GENERAL WASTE & RECYCLING, LLC
SW-620

Closure Plan and Post-Closure Plan Supplements For Coal Combustion Residue

Prepared for:

General Waste & Recycling, LLC

Prepared by:

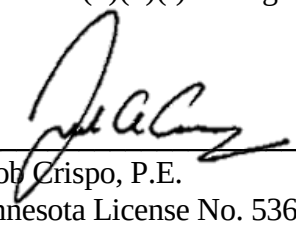
Northeast Technical Services, Inc.
526 Chestnut Street
Virginia, Minnesota 55792

(218) 741-4290

October 2016

Project Number: 6385C

"I hereby certify that this plan, specification, or report was prepared by me or under my direct supervision and that I am a duly Licensed Professional Engineer under the laws of the State of Minnesota. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate and complete. I certify that the "Closure Plan and Post-Closure Plan Supplements For Coal Combustion Residue" (October 2016) has been prepared consistent with recognized and generally accepted good engineering practices, and combined with excerpted Closure Plan and Post Closure Plan sections of the "Closure, Post-Closure, Contingency Action and Financial Assurance Plans" (April 2013) meet the requirements of a written Closure Plan per 40 CFR §257.102 (b)(1)(i) through (vi) and a written Post-Closure Plan per 40 CFR §257.104 (d)(1)(i) through (iii)."



10/14/2016

Jacob Crispo, P.E. Date
Minnesota License No. 53648

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PLAN SHEETS

(Obtained from April 2013 permitting documents.)

APPENDICES

(Obtained from April 2013 permitting documents.)

CLOSURE PLAN CCR SUPPLEMENT

Introduction

The purpose of these "Closure Plan and Post-Closure Plan Supplements For Coal Combustion Residue" (October 2016 Supplements) for General Waste & Recycling, LLC's (General Waste) Keewatin, Minnesota (Minnesota Pollution Control Agency permit number SW-620) landfill is to provide a written closure plan that meets the requirements of 40 CFR §257 (Subpart D – Standards for the Disposal of Coal Combustion Residuals in Landfills and Surface Impoundments). Excerpted Closure Plan and Post-Closure Plan sections of the: "Closure, Post-Closure, Contingency Action and Financial Assurance Plans" (April 8, 2013) are included as part of the October 2016 Supplements to ensure that 40 CFR §257.102 closure plan requirements are met.

CCR Facility Phased Development Plan

General Waste's CCR Landfill has been designed for construction in four major phases, Phases 1, 2, 3 and 4. Phase 1 of the CCR Landfill has been constructed. The total waste/daily cover volume for the CCR Landfill has been calculated as 2,428,700 cubic yards (c.y.). Each phase is divided into sub-cells. A summary of phased volumes by cell is provided below.

Phase	Waste/Daily Cover Volume (c.y.)
Phase 1	
• Cell A	125,350
• Cell B	214,850
• Cell C	338,000
Phase 2	
• Cell D	471,600
Phase 3	
• Cell E	790,000
Phase 4	
• Cell F	144,220
• Cell G	119,800
• Cell H	224,880
Total waste/daily cover: 2,428,700 c.y.	

General Waste's CCR Landfill has been permitted as an industrial waste disposal facility (SW-620). General Waste performed a market assessment of industrial waste generation in the area of the CCR Landfill. The industrial waste market in the area is primarily made up of mining industry wastes. Based on this assessment of available industrial waste volumes in the area, the CCR Landfill's central location, and discussions with generators in the market area, General Waste has concluded that waste receipts averaging 50,000 to 65,000 cubic yards per year are not unreasonable for the first few years. This range of annual waste receipts was used to determine the Phasing Plans at the CCR Landfill. Detailed design and phasing information is provided on **Plan Sheets 6-9** included with this Closure Plan Supplement.

The projected utilization rate is anticipated to be 50,000 to 65,000 cubic yards of waste capacity per year for the first several years, though the volume may vary considerably from year to year. Based on this predicted annual volume, the total operating life of the remaining ultimate capacity in the Landfill is approximately 38-48 years assuming steady receipts averaging 50,000 to 65,000 cubic yards per year. It is anticipated that within 10 years, capacity within Phase 1, Cells A-C, will be utilized. MPCA granted General Waste a 10-year permit for the capacity of and through Phase 1 of the CCR Landfill. Information concerning the site development is summarized in the Phasing Plans provided on **Plan Sheets 8-9** included with this Closure Plan Supplement.

Landfill Cap and Final Contour Plan

General Waste's demolition debris disposal facility is located adjacent to and on the same site as their CCR Landfill. As indicated above, General Waste's CCR Landfill (SW-620) has been permitted as an industrial debris disposal facility by MPCA. Overall final contour plans have been developed for both the demolition debris disposal facility and the CCR Landfill (i.e., the industrial debris disposal facility) and are presented on **Plan Sheet 6** of the Plan Set. As illustrated on the plan sheet, both facilities are tied into the same final cover system.

The final contours provide for **20%** sideslopes and **5%** top slopes to a maximum elevation of 1590 feet NGVD on the west portion of the overall fill area and 1500 feet NGVD for east portion of the overall fill area. The final contours have been designed to maximize site capacity and promote the run-off of incident precipitation. Each facility will be closed as fill areas reach final grade. Phasing plans are illustrated on **Plan Sheets 7-9**. A 10-year development plan is provided on **Plan Sheet 8.**

The final cover system has been designed to do the following:

- Minimize water infiltration into the fill area;
- Prevent ponding on the fill area;
- Retain slope stability;
- Reduce surface water and water erosion; and
- Sustain vegetative cover.

The Hydrological Evaluation of Landfill Performance (HELP) model was used to evaluate the final covers efficiency and estimate leachate generation from the landfill during the post closure period. Results from the HELP model calculated the final cover's efficiency at 100 percent of the total incident precipitation which exceeds minimum standard in the Solid Waste Management Rules. Leachate generation is estimated to be less than 37,500 gallons a year during post closure.

Both the demolition debris and the CCR Landfill will be tied into the same cover system. The cap design for both the demolition debris and the CCR Landfill consists from bottom to top of a minimum 12-inch subgrade, 6-inch buffer soil layer, and 40-mil textured linear low density polyethylene (LLDPE), overlain by a 12-inch sand drainage layer, a 6-inch general fill layer, and 6-inches of topsoil. Surface water management is presented on **Plan Sheet 18** and closure details are presented on **Plan Sheet 25**.

POST-CLOSURE PLAN CCR SUPPLEMENT

Introduction

The purpose of the October 2016 Supplements is also to provide a written post-closure plan that meets the requirements of 40 CFR §257 (Subpart D – Standards for the Disposal of Coal Combustion Residuals in Landfills and Surface Impoundments). Excerpted Closure Plan and Post-Closure Plan sections of the: "Closure, Post-Closure, Contingency Action and Financial Assurance Plans" (April 8, 2013) are included as part of the October 2016 Supplements to ensure that 40 CFR §257.104 post-closure plan requirements are met.

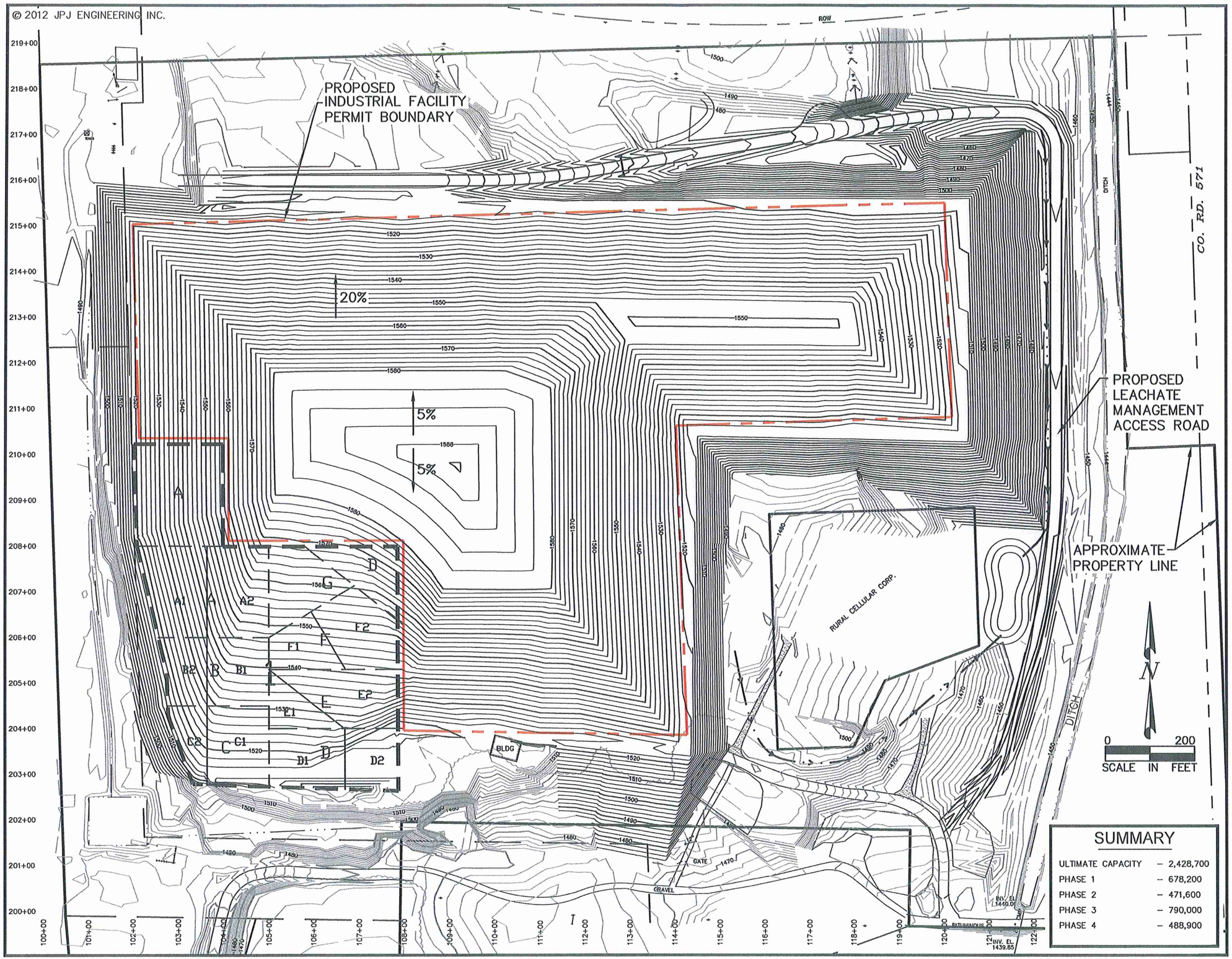
CCR Post-Closure Period

Per 40 CFR §257.104 a 30 year post-closure period is specified for General Waste's CCR Landfill in this Post Closure Plan CCR supplement. Within the "Closure, Post-Closure, Contingency Action and Financial Assurance Plans" (April 2013), a 20 year post-closure care period is specified to meet State of Minnesota requirements. This Post Closure Plan CCR Supplement serves to extend the Post Closure Period an additional 10 years for a total Post Closure Period of 30 years to meet CFR §257.104 requirements.

CCR Post-Closure Period Contact Information

Post-Closure Period contact information for the facility is as follows:

General Waste & Recycling, LLC
Facility Manager
PO Box 128
Keewatin, MN 55753
218-778-6600



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JPJ Engineering, Inc.
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GENERAL WASTE INDUSTRIAL LANDFILL
KEEWATIN, MINNESOTA

FINAL GRADE SITE PLAN

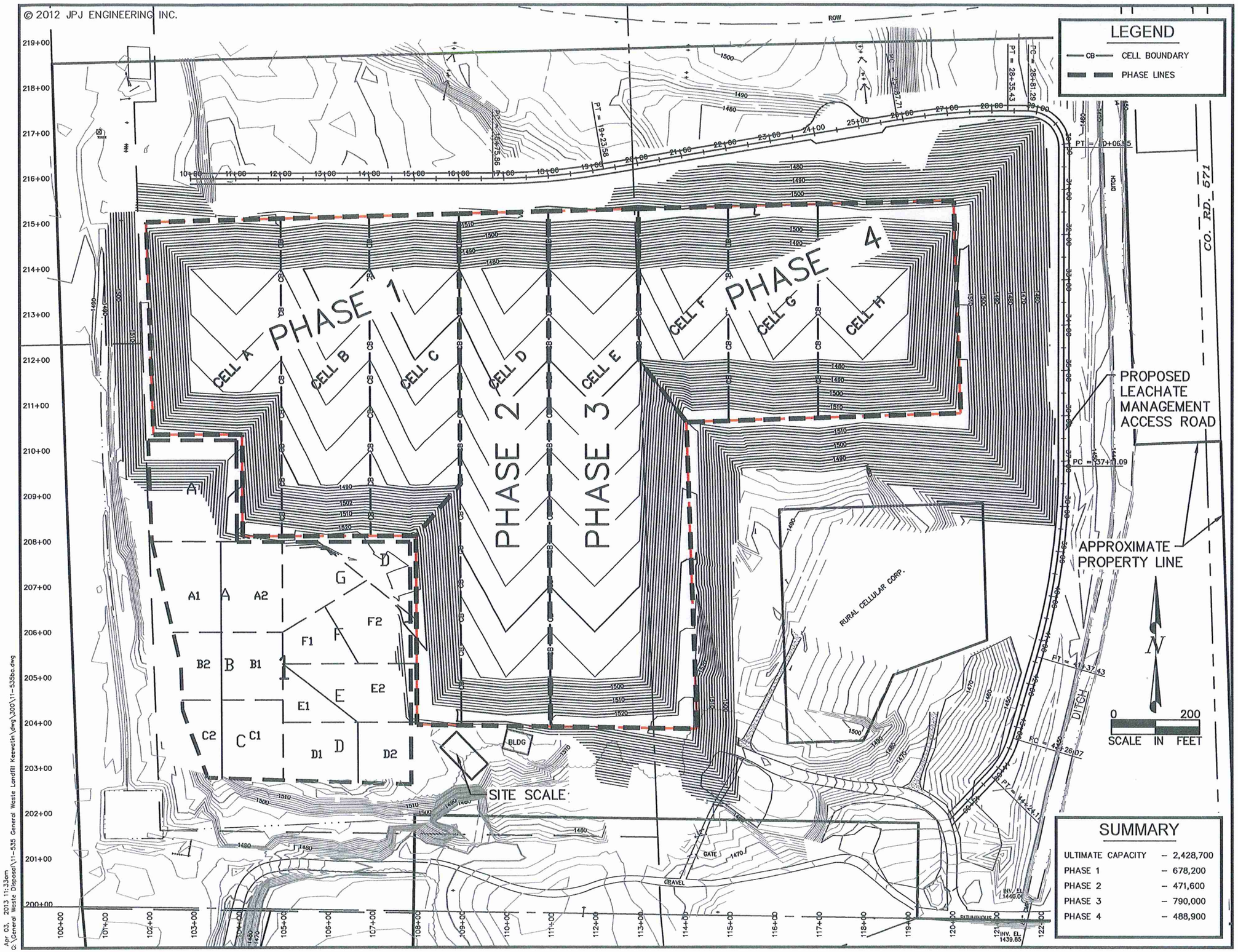
REVISION DATE:	DESCRIPTION:
3-25-13	PLAN REVISIONS

SURVEYED	ZZ
DESIGNED	JDM
DRAWN	WEH
CHECKED	

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

JOHN D. MATTONEN
DATE 04/03/13 LIC. NO. 23998

PROJECT # 6



SUMMARY

ULTIMATE CAPACITY	– 2,428,700
PHASE 1	– 678,200
PHASE 2	– 471,600
PHASE 3	– 790,000
PHASE 4	– 488,900

Apr 03, 2013 11:33am
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PHASING PLAN

REVISION DATE:	DESCRIPTION:
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DESIGNED	JDM
DRAWN	WEH
CHECKED	

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John D. Mattonen
JOHN D. MATTONEN
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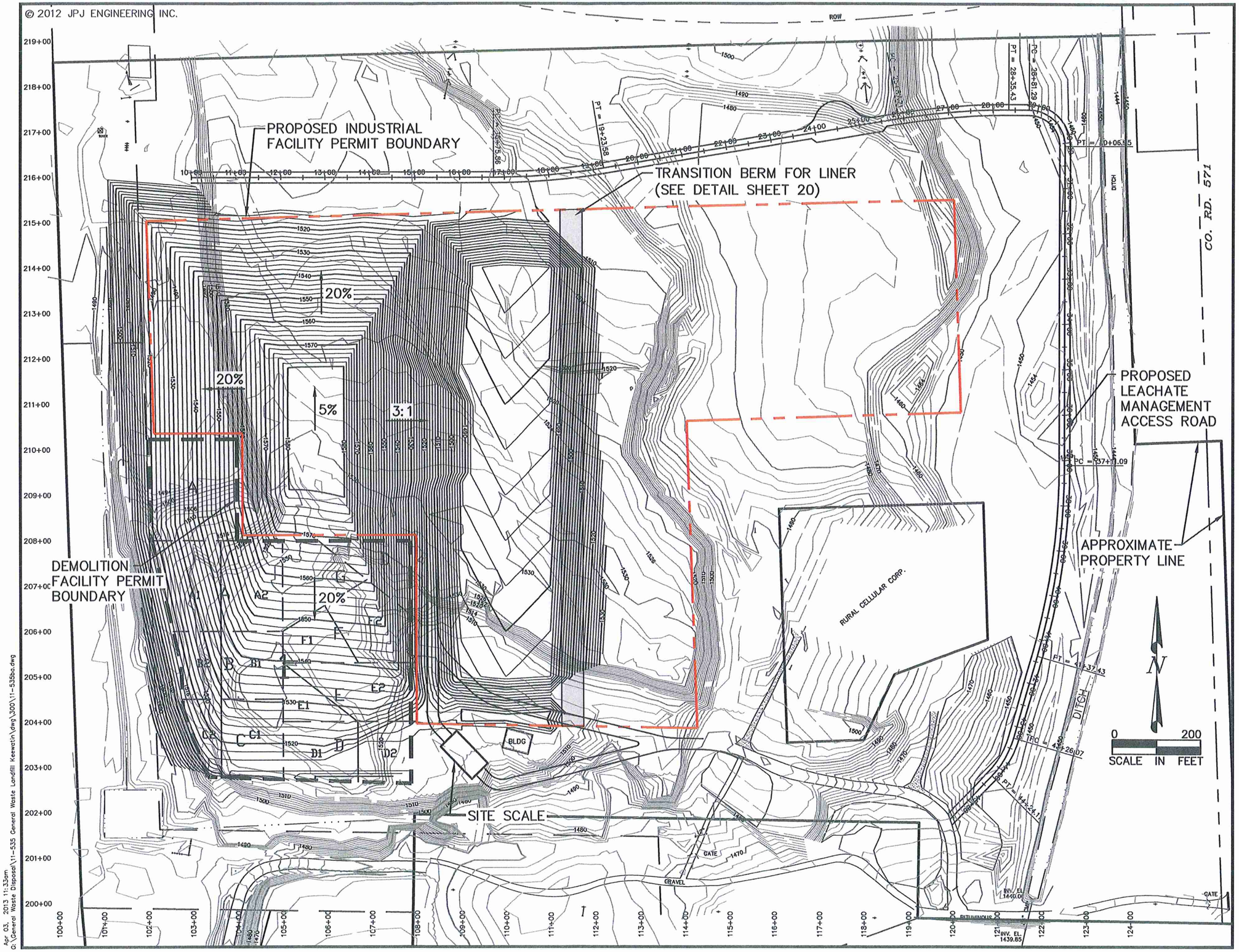
PROJECT # 7



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PHASE DEVELOPMENT PLAN PHASE 1 AND 10 YEAR PLAN

REVISION DATE:	DESCRIPTION:
3-25-13	PLAN REVISIONS

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DESIGNED	JDM
DRAWN	WEH
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JOHN D. MATTONEN
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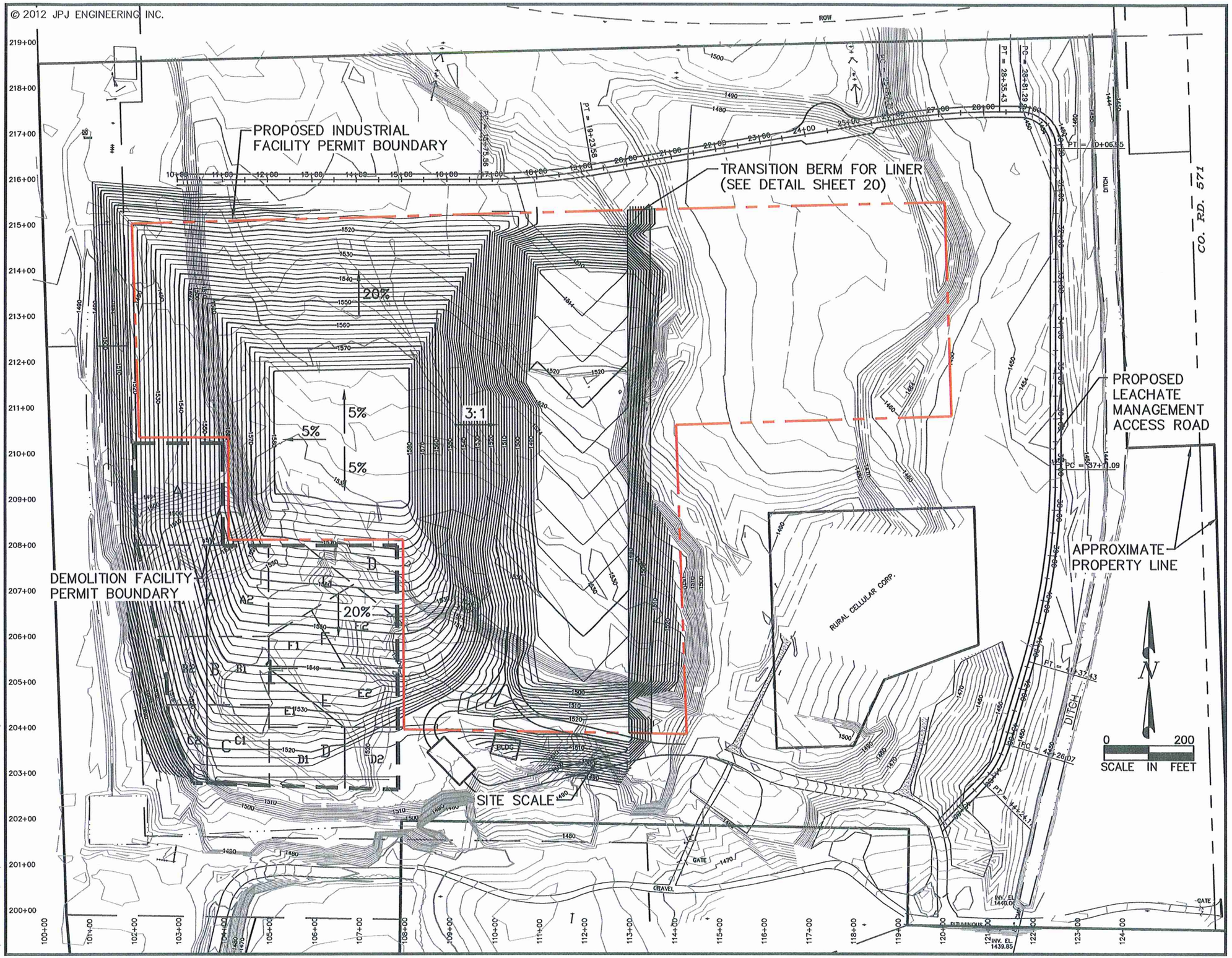
PROJECT # 8



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KEEWATIN, MINNESOTA

PHASE DEVELOPMENT PLAN PHASE 2

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DRAWN	WEH
CHECKED	

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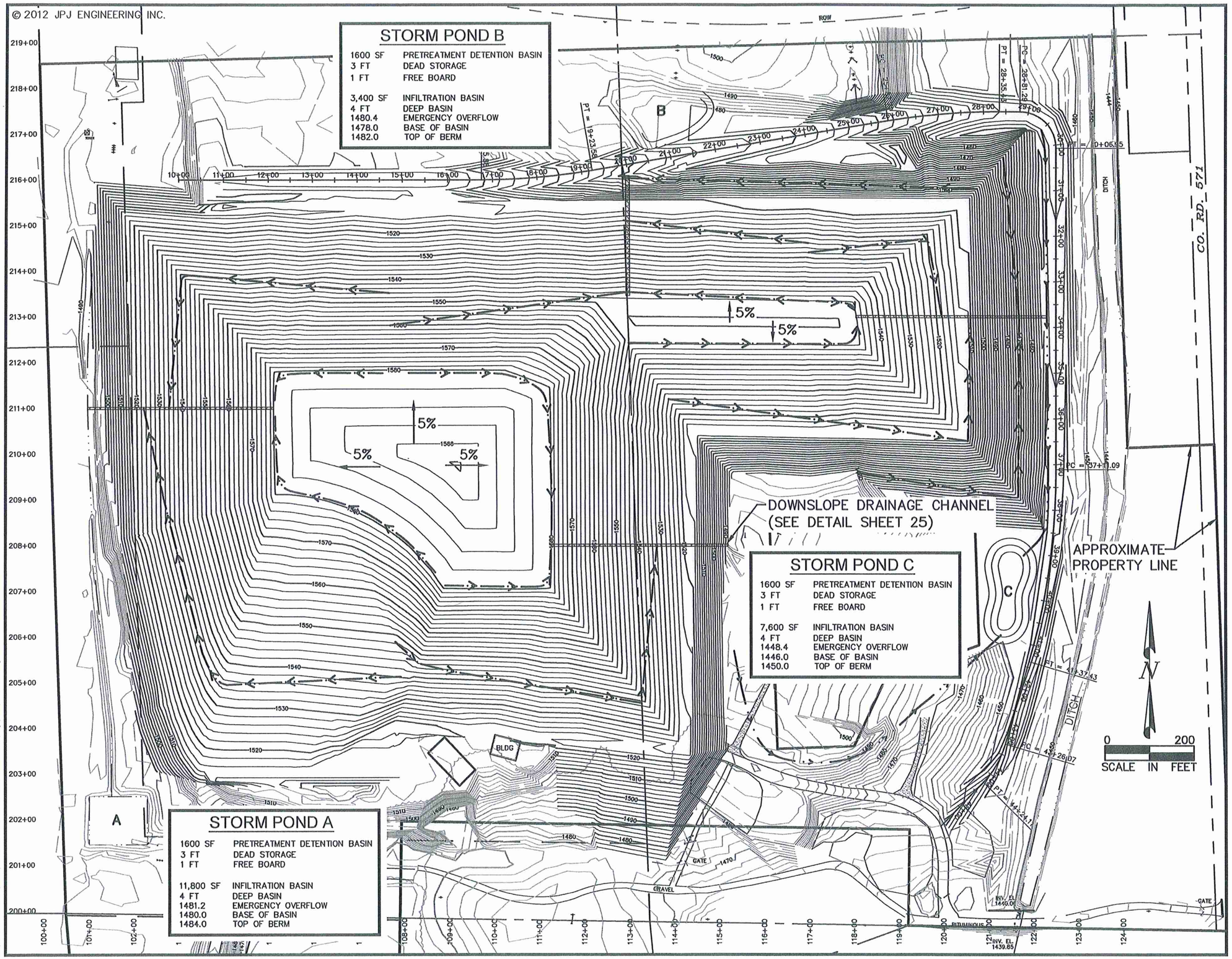
PROJECT # 9



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SURFACE WATER MANAGEMENT PLAN

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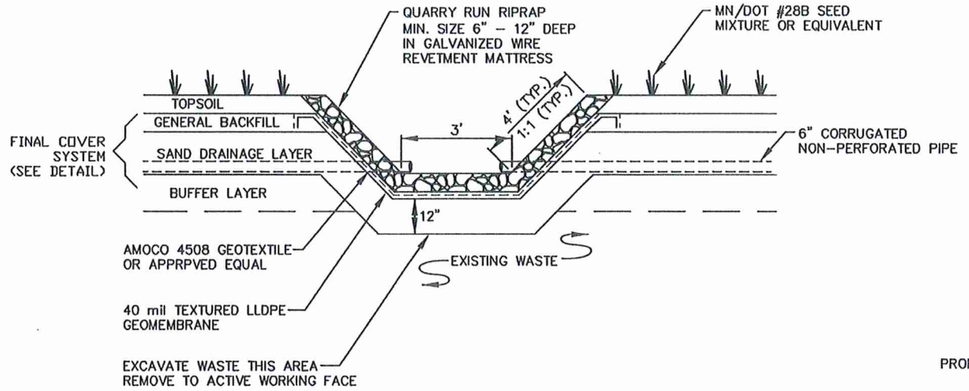
JOHN D. MATTONEN
DATE 04/03/13 LIC. NO. 23998

PROJECT # 18



DOWNSLOPE DRAINAGE CHANNEL SECTION

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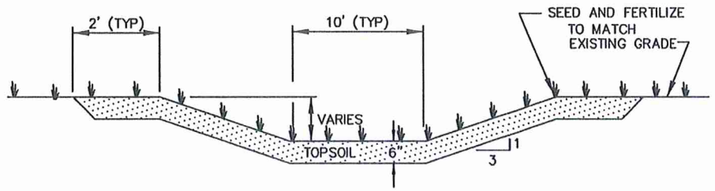

DRAINAGE DITCH DETAIL

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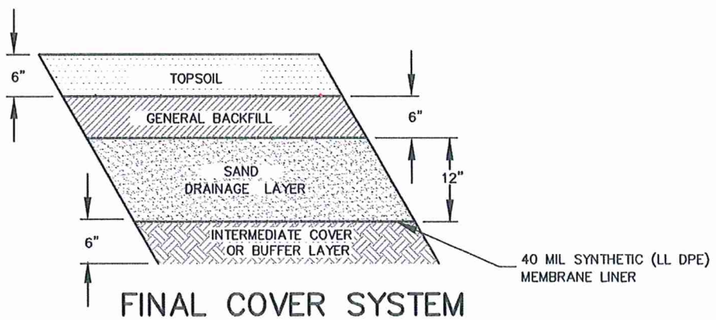

FINAL COVER SYSTEM

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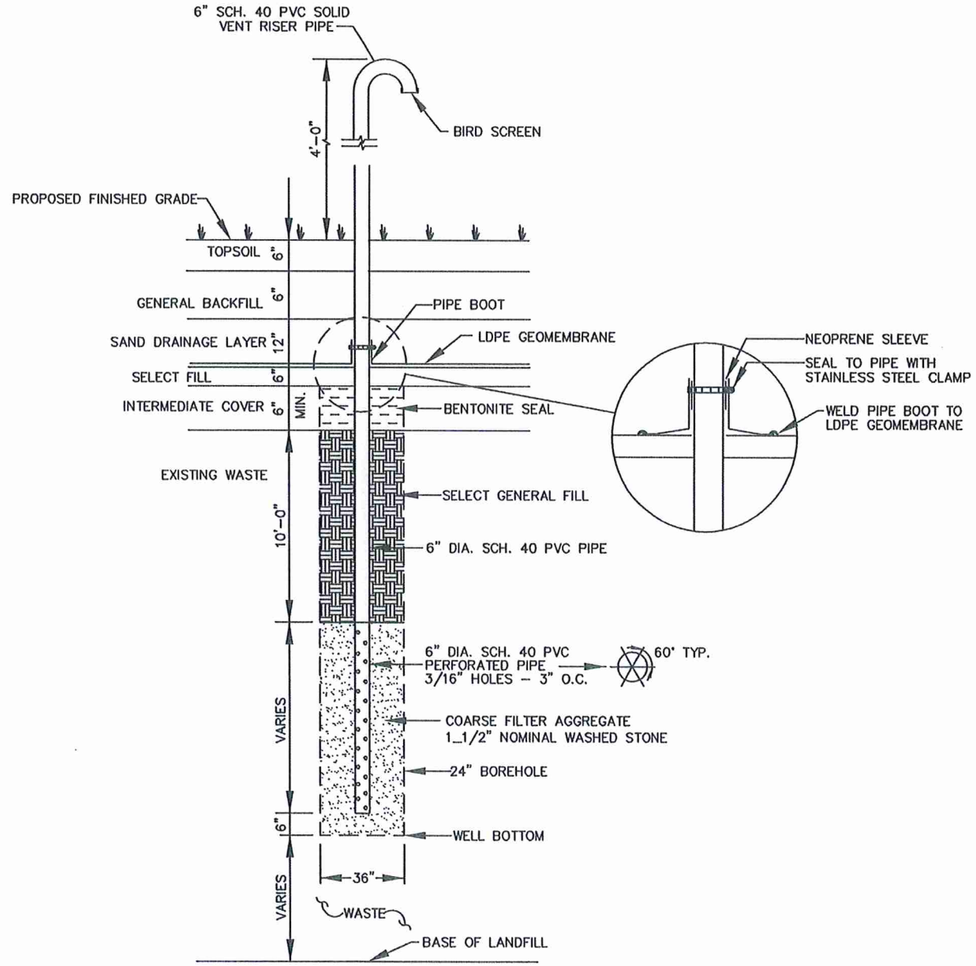

LANDFILL GAS VERTICAL COLLECTION WELL

NOT TO SCALE

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CLOSURE DETAILS

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PROJECT # 25

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APPENDICES

APPENDIX B

This appendix includes the excerpted Closure Plan and Post Closure Plan sections of the "Closure, Post-Closure, Contingency Action and Financial Assurance Plans" (April 2013).

Excerpted Closure Plan

2.0 CLOSURE PLAN

2.1 CLOSURE NOTIFICATION PROCEDURES

Notification of final facility closure will proceed in the following manner:

1. The MPCA will be notified in writing at least 90 days prior to final closure activities.

2. Regular facility customers will be given written notification of the closure date not less than 60 days prior to completion of landfilling activities. A repeat notification will be sent not less than 30 days prior to closure.

3. A Notice of Closure indicating the date of closure and the alternative solid waste management facility will be posted prominently at the Facility gate 60 days prior to closure.

4. A Notice of Closure will be published in all local newspapers on three occasions 60 and 30 days before closure and upon completion of waste acceptance. A copy of this notice will be sent to the MPCA within 10 days of publication.

After closure, no waste will be accepted for disposal at the Facility. A notice will be permanently posted at the gate stating the site is closed and providing information and directions to the designated alternative disposal sites or transfer stations.

2.2 SITE SECURITY

After closure, only those persons authorized by the Landfill will be permitted on the site to perform the closure and post-closure activities outlined in this report. Fencing or physical barriers will be maintained around the perimeter of the site, where appropriate. The entrance gate to the site will be locked to restrict unauthorized access and remain locked when authorized personnel are not on-site.

2.3 GRADING AND FINAL COVER

Grading of the final sequence shall be in accordance with the Engineering Plans prepared for the Landfill. Please refer to the *Engineering Report*, of these permitting documents for a discussion of the timing for each closure sequence. The grade of the final sequence will match that of adjacent sequences to provide a uniform grade to facilitate surface water discharge.

Final cover will be constructed in accordance with Minnesota Solid Waste Rules. The barrier layer of the final cover over the existing and future waste deposits will consist of a synthetic geomembrane not less than 40 mils in thickness. The geomembrane, general buffer, general fill and topsoil layers will be constructed and tested as described in the *CQA Plan* included as **Appendix F** of the *Engineering Report* of these permitting documents.

Final cover placement will be an on-going process as designated sequences of the Landfill reach final grade. The Engineering Plans can be referred to for phased development information. Upon termination of all landfilling activities, all grading and final cover placement will begin within 30 days or as weather permits. Documentation of final cover construction for each phase will be submitted under the seal of a registered professional engineer.

As applicable, the Landfill will reduce the amount of the financial assurance trust fund required for closure construction as each sequence is constructed and certified complete.

2.4 EROSION CONTROL AND SURFACE WATER DRAINAGE STRUCTURES

The final contour plan and corresponding slopes are designed to promote moderate sheet flow drainage of surface water to minimize erosion potential. In addition, earth berms were incorporated to control drainage by minimizing the flow distance and by directing surface water drainage into downslope drainage infrastructure. Surface water drainage calculations for the current cover system, as illustrated in the **Plan Sheets** in **Appendix H**, are included in **Appendix G**. If erosion problems on completed fill areas are prevalent, re-grading and turf establishment and/or other approved erosion control measures will be employed.

The topography of land surrounding the Landfill site is lower than the final contour elevations for the completed fill area. The perimeter access road for the Landfill also aides in reducing any potential problems of surface water run-on. Sedimentation/infiltration basins are established as outlined in the *Engineering Report* of these permitting documents. Should drainage problems arise, existing features will be upgraded or other appropriate actions taken to ensure adequate drainage.

2.5 VEGETATION

Vegetation will be established on final covered fill areas during the remaining active life of the site. This will substantially reduce the acreage that will require turf establishment during closure of the final sequence. The finished surface will be seeded, mulched, and fertilized in accordance with this plan and permit conditions. Topsoil amendment needs for turf establishment will be determined by a representative number of samples. Samples will be analyzed for soil pH, nitrogen and phosphorus levels.

As part of the final closure activities, areas previously covered and seeded will be inspected for adequacy of turf cover. Those areas lacking adequate vegetation will be reassessed and procedures taken (reseeding, fertilization, mulching, etc.) to ensure adequate establishment of turf. In the event of adverse weather conditions and upon approval of the MPCA, the requirements for completion of turf establishment may be extended.

During certain times of the year, based on weather conditions, it may be necessary to irrigate newly seeded areas. This will be accomplished sparingly on an as-needed basis.

In general, fibrous, shallow, laterally-growing roots will characterize the vegetation types that comprise the final turf material. The Minnesota Department of Transportation's specifications for seed mixture #3876 will be used.

An alternate seed mixture may be used, based on seasonal requirements. The MPCA will be advised prior to any changes in the seed mixture. The landfill operator will regularly inspect the turf cover to determine seeding, mulching, and/or fertilizing needs for maintaining adequate vegetation.

2.6 WASTE STORAGE

No waste, such as used tires, recyclables or appliances, will be in storage at the Landfill at the time of final closure. Items on-site prior to final closure will be removed from the site and no additional items accepted. Removal of any materials prior to final site closure will be financed through normal site operating funds and will not affect site closure costs.

2.7 CERTIFICATION

Upon completion of all closure activities, the MPCA will be provided with a certification by a professional engineer registered in the State of Minnesota that the Landfill has been closed in accordance with the approved plans and requirements, with all exceptions noted. The certification will be submitted no later than 60 days following completion of the stated closure activities.

The Landfill owner will submit a detailed description of the Landfill to the MPCA for approval within 30 days of closure. The description will include as-built drawings detailing the configuration, topography and locations of special features such as wells, tanks, etc. After approval, it will be submitted to the County Registrar of Deeds for recording. The plat plan will be prepared and certified by a land surveyor registered in Minnesota. The property description shall include the general type, quantity and locations of deposited solid waste, the estimated depth of waste fill and final terrain descriptions, and other pertinent characteristics of the completed Landfill.

Approval of the Landfill closure by the MPCA will be based upon a professional engineer's certification and inspection of the site by County and MPCA officials. A copy of the closure plan will be on file at the Landfill.

2.8 CLOSURE COST ESTIMATES

This section provides an engineering estimate of closure costs for the Landfill. The cost estimate is based on the physical site conditions at the time of completion of landfilling activities and the

applicable MPCA design requirements. All soil materials for closure activities are assumed to exist on Landfill property or within a ten mile radius of Landfill property. Closure costs were estimated assuming a competitive bid situation and construction by an independent contractor.

The closure cost estimate describes the necessary work items involved in completing the placement of final cover, installation of drainage control structures, establishing vegetation, various notifications and preparation of the closure certification. The estimate identifies the total costs for closure, assuming the largest area to be closed at any given time.

Closure costs have been estimated using current cost data and bid tabulations for recent earthwork construction projects in the area of the Landfill and throughout Minnesota. The Landfill closure costs were calculated at $611,400, as presented in **Table 1**. These costs are updated annually to reflect additional closure construction as well as changes in unit prices for closure construction items.

2.9 END USE

The current end-use proposal for the Landfill property is to designate the permitted Landfill area as an open area and limit access to authorized personnel only. Any future proposals would take into consideration the protection of the Landfill cap and associated facilities, including the environmental monitoring systems, as well as the safety of those utilizing the area.

Excerpted Post-Closure Plan

3.0 POST-CLOSURE PLAN

3.1 INSPECTIONS AND MAINTENANCE

Routine inspection of the site will occur at least four times a year (spring, summer, fall and winter). The inspections will include observations of cover integrity (e.g., erosion of the final cover or problems with vegetation quality); evaluation of settlement and surface water drainage; inspection of the leachate collection system; inspection of the landfill gas system; and inspection of monitoring systems and site security features. The current inspection checklist is contained in **Appendix D** of the *Engineering Report.* The inspection schedule will be modified when inspections indicate the need to include or exclude items. The revised version of the inspection checklist will be completed at the time of the subsequent inspections to document the findings. After the first five years of the post-closure period, the Landfill may propose an alternative inspection schedule to the MPCA Commissioner.

If a site inspection reveals any problems with leachate collection systems, landfill gas system, monitoring systems, security systems, or the final cover, appropriate corrective measures will be taken as outlined in the Contingency Action Plan. In addition, routine maintenance, such as mowing to prevent tree growth and maintaining drainage way flow capacity will be performed as needed.

Any features found to need repair or maintenance during the inspections will be promptly and properly repaired and maintained. This includes, but is not limited to, security fencing, monitoring wells, gas system, leachate collection systems, and surface water control structures.

Other inspection, monitoring, and maintenance practices are defined in the following sections below for specific facility features.

The Landfill will allow authorized employees or agents of the MPCA access to the Landfill site at any reasonable time for the purpose of conducting inspections and generally obtaining information pertaining to the environmental effect of the disposal facility.

3.1.1 Settlement

The amount of settlement depends on initial compaction, characteristics of waste and degree of decomposition. The majority of the ultimate settlement occurs within the first five years after initial placement. Under the current phased development plan, most settlement will occur during the period of active Landfill operations. Repair of the cap in any closed areas which settle will be accomplished within 30 days of the noted settlement, or as soon as practical. Therefore, settlement should not affect the basic engineering design for surface water drainage features.

If routine post-closure inspection of the site reveals potential surface water drainage problems due to differential settlement, corrective measures will be promptly taken. Additional cover materials will be used to restore and maintain a uniform grade and vegetation will also be restored. The additional cover materials and vegetation will be put in place using appropriate methods.

3.1.2 Final Cover and Vegetation

If routine inspection reveals problems with cover material, corrective measures will be taken to remedy the problem and prevent future occurrences. Cover material will be placed, graded and compacted to the appropriate specifications. The areas will be reassessed and amendments made according to procedures identified in the closure section of this report in order to provide for the establishment of adequate turf. If routine inspection reveals areas of cover vegetation which are poorly established or otherwise stressed, reseeding and/or growth and development measures will be instituted to establish an adequate turf.

3.1.3 Vector Control

During the closure and post-closure periods, an extermination service will be retained if vector control is deemed necessary. During the closure period, routine inspection and service by a pest control operator will be provided as needed.

3.1.4 Groundwater Monitoring

The groundwater monitoring system for the Landfill will be routinely inspected at the time of each sampling event. If inspection reveals that any groundwater monitoring wells are non-functional due to physical damage or changes in the aquifer system, action will be taken to correct the situation. The groundwater monitoring well protection system (i.e., protective casing and guard posts) will also be inspected for damage. If inspection reveals damage, components of well protection systems will be repaired or replaced.

All sampling and testing of groundwater monitoring wells during the closure and post-closure periods will be conducted in accordance with the procedures and requirements established by the MPCA. The results of the water quality testing will be submitted to the MPCA in accordance with appropriate reporting procedures.

3.1.5 Landfill Gas System

The proposed landfill gas management system includes both consists of passive gas wells. At this time no monitoring of the gas system is proposed, and inspections will be conducted as part of the quarterly inspection.

The potential for explosive hazards developing on-site or off-site as a result of migrating LFG is considered small, based on the nature of waste, site geology and the remote site location. As part of the post-closure plan, any LFG monitoring of on-site structures would be conducted at the time the environmental monitoring system sampling is conducted during the post-closure period. On-site structures, including the equipment/maintenance building and office, are well ventilated and do not have crawl spaces or basements. As these structures may be unoccupied for long periods during the post-closure care period, they will be included in the enclosed space air survey to determine if explosive conditions exist prior to entry.

3.1.6 Leachate Management System

The *Leachate Management Plan*, contained in **Appendix C** of the *Engineering Report*, describes the operation and maintenance of the system. The *Leachate Management Plan* will remain in effect throughout the post-closure care period, though it may be modified following closure of the facility. General inspections of the operator's panel for the leachate pumps will indicate when a high leachate level occurs for each of the base liner sump areas. A high leachate level could mean there has been a pump failure, or the leachate holding tank has reached design capacity. The HELP model shows that after final closure, leachate generation quickly declines. Using the HELP model, a volume of 37,500 gallons has been approximated for use in calculating the volume of leachate to be collected for treatment. This number will likely be greater during the first several years following closure, and then decline to a much reduced volume at the end of the post-closure period.

During post-closure, replacement pumps will be available within 48-hours in the event that one of the leachate pumps fails. If the leachate storage system is full, hauling procedures could be implemented and/or increased as appropriate, according to the *Leachate Management Plan* and the applicable permits.

The leachate collection system pipes will continue to be cleaned on an annual basis for the first five years of the post-closure period. After the first five years of the post-closure period, the Landfill may propose an alternative inspection and cleaning schedule to the MPCA Commissioner.

3.2 POST-CLOSURE COSTS

The post-closure cost estimate describes the tasks and assigns costs associated with the long-term maintenance of the Landfill. The costs are calculated on an annual basis and are presented in **Table 2**. The current (2013) annual post-closure costs are approximated as $24,565. Post-closure care can be described as administrative tasks, groundwater monitoring, leachate treatment, inspections, care of final cover, and general site maintenance.

For financial assurance purposes, it is necessary to determine the value of post-closure costs for the 20-year period at the time of Landfill closure. An inflation rate of 1.72 percent was provided by the MPCA for use in determining post-closure financial assurance for the 2012 Annual

Reporting year. The value of total post-closure care costs at the time of Landfill closure can be calculated using "time-value of money" equations provided by the MPCA. These calculations are presented in **Table 4**, modified from the MPCA's Annual Report Payment Rate Estimating Table. **Table 4** shows a 20-year current value post-closure care cost estimate of $590,360.

3.3 AMENDMENT OF POST-CLOSURE PLAN

A modified Post-Closure Plan will be prepared and submitted to the MPCA for any change or event that affects the Post-Closure Plan. Modifications will be identified in the facilities Annual Operating Report. This applies to, but is not limited to, any change in the monitoring system or procedures. The Post-Closure Plan will be amended whenever the permit is renewed.

APPENDIX F

GENERAL WASTE DISPOSAL AND RECOVERY SERVICES, INC.
SW-620

APPLICATION FOR MAJOR PERMIT MODIFICATION

CQA Manual

Prepared for:

General Waste Disposal and Recovery Services, Inc.

Prepared by:

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April 8, 2013

Project Number: 59118.00

"I certify under penalty of law that this document and all attachments were prepared under my direct supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate and complete."

Eric Hesse, P.E.
Minnesota Registration No. 22743

April 8, 2013
Date

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1.0 INTRODUCTION

1.1 PURPOSE AND SCOPE

This Construction Quality Assurance Manual describes Construction Quality Assurance (CQA) procedures, as well as construction quality control (CQC) procedures, for most construction projects at General Waste Disposal and Recovery Services, Inc. The overall goals of the CQA program are to assure that proper construction techniques and procedures are used and to verify that the materials and installation techniques used meet the project design requirements. Project-specific technical specifications will be prepared for each construction project that incorporates the procedures and requirements outlined in this CQA Manual. After completion of construction, a certification report documenting that material properties and placement procedures have been completed in accordance with the design standards will be submitted to the appropriate regulatory agencies.

The CQA program is intended to be used in conjunction with the project-specific drawing, specifications, and other documents necessary for construction. The CQA program covers several forms of construction that are performed at the facility; for any single construction project, only those portions of this plan applicable to the actual construction project being performed will apply.

2.0 MANAGEMENT ORGANIZATION

2.1 PARTIES

The parties discussed in this section are associated with the ownership, design, supply, manufacture, transportation, installation, and quality assurance of a component of the landfill, such as a lining system or leachate management system. The parties involved and their functions are described below:

Owner: The party that owns and operates the facility that is responsible for the overall coordination of CQA activities. The Owner is also responsible for selecting the necessary parties associated with construction.

Designer: The firm responsible for preparing the engineering design, associated plans, and specifications for the facility. The Designer for the project shall be a registered professional engineer in the State of Minnesota. The Designer may provide clarification necessitated during construction. In addition, the Designer may be responsible for construction oversight and preparation of the final Construction Certification Reports.

Construction Quality Assurance (CQA) Consultant: A firm, independent of the Owner, who observes, tests and documents construction activities on behalf of the Owner. The firm

designated as the CQA Consultant is responsible for communication of project design requirements and observing, testing, and documenting activities related to construction quality assurance. While in many cases the CQA Consultant and Designer are the same, this does not have to be the case; multiple firms may be utilized by General Waste for various projects. The CQA Consultant will identify and notify the Owner of any deviations or problems that arise during construction and assist in resolution. The CQA Consultant may also be responsible for preparation of the construction certification report required for submittal to the Minnesota Pollution Control Agency (MPCA). The CQA Consultant will have an individual identified as the CQA Monitor and a CQA Engineer. The CQA Monitor is typically an employee of the CQA Consultant, but portions of this may be subcontracted by the CQA Consultant on occasion. The CQA Monitor is also periodically referred to as the Resident Project Representative. The CQA Engineer will be a registered professional engineer in the State of Minnesota. The CQA Consultant may also be denoted as the Engineer in the Technical Specifications.

General Contractor: This firm is responsible for the construction of the entire project, and oversees the activities of itself and all construction subcontractors. A General Contractor may or may not be used on projects at the facility.

Earthwork Contractor: This firm is mainly responsible for the earthwork preparation and construction of the soil components of the lining system. The Earthwork Contractor typically prepares the subgrade or foundation soil on which the geosynthetics are placed. The Earthwork Contractor may also be responsible for placing the soil materials over the lining system. In addition, the Earthwork Contractor may install other components associated with the leachate collection system or a landfill gas system. The Earthwork Contractor and the General Contractor may or may not be the same firm

Pipe, Valve and Fitting (PVF) Supplier: The PVF Supplier is the firm responsible for the supply of piping components, valves and fittings. The PVF Supplier will be responsible for providing QC documentation that the materials meet the material requirements of the drawings, specifications, and other project requirements. The PVF Supplier is responsible for the condition of the product until the material is accepted by the Owner on-site.

Geosynthetic Manufacturer: The Geosynthetic Manufacturer is the firm or firms responsible for the production and supply of the various geosynthetic components. The geosynthetic manufacturer will be responsible for providing QC documentation that the materials meet the material requirements of the drawings, specifications, and other project requirements. The Geosynthetic Manufacturer is responsible for the condition of the product until the material is accepted by the Owner on-site.

Geosynthetic Installer: The Geosynthetic Installer is responsible for field handling, storing, placing, seaming, loading, and other aspects of the installation of geosynthetics.

Quality Assurance Laboratory: Firm that performs necessary testing on samples taken from the site.

Land Surveyor: An independent, registered, land surveyor that is responsible for marking and recording the necessary grades. The surveyor will also provide record surveying of necessary subgrade, liner and final cover system component thicknesses as well as locations and elevations of piping components and other appurtenances. The Land Surveyor shall employ a Registered Land Surveyor certified in the State of Minnesota.

2.2 COMMUNICATIONS

2.2.1 Preconstruction Meeting

A preconstruction meeting will be held prior to beginning construction. The Owner, the Owner's Representatives, the Contractor's Representative, the Engineer's Representatives and others as appropriate will attend the preconstruction meeting. Major topics discussed will be as follows:

1. Review responsibilities of each party.
2. Review lines of authority and communication.
3. Coordinate construction schedule.
4. Review project documents; provide clarification, if necessary.
5. Review anticipated issues, access, etc.
6. Review intended construction procedures.
7. Review health and safety items.
8. Review process for correction of potential defective work.
9. Site requirements.
10. Laboratory testing of material requirements.
11. Discuss any required modifications to the CQA Plan.
12. Review procedures for documentation and reporting information.
13. Review distribution and storage of documents and reports.
14. Establish protocol for testing and soil sample management.
15. Establish protocol for geosynthetic testing and sample management.

Minutes of the meeting will be taken and provided to the attendees for their records.

2.2.2 Progress Meetings

The Owner will typically schedule progress meetings at regular intervals. The Owner will determine the attendees at the progress meetings. Topics of discussion at the progress meetings will be:

- Work completed to-date;
- Schedules;
- Any changes or foreseeable issues;
- Documentation and any CQA testing completed to-date;
- Work anticipated to be completed prior to the next scheduled meeting.

The CQA Consultant shall log any problems, decisions, or questions arising at the meeting in this report.

2.2.3 Resolution Meeting

The Owner or CQA Consultant may call for a resolution meeting whenever there is a clarification needed to the project documents or there has been an unforeseen problem in construction. The result of this meeting will be a formal resolution agreed to by all relevant parties.

3.0 REPORTING REQUIREMENTS

3.1 STANDARD REPORTING PROCEDURES

The CQA Monitor will be on site to document construction activities. The CQA Monitor will prepare the daily activity logs and field notes, assemble the test reports, prepare the record drawings, and prepare the certification report. This section addresses the content of the various reports.

The CQA Monitor will issue a daily report of construction activities. These reports include, at a minimum, the following information:

1. Date, project name, location, and other identification.
2. Weather conditions, including temperatures and the amount of precipitation, if any.
3. Problems encountered and resolutions.
4. Descriptions and locations of ongoing construction, construction procedures, and construction quality control activities.
5. Equipment and personnel in each work area, including subcontractors.
6. Descriptions and specific locations of areas, or units, of work being tested and/or observed and documented.
7. Locations where samples were taken.

8. A summary of test results, failures, and retests.
9. Calibration or recalibration of test equipment, and actions taken as a result of calibration.
10. Physical properties of the soil during excavation, processing, placement and compaction.

3.2 REQUEST FOR INFORMATION (RFI) AND CORRECTIVE ACTION PLAN

The CQA Monitor is required to inform the CQA Project Manager in a timely manner, of any difference between the interpretation of the plans by the Contractor and the interpretation of the plans by the CQA Monitor. The Contractor will initiate an RFI whenever a discrepancy or question arises and formal response is required. Any actual or suspected work deficiencies will be brought to the attention of the Project Manager/ Project Engineer and Owner.

Design changes will be made only with written approval of the Owner, Project Manager and the CQA Project Manager.

A special meeting will be held when and if a problem or deficiency is present. The purpose of the meeting is to implement a Corrective Action Plan to define and resolve the problem or work out a deficiency as follows:

- Define and discuss the problem or deficiency.
- Review alternative solutions
- Implement an action plan to resolve the problem or deficiency

3.3 TEST REPORTS

The quality assurance laboratory will prepare a test report for each sample tested and provide copies to the CQA Consultant and/or Owner.

The test reports will contain the following information.

- Date;
- Sample I.D.;
- Project name and location;
- Sample size and description;
- Test being performed;
- Applicable ASTM or other standards;
- Method of sample preparation;
- Test results, including a statement that the test either passed or failed the project requirements, if applicable.

The test results will be signed by a representative of the laboratory certifying their accuracy and compliance with relevant standards.

3.4 RECORD DRAWINGS

The CQA Consultant will prepare record drawings to document the construction of a liner or cap system, gas components, or other construction activities. The plans will have elevations that are referenced to a U.S.G.S. datum.

For liner projects, the record drawings will contain the following at a minimum:

- Dimensions; maximum elevation and minimum elevation of the liner system constructed;
- Location and elevation of all sumps and all gravity pipes and drainage facilities;
- Quality assurance test locations and repair locations.

The CQA Consultant will work closely with the GI to ensure that panel numbers, seam locations, and destructive test numbers and locations are correctly located on the as-built drawings.

3.5 PHOTOGRAPHIC DOCUMENTATION

Photographs taken to document observations, problems, and/or deficiencies, or work in progress will include, without exception, identification of the date, location, direction, and time taken. Photographs will be filed in chronological order in a permanent protective file by the CQA Monitor.

3.6 FINAL CONSTRUCTION DOCUMENTATION REPORT

At the completion of the work on the site, the CQA Consultant will prepare a final certification/documentation report under the supervision of the CQA Engineer. This report will certify that the work has been constructed in substantial compliance with the approved plans and specifications and the MPCA requirements. Any deviations will be noted in the report.

4.0 LINER CONSTRUCTION DOCUMENTATION - EARTHWORK

4.1 RANDOM FILL

All random fill shall be placed in maximum 12-inch loose lifts and compacted to a minimum of 95% of Standard Proctor Density (ASTM D698) before proceeding to the next lift. The moisture content shall be within three percent of optimum moisture unless it is demonstrated that the material can be readily compacted to the specified minimum density without moisture adjustment.

The CONTRACTOR will be responsible for all quality control testing of the random fill to satisfy the requirements of the MPCA as outlined in the current MPCA Guidance for Soil

Construction Standards and Testing Frequencies for Landfill Cell and Final Cover Construction. The CQA Engineer will be responsible for construction quality assurance testing. At a minimum per the recommended testing guidelines, the random fill will be tested as follows:

- Standard Proctor OR Relative Density samples (ASTM D698-00 OR ASTM D4253-00) will be tested at a frequency of one test for each soil source. Test type will be governed by the soil type used for fill and the intended use of the soil.

- Nuclear and/or sand cone density tests (ASTM D1556 and D2933-96e1) will be performed as determined by the CQA Engineer. Compaction will be to 95% of Standard Proctor Density (ASTM D698-00).

- Samples will be collected and sieve analysis (ASTM D422-63 (1998)) performed at a frequency of one test for every 10,000 cubic yards (CY) of random fill placed. Frequency of testing may be increased as needed if soil conditions are variable.

4.2 SOIL MATERIALS IN LINER AND COVER SYSTEMS

4.2.1 Site Subgrade Preparation

At a minimum of the recommended testing guidelines for CQA testing of subgrade, the subgrade will be tested as follows:

- Samples will be collected and sieve analysis (ASTM D422-63 (1998)) performed at a frequency of one test per acre of subgrade.

- Samples will be collected soil classification (ASTM D2487-00) performed at a frequency of one test per acre of subgrade.

- Standard Proctor samples (ASTM D698-00) will be tested at a frequency of one test per acre of subgrade.

- Nuclear density tests (ASTM D2922), including water content (ASTM D2216 or D3017) will be performed on the compacted soils at a frequency of one test per acre. Compaction will be to 95% of Standard Density (ASTM D698-00).

4.2.2 Clay Liner

At a minimum of the recommended testing guidelines for CQA testing of borrow source evaluation conformance testing, the clay liner will be tested as follows:

- Samples will be collected and sieve analysis (ASTM D422-63 (1998)) performed at a frequency of one test for every 3,000 cubic yards (CY) of clay to be placed.

- Samples will be collected and tested to determine the Atterberg Limits (ASTM D4318) of the soil. Tests will be performed at a frequency of one test for every 3,000 cubic yards (CY) of clay to be placed.

- Samples will be collected soil classification (ASTM D2487-00) performed at a frequency of one test for every 3,000 cubic yards (CY) of clay to be placed.

- Standard Proctor samples (ASTM D698-00) will be tested at a frequency of one test for every 3,000 cubic yards (CY) of clay to be placed.

- Falling head permeability (ASTM D5084-90 (1997) EPA 9100) will be performed at a frequency of one test per 5,000 cubic yards (CY) of clay liner to be placed.

At a minimum of the recommended testing guidelines for CQA testing of in-place soils, the clay liner will be tested as follows:

- Nuclear and/or sand cone density tests (ASTM D1556 and D2933), including water content (ASTM D2216 and/or ASTM D3017) will be performed on the compacted soils at a frequency of one test per 100 foot grid per lift, offset each lift. Compaction will be to 95% of Standard Density (ASTM D698-00). Moisture content will be zero to five percent above optimum at the time of placement.

- In-place falling head permeability (ASTM D5084-90 (1997) EPA 9100) will be performed at a frequency of one test per acre per foot of in-place clay liner. In-place sampling will be completed with Shelby tubes (ASTM D1587-83).

4.2.3 Sand Drainage Layer

At a minimum of the recommended testing guidelines for CQA testing of borrow source evaluation conformance testing, the sand drainage layer will be tested as follows:

- Samples will be collected and sieve analysis (ASTM D422-63 (1998)) performed at a frequency of one test for every 2,000 cubic yards (CY) of sand drainage layer to be placed

- Samples will be collected and soil classification (ASTM D2487-00) performed at a frequency of one test for every 2,000 cubic yards (CY) of sand drainage layer to be placed.

- Samples will be collected and constant head permeability (ASTM D2434) performed at a frequency of one test for every 2,000 cubic yards (CY) of sand drainage layer to be placed.

At a minimum of the recommended testing guidelines for CQA testing of in-place soils, the sand drainage layer will be tested as follows:

- In-place samples will be collected and constant head permeability (ASTM D2434) performed at a frequency of one test for every acre of sand drainage layer placed.

4.2.4 Coarse Drainage Aggregate

At a minimum of the recommended testing guidelines for CQA testing the coarse drainage aggregate will be tested as follows:

- Samples will be collected and sieve analysis (ASTM D422-63 (1998)) performed at a frequency of one test for per source of coarse aggregate delivered and one test per source of coarse aggregate placed.

4.2.5 Intermediate Aggregate

At a minimum of the recommended testing guidelines for CQA testing the intermediate aggregate will be tested as follows:

- Samples will be collected and sieve analysis (ASTM D422-63 (1998)) performed at a frequency of one test for per source of intermediate aggregate delivered and one test per source of intermediate aggregate placed.

4.2.6 Class 5 Gravel

The Class 5 gravel shall be in accordance with MnDOT Standard Specification 3138.

At a minimum of the recommended testing guidelines, the Class 5 gravel will be tested as follows:

- Nuclear density tests (ASTM D1556) will be performed on the compacted gavel as required by the CQA Engineer. Compaction will be to at least 95% of Standard Proctor dry density.

4.2.7 Buffer Layer Soils

At a minimum of the recommended testing guidelines for CQA testing the soil buffer layer will be tested as follows:

- Samples will be collected and sieve analysis (ASTM D422-63 (1998)) performed at a frequency of one test for per source of buffer layer soils delivered and one test per acre of soil buffer layer placed.

4.2.8 General Buffer Soils (above Geomembrane)

At a minimum of the recommended testing guidelines for CQA testing the general buffer soils will be tested as follows:

- Samples will be collected and sieve analysis (ASTM D422-63 (1998)) performed at a frequency of one test for per source of general buffer soils delivered and one test per acre of general buffer soils placed.
- Samples will be collected and constant head permeability (ASTM D2434) performed at a frequency of one test for every 2,000 cubic yards (CY) of general buffer soils to be placed.
- In-place samples will be collected and constant head permeability (ASTM D2434) performed at a frequency of one test for every acre of general buffer soils placed.

4.2.9 General Fill Soils

At a minimum of the recommended testing guidelines for CQA testing the general fill soils will be tested as follows:

- Samples will be collected and sieve analysis (ASTM D422-63 (1998)) performed at a frequency of one test for per source of general fill soils delivered and one test per source of general fill soils placed.

4.2.10 Topsoil

Topsoil shall be in conformance with MnDOT Standard Specification 3877 for topsoil borrow and for the following parameters:

- Samples will be collected and sieve analysis (ASTM D422-63 (1998)) performed at a frequency of one test per source of topsoil to be placed.
- Samples will be collected and soil classification (ASTM D2487-00) performed at a frequency of one test per source of topsoil to be placed.
- Samples will be collected and nutrient content will be tested as determined by the CQA Engineer.

4.2.11 Summary

Table 1 defines the ASTM test methods to be employed in the earthwork portion of the CQA program.

TABLE 1
LABORATORY TEST METHODS
General Waste Disposal and Recovery Services, Inc.
Construction Quality Assurance Plan

Parameter	Method	Standard Number
Particle Size Analysis	Sieve and/or Hydrometer Analysis	ASTM D422 ASTM D1140
Atterberg Limits	N/A	ASTM D4318
Soil Classification	Unified Soil System Classification	ASTM D2487
Compaction (Moisture/Density Relationships using 5.5-pound hammer and 12-inch drop)	Standard Proctor Test	ASTM D698
Permeability	Constant Head Permeability Falling Head Permeability	ASTM D2434 ASTM D5084
Nutrient Content	Soil Science of America Classification	MnDOT 3877.2
Soil Density	Nuclear Density	ASTM D2922

Table 2 describes in detail the types and number of tests required for each earthwork liner and final cover component during construction. Construction quality assurance testing will be conducted on samples taken from the liner and final cover materials as it is placed during the course of construction.

Contractor is to perform source testing and whatever QC testing they deem necessary. The CQA Consultant will perform QA testing per the following table:

TABLE 2
SOILS CONSTRUCTION TESTING FREQUENCY
General Waste Disposal and Recovery Services, Inc.
Construction Quality Control and Quality Assurance Plan

Quality Assurance Testing Program	Particle Size Distribution	Atterberg Limits	Soil Classification	Moisture Density (Proctor)	Permeability	Nutrient Content	Nuclear Density / Moisture Content
Clay Liner	Source Testing Minimum 1/3000 CY Conformance Testing N/A	Source Testing Minimum 1/3000 CY Conformance Testing N/A	Source Testing Minimum 1/3000 CY Conformance Testing N/A	Source Testing Minimum 1/3000 CY Conformance Testing N/A	Source Testing Minimum 1/3000 CY Conformance Testing Minimum 1/acre/foot	Source Testing N/A Conformance Testing N/A	Source Testing N/A Conformance Testing Minimum 100 foot grid/lift
Sand Drainage Layer	Source Testing Minimum 1/2000 CY Conformance Testing N/A	Source Testing N/A Conformance Testing N/A	Source Testing Minimum 1/2000 CY Conformance Testing N/A	Source Testing N/A Conformance Testing N/A	Source Testing Minimum 1/2000 CY Conformance Testing Minimum 1/acre	Source Testing N/A Conformance Testing N/A	Source Testing N/A Conformance Testing N/A
Subgrade	Source Testing Minimum 1/acre Conformance Testing N/A	Source Testing N/A Conformance Testing N/A	Source Testing Minimum 1/acre Conformance Testing N/A	Source Testing Minimum 1/acre Conformance Testing N/A	Source Testing N/A Conformance Testing N/A	Source Testing N/A Conformance Testing N/A	Source Testing N/A Conformance Testing Minimum 1/acre
Class 5 Gravel	Source Testing Minimum 1/source Conformance Testing N/A	Source Testing N/A Conformance Testing N/A	Source Testing Minimum 1/source Conformance Testing N/A	Source Testing Minimum 1/source Conformance Testing N/A	Source Testing N/A Conformance Testing N/A	Source Testing N/A Conformance Testing N/A	Source Testing N/A Conformance Testing CQA Engineer Discretion

TABLE 2 - Continued
SOILS CONSTRUCTION TESTING FREQUENCY

Quality Assurance Testing Program	Particle Size Distribution	Atterberg Limits	Soil Classification	Moisture Density	Permeability	Nutrient Content	Nuclear Density / Moisture Content
Topsoil	Source Testing Minimum 1/source Conformance Testing N/A	Source Testing N/A Conformance Testing N/A	Source Testing Minimum 1/source Conformance Testing N/A	Source Testing N/A Conformance Testing N/A	Source Testing N/A Conformance Testing N/A	Source Testing N/A Conformance Testing CQA Engineer Discretion	Source Testing N/A Conformance Testing N/A
Coarse Aggregate	Source Testing Minimum 1/source Conformance Testing Minimum 1/source	Source Testing N/A Conformance Testing N/A	Source Testing N/A Conformance Testing N/A	Source Testing N/A Conformance Testing N/A	Source Testing N/A Conformance Testing N/A	Source Testing N/A Conformance Testing N/A	Source Testing N/A Conformance Testing N/A
Fine Aggregate	Source Testing Minimum 1/source Conformance Testing Minimum 1/source	Source Testing N/A Conformance Testing N/A	Source Testing N/A Conformance Testing N/A	Source Testing N/A Conformance Testing N/A	Source Testing N/A Conformance Testing N/A	Source Testing N/A Conformance Testing N/A	Source Testing N/A Conformance Testing N/A
Common Borrow / Random Fill	Source Testing Minimum 1/10,000 CY Conformance Testing N/A	Source Testing N/A Conformance Testing N/A	Source Testing Minimum 1/10,000 CY Conformance Testing N/A	Source Testing N/A Conformance Testing N/A	Source Testing N/A Conformance Testing N/A	Source Testing N/A Conformance Testing N/A	Source Testing N/A Conformance Testing CQA Engineer Discretion
General Buffer Layer (cover)	Source Testing Minimum 1/2000 CY Conformance Testing N/A	Source Testing N/A Conformance Testing N/A	Source Testing Minimum 1/2000 CY Conformance Testing N/A	Source Testing N/A Conformance Testing N/A	Source Testing Minimum 1/2000 CY Conformance Testing Minimum 1/acre	Source Testing N/A Conformance Testing N/A	Source Testing N/A Conformance Testing N/A

TABLE 2 - Continued
SOILS CONSTRUCTION TESTING FREQUENCY

Quality Assurance Testing Program	Particle Size Distribution	Atterberg Limits	Soil Classification	Moisture Density	Permeability	Nutrient Content	Nuclear Density / Moisture Content
General Fill Soil (cover)	Source Testing Minimum 1/Source Conformance Testing N/A	Source Testing N/A Conformance Testing N/A	Source Testing Minimum 1/Source Conformance Testing N/A	Source Testing N/A Conformance Testing N/A	Source Testing N/A Conformance Testing N/A	Source Testing N/A Conformance Testing N/A	Source Testing N/A Conformance Testing N/A
Soil Buffer Layer	Source Testing Minimum 1/Acre Conformance Testing N/A	Source Testing N/A Conformance Testing N/A	Source Testing Minimum 1/Source Conformance Testing N/A	Source Testing N/A Conformance Testing N/A	Source Testing N/A Conformance Testing N/A	Source Testing N/A Conformance Testing N/A	Source Testing N/A Conformance Testing N/A

4.3 LINER SOILS – DEPTH OF MATERIAL VERIFICATION

The Contractor will verify depth of materials by field survey. Minimum documentation of liner system for depth of material will be as described in the project specification.

Additional thickness verification may be conducted by the CQA Engineer as deemed necessary.

5.0 LINER CONSTRUCTION DOCUMENTATION-GEOSYNTHETICS

This section of the Construction Quality Assurance Manual applies to the 60-mil High Density Polyethylene (HDPE) geomembrane used in the landfill liner, the 40-mil LLDPE geomembrane used in the landfill final cover system construction and other geotextiles used for various purposes.

5.1 EARTHWORK-RELATED

There are certain aspects of earthwork that directly affect the geomembrane liner. These are the subgrade surface conditions and the backfill of the anchor trench.

5.1.1 Surface Preparation

The subgrade surface for the geomembrane liner (i.e., the compacted clay layer and the soil buffer layer) will be observed by the CQA Monitor during smooth drum rolling to detect soft or loose areas.

The geosynthetic Installer will certify in writing that the surface on which the geomembrane will be installed is acceptable. The geomembrane installer will give a signed Certificate of Acceptance to the CQA Monitor prior to commencement of geomembrane installation. Commencement of installation without written certification of the underlying subgrade acceptance will mean the Installer has accepted the clay or soil buffer layer surface.

After the subgrade for the geomembrane is accepted by the Installer, it is the Installer's responsibility to indicate to the CQA Monitor any change in the supporting soil condition that may require repair work.

Care will be taken to avoid excessive desiccation cracking of the geomembrane subgrade surface.

5.1.2 Anchor Trench

The anchor trench is the excavated and backfilled trench that keeps the geomembrane and associated geotextiles in place (in addition to the backfill material). It is essential that the anchor trench is excavated to the specified dimensions, backfilled with suitable materials and compacted sufficiently to hold the geomembrane in place prior to, during and after backfill and cover operations. Care should be taken not to damage the geomembrane during anchor trench backfilling operations.

5.2 GEOSYNTHETIC INSTALLATION - 60-MIL HIGH DENSITY POLYETHYLENE (HDPE), AND 40-MIL (LLDPE)

Construction quality assurance will be performed by the CQA Monitor on all components of HDPE geomembrane installation. Criteria to be used for determination of acceptability of the installation will be as identified in the project plans and specifications.

The Liner Installer will perform all QC trial testing and take QA samples of the installed liner at the frequency designated herein and in the specifications. The QA monitor will require additional sampling should site conditions or test results indicate the need for additional sampling. The QA monitor will not complete separate QA testing unless requested to do so by the Owner or Owners Resident Representative.

The liner materials and installation shall be in conformance with the CQA Plan, WMI contract and the most current Waste Management Geosynthetic Specification Tables for liner materials and construction.

5.2.1 Field Panel Placement

The CQA Monitor and the Installer will agree to an "identification code" for each field panel. The number-letter system will be consistent with the proposed panel layout developed by the Installer. The CQA Monitor will maintain a list showing the correspondence between panel identification numbers.

The CQA Monitor will verify that field panels are installed at the location indicated on the Installer's proposed panel layout plan or with agreed modifications. The Installer will maintain a drawing of the installed panel layout.

5.2.2 Trial Welds

The CQA Monitor will observe and verify that all trial weld procedures and testing methods are conducted according to the specifications. A minimum of one trial weld prior to beginning daily seaming and one trial weld every four hours will be tested per welding machine for each seaming technician. Additional test runs will be required following work interruptions or weather changes. The following information will be logged on Trial Weld forms by the CQA Consultant.

1. Date and time of the trial weld completion.
2. Ambient temperature.
3. Apparatus identification.
4. Seaming technician.
5. Wedge temperature and speed for fusion welding.
6. Trial weld number.

7. Pass or fail of the trial weld
8. Liner type and thickness

Table 3 includes the pass/fail criteria for trial welds.

The Contractor will perform field shear and peel tests of geomembrane seams using standardized specimen sizes in tensile testing machines with mechanically or electrically controlled rates of jaw separation. The tensile testing machine will be equipped with electrically controlled and smoothly moving jaw separation apparatus, capable of adjustments and defined settings for jaw separation rate, and displaying jaw separation rates and tensile loadings exerted on the geomembrane samples. Tensile testing machines will be accompanied by documentation for calibration conducted within one year of the start of geomembrane installation. Geomembrane samples will be prepared for field analyses by use of templates and cutting tools that prepare uniformly-sized samples.

5.2.3 Field Seaming

A seam number system compatible with the panel numbering system will be agreed upon between the CQA Monitor and the Installer. Weather conditions such as wind and ambient temperature will be logged for each construction day. CQA Project Manager and Owner approval will be obtained prior to geomembrane installation for ambient temperatures below 32°F and above 104°F. Seaming will be carried out on a continuing basis, with minimum time between deployment and seaming. Trial Testing criteria are outlined in **Table 3**.

TABLE 3
REQUIRED GEOMEMBRANE SEAM STRENGTHS AND RELATED PROPERTIES
(40 and 60 mil SMOOTH AND TEXTURED HDPE and LLDDE GEOMEMBRANE)
General Waste Disposal and Recovery Services, Inc.
Construction Quality Control Testing

PROPERTIES	TEST METHOD	FIELD SAMPLE SIZE	MINIMUM TEST FREQUENCY (1)	REQUIRED VALUES (2) (3)
Seam Shear Strength	ASTM D6392	42-in. along seam; 12 in. wide	Ave. 1 every 500 lf for each type of welding	Failure is more than 1 out of 5 having a shear strength value less than the specified value for the specific liner type and thickness.
Seam Shear Elongation (4)	ASTM D6392	42-in. along seam; 12 in. wide	Ave. 1 every 500 lf for each type of welding	Failure is more than 1 out of 5 having a shear elongation value less than 50 % Minimum value for the 1 out of 5 seam is 40 %.
Peel Strength	ASTM D6392	42-in. along seam; 12 in. wide	Ave. 1 every 500 lf for each type of welding	Failure is more than 1 out of 5 having a peel strength value less than the specified value for the specific liner type and thickness.
Peel Separation	ASTM D6392	42-in. along seam; 12 in. wide	Ave. 1 every 500 lf for each type of welding	Failure is more than 1 out of 5 having a peel separation value less than 25%. Minimum value for the 1 out of 5 seam is 20%
Air Pressure	GRI GM6	N/A	All dual-track seams tested by air pressure	3 psi drop with initial pressure 27-30 psi for 5 minutes, following an initial relaxation period
Vacuum Test	N/A	N/A	All single track wedge and extrusion seams tested by vacuum	Examine weld for approximately 10 seconds through window of vacuum of minimum 3 psig

Notes:
(1) Test frequencies may be modified at the discretion of the ENGINEER
(2) Based on GRI GM19, May 15, 2003. Listed values for each liner type apply to values of destructive samples as tested in the laboratory.
(3) For double fusion weld seams, both tracks shall be tested for compliance with the minimum property values for the specified liner type and thickness.
(4) Elongation measurements should be omitted for field testing.

5.2.4 Seam Preparation

The CQA Monitors will verify that:

1. Prior to seaming, the seam area is clean and free of moisture, dust, dirt, debris of any kind, and foreign material.
2. Seams are aligned with the fewest possible number of wrinkles and "fishmouths." "Fishmouths" will be slit, laid flat, bonded and then patched with a round or oval patch of the same geomembrane material. The patch will extend a minimum of 6 inches beyond the repair area in all directions.
3. The minimum panel overlap is 6 inches.

Extrusion Process

The Installer shall provide the CQA Monitor with certification that the extrudate meets the specifications and is comprised of the same resin type as the geomembrane sheeting.

The CQA Monitor will log the following information for each extrusion welded seam on designated seaming records which document the following:

1. Time and date of the beginning of each seam.
2. Seam number.
3. Seam length.
4. Seaming technician.
5. Apparatus identification.
6. Current weather conditions.

Fusion Process

The following information will be logged for the dual hot wedge seaming on the seaming records which document the following:

1. Date and time of the beginning of each seam.
2. Seam number.
3. Seam length.
4. Seaming technician.
5. Apparatus identification.
6. Current weather conditions.

5.2.5 Nondestructive Seam Testing

The Installer shall non-destructively test all field seams over their full length using a vacuum test unit, air pressure test (for double fusion seams only), or other approved method. The purpose of non-destructive tests is to check the tightness of seams. It does not provide any information on seam strength. The vacuum testing and air pressure testing of seams will be logged on non-destructive seam testing forms by the CQA Consultant. The following information will be logged:

1. Date and time of the completion of the test.
2. Seam number.
3. The general seam location.
4. The test crew.
5. The air pressure at the beginning and end of the test for double-track fusion.
6. The length of time that the air pressure was held for double-track fusion welds.
7. Pass or fail result of the test.
8. Retest results (when necessary).

Table 4 specifies the criteria for the non-destructive testing methods.

Vacuum Testing

The following equipment and procedures are applicable to vacuum testing.

1. The equipment shall consist of the following:
   a. A vacuum box assembly consisting of a rigid housing, a transparent viewing window, a soft neoprene gasket attached to the bottom, a porthole or valve assembly, and a vacuum gauge.
   b. A pump assembly equipped with a pressure controller and pipe connections.
   c. A rubber pressure/vacuum hose with fittings and connections.
   d. A soapy solution.
   e. A bucket and wide paint brush, or other means of applying the soapy solution.

2. The following procedures shall be followed:
   a. Energize the vacuum pump and reduce the tank pressure to approximately 5 psi (10 inches of Hg) (35 kPa) gauge.
   b. Wet a strip of geomembrane approximately 12" x 48" (0.3 m x 1.2 m) with the soapy solution.
   c. Place the box over the wetted area.
   d. Close the bleed valve and open the vacuum valve.
   e. Ensure that a leak-tight seal is created.

f. For a period of not less than 10 seconds, apply vacuum and examine the geomembrane through the viewing window for the presence of soap bubbles.

g. If no bubble appears after 10 seconds, close the vacuum valve and open the bleed valve, move the box over the next adjoining area with a minimum of 3 inches (75 mm) overlap, and repeat the process.

h. All areas where soap bubbles appear shall be marked and repaired in accordance with **Section 5.2.10**.

TABLE 4
NON-DESTRUCTIVE SEAM TESTING
General Waste Disposal and Recovery Services, Inc.
Construction Quality Control and Quality Assurance Plan

Test	Criteria Type	HDPE Criteria	
		Smooth	
		Specified	Documented
Vacuum Box 10 seconds Observation	Minimum Vacuum	5 psi	(Vacuum testing record to be completed during construction)
Air Pressure 5 minutes 40-mil @ 24-30 psi	Maximum Loss	2 psi	(Air pressure testing record to be completed during construction)

Notes:

Air Pressure Testing

The following procedures are applicable to double fusion welding which produces a double seam with an enclosed space.

1. The equipment shall consist of the following:
   a. An air pump (manual or motor driven), equipped with pressure gauge capable of generating and sustaining a pressure between 24 and 35 psi (165 and 241 kPa) and mounted on a cushion to protect the geomembrane. Pressure for the 40-mil liner will be between 24 and 30 psi.
   b. A rubber hose with fittings and connections.
   c. A sharp hollow needle, or other approved pressure feed device.
2. The following procedures shall be followed:
   a. Seal both ends of the seam to be tested.
   b. Insert needle or other approved pressure feed device into the air channel created by the fusion weld.
   c. Insert a protective cushion between the air pump and the geomembrane.
   d. Energize the air pump to a pressure of approximately 30 psi (200 kPa), close valve, allow two minutes for pressure to stabilize, and sustain pressure for at least 5 minutes.

e. If loss of pressure exceeds 2 psi (30 kPa) or does not stabilize, located faulty area and repair in accordance with **Section 5.2.10**.

f. Cut opposite end of tested seam area once testing is completed to verify continuity of the air channel. If air does not escape, located blockage and retest unpressurized area. Seal the cut end of the air channel.

g. Remove needle or other approved pressure feed device and seal.

Test Failure Procedures

The Installer shall complete any required repairs. For repairs, the CQA Monitors shall:

1. Observe the repair and testing of the repair in accordance with **Section 5.2.7** of this report.
2. Mark on the geomembrane that the repair has been made.
3. Document the repair procedures and test results.

5.2.6 Destructive Seam Testing

The CQA Monitors will select locations where seam samples will be cut out for laboratory testing. Those locations will be established as follows:

1. A minimum frequency of one test location per 500 feet (150 m) of seam length. This minimum frequency is to be determined as an average taken throughout the entire facility.
2. A maximum frequency will be agreed upon by the CQA Monitor and the Installer at the resolution and/or preconstruction meeting.
3. Test locations will be determined during seaming at the CQA Monitor's discretion. Selection of such locations may be prompted by suspicion of excess crystallinity, contamination, offset welds, or any other potential cause of imperfect welding.

The Installer will not be informed in advance of the locations where the seam samples will be taken. The sample for laboratory testing shall be located between the samples for field testing. The sample for laboratory testing shall be 12 inches (0.3 m) wide by 42 inches (1.1 m) long with the seam centered lengthwise. The sample shall be cut into three parts and distributed as follows:

1. One 12" wide x 18" long (0.3 m x 0.5 m) portion for Geosynthetic testing laboratory.
2. One 12" wide x 12" long (0.3 m x 0.3 m) portion to the Installer for operational laboratory testing.
3. One 12" wide x 12" long (0.3 m x 0.3 m) portion to the Owner for archive storage.

Samples shall be taken by the Installer as the seaming progresses in order to have laboratory test results before the geomembrane is covered by another material. The CQA Monitors will observe

and verify that testing and sampling procedures are conducted in accordance with the contract documents. This will include:

1. Assign a number to each sample and mark in accordingly;
2. Record sample location on the panel layout record drawing; and
3. Receive laboratory test results directly from the lab.

All holes in the geomembrane resulting from destructive seam sampling shall be immediately repaired in accordance with approved repair procedures. The continuity of the new seams in the repaired area shall be tested by the Installer as described in **Section 5.2.4**.

The CQA Monitors will verify all field tests have been accomplished and mark all samples and portions with the sample number.

5.2.7 Geosynthetic Testing Laboratory

The geosynthetic testing laboratory will be selected by the Installer and approved by the Owner. Destructive test samples will be packaged and shipped under the responsibility of the Installer in a manner that will not damage the test sample. The Owner will be responsible for storage and archiving the remaining portion of the sample.

Testing will include shear strength and peel adhesion. At least five specimens will be tested for each test method. Specimens will be selected alternately by test from the samples (i.e., peel, shear, peel, shear, etc.). Testing frequencies are shown in **Table 3**.

The geosynthetic testing laboratory will provide test results no more than 48 hours after they receive the samples. The Installer will give the CQA Monitor a copy of the results for review as soon as they become available.

5.2.8 Electric Leak Location Testing

Following completion of the geomembrane and sand drainage layer installation, the OWNER's subcontractor may conduct leak location testing as indicated in the Contract Specifications.

5.2.9 Defects and Repairs

All seamed and unseamed areas of the geomembrane will be examined by the CQA Monitor. Identification of defects, holes, blisters, undispersed raw materials, and any sign of contamination of foreign defects, the surface of the geomembrane shall be clean at the time of examination. The geomembrane surface shall be broomed clean or washed by the Installer if the amount of dust or mud inhibits examination.

When seaming of the geomembrane liner is completed (or when seaming of a large area of the geomembrane liner is completed) and prior to placing overlying materials, the CQA Monitors will observe the geomembrane wrinkles. The CQA Monitors will indicate to the Installer which wrinkles are not in accordance to the CQA plan. Oversized wrinkles will be replaced with a seam. The seam, thus produced, shall be tested like any other seam.

Any portion of the geomembrane exhibiting a flaw as determined by the CQA Monitor, or failing a destructive or nondestructive test shall be repaired. Repair procedures shall follow the guidelines listed below. The final decision as to the appropriate repair procedures shall be agreed upon between the CQA Monitor and the Installer.

5.2.10 Repair Procedures

The repair procedures available include:

- Patching, used to repair holes, tears, undispersed raw materials, and contamination by foreign matter.
- Extrusion bead welding used to repair pinholes, or other minor, localized flaws.
- Capping, used to repair large lengths of failed seams.
- Extrusion welding the flap, used to repair areas of inadequate fusion seams which have an exposed edge. Repairs of this type shall be approved by the CQA Monitor and shall not exceed 100 feet (30 m) in total length.
- Removing bad seam and replacing with a strip of new material welded into place.

For any repair method, the following provisions shall be satisfied:

- Surfaces of the geomembrane which are to be repaired using extrusion methods shall be ground no more than one hour prior to the repair.
- All surfaces shall be clean and dry at the time of the repair.
- All seaming equipment used in repairing procedures shall meet the requirements of the project CQA Plan.
- Patches or caps shall extend at least 6 inches (150 mm) beyond the edge of the defect, and all corners of patches shall be rounded with a radius of approximately 3 inches (75 mm).

5.2.11 Repair Verification

The CQA Monitor shall verify all nondestructive testing of repairs have been accomplished and shall record the number of each repair, date and test outcome. Each repair shall be nondestructively tested using the methods described in **Section 5.2.4** as appropriate. Repairs which pass the nondestructive test shall be taken as an indication of an adequate repair. Repairs more than 150 feet (50 m) long require destructive test sampling. Failed tests require that the repair shall be redone and retested until a passing test results.

When placing overlying material on the geomembrane, every effort must be made to minimize wrinkle development. If possible, cover should be placed during the coolest weather available. In addition, small wrinkles should be isolated and covered as quickly as possible to prevent their growth. The placement of cover materials shall be observed.

5.2.12 Geomembrane Acceptance

The geosynthetic cap system shall be considered acceptable when:

1. The installation is finished.
2. Verification of the adequacy of all seams and repairs, including associated testing, is complete.
3. All documentation of installation is completed and verified by the CQA Consultant.

The CQA Monitor will certify that installation has proceeded in accordance with the Quality Assurance Plan and Construction Plans except as noted in the documentation report.

The liner materials and installation shall be in conformance with the CQA Plan, WMI contract and the most current Waste Management Geosynthetic Specification Tables for liner materials and construction.

5.3 GEOTEXTILE

A geotextile may be used as a filter to prevent fines in the drainage layer from migrating into the coarse filter aggregate or into the gas collection piping.

The manufacturer shall provide a list of guaranteed minimum average roll value properties for the specified geotextile to be installed. Each roll of geotextile shall bear a label that identifies the properties.

The CQA Monitor will examine results and report any nonconformance to Owner. QC results will be reviewed and accepted or rejected by the CQA Monitor prior to deployment.

The geotextile material and installation shall be in conformance with the CQA Plan, WMI contract, and the most current Waste Management Geosynthetic specification Tables for geosynthetic materials and construction.

5.3.1 Roll Inspection

Prior to placement, rolls shall be inspected for damage and defects. During shipment and storage, geotextile shall be protected from ultraviolet light exposure, precipitation, mud, dirt, dust, puncture, cutting or any other damaging or deleterious conditions. Consistent with these objectives, geotextile rolls shall be shipped and stored in relatively opaque and watertight wrappings.

5.3.2 Placement

Geotextile shall be handled in such a manner as to ensure they are not damaged. In the presence of wind, the materials shall be weighted with sandbags until final covers are installed. Care shall be taken to ensure that any underlying liners/layers are not damaged during placement of geotextiles. Vehicle use directly over a geotextile that overlies a geomembrane is prohibited as a standard means of deployment

Care shall be taken to ensure that stones, mud, dirt and debris are not entrapped beneath the geotextile during placement and seaming operations that cause damage.

5.3.3 Seaming

Geotextiles shall be sealed by overlapping 4 inches and sewing or by an alternate method as approved by the CQA Consultant and Owner. Sewing threads shall be a polymeric material with chemical resistance similar to the geotextile.

The CQA Monitor shall observe and document that the panel overlap meets the project specifications and that there are no excessive folds or wrinkles in the geotextile.

5.3.4 Defects and Repairs

Any holes or tears in geotextiles shall be repaired by patching with the same geotextile materials. The patch shall be a minimum of 24 inches larger than the area to be repaired in all directions and shall be thermally spot-bonded or stitched in accordance with the technical specifications.

The CQA Monitor shall document that any holes or defects were repaired.

6.0 LEACHATE COLLECTION, CONVEYANCE SYSTEMS AND HEAD MONITORS

6.1 LEACHATE COLLECTION AND CONVEYANCE PIPING

Leachate collection piping and boot assemblies will be visually observed prior to placement of materials that cover them for conformance with requirements of the plans and specifications. The entire piping system will be observed and measurements made at 50-foot intervals to verify and document location and slope of pipe.

6.1.1 Testing

Pressure testing will be used to test all sections of HDPE leachate forcemain piping. Testing must be performed in the presence of the CQA Monitor. Testing will be performed on pipe sections prior to backfilling. Any leaks or defects shall be corrected and retested.

Low pressure air testing shall be used for testing the outer pipe of dual contained pressure forcemain. The test pressure shall be 10 psig at the high point of the section and shall not vary by more than 1% for one hour (corrected for temperature).

Hydrostatic pressure testing shall be used for testing pressure pipes, the inner forcemain of a dual contained system or any other sections identified to be hydrostatically tested. The test pressure for the hydrostatic pressure testing shall be in accordance with the technical specification at the high point of the section (typically 150 psig), and shall not vary by more than 1% for two hours.

The CQA Monitor will witness and document the final test of all piping. The test report for each piping system tested and for each tank testing shall include the following information at a minimum:

- Date of test
- Description and identification of piping system tested
- Type of test performed
- Test pressure
- Type and location of leaks detected, if any
- Corrective action taken to repair leaks
- Results of retesting

6.2 LEACHATE HEAD MONITORING RISERS

The locations and elevations of the pressure transducers will be measured. Invert elevations will be measured at the monitoring locations shown on the Contract Drawings and at the lowest points where they set on the geomembrane in the collection sumps.

6.3 LEACHATE MANHOLES AND CLEANOUTS

Manholes will be checked for conformance with the dimensions and layout shown on the Engineering Plans. Cleanouts will be checked for accessibility and functionality.

7.0 LANDFILL GAS WELLS

The locations and elevations of LFG wells will be confirmed prior to drilling the wells to ensure no damage will occur to the underlying liner system. The final location of wells will be documented and shown on the Contract Drawings.

8.0 VEGETATION SYSTEM

8.1 ESTABLISHING VEGETATION

Vegetation will be monitored over the course of one year to observe that it is sufficiently established. Areas in which the vegetation fails to grow will be reseeded, fertilized and mulched. The vegetation will consist of the seed mix or plantings designated in the project specifications or as directed by the Owner.

9.0 PUMPS AND CONTROLS

This section addresses pumps, including the collection sump sideslope riser pumps, meters, and associated electrical controls for pore water drain and leachate management systems. This section addresses the leachate condensate pumps, meters, and associated electrical controls for the gas collection systems.

9.1 MATERIAL QUALITY CONTROL

The Contractor shall inspect pumps, meters, and associated electric controls received at the site and shall verify that materials are:

1) In accordance with drawings and specifications.

2) Free of material defects.

3) Undamaged.

The Contractor shall be responsible for storing materials in a protected location where they will not be damaged.

The CQA Monitor shall examine the results and report any nonconformance to the Owner. QC results shall be reviewed and accepted or rejected by the Owner prior to installation.

9.2 OBSERVATION AND DOCUMENTATION

The Contractor shall install materials in accordance with engineering plans and specifications. All connections shall be made in accordance with manufacturer's recommendations. The pumping system equipment, especially related to the leachate removal/detection system, equipment will be documented by the CQA Monitor.

9.3 TESTING

The pump system and controls shall be tested for proper operation in accordance with manufacturer's requirements. This test will be observed by the CQA Monitor or Owner.

9.4 DAMAGE AND REPAIRS

Damaged or defective materials, as determined by CQA Monitor, will be removed and replaced.

10.0 SURFACE WATER DRAINAGE SYSTEM

10.1 SURFACE WATER DIVERSION BERMS AND CHANNELS

Surface water diversion berms and channels will be monitored visually for conformance with the Contract Documents. The configuration of permanent berms and channels will be included in the As-built Survey.

10.2 SURFACE WATER CONVEYANCE PIPING AND MANHOLES

Surface water piping and manholes will be visually checked for dirt, rocks and other debris prior to acceptance. Inverts will be shot and included in the As-built survey.

10.3 EROSION PROTECTION – RIPRAP AND MAT

All erosion protection will be visually checked for conformance with the plans and specifications. Riprap will be observed for location, functionality, and class per specifications.

11.0 DOCUMENTATION REPORT AND RECORD DRAWINGS

The documentation report is the summary document of the construction activities throughout the project. The construction portion of the report will include discussion of all documented

procedures. The report will include photographs, results from field and laboratory tests, survey documentation and as-built drawings.

The documentation report will be signed by a professional engineer licensed in the State of Minnesota.

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Appendix A
STANDARD CELL CONSTRUCTION SPECIFICATIONS

TECHNICAL SPECIFICATIONS FOR

GENERAL WASTE DISPOSAL AND RECOVERY SERVICES, INC.

LINER CONSTRUCTION

Prepared for:

General Waste Disposal and Recovery Services, Inc.
Keewatin, Minnesota

Prepared by:

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13400 15th Avenue North
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(763) 489-3100

Project Number: 59118.00

April __, 2013

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A. Remove surface debris.

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A. Verify that existing plant life and features designated to remain are tagged or identified.

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A. Protect utilities that remain from damage.

B. Protect trees, plant growth, and features designated to remain as final landscaping.

C. Protect bench marks from damage or displacement.

3.03 CLEARING

A. Clear areas required for access to site and execution of Work.

B. Remove trees and shrubs within marked areas and as shown on the plans. Remove stumps, root system to a depth of 36 inches below basegrade contours.

C. Clear undergrowth and deadwood without disturbing subsoil.

3.04 REMOVAL

A. Remove trees, stumps, and other debris from project area and dispose of on-site as directed by the OWNER.

END OF SECTION 02110

SECTION 02211

ROUGH GRADING

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Removal of topsoil and subsoil from areas to be excavated. Also includes relocation of stockpile for extension of access road.

B. Cutting, filling and rough grading the site, Landfill cell, access ramp to new cell and access road.

C. Construction of Perimeter Berm, ditching and transition berm.

1.02 RELATED SECTIONS

A. Section 02110 – Site Clearing.

B. Section 02900 – Clay Liner Construction

C. Section 02905 – Flexible Membrane Liner (FML) System

1.03 REFERENCES

A. ASTM D698 – Test Methods for Moisture-Density Relations of Soils and Soil-Aggregate Mixtures, Using 5.5 lb (2.49 Kg) Hammer and 12 inch (304.8 mm) Drop.

B. ASTM D1556 – Test Method for Density of Soil in Place by the Sand-Cone Method.

C. ASTM D2922 – Test Method for Density of Soil and Soil-Aggregate by Nuclear Method.

D. Mn/DOT "Standard Specification for Construction", 2000 Edition.

PART 2 PRODUCTS

2.01 MATERIALS

A. Topsoil: Excavated material, graded, free of roots, rocks larger than 1-inch, subsoil, debris, and large weeds.

B. Subsoil: Excavated material, graded, free of lumps larger than 3-inches, rocks larger than 1-inch, roots and debris.

C. All general fill for construction shall be obtained from either the subsoil to be excavated from the project area, or from the adjacent gravel pit, Duluth Ready Mix

Any excess general fill from the project area shall be used to construct the transition berm and perimeter berms.

D. General fill material shall be excavated material free of lumps larger than three inches, rocks larger than 1.5 inches, and debris. Common borrow shall not contain peat, muck, sod, roots or sharp objects. Common borrow materials shall be approved by OWNER and ENGINEER prior to beginning construction.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that survey benchmark and intended elevations for the Work are as indicated.

B. Additional test borings and other exploratory operations may be made by CONTRACTOR at CONTRACTOR'S expense. CONTRACTOR shall make arrangements for additional soils investigation with the OWNER.

3.02 PREPARATION

A. Complete pre-construction survey of all general areas and stockpiles to be excavated. Identify required lines, levels, contours, and datum. Identify limits and elevations of all existing soil stockpiles. Provide electronic and paper copy of pre-construction survey to Engineer prior to initiating excavation. Pre-construction survey will be the basis for determining pay quantities and must be approved by Engineer prior to initiating excavation.

B. Identify known underground, above ground, and aerial utilities. Stake and flag locations. Call Gopher State One Call. Notify utility company to remove utilities.

C. Protect above and below grade utilities which are to remain.

D. Protect plant life, and other features remaining as a portion of final landscaping.

E. Protect areas beyond construction zone with erosion control materials.

F. Protect bench marks from excavation equipment and vehicular traffic.

3.03 SUBSOIL EXCAVATION

A. Excavate subsoil from areas to be further excavated for liner construction, as indicated in the Drawings.

B. Utilize excavated subsoil for establishing base grades and construction of perimeter and transition berms, as illustrated in the Drawings.

C. Excess subsoil materials not required for perimeter berm construction shall be stockpiled on site, as directed by the OWNER.

3.04 FILLING

A. Fill areas and perimeter berm to contours and elevations as needed with unfrozen materials.

B. Place and compact material in continuous layers not exceeding 8 inches compacted depth, compacted to 95 percent Standard Proctor maximum density.

C. CONTRACTOR shall construct the general fill layer as defined in the project drawings. Depth of material shall be within plus-0.5 foot and minus-0.0 foot tolerance at all locations.

D. Maintain moisture content of fill materials to attain the required compaction.

E. Make grade changes gradual. Blend slope into level areas.

3.05 FINAL GRADING

A. Uniformly grade areas within limits of grading under this section, including adjacent transition areas. Smooth finish surface to within specified tolerances, compact with uniform levels or slopes between points where elevations are shown, or between such points and existing grades.

1. Do not commence final grading until construction, fill, backfill and rough grading have been completed and approved.

2. Areas that have been finish graded shall be protected from subsequent construction operations, traffic and erosion. Repair all areas that have become rutted by traffic or eroded by water or have been settled below the correct grade.

3. All areas disturbed by the CONTRACTOR's operations shall be restored to equal or better than original condition or the requirements of the work.

4. Conduct survey of finished subgrade in accordance with Sections 3.06 and 3.07.

3.06 TOLERANCES

A. Top Surface of Subgrade (3 feet below finished top of base grade contours in the base and 18 inches below finished top of base grade on the sideslopes as shown on the Drawings): Plus 0 or minus 0.3 foot.

3.07 FIELD QUALITY CONTROL

A. Field inspection and testing will be performed by the OWNER.

B. Coordinate survey and testing of finished subgrade with ENGINEER in accordance with Section 01050. Do no further excavation or material placement until all cross-sections or topographic survey necessary for determining pay quantities has been completed by and at the CONTRACTOR's expense and checked by the ENGINEER.

The topographic survey shall be performed by a Registered Land surveyor to record the top of subgrade elevation on a grid pattern not greater than 50 feet by 50 feet. All field notes and electronic (CAD) files must be provided with the survey.

C. Tests and analysis of fill material will be performed by the OWNER or ENGINEER in accordance with ASTM D698.

D. Compaction testing will be performed by the OWNER OR ENGINEER in accordance with ASTM D1556 or ASTM D2922.

E. If tests indicate Work does not meet specified requirements, remove Work, replace and retest at no cost to OWNER.

END OF SECTION 02211

SECTION 02270

GEOSYNTHETIC MATERIALS

PART 1 GENERAL

3.01 SECTION INCLUDES

A. Furnishing and installing non-woven geotextile filter fabric.

3.02 RELATED SECTIONS

A. Section 02900 – Clay Liner.

B. Section 02905 – Flexible Membrane.

C. Section 02907– Coarse Aggregate.

C. Section 02910 – Leachate Collection System.

1.03 REFERENCES

A. Minnesota Department of Transportation Standard Specifications for Construction, Current Edition, hereafter referred to as Mn/DOT Standard Specifications.

1.04 SUBMITTALS

A. Geotextile Filter Fabric: Submit for documentation quality control certificates from the manufacturer representative of the rolls delivered to the site. The document shall present test results for the physical properties specified below. A quality control certificate shall be submitted for each 50,000 square feet of continuously produced material. A quality control certificate shall be submitted for each roll of material that is not from a continuous production run for which a certificate has previously been provided.

PART 2 PRODUCTS

2.01 MATERIALS

A. Non-woven Geotextile Filter Fabric: SKAPS Nonwoven Civil Geotextiles (GT-180) (8-oz), or approved equal.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install filter fabric at the locations and to the dimensions shown on the Drawings. The filter fabric shall overlap at least 12 inches between panels.

END OF SECTION 02270

SECTION 02900

CLAY LINER CONSTRUCTION

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Construction of a 24-inch minimum thickness clay liner above the prepared subgrade in the liner portion of the construction area.

B. Bid Alternate – Construction of a 12-inch minimum thickness clay liner above the prepared subgrade in the slope liner portion of the construction area

B. Verifying material thickness requirements.

1.02 RELATED SECTIONS

A. Section 02211 – Rough Grading.

B. Section 02905 – Flexible Membrane Liner (FML) System.

C. Section 02915 – Sand Drainage Layer.

1.03 REFERENCES

A. ASTM D422 – Particle-Size Distribution

B. ASTM D4318 – Atterberg Limits

C. ASTM D2488 – Soils Description

D. ASTM D2487 – Soils Classification

E. ASTM D2216 – Moisture Content

F. ASTM D3017 – Moisture Content (Nuclear Method)

G. ASTM D1556 – Soil Density

H. ASTM D2922 – Soil Density (Nuclear Method)

I. ASTM D698 – Moisture - Density Relation of Soil

J. ASTM D2434 – Permeability of Sand Soils

K. ASTM D5084 – Permeability of Soils using a Flexible Wall Permeameter.

PART 2 PRODUCTS

2.01 MATERIALS

A. Specifications - Clay soil used by the CONTRACTOR for liner construction shall meet the following test/classification specifications:

Reference	Specification
ASTM D4318 – Atterberg Limits	Liquid Limit: ≥ 25% Plasticity Index: ≥ 12%
ASTM D422 – Particle Size Distribution	100% passing 3" sieve, min. 50% by weight passing #200 sieve, max. % gravel = 5%, max. rock size = 1" diameter, max. clod size = 3"
ASTM D2216 – Natural Moisture Content	N/A
ASTM D698 – Moisture/Density Relationship	N/A
ASTM D2434 – Soil Permeability	1×10^{-7} cm/sec
ASTM D2488 – Soils Description	N/A
ASTM D2487 – Soils Classification	CL, CH, no organic matter

B. Clay Borrow: Clay to be placed as liner material shall be tested to demonstrate compliance with material specifications as outlined in Part 3.03. The ENGINEER shall be provided with a document from an independent laboratory certifying that the clay soil borrow source meets the material specification described above.

Testing results shall be supplied to the ENGINEER two weeks prior to liner construction. The CONTRACTOR shall bear the costs of clay soil sampling and testing required to meet the above specifications. Costs associated with the ENGINEER's inspection and approval shall be borne by the OWNER.

C. The OWNER or ENGINEER reserves the option to inspect and reject unsuitable materials.

D. The CONTRACTOR is responsible for placement and compaction of accepted material to the specified compaction parameters and specified permeability requirements.

E. Any areas not meeting the compaction or the permeability standard shall be reworked at the CONTRACTOR's expense.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify site conditions and condition of haul roads.

3.02 CLAY LINER CONSTRUCTION

A. Clay material shall be loaded from either the source, and transported to the landfill site.

B. Clay material shall be placed for liner construction where shown on the Drawings.

C. Material shall be placed, graded and compacted in no greater than eight-inch lifts (after compaction), for a total minimum thickness of 24 inches (12 inches for Bid Alternate).

D. Grade stakes shall be placed and removed with each eight-inch lift applied, at locations other than where stakes were placed in the lift immediately preceding it. That is, the location of grade stakes will be offset from the location of grade stakes in the previous lift. This is required to prevent areas of lower compaction in the immediate vicinity of grade stakes from becoming continuous in subsequent lifts.

E. The water content of the clay material prior to and during placement shall be distributed uniformly throughout each layer. The allowable range of moisture content shall be between zero and five percent above the optimum moisture content as determined by ASTM D698. The CONTRACTOR shall adjust moisture content to achieve the allowable range and shall maintain optimum moisture content until placement of the flexible membrane liner.

F. The clay material shall be compacted to a minimum 95 percent of Standard Proctor Maximum Density (ASTM D698). The finished clay layer shall have a smooth and uniformly sloped surface to promote sheet flow drainage. Final compaction of the uppermost lift shall be completed with a smooth drum roller. Surface shall be within plus 0.2 or minus 0 foot tolerance of finished plan contours at all locations. Adjustments may be allowed, provided that grades are sufficiently developed to direct drainage toward the leachate collection piping.

G. The clay liner component of the composite liner system will be constructed in such a manner as to minimize the time between completion of a section of the clay liner and placement of the 60-mil HDPE flexible membrane. The CONTRACTOR shall be responsible for maintaining optimum moisture in the completed clay liner (most importantly the exposed surfaces) prior to placement of the flexible membrane liner.

H. The CONTRACTOR shall be responsible for filling all grade stake holes in the clay liner with bentonite (powder or chips) before placement of flexible membrane liner.

I. The clay liner shall have a maximum permeability of 1×10^{-7} cm/sec for each lift placed.

3.03 FIELD QUALITY CONTROL

A. Clay Source Testing

1. The following testing procedures will be performed for verification of off-site borrow source:

Description	Method	Frequency	Specification
Atterberg Limits	ASTM D4318	1 test/3,000 c.y.	Liquid Limit: ≥ 25% Plasticity Index: ≥ 12%
Particle Size Distribution	ASTM D422	1 test/3,000 c.y.	100% Passing 3" sieve, 50% (W/W) Passing #200 sieve, max. % gravel = 5%, max. rock size = 1" diameter, max. clod size = 3"
Water Content	ASTM D2216 or D3017	1 test/3,000 c.y.	Optimum moisture content
Density	ASTM D698 or D1557	1 test/3,000 c.y.	Maximum density
Soil Permeability	ASTM D5084, EPA 9100	1 test/5,000 c.y.	1×10^{-7} cm/sec (95% recompacted)
Soil Classification	ASTM D2487	1 test/3,000 c.y.	CL, CH, SC if soil meets permeability and other criteria, No organic matter

2. Testing of off-site clay soils shall be conducted by an independent laboratory. Costs associated with this testing shall be borne by the CONTRACTOR.

B. Construction

1. All soils testing shall be performed in accordance with applicable ASTM standards. The method, frequency, and minimum requirements for testing are summarized in the following table.

Description	Method	Frequency	Specification
Compaction/ Nuclear Density	ASTM D2922 and D1556	1 test/ 10,000 sf/ 8-inch lift	Minimum 95% standard proctor
Water Content	ASTM D2216 - Nuclear Method	1 test/10,000 sf/ 8-inch lift	0-5% above optimum
Thickness	Survey	50 ft. grid	Minus zero to plus 0.2-feet
Permeability	ASTM D5084 EPA 9100	1 test/acre/ft	Less than 1×10^{-7} cm/sec

2. Moisture tests and density tests will be performed by the ENGINEER (at the OWNERS expense) on each lift, at locations chosen by the ENGINEER but at a minimum of one test per 100 ft. grid per lift (1 test/10,000 s.f./8-inch lift). A minimum density of 95 percent of the maximum density and zero to five percent

above the optimum moisture content of the Standard Proctor Test (ASTM D698) will be required. Additional testing can be ordered at the discretion of the ENGINEER.

If clay material testing indicates that the compaction or moisture requirements are not being met, the CONTRACTOR shall excavate, scarify, adjust moisture, and recompact the nonconforming area. All costs associated with the remedial work, including retesting costs, shall be borne by the CONTRACTOR.

3. One permeability test (ASTM D2434) per twelve-inch-lift thickness of clay liner shall be performed on a 200 foot grid at locations chosen by the ENGINEER. Testing will be performed under the direction of the ENGINEER and at the OWNER's expense. CONTRACTOR shall cooperate with ENGINEER in performing permeability testing.

   If clay material testing indicates that the permeability requirements are not being met, the CONTRACTOR shall excavate, scarify, adjust moisture, and recompact the nonconforming area. All costs associated with the remedial work, including retesting costs, shall be borne by the CONTRACTOR.

4. Clay liner thickness shall be verified at the CONTRACTOR's expense. The verification will consist of a topographic survey performed by a Registered Land surveyor, as required in Section 01050, of the top of subgrade elevation and the top of completed clay liner elevation conducted on a grid pattern not greater than 50 feet by 50 feet. All field notes and electronic (CAD) files must be provided with the verification.

   Any areas showing less than the specified thickness of liner material shall be remediated, including additional testing and surveying as required to meet the thickness specification, at the CONTRACTOR's expense.

5. The CONTRACTOR shall obtain the approval of the ENGINEER for the minimum layer thickness before beginning the placement of subsequent layers.

END OF SECTION 02900

SECTION 02901

SOIL BUFFER LAYER

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Construction of a soil buffer layer over the sideslopes.

1.02 RELATED SECTIONS

A. Section 02211 – Rough Grading.

B. Section 02905 – Flexible Membrane Liner System.

1.03 REFERENCES

A. ASTM D698 – Moisture-Density Relation of Soils

B. ASTM D1556 – Density of Soil In-Place

C. ASTM D422 – Particle Size

D. ASTM D2487 – Soil Classification

E. ASTM D2922 – Soil Density Nuclear Method (shallow depth)

PART 2 PRODUCTS

2.01 MATERIALS

A. Materials for use in the buffer layer construction shall be classified as clean sand soil with 100% passing the 3/8-inch sieve and shall be free of sharp rocks and objects, muck, peat, roots or other organic debris. Material will be hauled on existing haul roads from stockpiles in the adjacent gravel pit, Duluth Ready Mix.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify site conditions under provision of Section 01039.

B. Verify condition of haul roads.

C. Verify that survey benchmark and intended elevations for work are as indicated.

3.02 BUFFER LAYER CONSTRUCTION

A. All topsoil, vegetation, rocks and other materials which may puncture the flexible GCL/membrane liner material shall be removed.

B. The buffer layer material shall be loaded from the adjacent gravel pit borrow areas or stockpiles and transported to the site.

C. The buffer layer shall be constructed where shown on the Plans.

D. Buffer layer shall be placed, graded and compacted to a six-inch minimum thickness on the sideslopes as shown on the Drawings.

E. Soil buffer layer may be placed in a single lift and compacted following placement. Soil buffer layer shall be compacted to 95 percent standard proctor maximum density ASTM D698).

F. The finished subgrade shall have a smooth and uniformly sloped surface. Surface shall be free of all rocks, protruding objects or any other materials that may puncture the flexible GCL/membrane liner material. Final compaction of the uppermost lift shall be completed with a smooth drum roller. Surface shall be within plus 0.2 or minus 0 foot tolerance of finished plan contours at all locations. Adjustments may be allowed, provided that grades are sufficiently developed to direct drainage toward the leachate collection piping.

G. The buffer layer will be constructed in such a manner as to minimize the time between completion and placement of the GCL. The CONTRACTOR shall be responsible for maintaining the completed buffer layer (most importantly the exposed surfaces) prior to placement of the flexible membrane liner.

H. Maintain moisture content of fill materials to attain the required compaction.

I. Make grade changes gradual. Blend slope into level areas.

3.03 FINAL GRADING

A. Uniformly grade areas within limits of grading under this section, including adjacent transition areas to conditions acceptable to the GCL Installation Contractor. Smooth finish surface to within specified tolerances, compact with uniform levels or slopes between points where elevations are shown, or between such points and existing grades.

1. Do not commence final grading until construction, fill, backfill and rough grading have been completed and approved.

2. Areas that have been finish graded shall be protected from subsequent construction operations, traffic and erosion. Repair all areas that have become rutted by traffic or eroded by water or have been settled below the correct grade.

3. All areas disturbed by the CONTRACTOR's operations shall be restored to equal or better than original condition or the requirements of the work.

3.04 FIELD QUALITY CONTROL

A. Field inspection and testing will be performed by the ENGINEER.

B. Coordinate survey and testing with ENGINEER. Do no further excavation or material placement until all cross-sections or topographic survey necessary for determining pay quantities has been completed and checked by the ENGINEER.

C. Tests and analysis of fill material will be performed in accordance with ASTM D698.

D. Compaction testing will be performed in accordance with ASTM D1556 or ASTM D2922.

E. If tests indicate Work does not meet specified requirements, remove Work, replace and retest at no cost to OWNER.

3.05 QUALITY CONTROL

A. The CONTRACTOR shall submit to the ENGINEER a letter from the GCL installer stating the manufacturer's authorized representative has inspected the subgrade and found the preparation to meet the project specifications and to be acceptable for cell construction.

B. Prior to installation, one particle-size analysis per 2,000 cubic yards of material to be placed will be submitted to the ENGINEER for approval. A minimum of three (3) tests shall be completed from the borrow source.

C. All buffer layer testing will be performed by a testing laboratory at the CONTRACTOR's expense. Additional testing may be ordered at the discretion of the ENGINEER.

D. If material testing indicates that the specified requirements are not being met, the CONTRACTOR shall excavate, replace and recompact the nonconforming area. All costs associated with the remedial work including retesting costs shall be borne by the CONTRACTOR.

E. Soil testing shall be performed in accordance with proper ASTM standards.

F. The thickness of the soil buffer layer shall be verified by survey.

END OF SECTION 02901

SECTION 02905

FLEXIBLE MEMBRANE LINER

PART 1 GENERAL

1.01 SECTION INCLUDES

A. The work covered under this section of the specifications shall include the furnishing of all material, labor, tools, equipment, tests and services necessary to install the smooth and textured 60-mil high density polyethylene (HDPE) flexible membrane liner (FML) as shown on the Drawings and in accordance with the specification. Smooth FML will be placed on base of cell and textured FML will be placed on the eastern sideslope and the transition berm flap, as shown on the Drawings. This section includes CONTRACTOR's construction of the liner anchor trenches as shown on the drawings.

B. The OWNER has made an Allowance for the CONTRACTOR to provide independent leak detection testing. Any and all repairs deemed necessary to the FML as a result of leak detection testing, shall be made in accordance with these Specifications by the liner installer and paid for by the CONTRACTOR. No additional costs for geosynthetic repairs resulting from the leak detection testing will be borne by the OWNER.

1.02 RELATED SECTIONS

A. Section 02211 - Rough Grading.

B. Section 02900 - Clay Liner Construction.

C. Section 02910 - Leachate Collection and Detection System.

D. Section 02915 - Granular Drainage Layer.

1.03 REFERENCES

A. Geosynthetic Research Institute (GRI) – GM 12.

B. GRI – GM 13.

C. GRI – GM 19.

D. ASTM D6392 - Practice for Determining the Integrity of Field Seams Used in Joining Flexible Polymeric Sheet Geomembranes.

E. ASTM D6693 – Standard Test Method for Tensile Properties of Plastics.

1.04 SUBMITTALS

A. The CONTRACTOR shall submit the following:

1. With the Proposal

   a. Name of the proposed manufacturer and Installer of HDPE flexible membrane.

   b. Itemization of any exceptions to the plans and specifications.

2. After contract award, before construction;

   a. Certified test reports done by an independent testing laboratory on the geomembrane to be installed which indicate compliance with GRI – GM12, GM 13 and GM 19 and these specifications.

   b. Proposed seaming methods and details of the flexible membrane sheet layout showing proposed flexible membrane sheet dimensions, identification numbers, and location of all field welds and/or seams.

   c. A submittal from the FML Installation Contractor outlining procedures for approval of subgrade preparation prior to installation of the flexible membrane liner.

   d. A letter from the flexible membrane manufacturer that states:

      - the manufacturer has reviewed and approved the specifications for the base preparation upon which the flexible membrane cap is to be installed.
      - the INSTALLATION CONTRACTOR of the flexible membrane has completed at least three similar jobs with installation of equal or greater square footage. A resume shall be included with the letter.

   e. Identification of the contact person at the OWNER designated independent laboratory that will perform the sheer and peel test results for the ENGINEER.

   f. Copies of the warranties and bonds for preliminary approval by the ENGINEER.

   g. Shop drawings of Flexible Membrane Liner and anchor trenches.

3. To be supplied with the FML material:

   a. The origin (resin suppliers name, resin production plant), identification (brand name, number) and production date of the resin.

   b. A copy of the quality control certificates issued by the resin supplier noting results of the density and melt index.

   c. Reports on the test conducted to verify the quality of the resin used to manufacture the geomembrane rolls supplied including specific gravity and melt index.

d. Laboratory test results and certification stating that all geomembrane rolls are furnished by one supplier, and that all rolls are manufactured from one resin type obtained from one resin supplier.

4. Upon Completion of leak detection testing:

a. A report from the leak detection testing firm detailing the testing performed, description and location of leaks detected.

5. Upon completion of the FML installation:

a. A letter from the INSTALLATION CONTRACTOR stating that the flexible membrane liner was installed in accordance with the manufacturer's specifications and the manufacturer's instructions.

b. A "Field Seam Sampling and Testing Report," including all information described in Part 4.

c. All material and installation warranty submittals as defined in Section 1.05.

1.05 WARRANTY

A. Material Warranty

1. The Manufacturer shall furnish the OWNER with the manufacturer's written warranty against manufacturing defects and material degradation of the flexible membrane for a period of 20 years from the date of Official Acceptance by the OWNER.

2. Flexible membrane to be warranted against the affects of municipal solid waste leachate.

B. Installation Warranty

1. The INSTALLATION CONTRACTOR shall warrant the installation of the flexible membrane liner against defects for a period of two (2) years from the date of Official Acceptance by the OWNER.

2. The INSTALLATION CONTRACTOR, or their designated representative, shall repair any defects due to improper installation which occur during the warranty period at no cost to the OWNER. This includes results of the leak detection testing.

3. The INSTALLATION CONTRACTOR shall furnish the OWNER with a written warranty covering the above requirements.

1.06 DELIVERY, STORAGE AND HANDLING

A. Deliver, store, protect and handle products to site under the following provisions and Section 01600.

B. Store geosynthetic rolls on a prepared surface (not on wooden pallets) in the space allocated by the OWNER. Protect rolls from puncture, dirt, grease, water, moisture, mud, mechanical abrasions, excessive heat or other damage. Stack geosynthetic rolls no more than three rolls high.

C. Use appropriate handling equipment to load, move, or deploy geosynthetic rolls. Appropriate handling equipment includes cloth chokers and spreader bar for loading, spreader, and roll bars for deployment. Dragging panels on ground surface will not be permitted.

D. Do not fold geosynthetic materials; folded or creased materials will be rejected.

PART 2 PRODUCTS

2.01 GENERAL

A. The materials supplied under these specifications shall be first quality products designed and manufactured specifically for the purposes of this work, and which have satisfactorily demonstrated by prior use to be suitable and durable for these purposes.

2.02 HIGH DENSITY POLYETHYLENE FLEXIBLE MEMBRANE LINER MATERIAL

A. The CONTRACTOR shall supply to the ENGINEER a quality control certificate certifying the test results of the applicable physical properties for HDPE membrane listed in GRI-GM13.

B. The HDPE materials shall be so produced as to be free of creases, holes, blister, undispersed raw materials or any sign of contamination by foreign matter. Any such defect shall be cause for rejection of material by the OWNER and the CONTRACTOR shall immediately remove the defective material from the site.

C. Both the smooth and textured material shall be nominal 60-mil thickness and resistant to, and not be affected by, sensitive to, or break down under exposure to, ultra-violet light. Each roll of furnished HDPE membrane shall be marked to show a minimum of the following information: product type, product thickness, manufacturing batch code, date of manufacture and physical dimension.

PART 3 EXECUTION

3.01 GENERAL

A. The ENGINEER shall be notified seven (7) days prior to commencing installation. The Installation Contractor shall have provided submittals and received approval of material and verified the preparation of the material base the FML is to be placed upon prior to commencing with the installation.

B. The INSTALLATION CONTRACTOR shall provide the OWNER with proof of adequate welding and testing equipment and materials on-site prior to the commencement of installation.

C. Sufficient sandbags and other need materials and equipment shall be on-site to complete installation of the geosynthetic components prior to commencement of any installation.

D. An authorized technical representative of the flexible membrane manufacturer shall be on-site during the installation.

E. Liner panels shall be laid in strict accordance to the manufacturer's instructions and shop drawings. Any necessary deviations shall be documented.

F. The CONTRACTOR shall carry out a visual inspection of the sheet rolls upon arrival at site for possible transport damage. As each sheet is unrolled, the INSTALLATION CONTRACTOR shall carry out further visual inspection of the sheet surface. All defects shall be repaired prior to installation. The OWNER retains the right to reject all defective material.

G. All field seams for liner shall be visually inspected and, in addition, all field seams shall be checked for its entire length using a non-destructive testing method per manufacturer's recommendation. Any weak or unbounded seam shall be repaired with an overlay patch and retested. All patches shall have rounded corners.

H. It shall be the CONTRACTOR's responsibility to provide adequate storage facilities for geosynthetics according to the manufacturer's recommendations. All materials stored on-site shall be protected to keep the material sheets clean and dry.

I. Based on the finding of the leak detection service, all necessary repairs will be made, and costs associated with the repairs paid for by the CONTRACTOR. No additional compensation shall be paid by the OWNER for repairs identified by the leak detection testing.

3.02 DEWATERING

A. The CONTRACTOR shall take all steps necessary, such as ditching, diking, and pumping to keep the excavation areas clear of water/leachate during the progress of the work and until the finished work is safe from damage. The CONTRACTOR shall provide all power, pumps, materials, and miscellaneous apparatus necessary, and shall be responsible for disposing of the water/leachate pumped from the excavation in a manner which will not interfere with other Work within the area or cause damage to property. The CONTRACTOR shall be held responsible for all erosion, sediment deposit, or other adverse results because of the dewatering operations and shall repair any areas affected at no additional cost the OWNER.

1. CONTRACTOR shall note that leachate may not be discharged to surface water or directly onto ground surface. Leachate must be managed in accordance the

Landfill's *Leachate Management Plan* (i.e. pumped into leachate management system or back into a lined landfill cell).

B. CONTRACTOR and liner installation contractor responsible for keeping water from getting between FML and clay. If water does accumulate between the FML and the liner, the area should be dewatered and area reworked as necessary.

3.03 HDPE MEMBRANE LINER PLACEMENT

A. The FML subsurface shall be smooth and free of all rocks, stones, sticks, roots, sharp objects, protuberances, weed growth, or debris of any kind. The surface shall provide a firm, unyielding foundation for the liner with no sudden, sharp, or abrupt changes or breaks in grade. No standing water or excessive moisture shall be evident at the time of liner installation. The receiving surface shall be maintained in an acceptable condition until completion of the liner installation.

CONTRACTOR shall provide ENGINEER with written certification from the liner installer verifying acceptability of the subgrade prior to placement of the geomembrane. The receiving surface shall be maintained in an acceptable condition until completion of the liner installation.

B. Panel Identification: Each panel shall be labeled with an identifying code number or letter consistent with the Installation Contractor's submitted panel layout drawing. The coding is subject to approval by the CQA Monitor.

C. The smooth and textured FML shall be installed throughout as indicated on the plans and approved panel layout. The FML shall be placed over the prepared surfaces in such a manner as to assure minimum handling. The sheets shall be of such lengths and widths and shall be placed in such a manner as to reduce field jointing to a minimum. Only those sheets of lining material which can be anchored and/or sealed together in one day shall be unpackaged and placed in position.

D. HDPE panels shall be laid in a longitudinal direction with a minimum overlap of four inches for wedge welds and three inches overlay for extrusion welds. The weld shall be placed uniformly and shall be of a type suitable for underwater use.

E. Geomembrane sheets shall be closely fit and sealed around inlets, outlets, and other projections through the lining. All projections through the lining shall be sealed and flashed with prefabricated boots. All sealing methods shall be submitted to the ENGINEER for preapproval.

F. Do not deploy FML in the presence of excessive moisture, precipitation, ponded water, or high winds.

G. The INSTALLATION CONTRACTOR shall consult the manufacturer as to the minimum and maximum temperature for handling the flexible membrane.

H. Any portion of the FML damaged during installation shall be removed and repaired using an additional piece of the liner material as specified herein.

I. Protect underlying surface from damage. Repair damage to subgrade or other underlying materials prior to completing deployment of FML.

J. Do not allow unnecessary vehicle traffic directly on FML.

K. Where access or haul roads over the HDPE are to be utilized, a minimum of 3 feet of suitable material as approved by the ENGINEER shall be placed at these locations. Other methods for protecting the HDPE along the haul roads shall be considered by the ENGINEER. The haul roads may be removed and the area restored to project specifications or left in-place at the direction of the ENGINEER.

L. Only sandbags may be used as required to hold the lining in position during installation. Sandbags shall be sufficiently close-knit to preclude fines from working through the bag. Under no circumstances shall the lining be subjected to materials, sandbags, equipment, or other items being dragged across its surface nor shall workmen and others slide down slopes atop the lining. All parties walking or working upon the HDPE material shall wear soft sole shoes. No smoking shall be permitted on the exposed liner material.

M. Install material to account for shrinkage and contraction while avoiding wrinkles. Install material stress-free with no bridging before it is covered. Add material as needed to avoid bridging.

N. Before wrinkles fold over, attempt to push them out. For wrinkles that can not be pushed out, cut them out and repair cuts prior to burial or at the direction of the ENGINEER.

O. Corners and edges of the HDPE shall be located as per Section 01050 of these specifications. The FML shall be secured in an anchor trench at the top of the slope in accordance with the Drawings.

3.04 FIELD SEAMS

A. All field joints shall be done by a seaming process according to the manufacturer's specifications. The lining shall be elevated to the temperature of the weld during installation. No solvents or adhesives shall be allowed.

B. Field seams shall meet the requirements of the ASTM tensile test for both shear (room temperature) (ASTM D6392) and peel (70 degree C) (ASTM D6392). An independent laboratory shall test the seams for shear and peel to verify that they meet the stated ASTM standards. These results shall be provided prior to shop drawing submittal.

C. Extreme care shall be taken throughout the work to avoid fishmouths (bubbles, folds, or imperfect contact) in the field seams. Where fishmouths do occur, they shall be slit out far enough from the seam to dissipate them, lapped, welded together in the lapped area, and a patch placed to cover the entire effected area.

D. Any portion of the liner damaged during installation, by any cause, shall be removed or repaired by using an additional piece of HDPE geomembrane as specified hereinafter.

E. Destructive and non-destructive testing shall be conducted according to the quality control program outlined in Part 4.

3.05 PATCHING

A. Any necessary repairs to the HDPE lining shall be patched with the lining material itself. The patch material shall extend a minimum of three (3) inches in each direction from the damaged area. All patches shall have rounded corners. All patches shall be welded to the main sheet with the extrusion welding process. All seams shall be tested using the vacuum box method (ASTM D6392). Hand held hot air welding shall be allowed only to tack the patch material in place prior to extrusion welding.

B. All joints, on completion of the work, shall be tightly bonded. Any lining surface showing injury due to scuffing, penetration by foreign objects, or distress from rough subgrade shall, as directed by the ENGINEER, be replaced or covered and sealed with an additional layer of HDPE lining of the proper size in accordance with the patching procedures.

3.06 EXTRUSION WELDING

A. The flexible membrane material shall be cleaned and prepared according to manufacturer's procedures, a copy of which shall be given to the ENGINEER one (1) week prior to beginning seaming. Extreme care shall be taken by the INSTALLATION CONTRACTOR in the preparation of the areas to be welded.

B. All sheeting shall be welded together by means of integration of the extrudate material with the lining material. The composition of the extrudate used for the welding of seams shall be identical to the flexible membrane material.

C. The welding equipment used shall be capable of continuously monitoring and controlling the temperatures of the extrusion welder nozzle so as to ensure that changes in the environmental conditions will not affect the integrity of the weld.

3.07 FUSION WELDING

A. The flexible membrane material shall be cleaned and prepared according to manufacturer's procedures, a copy of which shall be given to the ENGINEER one week prior to beginning seaming. Extreme care shall be taken by the INSTALLATION CONTRACTOR in the preparation of the areas to be welded.

B. All sheeting seamed with this process shall be welded together by means of the bond formed when two heated sheets are pressed together.

C. The fusion-welding apparatus shall be an automated vehicular mounted device with variable temperature and speed control.

D. The fusion-welding apparatus shall be fitted with a double wedge shoe to produce a double seam with an enclosed air space.

E. The fusion-welding apparatus shall be capable of continually monitoring and controlling the temperature in the zone of contact (wedge) where the machine is actually fusing the lining material so as to ensure changes in the environmental conditions will not affect the integrity of the weld.

3.08 HDPE INSPECTION

A. An authorized representative shall be present at the job site full-time during HDPE installation and shall certify in writing that the subgrade preparation and HDPE installation is acceptable.

B. The INSTALLATION CONTRACTOR shall provide to the ENGINEER a letter that states that the Installer has inspected the installation and that the installation was installed in accordance with the manufacturer's specifications.

C. Written documentation shall be compiled by the INSTALLATION CONTRACTOR on the installation of each field seam. This documentation shall be provided to the ENGINEER upon completion of the installation. The authorized representative shall certify in writing that the HDPE was properly installed. This approval shall in no way remove INSTALLATION CONTRACTOR liability for installation or the manufacturer's material warranty.

PART 4 QUALITY CONTROL

4.01 GENERAL

A. Before installation begins, the Installation Contractor shall appoint an experienced individual who will be on-site at all times during the installation to represent them in all matters relevant to this work. This appointment shall be subject to approval by the ENGINEER.

B. Before and during installation, weekly project coordination meetings shall be held with the designated representative of the Installation Contractor, CONTRACTOR, ENGINEER, and OWNER in attendance to review the following information. The following information shall be provided to the ENGINEER by the Installation Contractor during or before this meeting:

1. Progress of the work.

2. Adherence to the Specifications.

3. Adherence to the Quality Control Program, including the timely submission of the pertinent forms.

4. Planned work and methods for the ensuing week, including estimate of time remaining to completion of the work.

C. All of the Forms specified and required must be submitted in a timely fashion.

D. Any changes in the proposed method of work, subcontractors to be utilized, membrane resin or manufacturing must be approved in advance by the OWNER and ENGINEER. The Installation Contractor assumes all responsibility relevant to providing an acceptable product.

4.02 QUALITY CONTROL DURING MANUFACTURING

A. Random sampling of the extruded sheet material shall be performed by the manufacturer at the cost of the Installation Contractor to assure proper quality control in accordance with GRI GM 13. The minimum frequency of such sampling such be as follows:

1. One sample taken from each day's production, and

2. Samples selected randomly by the ENGINEER subsequent to material delivery, or

3. Other as proposed by the Installation Contractor and approved by the ENGINEER.

B. The samples shall be tested for the following properties:

1. Uniformity - Visual inspection to assure the material is free of holes, blisters, undispersed raw material, or foreign matter is mandatory.

2. Thickness - Measurement along the sample to assure that the sheet is within the specified tolerances.

3. Carbon Black - The proper amount, grade, and degree of dispersion are imperative to assure proper UV radiation protection (ASTM D5596).

4. Tensile Properties - One dimensional tensile testing which measures tensile strength at yield at break, and elongation at yield and at break shall be made (ASTM D6693).

C. The Installation Contractor shall provide the OWNER and ENGINEER with certified copies of the manufacturer's test results. No material shall be installed prior to furnishing the required test results.

D. The Installation Contractor shall be solely responsible for the quality of the material provided. Should any of the tests performed on the material yield unsatisfactory results, the Installation Contractor will be responsible for replacing the material with satisfactory materials without delay to the project or cost to the OWNER.

E. The OWNER and ENGINEER, at their discretion, may obtain additional random samples of the membrane sheets for further confirmatory testing. This testing will be at the expense of the OWNER. The Installation Contractor shall, at no additional cost, provide whatever reasonable assistance the OWNER or ENGINEER may require in obtaining the samples.

4.03 QUALITY CONTROL DURING INSTALLATION

A. The Installation Contractor will be required to conduct both destructive and non-destructive testing during the membrane installation as part of the quality control program.

B. The ENGINEER or RPR and Installation Contractor shall visually inspect all material to be included in the work for transport damage and uniformity and compare sheet identification numbers with those on the certification provided by the manufacturer to assure delivery of the appropriate material.

C. The ENGINEER or RPR and Installation Contractor shall also visually inspect the material for any damage incurred as a result of on-site storage.

D. A start-up field test of the seaming equipment and operator shall be performed on a test strip at or near the work location at the start and midpoint of each work day. All trial welds shall be conducted under the same conditions as will be encountered during actual seaming.

The test strip shall be a minimum of 6 feet in length for self-propelled seaming devices, and a minimum of 3 feet for hand-held seaming devices. The tensiometer used for testing the strips and test fixture for making the field test shall be provided by the Installation Contractor at no additional cost. One inch (1") wide cutouts of the test strips seams will be subject to shear and peel adhesion testing at the site. A minimum of three cutouts will be tested for shear, and an additional three cutouts will be tested for peel. All seam tests must be acceptable or the test strip will be repeated until all seam tests from a given test strip are found acceptable. The testing shall be observed by the ENGINEER or RPR. A seam test will be considered a failure if:

1. In the one-dimensional linear tension test, the bonded thickness of the seam fails before the adjacent sheet material for one or more of the three test specimens tested from each sample.

2. In the peel adhesion test, the two sheets comprising the seam separate at the bond interface before tearing an individual sheet (not a film tearing bond) for one or more of the three test specimens tested from each sample.

3. Upon visual inspection, the weld shows:

   a. Excessive deformation; stepping of the bottom sheet when viewed in cross-section.

   b. Discoloration of the sheet.

   c. Inadequate or excessively narrow or flat weld bead.

   d. Water blisters in weld bead.

e. Misaligned weld bead, i.e., weld not reasonably centered with respect to overlap.

f. Thinning of the sheet adjacent to the weld.

E. The fixture used for making the specified tests in the field shall be strong enough to permit the operator to determine that the seam is at least as strong as either sheet.

F. Destructive test samples of the installed membrane shall be collected at a minimum average frequency of one (1) test location for every 500 feet of seam length, from randomly determined locations approved by the ENGINEER. The cut-out sections shall be 12 inches wide by 42 inches long with the seam centered lengthwise. The resulting hole shall be patched with an oval shaped piece of 60-mil HDPE, and seamed in accordance with these Specifications.

The Installation Contractor shall provide a punch press, capable of cutting specimens in accordance with ASTM D 6392, for on-site preparation of three sub-specimens for testing. Each sub-specimen shall be properly tagged with the date, location, sample number, and seaming machine number, and distributed as follows:

1. One 12-inch by 15-inch to the installer for field testing. The Installation Contractor shall test the weld in shear and peel with the Installation Contractor's on-site tensiometer in accordance with ASTM D 6392. Testing shall be completed and reported to the ENGINEER prior to backfilling the seam the coupon represents.

2. One 12-inch by 15-inch for independent laboratory peel and shear testing in accordance with ASTM D 6392. The Installation Contractor shall transmit test results to the ENGINEER within 24 hours after the laboratory receives the weld samples.

3. One 12-inch by 12-inch to the ENGINEER for archive storage.

G. A log shall be maintained by the Installation Contractor for the purpose of recording all test results.

H. If at any time during the installation, the ENGINEER has reason to believe that the seaming process is not performing adequately, he may, to avoid destructive sampling of the installed membrane, request additional test strips. This shall be done by the Installation Contractor at no additional cost. If the test strip seams fail at the site, the reason for the failure shall be resolved before any seaming of the membrane continues within the facility.

I. No membrane will be covered by the CONTRACTOR until such time as the ENGINEER has reviewed the test results required by these Specifications. At a minimum, the pre-delivery testing, the daily log of test strip seam results, laboratory results, as-built drawings of the completed area, and approval of the seams in place will be reviewed. The Installation Contractor shall be held responsible for protection of the installed membranes prior to placement of the granular drainage layer.

J. The ENGINEER and Installation Contractor shall visually inspect all membrane seams. In addition, with regard to the membrane components of the landfill, the Installation Contractor shall test all seams along the entire length, in the manner approved prior to installation, in the presence of the ENGINEER's representative. The recommended test methods are as follows:

1. Pressurized Dual Seam - All field seams made by a double seam hot wedge welding device shall be tested by applying air pressure to a sealed length of seam and monitoring the pressure over time. After making the seam between two adjacent liner panels, each end of the air channel in the weld shall be sealed. A needle, or other approved device, shall be inserted into the sealed channel created by the fusion weld and the channel inflated to a minimum pressure of 30 psig. Monitor and record the pressure in the channel for a period of 5 minutes with an air pressure gauge calibrated in 1 psi increments. The seam shall be considered passing if the pressure drop in 5 minutes is less than 4 psi.

   At the conclusion of the test, cut the end of the air channel at the end opposite the pressure gauge. A decrease in gauge pressure must be observed or the air channel will be considered blocked and the test must be repeated in each direction from the point of blockage.

   Air channels which do not hold the minimum specified air pressure, shall be further inspected to identify the location and nature of any unbonded sections of seam. The seam shall then be repaired and retested.

2. Vacuum Box Testing - All field seams, with the exception of hot wedge seams passing the dual seam pressure test described above, shall be inspected for unbonded areas by applying a vacuum to a soaped section of seam. The vacuum shall be applied by a vacuum box equipped with a vacuum gauge, a clear glass view panel in the top, and a soft rubber gasket on the periphery of the open bottom.

   A section of the seam shall be soaped thoroughly and the vacuum box shall be placed over the soaped seam section and the gasket sealed to the liner. A vacuum of between four and eight inches of Mercury (Hg) shall then be applied to the box and the seam observed for signs of bubbles which will appear over unbonded areas. All unbonded areas shall be marked and repaired by the Installation Contractor.

K. All welds shall be observed for traces of deformation to the liner panels. Any welds which, in the opinion of the ENGINEER have caused excessive deformation or show visual signs of overheating of the liner panels, shall be repaired at no additional cost to the OWNER regardless of the result of any destructive testing on the seam. The deficient seam shall be cut out, the liner panels again overlapped and welded, or the seam overcapped.

L. Based on the finding of the leak detection service, the ENGINEER will make the determination as to responsibility of each repair necessary. Costs for material defects and repairs necessary to due installation will be the responsibility of the contracted liner

installer. Costs for repairs necessary to due soil materials, placement of the sand drainage layer, or heavy equipment, will be the responsibility of the CONTRACTOR.

M. The Installation Contractor shall provide a Field Seam Sampling and Testing Report to the OWNER and ENGINEER upon completion of FML installation. The report shall include the following:

1. Complete identification of membrane liner system, including type of resin, sheet, source, and thickness.

2. The quality control tests used as specified and/or directed.

3. Complete description of field sampling and analysis procedures, including number of test specimens, size of test specimens, type of test machine used, grip separation, and crosshead speed.

4. Complete description of laboratory test methods.

5. Field and laboratory peel and tensile load values for individual specimens in pounds per inch of width, and also the average load value for each group of specimens.

6. Type of failure in the tests, that is, within the seam within the sheet material, clamp edge or seam edge, for each individual specimen.

7. For non-destructive testing, type of non-destructive test, and number of apparent failures and repairs of seams as reported on a 100 lineal feet of seam basis.

8. Log of all quality control work.

9. Record drawing.

10. Certification by Installation Contractor that all materials were installed in accordance with these Plans and Specifications.

N. Geomembrane Acceptance:

1. Installation Contractor will retain ownership and responsibility for the geomembrane until acceptance by OWNER. Geomembrane liner will be accepted by OWNER when:

   a. Installation is complete;

   b. Leak detection testing has been completed and all necessary repairs identified have been made; and

c. Written certification letters, including subgrade acceptance letter, resin information letter, leak detection testing results, "Field Seam Sampling and Testing Report", and "as-built" drawings, are received by the OWNER.

END OF SECTION 02905

SECTION 02906

INTERMEDIATE AGGREGATE

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Work under this section includes descriptions and requirements for the installation of the intermediate aggregate in the leachate collection sumps and trenches.

1.02 RELATED SECTIONS

Section 02210 – Rough Grading
Section 02907 – Coarse Aggregate
Section 02915 – Sand Drainage Layer
Section 02910 – Leachate Collection System

1.03 REFERENCES

A. American Society for Testing and Materials (ASTM):

1. ASTM D422-63 – Standard Method for Particle Size Analysis of Soils.

2. ASTM D2487-85 – Standard Test Method for Classification of Soils for Engineering Purposes.

1.04 SUBMITTALS

A. Location of off-site source of materials.

B. Name, address, telephone number and contact person of independent soils laboratory.

C. Off site source material analyses (See part 1.05).

1.05 SOIL MATERIAL SOURCE QUALITY ASSURANCE

A. Independent soils laboratory to be approved by OWNER.

B. Source testing to be performed by the OWNER.

C. Provide one (1) test per 1,000 lineal feet (minimum of three (3) tests) of each of the following test results per source:

1. Grain size analysis (D422).

2. USCS soil classification (D2487).

PART 2 - PRODUCTS

2.01 SOIL MATERIALS

A. INTERMEDIATE FILTER BLANKET MATERIAL

1. Material will be hauled on existing haul roads from stockpiles in the adjacent gravel pit.

2 Durable washed, coarse rounded to subangular, durable gravel exhibiting the following characteristics:

Sieve	Percent Passing
3/8"	100%
#4	20-60%
#10	5-25%
#200	0-5%

3 Crushed aggregate and/or limestone are not allowed.

PART 3 - EXECUTION

3.01 FILL USAGE

A. Leachate collection trenches and sumps between coarse aggregate and sand drainage layer as shown on Drawings.

3.02 PREPARATION

A. CONTRACTOR to receive OWNER's permission to begin installation of intermediate aggregate.

3.03 PLACEMENT

A. Transport material into landfill cell in a manner that will not damage underlying soil or synthetic layers.

B. Place intermediate aggregate in trenches and sumps as shown on Drawings.

C. Do not compact.

D. CONTRACTOR shall place intermediate aggregate by such method as to prevent wrinkling and possible damage to the HDPE liner. Once the geosynthetic lining system has been accepted by the OWNER, it shall be the CONTRACTOR'S

responsibility to ensure that the geosynthetics are not damaged. Should they become damaged, the CONTRACTOR shall at his own expense:

1) Immediately notify ENGINEER

2) Have the FML INSTALLATION CONTRACTOR's make any necessary repairs at the CONTRACTOR'S expense.

3.04 FIELD QUALITY CONTROL

A. Comply with approved Quality Assurance Manual.

B. Testing:

1. Tests performed and frequency of tests specified in the Quality Assurance Manual.

2. CONTRACTOR is responsible for all costs related to retests of materials not meeting specifications.

3.05 ADJUSTMENT AND CLEANING

A. Remove excess material not suitable for use from the site.

END OF SECTION 02906

SECTION 02907

COARSE AGGREGATE

PART 1 - GENERAL

1.01 SUMMARY

A. Work under this section includes descriptions and requirements for the installation of the coarse aggregate in the leachate collection sumps and trenches. Material will be hauled on existing haul roads from stockpiles in the adjacent gravel pit, Duluth Ready Mix.

1.02 RELATED SECTIONS

Section 02211 – Rough Grading
Section 02906 – Intermediate Aggregate
Section 02910 – Leachate Collection System
Section 02915 – Sand Drainage Layer

1.03 REFERENCES

A. American Society for Testing and Materials (ASTM):

1. ASTM D422-63 – Standard Method for Particle Size Analysis of Soils.

2. ASTM D2487-85 – Standard Test Method for Classification of Soils for Engineering Purposes.

1.04 SUBMITTALS

A. Location of off-site source of materials.

B. Name, address, telephone number and contact person of independent soils laboratory.

C. Off site source material analyses (See part 1.05).

1.05 SOIL MATERIAL SOURCE QUALITY ASSURANCE

A. Independent soils laboratory to be approved by OWNER.

B. Source testing to be performed by CONTRACTOR at no cost to the OWNER.

C. Provide one (1) test per 1,000 lineal feet (minimum of three (3) tests) of each of the following test results per source:

1. Grain size analysis (D422).

2. USCS soil classification (D2487).

PART 2 - PRODUCTS

2.01 SOIL MATERIALS

A. COARSE AGGREGATE

Granular material, bank-run sand and bank-run gravel, consisting of rounded durable particles. Crushed aggregate not allowed. Limestone not allowed.

1. Grain Size: Range from maximum diameter of 1 ½-inch to minimum diameter of ½ inch (maximum 5% by weight passing #200 Sieve).

PART 3 - EXECUTION

3.01 FILL USAGE

A. Coarse Aggregate: Leachate collection sumps and trenches as shown on Drawings.

3.02 PREPARATION

A. CONTRACTOR to receive OWNER's permission to begin installation of coarse aggregate.

3.03 PLACEMENT

A. Transport material into landfill cell in a manner that will not damage underlying soil or synthetic layers.

B. Place coarse aggregate in sumps, and trenches as shown on Drawings.

C. Do not compact.

D. CONTRACTOR shall place coarse aggregate by such method as to prevent wrinkling and possible damage to the HDPE liner. Once the geosynthetic lining system has been accepted by the OWNER, it shall be the CONTRACTOR'S responsibility to ensure that the geosynthetics are not damaged. Should they become damaged, the CONTRACTOR shall at his own expense:
   1) Immediately notify ENGINEER
   2) Have the FML INSTALLATION CONTRACTORS make any necessary repairs at the CONTRACTOR's expense.

3.04 FIELD QUALITY CONTROL

A. Comply with approved Quality Assurance Manual.

B. Testing:

1. Tests performed and frequency of tests specified in the Quality Assurance Manual.
2. CONTRACTOR is responsible for all costs related to retests of materials not meeting specifications.

3.05 ADJUSTMENT AND CLEANING

A. Remove excess material not suitable for use from the site.

END OF SECTION 02907

SECTION 02910

LEACHATE COLLECTION SYSTEM

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Work included in this section consists of furnishing all plant, labor, equipment, appliance and materials required to furnish and install a complete leachate collection system as detailed on the Drawings. Leachate collection system includes:

1. Collection Piping
2. Cleanout Piping
3. Related Items

1.02 RELATED SECTIONS

A. Section 02906 – Intermediate Aggregate

B. Section 02907 – Coarse Aggregate

1.03 REFERENCES

A. ASTM D-1248 – Classification of Polyethylene Pipe

B. ASTM D-3350 – Cell Classification

C. ASTM D-2657 – Joining of Polyethylene Pipe

D. ASTM D1784 – Standard Specification for Rigid Poly and Chlorinated Poly Compounds.

E. ASTM D1785 – PVC Plastic Pipe, Schedule 40 and 80.

F. ASTM D2564 – Solvent Cements for PVC Plastic Pipe and Fittings.

G. ASTM D 2321 – Recommended Practice for Underground Installation of Flexible Thermoplastic Sewer Pipe

H. American Water Works Association (AWWA) Standards.

I. Mn/DOT "Standard Specifications for Construction", 2000 Edition.

1.04 SUBMITTALS

A. Provide shop drawings and product data under provisions of Section 01300.

B. Submit manufacturer's installation instructions under provisions of Section 01300.

1.05 PROJECT RECORD DOCUMENTS

A. Submit documents under provisions of Section 01700.

B. Accurately record horizontal and vertical location of pipe runs, connections, manholes and invert elevations. Reference to benchmark established by OWNER.

1.06 QUALIFICATIONS

A. Polyethylene piping shall be connected only by persons who have received training in the use of the fusion equipment according to the recommendations of the pipe supplier.

PART 2 PRODUCTS

2.01 POLYETHYLENE PIPE AND FITTINGS

A. Polyethylene pipe shall be PE 3408 and shall conform to the following minimum physical properties:

Property	**ASTM/Condition**	**Unit**	**Value**
Density	D1505	g/cm^3	0.955
Melting Point	DSC	°F	261
RSV	D1601	dl/g	3.0
Melt Index i2.16	D1238 (E)	gms/10 min.	0.14
Melt Index i21.6	D1238(F)	gms/10 min.	12.0
ESCR, Bell Test	D1693(C)	hours	>1500
Tensile Yield Strength	D638	psi	>3200
Elongation at Break	D638, Specimen 1	%	800
Tens. Modules of Elast.	D638	psi	113,000
Flexural Modules	D790	psi	136,000
Vicat Softening Temp.	D1525	°F	255
Brittleness Temp.	D746	°F	<-180
Heat Distortion Temp.	D648	°F	172
Thermal Expansion	D696	in/in/ °F	$1x10^{-4}$
Rockwell Hardness L	D785	--	49
Shore Hardness D	D2240	--	61
Hydrostatic Design	D2837	psi	800
Stress Basis	D2837 100,000 hrs 73 °F (23°C)	psi	1600
Classification			
Type/Class/Cat./Grade	D1248	III/C/5/P34	
Cell Classification	D3350	PE 345434C	
PPI Recommended Designation		PE 3408	

B. Leachate collection and cleanout pipe and fittings shall be six-inch SDR 11 polyethylene pipe. The pipe placed along the cell floor shall be perforated with 0.5 inch holes in two rows near the bottom of the pipe, with holes spaced at 6-inch intervals as shown on the Drawings.

C. Leachate collection, cleanout, and sump access pipe and fittings shall be heat fusion welded in accordance with the manufacturer's recommendations and ASTM D 2657.

2.02 AGGREGATE MATERIALS

1. Specifications for the various aggregate materials required for the construction are provided in Sections 02906 – Intermediate Aggregate, 02907 – Coarse Aggregate, and 02915 – Sand Drainage Layer.

2.03 FILTER FABRIC

A. Filter fabric shall consist of material to meet or exceed Mn/DOT Specification 3733, – Geotextile.

B. Filter fabric to be used around pipe bedding material and piping shall be as shown on the Drawings.

PART 3 EXECUTION

3.01 GENERAL

A. Install pipe, fittings and accessories at locations shown on the Drawings.

B. Suitable backfill material shall be furnished, placed and compacted around and above the pipe zone.

C. The interior of the pipe shall be carefully cleaned of all dirt, cement or the materials as the work progresses. Pipe shall be thoroughly flushed at the completion of work with water furnished by the CONTRACTOR.

D. Where lines are stubbed out for future connection, each stubbed out line shall be sealed to prevent entrance of groundwater into the pipe.

E. Filter fabric shall be installed in accordance with Mn/DOT Section 2511.3, B2. Splices and joints shall be overlapped a minimum of 18 inches.

