Marine View Heights
Stormwater Management Review

Drainage Review Report

Draft

Grant County
Public Works Department
124 Enterprise Street SE
Ephrata, WA 98823

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ACKNOWLEDGEMENTS

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Section 1—Project Location and Description

The Marine View Heights development is located in Grant County, Washington off of State Route 262 adjacent to Potholes State Park. A vicinity map is provided in Figure 1.1 showing the development location.

Marine View Heights was originally approved and constructed as a 100-acre private development with three distinct homeowner associations. There is a significant amount of grade (around 100 feet of fall south to north) and impervious surface within the development. The relatively steep grade and high level of impervious surface from homes, asphalt, packed gravel, and out buildings causes stormwater runoff to quickly concentrate during intense rain events, such as thunder storms. The concentrated runoff exceeds the capacity of the drainage system and causes damages to roads, ditches, and private property within the development and on adjacent properties. The private roads were laid out with very little consideration given to natural drainage paths and patterns.

Typical flooding and sediment deposition issues within Marine View Heights.

The County has since assumed operation and maintenance responsibilities for the roads, including the roadside drainage system. The existing drainage system is mainly shallow ditches in a grid pattern, interrupted by small driveway culverts, and is not up to current County public road standards. There is also a history of some ditches being filled and culverts being partially blocked with debris. The existing drainage system, along with system overflow, discharges onto the golf course surrounding O'Sullivan Sportsman Resort and into State Route 262 right-of-way.

The County has retained URS Corporation to: (1) identify the causes of drainage problems in the Marine View Heights development area; (2) develop several cost effective alternatives to solve drainage problems that occur within the development and reduce or eliminate the drainage impacts on adjacent properties (golf course, State Route 262); and (3) support the County to present the solutions and costs to the property owners and begin discussions about how best to fund and implement a preferred alternative.

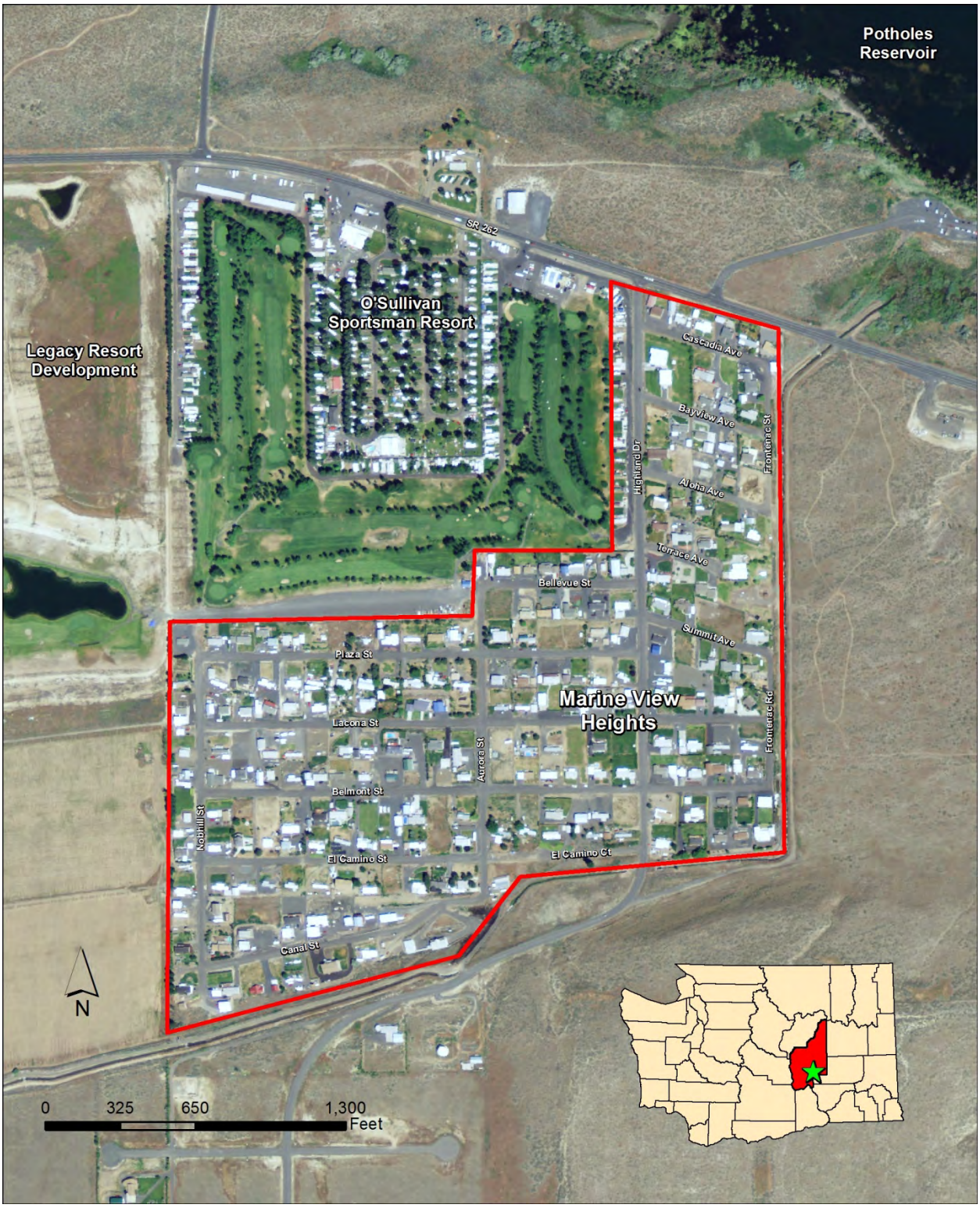

Figure 1.1—Vicinity Map

Section 2—Existing Conditions Evaluation

2.1 Data Gathering

A project kick-off meeting was held with County staff on March 13, 2013, during which known drainage problems were discussed and pictures of past events were obtained. Following the kick-off meeting URS conducted an initial field visit with County staff to observe the Marine View Heights drainage system, visit and discuss drainage problem areas, and identify the overall drainage patterns and outfall locations.

Most of the necessary data needed to complete the project tasks was available on the County's website or other on-line sources. The following data and was downloaded in GIS format:

- Aerial Imagery (2011 NAIP)
- Topography (NED DEM)
- Soils (USDA/NRCS)
- Groundwater (Ecology/Dept. Health)
- Drinking Water Wells (Ecology/Dept. Health)
- Property Boundaries (County GIS)
- Land Use/Zoning (County GIS)
- Culvert Point Data (County GIS)

Detailed field work was performed on April 18, 2013 to collect additional data and information necessary for hydrologic and hydraulic modeling. The data collected during the field visit included:

- Drainage Patterns
- Ditch Cross-Sections and Slopes
- Culvert Sizes/Lengths/Locations
- Outfall Locations
- Storm Drainage System Conditions/Deficiencies
- Additional Review of Problems Spots

URS staff collecting existing storm drainage system data.

All existing ditches and culverts were digitized in GIS based on the data collected in the field (see Appendix A). The GIS files are included on DVD #1.

2.2 Stakeholder Involvement

An on-site informational open house meeting was held on April 18, 2013 to discuss the scope of the project and collect relevant input and feedback from Marine View Heights residents and adjacent property owners. Several display boards were presented to explain the project goals, demonstrate known types of problems and problem areas, and show typical flow directions thru the project site (Appendix B). Stakeholders were also asked to participate in an exercise to help identify any other drainage problems and provide information that would assist with the development of conceptual solutions. To help document these concerns, stakeholders filled out a brief questionnaire that identified the location, type, and frequency of occurrence for each known problem. Copies of the completed questionnaires are provided in Appendix B, and a summary of the known problems identified by stakeholders is provided in Table 2.1.

Table 2.1 Summary of Stakeholder Known Problems Questionnaires			
Problem ID No.	Location	General Type of Problem	Approximate Frequency
1	7179 Bayview Ave.	Flooding, Sediment Accumulation, Erosion	Once every 2 years
2	Golf Course road	Flooding	Once every 2 years
3	7160 Summit Ave.	Flooding, Erosion	During large rain event
4	7220 Belmont St.	Flooding	During large rain event
5	Golf Course shop	Flooding, Damaged Infrastructure, Erosion	Once every 2 years
6	Golf Course road	Flooding, Sediment Accumulation, Erosion	During large rain event
7	SE corner of Golf Course	Flooding, Damaged Infrastructure, Erosion	Once every 2 years
8	6852 Canal St.	Flooding, Erosion	Once every year
9	6851 Belmont St.	Flooding, Sediment Accumulation, Erosion	Once every 2 years
10	6871 Belmont St.	Blocked/Undersized Culvert	Once every year
11	7053 Bellevue St.	Driveway Erosion	More than twice per year
12	6890 Canal St.	Flooding	Once every year

It should be noted that some of the problems reported by Marine View Heights residents fall into the "nuisance flooding" category. Nuisance flooding generally refers to drainage problems that do not cause significant damage to homes or infrastructure such as roads or utilities. Examples of nuisance flooding include lot-to-lot drainage issues, erosion of landscaping or gravel driveways, and minor yard flooding. Reviewing and solving nuisance flooding problems is beyond the scope of this report. Instead, URS's work has focused on addressing: (a) significant capacity restrictions within the stormwater drainage system; (b) locations where runoff concentrates and damages homes or infrastructure; and (c) problems created on adjacent properties (golf course) due to uncontrolled runoff from the Marine View Heights development.

2.3 Analysis Methods

The following manuals were consulted during this project:

- Stormwater Management Manual for Eastern Washington (September 2004)
- WSDOT Hydraulics Manual (June 2010)

Two single event design storms for use in eastern Washington were evaluated:

- The 3-hour short-duration storm distribution
- The 24-hour SCS Type 1A storm distribution

The 3-hour short-duration design storm better mimics typical eastern Washington thunderstorms and produces the greatest peak flow rates. The 24-hour SCS Type 1A design storm mimics longer late fall through winter storms. Compared to the 3-hour storm, the 24-hour Type 1A storm produces a lower peak flow but a greater volume of runoff. When solving drainage problems, it is prudent to use the peak flow from the 3-hour storm to properly size conveyance systems (pipes, culverts, ditches, flow splitters, energy dissipaters, etc.), but use the volume from the 24-hour storm to size storage and detention ponds.

When analyzing the existing Marine View Heights stormwater system, the 3-hour short-duration storm event will be used to estimate peak flow; and if potential solutions require the storage of water in a pond or swale, the 24-hour SCS Type 1A storm event will be used to estimate total volume of runoff.

The Santa Barbara Urban Hydrograph method was used to estimate peak flows and total runoff volume.

2.4 Hydrology

Drainage basins and subbasins were delineated in GIS based on topography, the layout of the existing drainage system, and observations made during the April 18, 2013 field visit. Basins and subbasins are shown in Appendix A and GIS files are included on DVD #1.

Hydrologic calculations were prepared for each basin and subbasin to determine peak flows and volumes for the 10-, 25-, and 100-year design storms (see Appendix A). Hydrologic modeling was not performed for a built-out condition, as the development appears to be virtually built-out in its existing state. Land use cover for all basins and subbasins was set at 50% pervious based on delineation of pervious area in five sample subbasins.

2.5 Identified Problems and Capacity Deficiencies

Based on discussions with the County and local residents, as well as field observations, the major drainage problems include:

- Concentrated runoff exceeds the capacity of the drainage system and causes damages to roads, ditches, and private property within the development and on adjacent properties.
- Nobhill Street, Aurora Street, Bellevue Street, and Highland Drive receive the worst damage during severe rain storms.
- There is no runoff storage; all flows drain into the golf course or State Route 262 right-of-way.
- During severe rain storms flows navigate through the golf course and affect residents within the O'Sullivan Sportsman Resort.
- The ditch system along Plaza Street in Basin 2 converges to a low spot at which point the water has nowhere to go except over the roadway to the north and into homeowner properties.

- Long impervious private driveways: runoff bypasses east-west ditch system and flows across the roadway and affects downstream property owners.
- Lack of ditch network along western edge of Aurora Street causes overland flow to bypass east-west ditches and flow across homeowner properties.
- Lack of ditch networks along the southern edges of Bayview Avenue and Aloha Avenue cause runoff to flow across homeowner properties.

Lack of ditch network along western edge of Aurora Street causes overland flow to bypass east-west ditches and flow across homeowner properties.

Hydraulic calculations were prepared for select culverts and ditches throughout the development to determine the capacity of the existing stormwater drainage system and to locate drainage deficiencies. **It was assumed that all culverts and ditches were free of sediment build-up or other capacity restricting debris such as tumble weeds.** Calculations and maps showing the 10-, 25-, and 100-year drainage deficiencies are included in Appendix C.

Hydraulic analysis of the existing stormwater drainage system revealed:

- The most downstream culverts on Nobhill Street and Highland Drive are estimated to be under capacity at the 10-year storm event.
- Due to the recent redirection of water along Highland Drive, the most downstream culvert on Aurora Street is not estimated to be under capacity until the 100-year storm event. The Bellevue Street ditch system originally received much of the upper part of Basin 4 until a culvert was removed and replaced with a new culvert diverting away from Bellevue Street and keeping it on the Highland Drive ditch system.
- Culverts along the east-west roadways are primarily 12 inches in diameter; at least 4 are undersized at the 10-year storm event, 5 at the 25-year, and 9 at the 100-year. *Note: not all culverts were analyzed; there may be culverts upstream of those identified that also are undersized.*

3.1 Preliminary Solutions

The alternatives that have been developed and reviewed have the goal of accommodating the 100-year peak flows and/or volumes without overtopping the drainage system. This is a conservative design storm, and it should be recognized that some of the recommended upgrades may not be necessary, or may be reduced in size, if the County chooses to accept a lower service level, such as the 25-year storm.

Three conceptual alternatives were developed to: (a) solve drainage problems that occur within the Marine View Heights development; and (b) reduce or eliminate the drainage impacts on adjacent properties (golf course, State Route 262). A fourth alternative was developed after an on-site meeting with golf course representatives, where it was determined that a hybrid alternative may better reflect the golf course layout, future development plans, and the intended use of existing golf course facilities. The conceptual alternatives are described below, followed by a matrix of pros and cons (Table 3.1). Figures of the alternatives are included in Appendix D.

It is important to note that a robust annual drainage system inspection and maintenance program must be implemented in order for any alternative to be successful (see *Operation and Maintenance* in Section 3.2).

Alternative # 1 – Utilize Existing Golf Course Pond

This alternative requires a new storm pipe to convey runoff from 71.5 acres to a new sedimentation pond at the northwest corner of the Marine View Heights development. The new sedimentation pond will be connected to the existing golf course pond via an outlet pipe. Given the soils in the area, we feel a sedimentation pond will be needed to reduce the amount of sediment going into the existing golf course pond. The homeowners of Marine View Heights would need to contribute to a maintenance fund for maintenance of the new and existing stormwater management system.

Alternative # 2 – Utilize Golf Course Property to Construct New Infiltration Swales

This alternative requires a new storm pipe to convey runoff from 76.0 acres to a pair of new infiltration swales located in the gravel access area between the existing golf course and the Marine View Heights development.

Alternative # 3 – Route Runoff to Potholes Reservoir

This alternative requires new storm pipe (or a combination of storm pipe and open channel) to convey runoff from 71.5 acres to Potholes Reservoir. Runoff would be collected in a storm pipe, exit the development at the bottom end of Nobhill Street, routed along the existing and new golf course properties, piped underneath State Route 262, and outfall in a depression leading to Potholes Reservoir.

Alternative #4 – New Retention Swale, New Retention Pond, and Expansion of Existing Pond

This alternative requires three new storm pipes to collect and convey runoff from basins 1, 2, 3, and part of 4 (71.5 acres) to a new sedimentation/retention swale with overflow to a new retention pond both located on golf course property. Together the two facilities would be capable of retaining approximately 3.1 acre-feet of water. The new pond would have an overflow pipe connected to the Lakeview Drive storm pipe (to be installed during Phase 3 of the Legacy Resort Development) that ultimately flows to an existing stormwater retention pond located on the Legacy Resort Development site. The existing retention pond is capable of being expanded by approximately 2 acre-feet. When the expanded retention pond approaches full, a proposed emergency pump station would pump water across State Route 262 via an existing 12-inch culvert.

Additional Ditch and Culvert Upgrades Required for Each Alternative

To alleviate the culvert capacity problem in the eastern ditch along Nobhill Street, it is recommended that a new culvert be installed at the intersection of Nobhill Street and Belmont Street to direct runoff to the western ditch along Nobhill Street. The western ditch is capable of carrying more water than is currently directed to it. However, select downstream 18-inch culverts would still need to be upsized to 24-inch culverts in order to handle the estimated peak flow from the 100-year, 3-hour storm event. The most downstream culvert on Highland Drive will need to be upsized from 18-inch to 24-inch in order to handle the estimated peak flow from the 100-year, 3-hour storm event.

All culverts along the east-west roadways should be upsized from 12-inch to 18-inch, especially those at the downstream end of ditch reaches. However, upsizing east-west roadway culverts do not need to be a high priority; during a large storm event, water will stack up and overtop each driveway as needed and continue along the ditch likely without spreading past the roadway crown.

A new ditch along the western edge of Aurora Street would help channel water into the El Camino, Belmont, Lacona, and Plaza Street ditch systems, thereby preventing runoff from bypassing those ditch systems and flowing across homeowner properties. Similarly, new ditches along the southern edge of Bayview Avenue and Aloha Avenue will prevent runoff from flowing across the street and onto downstream homeowner properties. The ditch cross sections can be as small as 12 inches deep for Aurora Street and 18 inches deep for Bayview and Aloha Avenues with 3H:1V side slopes to pass the 100-year, 3-hour storm event.

Table 3.1 Evaluation of Preliminary Solution Concepts				
Concept	Relative Cost	O&M Issues	ROW Issues	Golf Course Concerns
Concept #1 Sed. Pond to Exist. Pond	Medium - Sedimentation pond with outlet. - 1,900 feet of collection pipe.	- Routine Inspection and Maintenance. - Sedimentation Pond and Existing Pond will require occasional dredging to remove sediment. - Maintenance Agreement with Golf Course.	- Requires the purchase of 8396 SE Nob Hill St for Sedimentation Pond. - Easement required for outlet pipe to Existing Pond.	- The pond shown in this alternative is actually an irrigation pond and is not meant for stormwater retention.
Concept #2 Infiltration Swales	Low - Two infiltration swales. - 1,200 feet of collection pipe.	- Routine Inspection and Maintenance. - Swales will require occasional dredging to remove sediment. - Maintenance Agreement with Golf Course.	- Easement required for storm pipe and infiltration swales.	- The southernmost swale in this alternative would impede golf course maintenance operations.
Concept #3 Route to Potholes Res.	High - 4,750 feet of collection pipe.	- Routine Inspection and Maintenance.	- Easement required for storm pipe and/or open channel.	- Routing a separate storm pipe along Lakeview Drive would not be cost effective.
Concept #4 Swale to Pond to Exist. Pond	Medium - Sedimentation Swale. - Retention Pond. - Expand Existing Retention Pond. - 1,700 feet of collection pipe. - Upsize Lakeview Drive Storm Pipe.	- Routine Inspection and Maintenance. - Swales will require occasional dredging to remove sediment. - Maintenance Agreement with Golf Course.	- Easement required for storm pipes, swales, and ponds.	- Minor easement and O&M concerns that can be addressed.

3.2 Preferred Solution Alternative

A meeting was held on August 27, 2013 with Grant County to review and discuss the system capacity deficiency maps and preliminary solution concept plans. It was decided to select Concept #4 as the preferred solution alternative. Similarly, the Golf Course selected Concept #4 as their preferred alternative on September 9, 2013 during a corporate meeting.

Proposed locations for sedimentation swale and retention pond on existing golf course property.

As described above, the preferred solution alternative (Appendix E) involves routing 71.5 acres of runoff into three discrete storm pipes that outfall into a sedimentation/retention swale. The swale would be capable of storing approximately 1.5 acre-feet of stormwater before overflowing to a proposed retention pond. The proposed retention pond would be capable of storing an additional 1.6 acre-feet of stormwater before overflowing to the Lakeview Drive stormwater drainage system and into an existing stormwater retention pond both located on the new Legacy Resort development. The Lakeview Drive stormwater drainage system will be constructed during Phase 3 of the Legacy Resort development; this presents an opportunity to design and install a larger diameter storm pipe that can handle both Lakeview Drive stormwater as well as anticipated overflow from the proposed retention pond. The existing retention pond was only designed to handle runoff from select areas within the Legacy Resort; however, the Legacy Resort development is willing to allow the pond to be expanded by an additional 2 acre-feet. That brings the total runoff storage volume to approximately 5.1 acre-feet which is enough to keep the 25-year, 24-hour storm event on-site. This assumes that the original pond was properly sized to accommodate runoff from development within the Legacy Resort (a review of the Legacy Resort drainage plan/calculations was not performed by URS). Flows beyond the 25-year, 24-hour storm event will likely fill the existing (expanded) retention pond to capacity and will need to be routed underneath State Route 262 via an existing 12-inch culvert and a proposed emergency pump station. Alternatively, the proposed retention pond could be allowed to overflow onto the golf course by reducing the size of the overflow pipe to Lakeview Drive or installing a valve to restrict the flow to Lakeview Drive.

It is important for retention facilities to drain down within a reasonable time so another storm event can be accommodated. Due to the possibility of encountering soils with low infiltration rates, the proposed retention swale and pond would include low flow outlets to allow the accumulated runoff to drain down over approximately 72 hours. These are shown as 4-inch diameter outlets in Figures 3.1 and 3.2 below; however, the size should be refined during the design process.

As shown in Table 3-2, there is a significant difference in peak flows and volumes between the 24-Hour Type 1A storm event and the 3-Hour Short Duration storm event. This means that pipe sizes should be sized to handle the peak flows produced by the 3-Hour Short Duration storm event and runoff storage volume should be sized according to the 24-Hour Type 1A storm event.

Table 3.2
Estimated Peak Flows and Volumes for the Preferred Solution Alternative

Storm Pipe	Area (ac)	3-Hour Short Duration Storm Event					
		10-Year (0.69 in)		25-Year (0.92 in)		100-Year (1.39 in)	
		Peak Flow (cfs)	Volume (ac-ft)	Peak Flow (cfs)	Volume (ac-ft)	Peak Flow (cfs)	Volume (ac-ft)
A	34.70	14.38	0.73	21.40	1.12	38.66	2.03
B	6.07	3.70	0.13	5.45	0.20	9.86	0.36
C	30.70	11.29	0.65	16.84	0.99	30.49	1.80
Storm Pipe	Area (ac)	24-Hour Type 1A Storm Event					
		10-Year (1.2 in)		25-Year (1.5 in)		100-Year (1.8 in)	
		Peak Flow (cfs)	Volume (ac-ft)	Peak Flow (cfs)	Volume (ac-ft)	Peak Flow (cfs)	Volume (ac-ft)
A	34.70	4.00	1.65	5.45	2.26	7.18	2.92
B	6.07	0.77	0.29	1.06	0.40	1.40	0.51
C	30.70	3.37	1.46	4.59	2.00	6.04	2.59

The 100-year, 3-hour estimated flows from storm pipes A, B, and C were routed through the proposed swale and retention pond to determine the pipe sizes shown in Figure E.1 (Appendix E); calculations are provided in Appendix E. The combined peak flow entering the swale is estimated to be 79 cfs; the swale attenuates that peak flow down to 44 cfs which then enters the proposed retention pond that in turn attenuates the peak flow down to 20 cfs.

The 100-year, 24-hour storm event is estimated to produce 6 acre-feet of runoff; as shown in Figure E.1 (Appendix E), the swale and retention ponds combined are able to store approximately 5.1 acre-feet. As stated previously, an emergency pump station should be considered to route excess runoff from the existing (expanded) retention pond underneath State Route 262. Preliminary cross sections depicting the proposed swale and retention pond are shown in Figures 3.1 and 3.2. The golf course intends to utilize the proposed retention pond as a water feature during the irrigation season. Given the preliminary pond geometry, the water level in the proposed retention pond must be kept at or below an elevation of 1,114 feet (approximately 6 feet below the top of pond) to ensure adequate storage volume is available for stormwater runoff. The ultimate size and depth of the pond should be refined during the design process (with additional Golf Course input).

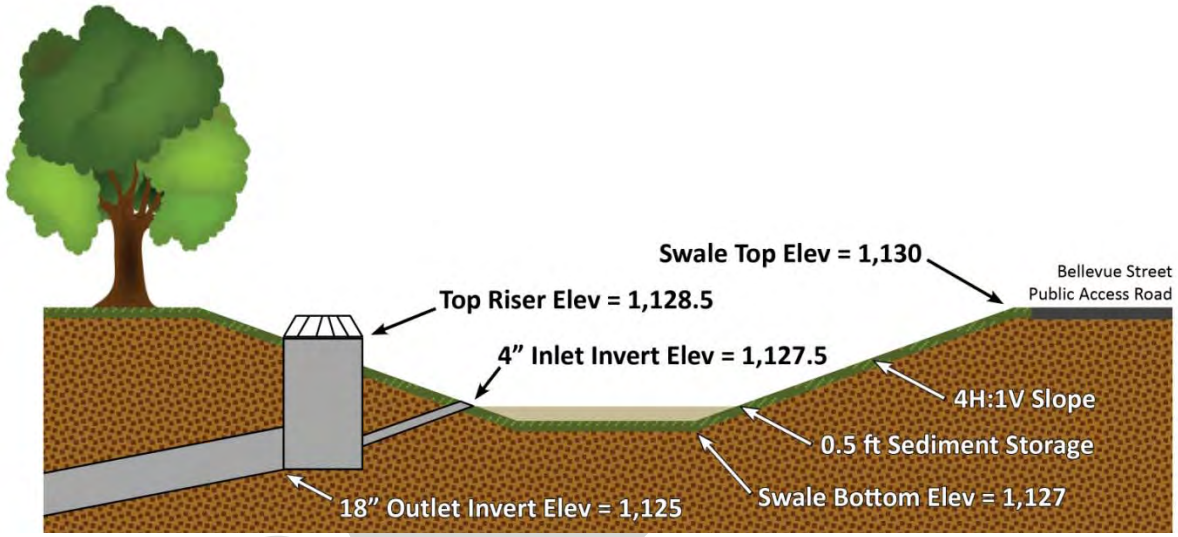

Figure 3.1—Conceptual Cross Section of Proposed Swale (Not-to-Scale)

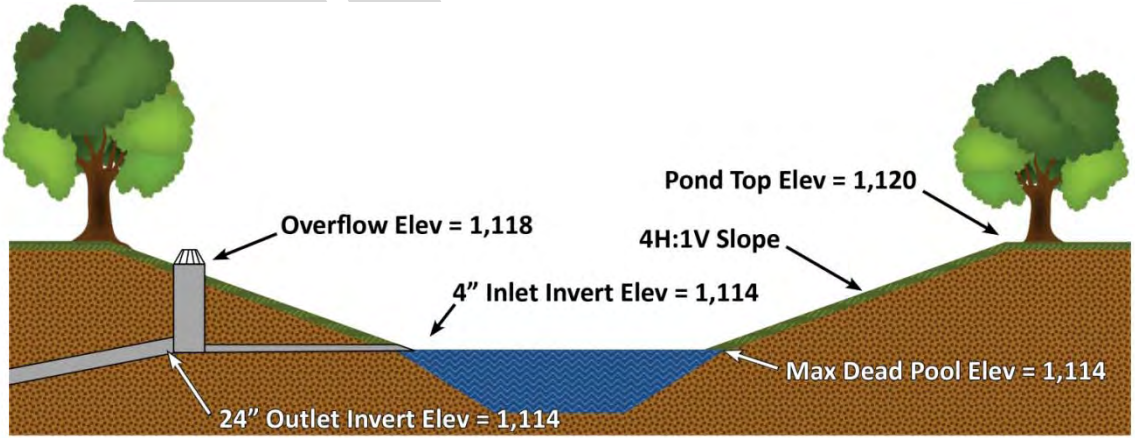

Figure 3.2—Conceptual Cross Section of Proposed Retention Pond (Not-to-Scale)

Project Phasing

Construction of this project could be completed in two phases:

- Phase 1 – Install everything up to Lakeview Drive (storm pipes A, B, and C; proposed swale and retention pond; overflow pipes). The swale and retention pond would be capable of storing up to 3.1 acre-feet of runoff (approximately the 10-year, 24-hour storm event). Runoff in excess of 3.1 acre-feet will overflow onto the golf course, but in a better location and more controlled manner than exists currently.
- Phase 2 – When Phase 3 of the Legacy Resort Development is ready for construction, connect the proposed pond overflow pipe to the Lakeview Drive storm pipe and expand the existing retention pond.

Drainage Easements

Drainage easements will need to be acquired for all stormwater drainage features not already within County or HOA right-of-way. With drainage easements in place, the County or HOA's will have access to all of the stormwater drainage components in order to conduct routine inspections and regular maintenance. Based on preliminary discussions, the Golf Course owners understand the need for drainage easements and are willing to work with the County and HOAs to get them incorporated into the Golf Course property.

Operation and Maintenance

Routine inspection and maintenance will be critical to assuring long-term performance of the stormwater drainage system. Hydraulic capacity of a pipe or ditch system is severely compromised when it fills with sediment or is plugged with debris. Discussion with residents and County staff indicates that tumbleweeds often accumulate at culvert entrances. If not quickly removed, the tumbleweeds become wet, compress, accumulate more tumbleweeds or other debris, and eventually become an effective culvert plug. Routine inspections should be performed for all components of the stormwater drainage system (ditches, culverts, pipes, inlets, manholes, swale, and retention ponds) to determine if maintenance is required. Residents should be given educational information annually about the importance of keeping their culverts clear of tumbleweeds, debris, or sediment. Based on information received from the Golf Course, prior sediment discharged from Marine View Heights may have killed some golf course turf, raising concerns about strong weed killers being used in the ditches that were the source of the sediment. Given that the preferred alternative would have runoff flowing into Golf Couse ponds, the use of strong persistent weed killers within ditches should be avoided.

Appendix F contains the recommended maintenance criteria from Ecology's Stormwater Management Manual for Eastern Washington (2004). Maintenance that should be anticipated includes: debris removal from culverts and sediment removal from the swale, manholes, inlets, culverts, and ditches. The O&M guidance in Appendix F is copied wholesale from the Stormwater Manual and is not all applicable to Marine View Heights. Therefore, it is recommended that a tailored O&M Plan be developed during the design process.

An operation and maintenance fund should be established that allows for routine inspections (at least twice per year) and maintenance as revealed through inspections. Other operational tasks that may require funding include: lawn/turf mowing of the swale and side slopes of the retention pond, as well as costs associated with operating the emergency pump station.

Cost Estimate

A planning level cost estimate has been provided in Appendix E detailing various costs such as: excavation, storm pipe, manholes, inlets, culvert upgrades, and easement acquisition, for each phase of the project. The cost estimate also includes additional engineering costs, routine operation and maintenance, as well as a contingency factor that is intended to cover such unknowns as: excavation through basalt and utility conflicts.

Potential Funding Sources

A formal financial analysis is beyond the scope for this project; however brief examples of potential funding options are provided below for consideration:

- **Drainage Improvement District** – Drainage improvement districts (DID) are a form of special purpose district allowed in Washington State as authorized under RCW 85.08. A DID can be created through the county legislative authority to meet a specific need of the local community, specifically a system of drainage improvements for the protection or reclamation of the land included in a district. The enabling legislation (Title 85 RCW) sets forth the purpose of the district, procedures for formation, powers, functions and duties, composition of the governing body, methods of finance, and other provisions.
- **Local Improvement District (LID)** – A number of entities have the power to create local improvement districts to finance capital projects that benefit only a portion of the entity's geographic area. Assessments are made in proportion to the benefit that the properties receive. The following select special districts can form local improvement districts: county roads and bridges service districts, fire protection districts, flood control zone districts, irrigation districts, park and recreation districts, port districts, transportation benefit districts, and water-sewer districts.
- **Local Drainage Utility** – Grant County could establish a local drainage utility to serve lands within the Marine View Heights development. The local drainage utility would be responsible for the planning, design, construction, maintenance, administration, and operation of the proposed drainage improvements. