ATTACHMENT 7-IX

SURFACE WATER SYSTEM CALCULATIONS

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Section 1

Executive Summary

1 EXECUTIVE SUMMARY

The objective of this appendix is to demonstrate that the surface water management system included in the Vertical and Lateral Expansion meets or exceeds the applicable state and federal regulatory requirements based on the 25-year 24-hour storm event. Included in this appendix are the following Sections: Executive Summary, Drainage Channel Design, Downlet Design, Drop Inlet & Culvert Design, Sedimentation Basin #4 Design, and Rainfall & Soil Data.

A combination of HydroCAD and Excel spreadsheets were used for most calculations. When reasonable, the same or similar specifications as in the previous permit application calculations were utilized. A summary of calculation methods and results are discussed in each section.

Section 2

Drainage Channel Design

2 DRAINAGE CHANNEL DESIGN

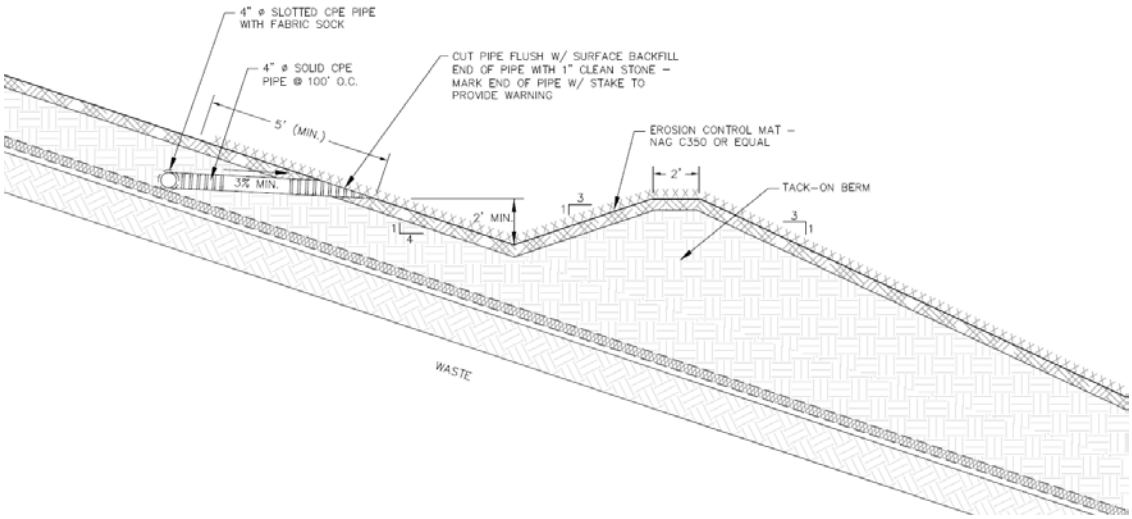
2.1 INTRODUCTION

This calculation demonstrates that the proposed final cover and perimeter drainage channels, as designed, accommodate the peak flow from the twenty-five year/twenty-four hour storm event.

2.2 DESIGN

FINAL COVER DRAINAGE CHANNELS

Terraces serve as final cover drainage channels. The proposed channels are triangular, drain by gravity at a minimum slope of 2%, and are lined with grass and an erosion control mat where necessary with a minimum permissible velocity of 10.5 fps per typical Manufacturer's specifications. Channel dimensions are summarized in Table 2.4A. A typical cross section is shown below.

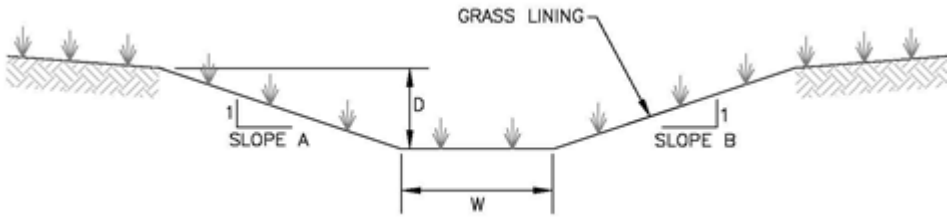


Final Cover Tack-On Berm Drainage Channel

PERIMETER DRAINAGE CHANNELS

The perimeter drainage channels and channels outside the limits of final cover consist of proposed and existing grass-lined trapezoidal channels that drain by gravity. Proposed

grass-lined channels are limited to a typical permissible velocity of 5.5 ft/s. Channel dimensions are summarized in Table 2.4B. A typical cross section for the perimeter drainage channels is shown below.



Perimeter Drainage Channel

2.3 CALCULATION

A typical manning's number of 0.03 was used to represent short grass lining for the final cover and perimeter drainage channels. Each channel was modeled using HydroCAD which uses the SCS Unit Hydrograph method (TR-20). Peak discharge, max velocity, and flow depth for the 25-year 24-hour storm event were calculated in the model. HydroCAD results can be found in Attachment 1.

2.4 CONCLUSION

The following tables summarizing the design and HydroCAD results indicate that the final cover and perimeter drainage channels are capable of transmitting the peak flow from the 25-year 24-hour storm event without being overtopped. The max velocity for each drainage channel during the 25-year, 24-hour storm event is below the applicable maximum permissible velocity.

TABLE 2.4A. FINAL COVER DRAINAGE CHANNELS									
Channel ID	Length (ft)	Avg. Slope (%)	Bottom Width (ft)	Sideslope A	Sideslope B	Manning's n	Total Depth (ft)	25-yr, 24-hr Storm Event	
								Peak Discharge (cfs)	Max Velocity (ft/s)
1A	400	2.0	0	3H:1V	3H:1V	0.03	2.0	3.66	3.46
1B	400	2.0	0	3H:1V	3H:1V	0.03	2.0	2.90	3.46
1C	400	2.0	0	3H:1V	3H:1V	0.03	2.0	2.90	3.45
1D	400	2.0	0	3H:1V	3H:1V	0.03	2.0	2.90	3.46
1E	400	2.0	0	3H:1V	3H:1V	0.03	2.0	2.90	3.45
1F	400	2.0	0	3H:1V	3H:1V	0.03	2.0	2.90	3.45
1G	400	2.0	0	3H:1V	3H:1V	0.03	2.0	2.90	3.45
1H	400	2.0	0	3H:1V	3H:1V	0.03	2.0	2.90	3.45
1I	667	2.0	0	3H:1V	3H:1V	0.03	2.0	5.02	3.46
1J	571	2.0	0	3H:1V	3H:1V	0.03	2.0	4.35	3.46
1K	475	2.0	0	3H:1V	3H:1V	0.03	2.0	3.69	3.46
1L	387	2.0	0	3H:1V	3H:1V	0.03	2.0	3.09	3.46
1M	285	2.0	0	3H:1V	3H:1V	0.03	2.0	2.46	3.46
1N	178	2.0	0	3H:1V	3H:1V	0.03	2.0	1.73	3.46
1O	100	2.0	0	3H:1V	3H:1V	0.03	2.0	0.97	3.46
2A	400	2.0	0	3H:1V	3H:1V	0.03	2.0	2.54	3.45
2B	100	2.0	0	3H:1V	3H:1V	0.03	2.0	1.17	3.45
2C	200	2.0	0	3H:1V	3H:1V	0.03	2.0	1.90	3.45
2D	300	2.0	0	3H:1V	3H:1V	0.03	2.0	2.78	3.45
2E	400	2.0	0	3H:1V	3H:1V	0.03	2.0	3.51	3.45
2F	500	2.0	0	3H:1V	3H:1V	0.03	2.0	3.75	3.46
2G	600	2.0	0	3H:1V	3H:1V	0.03	2.0	4.69	3.46
2H	800	2.0	0	3H:1V	3H:1V	0.03	2.0	4.63	3.46
2I	400	2.0	0	3H:1V	3H:1V	0.03	2.0	2.67	3.45
2J	400	2.0	0	3H:1V	3H:1V	0.03	2.0	2.89	3.45
2K	400	2.0	0	3H:1V	3H:1V	0.03	2.0	2.90	3.45
2L	400	2.0	0	3H:1V	3H:1V	0.03	2.0	2.91	3.45
2M	400	2.0	0	3H:1V	3H:1V	0.03	2.0	3.03	3.45
2N	400	2.0	0	3H:1V	3H:1V	0.03	2.0	2.90	3.45
2O	400	2.0	0	3H:1V	3H:1V	0.03	2.0	2.90	3.45
2P	400	2.0	0	3H:1V	3H:1V	0.03	2.0	2.92	3.46
2Q	400	2.0	0	3H:1V	3H:1V	0.03	2.0	3.08	3.46
3A	400	2.0	0	3H:1V	3H:1V	0.03	2.0	5.82	3.45
3B	400	2.0	0	3H:1V	3H:1V	0.03	2.0	2.90	3.45
3C	400	2.0	0	3H:1V	3H:1V	0.03	2.0	2.90	3.45
3D	400	2.0	0	3H:1V	3H:1V	0.03	2.0	2.90	3.45
3E	400	2.0	0	3H:1V	3H:1V	0.03	2.0	2.90	3.45
3F	400	2.0	0	3H:1V	3H:1V	0.03	2.0	2.90	3.45
3G	400	2.0	0	3H:1V	3H:1V	0.03	2.0	2.90	3.45
3H	400	2.0	0	3H:1V	3H:1V	0.03	2.0	2.90	3.45
3I	400	2.0	0	3H:1V	3H:1V	0.03	2.0	2.90	3.45
3J	400	2.0	0	3H:1V	3H:1V	0.03	2.0	3.17	3.45
3K	400	2.0	0	3H:1V	3H:1V	0.03	2.0	2.99	3.45
3L	400	2.0	0	3H:1V	3H:1V	0.03	2.0	2.87	3.45
3M	400	2.0	0	3H:1V	3H:1V	0.03	2.0	2.91	3.45
3N	400	2.0	0	3H:1V	3H:1V	0.03	2.0	2.92	3.45
3O	400	2.0	0	3H:1V	3H:1V	0.03	2.0	2.87	3.45
3P	400	2.0	0	3H:1V	3H:1V	0.03	2.0	2.93	3.45
3Q	400	2.0	0	3H:1V	3H:1V	0.03	2.0	2.93	3.45