3.02 PREPARATION

A. Identify required inverts, lines, levels, contours, and datum before beginning excavations.

B. Locate, identify, and protect utilities that remain from damage.

3.03 EXCAVATION

A. Excavate subsoil required for piping.

B. Cut trenches sufficiently wide to enable installation of piping and allow inspection. Provide sheeting and shoring as may be necessary to meet all requirements of the applicable safety codes and regulations for the protection of the work and safety of personnel.

C. Correct unauthorized excavation at no cost to OWNER.

D. Where existing conduits, drains, pipes, manholes, catch basins and other structures are encountered, they shall be carefully supported and protected from injury. In case of damage because of negligence, they shall be restored to original condition without cost to the OWNER.

3.04 DEWATERING

A. The CONTRACTOR shall take all steps necessary, such as ditching, diking, and pumping to keep the excavation areas clear of water during the progress of the work and until the finished work is safe from damage, The CONTRACTOR shall provide all power, pumps, materials, and miscellaneous apparatus necessary, and shall be responsible for disposing of the water pumped from the excavation in a manner which will not interfere with other Work within the area or cause damage to private property. The CONTRACTOR shall be held responsible for all erosion, sediment deposit, or other adverse results because of the dewatering operations and shall repair any areas affected at no additional cost the OWNER.

3.05 BEDDING

A. Piping shall be laid on stabilized trench bottom and shall be supported to its full length. Protect bottom of excavation from frost and do not place structures or pipe on frozen ground.

3.06 BACKFILLING

A. Compaction of materials placed within the pipe bedding and encasement zones shall be accomplished with portable or hand equipment methods, so as to achieve thorough consolidation under and around the pipe and avoid damage to the pipe. Above the cover zone material, the use of heavy roller type compaction equipment shall be limited to safe pipe loading.

B. Backfill materials shall be carefully placed in uniform loose thickness layers of eight-inches spread over the full width and length of the trench section to provide simultaneous support on both sides of the pipeline.

C. Maintain at or near optimum moisture content of backfill materials to attain minimum compaction of 95% Standard Proctor Maximum Density.

D. Any surplus of excavated material shall be disposed of on Landfill property in areas designated by OWNER.

E. Until expiration of the guarantee period, the CONTRACTOR shall assume full responsibility and expense for all backfill settlement and shall refill and restore the work as directed to maintain an acceptable surface condition, regardless of location. All additional materials required shall be furnished without additional cost to the OWNER.

3.07 PIPELINE TESTING

A. All non-perforated carrier pipe installed by the CONTRACTOR shall be air pressure tested prior to and following connection to the existing piping systems. Air pressure testing shall be a minimum of 5 psi and sustained for a period of 15 minutes without loss of pressure.

B. All carrier and collection pipe shall be tested for deflection after backfilling by CONTRACTOR with a 10% deflection (90% of inside pipe diameter, being aware of the fusion weld squeezeout) cylindrical mandrel (go/no-go device). The contact length of the mandrels' arms shall equal or exceed the nominal diameter of the pipe. Any pipe found to be deflected more than 10% shall be replaced.

C. Unacceptable pipe or pipe test results shall be remediated at CONTRACTOR's expense.

D. The ENGINEER or RPR shall be present during the performance of all testing work and shall be notified of the time of testing at least 48 hours prior to commencement of the Work.

3.08 FIELD QUALITY CONTROL

A. Tests and analysis of soil materials will be performed in accordance with ASTM D698.

B. Compaction testing will be performed in accordance with ASTM D2922 or ASTM D1556.

C. If tests indicate work does not meet specified requirements, remove work, replace and retest at no cost to OWNER.

D. Frequency of tests: At the discretion of the ENGINEER.

END OF SECTION 02910

SECTION 02915

SAND DRAINAGE LAYER

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Work in this section includes furnishing materials and placement of 12-inches of sand material over the 60-mil Textured HDPE liner. Material will be hauled on existing haul roads from stockpiles in the adjacent gravel pit, Duluth Ready Mix.

1.02 RELATED SECTIONS

A. Section 01050 – Field Engineering/Surveying.

B. Section 02905 – Flexible Membrane Liner FML System.

1.03 REFERENCES

A. Mn/DOT "Standard Specifications for Construction", 2000 Edition.

B. ASTM D2434 – Permeability of Granular Soils

C. ASTM D422 – Method for Particle-Size Analysis of Soils.

D. ASTM D2487 – Soil Classification

E. ASTM D2488 – Soil Description

PART 2 PRODUCTS

2.01 GRANULAR MATERIALS

A. The sand drainage layer shall be constructed with select granular fill consisting of clean granular material free of roots, organic material, trash, sharp and angular objects, and stones greater than 3/8 inch in diameter. The sand shall be free of clay lumps and silt with less than 2% passing the #200 sieve.

B. The sand drainage layer shall have a permeability after installation of at least 5×10^{-3} cm/sec or greater.

C. The CONTRACTOR shall pre-qualify the granular material at an OWNER approved testing laboratory for certification of the above specification at a minimum of one sample per 2,000 C.Y. (minimum of three tests) to be placed to demonstrate compliance with the material specifications. The test results shall be supplied to the ENGINEER seven (7) days prior to construction. The testing firm shall make recommendations for placement and compaction of the drainage blanket to maintain the permeability. The OWNER shall bear the costs of soil sampling and testing

required to meet the above specifications. Costs associated with the ENGINEER's inspection and approval shall be borne by the OWNER.

D. The OWNER or ENGINEER reserves the option to inspect and reject unsuitable materials.

E. The material for the sand drainage layer shall be classified as SC, SW-SM, SW-SC, SP-SM, or SP-SC with a uniformity coefficient less than 6 and no organic matter.

F. Any areas not meeting the construction standards shall be reworked at the CONTRACTOR's expense.

PART 3 EXECUTION

3.01 DRAINAGE LAYER CONSTRUCTION

A. The CONTRACTOR shall clean the geomembrane surface of all loose soil and debris before initiating placement of the sand drainage layer.

B. The CONTRACTOR shall place the sand drainage layer as shown on the Drawings.

C. The CONTRACTOR shall submit to the ENGINEER the manner and method of installing the sand drainage layer prior to beginning construction of the drainage layer.

D. The sand drainage layer shall be carefully placed to avoid damaging the FML and filter fabric. Material shall be placed at the outer edges of the liner and graded toward the center of the cell by a low ground pressure crawler tractor to eliminate equipment traffic on the liner. Any damage to the FML and/or filter fabric will be repaired at the CONTRACTOR's expense.

E. Stockpiling of material to a height of more than five feet shall be prohibited.

F. Thickness of sand drainage layer shall not vary by minus 0 percent or plus 0.20 feet of the plan thicknesses.

G. Equipment used for placing drainage layer shall not be driven directly on the flexible membrane/filter fabric.

H. Placement should be performed to minimize wrinkles in FML and filter fabric. Equipment operators should be briefed on method of placement and affects to thermal expansion and contraction of the liner.

I. If a wrinkle forms, every effort should be made to smooth the wrinkle out. The ENGINEER may direct the CONTRACTOR to work on other areas until more favorable conditions exist for placement of the sand drainage layer.

3.02 QUALITY CONTROL

A. Granular Material Prequalification Testing

1. The following procedures will be performed for borrow source verification:

Description	Method	Frequency	Specification
Particle Size Distribution	ASTM D422	1 test/2,000 c.y.	Max 2% by weight passing through #200 sieve, 100% by weight passing through the 3/8" sieve
Soil Permeability	ASTM D2434	1 test/2,000 c.y.	5×10^{-3} cm/sec
Soil Classification	ASTM D2487	1 test/2,000 c.y. (3 minimum)	SC, SW-SM, SW-SC, SP-SM, SP-SC, uniformity coefficient ≤ 6, no organic matter

2. Testing of granular soils shall be conducted by an independent laboratory. Costs associated with this testing shall be borne by the CONTRACTOR.

B. Drainage Layer Construction

1. Permeability testing of the drainage layer after installation shall be performed by the OWNER. Permeability tests shall be performed, one per 3,000 cubic yards of drainage material placed.

2. The permeability test for granular material (ASTM D2434) shall be performed at a recompacted density of 90% of the Standard Proctor Maximum Density.

3. The sand drainage layer shall have a permeability after installation of at least 1×10^{-3} cm/sec or greater.

C. Drainage Layer Thickness

1. The thickness of the drainage layer shall be verified by a topographic survey as required in Section 01050 along a grid pattern no greater than 50 ft. x 50 ft. at the CONTRACTOR's expense. Finished contour elevation of the sand drainage layer will be compared with the finished contour elevation of the clay to determine if adequate thickness is present. Thickness will also be verified using a measuring rule at locations selected by the ENGINEER.

2. The CONTRACTOR shall prepare a record drawing showing the location and thickness of the Phase 4B drainage layer and submit to the ENGINEER as required in Section 01050.

3. The CONTRACTOR shall place additional granular material in any area showing a deficiency of granular material and resurvey those areas at no cost to the OWNER.

END OF SECTION 02915

SECTION 02930

TOPSOIL

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Placement of the six-inch topsoil layer over the outer surface of the northern perimeter berm, as indicated on the Drawings.

1.02 RELATED SECTIONS

A. Section 02211 – Rough Grading.

1.03 REFERENCES

A. Mn/DOT "Standard Specification for Construction", 2000 Edition.

PART 2 PRODUCTS

2.01 MATERIALS

A. Topsoil borrow shall be obtained from stockpiled topsoil stripped from the area where excavation occurs or from an off-site borrow source.

B. Topsoil shall meet the requirements of Mn/DOT Specification 3877.

PART 3 EXECUTION

3.01 GENERAL

A. The CONTRACTOR shall spread a six-inch depth of topsoil over the area as defined on the project drawings.

B. Topsoil placement should be accomplished so as to not disturb the general fill.

C. The depth of the topsoil layer shall be within plus 0.20 foot or minus 0.0 foot tolerance.

END OF SECTION 02930

SECTION 02935

FINISH SITE WORK

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Finish Grading.

B. Soil Erosion and Sediment Control.

C. Turf Establishment.

D. Edge of Liner Markers.

E. Final Cleanup.

1.02 RELATED SECTIONS

A. Section 02211 – Rough Grading

1.03 REFERENCE

A. Mn/DOT "Standard Specifications for Construction", 2000 Edition.

B. ASTM D4318 – Standard Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.

1.04 SUBMITTALS

A. Submit shop drawings under provisions of Section 01300.

PART 2 PRODUCTS

2.01 SEED

A. Seed shall conform to all requirements of Mn/DOT Specification 3876 "Seed". Seed shall be mixture as tabulated below:

Plant Species	Rate (lb/acre)	Relative %
Park Kentucky bluegrass	20	40.0
Smooth bromegrass	10	20.0
Fed fescue	3	6.0
Timothy	4	8.0
Perennial ryegrass	10	20.0
White clover	3	6.0
TOTAL	50	100.0

B. The seed listed above shall be supplemented with perennial ryegrass at a rate of 50 lb per acre (total ryegrass application rate equal to 60 lb/acre).

2.02 FERTILIZER

A. Fertilizer shall be in accordance with Mn/DOT Specification 3881. Fertilizer shall contain nitrogen, phosphoric acid, and water soluble potash in the following percentages:

Nutrient	Percent
Nitrogen	10.0
Phosphoric Acid (phosphorus)	10.0
Water Soluble Potash (potassium)	10.0

2.03 MULCH

A. Mulch shall be in accordance with Mn/DOT Specification 3882, Type 1.

2.04 EROSION CONTROL BLANKETS

A. Erosion control blankets, where called for on the Drawings, shall be North American Green SC150, BonTerra CS2, or approved equivalent.

2.05 EDGE OF LINER MARKERS

A. Marker posts shall be "T"-shaped steel fence posts, six feet in length.

PART 3 EXECUTION

3.01 FINISH GRADING

A. Grade to eliminate uneven areas and low spots. Maintain profiles and contour of grade.

B. Remove roots, weeds and foreign material while grading.

C. Place six inches of topsoil on the landfill cell berms areas and along roadway shoulders. Topsoil can be salvaged topsoil material or obtained from on-site stockpiles as directed by the OWNER.

3.02 SOIL PREPARATIONS

A. Remove all undesirable weeds as directed.

B. Loosen topsoil on all areas with 2:1 slopes or flatter prior to seeding.

C. Cultivate to a depth of three inches using discs or other suitable equipment.

D. Operate equipment at right angles to direction of drainage.

E. Fill all washouts prior to cultivation.

F. Finish all areas to provide a smooth, moist, even-textured foundation on uniform density.

3.03 TURF ESTABLISHMENT

A. Topsoil preparation and seeding shall be accomplished in accordance with Mn/DOT Specification 2575 "Turf Establishment."

B. Applying Fertilizer and Conditions

1. Apply fertilizer uniformly over the designated area using mechanical spreading devices.

2. Fertilizer shall be applied at rate of 350 pounds per acre.

3. Apply fertilizer no more than 48 hours prior to seeding.

C. Sowing Seed

1. Apply seed mixture over designated areas at a rate of 50 lbs per acre, and 50 lbs per acre of additional perennial ryegrass.

2. Apply seed uniformly by mechanical or hydro-spreading method.

3. Cover all seeded areas by hand raking or other approved means prior to mulching.

D. Applying Mulch

1. Spread mulch uniformly by mechanical means over seeded areas of the project at a rate of 2 tons per acre.

2. Apply mulch in accordance with Mn/DOT Specification 2575.3F.

E. Disc Anchoring

1. Anchor Type 1 mulch with a disc which punches the mulch 2" to 3" into the soil.

2. Anchor mulch immediately after placement.

F. Placing Erosion Control Blankets

1. Place blankets as shown in the Drawings within 24 hours after seeding.

2. Overlap strip ends 10" minimum with upgrade strip on top.

3. Bury upgrade end of each strip minimum 6-inches into soil.

3.04 SOIL EROSION AND SEDIMENT CONTROL

A. Erosion control shall be accomplished in accordance with Mn/DOT Specification 2573, "Temporary Erosion Control," MPCA Permit No. MN G611000 "General Storm Water

Permit for Industrial Activity" under the National Pollutant Discharge Elimination System (NPDES) and State Disposal System (SDS) Permit Program, and MPCA Permit No. MN R 100001, "General Storm Water Permit for Construction Activity."

B. The CONTRACTOR will be responsible for obtaining coverage under the MPCA General Storm Water Permit for Construction Activity and installing appropriate erosion and sediment control devices for all areas disturbed by construction.

C. All silt fences and hay bales shall be inspected immediately after each run-off event and at least daily during prolonged rainfall.

D. Any required repairs will be made immediately. If sediment deposit reaches one-half the height of the barrier, the sediment shall be removed.

3.05 CLEANING

A. Remove all sediment and debris from pipe interior as it is installed.

B. Remove all sediment and debris from in-place pipe prior to installing extension pipe.

C. Remove all sediment and debris from existing (to be removed) pipe interior and exterior.

3.06 EDGE OF LINER MARKERS

A. Install edge of liner marker posts (steel "T" posts) at the corners and 50ft spacing on the liner, as detailed on the Drawings.

3.07 FINAL CLEANUP

A. Before final acceptance, the CONTRACTOR shall remove all surplus and discarded materials, equipment, rubbish, and temporary structures from the Landfill; and all parts of the work shall be left in a condition acceptable to the OWNER.

B. CONTRACTOR shall re-establish all disturbed areas adjacent to the Work to their original condition.

C. Restore borrow areas to drain as shown in the Drawings. Borrow areas shall be left in a neat and orderly condition.

D. Damage to access roads by construction traffic will be the responsibility of the CONTRACTOR. Before final acceptance of the Work, CONTRACTOR shall reshape, regrade, provide additional material, and compact all access and haul roads damaged by construction traffic as needed to provide a surface area complying with the above specifications for gravel road construction.

END OF SECTION 02935

Appendix B
STANDARD FINAL COVER CONSTRUCTION SPECIFICATIONS

TECHNICAL SPECIFICATIONS FOR

GENERAL WASTE DISPOSAL AND RECOVER SERVICES, INC.

FINAL COVER CONSTRUCTION

Prepared for:

General Waste Disposal and Recovery Services, Inc.
Keewatin, Minnesota

Prepared by:

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(763) 489-3100

Project Number: 59119.00

April __, 2013

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DIVISION 2 - SITEWORK

SECTION 02100

SITE PREPARATION

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Stripping vegetation and smooth, grading existing cover soils

B. Implementing and maintaining erosion controls.

1.02 BASIS FOR COMPENSATION

A. Compensation for all Work and materials covered under this Section of these Specifications will be in accordance with the provisions set forth in Section 01025, Measurement and Payment.

PART 2 PRODUCTS

NOT USED

PART 3 EXECUTION

3.01 STRIPPING VEGETATION

A. Strip vegetation from temporary cover within the final cover area, and smooth grade temporary cover. Surface of existing temporary cover shall be uniformly graded and shall result in a minimum of 12-inches of soil or alternative temporary cover material remaining over the existing waste.

3.02 TEMPORARY EROSION CONTROL

A. Implement temporary erosion control practices to conform to these Specifications and the requirements of the NPDES Construction Storm Water Runoff permit (CONTRACTOR'S responsibility to obtain), and the Owner including:

1. Furnish, install, and maintain temporary erosion controls necessary to prevent the erosion and transport of soils, silt, mud, and debris off site or to other areas of the site where damage could result.

2. Construct temporary erosion controls where there is evidence that sediment is being transported off-site, where drainage ways flow from the site, and elsewhere as required to control erosion.

3. Schedule operations to minimize the amount of area disturbed and thus susceptible to erosion at any given time.

4. Remove and dispose of all temporary erosion controls when turf has been fully established or when earthwork such as diversion dikes have eliminated the possibility of sediment transport off-site.

END OF SECTION 02100

SECTION 02220

ROUGH GRADING – FINAL COVER CONSTRUCTION

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Stripping and stockpiling topsoil

B. Final cover subgrade preparation.

C. Implementing and maintaining erosion controls.

D. Coordinating with geomembrane installer.

E. Furnishing (Screen/Import), placing, and fine grading subgrade soil fill layer

F. Furnishing (Screen/Import), placing, and fine grading buffer soil layer

G. Furnishing (Screen/Import), placing, and fine grading general buffer layer.

H. Furnishing (Screen/Import), placing, and fine grading general soil fill layer

I. Furnishing, placing, and fine grading topsoil.

J. Verifying material thickness requirements.

K. Installing plywood, and steel fence posts along edge of final cover at completion of the Work.

1.02 BASIS FOR COMPENSATION

A. Compensation for all Work and materials covered under this Section of these Specifications will be included in the Contract Price bid.

1.03 REFERENCES

A. Minnesota Department of Transportation Standard Specifications for Construction, 2000 Edition, hereafter referred to as Mn/DOT Standard Specifications.

B. American Society for Testing and Materials, Current Edition, hereafter referred to as ASTM.

1.04 SEQUENCING AND SCHEDULING

A. Owner will be evaluating results of Contractor's independent registered land surveyor's grade, slope, and material thickness verifications, collecting material samples, and conducting field testing of materials throughout the duration of the Project, as

described in Section 01400 of these Specifications. Do not proceed with subsequent operations until Owner or Owner's Representative has been notified and has been given opportunity to verify that the Work meets the requirements of these Specifications.

B. Contractor shall sequence construction to allow continued access to the active fill areas and debris fill areas.

1.05 JOB CONDITIONS

A. It shall be solely the Contractor's responsibility to review available tests and reports, conduct additional tests, and otherwise determine to its own satisfaction the location and nature of all surface and subsurface features and the soil and water conditions that may be encountered. Owner's information on site conditions may be reviewed at Owner's offices as scheduled with Owner.

B. It shall be solely the Contractor's responsibility to determine the means and methods for meeting the compaction requirements unless otherwise specified herein, except that compaction by flooding or puddling or other means that involve saturation or over-wetting the soil will not be permitted. Contractor shall be solely responsible for utilizing means and methods that protect adjacent structures and utilities from damage resulting from Contractor's operations, specifically including, but not limited to, settlement, consolidation, displacement, cracking, vibration, undermining, washout, and uplift caused by excavating, compaction, dewatering, or any other operation. If requested by Contractor, Owner will accompany Contractor in examination of existing adjacent structures prior to beginning the Work. Examination will be intended to provide Contractor opportunity to document relevant existing structural damage or problems.

C. Provide all shoring, bracing, sheet piling, trench boxes, tie backs, and other measures required to perform all Work in accordance with Laws and Regulations. Specifically, all excavations shall conform to the requirements of OSHA set forth in 29 CFR 1926, Subpart P (Occupational Safety and Health Standards-Excavations).

PART 2 PRODUCTS

2.01 MATERIALS

A. Contractor shall furnish all materials specified in this Section unless these materials are available as part of the work, the material meets the specifications, and use of the material is approved by the Owner.

B. Subgrade Fill: Subgrade fill may be obtained from on-site borrow areas as designated by the Owner. The Owner does not guarantee that on-site material will achieve these specifications. A mineral product consisting of sound durable particles, excluding crushed carbonate quarry rock, crushed concrete, and salvaged bituminous mixture, and free of all organic material. The material shall not contain lumps larger than 3-inches, rocks larger than 1.5-inches, and debris. Subgrade fill shall not contain peat,

muck, sod, roots, rubbish, or sharp objects. Subgrade fill materials shall be approved by Owner and Engineer prior to beginning construction.

C. Buffer Layer Soil: An aggregate mineral material with maximum 3/8-inch particle size, free from organic material, foreign matter, and refuse.

D. Flexible Membrane Cover:

E. General Buffer Layer soil: An aggregate mineral material with a maximum 3/8-inch particle size. Drainage sand must meet the following specifications: maximum 15% by weight of material passing a #200 sieve, 3/8" maximum particle size, minimum permeability of $7x10^{-4}$ cm/s.

F. General Fill Layer: General fill layer shall consist of fine-grained natural soil material having a Unified Soil Classification of SM, ML, SC, CL, or mixture thereof. General fill layer may contain organics but shall be, in the opinion of the Owner or Engineer, of such a mixture that will not result in excessive settlement of consolidation of the general fill layer. Rocks and lumps shall be less than 3- inches in the largest dimension

G. Topsoil: Furnished by Contractor and in conformance with MNDOT Std. Spec. 3877.2.A.

H. Riprap: Furnished by Contractor and in conformance with MNDOT Std. Spec. 3601.2.A, Class II.

I. Steel Fence Posts: The posts used to mark the south limits of the final cover shall be steel posts at least 6 feet ling. The steel posts shall be "studded tee" type with a minimum weight of 1.25 lbs/linear foot.

PART 3 EXECUTION

3.01 SLOPE PREPARATION

A. Furnish and place buffer soil to the required grades and elevations.

B. Smooth-grade the buffer layer to a smooth and uniform finished surface. Maintain the buffer layer during geomembrane installation. The finished Surface of the buffer layer shall be free of protruding stones, stones or other solid particles greater than 1/2-inch diameter, clods, foreign matter, and any material which may damage the geomembrane. Contractor shall visually inspect the finished surface and remove unacceptable materials prior to installation of the geomembrane.

3.02 BACKFILL AND COMPACTION

A. Place materials at the locations and to the dimensions and thicknesses shown on the Drawings. Furnish equipment suitable for soil conditions and compactive effort required to meet compaction criteria specified herein. Coarse-grained soils shall be

compacted using vibratory compaction equipment. Fine-grained soils shall be compacted using sheepsfoot compaction equipment.

B. Placing General Buffer Layer Drainage Sand over Geomembrane:

1. No backfill material shall be placed over the geomembrane until inspection and testing of the -geomembrane have been completed and all test results and required documentation have been submitted to Owner and Owner's Representative. After geomembrane inspection and review of the documentation, Owner will give Contractor written notice to proceed with the placement of materials over geomembrane. This notice does not imply final acceptance of the geomembrane or related work. Inspection and submission of required documentation for geomembrane work may be done in phases to facilitate timely placement of general buffer layer.

2. Place general buffer layer over the geomembrane in a single lift. Placement of the general buffer layer over the geomembrane shall be performed in accordance with the geomembrane manufacturer's recommendations, and under the supervision of the geomembrane installer's on-site representative.

3. In no case shall any construction equipment be allowed to travel directly on the geomembrane. A temporary 2-foot lift of general buffer layer shall be placed over the geomembrane in the main traffic areas (such as the pathway followed by trucks or in push lanes for dozers). A minimum 2- foot thickness of general buffer layer shall be in place over the geomembrane for rubber-tired vehicle traffic. A minimum 1-foot thickness of general buffer layer shall be in place over the geomembrane for tracked vehicle traffic. When sand is dumped along the edge of the geomembrane, a minimum 2-foot thickness shall be maintained beneath dozers, backhoes, or other equipment used to push or move the sand from the dumping location.

4. Spreading shall be performed by pushing general buffer layer from discrete dumping points along the built-up traffic areas, and pushing the materials outward over that material already placed. General buffer layer shall be rolled over the edge of the material already placed, rather than pushed or slid across the surface of the geomembrane.

5. General buffer layer placement shall be performed in a manner which minimizes the formation and propagation of wrinkles in the geomembrane. Wrinkles shall not be permitted to be folded over beneath the general buffer layer. Contractor shall perform general buffer layer placement operations in accordance with an approved placement plan. Minimum requirements include:

    a. Early-morning buffer placement activities (while the geomembrane is cool and relatively wrinkle-free) shall include placement of pushing lanes to anchor the geomembrane at intervals.

b. General buffer layer may be placed ahead of small wrinkles using a backhoe or similar equipment to trap the wrinkle

c. Buffer shall be pushed across the geomembrane in an up-slope direction so that slack which may develop in the geomembrane can be taken up in the anchor trench.

d. A spotter shall be assigned to work full time with each piece of earth moving equipment used for buffer placement over the geomembrane. The spotter shall be positioned to observe the location of the blade or bucket relative to the geomembrane and communicate this information to the equipment operator to prevent damage to the geomembrane. The spotter shall also track and minimize the formation and propagation of wrinkles in the geomembrane and communicate this information to the operator. Measures shall be taken to stop wrinkle formation and propagation.

e. Any damage which occurs to the geomembrane shall be reported immediately to Owner or Owner's representative so that repairs can be made. Contractor shall assist with repairs by removing sand from the damage area, maintaining access to the area until repairs are made, and placing cover materials promptly after repairs have been completed.

6. No special compactive effort other than that realized by placement of the general buffer layer shall be performed.

C. Place general fill layer over general buffer layer in a single lift. General fill layer shall be rolled over the edge of the material already placed so the underlying general buffer layer drainage material is not disturbed. Compaction shall be limited to that provided by construction vehicle traffic.

D. Topsoil:

1. Furnish and place topsoil to the thickness and at the locations shown on the Drawings.

2. In addition to the locations specifically shown on the Drawings, place topsoil to an approximate 6-inch thickness in other areas which may have been disturbed by Contractor's activities.

3. On slope areas, track marks from equipment shall run up-and-down the slope to aid in erosion control.

3.03 SITE GRADING

A. Smooth-grade all finished surfaces. Blend and match existing grades as required to produce uniform grades.

3.04 TOLERANCES

A. Construct the excavation and backfill work within the dimensional tolerances given below. Elevation and thickness tolerances are acceptable deviations from the elevations and material thicknesses shown on the Drawings.

B. Elevation Tolerances:

1. Geomembrane Subgrade: +/-0.1 foot.

2. Finished General Buffer Layer: +0.2 foot, -0.0 foot

C. Thickness Tolerances:

1. General Buffer Layer: -0.0 to +0.2 foot at a single point, -0.0 to +0.1 foot average of all points.

2. General Fill Layer: -0.0 foot, +0.2 foot.

3. Topsoil: -0.0 foot, +0.1 foot

3.05 FIELD QUALITY CONTROL

A. Contractor shall perform field quality control as specified in Section 01400 of these Specifications.

END OF SECTION 02220

SECTION 02270

GEOTEXTILES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Installing woven geotextile fabric.

B. Furnishing and installing erosion control blanket.

1.02 BASIS FOR COMPENSATION

A. Compensation for all Work and materials covered under this Section of these Specifications will be included in the lump sum Contract Price bid.

1.03 REFERENCES

A. Minnesota Department of Transportation Standard Specifications for Construction, 2000 Edition, hereafter referred to as Mn/DOT Standard Specifications.

1.04 SUBMITTALS

A. Submit for documentation Certificates of Compliance from the manufacturer for each roll of erosion blanket delivered to the Site. The document shall certify the test results of the physical properties specified below. A quality control certificate shall be submitted for each 50,000 square feet of continuously produced material (or other standard manufacturer frequency noted in bid submittal). A quality control certificate shall be submitted for each roll of material that is not from a continuous production run for which a certificate has previously been provided.

PART 2 PRODUCTS

2.01 MATERIALS

A. Woven Geotextile Fabric: Amoco 2006, Mirafi 600X, or approved equal, or approved by General Waste (Owner).

B. Non-woven Geotextile Fabric: Amoco 4510, Mirafi 1000N, Synthetic Industries 1201, or approved equal or approved by General Waste (Owner).

C. Erosion blanket for slope areas shall be North American Green SC150 or approved equal.

D. Erosion blanket for use as ditch liner shall be Tensar 1B 1000 or approved equal.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install Install geotextile fabrics at the locations and to the dimensions shown on the Drawings.

B. Woven filter fabric shall be placed under riprap at catch basins, and as shown on the Drawings. Adjacent panels shall be overlapped a minimum of 18 inches.

C. Install erosion blankets at the locations at to the dimensions as shown on the Drawings. Installation shall be in strict conformance with manufacturer's recommendations for panel overlap, staple patterns, anchorages, etc.

END OF SECTION 02270

SECTION 02610

PIPES AND FITTINGS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Furnishing and installing 6-inch drain tile with sock and fittings.

1.02 BASIS FOR COMPENSATION

A. Compensation for all Work covered under this Section of these Specifications will be included under the lump sum Contract Price bid.

1.03 REFERENCES

A. Minnesota Department of Transportation Standard Specifications for Construction, 2000 Edition, hereafter referred to as Mn/DOT Standard Specifications.

B. American Association of State Highway and Transportation Officials hereafter referred to as AASHTO.

C. American Society for Testing and Materials, current edition, hereafter referred to as ASTM.

1.04 SUBMITALS

A. Submit for documentation shop drawings on pipe, fittings, and inlet screens.

PART 2 PRODUCTS

PART 3 EXECUTION

3.01 CORRUGATED POLYETHYLENE DRAIN TUBING AND FITTINGS

A. Install drain tubing of the size and in the locations and to the elevations and grades shown on the Drawings.

B. Do not install drain tubing with bends of smaller radius than the minimum recommended by the manufacturer.

C. Care shall be taken to prevent crushing or deflecting the drain tubing by construction equipment traffic. After installation, Contractor shall mark locations of the drain tubing and restrict heavy equipment from traveling over the tubing.

END OF SECTION 02610

SECTION 02905

FLEXIBLE MEMBRANE COVER (FMC) SYSTEM

PART 1 GENERAL

1.01 SECTION INCLUDES

A. The work covered under this section consists of construction of the liner anchor trenches as shown on the drawings, and furnishing of the materials, labor, and equipment necessary for the installation of the 60-mil Textured High Density Polyethylene (HDPE) flexible membrane liner (FML) liner system as shown on the Drawings.

1.02 RELATED SECTIONS

A. Section 2100 – Site Preparation

B. Section 02220 – Rough Grading.

C. Section 02935 – Finished Site Work.

D. Section 02915 – Sand Drainage Layer.

1.03 REFERENCES

A. Geosynthetic Research Institute (GRI) – GM 13.

B. GRI – GM 19

C. ASTM D6392 – Standard Test Method for Determining the Integrity of Nonreinforced Geomembrane Seams Produced Using Thermo-Fusion Methods.

D. ASTM D638 – Standard Test Method for Tensile Properties of Plastics.

E. ASTM D4437 – Practice for Determining the Integrity of Field Seams Used in Joining Flexible Polymeric Sheet Geomembranes.

1.04 SUBMITTALS

A. After contract award, CONTRACTOR shall then submit the following:

1. Schedule: Submit to OWNER's and ENGINEER the construction schedule detailing time period for liner installation. Include hours worked per day, week and per shift. Indicate all weather delays built into schedule.

1.05 DELIVERY, STORAGE AND HANDLING

A. Deliver, store, protect and handle products to site under the following provisions and Section 01600.

B. Store geosynthetic rolls on a prepared surface (not on wooden pallets) in the space allocated by the OWNER. Protect rolls from puncture, dirt, grease, water, moisture, mud, mechanical abrasions, excessive heat or other damage. Stack geosynthetic rolls no more than three rolls high.

C. Use appropriate handling equipment to load, move, or deploy geosynthetic rolls. Appropriate handling equipment includes cloth chokers and spreader bar for loading, spreader, and roll bars for deployment. Dragging panels on ground surface will not be permitted.

D. Do not fold geosynthetic materials; folded or creased materials will be rejected.

PART 2 PRODUCTS

2.01 GENERAL

A. The materials shall consist of 60-mil Textured, High Density Polyethylene Flexible Membrane Liner. The materials supplied under these specifications shall be first quality products designed and manufactured specifically for the purposes of this work, and which have satisfactorily demonstrated by prior use to be suitable and durable for these purposes.

PART 3 EXECUTION

3.01 GENERAL

A. It shall be the CONTRACTOR's responsibility to provide adequate storage facilities for geosynthetics according to the manufacturer's recommendations. All materials stored on-site shall be protected to keep the material clean and dry.

3.02 HDPE FLEXIBLE MEMBRANE LINER PLACEMENT

A. The FML subsurface shall be smooth and free of all rocks, stones, sticks, roots, sharp objects, protuberances, weed growth, or debris of any kind. The surface shall provide a firm, unyielding foundation for the liner with no sudden, sharp, or abrupt changes or breaks in grade. No standing water or excessive moisture shall be evident at the time of liner installation. The receiving surface shall be maintained in an acceptable condition until completion of the liner installation.

PART 4 QUALITY CONTROL

4.01 GENERAL

A. Before installation begins, the FML INSTALLATION CONTRACTOR's shall appoint an experienced individual who will be on-site at all times during the installation to represent them in all matters relevant to this work. This appointment shall be subject to approval by the ENGINEER.

B. Before and during installation, weekly project coordination meetings shall be held with the designated representative of the FML INSTALLATION CONTRACTOR's, CONTRACTOR, ENGINEER, and OWNER in attendance to review the following information. The following information shall be provided to the ENGINEER by the FML INSTALLATION CONTRACTOR's during or before this meeting:

1. Progress of the work.

2. Adherence to the Specifications.

3. Adherence to the Quality Control Program, including the timely submission of the pertinent forms.

4. Planned work and methods for the ensuing week, including estimate of time remaining to completion of the work.

C. Any changes in the proposed method of work, subcontractors to be utilized, membrane resin or manufacturing must be approved in advance by the OWNER and ENGINEER. The FML INSTALLATION CONTRACTOR's assumes all responsibility relevant to providing an acceptable product.

END OF SECTION 02905

SECTION 02915

SAND DRAINAGE LAYER

PART 5 GENERAL

5.01 SECTION INCLUDES

A. Work in this section includes furnishing materials and placement of 12-inches of sand material over the 60-mil Textured HDPE liner. Material will be hauled on existing haul roads from stockpiles in the adjacent gravel pit, Duluth Ready Mix.

5.02 RELATED SECTIONS

A. Section 01050 – Field Engineering/Surveying.

B. Section 02905 – Flexible Membrane Liner FML System.

5.03 REFERENCES

A. Mn/DOT "Standard Specifications for Construction", 2000 Edition.

B. ASTM D2434 – Permeability of Granular Soils

C. ASTM D422 – Method for Particle-Size Analysis of Soils.

D. ASTM D2487 – Soil Classification

E. ASTM D2488 – Soil Description

PART 6 PRODUCTS

6.01 GRANULAR MATERIALS

A. The sand drainage layer shall be constructed with select granular fill consisting of clean granular material free of roots, organic material, trash, sharp and angular objects, and stones greater than 3/8 inch in diameter. The sand shall be free of clay lumps and silt with less than 2% passing the #200 sieve.

B. The sand drainage layer shall have a permeability after installation of at least 5×10^{-3} cm/sec or greater.

C. The CONTRACTOR shall pre-qualify the granular material at an OWNER approved testing laboratory for certification of the above specification at a minimum of one sample per 2,000 C.Y. (minimum of three tests) to be placed to demonstrate compliance with the material specifications. The test results shall be supplied to the ENGINEER seven (7) days prior to construction. The testing firm shall make recommendations for placement and compaction of the drainage blanket to maintain the permeability. The OWNER shall bear the costs of soil sampling and testing

required to meet the above specifications. Costs associated with the ENGINEER's inspection and approval shall be borne by the OWNER.

D. The OWNER or ENGINEER reserves the option to inspect and reject unsuitable materials.

E. The material for the sand drainage layer shall be classified as SC, SW-SM, SW-SC, SP-SM, or SP-SC with a uniformity coefficient less than 6 and no organic matter.

F. Any areas not meeting the construction standards shall be reworked at the CONTRACTOR's expense.

PART 7 EXECUTION

7.01 DRAINAGE LAYER CONSTRUCTION

A. The CONTRACTOR shall clean the geomembrane surface of all loose soil and debris before initiating placement of the sand drainage layer.

B. The CONTRACTOR shall place the sand drainage layer as shown on the Drawings.

C. The CONTRACTOR shall submit to the ENGINEER the manner and method of installing the sand drainage layer prior to beginning construction of the drainage layer.

D. The sand drainage layer shall be carefully placed to avoid damaging the FML and filter fabric. Material shall be placed at the outer edges of the liner and graded toward the center of the cell by a low ground pressure crawler tractor to eliminate equipment traffic on the liner. Any damage to the FML and/or filter fabric will be repaired at the CONTRACTOR's expense.

E. Stockpiling of material to a height of more than five feet shall be prohibited.

F. Thickness of sand drainage layer shall not vary by minus 0 percent or plus 0.20 feet of the plan thicknesses.

G. Equipment used for placing drainage layer shall not be driven directly on the flexible membrane/filter fabric.

H. Placement should be performed to minimize wrinkles in FML and filter fabric. Equipment operators should be briefed on method of placement and affects to thermal expansion and contraction of the liner.

I. If a wrinkle forms, every effort should be made to smooth the wrinkle out. The ENGINEER may direct the CONTRACTOR to work on other areas until more favorable conditions exist for placement of the sand drainage layer.

7.02 QUALITY CONTROL

A. Granular Material Prequalification Testing

1. The following procedures will be performed for borrow source verification:

Description	Method	Frequency	Specification
Particle Size Distribution	ASTM D422	1 test/2,000 c.y.	Max 2% by weight passing through #200 sieve, 100% by weight passing through the 3/8" sieve
Soil Permeability	ASTM D2434	1 test/2,000 c.y.	5×10^{-3} cm/sec
Soil Classification	ASTM D2487	1 test/2,000 c.y. (3 minimum)	SC, SW-SM, SW-SC, SP-SM, SP-SC, uniformity coefficient ≤ 6, no organic matter

2. Testing of granular soils shall be conducted by an independent laboratory. Costs associated with this testing shall be borne by the CONTRACTOR.

B. Drainage Layer Construction

1. Permeability testing of the drainage layer after installation shall be performed by the OWNER. Permeability tests shall be performed, one per 3,000 cubic yards of drainage material placed.

2. The permeability test for granular material (ASTM D2434) shall be performed at a recompacted density of 90% of the Standard Proctor Maximum Density.

3. The sand drainage layer shall have a permeability after installation of at least 1×10^{-3} cm/sec or greater.

C. Drainage Layer Thickness

1. The thickness of the drainage layer shall be verified by a topographic survey as required in Section 01050 along a grid pattern no greater than 50 ft. x 50 ft. at the CONTRACTOR's expense. Finished contour elevation of the sand drainage layer will be compared with the finished contour elevation of the clay to determine if adequate thickness is present. Thickness will also be verified using a measuring rule at locations selected by the ENGINEER.

2. The CONTRACTOR shall prepare a record drawing showing the location and thickness of the Phase 4B drainage layer and submit to the ENGINEER as required in Section 01050.

3. The CONTRACTOR shall place additional granular material in any area showing a deficiency of granular material and resurvey those areas at no cost to the OWNER.

END OF SECTION 02915

SECTION 02930

TURF ESTABLISHMENT

PART 8 GENERAL

8.01 SECTION INCLUDES

A. Establishing vegetation on all topsoiled areas of the site.

8.02 BASIS FOR COMPENSATION

A. Compensation for all Work and materials covered under this Section of these Specifications will be included in the lump sum Contract Price bid.

8.03 REFERENCES

A. Minnesota Department of Transportation Standard Specifications for Construction, 2000 Edition, hereafter referred to as Mn/DOT Standard Specifications.

PART 9 PRODUCTS

9.01 MATERIALS

A. Seed: In accordance with Mn/DOT Standard Specification 3876 with seed mixture as follows:

Species	Rate (lbs./acre)
Base Seed Mix	
Park Kentucky Bluegrass	75
Creeping Red Fescue	60
Perennial Ryegrass	15
For Spring Seeding Add:	
Noreen, Leo, or Carroll Birdsfoot Trefoil	10
For Dormant Seeding Add:	
Annual Ryegrass	10

B. Fertilizer: In accordance with Mn/DOT Standard Specification 3881. Fertilizer shall be applied at the rate and mixture recommended by the testing laboratory based on test results of the topsoil for: new lawn or turf, grass not watered, clippings not removed.

C. Mulch: Type I in accordance with Mn/DOT Standard Specification 3882.

PART 10 EXECUTION

10.01 SCHEDULE

A. The Contractor shall coordinate the turf establishment work with the topsoiling and finishing operations, so as to reduce to a minimum the lag time between the initial and final phases of the combined work and establish turf protection as soon as possible after the graded areas have been topsoiled or finish graded.

10.02 TURF ESTABLISHMENT

A. Establish turf on all disturbed and topsoiled areas. Turf establishment includes:

1. Soil preparation (Mn/DOT Standard Specification 2575.3B).
2. Fertilizing (Mn/DOT 2575.3C).
3. Sowing seed (Mn/DOT 2575.3D3).
4. Seedbed filming (Mn/DOT 2575.3E).
5. Applying mulch (Mn/DOT 2575.3F1).
6. Disk anchoring (Mn/DOT 2575.3H).

B. Seeding shall be performed within the dates specified in MNDOT Std. Spec. 2575.

10.03 WATERING

A. Watering shall be performed at the discretion of the Contractor, at the rate and frequency as may be necessary to initiate and sustain seed germination. Watering shall be performed by and at the expense of the Contractor until the work is accepted by the Owner.

10.04 MAINTENANCE

A. Rework/replace topsoil where original topsoil has eroded or washed away as directed by Owner.

B. Remulch any areas on which the original mulch has eroded, washed away, or blown off, as directed by Owner.

C. Reseed any areas on which the original seed has failed to grow, using the specified seed mixture, as directed by Owner.

D. Perform all necessary maintenance, replacement and repair work until acceptance of the Work by Owner. The expense of maintenance, replacement, and repair shall be borne by Contractor. Acceptance of work by Owner will occur in the spring of the year following performance of turf establishment when it is evident that turf has been established

END OF SECTION 02930

SECTION 02935

FINISH SITE WORK

PART 11 GENERAL

11.01 SECTION INCLUDES

A. Finish Grading.

B. Soil Erosion and Sediment Control.

C. Turf Establishment.

D. Edge of Liner Markers.

E. Final Cleanup.

11.02 RELATED SECTIONS

A. Section 02211 – Rough Grading

11.03 REFERENCE

A. Mn/DOT "Standard Specifications for Construction", 2000 Edition.

B. ASTM D4318 – Standard Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.

11.04 SUBMITTALS

A. Submit shop drawings under provisions of Section 01300.

PART 12 PRODUCTS

12.01 SEED

A. Seed shall conform to all requirements of Mn/DOT Specification 3876 "Seed". Seed shall be mixture as tabulated below:

Plant Species	Rate (lb/acre)	Relative %
Park Kentucky bluegrass	20	40.0
Smooth bromegrass	10	20.0
Fed fescue	3	6.0
Timothy	4	8.0
Perennial ryegrass	10	20.0
White clover	3	6.0
TOTAL	50	100.0

B. The seed listed above shall be supplemented with perennial ryegrass at a rate of 50 lb per acre (total ryegrass application rate equal to 60 lb/acre).

12.02 FERTILIZER

A. Fertilizer shall be in accordance with Mn/DOT Specification 3881. Fertilizer shall contain nitrogen, phosphoric acid, and water soluble potash in the following percentages:

Nutrient	Percent
Nitrogen	10.0
Phosphoric Acid (phosphorus)	10.0
Water Soluble Potash (potassium)	10.0

12.03 MULCH

A. Mulch shall be in accordance with Mn/DOT Specification 3882, Type 1.

12.04 EROSION CONTROL BLANKETS

A. Erosion control blankets, where called for on the Drawings, shall be North American Green SC150, BonTerra CS2, or approved equivalent.

12.05 EDGE OF LINER MARKERS

A. Marker posts shall be "T"-shaped steel fence posts, six feet in length.

PART 13 EXECUTION

13.01 FINISH GRADING

A. Grade to eliminate uneven areas and low spots. Maintain profiles and contour of grade.

B. Remove roots, weeds and foreign material while grading.

C. Place six inches of topsoil on the landfill cell berms areas and along roadway shoulders. Topsoil can be salvaged topsoil material or obtained from on-site stockpiles as directed by the OWNER.

13.02 SOIL PREPARATIONS

A. Remove all undesirable weeds as directed.

B. Loosen topsoil on all areas with 2:1 slopes or flatter prior to seeding.

C. Cultivate to a depth of three inches using discs or other suitable equipment.

D. Operate equipment at right angles to direction of drainage.

E. Fill all washouts prior to cultivation.

F. Finish all areas to provide a smooth, moist, even-textured foundation on uniform density.

13.03 TURF ESTABLISHMENT

A. Topsoil preparation and seeding shall be accomplished in accordance with Mn/DOT Specification 2575 "Turf Establishment."

B. Applying Fertilizer and Conditions

1. Apply fertilizer uniformly over the designated area using mechanical spreading devices.

2. Fertilizer shall be applied at rate of 350 pounds per acre.

3. Apply fertilizer no more than 48 hours prior to seeding.

C. Sowing Seed

1. Apply seed mixture over designated areas at a rate of 50 lbs per acre, and 50 lbs per acre of additional perennial ryegrass.

2. Apply seed uniformly by mechanical or hydro-spreading method.

3. Cover all seeded areas by hand raking or other approved means prior to mulching.

D. Applying Mulch

1. Spread mulch uniformly by mechanical means over seeded areas of the project at a rate of 2 tons per acre.

2. Apply mulch in accordance with Mn/DOT Specification 2575.3F.

E. Disc Anchoring

1. Anchor Type 1 mulch with a disc which punches the mulch 2" to 3" into the soil.

2. Anchor mulch immediately after placement.

F. Placing Erosion Control Blankets

1. Place blankets as shown in the Drawings within 24 hours after seeding.

2. Overlap strip ends 10" minimum with upgrade strip on top.

3. Bury upgrade end of each strip minimum 6-inches into soil.

13.04 SOIL EROSION AND SEDIMENT CONTROL

A. Erosion control shall be accomplished in accordance with Mn/DOT Specification 2573, "Temporary Erosion Control," MPCA Permit No. MN G611000 "General Storm Water

Permit for Industrial Activity" under the National Pollutant Discharge Elimination System (NPDES) and State Disposal System (SDS) Permit Program, and MPCA Permit No. MN R 100001, "General Storm Water Permit for Construction Activity."

B. The CONTRACTOR will be responsible for obtaining coverage under the MPCA General Storm Water Permit for Construction Activity and installing appropriate erosion and sediment control devices for all areas disturbed by construction.

C. All silt fences and hay bales shall be inspected immediately after each run-off event and at least daily during prolonged rainfall.

D. Any required repairs will be made immediately. If sediment deposit reaches one-half the height of the barrier, the sediment shall be removed.

13.05 CLEANING

A. Remove all sediment and debris from pipe interior as it is installed.

B. Remove all sediment and debris from in-place pipe prior to installing extension pipe.

C. Remove all sediment and debris from existing (to be removed) pipe interior and exterior.

13.06 EDGE OF LINER MARKERS

A. Install edge of liner marker posts (steel "T" posts) at the corners and 50ft spacing on the liner, as detailed on the Drawings.

13.07 FINAL CLEANUP

A. Before final acceptance, the CONTRACTOR shall remove all surplus and discarded materials, equipment, rubbish, and temporary structures from the Landfill; and all parts of the work shall be left in a condition acceptable to the OWNER.

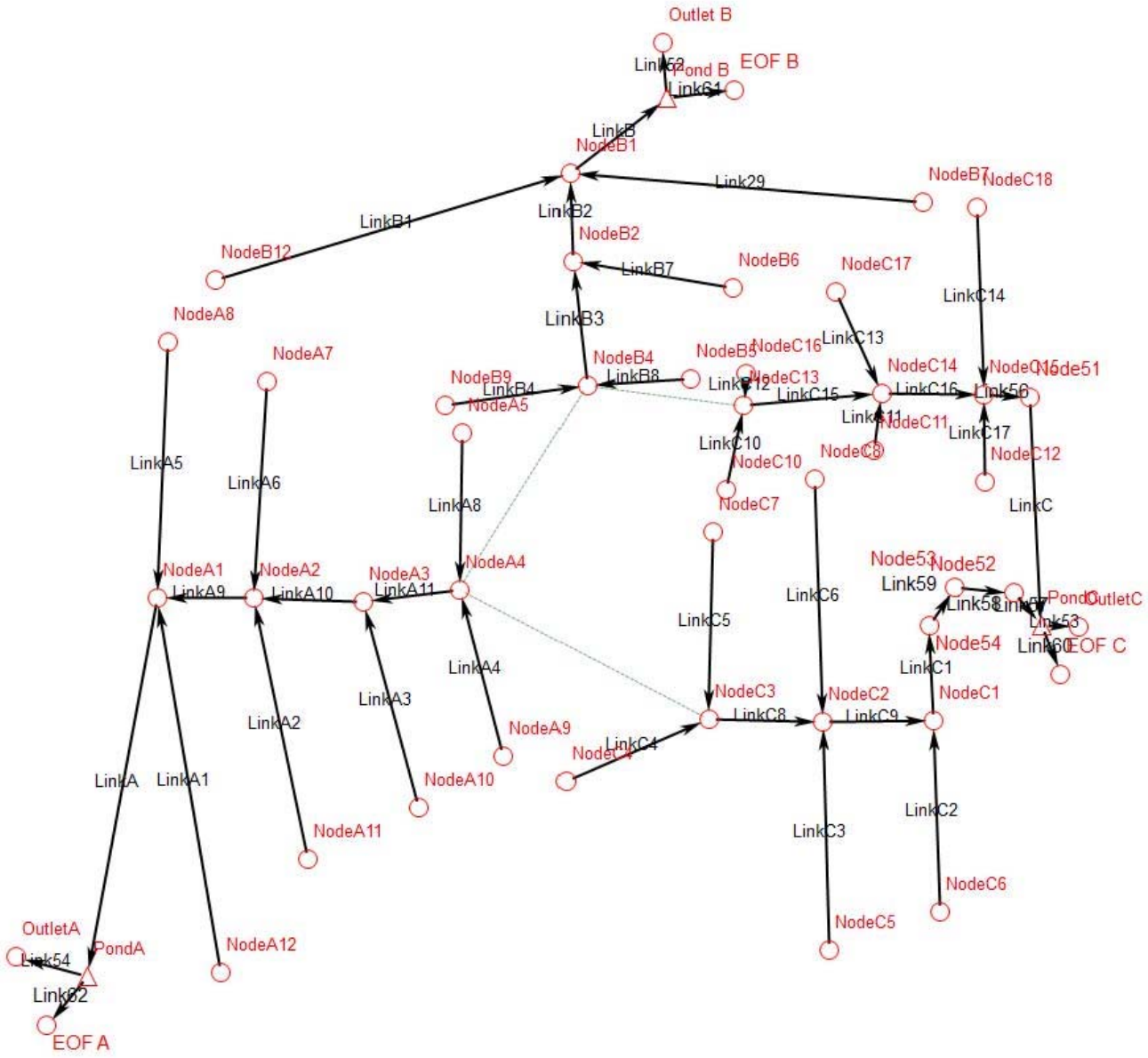
B. CONTRACTOR shall re-establish all disturbed areas adjacent to the Work to their original condition.

C. Restore borrow areas to drain as shown in the Drawings. Borrow areas shall be left in a neat and orderly condition.

D. Damage to access roads by construction traffic will be the responsibility of the CONTRACTOR. Before final acceptance of the Work, CONTRACTOR shall reshape, regrade, provide additional material, and compact all access and haul roads damaged by construction traffic as needed to provide a surface area complying with the above specifications for gravel road construction.

END OF SECTION 02935

APPENDIX G



General Waste	**Apr 13**
XPSWMM Model Frame	**Figure 1**

Assumptions:
Pond C = 26.5 Acres | Pond B = 10.5 Acres | Pond A = 20.1 Acres
Steep Landfill Cover - Grassed
Assume CN 80

Infiltration Basin Information
Pond B and C Udorthens - Well Drained Soils - **0.6** to 6.0 in/hr (Web Soil Survey)

Design Infiltration Rate	0.6	in/hr
Design Maximum Infiltration Time	48	hr

Pond A Slickens - Unclassified Drainage - **U/C** (Web Soil Survey)

Design Infiltration Rate	0.3	in/hr
Design Maximum Infiltration Time	48	hr

Pond C
Runoff/Infiltration Calculation

	Impervious	Vegetated	Total
Precipiation	90% Storm	90% Storm	
Rainfall (in/24hr)	1.25	1.25	
Runoff			
SCS Curve Number	98	80	
Potential Maximum Retention, S	0.20	2.50	
Rainfall Excess, R (inches)	1.03	0.17	
Retention (inches)	0.22	1.08	
	Single Event	Single Event	
Drainage Area (ac.)	0.50	26.00	26.50
Drainage Area (SF)	21,780	1,132,560	1,154,340
Total Runoff (CF)	1,878	16,335	*18,213*
Infiltration Plan Area (SF)			**7,589**
Infiltration Plan Area (AC)			0.17

Sedimentation Basin

Pretreatment sized with dead storage of 50% runoff from WQE

50% Runoff Volume from WQE	1,134	CF
Plan Area Assuming 3 Feet of Depth	378	SF

Pond B

Runoff/Infiltration Calculation

	Impervious	Vegetated	Total
Precipiation	90% Storm	90% Storm	
Rainfall (in/24hr)	1.25	1.25	
Runoff			
SCS Curve Number	98	80	
Potential Maximum Retention, S	0.20	2.50	
Rainfall Excess, R (inches)	1.03	0.17	
Retention (inches)	0.22	1.08	
	Single Event	Single Event	
Drainage Area (ac.)	0.50	10.00	10.50
Drainage Area (SF)	21,780	435,600	457,380
Total Runoff (CF)	1,878	6,283	*8,160*
Infiltration Plan Area (SF)			**3,400**
Infiltration Plan Area (AC)			0.08

Sedimentation Basin

Pretreatment sized with dead storage of 50% runoff from WQE

50% Runoff Volume from WQE	1,134	CF
Plan Area Assuming 3 Feet of Depth	378	SF

Pond A

Runoff/Infiltration Calculation

	Impervious	Vegetated	Total
Precipiation	90% Storm	90% Storm	
Rainfall (in/24hr)	1.25	1.25	
Runoff			
SCS Curve Number	98	80	
Potential Maximum Retention, S	0.20	2.50	
Rainfall Excess, R (inches)	1.03	0.17	
Retention (inches)	0.22	1.08	
	Single Event	Single Event	
Drainage Area (ac.)	0.50	19.60	20.10
Drainage Area (SF)	21,780	853,776	875,556
Total Runoff (CF)	1,878	12,314	*14,192*
Infiltration Plan Area (SF)			**11,827**
Infiltration Plan Area (AC)			0.27

Sedimentation Basin

Pretreatment sized with dead storage of 50% runoff from WQE

50% Runoff Volume from WQE	1,134	CF
Plan Area Assuming 3 Feet of Depth	378	SF

```
 Current Directory:   C:\XPS\XPSWMM~1
 Engine Name: C:\XPS\XPSWMM~1\SWMMEN~1.EXE




 Input File : \Users\kmlanglie\Desktop\XPSWMM\General Waste\genwaste-100yrV2.XP

          *=============================================*
          |                   xpswmm                    |
          |     Storm and Wastewater Management Model   |
          |         Developed by XP Solutions Inc.      |
          |=============================================|
          |                                             |
          | Last Update      : Oct., 2011               |
          | Interface Version: 2012                     |
          | Engine Version   : 12.0                     |
          | Data File Version: 12.4                     |
          | Serial Number    :                          |
          |                                             |
          *=============================================*

Engine Name: C:\XPS\XPSWMM~1\SWMMEN~1.EXE




*=================================================*
|       Input and Output file names by Layer      |
*=================================================*

 Input File  to Layer #     1 JIN.US


 Output File to Layer #     1 C:\Users\kmlanglie\Desktop\XPSWMM\General
Waste\genwaste.int


 Input File  to Layer #     2 C:\Users\kmlanglie\Desktop\XPSWMM\General
Waste\genwaste.int


 Output File to Layer #     2 JOT.US



*=========================================================*
|   Special command line arguments in XP-SWMM2000. This  |
|   now includes program defaults. $Keywords are the program|
|   defaults.  Other Keywords are from the SWMMCOM.CFG file.|
|   or the command line or any cfg file on the command line.|
|   Examples include these in the file xpswm.bat under the  |
|   section :solve or in the windows version XPSWMM32 in the|
|   file solve.bat                                        |
|                                                         |
|   Note: the cfg file should be in the subdirectory swmxp  |
|         or defined by the set variable in the xpswm.bat   |
|         file.  Some examples of the command lines possible|
```

are shown below:
swmmd swmmcom.cfg
swmmd my.cfg
swmmd nokeys nconv5 perv extranwq

$powerstation	0.0000	1	2
$perv	0.0000	0	4
$oldegg	0.0000	0	7
$as	0.0000	0	11
$noflat	0.0000	0	21
$oldomega	0.0000	0	24
$oldvol	0.0000	1	28
$implicit	0.0000	1	29
$oldhot	0.0000	1	31
$oldscs	0.0000	0	33
$flood	0.0000	1	40
$nokeys	0.0000	0	42
$pzero	0.0000	0	55
$oldvol2	0.0000	2	59
$storage2	0.0000	3	62
$oldhot1	0.0000	1	63
$pumpwt	0.0000	1	70
$ecloss	0.0000	1	77
$exout	0.0000	0	97
SPATIAL=0.55	0.5500	5	124
$djref = -1.0	-0.1000	3	143
$weirlen = 50	50.0000	1	153
$oldbnd	0.0000	1	154
$nogrelev	0.0000	1	161
$ncmid	0.0000	0	164
$new_nl_97	0.0000	2	290
SCSIADEPTH=ON	0.0000	1	293
$best97	0.0000	1	294
$newbound	0.0000	1	295
$q_tol = 0.01	0.0001	1	316
$new_storage	0.0000	1	322
$old_iteration	0.0000	1	333
$minlen=30.0	30.0000	1	346
$review_elevation	0.0000	1	383
$use_half_volume	0.0000	1	385
VERT_WALLS=ON	0.0000	1	389
$min_ts = 1.0	1.0000	1	407
$design_restart = on	0.0000	1	412
$zero_value=1.e-05	0.0000	1	415
SUBCATCHMENT_RES=ON	0.0000	1	419
$relax_depth = on	0.0000	1	427
$saveallpts = on	0.0000	1	434

Parameter Values on the Tapes Common Block.These are the values read from the data file and dynamically allocated by the model for this simulation.

Number of Subcatchments in the Runoff Block (NW)....	25
Number of Channel/Pipes in the Runoff Block (NG)....	0
Runoff Water quality constituents (NRQ).....	0
Runoff Land Uses per Subcatchment (NLU).....	0
Number of Elements in the Transport Block (NET).....	0
Number of Storage Junctions in Transport (NTSE).....	0
Number of Input Hydrographs in Transport (NTH).....	0

```
 Number of Elements in the Extran Block (NEE).........    52
 Number of Groundwater Subcatchments in Runoff (NGW).     0
 Number of Interface locations for all Blocks (NIE)..    52
 Number of Pumps in Extran (NEP).....................     0
 Number of Orifices in Extran (NEO)..................     0
 Number of Tide Gates/Free Outfalls in Extran (NTG)..     6
 Number of Extran Weirs (NEW)........................     0
 Number of scs hydrograph points.....................  1681
 Number of Extran printout locations (NPO)...........     0
 Number of Tide elements in Extran (NTE).............     6
 Number of Natural channels (NNC)....................     0
 Number of Storage junctions in Extran (NVSE)........     3
 Number of Time history data points in Extran(NTVAL).     0
 Number of Variable storage elements in Extran (NVST)     2
 Number of Input Hydrographs in Extran (NEH).........     0
 Number of Particle sizes in Transport Block (NPS)...     0
 Number of User defined conduits (NHW)...............    25
 Number of Connecting conduits in Extran (NECC)......    20
 Number of Upstream elements in Transport (NTCC).....    10
 Number of Storage/treatment plants (NSTU)...........     1
 Number of Values for R1 lines in Transport (NR1)....     0
 Number of Nodes to be allowed for (NNOD)............    52
 Number of Plugs in a Storage Treatment Unit.........     1


 ###########################################################
 #    Entry made to the Runoff Layer(Block) of SWMM    #
 #    Last Updated Oct., 2011 by XP Solutions          #

 *===========================================================*
 |          RUNOFF TABLES IN THE OUTPUT FILE.                |
 |  These are the more important tables in the output file.  |
 |  You can use your editor to find the table numbers,       |
 |  for example: search for Table R3 to check continuity.    |
 |  This output file can be imported into a Word Processor   |
 |  and printed on US letter or A4 paper using portrait      |
 |  mode, courier font, a size of 8 pt. and margins of 0.75  |
 |                                                           |
 | Table R1  - Physical Hydrology Data                       |
 | Table R2  - Infiltration data                             |
 | Table R3  - Raingage and Infiltration Database Names      |
 | Table R4  - Groundwater Data                              |
 | Table R5  - Continuity Check for Surface Water            |
 | Table R6  - Continuity Check for Channels/Pipes           |
 | Table R7  - Continuity Check for Subsurface Water         |
 | Table R8  - Infiltration/Inflow Continuity Check          |
 | Table R9  - Summary Statistics for Subcatchments          |
 | Table R10 - Sensitivity anlysis for Subcatchments         |
 *===========================================================*

                    GenWaste1


##############################################
#              RUNOFF JOB CONTROL            #
##############################################

 Snowmelt parameter - ISNOW.....................            0
 Number of rain gages - NRGAG...................            1
 Quality is not simulated - KWALTY..............            0
 Default evaporation rate used - IVAP...........            0
 Hour of day at start of storm - NHR............            0
```

```
 Minute of hour at start of storm - NMN.....            0
 Time TZERO at start of storm (hours).....          0.000
 Use U.S. Customary units for most I/O - METRIC...      0
 Runoff input print control...                          0
 Runoff graph plot control....                          0
 Runoff output print control..                          0
 Limit number of groundwater convergence messages to    10000

 Print headers every 50 lines - NOHEAD (0=yes, 1=no)    0

 Print land use load percentages -LANDUPR (0=no, 1=yes)     0
 Month, day, year of start of storm is:             1/ 1/1995
 Wet time step length (seconds).......                 60.0
 Dry time step length (seconds).......              86400.0
 Wet/Dry time step length (seconds)...                 60.0
 Simulation length is......                            24.0 Hours

 If Horton infiltration model is being used
 A mixture of infiltration options may be used in
 XP-SWMM2000 as a watershed specific option.
 Rate for regeneration of infiltration = REGEN * DECAY
 Decay is read in for each subcatchment
 REGEN = ..........................................  0.01000


 Raingage #.............................        1
 KTYPE  - Rainfall input type.............      0
 NHISTO - Total number of rainfall values..   240
 KINC   - Rainfall values(pairs) per line..    10
 KPRINT - Print rainfall(0-Yes,1-No).......     0
 KTIME  - Precipitation time units
 0 --> Minutes  1 --> Hours...............      1
 KPREP  - Precipitation unit type
 0 --> Intensity  1 --> Volume............      1
 KTHIS - Variable rainfall intervals
 0 --> No, > 1 --> Yes....................      0
 THISTO - Rainfall time interval..........   0.10
 TZRAIN - Starting time(KTIME units).....    0.00


#######################################
# Rainfall input summary from Runoff #
#######################################

 Total rainfall for gage #     1 is    5.2000 inches

   ##############################
   #        Data Group F1       #
   # Evaporation Rate (in/day) #
   ##############################

  JAN.  FEB.  MAR.  APR.  MAY   JUN.  JUL.  AUG.  SEP.  OCT.  NOV  DEC.
  ----  ----  ----  ----  ----  ----  ----  ----  ----  ----  ---- ----
 0.100 0.100 0.100 0.100 0.100 0.100 0.100 0.100 0.100 0.100 0.100 0.100


  ####################################################
  #  Table R1.  S U B C A T C H M E N T  D A T A     #
  #             Physical Hydrology Data              #
  ####################################################


   Deprs Deprs Prcnt
```

Number	Subcatchment Name	Channel or inlet	Width (ft)	Area (ac)	Per-cent Imperv	Slope ft/ft	"n" Imprv	"n" Perv	Storge -sion Imprv	Strge -sion Perv	Deten Zero
1	NodeA9#1	NodeA9	1.0000	.80000	0.00	1.000	0.020	0.020	0.000	0.000	0.00
2	NodeA5#1	NodeA5	1.0000	.92000	0.00	1.000	0.020	0.020	0.000	0.000	0.00
3	NodeB9#1	NodeB9	1.0000	1.9000	0.00	1.000	0.020	0.020	0.000	0.000	0.00
4	NodeB5#1	NodeB5	1.0000	.30000	0.00	1.000	0.020	0.020	0.000	0.000	0.00
5	NodeC16#1	NodeC16	1.0000	.15000	0.00	1.000	0.020	0.020	0.000	0.000	0.00
6	NodeC10#1	NodeC10	1.0000	.57000	0.00	1.000	0.020	0.020	0.000	0.000	0.00
7	NodeC17#1	NodeC17	1.0000	1.4500	0.00	1.000	0.020	0.020	0.000	0.000	0.00
8	NodeC11#1	NodeC11	1.0000	3.1300	0.00	1.000	0.020	0.020	0.000	0.000	0.00
9	NodeC18#1	NodeC18	1.0000	1.7000	0.00	1.000	0.020	0.020	0.000	0.000	0.00
10	NodeC12#1	NodeC12	1.0000	1.0000	0.00	1.000	0.020	0.020	0.000	0.000	0.00
11	NodeC4#1	NodeC4	1.0000	1.8000	0.00	1.000	0.020	0.020	0.000	0.000	0.00
12	NodeC7#1	NodeC7	1.0000	1.7000	0.00	1.000	0.020	0.020	0.000	0.000	0.00
13	NodeC5#1	NodeC5	1.0000	2.5000	0.00	1.000	0.020	0.020	0.000	0.000	0.00
14	NodeC8#1	NodeC8	1.0000	1.7000	0.00	1.000	0.020	0.020	0.000	0.000	0.00
15	NodeC6#1	NodeC6	1.0000	3.5000	0.00	1.000	0.020	0.020	0.000	0.000	0.00
16	NodeC1#1	NodeC1	1.0000	1.3000	0.00	1.000	0.020	0.020	0.000	0.000	0.00
17	Node54#1	Node54	1.0000	3.2000	0.00	1.000	0.020	0.020	0.000	0.000	0.00
18	NodeB6#1	NodeB6	1.0000	1.7000	0.00	1.000	0.020	0.020	0.000	0.000	0.00
19	NodeB12#1	NodeB12	1.0000	3.1000	0.00	1.000	0.020	0.020	0.000	0.000	0.00
20	NodeB7#1	NodeB7	1.0000	1.7000	0.00	1.000	0.020	0.020	0.000	0.000	0.00
21	NodeA10#1	NodeA10	1.0000	1.2000	0.00	1.000	0.020	0.020	0.000	0.000	0.00
22	NodeA11#1	NodeA11	1.0000	5.1000	0.00	1.000	0.020	0.020	0.000	0.000	0.00
23	NodeA7#1	NodeA7	1.0000	2.9900	0.00	1.000	0.020	0.020	0.000	0.000	0.00
24	NodeA8#1	NodeA8	1.0000	6.5800	0.00	1.000	0.020	0.020	0.000	0.000	0.00
25	NodeA12#1	NodeA12	1.0000	7.2000	0.00	1.000	0.020	0.020	0.000	0.000	0.00

##
####################
Table R2. SUBCATCHMENT DATA

```
#
#                    Infiltration or Time of Concentration Data
#
#
#
# Infiltration Type      Infl #1(#5)       Infl #2(#6)          Infl #3(#7)
    Infl #4(#8)  #
# SCS                  ->   Comp CN          Time Conc         Shape Factor
Depth or Fraction  #
# SBUH                 ->   Comp CN          Time Conc                  N/A
            N/A  #
# Green Ampt           ->   Suction          Hydr Cond           Initial MD
            N/A  #
# Horton               ->  Max Rate           Min Rate   Decay Rate (1/sec)
Max. Infilt. Volume  #
# Proportional         ->  Constant                N/A                  N/A
            N/A  #
# Initial/Cont Loss    ->   Initial         Continuing                  N/A
            N/A  #
# Initial/Proportional ->   Initial           Constant                  N/A
            N/A  #
# Laurenson Parameters ->   B Value       Pervious "n"      Impervious Cont
      Exponent  #
# Rational Formula     -> Tc Method   Flow Path Length      Flow Path Slope
Roughness or Retardance  #
#                                 (#1 - #4 is Impervious Data / #5 - #8 is Pervious
Data)              #
#                    Rational Formula Tc Method: 1 = Constant
#                                                2 = Friend's Equation
#                                                3 = Kinematic Wave
#                                                4 = Alameda Method
#                                                5 = Izzard's Formula
#                                                6 = Kerby's Equation
#                                                7 = Kirpich's Equation
#                                                8 = Bransby Williams Equation
#                                                9 = Federal Aviation Authority
Equation            #
################################################################################
###################
```

Subcatchment Number	Infl Name	Infl # 1	Infl # 2	Infl # 3	Infl # 4	Infl # 5	Infl # 6	Infl # 7	Infl # 8
1	NodeA9#1	80.0000	0.0833	484.0000	0.2000				
2	NodeA5#1	80.0000	0.0833	484.0000	0.2000				
3	NodeB9#1	80.0000	0.0833	484.0000	0.2000				
4	NodeB5#1	80.0000	0.0833	484.0000	0.2000				
5	NodeC16#1	80.0000	0.0833	484.0000	0.2000				

6	NodeC10#1	80.0000	0.0833	484.0000	0.2000
7	NodeC17#1	80.0000	0.0833	484.0000	0.2000
8	NodeC11#1	80.0000	0.0833	484.0000	0.2000
9	NodeC18#1	80.0000	0.0833	484.0000	0.2000
10	NodeC12#1	80.0000	0.0833	484.0000	0.2000
11	NodeC4#1	80.0000	0.0833	484.0000	0.2000
12	NodeC7#1	80.0000	0.0833	484.0000	0.2000
13	NodeC5#1	80.0000	0.0833	484.0000	0.2000
14	NodeC8#1	80.0000	0.0833	484.0000	0.2000
15	NodeC6#1	80.0000	0.0833	484.0000	0.2000
16	NodeC1#1	80.0000	0.0833	484.0000	0.2000
17	Node54#1	80.0000	0.0833	484.0000	0.2000
18	NodeB6#1	80.0000	0.0833	484.0000	0.2000
19	NodeB12#1	80.0000	0.0833	484.0000	0.2000
20	NodeB7#1	80.0000	0.0833	484.0000	0.2000
21	NodeA10#1	80.0000	0.0833	484.0000	0.2000
22	NodeA11#1	80.0000	0.0833	484.0000	0.2000
23	NodeA7#1	80.0000	0.0833	484.0000	0.2000
24	NodeA8#1	80.0000	0.0833	484.0000	0.2000
25	NodeA12#1	80.0000	0.0833	484.0000	0.2000

```
############################################################
#     Table R3.  SUBCATCHMENT  DATA                        #
#                Rainfall and Infiltration Database Names  #
############################################################
```

Subcatchment Number	Name	Gage No	Infiltration Type	Routing Type
1	NodeA9#1	1	SCS Method	SCS curvilinear
2	NodeA5#1	1	SCS Method	SCS curvilinear
3	NodeB9#1	1	SCS Method	SCS curvilinear
4	NodeB5#1	1	SCS Method	SCS curvilinear
5	NodeC16#1	1	SCS Method	SCS curvilinear
6	NodeC10#1	1	SCS Method	SCS curvilinear
7	NodeC17#1	1	SCS Method	SCS curvilinear
8	NodeC11#1	1	SCS Method	SCS curvilinear
9	NodeC18#1	1	SCS Method	SCS curvilinear
10	NodeC12#1	1	SCS Method	SCS curvilinear
11	NodeC4#1	1	SCS Method	SCS curvilinear
12	NodeC7#1	1	SCS Method	SCS curvilinear

13	NodeC5#1	1	SCS Method	SCS curvilinear
14	NodeC8#1	1	SCS Method	SCS curvilinear
15	NodeC6#1	1	SCS Method	SCS curvilinear
16	NodeC1#1	1	SCS Method	SCS curvilinear
17	Node54#1	1	SCS Method	SCS curvilinear
18	NodeB6#1	1	SCS Method	SCS curvilinear
19	NodeB12#1	1	SCS Method	SCS curvilinear
20	NodeB7#1	1	SCS Method	SCS curvilinear
21	NodeA10#1	1	SCS Method	SCS curvilinear
22	NodeA11#1	1	SCS Method	SCS curvilinear
23	NodeA7#1	1	SCS Method	SCS curvilinear
24	NodeA8#1	1	SCS Method	SCS curvilinear
25	NodeA12#1	1	SCS Method	SCS curvilinear

Total Number of Subcatchments... 25
Total Tributary Area (acres).... 57.19
Impervious Area (acres)..... 0.00
Pervious Area (acres)..... 57.19
Total Width (feet)..... 25.00
Impervious Area (%)..... 0.00

```
##################################################
#          S U B C A T C H M E N T  D A T A      #
#   Default, Ratio values for subcatchment data   #
#   Used with the calibrate node in the runoff.   #
# 1 - width     2 - area       3 - impervious %   #
# 4 - slope     5 - imp "n"    6 - perv "n"       #
# 7 - imp ds    8 - perv ds    9 - 1st infil      #
#10 - 2nd infil               11 - 3rd infil      #
##################################################
```

Column	1	2	3	4	5	6	7	8	9	10	11
Default	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Ratio	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000

```
*******************************************************
*     Arrangement of Subcatchments and Channel/Pipes    *
*******************************************************
```

Inlet		
NodeA9	No Tributary Channel/Pipes	
	Tributary Subareas.....	NodeA9#1
NodeA5	No Tributary Channel/Pipes	
	Tributary Subareas.....	NodeA5#1
NodeB9	No Tributary Channel/Pipes	
	Tributary Subareas.....	NodeB9#1
NodeB5	No Tributary Channel/Pipes	
	Tributary Subareas.....	NodeB5#1
NodeC16	No Tributary Channel/Pipes	
	Tributary Subareas.....	NodeC16#1
NodeC10	No Tributary Channel/Pipes	
	Tributary Subareas.....	NodeC10#1
NodeC17	No Tributary Channel/Pipes	
	Tributary Subareas.....	NodeC17#1
NodeC11	No Tributary Channel/Pipes	
	Tributary Subareas.....	NodeC11#1
NodeC18	No Tributary Channel/Pipes	
	Tributary Subareas.....	NodeC18#1

```
NodeC12         No Tributary Channel/Pipes
                Tributary Subareas........ NodeC12#1
NodeC4          No Tributary Channel/Pipes
                Tributary Subareas........ NodeC4#1
NodeC7          No Tributary Channel/Pipes
                Tributary Subareas........ NodeC7#1
NodeC5          No Tributary Channel/Pipes
                Tributary Subareas........ NodeC5#1
NodeC8          No Tributary Channel/Pipes
                Tributary Subareas........ NodeC8#1
NodeC6          No Tributary Channel/Pipes
                Tributary Subareas........ NodeC6#1
NodeC1          No Tributary Channel/Pipes
                Tributary Subareas........ NodeC1#1
Node54          No Tributary Channel/Pipes
                Tributary Subareas........ Node54#1
NodeB6          No Tributary Channel/Pipes
                Tributary Subareas........ NodeB6#1
NodeB12         No Tributary Channel/Pipes
                Tributary Subareas........ NodeB12#1
NodeB7          No Tributary Channel/Pipes
                Tributary Subareas........ NodeB7#1
NodeA10         No Tributary Channel/Pipes
                Tributary Subareas........ NodeA10#1
NodeA11         No Tributary Channel/Pipes
                Tributary Subareas........ NodeA11#1
NodeA7          No Tributary Channel/Pipes
                Tributary Subareas........ NodeA7#1
NodeA8          No Tributary Channel/Pipes
                Tributary Subareas........ NodeA8#1
NodeA12         No Tributary Channel/Pipes
                Tributary Subareas........ NodeA12#1


************************************************************
* Hydrographs will be stored for the following  25 INLETS *
************************************************************
NodeA9    NodeA5    NodeB9    NodeB5    NodeC16   NodeC10
NodeC17   NodeC11   NodeC18   NodeC12   NodeC4    NodeC7
NodeC5    NodeC8    NodeC6    NodeC1    Node54    NodeB6
NodeB12   NodeB7    NodeA10   NodeA11   NodeA7    NodeA8
NodeA12


***********************************************
*  Quality Simulation not included in this run *
***********************************************




************************************************
*  Precipitation Interface File Summary          *
*  Number of precipitation station....        1   *
************************************************

Location Station Number
-------- --------------
       1.             1


*********************************************
*      End of time step DO-loop in Runoff      *
```

```
 ************************************************

 Final Date (Mo/Day/Year)   =             1/ 2/1995
 Total number of time steps =                  1440
 Final Julian Date          =               1995002
 Final time of day          =                    0. seconds.
 Final time of day          =                 0.00   hours.
 Final running time         =               24.0000   hours.
 Final running time         =                1.0000    days.

 ***************************************************
 *     Extrapolation Summary for Watersheds        *
 * Explains the number of time steps and iterations *
 * used in the solution of the subcatchments.      *
 * # Steps ==> Total Number of Extrapolated Steps  *
 * # Calls ==> Total Number of OVERLND Calls       *
 ***************************************************

 Subcatchment   # Steps   # Calls Subcatchment   # Steps   # Calls
 ------------  -------  -------- -------------  -------  --------
 NodeA9#1             0         0 NodeA5#1             0         0 NodeB9#1
   0         0
 NodeB5#1             0         0 NodeC16#1            0         0 NodeC10#1
   0         0
 NodeC17#1            0         0 NodeC11#1            0         0 NodeC18#1
   0         0
 NodeC12#1            0         0 NodeC4#1             0         0 NodeC7#1
   0         0
 NodeC5#1             0         0 NodeC8#1             0         0 NodeC6#1
   0         0
 NodeC1#1             0         0 Node54#1             0         0 NodeB6#1
   0         0
 NodeB12#1            0         0 NodeB7#1             0         0 NodeA10#1
   0         0
 NodeA11#1            0         0 NodeA7#1             0         0 NodeA8#1
   0         0
 NodeA12#1            0         0


 ############################################################
 # Rainfall input summary from Runoff Continuity Check      #
 ############################################################

 Total rainfall read for gage #         1 is       5.2000 in
 Total rainfall duration for gage #     1 is      1440.00 minutes

 ***********************************************************
 * Table R5. CONTINUITY CHECK FOR SURFACE WATER            *
 *       Any continuity error can be fixed by lowering the *
 *       wet and transition time step. The transition time *
 *       should not be much greater than the wet time step.*
 ***********************************************************

                                                                Inches over
                                                  cubic feet    Total Basin
 Total Precipitation (Rain plus Snow)           1.079518E+06      5.200
 Total Infiltration                             4.400529E+05          2.120
 Total Evaporation                              2.075997E+04          0.100
 Surface Runoff from Watersheds                 6.166224E+05          2.970
 Total Water remaining in Surface Storage       0.000000E+00          0.000
 Infiltration over the Pervious Area...         4.400529E+05          2.120
                    --------
 Infiltration + Evaporation +
 Surface Runoff + Snow removal +
```

```
 Water remaining in Surface Storage +
 Water remaining in Snow Cover.........          1.077435E+06          5.190
 Total Precipitation + Initial Storage.          1.079518E+06          5.200


 The error in continuity is calculated as
 ****************************************
 * Precipitation + Initial Snow Cover  *
 *      - Infiltration -               *
 *Evaporation - Snow removal -         *
 *Surface Runoff from Watersheds -     *
 *Water in Surface Storage -           *
 *Water remaining in Snow Cover        *
 *--------------------------------------*
 * Precipitation + Initial Snow Cover  *
 ****************************************
 Percent Continuity Error..............                          0.1930


 ************************************************
 * Table R6. Continuity Check for Channel/Pipes     *
 *           You should have zero continuity error  *
 *           if you are not using runoff hydraulics *
 ************************************************
                                                                 Inches over
                                                  cubic feet     Total Basin
 Initial Channel/Pipe Storage.............     0.000000E+00          0.000
 Final Channel/Pipe Storage...............     0.000000E+00          0.000
 Surface Runoff from Watersheds...........     6.166224E+05          2.970
 Groundwater Subsurface Inflow or Diversion..  0.000000E+00          0.000
 Evaporation Loss from Channels...........     0.000000E+00          0.000
 Groundwater Flow Diverted Out of Network....  0.000000E+00          0.000
 Channel/Pipe/Inlet Outflow...............     6.166224E+05          2.970
 Initial Storage + Inflow.................     6.166224E+05          2.970
 Final Storage + Outflow + Diverted GW.....    6.166224E+05          2.970
 ****************************************
 * Final Storage + Outflow + Evaporation  - *
 * Watershed Runoff - Groundwater Inflow  - *
 *     Initial Channel/Pipe Storage         *
 *     ---------------------------------    *
 *  Final Storage + Outflow  + Evaporation  *
 ****************************************
 Percent Continuity Error.................                      0.0000

         ###################################################
         # Table R9. Summary Statistics for Subcatchments #
         ###################################################

 Note: Total Runoff Depth includes pervious & impervious areas.
       Pervious and Impervious Runoff Depth is only the runoff from those two areas.
       For catchments receiving redirected flow, this flow will only be shown if the
flow is not
       directed directly to the outlet. Flow that is getting redirected is also
listed with
       the original subcatchment.


 Subcatchment..........        NodeA9#1        NodeA5#1        NodeB9#1
NodeB5#1       NodeC16#1       NodeC10#1
 Area (acres)..........         0.80000         0.92000         1.90000
0.30000         0.15000         0.57000
 Percent Impervious.....        0.00000         0.00000         0.00000
0.00000         0.00000         0.00000
```

Total Rainfall (in)....	5.20000	5.20000	5.20000	5.20000	5.20000	5.20000	5.20000
Max Intensity (in/hr)..	7.12920	7.12920	7.12920	7.12920	7.12920	7.12920	7.12920

Pervious Area

Total Runoff Depth (in)	2.97025	2.97025	2.97025	2.97025	2.97025	2.97025	2.97025
Peak Runoff Rate (cfs).	3.82252	4.39589	9.07847	1.43344	0.71672	2.72354	

Total Impervious Area

Total Runoff Depth (in)	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
Peak Runoff Rate (cfs).	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	

Impervious Area with depression storage

Total Runoff Depth (in)	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
Peak Runoff Rate (cfs).	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	

Impervious Area without depression storage

Total Runoff Depth (in)	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
Peak Runoff Rate (cfs).	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	

Total Area

Total Runoff Depth (in)	2.97025	2.97025	2.97025	2.97025	2.97025	2.97025	2.97025
Peak Runoff Rate (cfs).	3.82252	4.39589	9.07847	1.43344	0.71672	2.72354	

Rational Formula

Pervious Tc. (mins)....	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
Perv. Intensity (in/hr)	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
Pervious C	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
Impervious Tc. (mins)..	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
Imp. Intensity (in/hr).	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
Impervious C	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
Partial Area (Ha).....	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
Partial Area Tc.....	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
Partial Area Intensity.	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000

Subcatchment.....	NodeC17#1	NodeC11#1	NodeC18#1

NodeC12#1	NodeC4#1	NodeC7#1		
Area (acres).....		1.45000	3.13000	1.70000
1.00000	1.80000	1.70000		
Percent Impervious.....		0.00000	0.00000	0.00000
0.00000	0.00000	0.00000		
Total Rainfall (in)....		5.20000	5.20000	5.20000
5.20000	5.20000	5.20000		
Max Intensity (in/hr)..		7.12920	7.12920	7.12920
7.12920	7.12920	7.12920		
Pervious Area				
Total Runoff Depth (in)		2.97025	2.97025	2.97025
2.97025	2.97025	2.97025		
Peak Runoff Rate (cfs).		6.92831	14.95559	8.12284
4.77814	8.60066	8.12284		
Total Impervious Area				
Total Runoff Depth (in)		0.00000	0.00000	0.00000
0.00000	0.00000	0.00000		
Peak Runoff Rate (cfs).		0.00000	0.00000	0.00000
0.00000	0.00000	0.00000		
Impervious Area with depression storage				
Total Runoff Depth (in)		0.00000	0.00000	0.00000
0.00000	0.00000	0.00000		
Peak Runoff Rate (cfs).		0.00000	0.00000	0.00000
0.00000	0.00000	0.00000		
Impervious Area without depression storage				
Total Runoff Depth (in)		0.00000	0.00000	0.00000
0.00000	0.00000	0.00000		
Peak Runoff Rate (cfs).		0.00000	0.00000	0.00000
0.00000	0.00000	0.00000		
Total Area				
Total Runoff Depth (in)		2.97025	2.97025	2.97025
2.97025	2.97025	2.97025		
Peak Runoff Rate (cfs).		6.92831	14.95559	8.12284
4.77814	8.60066	8.12284		
Rational Formula				
Pervious Tc. (mins)....		0.00000	0.00000	0.00000
0.00000	0.00000	0.00000		
Perv. Intensity (in/hr)		0.00000	0.00000	0.00000
0.00000	0.00000	0.00000		
Pervious C		0.00000	0.00000	0.00000
0.00000	0.00000	0.00000		
Impervious Tc. (mins)..		0.00000	0.00000	0.00000
0.00000	0.00000	0.00000		
Imp. Intensity (in/hr).		0.00000	0.00000	0.00000
0.00000	0.00000	0.00000		
Impervious C		0.00000	0.00000	0.00000
0.00000	0.00000	0.00000		
Partial Area (Ha).....		0.00000	0.00000	0.00000
0.00000	0.00000	0.00000		
Partial Area Tc.....		0.00000	0.00000	0.00000
0.00000	0.00000	0.00000		

Partial Area Intensity.	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000

Subcatchment.....	NodeC5#1	NodeC8#1	NodeC6#1	NodeC1#1	Node54#1	NodeB6#1
Area (acres).....	2.50000	1.70000	3.50000	1.30000	3.20000	1.70000
Percent Impervious.....	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
Total Rainfall (in)....	5.20000	5.20000	5.20000	5.20000	5.20000	5.20000
Max Intensity (in/hr)..	7.12920	7.12920	7.12920	7.12920	7.12920	7.12920

Pervious Area

Total Runoff Depth (in)	2.97025	2.97025	2.97025	2.97025	2.97025	2.97025	2.97025
Peak Runoff Rate (cfs).	11.94536	8.12284	16.72350	6.21159	15.29006	8.12284	

Total Impervious Area

Total Runoff Depth (in)	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
Peak Runoff Rate (cfs).	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	

Impervious Area with depression storage

Total Runoff Depth (in)	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
Peak Runoff Rate (cfs).	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	

Impervious Area without depression storage

Total Runoff Depth (in)	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
Peak Runoff Rate (cfs).	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	

Total Area

Total Runoff Depth (in)	2.97025	2.97025	2.97025	2.97025	2.97025	2.97025	2.97025
Peak Runoff Rate (cfs).	11.94536	8.12284	16.72350	6.21159	15.29006	8.12284	

Rational Formula

Pervious Tc. (mins)....	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
Perv. Intensity (in/hr)	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
Pervious C	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
Impervious Tc. (mins)..	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
Imp. Intensity (in/hr).	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
Impervious C	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000

0.00000	0.00000	0.00000					
Partial Area (Ha).....		0.00000	0.00000	0.00000			
0.00000	0.00000	0.00000					
Partial Area Tc.....		0.00000	0.00000	0.00000			
0.00000	0.00000	0.00000					
Partial Area Intensity.		0.00000	0.00000	0.00000			
0.00000	0.00000	0.00000					

Subcatchment.....	NodeB12#1	NodeB7#1	NodeA10#1	NodeA11#1	NodeA7#1	NodeA8#1
Area (acres).....	3.10000	1.70000	1.20000	5.10000	2.99000	6.58000
Percent Impervious.....	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
Total Rainfall (in)....	5.20000	5.20000	5.20000	5.20000	5.20000	5.20000
Max Intensity (in/hr)..	7.12920	7.12920	7.12920	7.12920	7.12920	7.12920

Pervious Area

Total Runoff Depth (in)	2.97025	2.97025	2.97025	2.97025	2.97025	2.97025
Peak Runoff Rate (cfs).	14.81225	8.12284	5.73377	24.36853	14.28665	31.44019

Total Impervious Area

Total Runoff Depth (in)	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
Peak Runoff Rate (cfs).	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000

Impervious Area with depression storage

Total Runoff Depth (in)	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
Peak Runoff Rate (cfs).	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000

Impervious Area without depression storage

Total Runoff Depth (in)	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
Peak Runoff Rate (cfs).	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000

Total Area

Total Runoff Depth (in)	2.97025	2.97025	2.97025	2.97025	2.97025	2.97025
Peak Runoff Rate (cfs).	14.81225	8.12284	5.73377	24.36853	14.28665	31.44019

Rational Formula

Pervious Tc. (mins)....	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
Perv. Intensity (in/hr)	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
Pervious C	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000

```
 Impervious Tc. (mins)..          0.00000          0.00000          0.00000
0.00000          0.00000          0.00000
 Imp. Intensity (in/hr).          0.00000          0.00000          0.00000
0.00000          0.00000          0.00000
 Impervious C ..........          0.00000          0.00000          0.00000
0.00000          0.00000          0.00000
 Partial Area (Ha)......          0.00000          0.00000          0.00000
0.00000          0.00000          0.00000
 Partial Area Tc........          0.00000          0.00000          0.00000
0.00000          0.00000          0.00000
 Partial Area Intensity.          0.00000          0.00000          0.00000
0.00000          0.00000          0.00000


 Subcatchment...........        NodeA12#1
 Area (acres)...........          7.20000
 Percent Impervious.....          0.00000
 Total Rainfall (in)....          5.20000
 Max Intensity (in/hr)..          7.12920

 Pervious Area
 -------------
 Total Runoff Depth (in)          2.97025
 Peak Runoff Rate (cfs).         34.40264

 Total Impervious Area
 ---------------------
 Total Runoff Depth (in)          0.00000
 Peak Runoff Rate (cfs).          0.00000

 Impervious Area with depression storage
 ---------------------------------------
 Total Runoff Depth (in)          0.00000
 Peak Runoff Rate (cfs).          0.00000

 Impervious Area without depression storage
 ------------------------------------------
 Total Runoff Depth (in)          0.00000
 Peak Runoff Rate (cfs).          0.00000

 Total Area
 ----------
 Total Runoff Depth (in)          2.97025
 Peak Runoff Rate (cfs).         34.40264

 Rational Formula
 ----------------
 Pervious Tc. (mins)....          0.00000
 Perv. Intensity (in/hr)          0.00000
 Pervious C ............          0.00000
 Impervious Tc. (mins)..          0.00000
 Imp. Intensity (in/hr).          0.00000
 Impervious C ..........          0.00000
 Partial Area (Ha)......          0.00000
 Partial Area Tc........          0.00000
 Partial Area Intensity.          0.00000

 ===> Runoff simulation ended normally.
 XXX End of Header Section XXX

 ###########################################################
 #    Entry made to the HYDRAULIC Layer of XP-SWMM     #
 #    Last Updated in Oct., 2011 by XP Solutions       #
```

GenWaste1

```
*=========================================================*
|        HYDRAULICS TABLES IN THE OUTPUT FILE             |
|  These are the more important tables in the output file.|
|  You can use your editor to find the table numbers,     |
|  for example: search for Table E20 to check continuity. |
|  This output file can be imported into a Word Processor |
|  and printed on US letter or A4 paper using portrait    |
|  mode, courier font, a size of 8 pt. and margins of 0.75|
|                                                         |
| Table E1   - Basic Conduit Data                         |
| Table E2   - Conduit Factor Data                        |
| Table E3a  - Junction Data                              |
| Table E3b  - Junction Data                              |
| Table E4   - Conduit Connectivity Data                  |
| Table E4a  - Dry Weather Flow Data                      |
| Table E4b  - Real Time Control Data                     |
| Table E5   - Junction Time Step Limitation Summary      |
| Table E5a  - Conduit Explicit Condition Summary         |
| Table E6   - Final Model Condition                      |
| Table E7   - Iteration Summary                          |
| Table E8   - Junction Time Step Limitation Summary      |
| Table E9   - Junction  Summary  Statistics              |
| Table E10  - Conduit   Summary  Statistics              |
| Table E11  - Area assumptions used in the analysis      |
| Table E12  - Mean conduit information                   |
| Table E13  - Channel losses(H) and culvert info         |
| Table E13a - Culvert Analysis Classification            |
| Table E14  - Natural Channel Overbank Flow Information  |
| Table E14a - Natural Channel Encroachment Information   |
| Table E14b - Floodplain Mapping                         |
| Table E15  - Spreadsheet Info List                      |
| Table E15a - Spreadsheet Reach List                     |
| Table E16  - New Conduit Output Section                 |
| Table E17  - Pump Operation                             |
| Table E18  - Junction Continuity Error                  |
| Table E19  - Junction Inflow & Outflow Listing          |
| Table E20  - Junction Flooding and Volume List          |
| Table E21  - Continuity balance at simulation end       |
| Table E22  - Model Judgement Section                    |
*=========================================================*

Time Control from Hydraulics Job Control
Year.........    1995 Month.......       1
Day..........       1 Hour........       0
Minute.......       0 Second......       0


Control information for simulation
----------------------------------

Integration cycles.................      1440
Length of integration step is......     60.00 seconds
Simulation length..................     24.00 hours
Do not create equiv. pipes(NEQUAL).         0
Use U.S. customary units for I/O...         0
Printing starts in cycle...........         1
```

```
 Intermediate printout intervals of.       500 cycles
 Intermediate printout intervals of.    500.00 minutes
 Summary printout intervals of......       500 cycles
 Summary printout time interval of..    500.00 minutes
 Hot start file parameter (REDO)....         0
 Initial time.......................      0.00 hours

 Iteration variables: Flow Tolerance.   0.00010
                      Head Tolerance.   0.00050
     Minimum depth (m or ft).........   0.00001
     Underrelaxation parameter.......   0.85000
     Time weighting parameter........   0.85000
     Conduit roughness factor........   1.00000
     Flow adjustment factor..........   1.00000
     Initial Condition Smoothing.....         0
     Courant Time Step Factor........   1.00000
     Default Expansion/Contraction K.   0.00000
     Default Entrance/Exit K.........   0.00000
     Routing Method..................   Dynamic Wave
 Default surface area of junctions...     12.57 square feet.
 Minimum Junction/Conduit Depth......   0.00001 feet.
 Ponding Area Coefficient............   5000.00
 Ponding Area Exponent...............    1.0000
 Minimum Orifice Length..............   1000.00 feet.
 NJSW input hydrograph junctions.....     0
      or user defined hydrographs....
```

===
| Table E1 - Conduit Data |
===

Inp Num	Conduit Name	Length (ft)	Conduit Class	Area (ft^2)	Manning Coef.	Max Width (ft)	Trapezoid Depth (ft)	Side Slopes
1	LinkA11	132.0000	Trapezoid	9.4500	0.0280	4.8000	1.5000	1.0000 1.0000
2	LinkA10	160.0000	Trapezoid	9.4500	0.0280	4.8000	1.5000	1.0000 1.0000
3	LinkA9	120.0000	Trapezoid	9.4500	0.0280	4.8000	1.5000	1.0000 1.0000
4	LinkA5	1010.0000	Trapezoid	12.3750	0.0850	0.0100	1.5000	7.0000 4.0000
5	LinkA1	1600.0000	Trapezoid	12.3750	0.0850	0.0100	1.5000	7.0000 4.0000
6	LinkA2	950.0000	Trapezoid	12.3750	0.0850	0.0100	1.5000	7.0000 4.0000
7	LinkA3	450.0000	Trapezoid	12.3750	0.0850	0.0100	1.5000	7.0000 4.0000
8	LinkA4	400.0000	Trapezoid	12.7500	0.0850	4.0000	1.5000	3.0000 3.0000
9	LinkA8	280.0000	Trapezoid	6.0000	0.0850	4.0000	1.5000	0.0000 0.0000
10	LinkA6	650.0000	Trapezoid	12.3750	0.0850	0.0100	1.5000	7.0000 4.0000
11	LinkC8	240.0000	Trapezoid	9.4500	0.0280	4.8000	1.5000	1.0000 1.0000
12	LinkC9	150.0000	Trapezoid	9.4500	0.0280	4.8000	1.5000	1.0000 1.0000

13	LinkC2	950.0000	Trapezoid	12.3750	0.0850	0.0100
1.5000	7.0000	4.0000				
14	LinkC3	900.0000	Trapezoid	12.3750	0.0850	0.0100
1.5000	7.0000	4.0000				
15	LinkC4	500.0000	Trapezoid	12.3750	0.0850	0.0100
1.5000	7.0000	4.0000				
16	LinkC5	800.0000	Trapezoid	9.0000	0.0850	6.0000
1.5000	0.0000	0.0000				
17	LinkC6	400.0000	Trapezoid	6.0000	0.0850	4.0000
1.5000	0.0000	0.0000				
18	LinkB2	112.0000	Trapezoid	9.4500	0.0280	4.8000
1.5000	1.0000	1.0000				
19	LinkB1	450.0000	Trapezoid	14.2500	0.0850	5.0000
1.5000	3.0000	3.0000				
20	LinkB4	600.0000	Trapezoid	12.3750	0.0850	0.0100
1.5000	7.0000	4.0000				
21	LinkB7	350.0000	Trapezoid	12.3750	0.0850	0.0100
1.5000	7.0000	4.0000				
22	Link29	725.0000	Trapezoid	11.2500	0.0850	0.0100
1.5000	7.0000	3.0000				
23	LinkC12	175.0000	Trapezoid	12.3750	0.0850	0.0100
1.5000	7.0000	4.0000				
24	LinkC10	550.0000	Trapezoid	12.3750	0.0850	0.0100
1.5000	7.0000	4.0000				
25	LinkC15	240.0000	Trapezoid	9.4500	0.0280	4.8000
1.5000	1.0000	1.0000				
26	LinkC13	550.0000	Trapezoid	6.0000	0.0850	4.0000
1.5000	0.0000	0.0000				
27	LinkC11	900.0000	Trapezoid	8.2500	0.0850	5.5000
1.5000	0.0000	0.0000				
28	LinkC16	120.0000	Trapezoid	9.4500	0.0280	4.8000
1.5000	1.0000	1.0000				
29	LinkC14	340.0000	Trapezoid	12.3750	0.0850	0.0100
1.5000	7.0000	4.0000				
30	LinkC17	310.0000	Trapezoid	12.3750	0.0850	0.0100
1.5000	7.0000	4.0000				
31	LinkA	800.0000	Trapezoid	18.0000	0.0850	6.0000
1.5000	4.0000	4.0000				
32	LinkB	150.0000	Trapezoid	24.0000	0.0850	10.0000
1.5000	4.0000	4.0000				
33	LinkB8	350.0000	Trapezoid	12.3750	0.0850	0.0100
1.5000	7.0000	4.0000				
34	LinkC	500.0000	Trapezoid	12.7500	0.0850	4.0000
1.5000	3.0000	3.0000				
35	LinkC1	155.0000	Trapezoid	21.0000	0.0850	8.0000
1.5000	4.0000	4.0000				
36	Link52	50.0000	Circular	0.7854	0.0140	1.0000
1.0000						
37	Link53	50.0000	Circular	0.7854	0.0140	1.0000
1.0000						
38	Link54	50.0000	Circular	0.7854	0.0140	1.0000
1.0000						
39	LinkB3	172.0000	Trapezoid	9.4500	0.0280	4.8000
1.5000	1.0000	1.0000				
40	Link56	33.0000	Trapezoid	9.4500	0.0280	4.8000
1.5000	1.0000	1.0000				
41	Link57	75.0000	Trapezoid	9.4500	0.0280	4.8000
1.5000	1.0000	1.0000				
42	Link58	335.0000	Trapezoid	30.0000	0.0850	8.0000
2.0000	3.0000	4.0000				
43	Link59	215.0000	Trapezoid	21.0000	0.0850	8.0000
1.5000	4.0000	4.0000				
44	Link60	40.0000	Trapezoid	6.0000	0.0850	10.0000

```
0.5000     4.0000     4.0000
   45           Link61    40.0000  Trapezoid    6.0000     0.0850    10.0000
0.5000     4.0000     4.0000
   46           Link62    40.0000  Trapezoid    6.0000     0.0850    10.0000
0.5000     4.0000     4.0000
 Total length of all conduits ....     18169.0000 feet

 *================================================*
 |      Table E2 -  Conduit Factor Data           |
 *================================================*

                                                                    Time     Low Flow  Depth
at
         Conduit     Number  Entrance      Exit Exp/Contc Weighting Roughness
Which    Flow
            Name of Barrels Loss Coef Loss Coef Coefficnt Parameter    Factor n
Changes Routing
 --------------- ---------- --------- --------- --------- --------- ---------
--------- -------
          Link52     1.0000    0.5000    0.7000    0.0000    0.8500    1.0000
0.0000 Standard - Dynamic Wave
          Link53     1.0000    0.5000    0.7000    0.0000    0.8500    1.0000
0.0000 Standard - Dynamic Wave
          Link54     1.0000    0.5000    0.7000    0.0000    0.8500    1.0000
0.0000 Standard - Dynamic Wave

 *================================================*
 | If there are messages about (sqrt(g*d)*dt/dx), or |
 | the sqrt(wave celerity)*time step/conduit length  |
 | in the output file all it means is that the       |
 | program will lower the internal time step to      |
 | satisfy this condition (explicit condition).      |
 | You control the actual internal time step by      |
 | using the minimum courant time step factor in the |
 | HYDRAULICS job control.  The message put in words |
 | states that the smallest conduit with the fastest |
 | velocity will control the time step selection.    |
 | You have further control by using the modify      |
 | conduit option in the HYDRAULICS Job Control.     |
 *================================================*


         Conduit     Courant
            Name       Ratio
 ---------------   ---------
         LinkA11        2.84  ===> Warning ! (sqrt(wave celerity)*time step/conduit
length)
         LinkA10        2.34  ===> Warning ! (sqrt(wave celerity)*time step/conduit
length)
          LinkA9        3.12  ===> Warning ! (sqrt(wave celerity)*time step/conduit
length)
          LinkA5        0.29
          LinkA1        0.18
          LinkA2        0.31
          LinkA3        0.66
          LinkA4        0.84
          LinkA8        1.49  ===> Warning ! (sqrt(wave celerity)*time step/conduit
length)
          LinkA6        0.45
          LinkC8        1.56  ===> Warning ! (sqrt(wave celerity)*time step/conduit
length)
          LinkC9        2.50  ===> Warning ! (sqrt(wave celerity)*time step/conduit
length)
```

```
          LinkC2        0.31
          LinkC3        0.33
          LinkC4        0.59
          LinkC5        0.52
          LinkC6        1.04  ===> Warning ! (sqrt(wave celerity)*time step/conduit
length)
          LinkB2        3.35  ===> Warning ! (sqrt(wave celerity)*time step/conduit
length)
          LinkB1        0.76
          LinkB4        0.49
          LinkB7        0.84
          Link29        0.41
         LinkC12        1.69  ===> Warning ! (sqrt(wave celerity)*time step/conduit
length)
         LinkC10        0.54
         LinkC15        1.56  ===> Warning ! (sqrt(wave celerity)*time step/conduit
length)
         LinkC13        0.76
         LinkC11        0.46
         LinkC16        3.12  ===> Warning ! (sqrt(wave celerity)*time step/conduit
length)
         LinkC14        0.87
         LinkC17        0.95
           LinkA        0.43
           LinkB        2.37  ===> Warning ! (sqrt(wave celerity)*time step/conduit
length)
          LinkB8        0.84
           LinkC        0.67
          LinkC1        2.25  ===> Warning ! (sqrt(wave celerity)*time step/conduit
length)
          Link52        6.81  ===> Warning ! (sqrt(wave celerity)*time step/conduit
length)
          Link53        6.81  ===> Warning ! (sqrt(wave celerity)*time step/conduit
length)
          Link54        6.81  ===> Warning ! (sqrt(wave celerity)*time step/conduit
length)
          LinkB3        2.18  ===> Warning ! (sqrt(wave celerity)*time step/conduit
length)
          Link56       11.36  ===> Warning ! (sqrt(wave celerity)*time step/conduit
length)
          Link57        5.00  ===> Warning ! (sqrt(wave celerity)*time step/conduit
length)
          Link58        1.19  ===> Warning ! (sqrt(wave celerity)*time step/conduit
length)
          Link59        1.62  ===> Warning ! (sqrt(wave celerity)*time step/conduit
length)
          Link60        5.57  ===> Warning ! (sqrt(wave celerity)*time step/conduit
length)
          Link61        5.57  ===> Warning ! (sqrt(wave celerity)*time step/conduit
length)
          Link62        5.57  ===> Warning ! (sqrt(wave celerity)*time step/conduit
length)

 *==================*
 |  Conduit Volume  |
 *==================*

 Full pipe or full open conduit volume
 Input full depth volume.............    2.1924E+05 cubic feet


 *================================================*
 |           Table E3a - Junction Data            |
```

Inp Num	Junction Name	Ground Elevation	Crown Elevation	Invert Elevation	Qinst cfs	Initial Depth-ft	Interface Flow (%)
1	NodeA4	1582.0000	1581.5000	1580.0000	0.0000	0.0000	100.0000
2	NodeA3	1555.5000	1555.5000	1554.0000	0.0000	0.0000	100.0000
3	NodeA2	1525.5000	1525.5000	1524.0000	0.0000	0.0000	100.0000
4	NodeA1	1497.5000	1497.5000	1494.0000	0.0000	0.0000	100.0000
5	NodeA8	1513.5000	1513.5000	1512.0000	0.0000	0.0000	100.0000
6	NodeA12	1529.5000	1529.5000	1528.0000	0.0000	0.0000	100.0000
7	NodeA11	1541.5000	1541.5000	1540.0000	0.0000	0.0000	100.0000
8	NodeA10	1563.5000	1563.5000	1562.0000	0.0000	0.0000	100.0000
9	NodeA9	1582.5000	1582.5000	1581.0000	0.0000	0.0000	100.0000
10	NodeA5	1582.5000	1582.5000	1581.0000	0.0000	0.0000	100.0000
11	NodeA7	1545.5000	1545.5000	1544.0000	0.0000	0.0000	100.0000
12	NodeC3	1581.5000	1581.5000	1580.0000	0.0000	0.0000	100.0000
13	NodeC2	1533.5000	1533.5000	1532.0000	0.0000	0.0000	100.0000
14	NodeC1	1490.5000	1490.5000	1489.0000	0.0000	0.0000	100.0000
15	NodeC6	1507.5000	1507.5000	1506.0000	0.0000	0.0000	100.0000
16	NodeC5	1549.5000	1549.5000	1548.0000	0.0000	0.0000	100.0000
17	NodeC4	1582.5000	1582.5000	1581.0000	0.0000	0.0000	100.0000
18	NodeC7	1582.5000	1582.5000	1581.0000	0.0000	0.0000	100.0000
19	NodeC8	1551.5000	1551.5000	1550.0000	0.0000	0.0000	100.0000
20	NodeB2	1519.5000	1519.5000	1518.0000	0.0000	0.0000	100.0000
21	NodeB1	1491.5000	1491.5000	1490.0000	0.0000	0.0000	100.0000
22	NodeB12	1513.5000	1513.5000	1512.0000	0.0000	0.0000	100.0000
23	NodeB9	1561.5000	1561.5000	1560.0000	0.0000	0.0000	100.0000
24	NodeB6	1525.5000	1525.5000	1524.0000	0.0000	0.0000	100.0000
25	NodeB7	1503.5000	1503.5000	1502.0000	0.0000	0.0000	100.0000
26	NodeC13	1547.5000	1547.5000	1546.0000	0.0000	0.0000	100.0000
27	NodeC16	1549.5000	1549.5000	1548.0000	0.0000	0.0000	100.0000
28	NodeC10	1549.5000	1549.5000	1548.0000	0.0000	0.0000	100.0000
29	NodeC14	1511.5000	1511.5000	1510.0000	0.0000	0.0000	100.0000

30	NodeC17	1523.5000	1523.5000	1522.0000	0.0000	0.0000	100.0000
31	NodeC11	1521.5000	1521.5000	1520.0000	0.0000	0.0000	100.0000
32	NodeC15	1471.5000	1471.5000	1470.0000	0.0000	0.0000	100.0000
33	NodeC18	1477.5000	1477.5000	1476.0000	0.0000	0.0000	100.0000
34	NodeC12	1477.5000	1477.5000	1476.0000	0.0000	0.0000	100.0000
35	PondA	1484.0000	1482.2000	1480.0000	0.0000	0.0000	100.0000
36	Pond B	1482.4000	1481.4000	1478.0000	0.0000	0.0000	100.0000
37	NodeB4	1547.5000	1547.5000	1546.0000	0.0000	0.0000	100.0000
38	NodeB5	1548.5000	1548.5000	1547.0000	0.0000	0.0000	100.0000
39	PondC	1450.4000	1449.4000	1446.0000	0.0000	0.0000	100.0000
40	Outlet B	1480.0000	1479.0000	1478.0000	0.0000	0.0000	100.0000
41	OutletC	1448.0000	1447.0000	1446.0000	0.0000	0.0000	100.0000
42	OutletA	1481.5000	1480.0000	1479.0000	0.0000	0.0000	100.0000
43	Node51	1453.5000	1453.5000	1452.0000	0.0000	0.0000	100.0000
44	Node52	1476.0000	1476.0000	1474.0000	0.0000	0.0000	100.0000
45	Node53	1482.0000	1482.0000	1480.0000	0.0000	0.0000	100.0000
46	Node54	1486.5000	1486.5000	1485.0000	0.0000	0.0000	100.0000
47	EOF C	1447.5000	1447.5000	1447.0000	0.0000	0.0000	100.0000
48	EOF B	1479.5000	1479.5000	1479.0000	0.0000	0.0000	100.0000
49	EOF A	1480.5000	1480.5000	1480.0000	0.0000	0.0000	100.0000

Table E3b - Junction Data

Inp Num	Junction Name	X Coord.	Y Coord.	Type of Manhole	Type of Inlet	Maximum Capacity	Pavement Shape	Slope
1	NodeA4	0.0000	0.0000	No P	Normal		0	0.0000
2	NodeA3	0.0000	0.0000	No P	Normal		0	0.0000
3	NodeA2	0.0000	0.0000	No P	Normal		0	0.0000
4	NodeA1	0.0000	0.0000	No P	Normal		0	0.0000
5	NodeA8	0.0000	0.0000	No P	Normal		0	0.0000
6	NodeA12	0.0000	0.0000	No P	Normal			

	0	0.0000				
7		NodeA11	0.0000	0.0000	No P	Normal
	0	0.0000				
8		NodeA10	0.0000	0.0000	No P	Normal
	0	0.0000				
9		NodeA9	0.0000	0.0000	No P	Normal
	0	0.0000				
10		NodeA5	0.0000	0.0000	No P	Normal
	0	0.0000				
11		NodeA7	0.0000	0.0000	No P	Normal
	0	0.0000				
12		NodeC3	0.0000	0.0000	No P	Normal
	0	0.0000				
13		NodeC2	0.0000	0.0000	No P	Normal
	0	0.0000				
14		NodeC1	0.0000	0.0000	No P	Normal
	0	0.0000				
15		NodeC6	0.0000	0.0000	No P	Normal
	0	0.0000				
16		NodeC5	0.0000	0.0000	No P	Normal
	0	0.0000				
17		NodeC4	0.0000	0.0000	No P	Normal
	0	0.0000				
18		NodeC7	0.0000	0.0000	No P	Normal
	0	0.0000				
19		NodeC8	0.0000	0.0000	No P	Normal
	0	0.0000				
20		NodeB2	0.0000	0.0000	No P	Normal
	0	0.0000				
21		NodeB1	0.0000	0.0000	No P	Normal
	0	0.0000				
22		NodeB12	0.0000	0.0000	No P	Normal
	0	0.0000				
23		NodeB9	0.0000	0.0000	No P	Normal
	0	0.0000				
24		NodeB6	0.0000	0.0000	No P	Normal
	0	0.0000				
25		NodeB7	0.0000	0.0000	No P	Normal
	0	0.0000				
26		NodeC13	0.0000	0.0000	No P	Normal
	0	0.0000				
27		NodeC16	0.0000	0.0000	No P	Normal
	0	0.0000				
28		NodeC10	0.0000	0.0000	No P	Normal
	0	0.0000				
29		NodeC14	0.0000	0.0000	No P	Normal
	0	0.0000				
30		NodeC17	0.0000	0.0000	No P	Normal
	0	0.0000				
31		NodeC11	0.0000	0.0000	No P	Normal
	0	0.0000				
32		NodeC15	0.0000	0.0000	No P	Normal
	0	0.0000				
33		NodeC18	0.0000	0.0000	No P	Normal
	0	0.0000				
34		NodeC12	0.0000	0.0000	No P	Normal
	0	0.0000				
35		PondA	0.0000	0.0000	No P	Normal
	0	0.0000				
36		Pond B	0.0000	0.0000	No P	Normal
	0	0.0000				
37		NodeB4	0.0000	0.0000	No P	Normal
	0	0.0000				

38	NodeB5	0.0000	0.0000	No	P	Normal
0	0.0000					
39	PondC	0.0000	0.0000	No	P	Normal
0	0.0000					
40	Outlet B	0.0000	0.0000	No	P	Normal
0	0.0000					
41	OutletC	0.0000	0.0000	No	P	Normal
0	0.0000					
42	OutletA	0.0000	0.0000	No	P	Normal
0	0.0000					
43	Node51	0.0000	0.0000	No	P	Normal
0	0.0000					
44	Node52	0.0000	0.0000	No	P	Normal
0	0.0000					
45	Node53	0.0000	0.0000	No	P	Normal
0	0.0000					
46	Node54	0.0000	0.0000	No	P	Normal
0	0.0000					
47	EOF C	0.0000	0.0000	No	P	Normal
0	0.0000					
48	EOF B	0.0000	0.0000	No	P	Normal
0	0.0000					
49	EOF A	0.0000	0.0000	No	P	Normal
0	0.0000					

Table E4 - Conduit Connectivity

Input Number	Conduit Name	Upstream Node	Downstream Node	Upstream Elevation	Downstream Elevation	
1	LinkA11	NodeA4	NodeA3	1580.0000	1554.0000	No Design
2	LinkA10	NodeA3	NodeA2	1554.0000	1524.0000	No Design
3	LinkA9	NodeA2	NodeA1	1524.0000	1496.0000	No Design
4	LinkA5	NodeA8	NodeA1	1512.0000	1496.0000	No Design
5	LinkA1	NodeA12	NodeA1	1528.0000	1496.0000	No Design
6	LinkA2	NodeA11	NodeA2	1540.0000	1524.0000	No Design
7	LinkA3	NodeA10	NodeA3	1562.0000	1554.0000	No Design
8	LinkA4	NodeA9	NodeA4	1581.0000	1580.0000	No Design
9	LinkA8	NodeA5	NodeA4	1581.0000	1580.0000	No Design
10	LinkA6	NodeA7	NodeA2	1544.0000	1524.0000	No Design
11	LinkC8	NodeC3	NodeC2	1580.0000	1532.0000	No Design
12	LinkC9	NodeC2	NodeC1	1532.0000	1489.0000	No Design
13	LinkC2	NodeC6	NodeC1	1506.0000	1489.0000	No Design
14	LinkC3	NodeC5	NodeC2	1548.0000	1532.0000	No Design
15	LinkC4	NodeC4	NodeC3	1581.0000	1580.0000	No Design

16	LinkC5	NodeC7	NodeC3	1581.0000	1580.0000
No Design					
17	LinkC6	NodeC8	NodeC2	1550.0000	1532.0000
No Design					
18	LinkB2	NodeB2	NodeB1	1518.0000	1490.0000
No Design					
19	LinkB1	NodeB12	NodeB1	1512.0000	1490.0000
No Design					
20	LinkB4	NodeB9	NodeB4	1560.0000	1546.0000
No Design					
21	LinkB7	NodeB6	NodeB2	1524.0000	1518.0000
No Design					
22	Link29	NodeB7	NodeB1	1502.0000	1490.0000
No Design					
23	LinkC12	NodeC16	NodeC13	1548.0000	1546.0000
No Design					
24	LinkC10	NodeC10	NodeC13	1548.0000	1546.0000
No Design					
25	LinkC15	NodeC13	NodeC14	1546.0000	1510.0000
No Design					
26	LinkC13	NodeC17	NodeC14	1522.0000	1510.0000
No Design					
27	LinkC11	NodeC11	NodeC14	1520.0000	1510.0000
No Design					
28	LinkC16	NodeC14	NodeC15	1510.0000	1470.0000
No Design					
29	LinkC14	NodeC18	NodeC15	1476.0000	1470.0000
No Design					
30	LinkC17	NodeC12	NodeC15	1476.0000	1470.0000
No Design					
31	LinkA	NodeA1	PondA	1494.0000	1480.0000
No Design					
32	LinkB	NodeB1	Pond B	1490.0000	1478.0000
No Design					
33	LinkB8	NodeB5	NodeB4	1547.0000	1546.0000
No Design					
34	LinkC	Node51	PondC	1452.0000	1446.0000
No Design					
35	LinkC1	NodeC1	Node54	1489.0000	1485.0000
No Design					
36	Link52	Pond B	Outlet B	1480.4000	1478.0000
No Design					
37	Link53	PondC	OutletC	1448.4000	1446.0000
No Design					
38	Link54	PondA	OutletA	1481.2000	1479.0000
No Design					
39	LinkB3	NodeB4	NodeB2	1546.0000	1518.0000
No Design					
40	Link56	NodeC15	Node51	1470.0000	1452.0000
No Design					
41	Link57	Node52	PondC	1474.0000	1446.0000
No Design					
42	Link58	Node53	Node52	1480.0000	1474.0000
No Design					
43	Link59	Node54	Node53	1485.0000	1480.0000
No Design					
44	Link60	PondC	EOF C	1448.4000	1447.0000
No Design					
45	Link61	Pond B	EOF B	1480.4000	1479.0000
No Design					
46	Link62	PondA	EOF A	1481.7000	1480.0000
No Design					

==========
| Storage Junction Data |
==========

STORAGE JUNCTION NUMBER OR NAME	JUNCTION TYPE	MAXIMUM OR CONSTANT SURFACE AREA (FT2)	PEAK OR CONSTANT VOLUME (CUBIC FEET)	CROWN ELEVATION (FT)	DEPTH STARTS FROM
PondA	Stage/Area	18730.8000	63999.0518	1484.0000	Node Invert
Pond B	Stage/Area	8450.6400	30001.8478	1482.4000	Node Invert
PondC	Stage/Area	13721.4000	51011.6774	1450.4000	Node Invert

==========
| Variable storage data for node | PondA
==========

Data Point	Elevation ft	Depth ft	Area ft^2	Volume ft^3	Area Volume acres ac-ft
1	1480.0000	0.0000	13416.4800	0.0000	0.3080 0.0000
2	1484.0000	4.0000	18730.8000	63999.0518	0.4300 1.4692

==========
| Variable storage data for node | Pond B
==========

Data Point	Elevation ft	Depth ft	Area ft^2	Volume ft^3	Area Volume acres ac-ft
1	1478.0000	0.0000	5009.4000	0.0000	0.1150 0.0000
2	1482.0000	4.0000	8450.6400	26621.5918	0.1940 0.6111
3	1482.4000	4.4000	8450.6400	30001.8478	0.1940 0.6887

==========
| Variable storage data for node | PondC
==========

Data Point	Elevation ft	Depth ft	Area ft^2	Volume ft^3	Area Volume acres ac-ft
1	1446.0000	0.0000	9191.1600	0.0000	0.2110 0.0000
2	1450.0000	4.0000	13721.4000	45523.1174	0.3150 1.0451
3	1450.4000	4.4000	13721.4000	51011.6774	0.3150 1.1711

```
*================================================*
|          FREE OUTFALL DATA (DATA GROUP I1)     |
|         BOUNDARY CONDITION ON DATA GROUP J1    |
*================================================*

Outfall at Junction....Outlet B         has boundary condition number...         1
Outfall at Junction....OutletC          has boundary condition number...         2
Outfall at Junction....OutletA          has boundary condition number...         3
Outfall at Junction....EOF C            has boundary condition number...         4
Outfall at Junction....EOF B            has boundary condition number...         5
Outfall at Junction....EOF A            has boundary condition number...         6


*================================================*
|        INTERNAL CONNECTIVITY INFORMATION       |
*================================================*

         CONDUIT         JUNCTION         JUNCTION
---------------- ---------------- ----------------
        FREE # 1         Outlet B         BOUNDARY
        FREE # 2          OutletC         BOUNDARY
        FREE # 3          OutletA         BOUNDARY
        FREE # 4            EOF C         BOUNDARY
        FREE # 5            EOF B         BOUNDARY
        FREE # 6            EOF A         BOUNDARY

*=================================================*
|        Boundary Condition Information           |
|                Data Groups J1-J4                |
*=================================================*


BC NUMBER..         1 has no control water surface.
BC NUMBER..         2 has no control water surface.
BC NUMBER..         3 has no control water surface.
BC NUMBER..         4 has no control water surface.
BC NUMBER..         5 has no control water surface.
BC NUMBER..         6 has no control water surface.


###########################################
# Header information from interface file: #
###########################################

Title from first computational layer:
GenWaste1


Title from immediately preceding computational layer
GenWaste1


Name of preceding layer:.............        Runoff Layer
Initial Julian date (IDATEZ).....................   1995001
Initial time of day in seconds (TZERO)............       0.0
No. Transfered input locations...................        25
No. Transfered pollutants........................         0
Size of total catchment area (acres).............     57.19

#################################################
# Element numbers of interface inlet locations: #
#################################################
```

NodeA9	NodeA5	NodeB9	NodeB5	NodeC16
NodeC10	NodeC17			
NodeC11	NodeC18	NodeC12	NodeC4	NodeC7
NodeC5	NodeC8			
NodeC6	NodeC1	Node54	NodeB6	NodeB12
NodeB7	NodeA10			
NodeA11	NodeA7	NodeA8	NodeA12	

Conversion factor to cfs for flow units on interface file. Multiply by:
1.00000

######## Important Information ########
Interface file start: 1995/01/01 00:00:00
Simulation start: 1995/01/01 00:00:00
Same date/time found in interface file and model

==========XP Note Field Summary==========

==========Conduit Convergence Criteria==========

Conduit Name	Full Flow	Conduit Slope
LinkA11	229.2187	0.1970
LinkA10	223.6407	0.1875
LinkA9	249.4817	0.2333
LinkA5	22.2082	0.0158
LinkA1	24.9534	0.0200
LinkA2	22.8988	0.0168
LinkA3	23.5263	0.0178
LinkA4	10.7353	0.0025
LinkA8	5.6564	0.0036
LinkA6	30.9508	0.0308
LinkC8	230.9752	0.2000
LinkC9	276.5278	0.2867
LinkC2	23.6035	0.0179
LinkC3	23.5263	0.0178
LinkC4	7.8909	0.0020
LinkC5	5.5629	0.0013

LinkC6	20.0783	0.0450
LinkB2	258.2381	0.2500
LinkB1	54.4813	0.0489
LinkB4	26.9527	0.0233
LinkB7	23.1023	0.0171
Link29	20.5596	0.0166
LinkC12	18.8630	0.0114
LinkC10	10.6401	0.0036
LinkC15	200.0304	0.1500
LinkC13	13.9807	0.0218
LinkC11	14.9035	0.0111
LinkC16	298.1876	0.3333
LinkC14	23.4396	0.0176
LinkC17	24.5476	0.0194
LinkA	41.0687	0.0175
LinkB	124.3737	0.0800
LinkB8	9.4315	0.0029
LinkC	23.5198	0.0120
LinkC1	60.1883	0.0258
Link52	7.2482	0.0480
Link53	7.2482	0.0480
Link54	6.9396	0.0440
LinkB3	208.3843	0.1628
Link56	381.4429	0.5455
Link57	315.5721	0.3733
Link58	84.8511	0.0179
Link59	57.1365	0.0233
Link60	11.0900	0.0350
Link61	11.0900	0.0350
Link62	12.2206	0.0425

==========

```
|    Initial Model Condition      |
| Initial Time =      0.02 hours  |
*=================================*

       Junction / Depth  / Elevation    ===>  "*" Junction is Surcharged.
          NodeA4/   0.00 /  1580.00           NodeA3/   0.00 /  1554.00
NodeA2/   0.00 /  1524.00
          NodeA1/   0.00 /  1494.00           NodeA8/   0.00 /  1512.00
NodeA12/   0.00 /  1528.00
         NodeA11/   0.00 /  1540.00          NodeA10/   0.00 /  1562.00
NodeA9/   0.00 /  1581.00
          NodeA5/   0.00 /  1581.00           NodeA7/   0.00 /  1544.00
NodeC3/   0.00 /  1580.00
          NodeC2/   0.00 /  1532.00           NodeC1/   0.00 /  1489.00
NodeC6/   0.00 /  1506.00
          NodeC5/   0.00 /  1548.00           NodeC4/   0.00 /  1581.00
NodeC7/   0.00 /  1581.00
          NodeC8/   0.00 /  1550.00           NodeB2/   0.00 /  1518.00
NodeB1/   0.00 /  1490.00
         NodeB12/   0.00 /  1512.00           NodeB9/   0.00 /  1560.00
NodeB6/   0.00 /  1524.00
          NodeB7/   0.00 /  1502.00          NodeC13/   0.00 /  1546.00
NodeC16/   0.00 /  1548.00
         NodeC10/   0.00 /  1548.00          NodeC14/   0.00 /  1510.00
NodeC17/   0.00 /  1522.00
         NodeC11/   0.00 /  1520.00          NodeC15/   0.00 /  1470.00
NodeC18/   0.00 /  1476.00
         NodeC12/   0.00 /  1476.00            PondA/   0.00 /  1480.00
Pond B/   0.00 /  1478.00
          NodeB4/   0.00 /  1546.00           NodeB5/   0.00 /  1547.00
PondC/   0.00 /  1446.00
        Outlet B/   0.00 /  1478.00          OutletC/   0.00 /  1446.00
OutletA/   0.00 /  1479.00
          Node51/   0.00 /  1452.00           Node52/   0.00 /  1474.00
Node53/   0.00 /  1480.00
          Node54/   0.00 /  1485.00            EOF C/   0.00 /  1447.00
EOF B/   0.00 /  1479.00
           EOF A/   0.00 /  1480.00

         Conduit/       FLOW   ===> "*" Conduit uses the normal flow option.
         LinkA11/       0.00          LinkA10/       0.00           LinkA9/
0.00
          LinkA5/       0.00           LinkA1/       0.00           LinkA2/
0.00
          LinkA3/       0.00           LinkA4/       0.00           LinkA8/
0.00
          LinkA6/       0.00           LinkC8/       0.00           LinkC9/
0.00
          LinkC2/       0.00           LinkC3/       0.00           LinkC4/
0.00
          LinkC5/       0.00           LinkC6/       0.00           LinkB2/
0.00
          LinkB1/       0.00           LinkB4/       0.00           LinkB7/
0.00
          Link29/       0.00          LinkC12/       0.00          LinkC10/
0.00
         LinkC15/       0.00          LinkC13/       0.00          LinkC11/
0.00
         LinkC16/       0.00          LinkC14/       0.00          LinkC17/
0.00
           LinkA/       0.00            LinkB/       0.00           LinkB8/
0.00
           LinkC/       0.00           LinkC1/       0.00           Link52/
```

0.00					
	Link53/	0.00	Link54/	0.00	LinkB3/
0.00					
	Link56/	0.00	Link57/	0.00	Link58/
0.00					
	Link59/	0.00	Link60/	0.00	Link61/
0.00					
	Link62/	0.00	FREE # 1/	0.00	FREE # 2/
0.00					
	FREE # 3/	0.00	FREE # 4/	0.00	FREE # 5/
0.00					
	FREE # 6/	0.00			

Conduit/ Velocity

	LinkA11/	0.00	LinkA10/	0.00	LinkA9/
0.00					
	LinkA5/	0.00	LinkA1/	0.00	LinkA2/
0.00					
	LinkA3/	0.00	LinkA4/	0.00	LinkA8/
0.00					
	LinkA6/	0.00	LinkC8/	0.00	LinkC9/
0.00					
	LinkC2/	0.00	LinkC3/	0.00	LinkC4/
0.00					
	LinkC5/	0.00	LinkC6/	0.00	LinkB2/
0.00					
	LinkB1/	0.00	LinkB4/	0.00	LinkB7/
0.00					
	Link29/	0.00	LinkC12/	0.00	LinkC10/
0.00					
	LinkC15/	0.00	LinkC13/	0.00	LinkC11/
0.00					
	LinkC16/	0.00	LinkC14/	0.00	LinkC17/
0.00					
	LinkA/	0.00	LinkB/	0.00	LinkB8/
0.00					
	LinkC/	0.00	LinkC1/	0.00	Link52/
0.00					
	Link53/	0.00	Link54/	0.00	LinkB3/
0.00					
	Link56/	0.00	Link57/	0.00	Link58/
0.00					
	Link59/	0.00	Link60/	0.00	Link61/
0.00					
	Link62/	0.00			

Conduit/ Cross Sectional Area

	LinkA11/	0.00	LinkA10/	0.00	LinkA9/
0.00					
	LinkA5/	0.00	LinkA1/	0.00	LinkA2/
0.00					
	LinkA3/	0.00	LinkA4/	0.00	LinkA8/
0.00					
	LinkA6/	0.00	LinkC8/	0.00	LinkC9/
0.00					
	LinkC2/	0.00	LinkC3/	0.00	LinkC4/
0.00					
	LinkC5/	0.00	LinkC6/	0.00	LinkB2/
0.00					
	LinkB1/	0.00	LinkB4/	0.00	LinkB7/
0.00					
	Link29/	0.00	LinkC12/	0.00	LinkC10/
0.00					

LinkC15/ 0.00 LinkC13/ 0.00 LinkC11/ 0.00
LinkC16/ 0.00 LinkC14/ 0.00 LinkC17/ 0.00
LinkA/ 0.00 LinkB/ 0.00 LinkB8/ 0.00
LinkC/ 0.00 LinkC1/ 0.00 Link52/ 0.00
Link53/ 0.00 Link54/ 0.00 LinkB3/ 0.00
Link56/ 0.00 Link57/ 0.00 Link58/ 0.00
Link59/ 0.00 Link60/ 0.00 Link61/ 0.00
Link62/ 0.00

Conduit/ Hydraulic Radius
LinkA11/ 0.00 LinkA10/ 0.00 LinkA9/ 0.00
LinkA5/ 0.00 LinkA1/ 0.00 LinkA2/ 0.00
LinkA3/ 0.00 LinkA4/ 0.00 LinkA8/ 0.00
LinkA6/ 0.00 LinkC8/ 0.00 LinkC9/ 0.00
LinkC2/ 0.00 LinkC3/ 0.00 LinkC4/ 0.00
LinkC5/ 0.00 LinkC6/ 0.00 LinkB2/ 0.00
LinkB1/ 0.00 LinkB4/ 0.00 LinkB7/ 0.00
Link29/ 0.00 LinkC12/ 0.00 LinkC10/ 0.00
LinkC15/ 0.00 LinkC13/ 0.00 LinkC11/ 0.00
LinkC16/ 0.00 LinkC14/ 0.00 LinkC17/ 0.00
LinkA/ 0.00 LinkB/ 0.00 LinkB8/ 0.00
LinkC/ 0.00 LinkC1/ 0.00 Link52/ 0.00
Link53/ 0.00 Link54/ 0.00 LinkB3/ 0.00
Link56/ 0.00 Link57/ 0.00 Link58/ 0.00
Link59/ 0.00 Link60/ 0.00 Link61/ 0.00
Link62/ 0.00

Conduit/ Upstream/ Downstream Elevation
LinkA11/ 1554.00/ 1554.00 LinkA10/ 1524.00/ 1524.00
LinkA9/ 1494.00/ 1494.00
LinkA5/ 1494.00/ 1494.00 LinkA1/ 1494.00/ 1494.00
LinkA2/ 1524.00/ 1524.00
LinkA3/ 1554.00/ 1554.00 LinkA4/ 1580.00/ 1580.00
LinkA8/ 1580.00/ 1580.00
LinkA6/ 1524.00/ 1524.00 LinkC8/ 1532.00/ 1532.00
LinkC9/ 1489.00/ 1489.00
LinkC2/ 1489.00/ 1489.00 LinkC3/ 1532.00/ 1532.00
LinkC4/ 1580.00/ 1580.00
LinkC5/ 1580.00/ 1580.00 LinkC6/ 1532.00/ 1532.00
LinkB2/ 1490.00/ 1490.00
LinkB1/ 1490.00/ 1490.00 LinkB4/ 1546.00/ 1546.00

```
LinkB7/  1518.00/  1518.00
          Link29/  1490.00/  1490.00         LinkC12/  1546.00/  1546.00
LinkC10/  1546.00/  1546.00
         LinkC15/  1510.00/  1510.00         LinkC13/  1510.00/  1510.00
LinkC11/  1510.00/  1510.00
         LinkC16/  1470.00/  1470.00         LinkC14/  1470.00/  1470.00
LinkC17/  1470.00/  1470.00
          LinkA/  1480.00/  1480.00           LinkB/  1478.00/  1478.00
LinkB8/  1546.00/  1546.00
          LinkC/  1446.00/  1446.00          LinkC1/  1485.00/  1485.00
Link52/  1478.00/  1478.00
          Link53/  1446.00/  1446.00          Link54/  1479.00/  1479.00
LinkB3/  1518.00/  1518.00
          Link56/  1452.00/  1452.00          Link57/  1446.00/  1446.00
Link58/  1474.00/  1474.00
          Link59/  1480.00/  1480.00          Link60/  1447.00/  1447.00
Link61/  1479.00/  1479.00
          Link62/  1480.00/  1480.00

 ===> System inflows (file) at     8.33 hours (  Junction / Inflow, cfs)

 NodeA9    / 8.61E-03 NodeA5    / 9.90E-03 NodeB9    / 2.05E-02 NodeB5    / 3.23E-03
NodeC16   / 1.61E-03 NodeC10   / 6.14E-03
 NodeC17   / 1.56E-02 NodeC11   / 3.37E-02 NodeC18   / 1.83E-02 NodeC12   / 1.08E-02
NodeC4    / 1.94E-02 NodeC7    / 1.83E-02
 NodeC5    / 2.69E-02 NodeC8    / 1.83E-02 NodeC6    / 3.77E-02 NodeC1    / 1.40E-02
Node54    / 3.45E-02 NodeB6    / 1.83E-02
 NodeB12   / 3.34E-02 NodeB7    / 1.83E-02 NodeA10   / 1.29E-02 NodeA11   / 5.49E-02
NodeA7    / 3.22E-02 NodeA8    / 7.08E-02
 NodeA12   / 7.75E-02

 Cycle        500      Time          8 Hrs - 20.00 Min

       Junction / Depth  / Elevation    ===>  "*" Junction is Surcharged.
          NodeA4/   0.00 /  1580.00           NodeA3/   0.00 /  1554.00
NodeA2/   0.02 /  1524.02
          NodeA1/   0.04 /  1494.04           NodeA8/   0.14 /  1512.14
NodeA12/   0.13 /  1528.13
         NodeA11/   0.17 /  1540.17          NodeA10/   0.11 /  1562.11
NodeA9/   0.02 /  1581.02
          NodeA5/   0.02 /  1581.02           NodeA7/   0.14 /  1544.14
NodeC3/   0.00 /  1580.00
          NodeC2/   0.01 /  1532.01           NodeC1/   0.03 /  1489.03
NodeC6/   0.14 /  1506.14
          NodeC5/   0.13 /  1548.13           NodeC4/   0.15 /  1581.15
NodeC7/   0.01 /  1581.01
          NodeC8/   0.02 /  1550.02           NodeB2/   0.01 /  1518.01
NodeB1/   0.02 /  1490.02
         NodeB12/   0.02 /  1512.02           NodeB9/   0.12 /  1560.12
NodeB6/   0.13 /  1524.13
          NodeB7/   0.11 /  1502.11          NodeC13/   0.00 /  1546.00
NodeC16/   0.05 /  1548.05
         NodeC10/   0.08 /  1548.08          NodeC14/   0.00 /  1510.00
NodeC17/   0.02 /  1522.02
         NodeC11/   0.02 /  1520.02          NodeC15/   0.01 /  1470.01
NodeC18/   0.13 /  1476.13
         NodeC12/   0.10 /  1476.10            PondA/   0.00 /  1480.00
Pond B/   0.01 /  1478.01
          NodeB4/   0.00 /  1546.00           NodeB5/   0.07 /  1547.07
PondC/   0.00 /  1446.00
        Outlet B/   0.00 /  1478.00          OutletC/   0.00 /  1446.00
OutletA/   0.00 /  1479.00
          Node51/   0.03 /  1452.03           Node52/   0.01 /  1474.01
```

```
Node53/   0.04 /  1480.04
          Node54/   0.04 /  1485.04            EOF C/   0.00 /  1447.00
EOF B/   0.00 /  1479.00
            EOF A/   0.00 /  1480.00

         Conduit/       FLOW   ===> "*" Conduit uses the normal flow option.
         LinkA11/       0.00*         LinkA10/       0.01*          LinkA9/
0.06           LinkA5/       0.02
          LinkA1/       0.02           LinkA2/       0.03           LinkA3/
0.01           LinkA4/       0.00
          LinkA8/       0.00           LinkA6/       0.02           LinkC8/
0.01*          LinkC9/       0.03*
          LinkC2/       0.02           LinkC3/       0.01           LinkC4/
0.01           LinkC5/       0.00
          LinkC6/       0.01           LinkB2/       0.03*          LinkB1/
0.03*          LinkB4/       0.01
          LinkB7/       0.01           Link29/       0.01          LinkC12/
0.00          LinkC10/       0.00
         LinkC15/       0.00*         LinkC13/       0.01          LinkC11/
0.01          LinkC16/       0.02*
         LinkC14/       0.01          LinkC17/       0.01            LinkA/
0.02           LinkB/       0.06
          LinkB8/       0.00            LinkC/       0.01           LinkC1/
0.06*          Link52/       0.00
          Link53/       0.00           Link54/       0.00           LinkB3/
0.01*          Link56/       0.04*
          Link57/       0.05           Link58/       0.05           Link59/
0.08*          Link60/       0.00
          Link61/       0.00           Link62/       0.00         FREE # 1/
0.00         FREE # 2/       0.00
        FREE # 3/       0.00         FREE # 4/       0.00         FREE # 5/
0.00         FREE # 6/       0.00

 ===> System inflows (file) at    16.67 hours (  Junction / Inflow, cfs)

 NodeA9    / 7.41E-02 NodeA5    / 8.53E-02 NodeB9    / 1.76E-01 NodeB5    / 2.78E-02
NodeC16   / 1.39E-02 NodeC10   / 5.28E-02
 NodeC17   / 1.34E-01 NodeC11   / 2.90E-01 NodeC18   / 1.58E-01 NodeC12   / 9.27E-02
NodeC4    / 1.67E-01 NodeC7    / 1.58E-01
 NodeC5    / 2.32E-01 NodeC8    / 1.58E-01 NodeC6    / 3.24E-01 NodeC1    / 1.20E-01
Node54    / 2.97E-01 NodeB6    / 1.58E-01
 NodeB12   / 2.87E-01 NodeB7    / 1.58E-01 NodeA10   / 1.11E-01 NodeA11   / 4.73E-01
NodeA7    / 2.77E-01 NodeA8    / 6.10E-01
 NodeA12   / 6.67E-01

 Cycle       1000      Time         16 Hrs - 40.00 Min

       Junction / Depth  / Elevation    ===>  "*" Junction is Surcharged.
          NodeA4/   0.02 /  1580.02           NodeA3/   0.03 /  1554.03
NodeA2/   0.06 /  1524.06
          NodeA1/   0.34 /  1494.34           NodeA8/   0.50 /  1512.50
NodeA12/   0.49 /  1528.49
         NodeA11/   0.50 /  1540.50          NodeA10/   0.29 /  1562.29
NodeA9/   0.16 /  1581.16
          NodeA5/   0.16 /  1581.16           NodeA7/   0.36 /  1544.36
NodeC3/   0.03 /  1580.03
          NodeC2/   0.04 /  1532.04           NodeC1/   0.17 /  1489.17
NodeC6/   0.38 /  1506.38
          NodeC5/   0.38 /  1548.38           NodeC4/   0.48 /  1581.48
NodeC7/   0.26 /  1581.26
          NodeC8/   0.09 /  1550.09           NodeB2/   0.03 /  1518.03
NodeB1/   0.09 /  1490.09
         NodeB12/   0.08 /  1512.08           NodeB9/   0.33 /  1560.33
```

```
NodeB6/   0.33 /  1524.33
          NodeB7/   0.33 /  1502.33          NodeC13/   0.01 /  1546.01
NodeC16/   0.14 /  1548.14
         NodeC10/   0.30 /  1548.30          NodeC14/   0.03 /  1510.03
NodeC17/   0.11 /  1522.11
         NodeC11/   0.20 /  1520.20          NodeC15/   0.04 /  1470.04
NodeC18/   0.32 /  1476.32
         NodeC12/   0.26 /  1476.26            PondA/   1.74 /  1481.74
Pond B/   2.53 /  1480.53
          NodeB4/   0.02 /  1546.02           NodeB5/   0.23 /  1547.23
PondC/   2.62 /  1448.62
        Outlet B/   0.12 /  1478.12          OutletC/   0.20 /  1446.20
OutletA/   0.42 /  1479.42
          Node51/   0.25 /  1452.25           Node52/   0.06 /  1474.06
Node53/   0.34 /  1480.34
          Node54/   0.20 /  1485.20            EOF C/   0.10 /  1447.10
EOF B/   0.05 /  1479.05
            EOF A/   0.01 /  1480.01

         Conduit/       FLOW   ===> "*" Conduit uses the normal flow option.
         LinkA11/       0.17*          LinkA10/       0.28*          LinkA9/
1.06           LinkA5/       0.66
          LinkA1/       0.74            LinkA2/       0.49          LinkA3/
0.11           LinkA4/       0.08
          LinkA8/       0.09            LinkA6/       0.29          LinkC8/
0.36*          LinkC9/       0.76*
          LinkC2/       0.34            LinkC3/       0.24          LinkC4/
0.18           LinkC5/       0.18
          LinkC6/       0.16            LinkB2/       0.37*         LinkB1/
0.29*          LinkB4/       0.18
          LinkB7/       0.16            Link29/       0.16         LinkC12/
0.01          LinkC10/       0.06
         LinkC15/       0.07*          LinkC13/       0.14         LinkC11/
0.31          LinkC16/       0.52*
         LinkC14/       0.16            LinkC17/       0.10           LinkA/
2.49*          LinkB/       0.83*
          LinkB8/       0.03              LinkC/       0.78*         LinkC1/
1.22*          Link52/       0.22
          Link53/       0.64            Link54/       2.61          LinkB3/
0.21*          Link56/       0.77*
          Link57/       1.54*           Link58/       1.54          Link59/
1.52*          Link60/       1.75
          Link61/       0.63            Link62/       0.08         FREE # 1/
0.22         FREE # 2/       0.64
        FREE # 3/       2.61          FREE # 4/       1.75         FREE # 5/
0.63         FREE # 6/       0.08


 *================================================*
 | Table E5 - Junction Time Limitation Summary    |
 |              (0.10 or 0.25)* Depth * Area      |
 | Time step = ----------------------------       |
 |                  Sum of Flow                   |
 *================================================*
 |  The time this junction was the limiting junction |
 |                is listed in the third column.  |
 *================================================*

         Junction     Time(.10)  Time(.25)  Time(sec)
-----------------     ---------  ---------  ---------
           NodeA4      422.8461   600.0000 42540.0000

           NodeA3      158.8423   397.1058     0.0000
```

NodeA2	15.4968	38.7420	0.0000
NodeA1	66.6853	166.7134	0.0000
NodeA8	84.0586	210.1464	0.0000
NodeA12	93.6501	234.1252	0.0000
NodeA11	49.2047	123.0117	0.0000
NodeA10	119.0724	297.6810	0.0000
NodeA9	113.1324	282.8311	0.0000
NodeA5	52.4224	131.0561	42720.0000
NodeA7	90.3629	225.9071	0.0000
NodeC3	340.3184	600.0000	0.0000
NodeC2	11.4726	28.6815	0.0000
NodeC1	79.4940	198.7349	0.0000
NodeC6	106.8971	267.2427	0.0000
NodeC5	106.2085	265.5213	0.0000
NodeC4	88.8629	222.1573	0.0000
NodeC7	53.0039	132.5098	0.0000
NodeC8	50.7222	126.8055	60.0000
NodeB2	62.2969	155.7424	0.0000
NodeB1	119.1483	297.8706	0.0000
NodeB12	82.1443	205.3607	0.0000
NodeB9	104.7072	261.7679	0.0000
NodeB6	88.8335	222.0836	0.0000
NodeB7	134.1190	335.2975	0.0000
NodeC13	600.0000	600.0000	0.0000
NodeC16	204.6938	511.7344	0.0000
NodeC10	149.4170	373.5425	0.0000
NodeC14	115.6526	289.1316	0.0000
NodeC17	55.6668	139.1670	0.0000
NodeC11	34.2966	85.7415	540.0000
NodeC15	41.8087	104.5218	0.0000
NodeC18	87.3745	218.4364	0.0000

NodeC12	107.7113	269.2783	0.0000
PondA	56.0739	140.1849	0.0000
Pond B	40.2694	100.6736	300.0000
NodeB4	560.0665	600.0000	0.0000
NodeB5	182.8198	457.0495	0.0000
PondC	41.1493	102.8733	240.0000
Outlet B	600.0000	600.0000	0.0000
OutletC	600.0000	600.0000	0.0000
OutletA	600.0000	600.0000	0.0000
Node51	78.1369	195.3423	0.0000
Node52	566.6332	600.0000	0.0000
Node53	53.3759	133.4397	0.0000
Node54	67.3477	168.3692	0.0000
EOF C	600.0000	600.0000	0.0000
EOF B	600.0000	600.0000	0.0000
EOF A	600.0000	600.0000	0.0000

The junction requiring the smallest time step was...NodeA5

Table E5a - Conduit Explicit Condition Summary

Courant = Conduit Length / Time step = Velocity + sqrt(g*depth)

Conduit Implicit Condition Summary

Courant = Conduit Length / Time step = Velocity

The 3rd column is the Explicit time step times the minimum courant time step factor

Minimum Conduit Time Step in seconds in the 4th column in the list. Maximum possible is 10 * maximum time step

The 5th column is the maximum change at any time step during the simulation. The 6th column is the wobble value which is an indicator of the flow stability.

You should use this section to find those conduits that are slowing your model down. Use modify conduits to alter the length of the slow conduits to make your simulation faster, or change the conduit name to "CHME?????" where ????? are any characters, this will lengthen the conduit based on the model time step, not the value listed in modify conduits.

