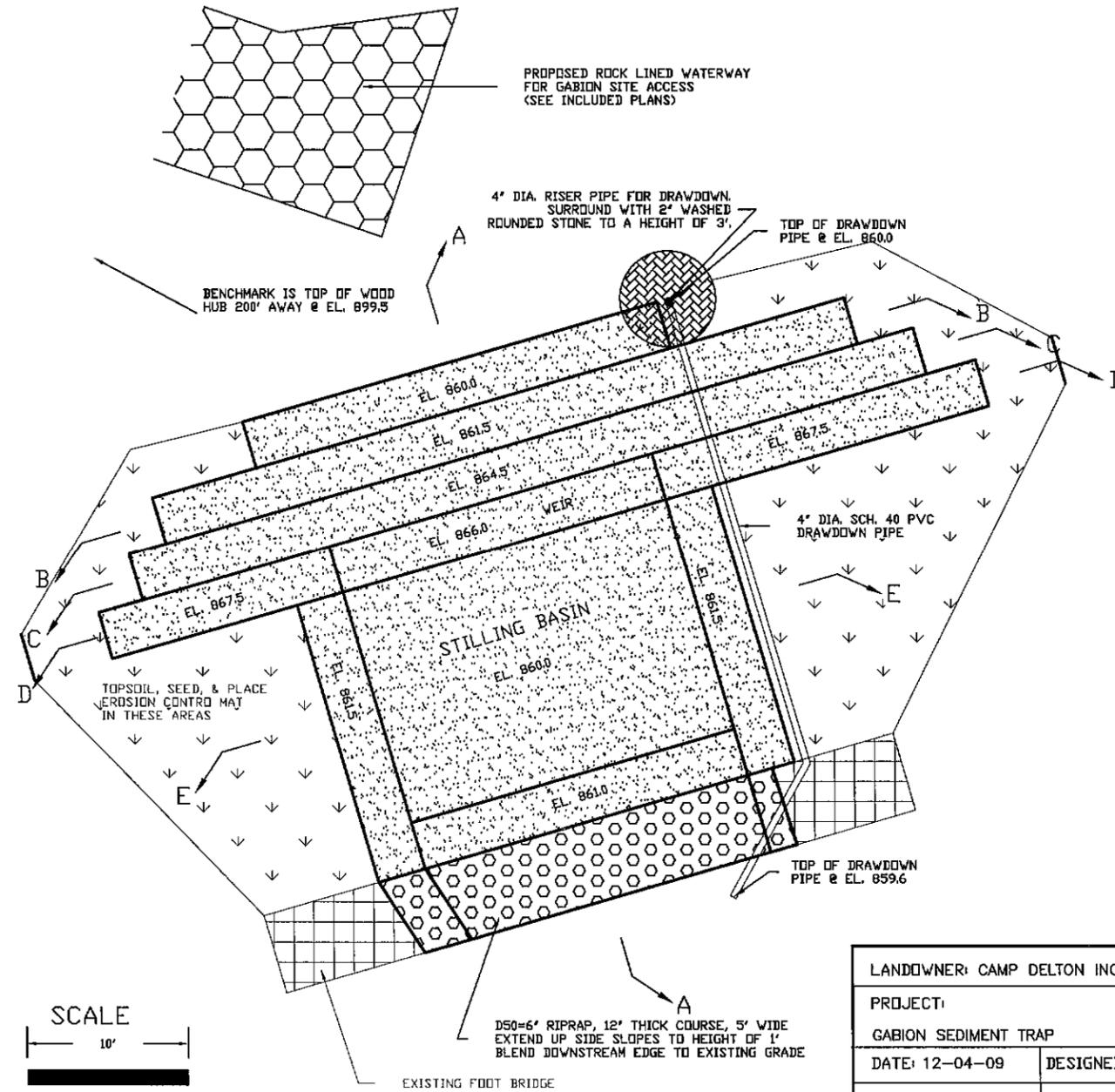
TOPSOILING & SEEDING: 1000 SQUARE FEET (ALL DISTURBED AREAS)

EROSION CONTROL MAT: 110 SQUARE YARDS INSTALLED (ALL DISTURBED AREAS)  
 (CLASS I, TYPE B MINIMUM)

ALL GRADES 2:1 OR FLATTER UNLESS OTHERWISE INDICATED.

PROJECT COMPLETION SHOULD BE PRIOR TO MID-MAY SO AS NOT TO INTERFERE WITH CAMPING SEASON. VERIFY WITH LANDOWNER.

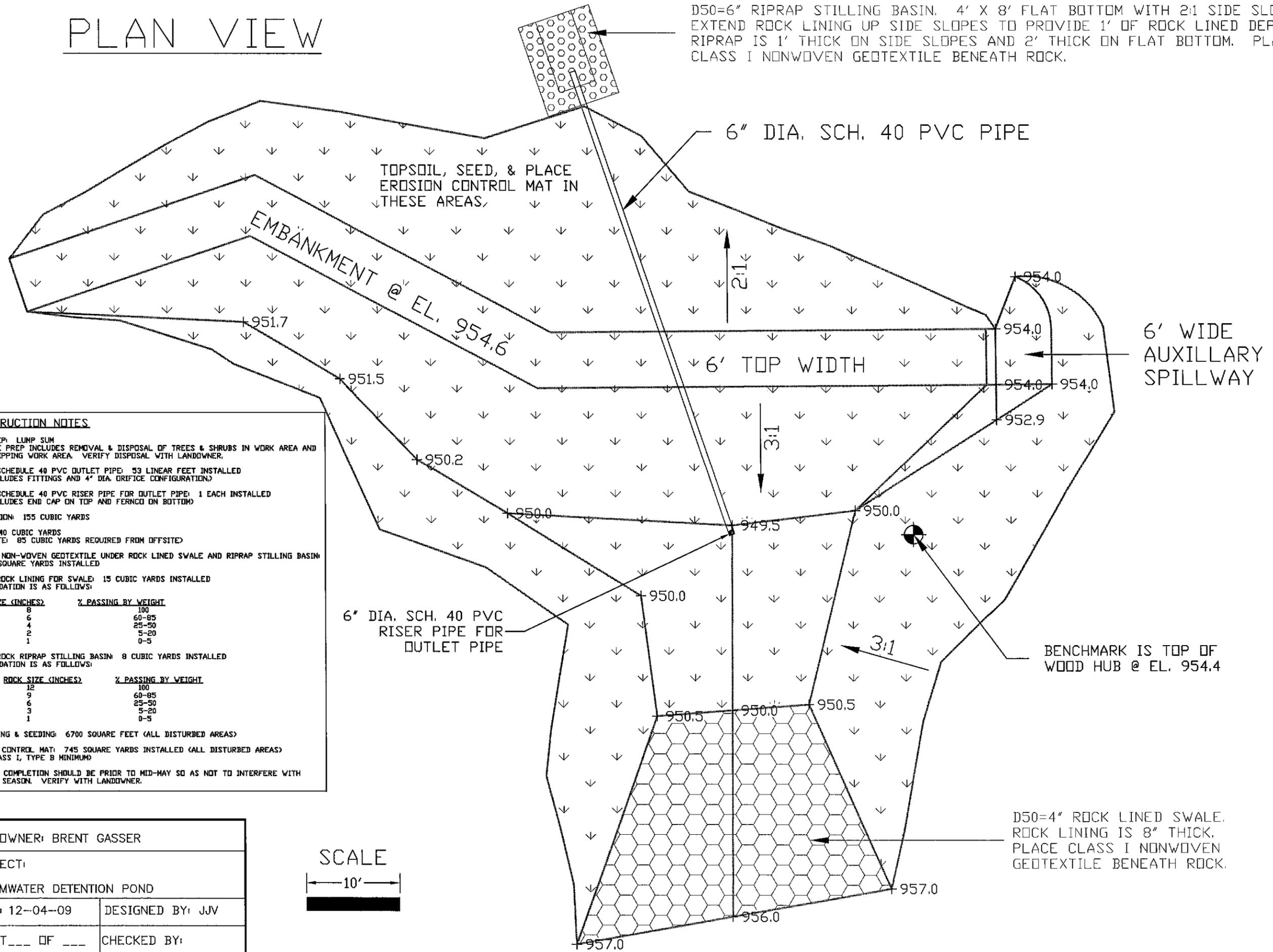
CONTACT SAUK COUNTY LAND CONSERVATION DEPT. PRIOR TO CONSTRUCTION FOR STATUS OF PERMIT APPROVAL.



LANDOWNER: CAMP DELTON INC.	
PROJECT: GABION SEDIMENT TRAP	
DATE: 12-04-09	DESIGNED BY: JJV
SHEET 3 OF 10	CHECKED BY:

# PLAN VIEW

D50=6" RIPRAP STILLING BASIN. 4' X 8' FLAT BOTTOM WITH 2:1 SIDE SLOPES. EXTEND ROCK LINING UP SIDE SLOPES TO PROVIDE 1' OF ROCK LINED DEPTH. RIPRAP IS 1' THICK ON SIDE SLOPES AND 2' THICK ON FLAT BOTTOM. PLACE CLASS I NONWOVEN GEOTEXTILE BENEATH ROCK.



TOPSOIL, SEED, & PLACE EROSION CONTROL MAT IN THESE AREAS.

EMBANKMENT @ EL. 954.6

6" DIA. SCH. 40 PVC PIPE

6' TOP WIDTH

6' WIDE AUXILLARY SPILLWAY

BENCHMARK IS TOP OF WOOD HUB @ EL. 954.4

6" DIA. SCH. 40 PVC RISER PIPE FOR OUTLET PIPE

D50=4" ROCK LINED SWALE. ROCK LINING IS 8" THICK. PLACE CLASS I NONWOVEN GEOTEXTILE BENEATH ROCK.

## CONSTRUCTION NOTES

SITE PREP: LUMP SUM  
 SITE PREP INCLUDES REMOVAL & DISPOSAL OF TREES & SHRUBS IN WORK AREA AND STRIPPING WORK AREA. VERIFY DISPOSAL WITH LANDOWNER.

6" DIA. SCHEDULE 40 PVC OUTLET PIPE: 53 LINEAR FEET INSTALLED (INCLUDES FITTINGS AND 4" DIA. ORIFICE CONFIGURATION)

6" DIA. SCHEDULE 40 PVC RISER PIPE FOR OUTLET PIPE: 1 EACH INSTALLED (INCLUDES END CAP ON TOP AND FERROD ON BOTTOM)

EXCAVATION: 155 CUBIC YARDS

FILL: 240 CUBIC YARDS (NOTE: 85 CUBIC YARDS REQUIRED FROM OFFSITE)

CLASS I NON-WOVEN GEOTEXTILE UNDER ROCK LINED SWALE AND RIPRAP STILLING BASIN: 90 SQUARE YARDS INSTALLED

D50=4" ROCK LINING FOR SWALE: 15 CUBIC YARDS INSTALLED  
 GRADATION IS AS FOLLOWS:

ROCK SIZE (INCHES)	% PASSING BY WEIGHT
8	100
6	60-85
4	25-50
2	5-20
1	0-5

D50=6" ROCK RIPRAP STILLING BASIN: 8 CUBIC YARDS INSTALLED  
 GRADATION IS AS FOLLOWS:

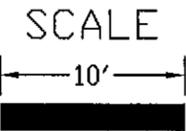
ROCK SIZE (INCHES)	% PASSING BY WEIGHT
12	100
9	60-85
6	25-50
3	5-20
1	0-5

TOPSOILING & SEEDING: 6700 SQUARE FEET (ALL DISTURBED AREAS)

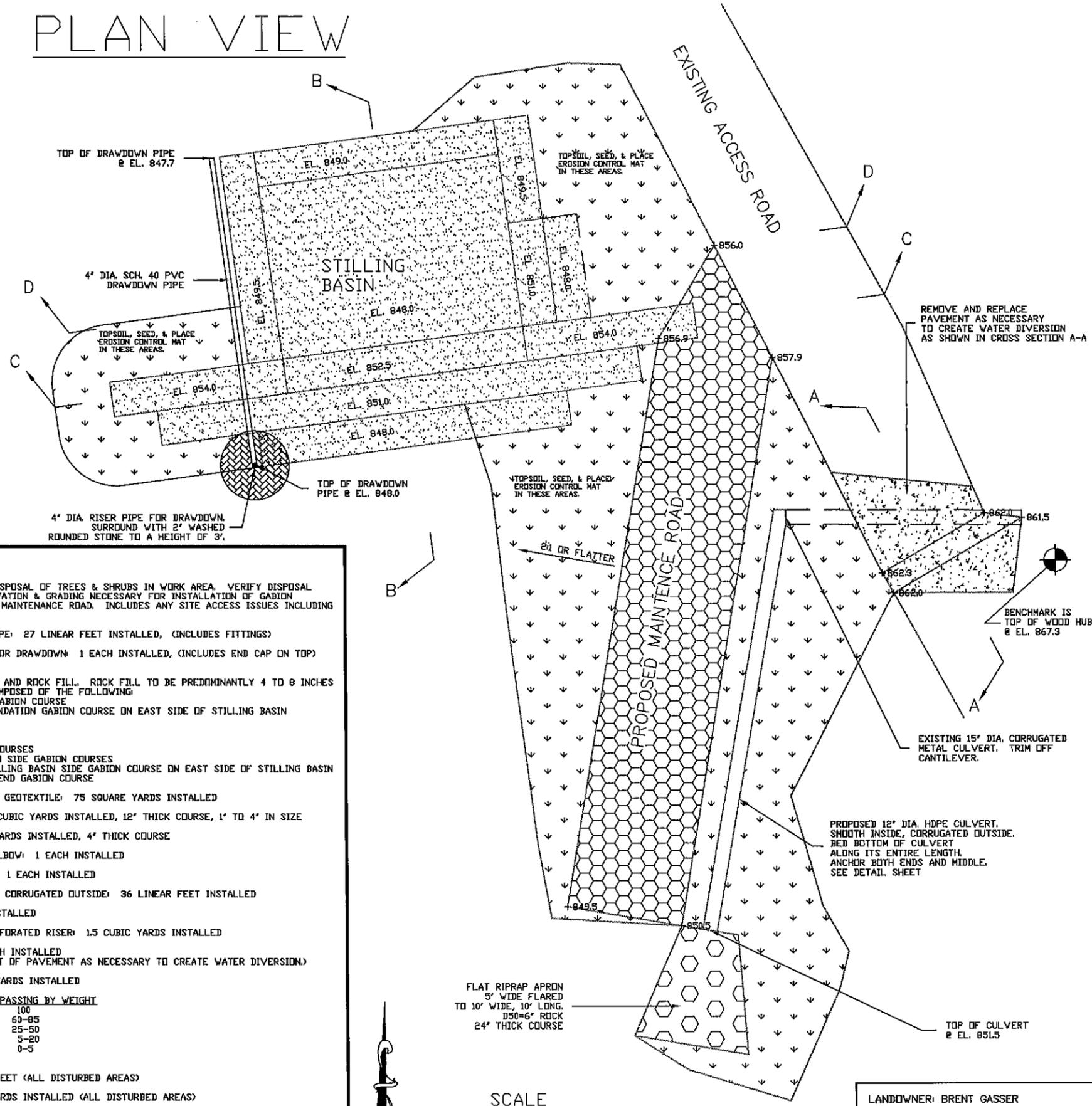
EROSION CONTROL MAT: 745 SQUARE YARDS INSTALLED (ALL DISTURBED AREAS) (CLASS I, TYPE B MINIMUM)

PROJECT COMPLETION SHOULD BE PRIOR TO MID-MAY SO AS NOT TO INTERFERE WITH CAMPING SEASON. VERIFY WITH LANDOWNER.

LANDOWNER: BRENT GASSER	
PROJECT: STORMWATER DETENTION POND	
DATE: 12--04--09	DESIGNED BY: JJV
SHEET ___ OF ___	CHECKED BY:

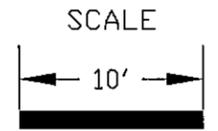


# PLAN VIEW



## CONSTRUCTION NOTES

- SITE PREP: LUMP SUM**  
 SITE PREP INCLUDES REMOVAL & DISPOSAL OF TREES & SHRUBS IN WORK AREA. VERIFY DISPOSAL WITH LANDOWNER. INCLUDES EXCAVATION & GRADING NECESSARY FOR INSTALLATION OF GABION STRUCTURE. INCLUDES GRADING OF MAINTENANCE ROAD. INCLUDES ANY SITE ACCESS ISSUES INCLUDING ANY REPAIRS OF ACCESS ROAD.
- 4" DIA. SCHEDULE 40 PVC DRAWDOWN PIPE: 27 LINEAR FEET INSTALLED, (INCLUDES FITTINGS)
- 4" DIA. SCHEDULE 40 PVC RISER PIPE FOR DRAWDOWN: 1 EACH INSTALLED, (INCLUDES END CAP ON TOP)
- GABION BASKETS: 91 CUBIC YARDS**  
 INCLUDES ASSEMBLY, INSTALLATION, AND ROCK FILL. ROCK FILL TO BE PREDOMINANTLY 4 TO 8 INCHES IN SIZE. GABION STRUCTURE IS COMPOSED OF THE FOLLOWING:  
 ONE 27'X27'X1.5' FOUNDATION GABION COURSE  
 ONE ADDITIONAL 9'X3'X1.5' FOUNDATION GABION COURSE ON EAST SIDE OF STILLING BASIN  
 ONE 36'X6'X1.5' GABION COURSE  
 ONE 42'X6'X1.5' GABION COURSE  
 ONE 45'X3'X1.5' GABION COURSE  
 TWO 15'X3'X1.5' WEIR GABION COURSES  
 TWO 18'X3'X1.5' STILLING BASIN SIDE GABION COURSES  
 ONE ADDITIONAL 9'X3'X1.5' STILLING BASIN SIDE GABION COURSE ON EAST SIDE OF STILLING BASIN  
 ONE 21'X3'X1' STILLING BASIN END GABION COURSE
- MAINTENANCE ROAD CLASS I NON-WOVEN GEOTEXTILE: 75 SQUARE YARDS INSTALLED
- MAINTENANCE ROAD BREAKER ROCK: 21 CUBIC YARDS INSTALLED, 12" THICK COURSE, 1" TO 4" IN SIZE
- MAINTENANCE ROAD GRAVEL: 7 CUBIC YARDS INSTALLED, 4" THICK COURSE
- 15" DIA. CORRUGATED METAL CULVERT ELBOW: 1 EACH INSTALLED
- 15" DIA. TO 12" DIA. CULVERT REDUCER: 1 EACH INSTALLED
- 12" DIA. HDPE CULVERT, SMOOTH INSIDE, CORRUGATED OUTSIDE: 36 LINEAR FEET INSTALLED
- CULVERT SUPPORT/ANCHOR: 3 EACH INSTALLED
- 2" WASHED ROUNDED STONE AROUND PERFORATED RISER: 1.5 CUBIC YARDS INSTALLED
- ACCESS ROAD WATER DIVERSION: 1 EACH INSTALLED  
 (INCLUDES REMOVAL & REPLACEMENT OF PAVEMENT AS NECESSARY TO CREATE WATER DIVERSION)
- D50=6" ROCK RIPRAP APRON: 6 CUBIC YARDS INSTALLED  
 GRADATION IS AS FOLLOWS:
- | ROCK SIZE (INCHES) | % PASSING BY WEIGHT |
|--------------------|---------------------|
| 12                 | 100                 |
| 9                  | 60-85               |
| 6                  | 25-50               |
| 3                  | 5-20                |
| 1                  | 0-5                 |
- TOPSOILING & SEEDING: 2500 SQUARE FEET (ALL DISTURBED AREAS)
- EROSION CONTROL MAT: 278 SQUARE YARDS INSTALLED (ALL DISTURBED AREAS)  
 (CLASS I, TYPE B MINIMUM)
- ALL GRADES 2:1 OR FLATTER UNLESS OTHERWISE INDICATED.
- PROJECT COMPLETION SHOULD BE PRIOR TO MID-MAY SO AS NOT TO INTERFERE WITH CAMPING SEASON. VERIFY WITH LANDOWNER.
- CONTACT SAUK COUNTY LAND CONSERVATION DEPT. PRIOR TO CONSTRUCTION FOR STATUS OF PERMIT APPROVAL.



LANDOWNER: BRENT GASSER	
PROJECT: GABION SEDIMENT TRAP	
DATE: 12-04-09	DESIGNED BY: JJV
SHEET ___ OF ___	CHECKED BY:

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# MIRROR LAKE

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 planners | engineers | advisors  
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 400 Viking Drive, Redsburg, Wisconsin 53959  
 Phone: (608) 524-4268 Fax: (608) 524-6218



YOGI BEAR ACCESS  
(GULLY 7)



YOGI BEAR ACCESS  
(GULLY 7)



DEVIL'S POST OFFICE  
(GULLY 5)



DEVIL'S POST OFFICE  
(GULLY 5)



(GULLY 4)



(GULLY 4)

MIRROR LAKE SITE PHOTOS  
 MIRROR LAKE SEDIMENT & NUTRIENT REDUCTION STUDY  
 JULY 27, 2010  
 SAUK COUNTY, WISCONSIN

REVISIONS		REVISIONS	
NO.	DATE	NO.	DATE

SCALE AS SHOWN  
 DATE 2010  
 DRAFTER NPFA  
 CHECKED XXX  
 PROJECT NO. 026086775  
 SHEET 1 OF 1  
 DWG. NO. NO.