TABLE 2.4A. FINAL COVER DRAINAGE CHANNELS									
Channel ID	Length (ft)	Avg. Slope (%)	Bottom Width (ft)	Sideslope A	Sideslope B	Manning's n	Total Depth (ft)	25-yr, 24-hr Storm Event	
								Peak Discharge (cfs)	Max Velocity (ft/s)
3R	400	2.0	0	3H:1V	3H:1V	0.03	2.0	5.08	3.45
4A	400	2.0	0	3H:1V	3H:1V	0.03	2.0	5.17	3.46
4B	400	2.0	0	3H:1V	3H:1V	0.03	2.0	5.15	3.46
4C	400	2.0	0	3H:1V	3H:1V	0.03	2.0	2.93	3.45
4D	400	2.0	0	3H:1V	3H:1V	0.03	2.0	2.93	3.45
4E	400	2.0	0	3H:1V	3H:1V	0.03	2.0	2.87	3.45
4F	400	2.0	0	3H:1V	3H:1V	0.03	2.0	2.92	3.45
4G	400	2.0	0	3H:1V	3H:1V	0.03	2.0	2.91	3.45
4H	400	2.0	0	3H:1V	3H:1V	0.03	2.0	2.87	3.45
4I	400	2.0	0	3H:1V	3H:1V	0.03	2.0	2.99	3.45
4J	400	2.0	0	3H:1V	3H:1V	0.03	2.0	3.17	3.45
4K	400	2.0	0	3H:1V	3H:1V	0.03	2.0	3.21	3.45
4L	400	2.0	0	3H:1V	3H:1V	0.03	2.0	2.98	3.45
4M	400	2.0	0	3H:1V	3H:1V	0.03	2.0	2.98	3.45
4N	400	2.0	0	3H:1V	3H:1V	0.03	2.0	2.81	3.45
4O	400	2.0	0	3H:1V	3H:1V	0.03	2.0	2.90	3.45
4P	400	2.0	0	3H:1V	3H:1V	0.03	2.0	2.83	3.45
4Q	400	2.0	0	3H:1V	3H:1V	0.03	2.0	3.01	3.45
4R	400	2.0	0	3H:1V	3H:1V	0.03	2.0	2.54	3.45
5A	400	2.0	0	3H:1V	3H:1V	0.03	2.0	4.55	3.45
5B	400	2.0	0	3H:1V	3H:1V	0.03	2.0	2.86	3.45
5C	400	2.0	0	3H:1V	3H:1V	0.03	2.0	2.71	3.45
5D	400	2.0	0	3H:1V	3H:1V	0.03	2.0	3.01	3.45
5E	400	2.0	0	3H:1V	3H:1V	0.03	2.0	2.83	3.45
5F	400	2.0	0	3H:1V	3H:1V	0.03	2.0	2.90	3.45
5G	400	2.0	0	3H:1V	3H:1V	0.03	2.0	2.81	3.45
5H	400	2.0	0	3H:1V	3H:1V	0.03	2.0	2.98	3.45
5I	400	2.0	0	3H:1V	3H:1V	0.03	2.0	2.98	3.45
5J	400	2.0	0	3H:1V	3H:1V	0.03	2.0	3.20	3.45
5K	400	2.0	0	3H:1V	3H:1V	0.03	2.0	3.02	3.45
5L	400	2.0	0	3H:1V	3H:1V	0.03	2.0	2.90	3.45
5M	400	2.0	0	3H:1V	3H:1V	0.03	2.0	2.90	3.45
5N	400	2.0	0	3H:1V	3H:1V	0.03	2.0	2.90	3.45
5O	400	2.0	0	3H:1V	3H:1V	0.03	2.0	3.03	3.45
5P	400	2.0	0	3H:1V	3H:1V	0.03	2.0	2.77	3.45
5Q	400	2.0	0	3H:1V	3H:1V	0.03	2.0	3.03	3.45
5R	400	2.0	0	3H:1V	3H:1V	0.03	2.0	2.77	3.45
6A	309	2.0	0	3H:1V	3H:1V	0.03	2.0	1.26	3.46
6B	400	2.0	0	3H:1V	3H:1V	0.03	2.0	2.59	3.45
6C	400	2.0	0	3H:1V	3H:1V	0.03	2.0	3.04	3.45
6D	400	2.0	0	3H:1V	3H:1V	0.03	2.0	2.62	3.45
6E	400	2.0	0	3H:1V	3H:1V	0.03	2.0	3.32	3.45
6F	400	2.0	0	3H:1V	3H:1V	0.03	2.0	2.97	3.45
6G	400	2.0	0	3H:1V	3H:1V	0.03	2.0	2.91	3.45
6H	400	2.0	0	3H:1V	3H:1V	0.03	2.0	2.79	3.45
6I	400	2.0	0	3H:1V	3H:1V	0.03	2.0	2.76	3.45
6J	722	2.0	0	3H:1V	3H:1V	0.03	2.0	5.05	3.46
6K	625	2.0	0	3H:1V	3H:1V	0.03	2.0	4.57	3.46
6L	525	2.0	0	3H:1V	3H:1V	0.03	2.0	4.11	3.46

TABLE 2.4A. FINAL COVER DRAINAGE CHANNELS									
Channel ID	Length (ft)	Avg. Slope (%)	Bottom Width (ft)	Sideslope A	Sideslope B	Manning's n	Total Depth (ft)	25-yr, 24-hr Storm Event	
								Peak Discharge (cfs)	Max Velocity (ft/s)
6M	420	2.0	0	3H:1V	3H:1V	0.03	2.0	3.64	3.46
6N	305	2.0	0	3H:1V	3H:1V	0.03	2.0	3.14	3.45
6O	306	2.0	0	3H:1V	3H:1V	0.03	2.0	2.03	3.45
6P	112	2.0	0	3H:1V	3H:1V	0.03	2.0	1.19	3.45
7A	104	2.0	0	3H:1V	3H:1V	0.03	2.0	1.52	3.46
7B	215	2.0	0	3H:1V	3H:1V	0.03	2.0	1.93	3.46
7C	300	2.0	0	3H:1V	3H:1V	0.03	2.0	2.61	3.46
7D	400	2.0	0	3H:1V	3H:1V	0.03	2.0	3.29	3.46
7E	500	2.0	0	3H:1V	3H:1V	0.03	2.0	4.19	3.46
7F	470	2.0	0	3H:1V	3H:1V	0.03	2.0	3.91	3.46
7G	410	2.0	0	3H:1V	3H:1V	0.03	2.0	3.25	3.46
7H	371	2.0	0	3H:1V	3H:1V	0.03	2.0	2.78	3.46
7I	300	2.0	0	3H:1V	3H:1V	0.03	2.0	2.35	3.46
7J	250	2.0	0	3H:1V	3H:1V	0.03	2.0	2.06	3.46
7K	240	2.0	0	3H:1V	3H:1V	0.03	2.0	2.07	3.46
7L	170	2.0	0	3H:1V	3H:1V	0.03	2.0	0.74	1.05
8A	340	2.0	0	3H:1V	3H:1V	0.03	2.0	2.54	3.46
8B	350	2.0	0	3H:1V	3H:1V	0.03	2.0	2.85	3.46
8C	370	2.0	0	3H:1V	3H:1V	0.03	2.0	2.94	3.46
8D	380	2.0	0	3H:1V	3H:1V	0.03	2.0	3.08	3.46
8E	390	2.0	0	3H:1V	3H:1V	0.03	2.0	3.12	3.46
8F	390	2.0	0	3H:1V	3H:1V	0.03	2.0	3.11	3.46
8G	380	2.0	0	3H:1V	3H:1V	0.03	2.0	3.40	3.46
8H	380	2.0	0	3H:1V	3H:1V	0.03	2.0	3.29	3.46
8I	520	2.0	0	3H:1V	3H:1V	0.03	2.0	4.18	3.46
8J	461	2.0	0	3H:1V	3H:1V	0.03	2.0	3.37	3.46
8K	420	2.0	0	3H:1V	3H:1V	0.03	2.0	3.27	3.46
8L	374	2.0	0	3H:1V	3H:1V	0.03	2.0	2.98	3.46
8M	327	2.0	0	3H:1V	3H:1V	0.03	2.0	2.67	3.46
8N	265	2.0	0	3H:1V	3H:1V	0.03	2.0	2.24	3.46
8O	216	2.0	0	3H:1V	3H:1V	0.03	2.0	1.80	3.46
8P	163	2.0	0	3H:1V	3H:1V	0.03	2.0	1.32	3.46
8Q	250	2.0	0	3H:1V	3H:1V	0.03	2.0	3.43	0.41
9A	51	2.0	0	3H:1V	3H:1V	0.03	2.0	1.11	3.46
9B	79	2.0	0	3H:1V	3H:1V	0.03	2.0	0.85	3.45
9C	96	2.0	0	3H:1V	3H:1V	0.03	2.0	1.09	3.45
9D	127	2.0	0	3H:1V	3H:1V	0.03	2.0	1.36	3.45
9E	151	2.0	0	3H:1V	3H:1V	0.03	2.0	1.58	3.45
9F	177	2.0	0	3H:1V	3H:1V	0.03	2.0	1.87	3.45
9G	213	2.0	0	3H:1V	3H:1V	0.03	2.0	1.92	3.45
9H	238	2.0	0	3H:1V	3H:1V	0.03	2.0	2.37	3.45
9I	281	2.0	0	3H:1V	3H:1V	0.03	2.0	2.32	3.45
9J	317	2.0	0	3H:1V	3H:1V	0.03	2.0	2.85	3.45
9K	317	2.0	0	3H:1V	3H:1V	0.03	2.0	2.17	3.45
9L	322	2.0	0	3H:1V	3H:1V	0.03	2.0	2.18	3.45
9M	329	2.0	0	3H:1V	3H:1V	0.03	2.0	2.52	3.45
9N	335	2.0	0	3H:1V	3H:1V	0.03	2.0	2.28	3.45
9O	419	2.0	0	3H:1V	3H:1V	0.03	2.0	3.02	3.46
9P	454	2.0	0	3H:1V	3H:1V	0.03	2.0	3.53	3.46

TABLE 2.4A. FINAL COVER DRAINAGE CHANNELS									
Channel ID	Length (ft)	Avg. Slope (%)	Bottom Width (ft)	Sideslope A	Sideslope B	Manning's n	Total Depth (ft)	25-yr, 24-hr Storm Event	
								Peak Discharge (cfs)	Max Velocity (ft/s)
9Q	493	2.0	0	3H:1V	3H:1V	0.03	2.0	3.53	3.46
9R	531	2.0	0	3H:1V	3H:1V	0.03	2.0	3.46	3.46
9S	575	2.0	0	3H:1V	3H:1V	0.03	2.0	3.93	3.46
9T	612	2.0	0	3H:1V	3H:1V	0.03	2.0	4.46	3.46
10A	260	2.0	0	3H:1V	3H:1V	0.03	2.0	2.92	3.46
10B	260	2.0	0	3H:1V	3H:1V	0.03	2.0	2.16	3.46
10C	260	2.0	0	3H:1V	3H:1V	0.03	2.0	1.94	3.46
10D	260	2.0	0	3H:1V	3H:1V	0.03	2.0	2.34	3.46
10E	260	2.0	0	3H:1V	3H:1V	0.03	2.0	1.97	3.46
10F	260	2.0	0	3H:1V	3H:1V	0.03	2.0	1.84	3.46
10G	200	2.0	0	3H:1V	3H:1V	0.03	2.0	1.58	3.46
10H	200	2.0	0	3H:1V	3H:1V	0.03	2.0	1.52	3.46
10I	200	2.0	0	3H:1V	3H:1V	0.03	2.0	1.09	3.46
10J	830	2.0	0	3H:1V	3H:1V	0.03	2.0	5.16	3.46
10K	720	2.0	0	3H:1V	3H:1V	0.03	2.0	4.82	3.46
10L	600	2.0	0	3H:1V	3H:1V	0.03	2.0	3.99	3.46
10M	483	2.0	0	3H:1V	3H:1V	0.03	2.0	2.95	3.46
10N	369	2.0	0	3H:1V	3H:1V	0.03	2.0	2.36	3.46
10O	265	2.0	0	3H:1V	3H:1V	0.03	2.0	1.74	3.46
10P	166	2.0	0	3H:1V	3H:1V	0.03	2.0	0.88	3.46
11A	400	2.0	0	3H:1V	3H:1V	0.03	2.0	4.60	3.46
11B	400	2.0	0	3H:1V	3H:1V	0.03	2.0	3.31	3.46
11C	400	2.0	0	3H:1V	3H:1V	0.03	2.0	2.92	3.46
11D	400	2.0	0	3H:1V	3H:1V	0.03	2.0	2.92	3.46
11E	400	2.0	0	3H:1V	3H:1V	0.03	2.0	2.92	3.46
11F	400	2.0	0	3H:1V	3H:1V	0.03	2.0	2.92	3.46
11G	400	2.0	0	3H:1V	3H:1V	0.03	2.0	2.92	3.46
11H	400	2.0	0	3H:1V	3H:1V	0.03	2.0	2.92	3.46
11I	400	2.0	0	3H:1V	3H:1V	0.03	2.0	2.92	3.46
11J	120	2.0	0	3H:1V	3H:1V	0.03	2.0	1.08	3.46
11K	172	2.0	0	3H:1V	3H:1V	0.03	2.0	1.50	3.46
11L	230	2.0	0	3H:1V	3H:1V	0.03	2.0	1.92	3.46
11M	282	2.0	0	3H:1V	3H:1V	0.03	2.0	2.29	3.46
11N	337	2.0	0	3H:1V	3H:1V	0.03	2.0	2.72	3.46
11O	393	2.0	0	3H:1V	3H:1V	0.03	2.0	3.03	3.46
11P	447	2.0	0	3H:1V	3H:1V	0.03	2.0	3.35	3.46
11Q	500	2.0	0	3H:1V	3H:1V	0.03	2.0	3.88	3.46
11R	400	2.0	0	3H:1V	3H:1V	0.03	2.0	5.43	3.46
12A	466	2.0	0	3H:1V	3H:1V	0.03	2.0	5.67	3.46
12B	359	2.0	0	3H:1V	3H:1V	0.03	2.0	2.51	3.46
12C	406	2.0	0	3H:1V	3H:1V	0.03	2.0	2.74	3.46
12D	456	2.0	0	3H:1V	3H:1V	0.03	2.0	3.15	3.46
12E	507	2.0	0	3H:1V	3H:1V	0.03	2.0	3.55	3.46
12F	560	2.0	0	3H:1V	3H:1V	0.03	2.0	3.93	3.46
12G	612	2.0	0	3H:1V	3H:1V	0.03	2.0	4.36	3.46
12H	665	2.0	0	3H:1V	3H:1V	0.03	2.0	4.33	3.46
12I	767	2.0	0	3H:1V	3H:1V	0.03	2.0	6.01	3.46
12J	400	2.0	0	3H:1V	3H:1V	0.03	2.0	2.79	3.46
12K	400	2.0	0	3H:1V	3H:1V	0.03	2.0	2.90	3.46

TABLE 2.4A. FINAL COVER DRAINAGE CHANNELS									
Channel ID	Length (ft)	Avg. Slope (%)	Bottom Width (ft)	Sideslope A	Sideslope B	Manning's n	Total Depth (ft)	25-yr, 24-hr Storm Event	
								Peak Discharge (cfs)	Max Velocity (ft/s)
12L	400	2.0	0	3H:1V	3H:1V	0.03	2.0	2.90	3.46
12M	400	2.0	0	3H:1V	3H:1V	0.03	2.0	2.86	3.46
12N	400	2.0	0	3H:1V	3H:1V	0.03	2.0	2.94	3.45
12O	400	2.0	0	3H:1V	3H:1V	0.03	2.0	2.90	3.45
12P	400	2.0	0	3H:1V	3H:1V	0.03	2.0	2.90	3.45
12Q	400	2.0	0	3H:1V	3H:1V	0.03	2.0	2.92	3.45
12R	400	2.0	0	3H:1V	3H:1V	0.03	2.0	6.02	3.46
13A	400	2.0	0	3H:1V	3H:1V	0.03	2.0	3.09	3.46
13B	400	2.0	0	3H:1V	3H:1V	0.03	2.0	2.91	3.46
13C	400	2.0	0	3H:1V	3H:1V	0.03	2.0	2.90	3.45
13D	400	2.0	0	3H:1V	3H:1V	0.03	2.0	2.90	3.45
13E	400	2.0	0	3H:1V	3H:1V	0.03	2.0	2.90	3.45
13F	400	2.0	0	3H:1V	3H:1V	0.03	2.0	2.90	3.45
13G	400	2.0	0	3H:1V	3H:1V	0.03	2.0	2.82	3.45
13H	400	2.0	0	3H:1V	3H:1V	0.03	2.0	2.90	3.45
13I	400	2.0	0	3H:1V	3H:1V	0.03	2.0	2.78	3.45
13J	848	2.0	0	3H:1V	3H:1V	0.03	2.0	5.49	3.46
13K	662	2.0	0	3H:1V	3H:1V	0.03	2.0	4.66	3.46
13L	562	2.0	0	3H:1V	3H:1V	0.03	2.0	4.25	3.46
13M	454	2.0	0	3H:1V	3H:1V	0.03	2.0	3.64	3.46
13N	360	2.0	0	3H:1V	3H:1V	0.03	2.0	2.92	3.46
13O	258	2.0	0	3H:1V	3H:1V	0.03	2.0	2.29	3.46
13P	177	2.0	0	3H:1V	3H:1V	0.03	2.0	1.40	3.46
13Q	140	2.0	0	3H:1V	3H:1V	0.03	2.0	0.90	3.46
14A	169	2.0	0	3H:1V	3H:1V	0.03	2.0	1.37	0.47
14B	169	2.0	0	3H:1V	3H:1V	0.03	2.0	1.51	3.46
14C	247	2.0	0	3H:1V	3H:1V	0.03	2.0	2.35	3.46
14D	345	2.0	0	3H:1V	3H:1V	0.03	2.0	2.90	3.46
14E	440	2.0	0	3H:1V	3H:1V	0.03	2.0	3.79	3.46
14F	538	2.0	0	3H:1V	3H:1V	0.03	2.0	4.26	3.46
14G	633	2.0	0	3H:1V	3H:1V	0.03	2.0	5.92	3.46
14H	400	2.0	0	3H:1V	3H:1V	0.03	2.0	2.90	3.46
14I	400	2.0	0	3H:1V	3H:1V	0.03	2.0	2.90	3.45
14J	400	2.0	0	3H:1V	3H:1V	0.03	2.0	2.90	3.45
14K	400	2.0	0	3H:1V	3H:1V	0.03	2.0	2.90	3.45
14L	400	2.0	0	3H:1V	3H:1V	0.03	2.0	2.90	3.45
14M	400	2.0	0	3H:1V	3H:1V	0.03	2.0	2.90	3.45
14N	400	2.0	0	3H:1V	3H:1V	0.03	2.0	2.90	3.45
14O	400	2.0	0	3H:1V	3H:1V	0.03	2.0	2.90	3.46
14P	400	2.0	0	3H:1V	3H:1V	0.03	2.0	3.12	3.46

TABLE 2.4B. PERIMETER DRAINAGE CHANNELS									
Channel ID	Length (ft)	Avg. Slope (%)	Bottom Width (ft)	Sideslope A	Sideslope B	Manning's n	Total Depth (ft)	25-yr, 24-hr Storm	
								Peak Discharge (cfs)	Max Velocity (ft/s)
P-1	200	1.5	5	3H:1V	3H:1V	0.03	4.0	44.91	11.50
P-3	800	0.5	5	3H:1V	3H:1V	0.03	4.0	66.32	8.84
P-4	800	0.5	5	3H:1V	3H:1V	0.03	4.0	110.06	10.24
P-5	800	0.5	5	3H:1V	3H:1V	0.03	4.0	148.58	11.13
P-6	1445	0.5	5	3H:1V	3H:1V	0.03	4.0	175.33	11.66
P-7	565	0.5	5	3H:1V	3H:1V	0.03	4.0	184.49	11.82
P-12	812	0.6	5	3H:1V	3H:1V	0.03	4.0	100.44	10.74
P-13	800	0.5	5	3H:1V	3H:1V	0.03	4.0	47.59	8.01
P-14	600	0.5	5	3H:1V	3H:1V	0.03	4.0	45.93	7.93
P-14A	100	3.0	5	3H:1V	3H:1V	0.03	4.0	45.87	18.35

2.5 REFERENCES

1. HydroCAD Software Solutions LLC, HydroCAD Owner's Manual, Version 10, 2011, Computer Software Program.

Section 3

Downlet Design

3 DOWNLET DESIGN

3.1 INTRODUCTION

This calculation demonstrates that the proposed downlets accommodate the peak flow from the twenty-five year/twenty-four hour storm event.

3.2 DESIGN

Downlets have been designed as 24" diameter corrugated polyethylene pipes with smooth interiors. In some cases smaller diameter pipes will support flow from upper terrace sections, but in general 24" pipes will accommodate the facility. Downlets will intercept surface water from the final cover drainage channels and discharge to perimeter channels and culverts.

3.3 CALCULATION

Downlet sizing calculations utilized Manning's equation to solve for discharge capacity of each downlet. The discharge capacity calculation worksheet is attached to the end of this section. The discharge capacity was then compared to the peak discharge during 25-year, 24-hour storm event. A typical manning's number of 0.010 was used for the smooth interior surface of the downlets. Each downlet's peak discharge for the 25-year, 24-hour storm event was modeled using HydroCAD, and comprised of the sum of all contributing final cover drainage channel hydrographs. HydroCAD results can be found in Attachment 1.

3.4 CONCLUSION

The following summary table, Table 3.4A, indicates that the downlets are capable of transmitting the peak discharge during the 25-year, 24-hour storm event without the contributing drainage channel being overtopped.

TABLE 3.4A. DOWNLET SUMMARY TABLE

Downlet ID	Avg. Slope (%)	Diameter (ft)	Pipe Type	25-yr 24-hr Storm Event	
				Peak Discharge (cfs)	Discharge Capacity (cfs)
DL-1	25.0	2.0	Corrugated Polyethylene w/ Smooth Interior	37.20	147.1
DL-2	25.0	2.0	Corrugated Polyethylene w/ Smooth Interior	40.14	147.1
DL-3	25.0	2.0	Corrugated Polyethylene w/ Smooth Interior	44.67	147.1
DL-4	25.0	2.0	Corrugated Polyethylene w/ Smooth Interior	44.13	147.1
DL-5	25.0	2.0	Corrugated Polyethylene w/ Smooth Interior	47.76	147.1
DL-6	25.0	2.0	Corrugated Polyethylene w/ Smooth Interior	39.83	147.1
DL-7	25.0	2.0	Corrugated Polyethylene w/ Smooth Interior	22.52	147.1
DL-8	25.0	2.0	Corrugated Polyethylene w/ Smooth Interior	41.86	147.1
DL-9	25.0	2.0	Corrugated Polyethylene w/ Smooth Interior	40.89	147.1
DL-10	25.0	2.0	Corrugated Polyethylene w/ Smooth Interior	31.22	147.1
DL-11	25.0	2.0	Corrugated Polyethylene w/ Smooth Interior	43.90	147.1
DL-12	25.0	2.0	Corrugated Polyethylene w/ Smooth Interior	48.87	147.1
DL-13	25.0	2.0	Corrugated Polyethylene w/ Smooth Interior	40.80	147.1
DL-14	25.0	2.0	Corrugated Polyethylene w/ Smooth Interior	37.98	147.1

3.5 REFERENCES

1. HydroCAD Software Solutions LLC, HydroCAD Owner's Manual, Version 10, 2011, Computer Software Program.

Section 4

Drop Inlet & Culvert Design

4 DROP INLET & CULVERT DESIGN

4.1 INTRODUCTION

This calculation demonstrates that the drop inlet structures and culverts, as designed, are capable of transmitting the peak flow during the 25-year 24-hour storm event.

4.2 DESIGN

Several drop inlets are proposed to convey surface water from the perimeter drainage channels to the sediment ponds. Each drop inlet is designed as a reinforced concrete pipe (RCP) open-top manholes with a RCP discharge culvert connected to the lower end of the manhole. Each manhole includes a trash rack installed at the top opening to keep larger debris out and also to act as a safety precaution.

4.3 CALCULATION

The proposed drop inlet structures and culverts were modeled in HydroCAD for the 25-year 24-hour storm event. Flood elevations at the inlets of each structure were set to the low point of the adjacent road or perimeter berm. The peak elevation during the 25-year 24-hour storm at the inlet of each structure was checked to make sure the specified flood elevation was not breached. HydroCAD results are included in Attachment 1.

4.4 CONCLUSION

Drop inlets structures and culverts have been designed to convey the peak flow during the 25-year 24–hour storm event without the inlet flood elevation being breached. The following table summarizes the design and results of HydroCAD modeling.

TABLE 4.4A. DROP INLET MANHOLE SUMMARY

Drop Inlet Manhole ID	Diameter, D (ft)	Manhole Orifice El. (ft msl)	Flood El. (ft msl)	Peak El. 25-yr 24-hr (ft msl)	Freeboard 25-yr 24-hr (ft)
DI-2	24.0	675.05	680.00	679.07	0.93
DI-7A	36.0	649.00	653.00	652.07	0.93
DI-8	36.0	647.20	651.20	650.11	1.09
DI-9	36.0	649.00	653.00	650.73	2.27
DI-10	36.0	680.00	684.00	681.2	2.80
DI-11	36.0	670.00	675.00	674.27	0.73

4.5 REFERENCES

1. HydroCAD Software Solutions LLC, HydroCAD Owner's Manual, Version 10, 2011, Computer Software Program.

2. Federal Highway Administration (FHWA), Hydraulic Design of Highway Culverts, September 1985.

Section 5

Sedimentation Basin Design

5 SEDIMENTATION BASIN DESIGN

5.1 INTRODUCTION

An existing basin (Basin 1) is located on the west side of the landfill area which discharges west through an existing outlet into a drainage swale or ditch. No significant changes are being made to the drainage area, discharge, or design of this basin.

An existing basin (Basin 3) is located northeast of the current landfill area which discharges east through an existing outlet into a drainage swale or ditch surrounded by trees and brush. Discharge from the basin ultimately flows to the Mosquito Creek at the northeast corner of the property.

Drainage calculations were previously prepared for the facility's storm water management features which included a determination of the expected peak discharge for a 25 yr, 24-hr rainfall event for Basin 3. Results of the HydroCAD model indicate a peak discharge from this basin is not expected to exceed the previously estimated 153 cfs.

An upland basin (Basin 4) will be constructed on the landfill property. The basin will be approximately 4.1 acres in area and located north of the lateral expansion area to manage storm water from the expansion which is east of the existing landfill. The final grades of the expanded landfill will utilize a series of storm water control drainage channels and downlets and perimeter ditches, as well as the existing and proposed storm water basins.

No new outfall will be constructed from Basin 4. Storm water will be conveyed from the new Basin 4 to the existing Basin 3 through an open ditch with culverts extending beneath the perimeter haul road.

5.2 NOTES

1. Generation and routing of hydrographs were performed in HydroCAD Version 10 software. HydroCAD results are included in Attachments 1.
2. Routing for the 25-year 24-hour storm event has been performed with the initial pool elevation at the invert of the spillway.

5.3 BASIN DESIGN & MODELING RESULTS

As indicated above, the peak discharge for a 25 yr, 24-hr rainfall event for existing Basin 3 was previously estimated to be 153 cfs. HydroCAD software was utilized to route the anticipated storm water from the proposed landfill expansion through perimeter ditches and both Basins 3 and 4 to the existing outfall location to demonstrate that the peak discharge from a 25 yr, 24-hr rainfall event will be at or about the previously estimated peak discharge.

The basin outlet was modeled using HydroCAD software resulting in a peak discharge at or below previously estimated flows, therefore, existing Basin 3 and the current discharge pipe is adequately sized and no additional discharge location is needed. Output data from HydroCAD modeling of the basin and discharge flow is attached.

Sediment will be removed as needed from the storm water basins. In addition to vegetation control, check dams will be located along the east ditch leading into Basin 4 and in the open ditch connecting Basins 3 and 4 to provide additional sediment control.

5.4 Conclusion

Through the use of storm water management and sediment control measures storm water from the proposed expansion will discharge at the same location and at the same estimated peak flow as the current facility. Discharge flow will continue by way of the existing stream/ditch and travel through the low lying area through which additional improvement to the water quality is expected prior to reaching the Mosquito Creek.

5.5 REFERENCES

1. HydroCAD Software Solutions LLC, HydroCAD Owner's Manual, Version 10, 2011, Computer Software Program.

Section 6

Rainfall & Soil Data

6 RAINFALL & SOIL DATA

6.1 RAINFALL DATA

Rainfall depths for the 24-hour storm events were based on SCS Type II rainfall distribution data for Ottawa County, Michigan using NOAA Atlas-14 data. This resulted in a 25-Year 24 hour storm event of 4.25 inches.

6.2 RUNOFF CURVE NUMBER

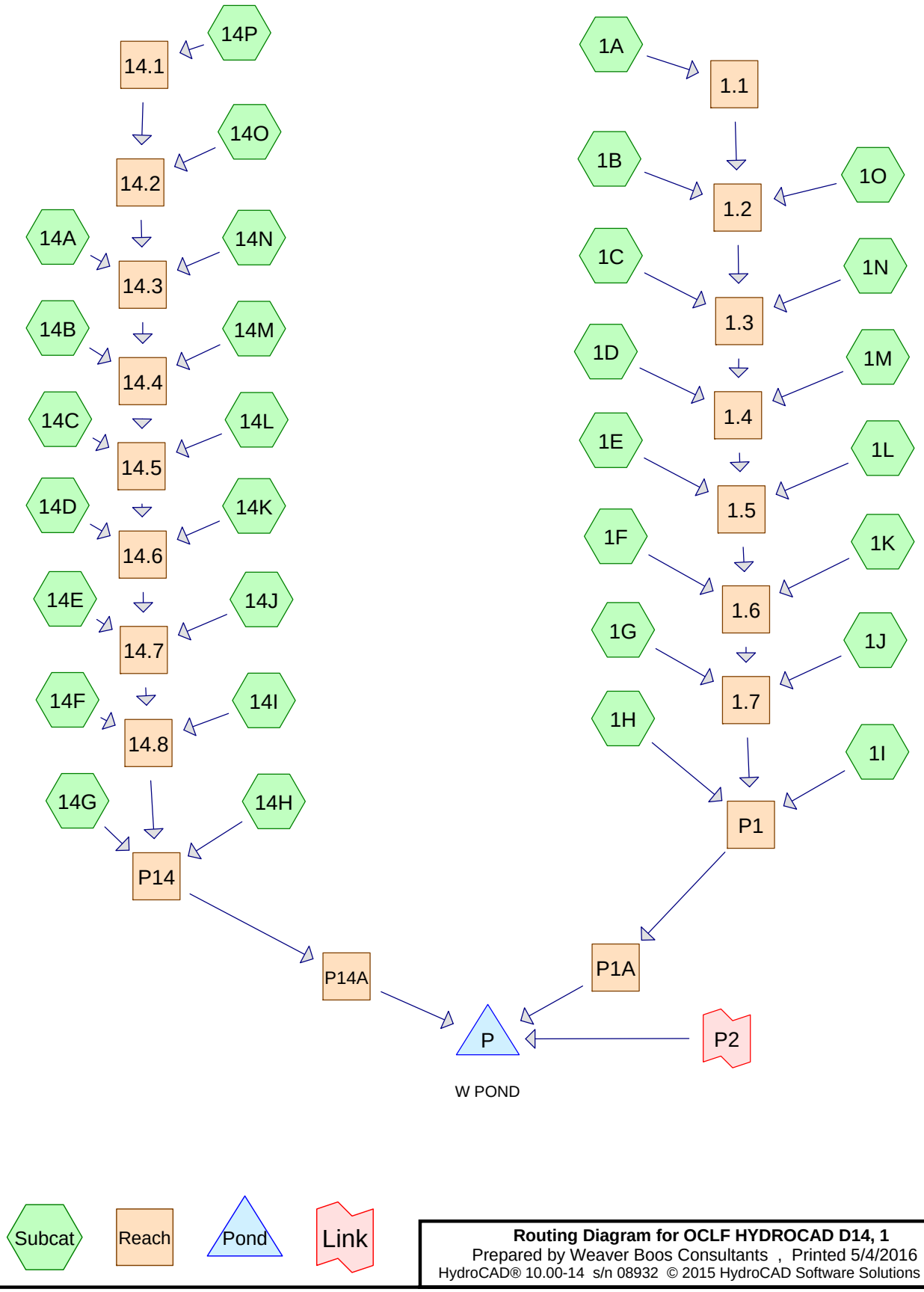
The attached Table 2-2a (Natural Resources Conservation Service, 1986) was used to determine the runoff curve number used in all surface water calculations. A Hydrologic Soil Group of C was selected. Cover type was selected to be grass cover in fair condition. The resulting curve number was 74.

6.3 REFERENCES

1. Natural Resources Conservation Service. Urban Hydrology for Small Watersheds TR-55. June 1986

Attachment 1

25-Yr 24-Hr HydroCAD



Routing Diagram for OCLF HYDROCAD D14, 1
Prepared by Weaver Boos Consultants , Printed 5/4/2016
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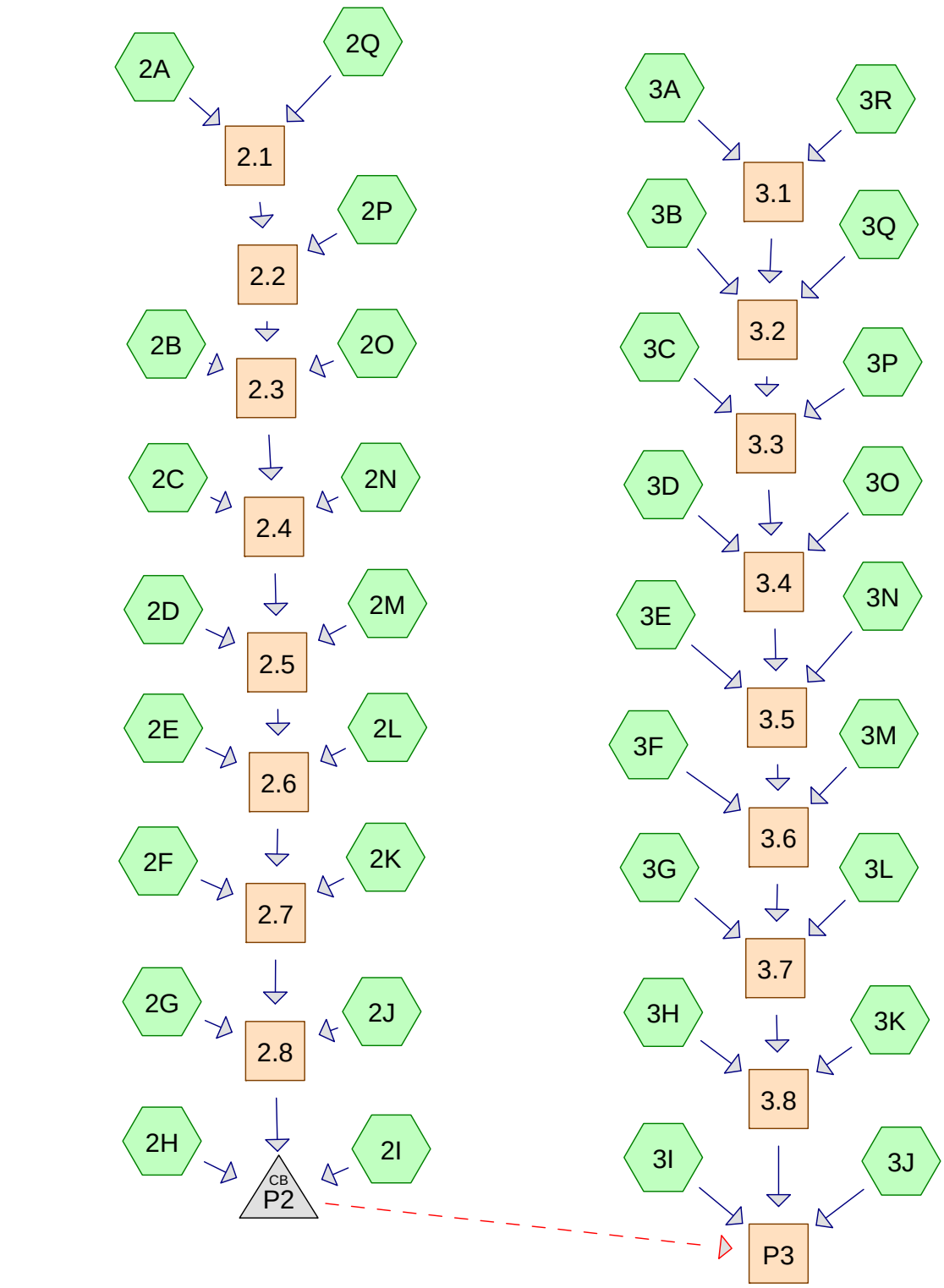
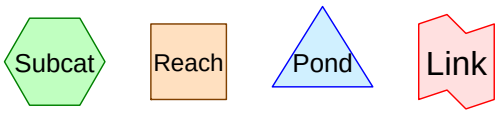
Pipe Listing (all nodes)

Line#	Node Number	In-Invert (feet)	Out-Invert (feet)	Length (feet)	Slope (ft/ft)	n	Diam/Width (inches)	Height (inches)	Inside-Fill (inches)
1	1.1	857.00	832.00	100.0	0.2500	0.010	12.0	0.0	0.0
2	1.2	832.00	807.00	100.0	0.2500	0.010	12.0	0.0	0.0
3	1.3	807.00	782.00	100.0	0.2500	0.010	12.0	0.0	0.0
4	1.4	782.00	757.00	100.0	0.2500	0.010	12.0	0.0	0.0
5	1.5	757.00	732.00	100.0	0.2500	0.010	18.0	0.0	0.0
6	1.6	732.00	707.00	100.0	0.2500	0.010	18.0	0.0	0.0
7	1.7	707.00	682.00	100.0	0.2500	0.010	18.0	0.0	0.0
8	14.1	882.00	857.00	100.0	0.2500	0.010	12.0	0.0	0.0
9	14.2	857.00	832.00	100.0	0.2500	0.010	12.0	0.0	0.0
10	14.3	832.00	807.00	100.0	0.2500	0.010	12.0	0.0	0.0
11	14.4	807.00	782.00	100.0	0.2500	0.010	12.0	0.0	0.0
12	14.5	782.00	757.00	100.0	0.2500	0.010	18.0	0.0	0.0
13	14.6	757.00	732.00	100.0	0.2500	0.010	18.0	0.0	0.0
14	14.7	732.00	707.00	100.0	0.2500	0.010	18.0	0.0	0.0
15	14.8	707.00	682.00	100.0	0.2500	0.010	18.0	0.0	0.0
16	P14A	679.00	676.00	100.0	0.0300	0.010	24.0	0.0	0.0
17	P1A	679.00	676.00	100.0	0.0300	0.010	24.0	0.0	0.0
18	P	665.00	664.00	50.0	0.0200	0.010	24.0	0.0	0.0





Routing Diagram for OCLF HYDROCAD D2-3
Prepared by Weaver Boos Consultants , Printed 5/9/2016
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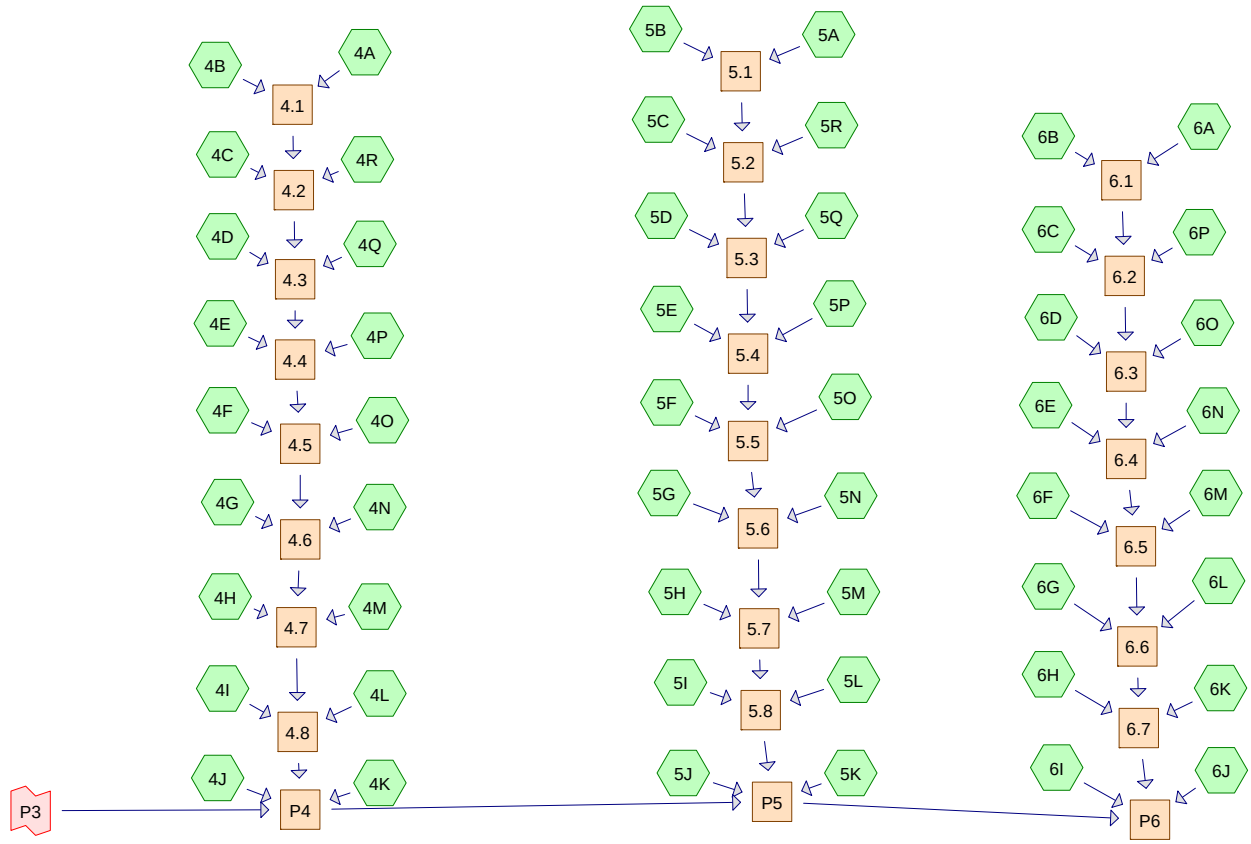
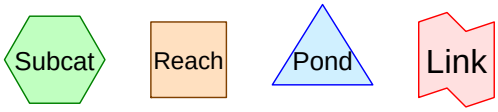
Pipe Listing (all nodes)

Line#	Node Number	In-Invert (feet)	Out-Invert (feet)	Length (feet)	Slope (ft/ft)	n	Diam/Width (inches)	Height (inches)	Inside-Fill (inches)
1	2.1	882.00	857.00	100.0	0.2500	0.010	12.0	0.0	0.0
2	2.2	857.00	832.00	100.0	0.2500	0.010	12.0	0.0	0.0
3	2.3	832.00	807.00	100.0	0.2500	0.010	12.0	0.0	0.0
4	2.4	807.00	782.00	100.0	0.2500	0.010	12.0	0.0	0.0
5	2.5	782.00	757.00	100.0	0.2500	0.010	18.0	0.0	0.0
6	2.6	757.00	732.00	100.0	0.2500	0.010	18.0	0.0	0.0
7	2.7	732.00	707.00	100.0	0.2500	0.010	18.0	0.0	0.0
8	2.8	707.00	682.00	100.0	0.2500	0.010	18.0	0.0	0.0
9	3.1	880.00	855.00	100.0	0.2500	0.010	12.0	0.0	0.0
10	3.2	855.00	830.00	100.0	0.2500	0.010	12.0	0.0	0.0
11	3.3	830.00	805.00	100.0	0.2500	0.010	12.0	0.0	0.0
12	3.4	805.00	780.00	100.0	0.2500	0.010	18.0	0.0	0.0
13	3.5	780.00	755.00	100.0	0.2500	0.010	18.0	0.0	0.0
14	3.6	755.00	730.00	100.0	0.2500	0.010	18.0	0.0	0.0
15	3.7	730.00	705.00	100.0	0.2500	0.010	18.0	0.0	0.0
16	3.8	705.00	680.00	100.0	0.2500	0.010	18.0	0.0	0.0
17	P2	674.05	667.05	800.0	0.0088	0.010	24.0	0.0	0.0





Routing Diagram for OCLF HYDROCAD D4-6
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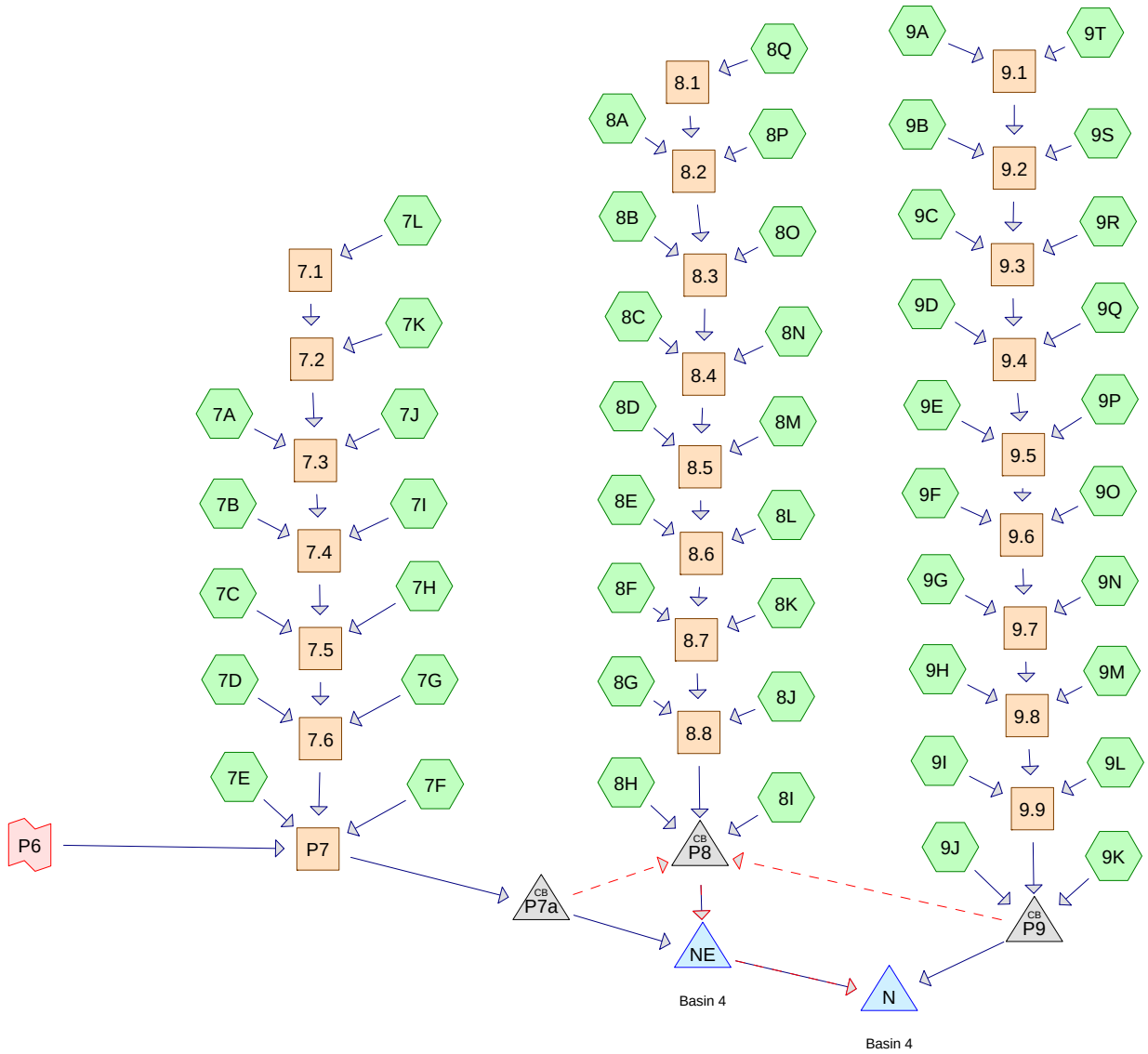
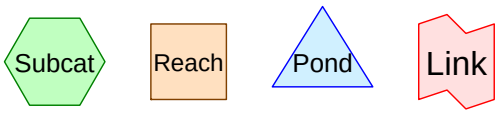
Pipe Listing (all nodes)