Conduit	Time(exp)	Expl*Cmin	Time(imp)	Time(min)	Max Qchange	Wobble	Type of Soln
LinkA11	15.0106	15.0106	21.3731	431.0000	-0.0376	0.0598	Normal Soln
LinkA10	16.5282	16.5282	25.0813	0.0000	-0.0701	0.1062	Normal Soln
LinkA9	6.7040	6.7040	8.4840	0.0000	0.2082	0.2841	Normal Soln
LinkA5	164.8455	164.8455	600.0000	0.0000	0.0967	1.1822	Normal Soln
LinkA1	157.9324	157.9324	160.3072	0.0000	0.0927	1.2121	Normal Soln
LinkA2	157.0707	157.0707	600.0000	0.0000	0.0922	0.9527	Normal Soln
LinkA3	85.7774	85.7774	360.8068	0.0000	0.0276	0.4284	Normal Soln
LinkA4	80.9734	80.9734	571.1272	0.0000	0.0160	0.5732	Normal Soln
LinkA8	43.3035	43.3035	265.2147	0.0000	0.0242	1.3510	Normal Soln
LinkA6	102.4683	102.4683	336.0038	0.0000	-0.0690	0.8206	Normal Soln
LinkC8	26.2183	26.2183	37.9264	0.0000	0.0522	0.0739	Normal Soln
LinkC9	14.5254	14.5254	27.2662	0.0000	0.1510	0.1823	Normal Soln
LinkC2	53.4041	53.4041	53.8410	3.0000	-0.1150	1.2358	Normal Soln
LinkC3	151.9017	151.9017	600.0000	0.0000	0.0463	0.7963	Normal Soln
LinkC4	92.7715	92.7715	600.0000	0.0000	0.0337	1.2062	Normal Soln
LinkC5	130.3605	130.3605	600.0000	0.0000	0.0254	1.3583	Normal Soln
LinkC6	53.1582	53.1582	160.5039	0.0000	0.0489	0.7803	Normal Soln
LinkB2	11.4366	11.4366	19.0631	0.0000	0.0954	0.1262	Normal Soln
LinkB1	64.7017	64.7017	170.6240	0.0000	-0.1830	0.5424	Normal Soln
LinkB4	102.9598	102.9598	399.0794	0.0000	0.0422	0.5806	Normal Soln
LinkB7	61.4054	61.4054	253.4910	0.0000	0.0443	0.6504	Normal Soln
Link29	133.2692	133.2692	518.8999	0.0000	0.0391	0.6749	Normal Soln
LinkC12	12.7447	12.7447	12.8835	9.0000	-0.0042	0.0696	Normal Soln
LinkC10	121.7836	121.7836	600.0000	0.0000	0.0085	0.3552	Normal Soln
LinkC15	46.6332	46.6332	86.2428	0.0000	0.0129	0.0249	Normal Soln
LinkC13	78.0534	78.0534	306.1054	0.0000	0.0353	0.8770	Normal Soln
LinkC11	129.1873	129.1873	600.0000	0.0000	0.0601	1.0025	Normal Soln
LinkC16	8.6352	8.6352	10.9664	0.0000	0.1007	0.1071	Normal Soln
LinkC14	59.8762	59.8762	242.7601	0.0000	-0.0451	0.6409	

```
Normal Soln
         LinkC17    29.7980    29.7980    30.3538     2.0000       0.0256   0.3604
Normal Soln
          LinkA     92.6253    92.6253   417.0515     0.0000       0.3132   3.0327
Normal Soln
          LinkB     18.5363    18.5363   156.9421     0.0000      -0.2329   0.5989
Normal Soln
         LinkB8     89.7035    89.7035   600.0000     0.0000       0.0054   0.2329
Normal Soln
          LinkC     60.6556    60.6556   224.7407     0.0000       0.1511   1.9838
Normal Soln
         LinkC1     19.2604    19.2604    42.4637     2.0000       0.2715   1.5028
Normal Soln
         Link52      3.7360     3.7360     6.3799     0.0000       0.0548   1.4375
Normal Soln
         Link53      3.2396     3.2396     5.9483     0.0000       0.0631   1.6360
Normal Soln
         Link54      3.0926     3.0926     5.8608   715.0000       0.0461   1.6398
Normal Soln
         LinkB3     17.8557    17.8557    25.2110     0.0000       0.0501   0.0853
Normal Soln
         Link56      3.1535     3.1535     6.0965   278.0000       0.2086   0.1459
Normal Soln
         Link57      7.0883     7.0883    22.4642     0.0000       0.3972   0.2846
Normal Soln
         Link58     40.2080    40.2080   137.5968     0.0000       0.2959   1.0582
Normal Soln
         Link59     25.6169    25.6169    97.6478     0.0000       0.3720   1.9899
Normal Soln
         Link60      4.5029     4.5029    11.2314     0.0000       0.4169  10.4061
Normal Soln
         Link61      5.5001     5.5001    14.8142     0.0000       0.2864   5.1178
Normal Soln
         Link62      4.7535     4.7535    11.7463     0.0000       0.2994   7.6403
Normal Soln
The conduit with the smallest time step limitation was..Link54
The conduit with the largest wobble was.................Link60
The conduit with the largest flow change in any
consecutive time step...................................Link60

 *================================================*
 |  Table E6. Final Model Condition               |
 |            This table is used for steady state |
 |            flow comparison and is the information|
 |            saved to the hot-restart file.      |
 |            Final Time =    24.017 hours        |
 *================================================*

 Junction / Depth  / Elevation    ===>  "*" Junction is Surcharged.
          NodeA4/   0.01 /  1580.01/          NodeA3/   0.02 /  1554.02/
NodeA2/   0.05 /  1524.05/
          NodeA1/   0.22 /  1494.22/          NodeA8/   0.38 /  1512.38/
NodeA12/   0.37 /  1528.37/
         NodeA11/   0.38 /  1540.38/         NodeA10/   0.22 /  1562.22/
NodeA9/   0.11 /  1581.11/
          NodeA5/   0.11 /  1581.11/          NodeA7/   0.28 /  1544.28/
NodeC3/   0.02 /  1580.02/
          NodeC2/   0.03 /  1532.03/          NodeC1/   0.11 /  1489.11/
NodeC6/   0.30 /  1506.30/
          NodeC5/   0.29 /  1548.29/          NodeC4/   0.37 /  1581.37/
NodeC7/   0.17 /  1581.17/
          NodeC8/   0.06 /  1550.06/          NodeB2/   0.02 /  1518.02/
NodeB1/   0.06 /  1490.06/
```

```
         NodeB12/   0.05 /  1512.05/          NodeB9/   0.25 /  1560.25/
NodeB6/   0.25 /  1524.25/
         NodeB7/   0.26 /  1502.26/         NodeC13/   0.01 /  1546.01/
NodeC16/   0.11 /  1548.11/
         NodeC10/   0.23 /  1548.23/         NodeC14/   0.02 /  1510.02/
NodeC17/   0.07 /  1522.07/
         NodeC11/   0.13 /  1520.13/         NodeC15/   0.02 /  1470.02/
NodeC18/   0.25 /  1476.25/
         NodeC12/   0.20 /  1476.20/           PondA/   1.53 /  1481.53/
Pond B/   2.49 /  1480.49/
          NodeB4/   0.02 /  1546.02/          NodeB5/   0.18 /  1547.18/
PondC/   2.55 /  1448.55/
        Outlet B/   0.08 /  1478.08/         OutletC/   0.14 /  1446.14/
OutletA/   0.29 /  1479.29/
         Node51/   0.16 /  1452.16/          Node52/   0.04 /  1474.04/
Node53/   0.22 /  1480.22/
         Node54/   0.13 /  1485.13/           EOF C/   0.06 /  1447.06/
EOF B/   0.03 /  1479.03/
          EOF A/   0.00 /  1480.00/

   Conduit/       Flow   ===> "*" Conduit uses the normal flow option.
         LinkA11/       0.08*/         LinkA10/       0.14*/          LinkA9/
0.52 /
          LinkA5/       0.32 /          LinkA1/       0.35 /          LinkA2/
0.24 /
          LinkA3/       0.06 /          LinkA4/       0.04 /          LinkA8/
0.04 /
          LinkA6/       0.14 /          LinkC8/       0.17*/          LinkC9/
0.37*/
          LinkC2/       0.17 /          LinkC3/       0.12 /          LinkC4/
0.09 /
          LinkC5/       0.08 /          LinkC6/       0.08 /          LinkB2/
0.18*/
          LinkB1/       0.15*/          LinkB4/       0.09 /          LinkB7/
0.08 /
          Link29/       0.08 /         LinkC12/       0.01 /         LinkC10/
0.03 /
         LinkC15/       0.03*/         LinkC13/       0.07 /         LinkC11/
0.15 /
         LinkC16/       0.25*/         LinkC14/       0.08 /         LinkC17/
0.05 /
           LinkA/       1.20*/           LinkB/       0.41*/          LinkB8/
0.01 /
           LinkC/       0.38*/          LinkC1/       0.60*/          Link52/
0.10 /
          Link53/       0.30 /          Link54/       1.24 /          LinkB3/
0.10*/
          Link56/       0.38*/          Link57/       0.75*/          Link58/
0.75 /
          Link59/       0.75*/          Link60/       0.85 /          Link61/
0.32 /
          Link62/       0.00 /        FREE # 1/       0.10 /        FREE # 2/
0.30 /
        FREE # 3/       1.24 /        FREE # 4/       0.85 /        FREE # 5/
0.32 /
        FREE # 6/       0.00 /

          Conduit/   Velocity
          LinkA11/       1.11 /         LinkA10/       0.94 /          LinkA9/
2.86 /
          LinkA5/       0.61 /          LinkA1/       0.68 /          LinkA2/
0.54 /
          LinkA3/       0.38 /          LinkA4/       0.14 /          LinkA8/
```

```
0.17 /
        LinkA6/       0.60 /         LinkC8/       1.46 /         LinkC9/
1.14 /
        LinkC2/       0.53 /         LinkC3/       0.46 /         LinkC4/
0.20 /
        LinkC5/       0.14 /         LinkC6/       0.45 /         LinkB2/
1.05 /
        LinkB1/       0.52 /         LinkB4/       0.47 /         LinkB7/
0.41 /
        Link29/       0.43 /        LinkC12/       0.19 /        LinkC10/
0.18 /
       LinkC15/       0.49 /        LinkC13/       0.34 /        LinkC11/
0.34 /
       LinkC16/       2.29 /        LinkC14/       0.41 /        LinkC17/
0.38 /
         LinkA/       0.13 /          LinkB/       0.02 /         LinkB8/
0.14 /
         LinkC/       0.03 /         LinkC1/       0.58 /         Link52/
3.18 /
        Link53/       4.29 /         Link54/       5.90 /         LinkB3/
1.22 /
        Link56/       0.89 /         Link57/       0.09 /         Link58/
0.61 /
        Link59/       0.49 /         Link60/       0.74 /         Link61/
0.51 /
        Link62/       0.00 /

       Conduit/      Width
       LinkA11/      4.83 /         LinkA10/      4.86 /         LinkA9/
4.88 /
        LinkA5/       3.21 /         LinkA1/       3.21 /         LinkA2/
2.55 /
        LinkA3/       1.44 /         LinkA4/       4.38 /         LinkA8/
4.00 /
        LinkA6/       1.90 /         LinkC8/       4.85 /         LinkC9/
4.93 /
        LinkC2/       2.40 /         LinkC3/       1.92 /         LinkC4/
2.37 /
        LinkC5/       6.00 /         LinkC6/       4.00 /         LinkB2/
4.87 /
        LinkB1/       5.33 /         LinkB4/       1.61 /         LinkB7/
1.64 /
        Link29/       1.67 /        LinkC12/       0.71 /        LinkC10/
1.42 /
       LinkC15/       4.83 /        LinkC13/       4.00 /        LinkC11/
5.50 /
       LinkC16/       4.85 /        LinkC14/       1.65 /        LinkC17/
1.34 /
         LinkA/      12.51 /          LinkB/      19.20 /         LinkB8/
1.19 /
         LinkC/      11.42 /         LinkC1/       8.97 /         Link52/
0.55 /
        Link53/       0.70 /         Link54/       0.93 /         LinkB3/
4.84 /
        Link56/       4.97 /         Link57/       7.14 /         Link58/
8.99 /
        Link59/       9.39 /         Link60/      10.87 /         Link61/
10.49 /
        Link62/      10.00 /

       Junction/      EGL
         NodeA4/      0.01 /         NodeA3/       0.04 /         NodeA2/
0.06 /
```

NodeA1/	2.20 /	NodeA8/	0.38 /	NodeA12/	0.37 /	NodeA11/	0.38 /	NodeA10/
0.22 /	NodeA9/	0.11 /	NodeA5/	0.11 /	NodeA7/	0.28 /	NodeC3/	0.02 /
NodeC2/	0.06 /	NodeC1/	0.13 /	NodeC6/	0.30 /	NodeC5/	0.29 /	NodeC4/
0.37 /	NodeC7/	0.17 /	NodeC8/	0.06 /	NodeB2/	0.04 /	NodeB1/	0.07 /
NodeB12/	0.05 /	NodeB9/	0.25 /	NodeB6/	0.25 /	NodeB7/	0.26 /	NodeC13/
0.01 /	NodeC16/	0.11 /	NodeC10/	0.23 /	NodeC14/	0.03 /	NodeC17/	0.07 /
NodeC11/	0.13 /	NodeC15/	0.11 /	NodeC18/	0.25 /	NodeC12/	0.20 /	PondA/
1.53 /	Pond B/	2.49 /	NodeB4/	0.02 /	NodeB5/	0.18 /	PondC/	2.55 /
Outlet B/	0.24 /	OutletC/	0.42 /	OutletA/	0.83 /	Node51/	0.17 /	Node52/
0.05 /	Node53/	0.23 /	Node54/	0.14 /	EOF C/	0.07 /	EOF B/	0.03 /
EOF A/	0.00 /							

Junction/ Freeboard

NodeA4/	1.99 /	NodeA3/	1.48 /	NodeA2/	1.45 /	NodeA1/	3.28 /	NodeA8/
1.12 /	NodeA12/	1.13 /	NodeA11/	1.12 /	NodeA10/	1.28 /	NodeA9/	1.39 /
NodeA5/	1.39 /	NodeA7/	1.22 /	NodeC3/	1.48 /	NodeC2/	1.47 /	NodeC1/
1.39 /	NodeC6/	1.20 /	NodeC5/	1.21 /	NodeC4/	1.13 /	NodeC7/	1.33 /
NodeC8/	1.44 /	NodeB2/	1.48 /	NodeB1/	1.44 /	NodeB12/	1.45 /	NodeB9/
1.25 /	NodeB6/	1.25 /	NodeB7/	1.24 /	NodeC13/	1.49 /	NodeC16/	1.39 /
NodeC10/	1.27 /	NodeC14/	1.48 /	NodeC17/	1.43 /	NodeC11/	1.37 /	NodeC15/
1.48 /	NodeC18/	1.25 /	NodeC12/	1.30 /	PondA/	2.47 /	Pond B/	1.91 /
NodeB4/	1.48 /	NodeB5/	1.32 /	PondC/	1.85 /	Outlet B/	1.92 /	OutletC/
1.86 /	OutletA/	2.21 /	Node51/	1.34 /	Node52/	1.96 /	Node53/	1.78 /

Node54/ 1.37 / EOF C/ 0.44 / EOF B/ 0.47 /
EOF A/ 0.50 /

Junction/ Max Volume
NodeA4/ 2.35 / NodeA3/ 3.32 / NodeA2/ 6.00 /
NodeA1/ 23.13 / NodeA8/ 18.85 / NodeA12/ 18.85 /
NodeA11/ 18.85 / NodeA10/ 14.23 / NodeA9/ 12.98 /
NodeA5/ 18.85 / NodeA7/ 17.72 / NodeC3/ 2.68 /
NodeC2/ 4.60 / NodeC1/ 16.34 / NodeC6/ 15.75 /
NodeC5/ 17.97 / NodeC4/ 18.85 / NodeC7/ 18.85 /
NodeC8/ 14.25 / NodeB2/ 3.68 / NodeB1/ 9.87 /
NodeB12/ 9.61 / NodeB9/ 16.29 / NodeB6/ 16.53 /
NodeB7/ 14.38 / NodeC13/ 1.39 / NodeC16/ 7.14 /
NodeC10/ 13.05 / NodeC14/ 3.34 / NodeC17/ 16.84 /
NodeC11/ 18.85 / NodeC15/ 4.02 / NodeC18/ 16.34 /
NodeC12/ 12.98 / PondA/ 46188.47 / Pond B/ 21857.71 /
NodeB4/ 2.91 / NodeB5/ 10.42 / PondC/ 44626.74 /
Outlet B/ 7.80 / OutletC/ 8.48 / OutletA/ 9.06 /
Node51/ 18.85 / Node52/ 6.01 / Node53/ 25.13 /
Node54/ 18.85 / EOF C/ 11.10 / EOF B/ 7.24 /
EOF A/ 9.70 /

Junction/Total Fldng
NodeA4/ 0.00 / NodeA3/ 0.00 / NodeA2/ 0.00 /
NodeA1/ 0.00 / NodeA8/ 0.00 / NodeA12/ 0.00 /
NodeA11/ 0.00 / NodeA10/ 0.00 / NodeA9/ 0.00 /
NodeA5/ 0.00 / NodeA7/ 0.00 / NodeC3/ 0.00 /
NodeC2/ 0.00 / NodeC1/ 0.00 / NodeC6/ 0.00 /
NodeC5/ 0.00 / NodeC4/ 0.00 / NodeC7/ 0.00 /
NodeC8/ 0.00 / NodeB2/ 0.00 / NodeB1/ 0.00 /
NodeB12/ 0.00 / NodeB9/ 0.00 / NodeB6/ 0.00 /
NodeB7/ 0.00 / NodeC13/ 0.00 / NodeC16/ 0.00 /
NodeC10/ 0.00 / NodeC14/ 0.00 / NodeC17/ 0.00 /
NodeC11/ 0.00 / NodeC15/ 0.00 / NodeC18/ 0.00 /
NodeC12/ 0.00 / PondA/ 0.00 / Pond B/

```
0.00 /
          NodeB4/       0.00 /          NodeB5/       0.00 /           PondC/
0.00 /
        Outlet B/       0.00 /         OutletC/       0.00 /         OutletA/
0.00 /
          Node51/       0.00 /          Node52/       0.00 /          Node53/
0.00 /
          Node54/       0.00 /           EOF C/       0.00 /           EOF B/
0.00 /
           EOF A/       0.00 /

          Conduit/ Cross Sectional Area
          LinkA11/       0.07 /         LinkA10/       0.15 /          LinkA9/
0.18 /
          LinkA5/       0.52 /          LinkA1/       0.52 /          LinkA2/
0.45 /
          LinkA3/       0.15 /          LinkA4/       0.28 /          LinkA8/
0.26 /
          LinkA6/       0.24 /          LinkC8/       0.12 /          LinkC9/
0.32 /
          LinkC2/       0.31 /          LinkC3/       0.26 /          LinkC4/
0.42 /
          LinkC5/       0.60 /          LinkC6/       0.18 /          LinkB2/
0.18 /
          LinkB1/       0.28 /          LinkB4/       0.19 /          LinkB7/
0.20 /
          Link29/       0.19 /         LinkC12/       0.04 /         LinkC10/
0.16 /
         LinkC15/       0.07 /         LinkC13/       0.20 /         LinkC11/
0.44 /
         LinkC16/       0.11 /         LinkC14/       0.19 /         LinkC17/
0.12 /
           LinkA/       9.23 /           LinkB/      22.62 /          LinkB8/
0.10 /
           LinkC/      13.76 /          LinkC1/       1.03 /          Link52/
0.03 /
          Link53/       0.07 /          Link54/       0.21 /          LinkB3/
0.09 /
          Link56/       0.43 /          Link57/       8.54 /          Link58/
1.23 /
          Link59/       1.52 /          Link60/       1.15 /          Link61/
0.63 /
          Link62/       0.00 /

          Conduit/  Final Volume
          LinkA11/       9.78 /         LinkA10/      23.75 /          LinkA9/
21.94 /
          LinkA5/     527.70 /          LinkA1/     825.28 /          LinkA2/
427.63 /
          LinkA3/      67.46 /          LinkA4/     110.04 /          LinkA8/
72.01 /
          LinkA6/     153.84 /          LinkC8/      27.82 /          LinkC9/
48.64 /
          LinkC2/     297.19 /          LinkC3/     234.85 /          LinkC4/
211.87 /
          LinkC5/     482.06 /          LinkC6/      70.24 /          LinkB2/
19.64 /
          LinkB1/     126.32 /          LinkB4/     115.87 /          LinkB7/
68.63 /
          Link29/     137.12 /         LinkC12/       6.44 /         LinkC10/
85.55 /
         LinkC15/      16.80 /         LinkC13/     109.87 /         LinkC11/
400.06 /
```

LinkC16/ 13.29 / LinkC14/ 65.54 / LinkC17/ 38.57 /
LinkA/ 7382.82 / LinkB/ 3393.72 / LinkB8/ 35.34 /
LinkC/ 6880.93 / LinkC1/ 159.34 / Link52/ 1.59 /
Link53/ 3.50 / Link54/ 10.51 / LinkB3/ 14.67 /
Link56/ 14.07 / Link57/ 640.44 / Link58/ 412.60 /
Link59/ 326.04 / Link60/ 45.92 / Link61/ 25.08 /
Link62/ 0.00 /

Conduit/ Hydraulic Radius
LinkA11/ 0.02 / LinkA10/ 0.03 / LinkA9/ 0.04 /
LinkA5/ 0.14 / LinkA1/ 0.14 / LinkA2/ 0.11 /
LinkA3/ 0.06 / LinkA4/ 0.06 / LinkA8/ 0.06 /
LinkA6/ 0.09 / LinkC8/ 0.02 / LinkC9/ 0.06 /
LinkC2/ 0.11 / LinkC3/ 0.09 / LinkC4/ 0.11 /
LinkC5/ 0.10 / LinkC6/ 0.04 / LinkB2/ 0.04 /
LinkB1/ 0.05 / LinkB4/ 0.07 / LinkB7/ 0.07 /
Link29/ 0.08 / LinkC12/ 0.03 / LinkC10/ 0.06 /
LinkC15/ 0.01 / LinkC13/ 0.05 / LinkC11/ 0.08 /
LinkC16/ 0.02 / LinkC14/ 0.07 / LinkC17/ 0.06 /
LinkA/ 0.56 / LinkB/ 0.76 / LinkB8/ 0.05 /
LinkC/ 0.74 / LinkC1/ 0.11 / Link52/ 0.05 /
Link53/ 0.09 / Link54/ 0.18 / LinkB3/ 0.02 /
Link56/ 0.08 / Link57/ 0.72 / Link58/ 0.13 /
Link59/ 0.16 / Link60/ 0.10 / Link61/ 0.06 /
Link62/ 0.00 /

Conduit/ Upstream/ Downstream Elevation
LinkA11/ 1580.01/ 1554.02 LinkA10/ 1554.02/ 1524.05 LinkA9/ 1524.05/ 1496.03/
LinkA5/ 1512.38/ 1496.18 LinkA1/ 1528.37/ 1496.19 LinkA2/ 1540.38/ 1524.05/
LinkA3/ 1562.22/ 1554.02 LinkA4/ 1581.11/ 1580.01 LinkA8/ 1581.11/ 1580.01/
LinkA6/ 1544.28/ 1524.05 LinkC8/ 1580.02/ 1532.03 LinkC9/ 1532.03/ 1489.11/
LinkC2/ 1506.30/ 1489.11 LinkC3/ 1548.29/ 1532.03 LinkC4/ 1581.37/ 1580.02/
LinkC5/ 1581.17/ 1580.02 LinkC6/ 1550.06/ 1532.03 LinkB2/ 1518.02/ 1490.06/
LinkB1/ 1512.05/ 1490.06 LinkB4/ 1560.25/ 1546.02 LinkB7/ 1524.25/ 1518.02/
Link29/ 1502.26/ 1490.06 LinkC12/ 1548.11/ 1546.01

```
LinkC10/  1548.23/  1546.01/
         LinkC15/  1546.01/  1510.02         LinkC13/  1522.07/  1510.02
LinkC11/  1520.13/  1510.02/
         LinkC16/  1510.02/  1470.02         LinkC14/  1476.25/  1470.02
LinkC17/  1476.20/  1470.02/
          LinkA/  1494.22/  1481.53           LinkB/  1490.06/  1480.49
LinkB8/  1547.18/  1546.02/
          LinkC/  1452.16/  1448.55          LinkC1/  1489.11/  1485.13
Link52/  1480.49/  1478.08/
          Link53/  1448.55/  1446.14          Link54/  1481.53/  1479.29
LinkB3/  1546.02/  1518.02/
          Link56/  1470.02/  1452.16          Link57/  1474.04/  1448.55
Link58/  1480.22/  1474.04/
          Link59/  1485.13/  1480.22          Link60/  1448.55/  1447.06
Link61/  1480.49/  1479.03/
          Link62/  1480.00/  1480.00
```

===
| Table E7 - Iteration Summary |
===

Total number of time steps simulated.....	1440
Total number of passes in the simulation.....	19756
Total number of time steps during simulation....	11703
Ratio of actual # of time steps / NTCYC.....	8.127
Average number of iterations per time step.....	1.688
Average time step size(seconds).....	7.383
Smallest time step size(seconds).....	3.000
Largest time step size(seconds).....	60.000
Average minimum Conduit Courant time step (sec).	24.427
Average minimum implicit time step (sec).....	5.545
Average minimum junction time step (sec).....	5.545
Average Courant Factor Tf.....	5.545
Number of times omega reduced.....	1807

===
| Table E8 - Junction Time Step Limitation Summary |
===
| Not Convr = Number of times this junction did not |
| converge during the simulation. |
| Avg Convr = Average junction iterations. |
| Conv err = Mean convergence error. |
| Omega Cng = Change of omega during iterations |
| Max Itern = Maximum number of iterations |
===

Junction	Not Convr	Avg Convr	Total Itt	Omega Cng	Max Itern	Ittrn >10	Ittrn >25	Ittrn >40
NodeA4	0	1.59	18562	0	11	1	0	0
NodeA3	0	1.60	18739	3	6	0	0	0
NodeA2	0	2.53	29585	17	399	14	14	14
NodeA1	0	2.96	34622	21	436	21	19	19
NodeA8	0	1.73	20249	0	6	0	0	0
NodeA12	0	1.79	20954	0	6	0	0	0

NodeA11	0	1.63	19075	0	5	0	0
NodeA10	0	1.41	16445	0	5	0	0
NodeA9	0	1.35	15834	0	5	0	0
NodeA5	0	1.34	15653	0	6	0	0
NodeA7	0	1.53	17946	0	6	0	0
NodeC3	0	1.76	20609	0	11	1	0
NodeC2	0	2.05	24015	411	6	0	0
NodeC1	0	2.18	25561	0	9	0	0
NodeC6	0	1.58	18436	0	6	0	0
NodeC5	0	1.51	17623	0	5	0	0
NodeC4	0	1.44	16805	0	6	0	0
NodeC7	0	1.46	17097	0	5	0	0
NodeC8	0	1.41	16496	0	6	0	0
NodeB2	0	1.79	20993	172	6	0	0
NodeB1	0	2.14	25041	1	22	1	0
NodeB12	0	1.53	17930	0	6	0	0
NodeB9	0	1.45	16986	0	5	0	0
NodeB6	0	1.44	16844	0	5	0	0
NodeB7	0	1.46	17101	0	5	0	0
NodeC13	0	1.45	17005	0	5	0	0
NodeC16	0	1.13	13189	0	5	0	0
NodeC10	0	1.28	14991	0	5	0	0
NodeC14	0	1.93	22550	216	6	0	0
NodeC17	0	1.42	16632	0	5	0	0
NodeC11	0	1.53	17849	0	6	0	0
NodeC15	0	2.22	25926	763	14	13	0
NodeC18	0	1.43	16740	0	5	0	0
NodeC12	0	1.35	15823	0	5	0	0
PondA	0	1.74	20400	40	17	1	0
Pond B	0	1.63	19105	39	13	2	0
NodeB4	0	1.65	19293	1	6	0	0
NodeB5	0	1.21	14201	0	5	0	0

0	0							
	PondC	0	2.11	24718	37	12	1	
0	0							
	Outlet B	0	1.51	17701	0	7	0	
0	0							
	OutletC	0	1.81	21160	0	9	0	
0	0							
	OutletA	0	1.78	20887	0	8	0	
0	0							
	Node51	0	2.09	24489	0	6	0	
0	0							
	Node52	0	2.25	26359	77	9	0	
0	0							
	Node53	0	1.98	23191	3	6	0	
0	0							
	Node54	0	2.34	27431	0	9	0	
0	0							
	EOF C	0	1.72	20122	2	18	1	
0	0							
	EOF B	0	1.56	18291	1	7	0	
0	0							
	EOF A	0	1.74	20344	3	14	1	
0	0							

Total number of iterations for all junctions.. 977598

Minimum number of possible iterations..... 573447

Efficiency of the simulation..... 1.70

Excellent Efficiency

==========
| Extran Efficiency is an indicator of the efficiency of the simulation. Ideal efficiency is one iteration per time step. Altering the underrelaxation parameter, lowering the time step, increasing the flow and head tolerance are good ways of improving the efficiency, another is lowering the internal time step. The lower the efficiency generally the faster your model will run. If your efficiency is less than 1.5 then you may try increasing your time step so that your overall simulation is faster. Ideal efficiency would be around 2.0 |

Good Efficiency	< 1.5 mean iterations
Excellent Efficiency	< 2.5 and > 1.5 mean iterations
Good Efficiency	< 4.0 and > 2.5 mean iterations
Fair Efficiency	< 7.5 and > 4.0 mean iterations
Poor Efficiency	> 7.5 mean iterations

Table E9 - JUNCTION SUMMARY STATISTICS

The Maximum area is only the area of the node, it does not include the area of the surrounding conduits

Junction	Maximum Area	Maximum Gutter Junction Depth	Maximum Ground Gutter Elevation	Uppermost Maximum PipeCrown Gutter Elevation	Maximum Junction Elevation	Time of Occurence		Feet of Surcharge at Max Elevation	Freeboard of node
	ft^2	Name feet	Width feet	Velocity feet ft/s	feet	Hr.	Min.		feet
NodeA4	12.5660	1582.0000	1581.5000	1580.1873	12	1	0.0000	1.8127	
	0.0000	0.0000	0.0000						
NodeA3	12.5660	1555.5000	1555.5000	1554.2644	12	1	0.0000	1.2356	
	0.0000	0.0000	0.0000						
NodeA2	12.5660	1525.5000	1525.5000	1524.4778	12	0	0.0000	1.0222	
	0.0000	0.0000	0.0000						
NodeA1	12.5660	1497.5000	1497.5000	1495.8410	12	4	0.0000	1.6590	
	0.0000	0.0000	0.0000						
NodeA8	12.5660	1513.5000	1513.5000	1513.5000	11	56	0.0000	0.0000	
	0.0000	0.0000	0.0000						
NodeA12	12.5660	1529.5000	1529.5000	1529.5000	12	0	0.0000	0.0000	
	0.0000	0.0000	0.0000						
NodeA11	12.5660	1541.5000	1541.5000	1541.5000	11	54	0.0000	0.0000	
	0.0000	0.0000	0.0000						
NodeA10	12.5660	1563.5000	1563.5000	1563.1321	12	0	0.0000	0.3679	
	0.0000	0.0000	0.0000						
NodeA9	12.5660	1582.5000	1582.5000	1582.0333	12	3	0.0000	0.4667	
	0.0000	0.0000	0.0000						
NodeA5	12.5660	1582.5000	1582.5000	1582.5000	11	58	0.0000	0.0000	
	0.0000	0.0000	0.0000						
NodeA7	12.5660	1545.5000	1545.5000	1545.4100	12	0	0.0000	0.0900	
	0.0000	0.0000	0.0000						
NodeC3	12.5660	1581.5000	1581.5000	1580.2133	12	2	0.0000	1.2867	
	0.0000	0.0000	0.0000						
NodeC2	12.5660	1533.5000	1533.5000	1532.3662	12	0	0.0000	1.1338	
	0.0000	0.0000	0.0000						
NodeC1	12.5660	1490.5000	1490.5000	1490.3002	12	0	0.0000	0.1998	
	0.0000	0.0000	0.0000						
NodeC6	12.5660	1507.5000	1507.5000	1507.2534	12	0	0.0000	0.2466	
	0.0000	0.0000	0.0000						
NodeC5	12.5660	1549.5000	1549.5000	1549.4299	12	3	0.0000	0.0701	
	0.0000	0.0000	0.0000						
NodeC4	12.5660	1582.5000	1582.5000	1582.5000	11	56	0.0000	0.0000	
	0.0000	0.0000	0.0000						
NodeC7	12.5660	1582.5000	1582.5000	1582.5000	11	57	0.0000	0.0000	
	0.0000	0.0000	0.0000						
NodeC8	12.5660	1551.5000	1551.5000	1551.1339	12	59	0.0000	0.3661	
	0.0000	0.0000	0.0000						

NodeB2	1519.5000	1519.5000	1518.2933	12	0	0.0000	1.2067	
12.5660	0.0000	0.0000	0.0000					
NodeB1	1491.5000	1491.5000	1490.7856	12	0	0.0000	0.7144	
12.5660	0.0000	0.0000	0.0000					
NodeB12	1513.5000	1513.5000	1512.7650	11	58	0.0000	0.7350	
12.5660	0.0000	0.0000	0.0000					
NodeB9	1561.5000	1561.5000	1561.2966	12	1	0.0000	0.2034	
12.5660	0.0000	0.0000	0.0000					
NodeB6	1525.5000	1525.5000	1525.3158	12	59	0.0000	0.1842	
12.5660	0.0000	0.0000	0.0000					
NodeB7	1503.5000	1503.5000	1503.1443	12	1	0.0000	0.3557	
12.5660	0.0000	0.0000	0.0000					
NodeC13	1547.5000	1547.5000	1546.1106	12	4	0.0000	1.3894	
12.5660	0.0000	0.0000	0.0000					
NodeC16	1549.5000	1549.5000	1548.5685	12	0	0.0000	0.9315	
12.5660	0.0000	0.0000	0.0000					
NodeC10	1549.5000	1549.5000	1549.0385	12	4	0.0000	0.4615	
12.5660	0.0000	0.0000	0.0000					
NodeC14	1511.5000	1511.5000	1510.2662	12	1	0.0000	1.2338	
12.5660	0.0000	0.0000	0.0000					
NodeC17	1523.5000	1523.5000	1523.3400	12	0	0.0000	0.1600	
12.5660	0.0000	0.0000	0.0000					
NodeC11	1521.5000	1521.5000	1521.5000	11	55	0.0000	0.0000	
12.5660	0.0000	0.0000	0.0000					
NodeC15	1471.5000	1471.5000	1470.3199	12	0	0.0000	1.1801	
12.5660	0.0000	0.0000	0.0000					
NodeC18	1477.5000	1477.5000	1477.3005	12	59	0.0000	0.1995	
12.5660	0.0000	0.0000	0.0000					
NodeC12	1477.5000	1477.5000	1477.0331	12	59	0.0000	0.4669	
12.5660	0.0000	0.0000	0.0000					
PondA	1484.0000	1482.2000	1483.0121	12	10	0.8121	0.9879	
17336.001	0.0000	0.0000	0.0000					
Pond B	1482.4000	1481.4000	1481.4169	12	4	0.0169	0.9831	
7893.2894	0.0000	0.0000	0.0000					
NodeB4	1547.5000	1547.5000	1546.2318	12	1	0.0000	1.2682	
12.5660	0.0000	0.0000	0.0000					
NodeB5	1548.5000	1548.5000	1547.8296	12	3	0.0000	0.6704	
12.5660	0.0000	0.0000	0.0000					
PondC	1450.4000	1449.4000	1449.9345	12	8	0.5345	0.4655	
13639.864	0.0000	0.0000	0.0000					
Outlet B	1480.0000	1479.0000	1478.6210	12	1	0.0000	1.3790	
12.5660	0.0000	0.0000	0.0000					
OutletC	1448.0000	1447.0000	1446.6746	12	8	0.0000	1.3254	
12.5660	0.0000	0.0000	0.0000					
OutletA	1481.5000	1480.0000	1479.7213	12	10	0.0000	1.7787	
12.5660	0.0000	0.0000	0.0000					
Node51	1453.5000	1453.5000	1453.5000	11	58	0.0000	0.0000	
12.5660	0.0000	0.0000	0.0000					
Node52	1476.0000	1476.0000	1474.4786	12	2	0.0000	1.5214	
12.5660	0.0000	0.0000	0.0000					
Node53	1482.0000	1482.0000	1482.0000	11	57	0.0000	0.0000	
12.5660	0.0000	0.0000	0.0000					
Node54	1486.5000	1486.5000	1486.5000	11	58	0.0000	0.0000	
12.5660	0.0000	0.0000	0.0000					
EOF C	1447.5000	1447.5000	1447.8830	12	8	0.3830	0.0000	
12.5660	0.0000	0.0000	0.0000					
EOF B	1479.5000	1479.5000	1479.5758	12	4	0.0758	0.0000	
12.5660	0.0000	0.0000	0.0000					
EOF A	1480.5000	1480.5000	1480.7723	12	10	0.2723	0.0000	
12.5660	0.0000	0.0000	0.0000					

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| Table E10 - CONDUIT SUMMARY STATISTICS |

| Note: The peak flow may be less than the design flow and the conduit may still surcharge because of the downstream boundary conditions.

| * denotes an open conduit that has been overtopped this is a potential source of severe errors

Conduit Name	Maximum Design Flow (cfs)	Water Elev at Pipe Ends US (ft)	Water Elev at Pipe Ends DS (ft)	Conduit Velocity US (ft/s)	Conduit Velocity DS (ft/s)	Maximum Ratio Design Depth (in)	Maximum Computed Flow (cfs)	Time of Occurence Hr.	Time of Occurence Min.	Maximum Computed Velocity (ft/s)	Time of Occurence Hr.	Time of Occurence Min.	Ratio of Max. to Design Flow
LinkA11	229.2187	1580.187	1554.264	24.2559	0.125	18.0000	6.8929	12	1	6.1768	12	2	0.0301
LinkA10	223.6407	1554.264	1524.478	23.6657	0.176	18.0000	11.9314	12	1	6.3802	12	1	0.0534
LinkA9	249.4817	1524.478	1496.478	26.4002	0.319	18.0000	35.6578	12	1	14.1445	12	1	0.1429
LinkA5	22.2082	1513.500	1496.814	1.7946	1.000	18.0000	13.2803	12	0	7.8183	7	13	0.5980 *
LinkA1	24.9534	1529.500	1496.862	2.0164	1.000	18.0000	15.2952	12	3	9.9808	7	13	0.6130 *
LinkA2	22.8988	1541.500	1524.478	1.8504	1.000	18.0000	11.0136	12	1	8.3043	7	13	0.4810 *
LinkA3	23.5263	1563.132	1554.264	1.9011	0.755	18.0000	5.0597	12	0	6.0902	7	14	0.2151
LinkA4	10.7353	1582.033	1580.187	0.8420	0.689	18.0000	3.0946	12	3	0.7005	12	3	0.2883
LinkA8	5.6564	1582.500	1580.187	0.9427	1.000	18.0000	3.8390	12	0	1.0558	12	0	0.6787 *
LinkA6	30.9508	1545.410	1524.478	2.5011	0.940	18.0000	12.7486	12	0	1.9351	12	0	0.4119
LinkC8	230.9752	1580.213	1532.366	24.4418	0.142	18.0000	8.6178	12	2	6.3316	12	7	0.0373
LinkC9	276.5278	1532.366	1490.300	29.2622	0.244	18.0000	25.3642	12	0	5.5029	12	0	0.0917
LinkC2	23.6035	1507.253	1490.300	1.9074	0.836	18.0000	14.6559	12	0	17.6445	7	13	0.6209
LinkC3	23.5263	1549.430	1532.366	1.9011	0.953	18.0000	9.4201	12	3	6.0391	7	14	0.4004
LinkC4	7.8909	1582.500	1580.213	0.6377	1.000	18.0000	4.7986	12	0	0.6926	12	0	0.6081 *
LinkC5	5.5629	1582.500	1580.213	0.6181	1.000	18.0000	3.8193	12	0	0.6912	12	0	0.6866 *
LinkC6	20.0783	1551.134	1532.366	3.3464	0.756	18.0000	7.8482	12	59	2.4932	12	59	0.3909
LinkB2	258.2381	1518.293	1490.786	27.3268	0.196	18.0000	16.3643	12	0	5.8758	12	1	0.0634
LinkB1	54.4813	1512.765	1490.786	3.8232	0.510	18.0000	14.7757	11	58	2.6477	11	58	0.2712
LinkB4	26.9527	1561.297	1546.232	2.1780	0.864	18.0000	7.8586	12	1	8.0044	7	13	0.2916
LinkB7	23.1023	1525.316	1518.293	1.8669	0.877	18.0000	7.5341	12	59	5.6430	7	14	0.3261
Link29	20.5596	1503.144	1490.786	1.8275	0.763	18.0000	6.9712	12	0	1.3974	12	0	0.3391
LinkC12	18.8630			1.5243		18.0000	0.6569	12	0	13.5833	7	18	

0.0348	1548.568	1546.111	0.379	0.074							
	LinkC10	10.6401	0.8598	18.0000	1.9016	12	4	3.0826	7	16	
0.1787	1549.038	1546.111	0.692	0.074							
	LinkC15	200.0304	21.1672	18.0000	2.5029	12	4	2.7838	12	4	
0.0125	1546.111	1510.266	0.074	0.177							
	LinkC13	13.9807	2.3301	18.0000	6.1577	12	0	1.7972	12	0	
0.4404	1523.340	1510.266	0.893	0.177							
	LinkC11	14.9035	1.8065	18.0000	7.5406	12	1	1.4512	12	1	
0.5060	1521.500	1510.266	1.000	0.177	*						
	LinkC16	298.1876	31.5542	18.0000	16.0811	12	1	10.9426	12	4	
0.0539	1510.266	1470.320	0.177	0.213							
	LinkC14	23.4396	1.8941	18.0000	7.5314	12	59	5.8065	7	14	
0.3213	1477.300	1470.320	0.867	0.213							
	LinkC17	24.5476	1.9836	18.0000	4.4339	12	59	10.2129	7	16	
0.1806	1477.033	1470.320	0.689	0.213							
	LinkA	41.0687	2.2816	36.1449	62.8742	12	4	1.9202	12	59	
1.5310	1495.841	1483.012	0.611	1.000							
	LinkB	124.3737	5.1822	41.0027	37.3810	12	0	0.9573	11	58	
0.3006	1490.786	1481.417	0.230	1.000	*						
	LinkB8	9.4315	0.7621	18.0000	1.1048	12	3	2.6019	7	16	
0.1171	1547.830	1546.232	0.553	0.155							
	LinkC	23.5198	1.8447	47.2134	23.5198	11	58	2.2248	7	18	
1.0000	1453.500	1449.934	0.381	1.000							
	LinkC1	60.1883	2.8661	18.0000	45.4879	12	0	3.6502	7	11	
0.7558	1490.300	1486.500	0.867	1.000	*						
	Link52	7.2482	9.2286	12.0000	5.1231	12	1	7.8406	12	8	
0.7068	1481.417	1478.621	1.017	0.621							
	Link53	7.2482	9.2286	12.0000	5.7753	12	8	8.4060	12	8	
0.7968	1449.934	1446.675	1.534	0.675							
	Link54	6.9396	8.8358	12.0000	6.0334	12	10	8.5321	12	10	
0.8694	1483.012	1479.721	1.812	0.721							
	LinkB3	208.3843	22.0513	18.0000	8.9303	12	1	6.8226	12	2	
0.0429	1546.232	1518.293	0.155	0.196							
	Link56	381.4429	40.3643	18.0000	27.9334	12	0	5.4205	12	0	
0.0732	1470.320	1453.500	0.213	1.000	*						
	Link57	315.5721	33.3939	47.2134	45.2493	12	2	3.3862	11	57	
0.1434	1474.479	1449.934	0.122	1.000							
	Link58	84.8511	2.8284	24.0000	45.2475	12	7	2.4348	12	7	
0.5333	1482.000	1474.479	1.000	0.239	*						
	Link59	57.1365	2.7208	24.0000	57.1365	11	59	2.2018	11	59	
1.0000	1486.500	1482.000	0.750	1.000	*						
	Link60	11.0900	1.8483	18.4134	58.1279	12	8	3.5620	12	8	
5.2415	1449.934	1447.500	1.000	0.326							
	Link61	11.0900	1.8483	12.2027	28.5356	12	4	2.7002	12	4	
2.5731	1481.417	1479.500	1.000	0.492	*						
	Link62	12.2206	2.0368	15.7449	46.6837	12	10	3.4067	12	10	
3.8201	1483.012	1480.500	1.000	0.381							
	FREE # 1	Undefnd	Undefnd	Undefn	5.1244	12	1				
	FREE # 2	Undefnd	Undefnd	Undefn	5.7753	12	8				
	FREE # 3	Undefnd	Undefnd	Undefn	6.0334	12	10				
	FREE # 4	Undefnd	Undefnd	Undefn	58.1282	12	8				
	FREE # 5	Undefnd	Undefnd	Undefn	28.5359	12	4				
	FREE # 6	Undefnd	Undefnd	Undefn	46.6834	12	10				

Table E11. Area assumptions used in the analysis
Subcritical and Critical flow assumptions from Subroutine Head. See Figure 17-1 in the manual for further information.

Duration	Duration	Durat. of	Durat. of

Conduit Name	# of Dry Flow(min)	# of Sub-Critical Flow(min)	Upstream Critical Flow(min)	Downstream Critical Flow(min)	Maximum Hydraulic Radius-m	Maximum X-Sect Area(ft^2)	Maximum Vel*D (ft^2/s)
LinkA11	433.0000	1007.0000	0.0000	0.0000	0.2050	1.1164	1.3944
LinkA10	436.0000	1004.0000	0.0000	0.0000	0.3172	1.8710	2.3636
LinkA9	437.3333	0.0000	0.0000	1002.6667	0.4098	2.5210	6.7561
LinkA5	431.0000	0.0000	0.0000	1009.0000	0.5859	8.4605	1.8165
LinkA1	431.0000	0.0000	0.0000	1009.0000	0.5964	8.6581	2.0865
LinkA2	431.0000	1009.0000	0.0000	0.0000	0.5114	7.3816	1.4755
LinkA3	431.0000	1009.0000	0.0000	0.0000	0.3648	4.0567	0.8705
LinkA4	432.0000	1008.0000	0.0000	0.0000	0.4570	4.4182	0.4272
LinkA8	432.0000	1008.0000	0.0000	0.0000	0.5483	3.6363	0.8904
LinkA6	431.0000	1009.0000	0.0000	0.0000	0.4871	6.5884	1.8249
LinkC8	433.0000	1007.0000	0.0000	0.0000	0.2547	1.4393	1.7347
LinkC9	436.6667	1003.3333	0.0000	0.0000	0.5993	4.6094	4.5823
LinkC2	431.0000	1009.0000	0.0000	0.0000	0.6266	8.9491	2.0909
LinkC3	431.0000	1009.0000	0.0000	0.0000	0.4671	6.5201	1.2944
LinkC4	431.0000	1009.0000	0.0000	0.0000	0.4530	6.9280	0.5933
LinkC5	432.0000	1008.0000	0.0000	0.0000	0.6396	5.5259	0.5921
LinkC6	435.0000	1005.0000	0.0000	0.0000	0.5363	3.1479	1.8640
LinkB2	436.6667	1003.3333	0.0000	0.0000	0.4270	2.7949	3.1561
LinkB1	432.0000	1008.0000	0.0000	0.0000	0.5698	5.6218	2.0073
LinkB4	430.0000	1010.0000	0.0000	0.0000	0.4021	5.2266	1.1487
LinkB7	431.0000	1009.0000	0.0000	0.0000	0.4206	5.4569	1.1100
Link29	431.0000	1009.0000	0.0000	0.0000	0.4802	4.9894	1.3458
LinkC12	432.0000	1008.0000	0.0000	0.0000	0.1774	1.0084	0.2192
LinkC10	431.0000	1009.0000	0.0000	0.0000	0.3055	3.2987	0.3308
LinkC15	437.0000	1003.0000	0.0000	0.0000	0.1672	0.9026	0.5204
LinkC13	435.0000	1005.0000	0.0000	0.0000	0.5469	3.4264	1.4415
LinkC11	433.5000	1006.5000	0.0000	0.0000	0.6430	5.1962	1.2814
LinkC16	438.8000	1001.2000	0.0000	0.0000	0.2626	1.4774	

LinkC14	431.0000	1009.0000	0.0000	0.0000	0.4225	5.3772
3.1853						
LinkC17	431.0000	1009.0000	0.0000	0.0000	0.3503	3.4881
1.1343						
LinkA	434.0000	1006.0000	0.0000	0.0000	1.4123	37.0307
0.8595						
LinkB	432.0000	1008.0000	0.0000	0.0000	1.2863	41.7358
4.1648						
LinkB8	432.0000	1008.0000	0.0000	0.0000	0.2755	2.2181
1.9090						
LinkC	437.0000	1003.0000	0.0000	0.0000	1.4831	34.7495
0.2637						
LinkC1	430.5000	1009.5000	0.0000	0.0000	0.9682	18.8897
1.9862						
Link52	713.1875	726.8125	0.0000	0.0000	0.2906	0.6651
3.3707						
Link53	711.4000	728.6000	0.0000	0.0000	0.2906	0.6951
6.2644						
Link54	705.4167	734.5833	0.0000	0.0000	0.2907	0.7071
9.2827						
LinkB3	435.0000	1005.0000	0.0000	0.0000	0.2368	1.3127
10.8019						
Link56	436.0000	1004.0000	0.0000	0.0000	0.6282	5.1532
1.7835						
Link57	435.0000	1005.0000	0.0000	0.0000	1.1946	16.8181
4.9246						
Link58	434.8333	1005.1667	0.0000	0.0000	0.9124	18.5839
6.3512						
Link59	431.0000	1009.0000	0.0000	0.0000	1.1550	25.9500
3.0172						
Link60	711.4000	728.6000	0.0000	0.0000	0.7924	16.3195
3.8531						
Link61	713.1875	726.8125	0.0000	0.0000	0.6191	10.5679
3.6221						
Link62	1092.2981	347.7019	0.0000	0.0000	0.7197	13.7037
2.0477						
3.0837						

Table E12. Mean Conduit Flow Information

Conduit Name	Mean Flow (cfs)	Total Flow (ft^3)	Mean Percent Change	Low Flow Weightng	Mean Froude Number	Mean Hydraulic Radius	Mean Cross Area	Conduit Roughness
LinkA11	0.2125	18362.242	0.0001	0.9627	1.7808	0.0307	0.1534	0.0280
LinkA10	0.3618	31263.019	0.0002	0.9622	1.3721	0.0541	0.2782	0.0280
LinkA9	1.2863	111134.48	0.0007	0.9621	2.9059	0.0721	0.3765	0.0280
LinkA5	0.7335	63377.667	0.0002	0.9627	0.2693	0.2052	1.3541	0.0850

	LinkA1	0.8456	73059.744	0.0002	0.9627	0.2975	0.2082
1.3904	0.0850						
	LinkA2	0.5524	47730.453	0.0002	0.9627	0.4635	0.1628
1.1204	0.0850						
	LinkA3	0.1494	12912.383	0.0001	0.9625	0.4685	0.0934
0.4010	0.0850						
	LinkA4	0.0990	8550.9315	0.0001	0.9627	0.2222	0.1018
0.5941	0.0850						
	LinkA8	0.1136	9817.5246	0.0001	0.9627	0.2786	0.1094
0.5158	0.0850						
	LinkA6	0.3726	32188.423	0.0002	0.9627	0.4823	0.1237
0.6372	0.0850						
	LinkC8	0.3997	34529.887	0.0002	0.9627	1.8875	0.0469
0.2382	0.0280						
	LinkC9	0.9218	79645.896	0.0005	0.9621	1.2279	0.1183
0.6753	0.0280						
	LinkC2	0.4365	37715.148	0.0002	0.9627	0.2767	0.1585
0.8435	0.0850						
	LinkC3	0.3107	26840.425	0.0002	0.9626	0.4463	0.1256
0.7048	0.0850						
	LinkC4	0.2076	17939.045	0.0001	0.9627	0.2423	0.1485
1.0182	0.0850						
	LinkC5	0.1922	16607.144	0.0001	0.9627	0.1828	0.1680
1.1682	0.0850						
	LinkC6	0.2118	18296.691	0.0001	0.9627	0.4923	0.0826
0.3684	0.0850						
	LinkB2	0.4854	41939.572	0.0003	0.9621	1.3733	0.0688
0.3658	0.0280						
	LinkB1	0.3876	33486.500	0.0002	0.9627	0.4061	0.0977
0.6210	0.0850						
	LinkB4	0.2366	20444.355	0.0001	0.9626	0.6107	0.1045

0.5208	0.0850						
LinkB7	0.2119	18309.034	0.0001	0.9625	0.4815	0.1062	
0.5201	0.0850						
Link29	0.2109	18223.570	0.0001	0.9627	0.2972	0.1208	
0.5033	0.0850						
LinkC12	0.0187	1614.0616	0.0000	0.9620	0.3556	0.0460	
0.0973	0.0850						
LinkC10	0.0708	6121.3260	0.0000	0.9624	0.3174	0.0914	
0.4128	0.0850						
LinkC15	0.0895	7730.1371	0.0000	0.9621	1.0014	0.0288	
0.1439	0.0280						
LinkC13	0.1802	15571.336	0.0001	0.9627	0.4269	0.0925	
0.4232	0.0850						
LinkC11	0.3486	30121.680	0.0001	0.9627	0.4146	0.1430	
0.9086	0.0850						
LinkC16	0.6182	53410.429	0.0003	0.9617	2.8211	0.0448	
0.2268	0.0280						
LinkC14	0.2119	18307.157	0.0001	0.9625	0.4457	0.1068	
0.5106	0.0850						
LinkC17	0.1247	10770.121	0.0001	0.9624	0.4099	0.0876	
0.3298	0.0850						
LinkA	2.8729	248215.43	0.0012	0.9624	0.1117	0.6321	
11.5525	0.0850						
LinkB	1.0846	93710.712	0.0007	0.9627	0.0562	0.7191	
21.0910	0.0850						
LinkB8	0.0371	3209.3887	0.0000	0.9623	0.1904	0.0765	
0.2607	0.0850						
LinkC	0.9415	81347.612	0.0004	0.9619	0.0550	0.7491	
13.8436	0.0850						
LinkC1	1.5196	131294.63	0.0009	0.9627	0.3188	0.2029	
2.3270	0.0850						

Link52	0.2047	17681.958	0.0001	0.8500	1.6982	0.0779	0.0761
0.0140							
Link53	0.4859	41982.513	0.0001	0.8523	1.7214	0.1207	0.1492
0.0140							
Link54	1.3164	113739.44	0.0001	0.8594	1.5891	0.1999	0.3355
0.0140							
LinkB3	0.2737	23643.703	0.0002	0.9623	1.7804	0.0353	0.1774
0.0280							
Link56	0.9546	82474.429	0.0006	0.9622	1.0692	0.1440	0.8642
0.0280							
Link57	1.8437	159293.17	0.0007	0.9624	0.2847	0.6912	8.2328
0.0280							
Link58	1.8439	159310.39	0.0008	0.9623	0.5431	0.2225	2.7356
0.0850							
Link59	1.9135	165324.11	0.0010	0.9628	0.2460	0.2718	3.4568
0.0850							
Link60	1.9645	169731.51	0.0009	0.8523	0.4834	0.1715	2.3104
0.0850							
Link61	0.7018	60633.677	0.0005	0.8500	0.4523	0.0989	1.1977
0.0850							
Link62	1.2951	111898.45	0.0008	0.4497	0.2744	0.0879	1.2788
0.0850							
FREE # 1	0.2046	17681.419					
FREE # 2	0.4859	41983.223					
FREE # 3	1.3164	113738.92					
FREE # 4	1.9646	169737.98					
FREE # 5	0.7017	60628.520					

FREE # 6 1.2948 111872.94

==
| Table E13. Channel losses(H), headwater depth (HW), tailwater |
| depth (TW), critical and normal depth (Yc and Yn). |
| Use this section for culvert comparisons |
==

Conduit Name	Maximum Flow	Head Loss	Friction Loss	Critical Depth	Normal Depth	HW Elevat	TW Elevat	
LinkA11	6.8923	0.0000	14.9135	0.3884	0.1867	1580.1873	1554.2642	Max Flow
LinkA10	11.9169	0.0000	10.7036	0.5534	0.2632	1554.2642	1524.4768	Max Flow
LinkA9	35.6572	0.0000	28.0643	1.1035	0.4776	1524.4778	1496.4776	Max Flow
LinkA5	13.2795	0.0000	16.6100	0.8144	1.2352	1513.5000	1496.8144	Max Flow
LinkA1	15.2952	0.0000	32.5520	0.8620	1.2470	1529.5000	1496.8620	Max Flow
LinkA2	11.0136	0.0000	16.9912	0.7555	1.1388	1541.5000	1524.4778	Max Flow
LinkA3	5.0574	0.0000	8.7899	0.5530	0.8417	1563.1318	1554.2642	Max Flow
LinkA4	3.0937	0.0000	1.8241	0.2476	0.8041	1582.0331	1580.1868	Max Flow
LinkA8	3.8388	0.0000	2.2795	0.3056	1.1379	1582.4999	1580.1869	Max Flow
LinkA6	12.7282	0.0000	20.7844	0.8007	1.0736	1545.4089	1524.4778	Max Flow
LinkC8	8.6175	0.0000	22.1944	0.4490	0.2119	1580.2133	1532.3637	Max Flow
LinkC9	25.3496	0.0000	3.2266	0.8929	0.3658	1532.3660	1490.2999	Max Flow
LinkC2	14.6533	0.0000	17.2187	0.8477	1.2531	1507.2533	1490.3000	Max Flow
LinkC3	9.4079	0.0000	16.9678	0.7096	1.0620	1549.4295	1532.3616	Max Flow
LinkC4	4.7983	0.0000	2.2649	0.5421	1.2432	1582.5000	1580.2133	Max Flow
LinkC5	3.8192	0.0000	2.2690	0.2321	1.1598	1582.5000	1580.2133	Max Flow
LinkC6	7.8405	0.0000	18.6701	0.4920	0.7779	1551.1338	1532.3622	Max Flow
LinkB2	16.3540	0.0000	4.2710	0.6772	0.2927	1518.2931	1490.7824	Max Flow
LinkB1	14.6519	0.0000	21.9955	0.5700	0.7609	1512.7614	1490.7785	Max Flow
LinkB4	7.8573	0.0000	14.9556	0.6607	0.9431	1561.2966	1546.2315	Max Flow
LinkB7	7.5320	0.0000	6.9277	0.6490	0.9835	1525.3155	1518.2924	Max Flow
Link29	6.9668	0.0000	12.3228	0.6536	0.9978	1503.1440	1490.7824	Max Flow
LinkC12	0.6566	0.0000	2.4397	0.2436	0.4244	1548.5685		

1546.1047	Max Flow					
	LinkC10	1.8986	0.0000	2.9067	0.3727	0.7847 1549.0379
1546.1102	Max Flow					
	LinkC15	2.5014	0.0000	7.1294	0.1996	0.1088 1546.1105
1510.2646	Max Flow					
	LinkC13	6.1514	0.0000	12.9976	0.4187	0.8434 1523.3385
1510.2660	Max Flow					
	LinkC11	7.5402	0.0000	11.1966	0.3873	0.9419 1521.5000
1510.2661	Max Flow					
	LinkC16	16.0742	0.0000	32.6321	0.6700	0.2650 1510.2661
1470.3176	Max Flow					
	LinkC14	7.5283	0.0000	6.8840	0.6488	0.9781 1477.3002
1470.3196	Max Flow					
	LinkC17	4.4320	0.0000	6.6385	0.5243	0.7880 1477.0328
1470.3196	Max Flow					
	LinkA	62.8452	0.0000	14.1192	1.1587	1.8581 1495.8406
1482.8521	Max Flow					
	LinkB	37.3742	0.0000	12.2494	0.6867	0.7853 1490.7855
1481.2787	Max Flow					
	LinkB8	1.1046	0.0000	1.5863	0.3008	0.6695 1547.8296
1546.2292	Max Flow					
	LinkC	23.5198	0.0000	6.0639	0.8266	1.5000 1453.5000
1449.4533	Max Flow					
	LinkC1	45.4751	0.0000	3.0697	0.8605	1.2996 1490.3000
1486.5000	Max Flow					
	Link52	5.1066	1.1986	1.8691	0.9215	0.6195 1481.3717
1478.6195	Max Flow					
	Link53	5.7750	1.3796	1.8048	0.9454	0.6746 1449.9341
1446.6746	Max Flow					
	Link54	6.0324	1.4018	1.8775	0.9546	0.7212 1483.0111
1479.7212	Max Flow					
	LinkB3	8.9251	0.0000	19.4253	0.4593	0.2311 1546.2317
1518.2915	Max Flow					
	Link56	27.8901	0.0000	0.7957	0.9477	0.3188 1470.3196
1453.5000	Max Flow					
	Link57	45.2450	0.0000	21.3981	1.2769	0.4785 1474.4786
1449.3261	Max Flow					
	Link58	45.2442	0.0000	7.3416	0.8722	1.4540 1482.0000
1474.4786	Max Flow					
	Link59	57.1365	0.0000	5.0561	0.9817	1.5000 1486.5000
1482.0000	Max Flow					
	Link60	58.1047	0.0000	2.2644	0.8827	1.2782 1449.9341
1447.5000	Max Flow					
	Link61	28.5313	0.0000	1.8084	0.5757	0.8405 1481.4168
1479.5000	Max Flow					
	Link62	46.6285	0.0000	2.3545	0.7717	1.0574 1483.0111
1480.5000	Max Flow					

Table E13a. CULVERT ANALYSIS CLASSIFICATION, and the time the culvert was in a particular classification during the simulation. The time is in minutes. The Dynamic Wave Equation is used for all conduit analysis but the culvert flow classification condition is based on the HW and TW depths.