# WISCONSIN CONSTRUCTION SPECIFICATION

## 1. CLEARING

### 1. SCOPE

The work shall consist of the clearing and disposal of trees, snags, logs, brush, shrubs, stumps, and rubbish from the designated areas.

### 2. MARKING

The limits of the areas to be cleared will be marked by means of stakes, flags, tree markings, or other suitable methods. Trees to be left standing and uninjured will be designated by special markings placed on the trunks at a height of about 6 feet above the ground surface.

### 3. PROTECTION OF EXISTING VEGETATION

Trees and other woody vegetation designated to remain undisturbed shall be protected from damage throughout the entire construction period. Any damage resulting from the Contractor's operations or neglect shall be repaired by the Contractor.

Earthfill, stockpiling of materials, vehicular parking, and excessive foot or vehicular traffic shall not be allowed within the dripline of vegetation designated to remain in place. Vegetation damaged by any of these or similar actions shall be replaced with viable vegetation of the same species.

Any cuts, skins, scrapes, or bruises to the bark of the vegetation shall be carefully trimmed and local nursery accepted procedures used to seal damaged bark.

Any limbs or branches 0.5-inch or larger in diameter that are broken, severed, or otherwise seriously damaged during construction shall be cut off at the base of the damaged limb or branch flush with the adjacent limb or tree trunk.

All roots 1 inch or larger in diameter that are cut, broken, or otherwise severed during construction operations shall have the end smoothly cut perpendicular to the root. Roots exposed during excavation or other operations shall be covered with moist earth and/or backfilled as soon as possible to prevent them from drying.

### 4. CLEARING

Trees, brush, shrubs, stumps, and other woody growth shall be cleared to a height not exceeding 12 inches above the ground surface. Such growth may be cleared by cutting, pulling, grubbing, or other approved methods.

Trees shall be felled in such a manner as to avoid damage to trees that are to be left standing, existing structures, utilities, and with regard for the safety of persons.

When the designated areas to be cleared include borrow areas and/or areas upon which improvements are to be constructed, the required grubbing of stumps, roots, and other objectionable material in these areas shall be a part of this specification. The grubbing shall consist of the removal of all stumps, roots of 1 inch in diameter or larger, buried logs, and other objectionable material to a minimum depth of 2 feet below a structure subgrade and 1 foot below an embankment foundation.

5. SITE EROSION CONTROL

Measures shall be installed, or the work performed in a manner that will minimize site erosion, and the production of sediment. Protective measures shall include but are not limited to diversions, waterways, seeding, mulching, sediment basins, and silt fences.

6. DISPOSAL

All materials cleared from the designated areas shall be burned or buried at approved locations or otherwise removed from the site. Buried materials shall be covered with a minimum of 2 feet of earthfill (including any topsoil added for seeding).

The Contractor is responsible for complying with all rules and regulations for disposal at locations away from the construction site or for the burning of cleared materials.

# WISCONSIN CONSTRUCTION SPECIFICATION

## 2. EXCAVATION

### 1. SCOPE

The work shall consist of the excavation of all materials necessary for the construction of the work.

### 2. USE OF EXCAVATED MATERIALS

To the extent that they are needed, all suitable materials removed from the specified excavations shall be used in the construction of the required earthfill. The suitability of materials for specific purposes will be determined by the Technician. The Contractor shall not waste or otherwise dispose of suitable excavated materials.

### 3. DISPOSAL OF WASTE MATERIALS

All surplus or unsuitable excavated materials will be designated as waste and shall be disposed of at the locations shown on the drawings or as approved by the Technician. Waste materials shall not be placed in wetlands.

Material placed in designated waste disposal areas shall be left in a neat and sightly condition and sloped to provide positive drainage. Compaction of the waste materials will not be required unless specified by the construction plans.

Waste material excavated from channels may be deposited in leveled spoilbanks or areas adjacent to the channel work (if permissible). The shape and slopes of the spoilbanks shall be indicated on the drawings or as approved by the Technician. Spoil piles shall be located a minimum of 12 feet from the top of the channel side slope.

Spoil piles or disposal areas shall be protected to minimize site erosion and the production of sediment. Protective measures may include but are not limited to diversions, seeding, mulching, sediment basins, and silt fences.

### 4. SPECIAL REQUIREMENTS FOR STRUCTURE AND TRENCH EXCAVATION

The required dimensions and side slopes of all structure and trench excavations shall be as shown on the drawings.

Excavation beyond the limits of the specified lines and grades shall be corrected by filling the resulting voids with approved compacted materials.

Excavation for the installation of pipes shall follow the practices contained in the Occupational Safety and Health Administration (OSHA) Subpart P, Excavation, of 29 CFR 1926.650, .651 and .652.

Side slopes shall be excavated or braced to safeguard the work and workers. When bracing or supporting is required, the width of the excavation shall be adjusted to allow for the space

occupied by the sheeting, bracing, or other supporting installations. The Contractor shall furnish, place, and subsequently remove such supporting installations.

#### 5. REMOVAL OF WATER

The Contractor shall construct and maintain all necessary cofferdams, channels, flumes, pumping equipment, and/or other temporary diversion and protective work for dewatering the various parts of the work. Foundations, cutoff trenches, and other parts of the work shall be maintained free from water as required for constructing each part of the work. After having served their purpose, all cofferdams and other temporary protective works shall be removed, or leveled to give a sightly appearance and so as not to interfere in any way with the operation, usefulness, or stability of the permanent structure.

#### 6. BORROW EXCAVATION

When the quantities of suitable materials obtained from specified excavations are insufficient to construct the specified fill portions of the permanent works, additional materials shall be obtained from the designated borrow areas.

When shown on the drawings, sediment basins, terraces, diversions, or other measures shall be constructed to protect the borrow areas from erosion and retain sediment within the borrow area.

The upper six (6) inches shall be stripped from all borrow areas. This stripping shall be performed immediately prior to use of the borrow material to reduce the time the area is exposed to erosion. For large borrow areas, only a portion of the area should be stripped at a time. This material shall be redistributed over the area from which it came after borrow excavation is completed.

The extent of excavation and the selection of materials from the borrow area shall be as directed by the Technician. On completion of excavation, all borrow pits shall be left in a neat and sightly condition. All borrow areas shall be graded to blend with existing topography and sloped to prevent ponding and provide positive drainage.

## WISCONSIN CONSTRUCTION SPECIFICATION

### 3. EARTHFILL

#### 1. SCOPE

The work shall consist of placing the earthfill required by the drawings. This specification does not apply to the earthfill required for waste storage facilities.

#### 2. MATERIALS

All fill materials shall be obtained from required excavations and designated borrow areas. The selection, blending, routing, and disposition of materials in the various fills shall be subject to approval by Technician.

Fill materials shall contain no sod, brush, roots, frozen soil, or other perishable materials. Stones larger than two-thirds of the uncompacted layer thickness shall be removed from the materials prior to compaction of the fill. .

#### 3. FOUNDATION PREPARATION

The foundation area shall be cleared of trees, stumps, roots, brush, rubbish, and stones having a maximum dimension greater than six (6) inches. Foundations shall be stripped to remove vegetation and other unsuitable materials or to the depth shown on the drawings, whichever is greater. Topsoil shall be stripped from the foundation area and stockpiled for use as a top dressing for vegetation establishment unless otherwise shown on the drawings.

Earth foundations shall be graded to remove surface irregularities and slopes steeper than 1:1.

The foundation surfaces shall be scarified parallel to the centerline of the fill to a minimum depth of 2 inches. The moisture content of the scarified materials shall be maintained as specified for the earthfill. The surface materials of the foundation shall be compacted and bonded with the first layer of earthfill as specified for subsequent layers of earthfill.

#### 4. PLACEMENT

Fill shall not be placed until the required excavation and preparation of the underlying foundation is completed and inspected and approved by the Technician. No fill shall be placed upon a frozen surface nor shall snow, ice, or frozen material be incorporated in the fill.

Fill shall be placed in approximately horizontal layers beginning at the lowest elevation of the foundation. The thickness of each layer of fill prior to compaction shall be as specified in Table 1. Materials placed by dumping in piles or windrows shall be spread uniformly to not more than the specified layer thickness prior to compaction.

Adjacent to structures, earthfill shall be placed in 4-inch lifts (prior to compaction) in a manner adequate to prevent damage to the structure and to allow the structure to gradually and uniformly assume the backfill loads.

The height of the fill shall be increased at approximately the same rate on all sides of the structure.

Placement of fill adjacent to concrete structures may begin after the concrete has cured for the minimum time specified.

Earthfill in dams, levees, and other structures designed to impound water shall be placed to meet the following additional requirements:

- a. The distribution of materials throughout each zone shall be essentially uniform, and the fill shall be free from lenses, pockets, streaks, or layers of material differing substantially in texture, moisture content, or gradation from the surrounding material.
- b. The embankment top shall be maintained approximately level during construction except for sectional construction as described in Section 7.
- c. Dam embankments shall be constructed in continuous layers from abutment to abutment, except where openings to facilitate construction or to allow passage of stream flow during construction are specified.
- d. If the surface of any layer becomes too hard and smooth to achieve a suitable bond with the succeeding layer, it shall be scarified parallel to the axis of the fill to a depth of not less than 2 inches before the next layer is placed.

## 5. CONTROL OF MOISTURE CONTENT

Fill materials shall have a moisture content sufficient to insure the required compaction. When kneaded in the hand, the soil will form a ball which does not readily separate and will not extrude out of the hand when squeezed tightly. The adequacy of the moisture content will be determined by the Technician.

Fill material or the top surface of the preceding layer of compacted fill that becomes too dry to permit suitable bond shall either be removed or scarified and wetted by sprinkling to an acceptable moisture content prior to placement of the next layer of fill.

Fill material that is too wet when deposited or the top surface of the preceding layer of compacted fill that becomes too wet shall be either removed or allowed to dry to an acceptable moisture content before compaction or placing additional layers of fill.

## 6. COMPACTION

The Contractor shall furnish and operate the types and kinds of equipment necessary to compact the fill materials.

Unless otherwise specified on the plans or approved by the Technician, compaction requirements for each layer of fill material are as shown in Table 1.

Each pass shall consist of at least one complete coverage by the wheel, track, or roller over the entire surface of the fill layer in a direction parallel to the main axis of the fill.

Adjacent to structures or in confined areas, compaction of the fill shall be accomplished by means of manually directed power tampers or plate vibrators or hand tamping, unless

otherwise specified. The Technician shall determine if adequate compaction is being achieved. Heavy equipment shall not be operated within 2 feet of any structure. Compaction by means of drop weights operating from a crane or hoist of any type will not be permitted.

#### 7. SPECIAL REQUIREMENTS FOR SECTIONAL CONSTRUCTION OF EMBANKMENTS

When sectional (or phase) construction of embankments is authorized, the work shall be accomplished in the following manner:

Each section of the embankment that is constructed in the first phase shall be so placed that a slope not steeper than 3 feet horizontal to 1 foot vertical is maintained at the end of the embankment section adjacent to the gap in construction or closure section.

Prior to placement of the closure sections, the surfaces of completed fills and excavations that will be in contact with the closure shall be stripped of all loose material, scarified, moistened, and recompactd as necessary.

**Table 1 - Equipment Compaction Requirements**

<b>Equipment Type</b>	<b>Applicable Soils<sup>1</sup></b>	<b>Maximum Fill Height<sup>2</sup> (feet)</b>	<b>Layer Thickness<sup>3</sup> (inches)</b>	<b>Minimum Passes<sup>4</sup></b>
Sheepsfoot roller (10,000 lb. min. operating weight)	ML, MH, CL, CH or SM, SC, GM, GC with >20% fines	None	9	1
Vibratory tamping roller (9,000 lb. min. operating weight)	SM, SC, GM, GC	None	9	2
Rubber-tired scraper (fully loaded)	GM, GC, SM, SC, ML, MH, CL, CH	20	9	1
Rubber-tired front end loader (fully loaded)	GM, GC, SM, SC, ML, MH, CL, CH	20	6	1
Track-type crawler (standard tracks)  30,000 lb. min.	GM, GC, SM, SC, ML, CL	10**	6	2
	SP, SW, GP, GW	6**	12	4
	CL, ML, SC, SM	15##	3	2
less than 30,000 lb.	GM, GC, GP, GW, SM, SC, SP, SW, ML, CL	6**	6	2
Farm tractor (2,400 lb. min.)	GM, GC, SM, SC, ML, MH, CL, CH	15	6	2
Steel drum vibratory roller (10,000 lb. min.)	SP, SW, GP, GW	None**	12	2

<sup>1</sup> Unified Soil Classification System.

<sup>2</sup> Measured from the top of the fill to the lowest point along the centerline of the fill.

<sup>3</sup> Prior to Compaction.

<sup>4</sup> The Technician shall determine if adequate compaction is being achieved. Additional passes may be required.

\*\* The fill shall not have a permanent body of water stored against it.

## This method may only be used for embankments that will not have the potential for a permanent body of water stored against it that is greater than 1/4 acre in surface area or more than 6 feet deep.

# WISCONSIN CONSTRUCTION SPECIFICATION

## 9. ROCK RIPRAP

### 1. SCOPE

The work shall consist of testing, furnishing, transporting, and placing rock riprap, including filter, bedding or geotextile materials where specified, in the construction of loose rock riprap revetments, blankets, rock toes, crossings, rock chutes, channel linings and other similar structures.

### 2. QUALITY OF MATERIALS

The rock shall be obtained from specified sources or sources as approved by the Technician. Rock sources used for streambank protection, lined waterways, rock chutes, or other similar major projects (Job Class II and above) shall be tested prior to use. A test is required a minimum of every five (5) years. The Technician may require a more current test.

Rock riprap from igneous or metamorphic origins such as granite, basalt, and quartzite may be used without testing. Dolomite from quarries within the map legend units shown in Figure 1 may also be used without testing:

- Dolomite (Sd) - all counties.
- Sinnipee Group (Os) and Prairie du Chien (Opc) - Marinette, Oconto, Shawano, Brown, Outagamie, Calumet, Winnebago, Green Lake, and Fond du Lac.

The Technician shall inspect and approve sources of these rock types prior to use and determine if testing is required.

Rock for equipment or cattle channel crossings, access roads, heavy use area protection or similar minor structures need not be tested.

Individual rock fragments shall be dense, sound and free from cracks, seams and other defects conducive to accelerated weathering. The rock fragments shall be angular to subrounded in shape. The least dimension of each individual rock fragment shall be not less than one-third the greatest dimension of the fragment. It should also be free from dirt, clay, sand, rock fines and other materials not meeting the gradation limits. Rock shall be excavated, selected and handled as necessary to meet the grading requirements stated in the construction plans.

Representative samples of rock requiring testing shall conform to the following requirements:

Bulk Specific Gravity (saturated surface-dry basis). Not less than 2.50 when tested in accordance with ASTM Specification C 127 on samples prepared as described for soundness testing.

Absorption. Not more than four (4.0) percent when tested in accordance with ASTM Specification C 127 on samples prepared as described for soundness testing.

Soundness. The weight loss in five cycles shall not be more than 28 percent when tested by the sodium sulfate soundness test method. Losses in excess of 20 percent are acceptable only when the design  $D_{50}$  rock size has been increased by 10 percent for a loss of 20-23.9 percent or 20 percent for a loss of 24-28 percent.

### 3. METHODS OF TESTING

Bulk Specific Gravity and Absorption shall be determined by ASTM Method C 127 on samples prepared as described for rock cube soundness testing.

Rock Cube Soundness. Soundness testing shall be performed by ASTM Method C 88 for coarse aggregate modified as follows:

The sodium sulfate soundness test shall be performed on a test sample of  $5000 \pm 300$  grams of rock fragments, reasonably uniform in size and cubical in shape and weighing, after sampling, approximately 100 grams each. The test sample shall be obtained from rock samples that are representative of the total rock mass, as noted in ASTM Specification D 4992, and that have been sawed into slabs as described in ASTM Specification D 5121. The samples shall be further reduced in size by sawing the slabs into cubic blocks. The thickness of the slabs and the size of the sawed blocks shall be determined by the size of the available test apparatus and as necessary to provide, after sawing, the approximate 100 gram samples.

Due to internal defects, some of the cubes may break during the sawing process or during the initial soaking period. Cubes that break during this preparatory process shall not be tested. Such breakage, including an approximation of the percentage of cubes that break, shall be noted in the test report.

After the sample has been dried, following completion of the final test cycle and washing to remove the sodium sulfate, the loss of weight shall be determined by subtracting from the original weight of the sample the final weight of all fragments which have not broken into three or more fragments. The test report shall show the percentage loss of the weight.

### 4. GRADATION

The gradation of the rock riprap and filter or bedding material shall be as shown in the construction plans.

Rock used for streambank protection, lined waterways, rock chutes, or other similar major projects (Job Class II and above) shall have a gradation verification be done by one of the following methods.

#### Method A

Measurement of a random truck load of stone (reference sample) according to the procedure outlined in EFH-17, Procedure for Determining Rock Weights, Sizes, and Gradations; or ASTM D5519, Standard Test Methods for Particle Size Analysis of Natural and Man-Made Riprap Materials (Test Method A).

#### Method B

Creation of reference samples of rock of at least 0.5 tons, made according to the procedure outlined in EFH-17 (Tables 1 - 5), creating the envelope limits of the gradation specified.

Control of project gradation will be by visual inspection comparing rock delivered to the reference samples.

The reference sample(s) may be used as part of the finished riprap or remain at the quarry.

Any difference of opinion between the Technician and the Contractor shall be resolved by dumping and checking (by measurement) the gradation of a random truck load of stone by Method A. Mechanical equipment, a sorting site, and labor needed to assist in checking gradation shall be provided by the Contractor at no additional cost.

#### 5. SUBGRADE PREPARATION

The subgrade surfaces on which the riprap, filter or bedding material is to be placed shall be cut or filled and graded to the lines and grades as shown on the drawings or as directed by the Technician. When fill to subgrade lines is required, it shall consist of approved materials and shall be compacted as specified in Wisconsin Construction Specification 3, Earthfill. Riprap, filter, bedding or geotextile shall not be placed until the foundation preparation is completed, and approved by the Technician.

#### 6. FILTER AND BEDDING

Filter or bedding material, when required, shall be spread uniformly on the prepared subgrade surfaces to the depth shown on the drawings. The surfaces of the layers shall be finished reasonably free of mounds, dips or windrows and shall meet the gradation shown on the plans or as specified in Wisconsin Construction Specification 8.

Geotextile, when required, shall meet the requirements shown on the drawings and as specified in Wisconsin Construction Specification 13, Geotextiles.

#### 7. PLACING ROCK RIPRAP

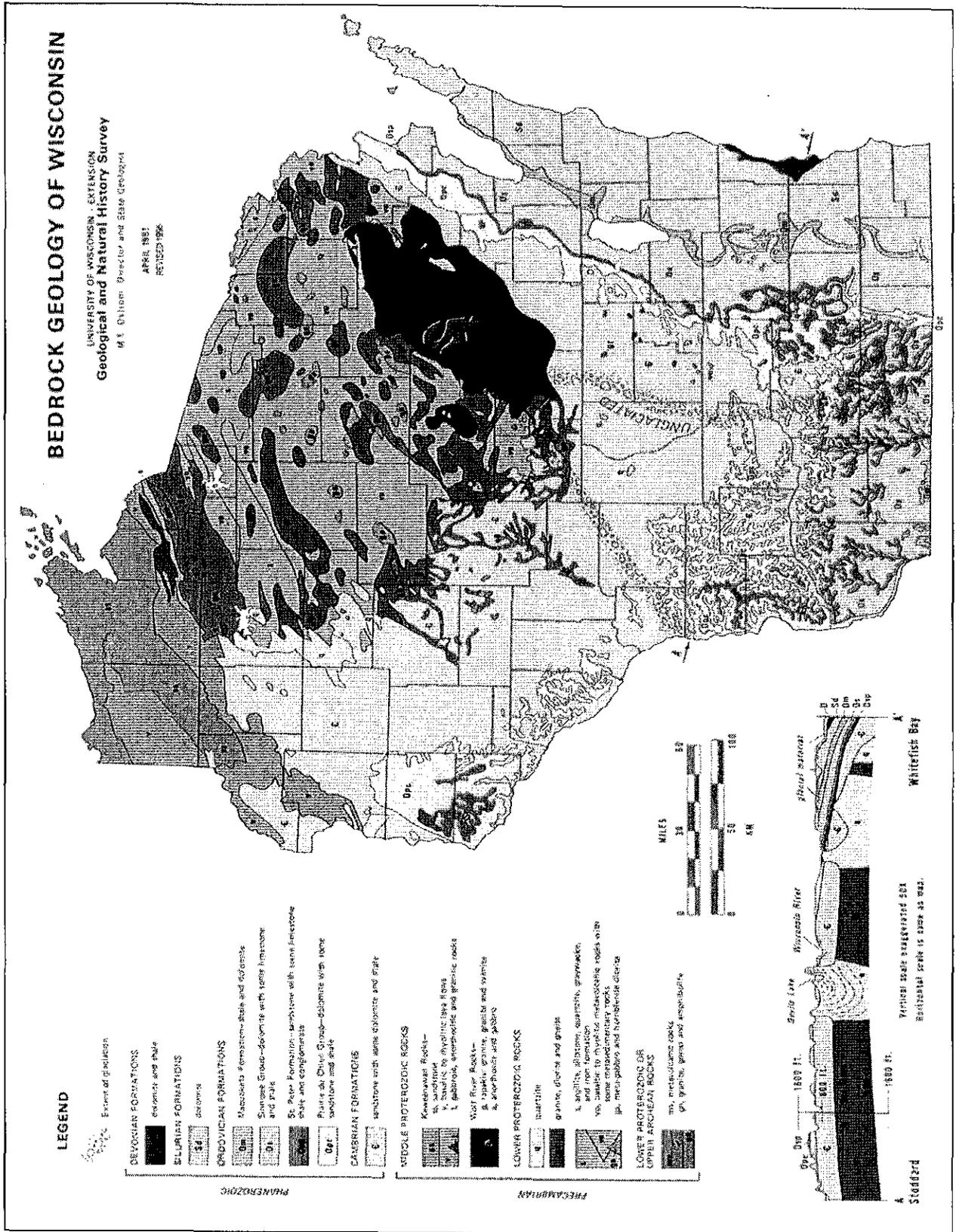
The rock riprap shall be placed by equipment on the surfaces and to the depths specified. The rock riprap shall be installed to the full course thickness in one operation and in such a manner as to avoid displacement of underlying materials. The rock for riprap shall be delivered and placed in a manner that will ensure that the riprap in-place shall be reasonably homogeneous with the larger rocks uniformly distributed and firmly in contact one to another with the smaller rocks and spalls filling the voids between the larger rocks. Some hand placing may be required to provide a neat and uniform surface or to prevent damage to structures.

#### 8. VEGETATED ROCK RIPRAP

If the rock riprap is to be vegetated, topsoil shall be placed by equipment in the riprap voids (surface) and on the surface of the rock to the depth specified. The topsoil placement shall not take place before the placement of the rock riprap is approved by the Technician. Topsoil shall be placed in such a manner as to avoid displacement of the underlying rock.

The topsoil may extend from the top of the riprap down to the bankfull elevation (OHWM) or as shown on the drawings. Care shall be taken so topsoil is retained on the rock and is not allowed into the water body. The area shall be seeded and mulched within 12 hours following topsoil placement.

Figure 1



## WISCONSIN CONSTRUCTION SPECIFICATION

### 13. GEOTEXTILES

#### 1. SCOPE

This work shall consist of furnishing all materials, equipment, and labor necessary for the installation of geotextiles.

#### 2. MATERIALS

The class and type of geotextile shall be as shown on the drawings.

Geotextiles shall be manufactured from synthetic long chain or continuous polymeric filaments or yarns composed of at least 95 percent by weight of polypropylene, polyethylene, polyester, polyamide, or polyvinylidene-chloride. Fibers shall contain stabilizers and/or inhibitors to enhance its resistance to ultraviolet light. The geotextile shall be formed into a stable network of filaments or yarns that retain dimensional stability relative to each other, including selvages. The geotextile shall be free of any chemical treatment or coating that might significantly reduce its permeability and shall have no flaws or defects that significantly alter its physical properties.

Thread used for factory or field sewing shall be of a contrasting color to the fabric and made of polypropylene, polyester, or polyamide thread. The sewing thread shall have a minimum breaking strength of 28 pounds when tested in accordance to ASTM D 2256. The thread shall be as resistant to ultraviolet light as the geotextile being sewn.

Additional requirements for geotextile materials are as follows:

##### a. Slit Tape Geotextile

Slit tape geotextile shall conform to the physical properties listed in Table 1. The slit tape geotextile shall be manufactured from a filament that is woven. The edges of the material shall be selvaged or otherwise finished to prevent the outer filament from unraveling.

##### b. Woven Geotextile

Woven geotextile shall conform to the physical properties listed in TABLE 1. The woven geotextile shall be manufactured from monofilament yarn that is woven into a uniform pattern with distinct and measurable openings. The fabric shall be manufactured so that the yarns will retain their relative position with regard to each other. The edges of the material shall be selvaged or otherwise finished to prevent the outer yarn from unraveling.

##### c. Nonwoven Geotextile

Nonwoven geotextile shall conform to the physical properties listed in TABLE 2. Nonwoven geotextile shall be manufactured from randomly oriented fibers that have been bonded together by needle-punching.

### 3. SHIPPING AND STORAGE

Geotextiles labeling, shipment, and storage shall follow ASTM D 4873. Product labels shall clearly show the manufacturer or supplier name, style name, and roll number. Each geotextile roll shall be wrapped with a material that will protect the geotextile, including the ends of the roll, from damage due to shipment, water, sunlight, and contaminants. The protective wrapping shall be maintained during periods of shipment and storage.

Prior to use, the geotextile shall be inspected and approved by the Technician, then stored in a clean, dry, place, out of direct sunlight, not subject to temperature extremes, and with the manufacturer's protective cover in place.

### 4. SURFACE PREPARATION

The surface on which the geotextile is to be placed shall be graded to the neat lines and grades as shown on the drawings. The surface shall be reasonably smooth and free of holes, vegetation, excessive mud, and projections. The surface preparation will be inspected and approved by the Technician prior to placing the geotextile.

### 5. PLACEMENT

#### a. General

The geotextile shall be placed on the approved, prepared surface at the locations and in accordance with the details shown on the drawings. The geotextile shall be unrolled along the placement area and loosely laid (not stretched) in such a manner that it will conform to the surface irregularities when the stone or other material is placed on or against it. The geotextile may be folded and overlapped to permit proper placement in the designated area.

No cuts, punctures, tears, or gaps in sewn or overlapped joints will be permitted in the geotextile.

The panel length shall be placed parallel to the direction of water flow, except as stated below in paragraph b. Slope Protection and d. Road Stabilization.

The geotextile panels may be joined by overlapping the roll ends 36 inches and sides a minimum of 18 inches and securing the overlap against the underlying foundation materials. The fabric shall be restrained as needed to prevent lifting and displacement during construction. Allowable restraint methods include backfilled trenches, stitching, sandbags, rocks, and securing pins that are approved and provided by the geotextile manufacturer. The upstream or up-slope geotextile shall overlap the abutting down-slope geotextile.

The geotextile panels may be joined by machine sewing using thread described under 2. Materials. The seam shall conform to Federal Standard SSa-2, SSn-2 or SSd-2, using a minimum of 4 stitches per inch per stitch line for heavy geotextiles and a minimum of 6 stitches per inch per stitch line for light to medium geotextiles. The sewing shall consist of two parallel stitched rows spaced approximately 1 inch apart. Federal Standard 401 stitches shall be used. All seaming and stitching of woven

geotextiles shall be in the selvage. Non-woven geotextiles shall be sewn a minimum of ½ inch from the edge. In cases where wave action or multidirectional flow is anticipated, all seams perpendicular to flow shall be sewn.

The geotextile shall be restrained as needed during placement of overlying materials to prevent slippage, folding, or other movements of the geotextile.

Prior to covering, the geotextile shall be inspected by the Technician to ensure that the geotextile has not been damaged during construction. Backfill shall be placed by end dumping onto the geotextile from the edge of the geotextile or over previously placed backfill. Vehicles shall not be allowed directly on the geotextile. Materials shall be placed on the geotextile without causing tears, punctures, or separations of overlaps or sewn joints. Should such damage occur, the backfill around the damaged or displaced area will be removed and the subgrade restored to the original approved condition. Repair of the area shall consist of a patch of the same type of geotextile overlaying the existing geotextile. The patch shall extend a minimum of 2 feet from the edge of any damaged area.

b. Slope Protection

The geotextile shall not be placed until it can be anchored and protected with the intended covering within 48 hours. Temporary cover, for protection from ultraviolet light, may be used if the 48-hour limit will be exceeded. Material will not be dropped from a height of more than 3 feet on to uncovered geotextile. In lakeshore applications, the geotextile may be unrolled parallel or perpendicular to the bank. The geotextile shall be joined by machine sewing if the panel length is placed perpendicular to the direction of water flow (wave runup).

c. Subsurface Drains

The geotextile shall not be placed until drainfill or other material can be used to cover it within the same working day. Material will not be dropped from a height of more than 5 feet on to the geotextile and sharp, angular aggregates will not be used unless the drawing details state otherwise.

d. Road Stabilization

The geotextile shall be unrolled in a direction parallel to the roadway centerline in a loose manner permitting it to conform to surface irregularities when the roadway fill material is placed on it. Overlap shall be in the direction of construction. The minimum overlap of geotextile panels joined without sewing shall be 24 inches. The geotextile may be temporarily secured with pins recommended by the manufacturer. They shall be removed prior to placement of the covering material. Slit tape geotextile shall not be used in a wet location. Material will not be dropped from a height of more than 5 feet on to uncovered geotextile.

**Table 1. Requirements for Woven Geotextiles by Use**

Property	Test Method	Slope Protection		Road Stabilization	
		Unprotected (Class I)	Protected (Class II)	(Class IV)	Slit Tape
Tensile Strength (lbs.) <sup>1</sup>	ASTM D 4632 Grab Test	250 min. in any principal direction	120 min. in any principal direction	180 min. in any principal direction	200 min. in any principal direction
Bursting Strength (psi) <sup>1</sup>	ASTM D 3786 Diaphragm Tester	480 min.	300 min.	250 min.	400 min.
Elongation at failure (Percent) <sup>1</sup>	ASTM D 4632 Grab Test	20 max.	35 max.	35 max.	10 max.
Puncture (lbs.) <sup>1</sup>	ASTM D 4833	150 min.	60 min.	60 min.	90 min.
Ultraviolet Light (percent residual tensile strength)	ASTM D 4355 150 hours exposure	70 min.	70 min.	70 min.	70 min.
Apparent Opening Size (AOS)	ASTM D 4751	≥ #100 (.150 mm) and ≤ #70 (.212 mm) <sup>3</sup>	≥ #100 (.150 mm) and ≤ #70 (.212 mm) <sup>3</sup>	≥ #100 (.150 mm) and ≤ #70 (.212 mm) <sup>3</sup>	As specified or a min. size > #50 <sup>3</sup>
Percent Open Area (POA)	CW-02215 <sup>2</sup>	4.0 min.	4.0 min.	1.0 min.	N/A
Permittivity (1/seconds) (gal/sq. ft./min.)	ASTM D 4491	0.20 min. 15 min.	0.10 min. 7.5 min.	0.10 min. 7.5 min.	0.05 min. 3.8 min.

<sup>1</sup>Minimum average roll values (MARV); calculated as the mean minus two standard deviations, yielding a 95 percent confidence level that the table value will be equaled or exceeded.