Line#	Node Number	In-Invert (feet)	Out-Invert (feet)	Length (feet)	Slope (ft/ft)	n	Diam/Width (inches)	Height (inches)	Inside-Fill (inches)
1	6A	0.00	0.00	140.0	0.2500	0.010	12.0	0.0	0.0
2	4.1	874.00	849.00	100.0	0.2500	0.010	12.0	0.0	0.0
3	4.2	849.00	824.00	100.0	0.2500	0.010	12.0	0.0	0.0
4	4.3	824.00	799.00	100.0	0.2500	0.010	12.0	0.0	0.0
5	4.4	799.00	774.00	100.0	0.2500	0.010	18.0	0.0	0.0
6	4.5	774.00	749.00	100.0	0.2500	0.010	18.0	0.0	0.0
7	4.6	749.00	724.00	100.0	0.2500	0.010	18.0	0.0	0.0
8	4.7	724.00	699.00	100.0	0.2500	0.010	18.0	0.0	0.0
9	4.8	699.00	674.00	100.0	0.2500	0.010	18.0	0.0	0.0
10	5.1	866.00	841.00	100.0	0.2500	0.010	12.0	0.0	0.0
11	5.2	841.00	816.00	100.0	0.2500	0.010	12.0	0.0	0.0
12	5.3	816.00	791.00	100.0	0.2500	0.010	18.0	0.0	0.0
13	5.4	791.00	766.00	100.0	0.2500	0.010	18.0	0.0	0.0
14	5.5	766.00	741.00	100.0	0.2500	0.010	18.0	0.0	0.0
15	5.6	741.00	716.00	100.0	0.2500	0.010	18.0	0.0	0.0
16	5.7	716.00	691.00	100.0	0.2500	0.010	18.0	0.0	0.0
17	5.8	691.00	666.00	100.0	0.2500	0.010	18.0	0.0	0.0
18	6.1	841.00	816.00	100.0	0.2500	0.010	12.0	0.0	0.0
19	6.2	816.00	791.00	100.0	0.2500	0.010	12.0	0.0	0.0
20	6.3	791.00	766.00	100.0	0.2500	0.010	12.0	0.0	0.0
21	6.4	766.00	741.00	100.0	0.2500	0.010	18.0	0.0	0.0
22	6.5	741.00	716.00	100.0	0.2500	0.010	18.0	0.0	0.0
23	6.6	716.00	691.00	100.0	0.2500	0.010	18.0	0.0	0.0
24	6.7	691.00	666.00	100.0	0.2500	0.010	18.0	0.0	0.0





Routing Diagram for OCLF HYDROCAD D7-9
Prepared by Weaver Boos Consultants , Printed 5/9/2016
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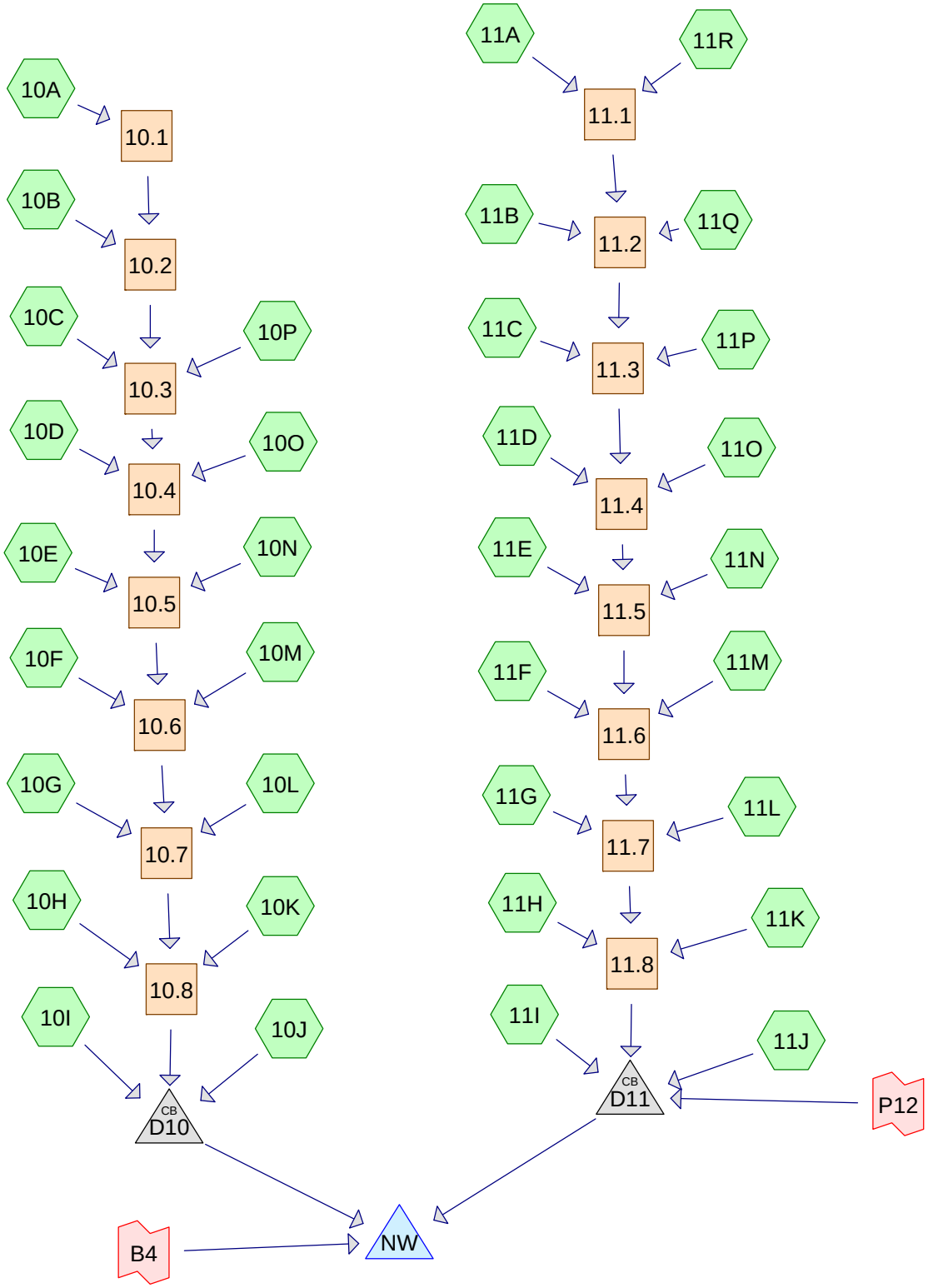
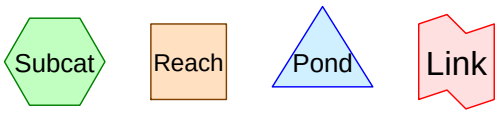
Pipe Listing (all nodes)

Line#	Node Number	In-Invert (feet)	Out-Invert (feet)	Length (feet)	Slope (ft/ft)	n	Diam/Width (inches)	Height (inches)	Inside-Fill (inches)
1	7.1	812.00	787.00	100.0	0.2500	0.010	12.0	0.0	0.0
2	7.2	787.00	762.00	100.0	0.2500	0.010	12.0	0.0	0.0
3	7.3	762.00	737.00	100.0	0.2500	0.010	12.0	0.0	0.0
4	7.4	737.00	712.00	100.0	0.2500	0.010	12.0	0.0	0.0
5	7.5	712.00	687.00	100.0	0.2500	0.010	12.0	0.0	0.0
6	7.6	687.00	662.00	100.0	0.2500	0.010	18.0	0.0	0.0
7	8.1	850.00	825.00	100.0	0.2500	0.010	12.0	0.0	0.0
8	8.2	825.00	806.00	76.0	0.2500	0.010	12.0	0.0	0.0
9	8.3	806.00	781.00	100.0	0.2500	0.010	12.0	0.0	0.0
10	8.4	781.00	756.00	100.0	0.2500	0.010	12.0	0.0	0.0
11	8.5	756.00	731.00	100.0	0.2500	0.010	18.0	0.0	0.0
12	8.6	731.00	706.00	100.0	0.2500	0.010	18.0	0.0	0.0
13	8.7	706.00	681.00	100.0	0.2500	0.010	18.0	0.0	0.0
14	8.8	681.00	656.00	100.0	0.2500	0.010	18.0	0.0	0.0
15	9.1	870.00	847.50	90.0	0.2500	0.010	12.0	0.0	0.0
16	9.2	847.50	822.50	100.0	0.2500	0.010	12.0	0.0	0.0
17	9.3	822.50	797.50	100.0	0.2500	0.010	12.0	0.0	0.0
18	9.4	797.50	772.50	100.0	0.2500	0.010	18.0	0.0	0.0
19	9.5	772.50	747.50	100.0	0.2500	0.010	18.0	0.0	0.0
20	9.6	747.50	722.50	100.0	0.2500	0.010	18.0	0.0	0.0
21	9.7	722.50	697.50	100.0	0.2500	0.010	18.0	0.0	0.0
22	9.8	697.50	672.50	100.0	0.2500	0.010	18.0	0.0	0.0
23	9.9	672.50	647.50	100.0	0.2500	0.010	18.0	0.0	0.0
24	N	642.50	642.00	60.0	0.0083	0.010	36.0	0.0	0.0
25	P7a	647.00	646.50	60.0	0.0083	0.010	36.0	0.0	0.0
26	P7a	650.00	651.00	215.0	-0.0047	0.010	150.0	48.0	0.0
27	P8	647.20	646.50	70.0	0.0100	0.010	36.0	0.0	0.0
28	P9	649.00	648.00	100.0	0.0100	0.010	36.0	0.0	0.0
29	P9	649.20	650.20	485.0	-0.0021	0.010	60.0	48.0	0.0



Basin 3



Routing Diagram for OCLF HYDROCAD D10-11
Prepared by Weaver Boos Consultants , Printed 5/9/2016
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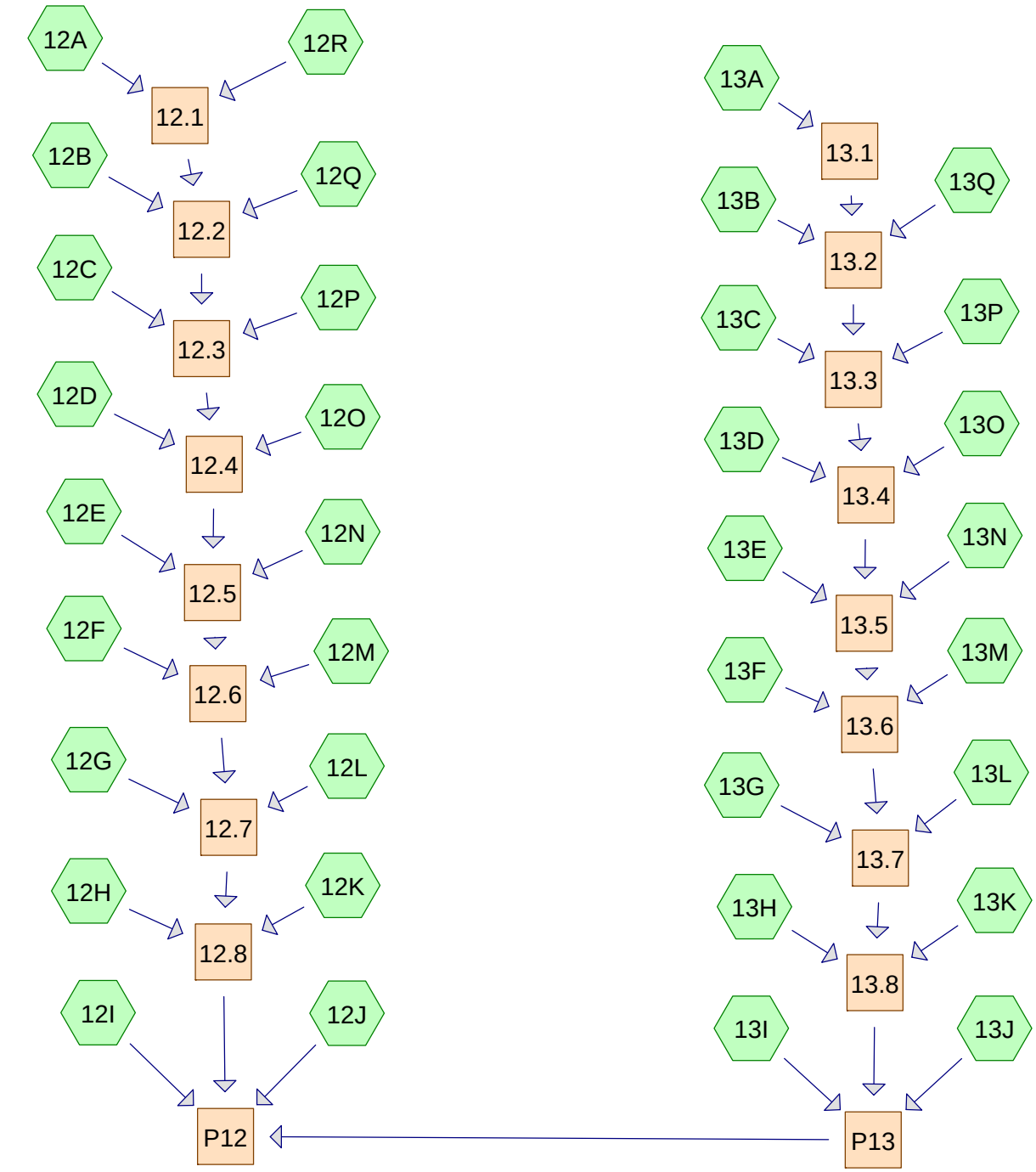
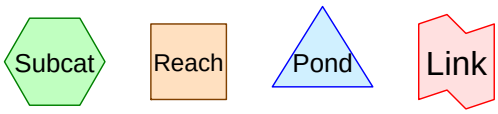
Pipe Listing (all nodes)

Line#	Node Number	In-Invert (feet)	Out-Invert (feet)	Length (feet)	Slope (ft/ft)	n	Diam/Width (inches)	Height (inches)	Inside-Fill (inches)
1	10.1	880.00	857.50	90.0	0.2500	0.010	12.0	0.0	0.0
2	10.2	857.50	837.50	80.0	0.2500	0.010	12.0	0.0	0.0
3	10.3	837.50	812.50	100.0	0.2500	0.010	12.0	0.0	0.0
4	10.4	812.50	790.00	90.0	0.2500	0.010	12.0	0.0	0.0
5	10.5	790.00	765.00	100.0	0.2500	0.010	12.0	0.0	0.0
6	10.6	765.00	740.00	100.0	0.2500	0.010	18.0	0.0	0.0
7	10.7	740.00	715.00	100.0	0.2500	0.010	18.0	0.0	0.0
8	10.8	715.00	690.00	100.0	0.2500	0.010	18.0	0.0	0.0
9	11.1	880.00	855.00	100.0	0.2500	0.010	12.0	0.0	0.0
10	11.2	855.00	830.00	100.0	0.2500	0.010	12.0	0.0	0.0
11	11.3	830.00	805.00	100.0	0.2500	0.010	18.0	0.0	0.0
12	11.4	805.00	780.00	100.0	0.2500	0.010	18.0	0.0	0.0
13	11.5	780.00	755.00	100.0	0.2500	0.010	18.0	0.0	0.0
14	11.6	755.00	730.00	100.0	0.2500	0.010	18.0	0.0	0.0
15	11.7	730.00	705.00	100.0	0.2500	0.010	18.0	0.0	0.0
16	11.8	705.00	680.00	100.0	0.2500	0.010	18.0	0.0	0.0
17	D10	675.00	651.00	120.0	0.2000	0.010	36.0	0.0	0.0
18	D11	650.00	647.00	120.0	0.0250	0.010	36.0	0.0	0.0
19	NW	641.40	640.40	70.0	0.0143	0.010	36.0	0.0	0.0





Routing Diagram for OCLF HYDROCAD D12-13
Prepared by Weaver Boos Consultants , Printed 5/4/2016
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Pipe Listing (all nodes)

Line#	Node Number	In-Invert (feet)	Out-Invert (feet)	Length (feet)	Slope (ft/ft)	n	Diam/Width (inches)	Height (inches)	Inside-Fill (inches)
1	12.1	880.00	855.00	100.0	0.2500	0.010	12.0	0.0	0.0
2	12.2	855.00	662.50	100.0	1.9250	0.010	12.0	0.0	0.0
3	12.3	830.00	805.00	100.0	0.2500	0.010	12.0	0.0	0.0
4	12.4	805.00	780.00	100.0	0.2500	0.010	18.0	0.0	0.0
5	12.5	780.00	755.00	100.0	0.2500	0.010	18.0	0.0	0.0
6	12.6	755.00	730.00	100.0	0.2500	0.010	18.0	0.0	0.0
7	12.7	730.00	705.00	100.0	0.2500	0.010	18.0	0.0	0.0
8	12.8	705.00	680.00	100.0	0.2500	0.010	18.0	0.0	0.0
9	13.1	880.00	855.00	100.0	0.2500	0.010	12.0	0.0	0.0
10	13.2	855.00	662.50	100.0	1.9250	0.010	12.0	0.0	0.0
11	13.3	830.00	805.00	100.0	0.2500	0.010	12.0	0.0	0.0
12	13.4	805.00	780.00	100.0	0.2500	0.010	12.0	0.0	0.0
13	13.5	780.00	755.00	100.0	0.2500	0.010	18.0	0.0	0.0
14	13.6	755.00	730.00	100.0	0.2500	0.010	18.0	0.0	0.0
15	13.7	730.00	705.00	100.0	0.2500	0.010	18.0	0.0	0.0
16	13.8	705.00	680.00	100.0	0.2500	0.010	18.0	0.0	0.0

Attachment 2

Erosion Calculation

Weaver Consultants Group	PROJECT	Ottawa County Farms Landfill Expansion			Project Number
	SUBJECT	Surface Water Calculations			0120-685-11-03
	Designed By	Date	Checked By	Date	Sheet No.
	Katie Kinley	4/26/2016	TAP	4/27/2016	1 of 2
Objective:	Estimate erosion based on spacing of storm water berms				
References:	Waste Management Division - Final Cover Erosion Control Guidance MDEQ Guidance Colorado Floodplain and Stormwater Criteria Manual				

Step 1: Complete soil loss calculation.

Using the Universal Soil Loss Equation A=R*C*LS*K*P

		4:1 slopes	4% top
A= Computed soil loss in tons/acre-year		**1.81412**	**0.35112**
R= Rainfall Energy Factor	from Ottawa County	100	100
C= Cropping Management Factor	from Table	0.014	0.014
LS= Slope Length Factor	from Table	2.67	1.14
		3.22	
K= Soil Erodibility Factor	from Table	0.22	0.22
P= Erosion Control Practice Factor	From Practice	1	1

Given a maximum vertical spacing of 100' between berms on the 4:1 slopes, 1.81412 tons/acre-year of soil will be lost. This includes 48' of 3:1 slopes from storm water terraces and complies with the maximum allowable erosion of 2 tons/acre-year required by R299.4425.8

Given a maximum vertical spacing of 400' between berms on the 4% slopes, 0.35112 tons/acre-year of soil will be lost. This complies with the maximum allowable erosion of 2 tons/acre-year required by R299.4425.8

Typical spacing of berms on the final cover slopes is 100' vertical by 400' horizontal.
Typical spacing of berms on the final cover top deck is 400' vertical by 400' horizontal.

Scour in terraces:
MAX Permissible velocity to prevent scour: 5.5 fps
per Attachment 1

Per HydroCAD, to keep within the permissible velocity with 2% channel slopes typical, channel length averages 400'

Weaver Consultants Group	PROJECT	Ottawa County Farms Landfill Expansion			Project Number
	SUBJECT	Surface Water Calculations			0120-685-11-03
	Designed By	Date	Checked By	Date	Sheet No.
	Katie Kinley	4/26/2016	TAP	4/27/2016	2 of 2
Objective:	Estimate erosion based on spacing of storm water berms				
References:	Waste Management Division - Final Cover Erosion Control Guidance MDEQ Guidance Colorado Floodplain and Stormwater Criteria Manual				

Step 2: Complete HydroCAD Model

Size terraces to accommodate 25 year storm event.

Peak flows were obtained from the HydroCAD model output.

Roughness coefficinet, n, for vegetated channels determined by typical values presented in HydroCAD.

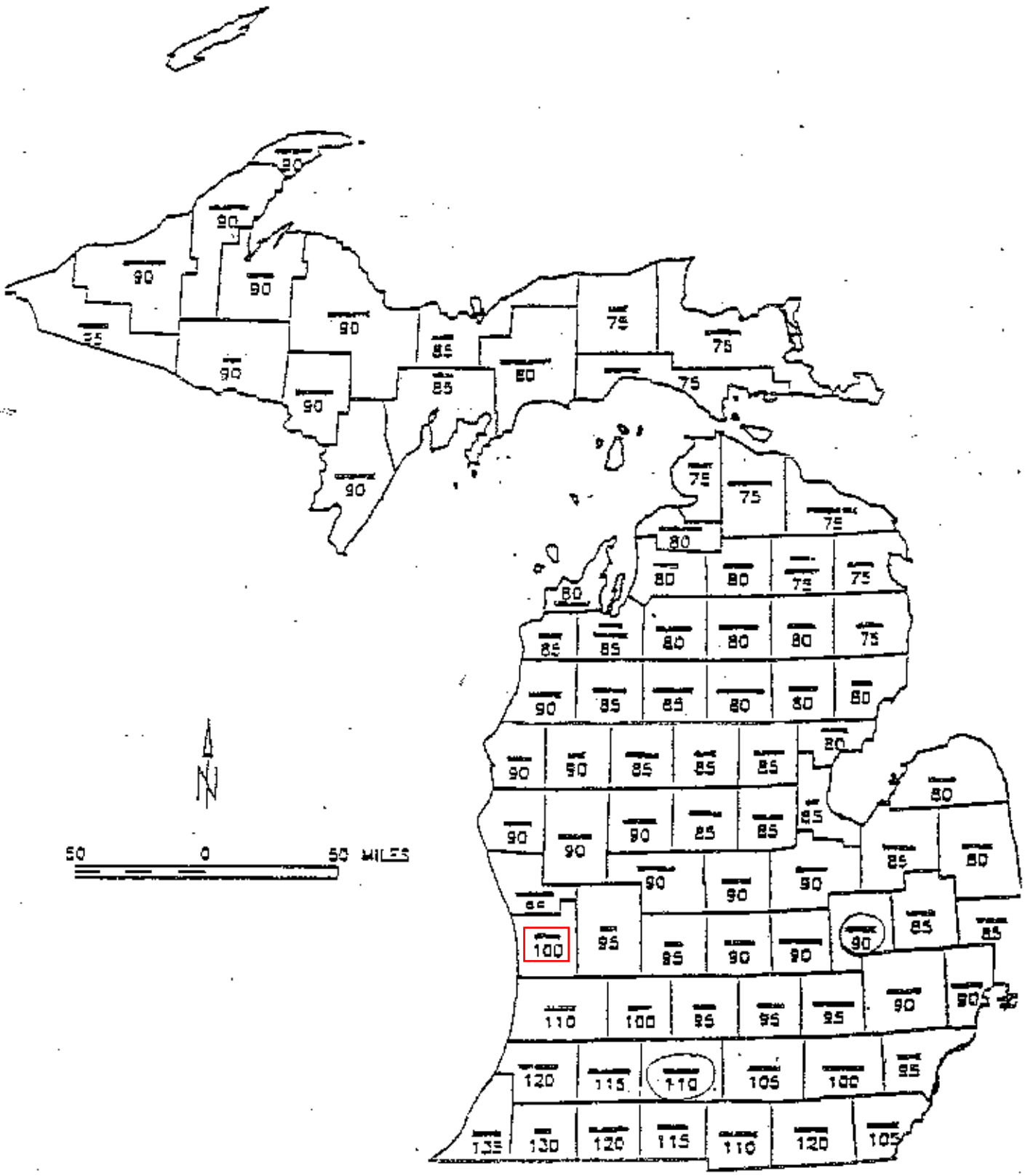
The Rainfall Energy factor (R) has been calculated for all of the Michigan counties by the NRCS. A map of these factors calculated by county has been included in attachment 1. The R factors are based on recent rainfall data.

The DEQ suggests that a sound approach to estimating the C factor would be to use a value corresponding to 80%, 90%, or 95% - 100% soil surface coverage (depending on seeding rates, mulching rates, fertilization, mowing and topsoil organic content) with an adjustment for the weed component. The corresponding C factor would range from 0.007, at a minimum, to a possible higher number based upon local conditions and vegetative care plans. The table below summarizes recommended care and preparation steps to achieve each C factor and the maximum swale separation to be used for design purposes. The care and preparation steps summarized with each C factor are efforts that the DEQ believes will achieve the corresponding ground cover estimates. There are so many different permutations of site preparation, materials utilized and vegetative care that it is not practical to enumerate all of them. Different combinations may be approved as long as the facility is able to demonstrate equivalent erosion protection and that the design assumptions made are achieved.

DEQ Design Recommendations

Ground Cover Estimate		Suggested C value	Maximum Separation
95% - 100%			
Topsoil :	organic matter ≥ 2.5%		
Seeding :	NRCS Critical Area Planting Guide		
Mulching :	NRCS Critical Area Planting Guide	0.007	60' vertical if A ≤ 2.0
Fertilization :	NRCS Critical Area Planting Guide		
Mowing :	Minimum of two annually		
90%			
Topsoil :	1.25% ≤ organic matter < 2.5%		
Seeding :	NRCS Critical Area Planting Guide		
Mulching :	NRCS Critical Area Planting Guide	0.014	60' vertical if A ≤ 2.0
Fertilization :	None Prescribed		
Mowing :	Minimum of one annually		
80% or Less			
Topsoil :	organic matter < 1.25%		
Seeding :	NRCS Critical Area Planting Guide	0.028 or higher depending on local conditions	60' vertical if A ≤ 2.0
Mulching :	NRCS Critical Area Planting Guide		
Fertilization :	None Prescribed		
Mowing :	None Prescribed		

The actual level of coverage of the vegetation will need to be measured on the final cover to ensure that the design assumptions are being met. It may be advisable to include a provision for repairing the final cover vegetation if the level of growth does not correspond with the design assumptions after a reasonable time period. If the level of coverage is not being achieved, extra care for the vegetation should be considered before the final cover is repaired. The facility should consult with an agronomist/soil scientist to pursue the most appropriate measures to remedy inadequate growth.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50 0 50 MILES

Table 4-1.
Values for steepness factor, LS, for high rate of rill or interrill erosion.[1]

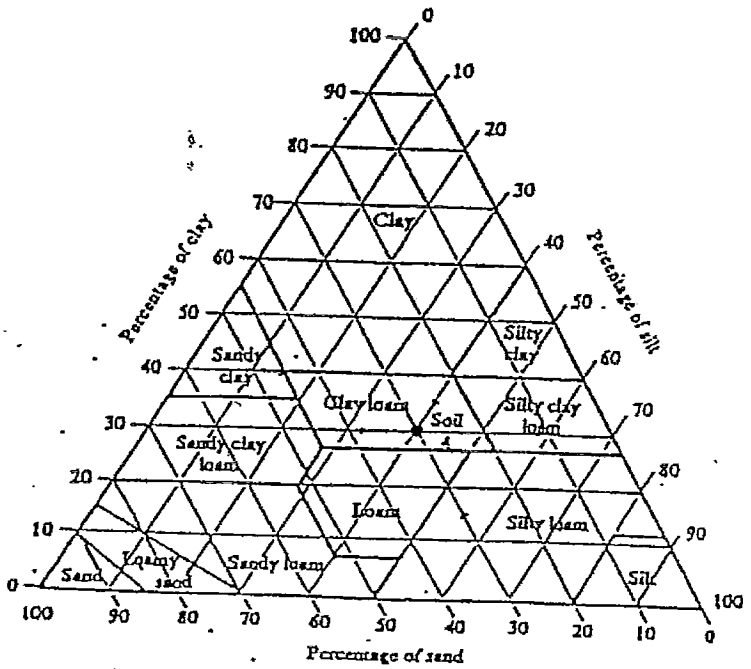
Slope (%)	Horizontal slope length (ft)																
	<3	6	9	12	15	25	50	75	100	150	200	250	300	400	600	800	1000
0.2	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.06	0.06	0.06	0.06	0.06	0.06	
0.5	0.07	0.07	0.07	0.07	0.07	0.07	0.08	0.08	0.09	0.09	0.10	0.10	0.10	0.11	0.12	0.12	
1.0	0.09	0.09	0.09	0.09	0.09	0.10	0.13	0.14	0.15	0.17	0.18	0.19	0.20	0.22	0.24	0.26	
2.0	0.13	0.13	0.13	0.13	0.13	0.16	0.21	0.25	0.28	0.33	0.37	0.40	0.43	0.48	0.56	0.63	
3.0	0.17	0.17	0.17	0.17	0.17	0.21	0.30	0.36	0.41	0.50	0.57	0.64	0.69	0.80	0.96	1.10	
4.0	0.20	0.20	0.20	0.20	0.20	0.24	0.38	0.47	0.55	0.68	0.79	0.89	0.98	1.14	1.42	1.65	
5.0	0.23	0.23	0.23	0.23	0.23	0.31	0.46	0.58	0.68	0.86	1.02	1.16	1.28	1.51	1.91	2.25	
6.0	0.26	0.26	0.26	0.26	0.26	0.36	0.54	0.69	0.82	1.05	1.25	1.43	1.60	1.90	2.43	2.89	
8.0	0.32	0.32	0.32	0.32	0.32	0.45	0.70	0.91	1.10	1.43	1.72	1.99	2.24	2.70	3.52	4.24	
10.0	0.35	0.37	0.38	0.39	0.40	0.57	0.91	1.20	1.46	1.92	2.34	2.72	3.09	3.75	4.98	6.07	
12.0	0.36	0.41	0.43	0.47	0.49	0.71	1.15	1.54	1.88	2.51	3.07	3.60	4.09	5.01	6.67	8.17	
14.0	0.38	0.45	0.51	0.55	0.58	0.85	1.40	1.87	2.31	3.09	3.81	4.48	5.11	6.30	8.45	10.40	
16.0	0.39	0.49	0.56	0.62	0.67	0.98	1.64	2.21	2.73	3.68	4.56	5.37	6.15	7.60	10.26	12.69	
20.0	0.41	0.58	0.67	0.76	0.84	1.24	2.10	2.86	3.57	4.85	6.04	7.16	8.22	10.24	13.94	17.33	
25.0	0.45	0.66	0.80	0.93	1.04	1.56	2.67	3.67	4.59	6.30	7.88	9.38	10.81	13.53	18.57	22.24	
30.0	0.48	0.72	0.91	1.08	1.24	1.86	3.22	4.44	5.58	7.70	9.67	11.55	13.33	16.77	23.14	29.07	
40.0	0.53	0.85	1.13	1.37	1.59	2.41	4.24	5.89	7.44	10.33	13.07	15.67	18.17	22.95	31.89	40.29	
50.0	0.58	0.97	1.31	1.62	1.91	2.91	5.16	7.20	9.13	12.73	16.16	19.42	22.57	28.60	39.95	50.63	
60.0	0.63	1.07	1.47	1.84	2.19	3.36	5.97	8.37	10.63	14.39	18.32	22.01	25.51	32.67	47.18	59.91	

[1]Same as for freshly prepared construction and some highly disturbed soil conditions with little or no cover (not applicable to cracking soil).

APPROXIMATE VALUES OF FACTOR K FOR USDA TEXTURAL CLASSES

Texture class	Organic matter content <0.5% K	2% K	4% K
Sand	0.05	0.03	0.02
Fine sand	.16	.14	.10
Very fine sand	.42	.36	.28
Loamy sand	.12	.10	.08
Loamy fine sand	.24	.20	.16
Loamy very fine sand	.44	.38	.30
Sandy loam	.27	.24	.19
Fine sandy loam	.35	.30	.24
Very fine sandy loam	.47	.41	.33
Loam	.38	.34	.29
Silt loam	.48	.42	.33
Silt	.60	.52	.42
Sandy clay loam	.27	.25	.21
Clay loam	.28	.25	.21
Silty clay loam	.37	.32	.26
Sandy clay	.14	.13	.12
Silty clay	.25	.23	.19
Clay		0.13–0.29	

The values shown are estimated averages of broad ranges of specific-soil values. When a texture is near the borderline of two texture classes, use the average of the two K values.



U.S. Department of Agriculture textural classification

MAXIMUM PERMISSIBLE MEAN CHANNEL VELOCITY

MATERIAL / LINING	MAXIMUM PERMISSIBLE MEAN VELOCITY (fps)
NATURAL & IMPROVED UNLINED CHANNELS	
Erosive Soils:	
Loams, Sands, Noncolloidal Silts	3.0
Less Erosive Soils:	
Clays, Shales, Cobbles, Gravel	5.0
FULLY LINED CHANNELS	
Unreinforced Vegetation	5.5
Loose Riprap	10.0
Grouted Riprap	15.0
Gibbons	15.0
Soil-Cement	15.0
Concrete	35.0

NOTES:

1. For composite lined channels, use the lowest of the maximum mean velocities for the materials used in the composite lining.
2. Deviations from the above values are only allowed with appropriate engineering analysis and/or suitable agreements for maintenance responsibilities.
3. Maximum permissible velocities based upon non-clear water conditions.