Conduit Name	Outlet Control	Outlet Inlet Control	Entrance Control	Steep Slope TW Slug Flow Entrance Control	Mild Slope TW > D Outlet Control	Mild Slope TW <= D Outlet Control
	Critical D	Mild Slope Control	Insignf	Outlet/		

Control	Control Configuration									
	LinkA11	0.0000	0.0000	1440.0000	0.0000	0.0000	0.0000	0.0000	0.0000	None
	LinkA10	0.0000	0.0000	1440.0000	0.0000	0.0000	0.0000	0.0000	0.0000	None
	LinkA9	0.0000	0.0000	1440.0000	0.0000	0.0000	0.0000	0.0000	0.0000	None
	LinkA5	469.0000	539.0000	432.0000	0.0000	0.0000	0.0000	0.0000	0.0000	None
	LinkA1	461.0000	547.0000	432.0000	0.0000	0.0000	0.0000	0.0000	0.0000	None
	LinkA2	1005.0000	3.0000	432.0000	0.0000	0.0000	0.0000	0.0000	0.0000	None
	LinkA3	994.0000	13.0000	433.0000	0.0000	0.0000	0.0000	0.0000	0.0000	None
	LinkA4	114.0000	894.0000	432.0000	0.0000	0.0000	0.0000	0.0000	0.0000	None
	LinkA8	167.0000	841.0000	432.0000	0.0000	0.0000	0.0000	0.0000	0.0000	None
	LinkA6	1004.0000	4.0000	432.0000	0.0000	0.0000	0.0000	0.0000	0.0000	None
	LinkC8	0.0000	0.0000	1440.0000	0.0000	0.0000	0.0000	0.0000	0.0000	None
	LinkC9	0.0000	0.0000	1440.0000	0.0000	0.0000	0.0000	0.0000	0.0000	None
	LinkC2	766.0000	242.0000	432.0000	0.0000	0.0000	0.0000	0.0000	0.0000	None
	LinkC3	995.0000	12.0000	433.0000	0.0000	0.0000	0.0000	0.0000	0.0000	None
	LinkC4	991.0000	17.0000	432.0000	0.0000	0.0000	0.0000	0.0000	0.0000	None
	LinkC5	106.0000	902.0000	432.0000	0.0000	0.0000	0.0000	0.0000	0.0000	None
	LinkC6	48.0000	957.0000	435.0000	0.0000	0.0000	0.0000	0.0000	0.0000	None
	LinkB2	0.0000	0.0000	1440.0000	0.0000	0.0000	0.0000	0.0000	0.0000	None
	LinkB1	0.0000	1008.0000	432.0000	0.0000	0.0000	0.0000	0.0000	0.0000	None
	LinkB4	1000.0000	7.0000	433.0000	0.0000	0.0000	0.0000	0.0000	0.0000	None
	LinkB7	1003.0000	4.0000	433.0000	0.0000	0.0000	0.0000	0.0000	0.0000	None
	Link29	947.0000	61.0000	432.0000	0.0000	0.0000	0.0000	0.0000	0.0000	None
	LinkC12	976.0000	27.0000	437.0000	0.0000	0.0000	0.0000	0.0000	0.0000	None
	LinkC10	985.0000	20.0000	435.0000	0.0000	0.0000	0.0000	0.0000	0.0000	None
	LinkC15	0.0000	0.0000	1440.0000	0.0000	0.0000	0.0000	0.0000	0.0000	None
	LinkC13	108.0000	897.0000	435.0000	0.0000	0.0000	0.0000	0.0000	0.0000	None
	LinkC11	551.0000	456.0000	433.0000	0.0000	0.0000	0.0000	0.0000	0.0000	None
	LinkC16	0.0000	0.0000	1440.0000	0.0000	0.0000	0.0000	0.0000	0.0000	None
	LinkC14	997.0000	10.0000	433.0000	0.0000	0.0000	0.0000	0.0000	0.0000	None
	LinkC17	989.0000	16.0000	435.0000	0.0000	0.0000	0.0000	0.0000	0.0000	None

0.0000	0.0000	None						
	LinkA	130.0000	874.0000	435.0000	0.0000	1.0000	0.0000	
0.0000	0.0000	None						
	LinkB	43.0000	960.0000	432.0000	0.0000	5.0000	0.0000	
0.0000	0.0000	None						
	LinkB8	917.0000	88.0000	435.0000	0.0000	0.0000	0.0000	
0.0000	0.0000	None						
	LinkC	45.0000	949.0000	437.0000	0.0000	9.0000	0.0000	
0.0000	0.0000	None						
	LinkC1	1.0000	1008.0000	431.0000	0.0000	0.0000	0.0000	
0.0000	0.0000	None						
	Link52	0.0000	0.0000	1440.0000	0.0000	0.0000	0.0000	
0.0000	0.0000	None						
	Link53	0.0000	0.0000	1440.0000	0.0000	0.0000	0.0000	
0.0000	0.0000	None						
	Link54	0.0000	0.0000	1440.0000	0.0000	0.0000	0.0000	
0.0000	0.0000	None						
	LinkB3	0.0000	0.0000	1440.0000	0.0000	0.0000	0.0000	
0.0000	0.0000	None						
	Link56	0.0000	0.0000	1440.0000	0.0000	0.0000	0.0000	
0.0000	0.0000	None						
	Link57	0.0000	0.0000	1440.0000	0.0000	0.0000	0.0000	
0.0000	0.0000	None						
	Link58	881.0000	125.0000	434.0000	0.0000	0.0000	0.0000	
0.0000	0.0000	None						
	Link59	5.0000	1001.0000	431.0000	0.0000	3.0000	0.0000	
0.0000	0.0000	None						
	Link60	40.0000	689.0000	711.0000	0.0000	0.0000	0.0000	
0.0000	0.0000	None						
	Link61	54.0000	673.0000	713.0000	0.0000	0.0000	0.0000	
0.0000	0.0000	None						
	Link62	86.0000	262.0000	1092.0000	0.0000	0.0000	0.0000	
0.0000	0.0000	None						

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| Kinematic Wave Approximations |
| Time in Minutes for Each Condition |
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Conduit Name	Duration of Normal Flow	Slope Criteria	Super-Critical	Roll Waves
LinkA11	996.0000	996.0000	963.0000	0.0000
LinkA10	993.0000	993.0000	894.7500	0.0000
LinkA9	5.6371	16.6996	1008.0000	0.0000
LinkA5	0.0000	0.0000	4.0000	0.0000
LinkA1	0.0000	0.0000	4.0000	0.0000
LinkA2	0.0000	0.0000	15.0000	0.0000
LinkA3	0.0000	0.0000	4.5000	0.0000
LinkA4	5.0000	5.0000	8.0000	0.0000
LinkA8	3.0000	3.0000	8.0000	0.0000
LinkA6	0.0000	0.0000	0.0000	0.0000
LinkC8	980.5000	980.5000	945.1667	0.0000
LinkC9	1000.0000	1006.0000	905.0000	0.0000
LinkC2	12.6132	16.6132	4.0000	0.0000
LinkC3	0.0000	0.0000	0.5000	0.0000
LinkC4	0.0000	0.0000	0.0000	0.0000
LinkC5	0.0000	0.0000	77.0000	0.0000
LinkC6	0.0000	0.0000	26.0000	0.0000
LinkB2	984.0000	1006.5000	963.8333	0.0000
LinkB1	861.3092	862.0271	24.0000	0.0000
LinkB4	0.0000	0.0000	29.5000	0.0000
LinkB7	0.0000	0.0000	23.0000	0.0000

Link29	0.0000	0.0000	0.0000	0.0000
LinkC12	0.0000	0.0000	57.0000	0.0000
LinkC10	0.0000	0.0000	0.0000	0.0000
LinkC15	997.0000	997.0000	413.9934	0.0000
LinkC13	0.0000	0.0000	7.7667	0.0000
LinkC11	0.0000	0.0000	4.6667	0.0000
LinkC16	994.0000	998.6000	998.6000	0.0000
LinkC14	0.0000	0.0000	12.5000	0.0000
LinkC17	0.0000	0.0000	11.0000	0.0000
LinkA	825.8000	825.8000	32.8333	0.0000
LinkB	928.3333	928.3333	20.5000	0.0000
LinkB8	0.0000	0.0000	0.0000	0.0000
LinkC	876.7500	876.7500	1.2000	0.0000
LinkC1	995.0000	995.0000	2.0000	0.0000
Link52	0.0000	0.0000	726.8125	0.0000
Link53	0.0000	0.0000	728.6000	0.0000
Link54	0.0000	0.0000	734.4167	0.0000
LinkB3	983.5000	983.5000	998.5000	0.0000
Link56	986.0000	986.0000	927.5000	0.0000
Link57	927.6667	927.6667	143.5000	0.0000
Link58	3.0000	3.0000	13.5000	0.0000
Link59	946.5000	946.5000	15.0000	0.0000
Link60	0.0000	0.0000	0.0667	0.0000
Link61	0.0000	0.0000	0.0000	0.0000
Link62	0.0000	0.0000	0.0625	0.0000

Table E15 - SPREADSHEET INFO LIST

Conduit Flow and Junction Depth Information for use in spreadsheets. The maximum values in this table are the true maximum values because they sample every time step. The values in the review results may only be the maximum of a subset of all the time steps in the run.

Note: These flows are only the flows in a single barrel.

Conduit Name	Maximum Flow (cfs)	Total Flow (ft^3)	Maximum Velocity (ft/s)	Maximum Volume (ft^3)	##	Junction Name	Invert Elevation (ft)	Maximum Elevation (ft)	##
LinkA11	6.8929	18362.2421	6.1768	1.5161	##	NodeA4	1580.0000	1580.1873	
LinkA10	11.9314	31263.0186	6.3802	4.8378	##	NodeA3	1554.0000	1554.2644	
LinkA9	35.6578	111134.4824	14.1445	5.1594	##	NodeA2	1524.0000	1524.4778	
LinkA5	13.2803	63377.6674	7.8183	390.3186	##	NodeA1	1494.0000	1495.8410	
LinkA1	15.2952	73059.7443	9.9808	339.1540	##	NodeA8	1512.0000	1513.5000	

	LinkA2	11.0136	47730.4528		8.3043	166.4332	##
NodeA12	1528.0000	1529.5000					
	LinkA3	5.0597	12912.3830		6.0902	45.0472	##
NodeA11	1540.0000	1541.5000					
	LinkA4	3.0946	8550.9315		0.7005	266.2849	##
NodeA10	1562.0000	1563.1321					
	LinkA8	3.8390	9817.5246		1.0558	154.6170	##
NodeA9	1581.0000	1582.0333					
	LinkA6	12.7486	32188.4229		1.9351	82.3096	##
NodeA5	1581.0000	1582.5000					
	LinkC8	8.6178	34529.8868		6.3316	2.6732	##
NodeA7	1544.0000	1545.4100					
	LinkC9	25.3642	79645.8965		5.5029	20.6957	##
NodeC3	1580.0000	1580.2133					
	LinkC2	14.6559	37715.1475		17.6445	652.2119	##
NodeC2	1532.0000	1532.3662					
	LinkC3	9.4201	26840.4246		6.0391	101.1909	##
NodeC1	1489.0000	1490.3002					
	LinkC4	4.7986	17939.0447		0.6926	512.2355	##
NodeC6	1506.0000	1507.2534					
	LinkC5	3.8193	16607.1437		0.6912	777.6565	##
NodeC5	1548.0000	1549.4299					
	LinkC6	7.8482	18296.6907		2.4932	23.0515	##
NodeC4	1581.0000	1582.5000					
	LinkB2	16.3643	41939.5725		5.8758	8.8319	##
NodeC7	1581.0000	1582.5000					
	LinkB1	14.7757	33486.5000		2.6477	89.9583	##
NodeC8	1550.0000	1551.1339					
	LinkB4	7.8586	20444.3550		8.0044	37.0936	##
NodeB2	1518.0000	1518.2933					
	LinkB7	7.5341	18309.0336		5.6430	68.9544	##
NodeB1	1490.0000	1490.7856					

	Link29	6.9712	18223.5696	1.3974	222.8745	##	
NodeB12	1512.0000	1512.7650					
	LinkC12	0.6569	1614.0616	13.5833	6.8241	##	
NodeB9	1560.0000	1561.2966					
	LinkC10	1.9016	6121.3260	3.0826	67.2065	##	
NodeB6	1524.0000	1525.3158					
	LinkC15	2.5029	7730.1371	2.7838	1.6159	##	
NodeB7	1502.0000	1503.1443					
	LinkC13	6.1577	15571.3359	1.7972	35.7818	##	
NodeC13	1546.0000	1546.1106					
	LinkC11	7.5406	30121.6802	1.4512	105.2720	##	
NodeC16	1548.0000	1548.5685					
	LinkC16	16.0811	53410.4287	10.9426	1.4271	##	
NodeC10	1548.0000	1549.0385					
	LinkC14	7.5314	18307.1570	5.8065	73.4514	##	
NodeC14	1510.0000	1510.2662					
	LinkC17	4.4339	10770.1207	10.2129	45.4818	##	
NodeC17	1522.0000	1523.3400					
	LinkA	62.8742	248215.4268	1.9202	6409.0833	##	
NodeC11	1520.0000	1521.5000					
	LinkB	37.3810	93710.7116	0.9573	1688.1870	##	
NodeC15	1470.0000	1470.3199					
	LinkB8	1.1048	3209.3887	2.6019	138.2671	##	
NodeC18	1476.0000	1477.3005					
	LinkC	23.5198	81347.6116	2.2248	11140.2096	##	
NodeC12	1476.0000	1477.0331					
	LinkC1	45.4879	131294.6301	3.6502	1107.1364	##	
PondA	1480.0000	1483.0121					
	Link52	5.1231	17681.9577	7.8406	8.3227	##	
Pond B	1478.0000	1481.4169					
	Link53	5.7753	41982.5130	8.4060	9.4534	##	

NodeB4	1546.0000	1546.2318				
	Link54	6.0334	113739.4428	8.5321	11.4074	##
NodeB5	1547.0000	1547.8296				
	LinkB3	8.9303	23643.7028	6.8226	2.3868	##
PondC	1446.0000	1449.9345				
	Link56	27.9334	82474.4288	5.4205	13.7664	##
Outlet B	1478.0000	1478.6210				
	Link57	45.2493	159293.1731	3.3862	161.6590	##
OutletC	1446.0000	1446.6746				
	Link58	45.2475	159310.3868	2.4348	413.3929	##
OutletA	1479.0000	1479.7213				
	Link59	57.1365	165324.1081	2.2018	2262.4583	##
Node51	1452.0000	1453.5000				
	Link60	58.1279	169731.5055	3.5620	204.4838	##
Node52	1474.0000	1474.4786				
	Link61	28.5356	60633.6767	2.7002	140.7947	##
Node53	1480.0000	1482.0000				
	Link62	46.6837	111898.4527	3.4067	144.8538	##
Node54	1485.0000	1486.5000				
	FREE # 1	5.1244	17681.4190	0.0000	0.0000	##
EOF C	1447.0000	1447.8830				
	FREE # 2	5.7753	41983.2226	0.0000	0.0000	##
EOF B	1479.0000	1479.5758				
	FREE # 3	6.0334	113738.9210	0.0000	0.0000	##
EOF A	1480.0000	1480.7723				
	FREE # 4	58.1282	169737.9756	0.0000	0.0000	##
	FREE # 5	28.5359	60628.5199	0.0000	0.0000	##
	FREE # 6	46.6834	111872.9441	0.0000	0.0000	##

Table E15a - SPREADSHEET REACH LIST
Peak flow and Total Flow listed by Reach or those conduits or diversions having the same upstream and downstream nodes.

Upstream Node	Downstream Node	Maximum Flow (cfs)	Total Flow (ft^3)
NodeA4	NodeA3	6.8929	18362.2421
NodeA3	NodeA2	11.9314	31263.0186
NodeA2	NodeA1	35.6578	111134.482
NodeA8	NodeA1	13.2803	63377.6674
NodeA12	NodeA1	15.2952	73059.7443
NodeA11	NodeA2	11.0136	47730.4528
NodeA10	NodeA3	5.0597	12912.3830
NodeA9	NodeA4	3.0946	8550.9315
NodeA5	NodeA4	3.8390	9817.5246
NodeA7	NodeA2	12.7486	32188.4229
NodeC3	NodeC2	8.6178	34529.8868
NodeC2	NodeC1	25.3642	79645.8965
NodeC6	NodeC1	14.6559	37715.1475

NodeC5	NodeC2	9.4201	26840.4246
NodeC4	NodeC3	4.7986	17939.0447
NodeC7	NodeC3	3.8193	16607.1437
NodeC8	NodeC2	7.8482	18296.6907
NodeB2	NodeB1	16.3643	41939.5725
NodeB12	NodeB1	14.7757	33486.5000
NodeB9	NodeB4	7.8586	20444.3550
NodeB6	NodeB2	7.5341	18309.0336
NodeB7	NodeB1	6.9712	18223.5696
NodeC16	NodeC13	0.6569	1614.0616
NodeC10	NodeC13	1.9016	6121.3260
NodeC13	NodeC14	2.5029	7730.1371
NodeC17	NodeC14	6.1577	15571.3359
NodeC11	NodeC14	7.5406	30121.6802
NodeC14	NodeC15	16.0811	53410.4287
NodeC18	NodeC15	7.5314	18307.1570

NodeC12	NodeC15	4.4339	10770.1207
NodeA1	PondA	62.8742	248215.427
NodeB1	Pond B	37.3810	93710.7116
NodeB5	NodeB4	1.1048	3209.3887
Node51	PondC	23.5198	81347.6116
NodeC1	Node54	45.4879	131294.630
Pond B	Outlet B	5.1231	17681.9577
PondC	OutletC	5.7753	41982.5130
PondA	OutletA	6.0334	113739.443
NodeB4	NodeB2	8.9303	23643.7028
NodeC15	Node51	27.9334	82474.4288
Node52	PondC	45.2493	159293.173
Node53	Node52	45.2475	159310.387
Node54	Node53	57.1365	165324.108
PondC	EOF C	58.1279	169731.505
Pond B	EOF B	28.5356	60633.6767

PondA EOF A 46.6837 111898.453

```
 ###########################################################
 # Table E16. New Conduit Information Section              #
 #            Conduit Invert (IE) Elevation and Conduit    #
 #            Maximum Water Surface (WS) Elevations        #
 ###########################################################
```

Conduit Name	Upstream Node	Downstream Node	IE Up	IE Dn	WS Up	WS Dn	Conduit Type
LinkA11	NodeA4	NodeA3	1580.0000	1554.0000	1580.1873	1554.2644	Trapezoid
LinkA10	NodeA3	NodeA2	1554.0000	1524.0000	1554.2644	1524.4778	Trapezoid
LinkA9	NodeA2	NodeA1	1524.0000	1496.0000	1524.4778	1496.4776	Trapezoid
LinkA5	NodeA8	NodeA1	1512.0000	1496.0000	1513.5000	1496.8144	Trapezoid
LinkA1	NodeA12	NodeA1	1528.0000	1496.0000	1529.5000	1496.8620	Trapezoid
LinkA2	NodeA11	NodeA2	1540.0000	1524.0000	1541.5000	1524.4778	Trapezoid
LinkA3	NodeA10	NodeA3	1562.0000	1554.0000	1563.1321	1554.2644	Trapezoid
LinkA4	NodeA9	NodeA4	1581.0000	1580.0000	1582.0333	1580.1873	Trapezoid
LinkA8	NodeA5	NodeA4	1581.0000	1580.0000	1582.5000	1580.1873	Trapezoid
LinkA6	NodeA7	NodeA2	1544.0000	1524.0000	1545.4100	1524.4778	Trapezoid
LinkC8	NodeC3	NodeC2	1580.0000	1532.0000	1580.2133	1532.3662	Trapezoid
LinkC9	NodeC2	NodeC1	1532.0000	1489.0000	1532.3662		

LinkC2 NodeC6 NodeC1 1506.0000 1489.0000 1507.2534 1490.3002 Trapezoid

LinkC3 NodeC5 NodeC2 1548.0000 1532.0000 1549.4299 1532.3662 Trapezoid

LinkC4 NodeC4 NodeC3 1581.0000 1580.0000 1582.5000 1580.2133 Trapezoid

LinkC5 NodeC7 NodeC3 1581.0000 1580.0000 1582.5000 1580.2133 Trapezoid

LinkC6 NodeC8 NodeC2 1550.0000 1532.0000 1551.1339 1532.3662 Trapezoid

LinkB2 NodeB2 NodeB1 1518.0000 1490.0000 1518.2933 1490.7856 Trapezoid

LinkB1 NodeB12 NodeB1 1512.0000 1490.0000 1512.7650 1490.7856 Trapezoid

LinkB4 NodeB9 NodeB4 1560.0000 1546.0000 1561.2966 1546.2318 Trapezoid

LinkB7 NodeB6 NodeB2 1524.0000 1518.0000 1525.3158 1518.2933 Trapezoid

Link29 NodeB7 NodeB1 1502.0000 1490.0000 1503.1443 1490.7856 Trapezoid

LinkC12 NodeC16 NodeC13 1548.0000 1546.0000 1548.5685 1546.1106 Trapezoid

LinkC10 NodeC10 NodeC13 1548.0000 1546.0000 1549.0385 1546.1106 Trapezoid

LinkC15 NodeC13 NodeC14 1546.0000 1510.0000 1546.1106 1510.2662 Trapezoid

LinkC13 NodeC17 NodeC14 1522.0000 1510.0000 1523.3400 1510.2662 Trapezoid

LinkC11 NodeC11 NodeC14 1520.0000 1510.0000 1521.5000 1510.2662 Trapezoid

LinkC16	NodeC14	NodeC15	1510.0000	1470.0000	1510.2662	1470.3199 Trapezoid
LinkC14	NodeC18	NodeC15	1476.0000	1470.0000	1477.3005	1470.3199 Trapezoid
LinkC17	NodeC12	NodeC15	1476.0000	1470.0000	1477.0331	1470.3199 Trapezoid
LinkA	NodeA1	PondA	1494.0000	1480.0000	1495.8410	1483.0121 Trapezoid
LinkB	NodeB1	Pond B	1490.0000	1478.0000	1490.7856	1481.4169 Trapezoid
LinkB8	NodeB5	NodeB4	1547.0000	1546.0000	1547.8296	1546.2318 Trapezoid
LinkC	Node51	PondC	1452.0000	1446.0000	1453.5000	1449.9345 Trapezoid
LinkC1	NodeC1	Node54	1489.0000	1485.0000	1490.3002	1486.5000 Trapezoid
Link52	Pond B	Outlet B	1480.4000	1478.0000	1481.4169	1478.6210 Circular
Link53	PondC	OutletC	1448.4000	1446.0000	1449.9345	1446.6746 Circular
Link54	PondA	OutletA	1481.2000	1479.0000	1483.0121	1479.7213 Circular
LinkB3	NodeB4	NodeB2	1546.0000	1518.0000	1546.2318	1518.2933 Trapezoid
Link56	NodeC15	Node51	1470.0000	1452.0000	1470.3199	1453.5000 Trapezoid
Link57	Node52	PondC	1474.0000	1446.0000	1474.4786	1449.9345 Trapezoid
Link58	Node53	Node52	1480.0000	1474.0000	1482.0000	1474.4786 Trapezoid
Link59	Node54	Node53	1485.0000	1480.0000	1486.5000	1482.0000 Trapezoid

```
          Link60            PondC            EOF C 1448.4000 1447.0000 1449.9345
1447.5000 Trapezoid


          Link61           Pond B            EOF B 1480.4000 1479.0000 1481.4169
1479.5000 Trapezoid


          Link62            PondA            EOF A 1481.7000 1480.0000 1483.0121
1480.5000 Trapezoid
```

Table E18 - Junction Continuity Error. Division by Volume added 11/96
Continuity Error = Net Flow + Beginning Volume - Ending Volume / Total Flow + (Beginning Volume + Ending Volume)/2
Net Flow = Node Inflow - Node Outflow
Total Flow = absolute (Inflow + Outflow)
Intermediate column is a judgement on the node continuity error.
Excellent < 1 percent Great 1 to 2 percent Good 2 to 5 percent
Fair 5 to 10 percent Poor 10 to 25 percent Bad 25 to 50 percent
Terrible > 50 percent

Junction Name	<------Continuity Error -------> Volume	% of Node	% of Inflow	Remaining Volume	Beginning Volume	Net Flow	Total Flow Thru Node	Failed to Converge
NodeA4	-75.8334	-0.2062	0.0123	78.6809	0.0000	2.8474	36730.6983	0
NodeA3	-34.4500	-0.0551	0.0056	39.4003	0.0000	4.9502	62537.6437	0
NodeA2	-207.2013	-0.0932	0.0336	223.3219	0.0000	16.1206	222316.3767	0
NodeA1	-4699.6054	-0.9441	0.7622	4009.6266	0.0000	-689.9788	495787.3209	0
NodeA8	33.9848	0.0253	0.0055	234.8143	0.0000	7567.1017	134320.8351	0
NodeA12	99.8338	0.0662	0.0162	368.4879	0.0000	4569.4277	150687.5266	0
NodeA11	5.4192	0.0053	0.0009	150.3812	0.0000	7257.8228	102716.7986	0

NodeA10	-0.5606	-0.0022	0.0001	24.9953	0.0000	
24.4346	25850.3467	0				
NodeA9	28.0247	0.1629	0.0045	45.6736	0.0000	
73.6983	17176.2406	0				
NodeA5	14.9803	0.0758	0.0024	30.5574	0.0000	
101.0518	19736.6301	0				
NodeA7	-11.0204	-0.0171	0.0018	58.0357	0.0000	
47.0154	64425.5158	0				
NodeC3	-267.8896	-0.3870	0.0434	277.4451	0.0000	
9.5555	69076.0752	0				
NodeC2	-150.7401	-0.0946	0.0244	150.4816	0.0000	
-0.2585	159312.8987	0				
NodeC1	-161.4744	-0.0614	0.0262	227.9173	0.0000	
66.4429	262671.8015	0				
NodeC6	-102.3214	-0.1355	0.0166	125.9050	0.0000	
23.5836	75450.8750	0				
NodeC5	29.8837	0.0555	0.0048	82.1251	0.0000	
112.0088	53794.5157	0				
NodeC4	-24.0848	-0.0644	0.0039	72.5261	0.0000	
1468.0312	37345.9902	0				
NodeC7	100.6951	0.2874	0.0163	197.3524	0.0000	
1722.5996	34935.9256	0				
NodeC8	-2.2836	-0.0062	0.0004	34.1191	0.0000	
31.8355	36625.4726	0				
NodeB2	-37.2422	-0.0444	0.0060	40.0466	0.0000	
2.8044	83892.3089	0				
NodeB1	-1596.9823	-0.8489	0.2590	1511.9519	0.0000	
-85.0304	187360.3537	0				
NodeB12	-121.5081	-0.1815	0.0197	64.0154	0.0000	
-57.4927	66909.5729	0				
NodeB9	-1.4435	-0.0035	0.0002	40.6399	0.0000	
39.1964	40929.4642	0				

NodeB6 -7.4771 -0.0204 0.0012 25.6855 0.0000
18.2085 36637.8156 0

NodeB7 50.0116 0.1367 0.0081 54.0177 0.0000
104.0293 36552.3516 0

NodeC13 -33.6692 -0.2174 0.0055 37.7042 0.0000
4.0350 15465.5246 0

NodeC16 -0.4387 -0.0136 0.0001 3.4906 0.0000
3.0519 3231.3070 0

NodeC10 -6.0826 -0.0495 0.0010 29.8320 0.0000
23.7494 12266.8587 0

NodeC14 -228.8176 -0.2139 0.0371 233.2830 0.0000
4.4654 106833.5817 0

NodeC17 11.0770 0.0355 0.0018 50.3374 0.0000
61.4144 31204.7087 0

NodeC11 85.9559 0.1344 0.0139 170.0495 0.0000
3626.0300 63868.2022 0

NodeC15 -50.6813 -0.0307 0.0082 48.7507 0.0000
-1.9306 164962.1351 0

NodeC18 -5.0099 -0.0137 0.0008 25.0085 0.0000
19.9985 36635.9389 0

NodeC12 -4.9938 -0.0232 0.0008 15.6788 0.0000
10.6851 21551.7571 0

PondA -2924.5449 -0.6010 0.4743 25484.0751 0.0000
22559.5302 473853.3223 0

Pond B -956.5771 -0.5309 0.1551 16338.6724 0.0000
15382.0953 172026.3461 0

NodeB4 -51.6164 -0.1091 0.0084 56.7973 0.0000
5.1809 47297.4465 0

NodeB5 10.7296 0.1663 0.0017 13.9898 0.0000
24.7193 6443.8796 0

PondC -1221.2432 -0.2613 0.1981 30136.9609 0.0000

28915.7177 452354.8032 0

Outlet B -2.6092 -0.0074 0.0004 1.8266 0.0000
-0.7826 35363.3767 0

OutletC -4.4778 -0.0053 0.0007 3.4624 0.0000
-1.0154 83965.7356 0

OutletA -12.1514 -0.0053 0.0020 8.7842 0.0000
-3.3672 227478.3638 0

Node51 -3392.1280 -2.0523 0.5501 2931.2284 0.0000
1117.9775 163822.0405 0

Node52 -440.7141 -0.1382 0.0715 434.7621 0.0000
-5.9520 318603.5599 0

Node53 -101.1953 -0.0312 0.0164 341.8407 0.0000
5983.2855 324634.4949 0

Node54 -198.2631 -0.0599 0.0322 247.4011 0.0000
450.2121 331119.9747 0

EOF C -23.7241 -0.0070 0.0038 22.0156 0.0000
-1.7085 339469.4810 0

EOF B -12.8733 -0.0106 0.0021 11.8468 0.0000
-1.0264 121262.1966 0

EOF A -0.2131 -0.0001 0.0000 0.0002 0.0000
-0.2129 223771.3968 0

The total continuity error was -16704. cubic feet
The remaining total volume was 84816. cubic feet
Your mean node continuity error was Excellent
Your worst node continuity error was Excellent

Table E19 - Junction Inflow & Outflow Listing
Units are either ft^3 or m^3 depending on the units in your model.

Junction Name	Constant Inflow to Node	User Inflow to Node	Interface Inflow to Node	DWF Inlow to Node	Inflow through Outfall	RNF Layer Outflow to Node	Evaporation from Node	Inflow from 2D Layer
NodeA8	0.0000	0.0000	70927.4778	0.0000	0.0000			

0.0000	7298.3025	0.0000	0.0000					
NodeA12	0.0000	0.0000	77610.6140	0.0000	0.0000	0.0000	4101.1059	0.0000	0.0000
NodeA11	0.0000	0.0000	54974.1849	0.0000	0.0000	0.0000	7102.0224	0.0000	0.0000
NodeA10	0.0000	0.0000	12935.1023	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
NodeA9	0.0000	0.0000	8623.4016	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
NodeA5	0.0000	0.0000	9916.9118	0.0000	0.0000	0.0000	55.5141	0.0000	0.0000
NodeA7	0.0000	0.0000	32229.9633	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
NodeC1	0.0000	0.0000	14013.0275	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
NodeC6	0.0000	0.0000	37727.3818	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
NodeC5	0.0000	0.0000	26948.1299	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
NodeC4	0.0000	0.0000	19402.6535	0.0000	0.0000	0.0000	1419.5899	0.0000	0.0000
NodeC7	0.0000	0.0000	18324.7283	0.0000	0.0000	0.0000	1424.5521	0.0000	0.0000
NodeC8	0.0000	0.0000	18324.7283	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
NodeB12	0.0000	0.0000	33415.6810	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
NodeB9	0.0000	0.0000	20480.5787	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
NodeB6	0.0000	0.0000	18324.7283	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

NodeB7	0.0000	0.0000	18324.7283	0.0000	0.0000	0.0000	0.0000
NodeC16	0.0000	0.0000	1616.8878	0.0000	0.0000	0.0000	0.0000
NodeC10	0.0000	0.0000	6144.1736	0.0000	0.0000	0.0000	0.0000
NodeC17	0.0000	0.0000	15629.9153	0.0000	0.0000	0.0000	0.0000
NodeC11	0.0000	0.0000	33739.0586	0.0000	0.0000	3370.0247	0.0000
NodeC18	0.0000	0.0000	18324.7283	0.0000	0.0000	0.0000	0.0000
NodeC12	0.0000	0.0000	10779.2519	0.0000	0.0000	0.0000	0.0000
NodeB5	0.0000	0.0000	3233.7756	0.0000	0.0000	0.0000	0.0000
Outlet B	0.0000	0.0000	0.0000	0.0000	0.0000	17681.4190	0.0000
OutletC	0.0000	0.0000	0.0000	0.0000	0.0000	41983.2226	0.0000
OutletA	0.0000	0.0000	0.0000	0.0000	0.0000	113738.9210	0.0000
Node51	0.0000	0.0000	0.0000	0.0000	0.0000	1578.8771	0.0000
Node53	0.0000	0.0000	0.0000	0.0000	0.0000	5742.6401	0.0000
Node54	0.0000	0.0000	34493.6062	0.0000	0.0000	401.0742	0.0000
EOF C	0.0000	0.0000	0.0000	0.0000	0.0000	169735.5001	0.0000
EOF B	0.0000	0.0000	0.0000	0.0000	0.0000	60628.2358	0.0000

EOF A 0.0000 0.0000 0.0000 0.0000 0.0000
0.0000 111879.9706 0.0000 0.0000

===
| Table E20 - Junction Flooding and Volume Listing. |
| The maximum volume is the total volume |
| in the node including the volume in the |
| flooded storage area. This is the max |
| volume at any time. The volume in the |
| flooded storage area is the total volume|
| above the ground elevation, where the |
| flooded pond storage area starts. |
| The fourth column is instantaneous, the fifth is the|
| sum of the flooded volume over the entire simulation|
| Units are either ft^3 or m^3 depending on the units.|
===

Junction Name	Surcharged Time (min)	Flooded Time(min)	Out of 1D-System (Flooded Volume)	Maximum Volume	Passed to 2D OR Volume in allowed Pond	Stored Flood cell of 1D-System
NodeA4	0.0000	0.0000	0.0000	2.3541	0.0000	
NodeA3	0.0000	0.0000	0.0000	3.3229	0.0000	
NodeA2	0.0000	0.0000	0.0000	6.0035	0.0000	
NodeA1	0.0000	0.0000	0.0000	23.1342	0.0000	
NodeA8	0.0000	9.8421	7298.3025	18.8490	0.0000	
NodeA12	0.0000	6.5263	4101.1059	18.8490	0.0000	
NodeA11	0.0000	12.4149	7102.0224	18.8490	0.0000	
NodeA10	0.0000	0.0000	0.0000	14.2258	0.0000	
NodeA9	0.0000	0.0000	0.0000	12.9846		

0.0000					
NodeA5	0.0000	3.0026	55.5141	18.8490	0.0000
NodeA7	0.0000	0.0000	0.0000	17.7185	0.0000
NodeC3	0.0000	0.0000	0.0000	2.6801	0.0000
NodeC2	0.0000	0.0000	0.0000	4.6012	0.0000
NodeC1	0.0000	0.0000	0.0000	16.3379	0.0000
NodeC6	0.0000	0.0000	0.0000	15.7506	0.0000
NodeC5	0.0000	0.0000	0.0000	17.9679	0.0000
NodeC4	0.0000	9.1053	1419.5899	18.8490	0.0000
NodeC7	0.0000	8.4737	1424.5521	18.8490	0.0000
NodeC8	0.0000	0.0000	0.0000	14.2486	0.0000
NodeB2	0.0000	0.0000	0.0000	3.6850	0.0000
NodeB1	0.0000	0.0000	0.0000	9.8717	0.0000
NodeB12	0.0000	0.0000	0.0000	9.6132	0.0000
NodeB9	0.0000	0.0000	0.0000	16.2933	0.0000
NodeB6	0.0000	0.0000	0.0000	16.5347	0.0000

NodeB7	0.0000	0.0000	0.0000	14.3787	0.0000
NodeC13	0.0000	0.0000	0.0000	1.3895	0.0000
NodeC16	0.0000	0.0000	0.0000	7.1431	0.0000
NodeC10	0.0000	0.0000	0.0000	13.0494	0.0000
NodeC14	0.0000	0.0000	0.0000	3.3445	0.0000
NodeC17	0.0000	0.0000	0.0000	16.8390	0.0000
NodeC11	0.0000	10.6111	3370.0247	18.8490	0.0000
NodeC15	0.0000	0.0000	0.0000	4.0194	0.0000
NodeC18	0.0000	0.0000	0.0000	16.3421	0.0000
NodeC12	0.0000	0.0000	0.0000	12.9820	0.0000
PondA	57.6875	0.0000	0.0000	46188.4677	0.0000
Pond B	3.3158	0.0000	0.0000	21857.7102	0.0000
NodeB4	0.0000	0.0000	0.0000	2.9129	0.0000
NodeB5	0.0000	0.0000	0.0000	10.4248	0.0000
PondC	23.7895	0.0000	0.0000	44626.7406	0.0000
Outlet B	0.0000	0.0000	0.0000	7.8029	0.0000

OutletC	0.0000	0.0000	0.0000	8.4767	0.0000
OutletA	0.0000	0.0000	0.0000	9.0639	0.0000
Node51	0.0000	7.7895	1578.8771	18.8490	0.0000
Node52	0.0000	0.0000	0.0000	6.0140	0.0000
Node53	0.0000	9.6211	5742.6401	25.1320	0.0000
Node54	0.0000	4.6316	401.0742	18.8490	0.0000
EOF C	28.6988	0.0000	0.0000	11.0954	0.0000
EOF B	9.6605	0.0000	0.0000	7.2355	0.0000
EOF A	30.6500	0.0000	0.0000	9.7043	0.0000

==================================
| Simulation Specific Information |
==================================

Number of Input Conduits..... 46 Number of Simulated Conduits..... 52
Number of Natural Channels..... 0 Number of Junctions..... 49
Number of Storage Junctions..... 3 Number of Weirs..... 0
Number of Orifices..... 0 Number of Pumps..... 0
Number of Free Outfalls..... 6 Number of Tide Gate Outfalls..... 0

==
| Average % Change in Junction or Conduit is defined as: |
| Conduit % Change ==> 100.0 (Q(n+1) - Q(n)) / Qfull |
| Junction % Change ==> 100.0 (Y(n+1) - Y(n)) / Yfull |
==

The Conduit with the largest average change was..LinkA with 0.001 percent
The Junction with the largest average change was.PondC with 0.034 percent
The Conduit with the largest sinuosity was.......Link60 with 10.406

Table E21. Continuity balance at the end of the simulation Junction Inflow, Outflow or Street Flooding Error = Inflow + Initial Volume - Outflow - Final Volume		
Inflow Junction	Inflow Volume,ft^3	Average Inflow, cfs
NodeA8	70943.1677	0.8211
NodeA12	77627.7823	0.8985
NodeA11	54986.3458	0.6364
NodeA10	12937.9637	0.1497
NodeA9	8625.3091	0.0998
NodeA5	9919.1055	0.1148
NodeA7	32237.0929	0.3731
NodeC1	14016.1274	0.1622
NodeC6	37735.7275	0.4368
NodeC5	26954.0911	0.3120
NodeC4	19406.9456	0.2246
NodeC7	18328.7819	0.2121
NodeC8	18328.7819	0.2121
NodeB12	33423.0729	0.3868

NodeB9	20485.1092	0.2371
NodeB6	18328.7819	0.2121
NodeB7	18328.7819	0.2121
NodeC16	1617.2455	0.0187
NodeC10	6145.5328	0.0711
NodeC17	15633.3728	0.1809
NodeC11	33746.5220	0.3906
NodeC18	18328.7819	0.2121
NodeC12	10781.6364	0.1248
NodeB5	3234.4909	0.0374
Node54	34501.2366	0.3993
NodeA8	-7298.3025	-0.0845
NodeA12	-4101.1059	-0.0475
NodeA11	-7102.0224	-0.0822
NodeA5	-55.5141	-0.0006

NodeC4	-1419.5899	-0.0164
NodeC7	-1424.5521	-0.0165
NodeC11	-3370.0247	-0.0390
Outlet B	-17681.4190	-0.2046
OutletC	-41983.2226	-0.4859
OutletA	-113738.9210	-1.3164
Node51	-1578.8771	-0.0183
Node53	-5742.6401	-0.0665
Node54	-401.0742	-0.0046
EOF C	-169735.5001	-1.9645
EOF B	-60628.2358	-0.7017
EOF A	-111879.9706	-1.2949

Outflow Junction	Outflow Volume,ft^3	Average Outflow, cfs
NodeA8	7298.3025	0.0845
NodeA12	4101.1059	0.0475
NodeA11	7102.0224	0.0822

NodeA5	55.5141	0.0006
NodeC4	1419.5899	0.0164
NodeC7	1424.5521	0.0165
NodeC11	3370.0247	0.0390
Outlet B	17681.4190	0.2046
OutletC	41983.2226	0.4859
OutletA	113738.9210	1.3164
Node51	1578.8771	0.0183
Node53	5742.6401	0.0665
Node54	401.0742	0.0046
EOF C	169735.5001	1.9645
EOF B	60628.2358	0.7017
EOF A	111879.9706	1.2949

==

| Initial system volume = 0.0000 Cu Ft |

```
| Total system inflow volume   =    616465.4186 Cu Ft |

| Inflow + Initial volume      =    616465.4186 Cu Ft |

*=====================================================*

| Total system outflow         =    548140.9721 Cu Ft |

| Volume left (Final volume)   =     84816.0020 Cu Ft |

| Evaporation                  =         0.0000 Cu Ft |

| Outflow + Final Volume       =    632956.9741 Cu Ft |

*=====================================================*



*=============================================*
| Total Model Continuity Error                |
| Error in Continuity, Percent =       -2.6752 |
| Error in Continuity, ft^3    =     -16491.555 |
| + Error means a continuity loss, - a gain   |
*=============================================*


#####################################################
# Table E22. Numerical Model judgement section      #
#####################################################
Overall error was (minimum of Table E18 & E21)            -2.6752 percent



Worst nodal error was in node NodeA1          with        -0.9479 percent



Of the total inflow this loss was                          0.7623 percent
```

Your overall continuity error was Good

Excellent Efficiency

Efficiency of the simulation 1.70

Most Number of Non Convergences at one Node 0.

Total Number Non Convergences at all Nodes 0.

Total Number of Nodes with Non Convergences 0.

```
############################################################
# Table E23. New Basin Design Information                  #
#            Maximum Hydraulic Grade Line,                 #
#            Out Conduit Sizes and Maximum Flow            #
############################################################
```

A) Resize d/s Pipes based on given HGL
B) Resize Basin based on given HGL
C) Resize d/s Pipes and Basin based on HGL and max discharge
D) Resize d/s pipes based on given max discharge

Basin Name	Type	Max.HGL (ft)	Conduit	Depth (ft)	Width (ft)	Barrels	Max.Flow (ft^3/s)

```
---------

 ===> Hydraulic model simulation ended normally.
 ===> XP-SWMM Simulation ended normally.




 ===> Your input file was named  : C:\Users\kmlanglie\Desktop\XPSWMM\General
Waste\genwaste-100yrV2.DAT


 ===> Your output file was named : C:\Users\kmlanglie\Desktop\XPSWMM\General
Waste\Output\genwaste-100yrV2_Established.out



 *============================================================*
 |             SWMM Simulation Date and Time Summary          |
 *============================================================*
 | Starting Date... April       3, 2013  Time...   15:48: 6:73  |
 |   Ending Date... April       3, 2013  Time...   15:48:13:50  |
 |  Elapsed Time...    0.11283 minutes or      6.77000 seconds  |
 *============================================================*
```