<sup>2</sup>Test Methods prepared by U. S. Army Corps of Engineers

<sup>3</sup>U. S. Standard Sieve Size

**Table 2. Requirements for Nonwoven Geotextiles by Use**

Property	Test Method	Slope Protection		Subsurface Drainage	Road Stabilization
		Unprotected (Class I)	Protected (Class II)	(Class III)	(Class IV) <sup>3</sup>
Tensile Strength (lbs.) <sup>1</sup>	ASTM D 4632 Grab Test	180 min.	120 min.	90 min.	180 min.
Bursting Strength (psi) <sup>1</sup>	ASTM D 3786 Diaphragm Tester	320 min.	210 min.	180 min.	250 min.
Elongation At failure(percent) <sup>1</sup>	ASTM D 4632 Grab Test	≥ 50	≥ 50	≥ 50	≥ 50
Puncture(lbs.) <sup>1</sup>	ASTM D 4833	80 min.	60 min.	40 min.	40 min.
Ultra- Violet Light(percent residual tensile strength)	ASTM D 4355 150 hours exposure	70 min.	70 min.	70 min.	70 min.
Apparent Opening Size (AOS)	ASTM D 4751	As specified or max. #40 <sup>2</sup>			
Permittivity (1/seconds) (gal/sq. ft./min.)	ASTM D 4491	0.70 min. 52.5 min.	0.70 min. 52.5 min.	0.70 min. 52.5 min.	0.10 min. 7.5 min.

<sup>1</sup>minimum average roll values (MARV); calculated as the mean minus two standard deviations, yielding a 95 percent confidence level that the table value will be equaled or exceeded.

<sup>2</sup>U. S. Standard Sieve Size.

<sup>3</sup>Heat-bonded or resin-bonded geotextile may be used.

# WISCONSIN CONSTRUCTION SPECIFICATION

## 15. Plastic Pipe Conduits

### 1. SCOPE

The work shall consist of furnishing and installing polyvinyl chloride (PVC), acrylonitrile-butadiene-styrene (ABS), and polyethylene (PE) plastic pipe and the necessary fittings as shown on the drawings. **This specification does not apply to corrugated polyethylene tubing used for subsurface drainage systems.**

### 2. MATERIALS

Polyvinyl chloride (PVC) pipe and fittings shall conform to the requirements of the following ASTM specifications unless otherwise stated on the drawings.

- a. D 1785 PVC Plastic Pipe, Schedules 40, 80, and 120.
- b. D 2241 PVC Pressure-Rated Pipe (SDR Series).
- c. D 2464 Threaded PVC Plastic Pipe Fittings, Schedule 80.
- d. D 2466 PVC Plastic Pipe Fittings, Schedule 40.
- e. D 2467 Socket-Type PVC Plastic Pipe Fittings, Schedule 80.
- f. D 2729 PVC Sewer Pipe and Fittings.
- g. D 3034 Type PSM PVC Sewer Pipe and Fittings.
- h. F 679 PVC Large-Diameter Plastic Gravity Sewer Pipe and Fittings.
- i. F 789 Type PS-46 PVC Plastic Gravity Flow Sewer Pipe and Fittings.
- j. F 794 PVC Profile Gravity Sewer Pipe and Fittings, Based on Controlled Inside Diameter.
- k. F 949 PVC Corrugated Sewer Pipe with a Smooth Interior and Fittings.

Acrylonitrile-butadiene-styrene (ABS) plastic pipe and fittings shall conform to the requirements of the following ASTM specifications unless otherwise stated on the drawings.

- a. D 1527 ABS Plastic Pipe, Schedules 40 and 80.
- b. D 2282 ABS Plastic Pipe (SDR-PR)
- c. D 2468 ABS Plastic Pipe Fittings, Schedule 40.
- d. D 2469 Socket-Type ABS Plastic Pipe Fittings, Schedule 80.
- e. D 2751 ABS Sewer Pipe and Fittings.

Polyethylene (PE) plastic pipe and fittings shall conform to the requirements of the following ASTM specifications unless otherwise stated on the drawings.

- a. D 2104 PE Plastic Pipe, Schedule 40.
- b. D 2239 PE Plastic Pipe (SIDR-PR) Based on Controlled Inside Diameter.
- c. D 2447 PE Plastic Pipe, Schedules 40 and 80, Based on Outside Diameter.
- d. D 3035 PE Plastic Pipe (SDR-PR) Based on Controlled Outside Diameter.
- e. F 405 Corrugated Polyethylene (PE) Tubing and Fittings.
- f. F 667 Large Diameter Corrugated PE Tubing and Fittings.
- g. F 714 PE Plastic Pipe (SDR-PR) Based on Outside Diameter.
- h. F 2306 PE Plastic Pipe and Fittings - Annular Corrugated Profile Walled - Based on Inside Diameter

The pipe shall be homogeneous throughout and free from visible cracks, holes, foreign matter, or other defects. The pipe shall be as uniform in color, opacity, density, and other physical properties as is commercially practicable.

### 3. JOINTS AND FITTINGS

Joints and fittings shall be of the same or similar materials as the pipe and equal to or exceeding that specified for the pipe to which it is attached.

Joints may be bell and spigot type with elastomeric gaskets, coupling type with elastomeric gaskets on each end or solvent cemented. The joints shall be installed according to the manufacturer's recommendations unless otherwise specified.

When a lubricant is required to facilitate joint assembly, it shall be a type having no detrimental effect on the gasket or pipe material.

### 4. HANDLING AND STORAGE

Pipe shall be delivered to the job site and handled by means which provide adequate support to the pipe and does not subject it to undue stresses or damage. When handling and placing plastic pipe, care shall be taken to prevent impact blows, abrasion damage, and gouging or cutting. All special handling requirements of the manufacturer shall be strictly observed. Special care shall be taken to avoid impact when the pipe must be handled at temperatures of 40°F or less.

Pipe shall be stored on a relatively flat surface so that the barrels are evenly supported. Unless the pipe is specifically coated to withstand exposure to ultraviolet radiation, it shall be covered with an opaque material when stored outdoors for a period of 15 days or longer.

### 5. LAYING AND BEDDING THE PIPE

The pipe shall be laid to the lines and grades as shown on the drawings and specified herein. The pipe shall be laid so that there is no reversal of grade between joints, unless otherwise shown on the drawings. The pipe shall not be dropped or dumped on the bedding or into the pipe trench. The ground surface near the pipe trench shall be free of loose rocks and stones greater than 1 inch in diameter. This ensures that rock will not be displaced and impact the pipe.

Just before placement, each pipe section shall be inspected to ensure that all foreign material is removed from inside the pipe. The pipe ends and the couplings shall be free of foreign material when assembled. At the completion of a work shift, all open ends of the pipeline shall be temporarily closed off using a suitable cover or plug.

Care shall be taken to prevent distortion and damage during unusually hot (over 90°F) or cold weather (under 40°F). After the pipe has been assembled in the trench, it shall be allowed to reach ground temperature before backfilling to prevent pull out of joints due to thermal contraction.

Bell and spigot pipe shall be laid with the bell pointed upstream. The pipe ends and couplings shall be free of foreign material when assembled.

Perforated pipe shall be laid with the perforations down and oriented symmetrically about the vertical centerline. Perforations shall be clear of any obstructions when the pipe is laid and before the pipe is approved for backfill.

The pipe shall be firmly and uniformly bedded throughout its entire length. The bedding depth and materials to be used will be as shown on the drawings. For pipe with bell joints, the bedding material shall be excavated at the locations of the bells to prevent the pipe from being supported by the bells.

## 6. PIPE EMBEDMENT

Earth bedding – The pipe shall be firmly and uniformly placed on compacted earthfill bedding or an in-place earth material bedding of ample bearing strength to support the pipe without noticeable settlement. The earth material on which the pipe is placed shall be of uniform density to prevent differential settlement.

Unless otherwise specified, a groove that closely conforms to the outside surface of the pipe shall be formed in the bedding. The depth of the groove shall be equal to or greater than 0.3 of the pipe diameter.

Earth bedding shall be compacted to a density not less than adjacent undisturbed in-place earth material or be compacted earth backfill. Earthfill material used for compacted earth bedding shall be free of rocks or stones greater than 1 inch in diameter and earth clods greater than 2 inches in diameter. The pipe shall be loaded sufficiently during the compaction of bedding under the haunches and around the sides of the pipe to prevent displacement from its final approved placement.

Sand, gravel, or crushed rock bedding – When sand, gravel, or crushed rock bedding is specified, the pipe shall be firmly and uniformly placed on the bedding material. Material for bedding shall not exceed 1 inch in diameter. Unless otherwise shown on the drawings, the coarse-grained bedding material shall be carefully placed and compacted to a depth equal to or greater than 0.3 of the diameter of the pipe above the bottom of the pipe. The pipe shall be loaded sufficiently during backfilling and compaction around the sides to prevent displacement of the pipe from its final approved placement.

Pipe encased in drainfill – The pipe shall be firmly and uniformly placed on bedding of specified drainfill. Drainfill shall be placed and compacted as specified in Wisconsin Construction Specification 8, Drainfill or as shown on the drawings. The pipe shall be loaded sufficiently during backfilling around the sides and during compaction to prevent displacement of the pipe.

Pipe encased in concrete – Concrete encasement shall be carefully placed to form a continuous uniform support around the entire circumference of the pipe or as shown on the drawings. Pipes encased in concrete shall be securely anchored to prevent movement of the pipe during concrete placement. A clear distance of 1.5 inches shall be maintained between the pipe and any reinforcing steel.

## 7. BACKFILL

Initial backfill – Unless otherwise specified or shown on the drawings, initial backfill to 6 inches above the top of the conduit is required. Earth haunching and initial backfill material shall consist of soil material that is free of rocks, stones, or hard clods more than 1 inch in diameter. Coarse backfill material shall be the specified sand, gravel, crushed rock, or drainfill material.

Initial backfill shall be placed in two stages. In the first stage (haunching), backfill is placed to the pipe spring line (center of pipe). In the second stage, it is placed to 6 inches above the top of the pipe.

The first stage material shall be worked carefully under the haunches of the pipe to provide continuous support throughout the entire pipe length. The haunching backfill material shall be placed in layers that have a maximum thickness of about 6 inches and are compacted as shown on the drawings or as stated in the Wisconsin Construction Specification appropriate for the backfill material. During compaction operations, care shall be taken to ensure that the tamping or vibratory equipment does not come in contact with the pipe and the pipe is not deformed or displaced.

Final backfill -- Final backfill shall consist of placing the remaining material required to complete the backfill from the top of the initial backfill to the ground surface, including mounding at the top of the trench. Final backfill material within 2 feet of the top of the pipe shall be free of debris or rocks larger than 3 inches nominal diameter. Coarse backfill material shall be the specified sand, gravel, crushed rock, or drainfill. Final backfill shall be placed in approximately uniform, compacted layers. Final backfill compaction and layer thickness requirements shall be as shown on the drawings or as stated in the Wisconsin Construction Specification appropriate for the backfill material.

# WISCONSIN CONSTRUCTION SPECIFICATION

## 17. Wire Mesh Gabions and Mattresses

### 1. SCOPE

The work shall consist of furnishing, assembling and installing rock filled wire mesh gabion baskets and mattresses.

### 2. TYPES

Gabions shall consist of rectangular wire mesh formed containers filled with rock. Gabions will conform to one of the following mesh types:

Woven Mesh - Non-raveling double twisted hexagonal wire mesh, consisting of two wires twisted together in two 180 degree turns.

Welded Mesh - Welded-wire mesh with a uniform square or rectangular pattern and a resistance weld at each intersection. The welded wire connections shall conform with the requirements of ASTM A 185, including wire smaller than W1.2 (0.124 in.); except that the welded connections shall have a minimum average shear strength of 70% and a minimum shear strength of 60% of the minimum ultimate tensile strength of the wire.

Gabions shall be furnished as baskets or mattresses, as shown in the construction plans. Baskets have a height of 12 inches or greater. Mattresses have a thickness of 12 inches or less.

Baskets and mattresses shall be fabricated within a dimension tolerance of plus or minus 5 percent, except that the mattress height shall be within 10 percent.

### 3. MATERIALS

Gabions shall be fabricated, assembled and installed in accordance with the nominal wire sizes and dimensions found in Tables 1 and 2.

Wire for fabrication and assembly shall be hot-dipped galvanized. The wire shall have a minimum tensile strength of 60,000 psi. Galvanized steel wire shall conform to ASTM A 641, Class 3, Soft Temper.

Spiral binders are the standard fastener for welded-mesh gabion baskets and mattresses, and shall be formed from wire meeting the same quality and coating thickness requirements as specified for the gabion baskets and mattresses. Alternate fasteners for use with wire mesh gabions, such as ring fasteners, shall be formed from wire meeting the same quality and coating thickness requirements as specified for the gabions.

Gabion baskets or mattresses with PVC coating shall be interconnected using ring fasteners made of stainless steel or PVC-coated spiral fasteners. All fasteners shall meet the closing requirements of the gabion manufacturer.

**Table 1\***

**Gabion Baskets**  
**Height 12, 18, or 36 Inches; Length as Specified**

Type of Wire	Mesh Size Inches	Wire Diameter Inches	PVC Coating Inches	Total Diameter Inches	Galvanized Coating Oz./SF
Woven Mesh	3 ¼ x 4 ½	0.118	None	0.118	0.80
	3 ¼ x 4 ½	0.105	0.02	0.145	0.80
Selvage		0.153	None	0.153	0.80
		0.132	0.02	0.172	0.80
Lacing and Internal Connecting Wire		0.086	0.02	0.126	0.70
Welded mesh	3 x 3	0.118	None	0.118	0.80
	3 x 3	0.105	0.02	0.145	0.80
Spiral Binder		0.105	0.02	0.145	0.80

**Table 2\***

**Gabion Mattresses**  
**Height 6, 9, or 12 Inches; Length as Specified**

Type of Wire	Mesh Size Inches	Wire Diameter Inches	PVC Coating Inches	Total Diameter Inches	Galvanized Coating Oz./SF
Woven Mesh	2 ½ x 3 ¼	0.086	0.02	0.126	0.70
Selvage		0.105	0.02	0.145	0.80
Lacing and Internal Connecting Wire		0.086	0.02	0.126	0.70
Welded Mesh	1 ½ x 3	0.080	0.02	0.120	0.70
Spiral Binder		0.105	0.02	0.145	0.80

\*NOTE: The wire sizes and PVC coating thickness shown are nominal sizes.  
 The wire diameter includes the galvanizing coating thickness.

When Epoxy or Polyvinyl Chloride (PVC) coated wire is used, the galvanized wire shall be coated by fusion bonded epoxy; or fusion bonded, extruded, or extruded and bonded PVC material. The wire coating shall be colored black, gray, green or silvery; and the initial properties of the PVC coating shall meet the following requirements:

- Specific Gravity. In the range of 1.25 to 1.35, ASTM D 792.
- Abrasion Resistance. The percentage of weight loss shall be less than 12%, when tested according to ASTM D 1242, Method B at 200 cycles, CSI-A Abrader Tape, 80 Grit.
- Brittleness Temperature. Not higher than 15 °F, ASTM D 746.
- Tensile Strength. Extruded Coating (not less than 2,980 psi., ASTM D 412). Fusion Bonded Coating (not less than 2,275 psi., ASTM D 638).
- Modulus of Elasticity. Extruded Coating (not less than 2,700 psi. at 100 percent strain, ASTM D 412). Fusion Bonded Coating (not less than 2050 psi. at 100 percent strain, ASTM D 638).
- Ultraviolet Light Exposure. A test period of not less than 3000 hours, using apparatus Type E at 63 °C, ASTM G 23.
- Salt Spray Test. A test period of not less than 3000 hours, ASTM B 117.

Rock shall conform to the quality requirements in Wisconsin Construction Specification 9, Loose Rock Riprap, unless otherwise specified in the construction plan. At least 85 percent of the rock particles, by weight, shall be within the predominant rock size range shown in Table 3.

**Table 3**  
**Rock Requirements**

<b>Gabion Basket or Mattress Height</b>	<b>Predominant Rock Size Inches</b>	<b>Minimum Rock Dimension Inches</b>	<b>Max. Rock Dimension Inches</b>
18 or 36 Inch Basket	4 to 8	4	9
12 Inch Basket or Mattress	4 to 6	3	8
6 or 9 Inch Mattress	3 to 6	3	6

Prior to delivery to the site, the Contractor shall inform the Technician in writing of the source from which the rock will be obtained, and provide the test data by which the material was determined by the Contractor to meet the specification.

Bedding or filter material, when specified, shall meet the gradation shown on the plans or as specified in Wisconsin Construction Specification 8, Drainfill.

Geotextile, when specified, shall conform to the requirements specified in Wisconsin Construction Specification 13, Geotextiles.

#### 4. FOUNDATION PREPARATION

The foundation on which the gabions are to be placed shall be cut or filled and graded to the lines and grades shown on the drawings. Surface irregularities, loose material, vegetation, and all foreign matter shall be removed from foundations. When fill is required, it shall consist of materials conforming to the specified requirements. Gabions and bedding or specified geotextiles shall not be placed until the foundation preparation is completed, and the subgrade surfaces have been inspected and approved by the Technician.

Compaction of bedding or filter material will be required as specified in Wisconsin Construction Specification 8, Drainfill. The surface of the finished material shall be to grade and free of mounds, dips or windrows. Geotextile shall be installed in accordance with the requirements of Wisconsin Construction Specification 13, Geotextiles.

#### 5. ASSEMBLY AND PLACEMENT

Unless otherwise specified in the construction plan, the assembly and placement of gabions shall be in accordance with the following procedures:

Assembly - Rotate the gabion panels into position and join the vertical edges with fasteners for gabion assembly. Where lacing wire is used, wrap the wire with alternating single and double half-hitches at intervals between four (4) to five (5) inches. Where spiral fasteners are used for welded-wire mesh, crimp the ends to secure the spirals in place. Where ring type fasteners are used for basket assembly, install the fasteners at a maximum spacing of 6 inches. Use the same fastening procedures to install interior diaphragms where they are required.

Interior diaphragms will be installed to assure that no open intervals are present that exceed three (3) feet.

Placement - Place the empty gabions on the foundation and interconnect the adjacent gabions along the top, bottom, and vertical edges using lacing wire, spiral fasteners, or ring fasteners. Wrap the wire with alternating single and double half-hitches at intervals between four (4) to six (6) inches. Ring fasteners shall not be spaced more than six (6) inches apart. Spirals are screwed down at the connecting edges, then each end of the spiral is crimped to secure it in place. Lacing wire will be used as needed to supplement the interconnection of welded mesh gabions, and the closing of lids.

Interconnect each layer of gabions to the underlying layer of gabions along the front, back, and sides. Stagger the vertical joints between the gabions of adjacent rows and layers by at least one-half of a cell length.

#### 6. FILLING OPERATION

After adjacent empty woven wire gabion units are set to line and grade and common sides properly connected, they shall be placed in straight line tension and stretched to remove any kinks from the mesh and to gain a uniform alignment. Staking of the gabions may be done to maintain the established proper alignment prior to the placement of rock. No stakes shall be placed through geotextile material.

Internal connecting cross-tie wires shall be placed in each unrestrained gabion cell greater than 18 inches in height, including gabion cells left temporarily unrestrained. Two internal connecting wires shall be placed concurrently with rock placement, at each 12-inch interval of depth.

In woven mesh gabions, these cross-ties will be placed evenly spaced along the front face and connecting to the back face. All cross-tie wires shall be looped around two mesh openings and each wire end shall be secured by a minimum of five 180 degree twists around itself after looping.

In welded mesh gabions, these cross-ties or stiffeners will be placed across the corners of the gabions (at 12 inches from the corners) providing diagonal bracing. Preformed hooked wire stiffeners will be used.

The gabions shall be carefully filled with rock, either by machine or hand methods, maintaining alignment, avoiding bulges, and providing a compact mass that minimizes voids. Machine placement will require supplementing with hand work to ensure the desired results. The cells in any row shall be filled in stages so that the depth of rock placed in any one cell does not exceed the depth of rock in any adjoining cell by more than 12 inches. Along the exposed faces, the outer layer of stone shall be carefully placed and arranged by hand to ensure a neat, compact placement with a uniform appearance.

The last layer of rock shall be uniformly overfilled 1-2 inches for gabions and 0.5-1 inch for gabion mattresses to allow for rock settlement. Lids shall be stretched tight over the rock fill using only approved lid closing tools. The use of crowbars or other single point leverage bars for lid closing is prohibited. The lid shall be stretched until it meets the perimeter edges of the front and end panels. The gabion lid shall then be secured to the sides, ends, and diaphragms with spiral binders or lacing wire wrapped with alternating single and double half-hitches in the mesh openings. Ring fasteners spaced not more than six (6) inches apart may be used for lid closure.

Any damage to the wire or coatings during assembly, placement and filling shall be repaired promptly in accordance with the manufacturer's recommendations or replaced with undamaged gabion baskets.

**Waldo Peterson Property  
Quantities**

December 1, 2009

Item #	Description	Unit of Measure	Estimated Quantity
<b>Storm Water</b>			
1	24" Storm Sewer RCP	LF	37
2	24" Vertical Stand Pipe	LF	7
3	Base Aggregate Dense - 3"	CY	105
4	Base Aggregate Dense - 1 1/4 "	CY	210
5	6" Drain Pipe With Connections	LF	60
6	Detention Basin Excavation	CY	360
7	Rock Gabion	EA	6
8	Rock Mattress	EA	2
9	Medium Riprap (See Detail)	CY	105
10	Heavy Riprap (See Detail)	CY	2
11	Gabion Stone-Clear Well Graded Stone Maximum 6" Dia.	CY	18
12	Class I Non-Woven Geotextile	SY	300
13	Clearing & Grubbing	LS	1
<b>Erosion Control</b>			
14	Erosion Mat (Type 1 Class A Per Wisconsin D.O.T. P.A.L.	SY	40
15	Seeding/mulch	SY	40

**Hutchison & Steinhoff Property  
Quantities**

December 1, 2009

Item #	Description	Unit of Measure	Estimated Quantity
<b>Storm Water</b>			
1	Base Aggregate Dense 1 1/4"	CY	10.6
2	Base Aggregate Dense 3"	CY	19
3	Rock Gabion - Filled	EA	2
4	Rock Mattress - Filled	EA	1
5	Medium Riprap (See Detail)	CY	45
6	Heavy Riprap (See Detail)	CY	1
7	Gabion Stone-Clear Well Graded Stone Maximum 6" Dia.	CY	6
8	Class I Non-Woven Geotextile	SY	120
9	Clearing & Grubbing	LS	1
<b>Erosion Control</b>			
10	Erosion Mat (Type 1 Class A Per Wisconsin D.O.T. P.A.L.	SY	30
11	Seeding/mulch	SY	30

**Vierbicher**

400 Viking Drive, P.O. Box 379  
 Reedsburg, Wisconsin 53959  
 Phone (608) 524-6468  
 Fax (608) 524-8218

JOB Hutchison & Steinhoff Rock chute

SHEET NO. 1 OF 2

CALCULATED BY \_\_\_\_\_ DATE \_\_\_\_\_

CHECKED BY \_\_\_\_\_ DATE \_\_\_\_\_

SCALE \_\_\_\_\_

Rock Size

$q_e$  = equivalent unit discharge  
 $S_{ch}$  = Bed Slope ft/ft  
 $D_{50}$  = 50 percent passing by weight

$$D_{50} = \left[ \frac{q_e (S_{ch})^{0.58}}{3.95 (10)^{-2}} \right]$$

Equation 2. SCS 6-WI-26

Discharge

$$Q_{10} = 10.74 \text{ cfs}$$

$$Q_{25} = 13.17 \text{ cfs}$$

$$\text{Slope} = (884 - 879) / 24 = 21\% \approx (5:1)$$

- Assume 10.0 Ft. Bottom width

$$D_{50} = \left[ \frac{(13.2/10) (0.21)^{0.58}}{3.95 (10)^{-2}} \right]^{1/1.89}$$

$$D_{50} = 4.0$$

Manning's 'n'

$$n = 0.047 (D_{50} S_{ch})^{0.147}$$

$$n = 0.047 (4.0 \cdot 0.21)^{0.147}$$

$$n = 0.05$$

Factor of Safety (Fs)

$$D_{50} \cdot (Fs) = D_{50}^*$$

$$D_{50} = 4.0 \quad (Fs) = 1.3$$

$$4.0 \cdot 1.3 = 5.2$$

\* Assume 50% angular 50% round

Rock lining thickness

The maximum rock thickness shall be  $2 \cdot D_{50}^{\uparrow}$  which is also the size of the largest rock that shall be used.

$$2 \cdot 5.2 = 10.4$$

\* Geotextile will be used as  $T_B$   
 Assume  $T_B = 0$ .

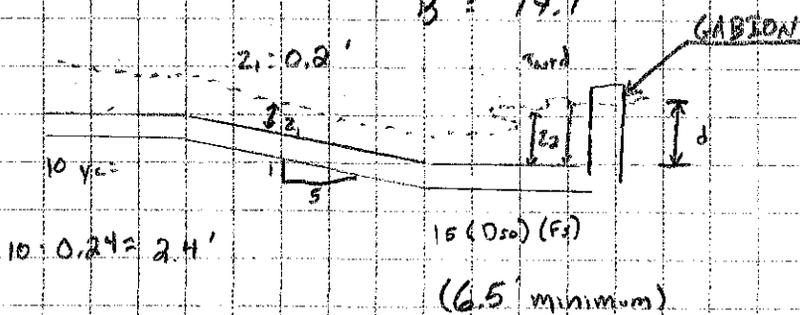
- $B'$  = lowest excavation bottom width
- $B$  = design bottom width
- $T_B$  = Thickness of bedding
- $T_R$  = Thickness of rock
- $Z$  = side slope ratio

$$T_R = 10.4 / 12 = .87$$

$$B' = B + \frac{(T_R + T_B)}{Z}$$

$$B' = 10 + \frac{(.87 + 0)}{.21}$$

$$B' = 14.1'$$



$F_s = 1.3$  Factor of Safety  
 $Z = 0.2$  Normal Depth in chute

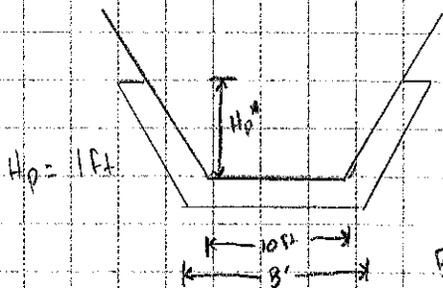
$n$  value = .05 Manning's roughness coefficient

$(D_{50}) (F_s) = 5.2$  in Minimum Design  $D_{50}^{\uparrow}$

$2(D_{50}) (F_s) = 10.4$  in Rock chute thickness

$T_R + d = 3.3'$  Tailwater above outlet apron

$Z_2 = 0.43$  Hydraulic Jump Height



Rock thickness = 10.4 in

$H_p$  along chute no less than  $Z_2 U_{50} : 1$  foot

**Vierbicher**  
 400 Viking Drive, P.O. Box 379  
 Reedsburg, Wisconsin 53959  
 Phone (608) 524-6468  
 Fax (608) 524-8218

JOB Waldo Peterson Rock chute  
 SHEET NO. \_\_\_\_\_ OF \_\_\_\_\_  
 CALCULATED BY \_\_\_\_\_ DATE \_\_\_\_\_  
 CHECKED BY NDEA DATE 11-20-09  
 SCALE \_\_\_\_\_

Rock size

$q_e$  = equivalent unit discharge in  $\text{ft}^3/\text{sec}/\text{ft}$

Sch = Bed Slope ft/ft

$D_{50}$  = 50 percent passing by weight

$$D_{50} = \left[ \frac{q_e (\text{Sch})^{1.58}}{3.95 (10)^{-2}} \right]^{1/1.89}$$

(Equation 2 SCS 6-WI-26)

DISCH. =  $Q_{10} = 10.5 \text{ cfs}$   
 $Q_{85} = 13.9 \text{ cfs}$

Slope =  $889 - 871 \div 54 = 33.3\% (3:1)$

- Assume 10.0 ft Bottom Width

$$D_{50} = \left[ \frac{(13.9/10) (0.333)^{0.58}}{3.95 (10)^{-2}} \right]^{1/1.89}$$

$D_{50} = 4.7$

Manning's "n"

$$n = 0.047 (D_{50} \cdot \text{Sch})^{0.147}$$

$$n = 0.047 (4.7 \cdot 0.333)^{0.147}$$

$n = .05$

Factor of Safety ( $F_s$ )

$D_{50} \cdot (F_s) = D_{50}^*$   
 $D_{50} = 4.7$   $(F_s) = 1.3$

$4.7 \cdot 1.3 = \boxed{6.11}$

Table 1- Factor of Safety ( $F_s$ ) (SCS 6-WI-27)  
 Assume 50% angular 50% round

Rock Lining Thickness

The minimum rock thickness shall be  $2 \cdot D_{50}''$  which is also the size of the largest rock that shall be used.

$$2 \cdot 6.11 = 12.22$$

$T_B =$  Bed thickness  
 $T_B = 12.2''$

Use  $D_{50}'' = 8''$  medium riprap

<sup>a</sup>60 cent. 1/2 will be used as alternative

The larger rocks must be uniformly distributed throughout the entire rock mass and firmly in contact with each other. Smaller rock and spalls shall fill the voids between the larger rocks.

- $B'$  = lowest excavation bottom width
- $B$  = design bottom width
- $T_B$  = thickness of bedding
- $T_L$  = thickness of rock
- $z$  = side slope ratio

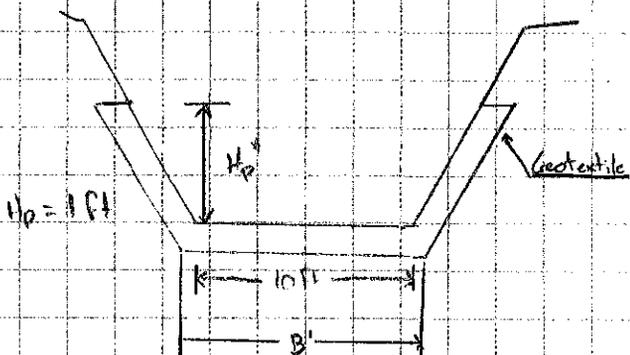
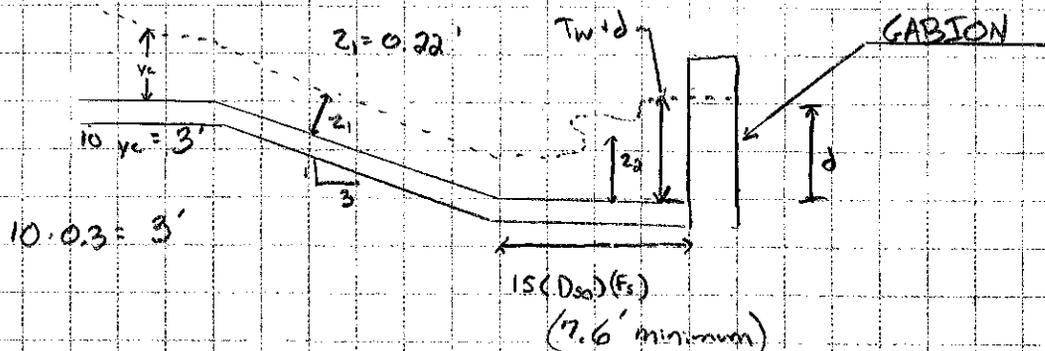
$$B' = B + \frac{(T_L + T_B)}{z}$$

$$B' = 10 + \frac{(1 + 0)}{.333}$$

$$B' = 13.0'$$

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JOB \_\_\_\_\_  
 SHEET NO. \_\_\_\_\_ OF \_\_\_\_\_  
 CALCULATED BY \_\_\_\_\_ DATE \_\_\_\_\_  
 CHECKED BY \_\_\_\_\_ DATE \_\_\_\_\_  
 SCALE \_\_\_\_\_



- 1.39 cfs/A Equivalent unit discharge
- $F_s = 1.3$  Factor of safety
- $z_1 = 0.22'$  Normal depth in chute
- $n\text{-value} = .05$  Manning's roughness coefficient
- $D_{50}(F_s) = 6.11\text{ in.}$  Minimum Design  $D_{50}$
- $2(D_{50})(F_s) = 12.2\text{ in.}$  Rock chute thickness
- $T_w + d = 3.5'$  Tailwater above outlet apron
- $z_2 = 0.45'$  Hydraulic jump height

$B' = 13.0'$   
 Rock thickness = 12.2 in.

$H_p$  along chute no less than  $z_2$  Use: 1 foot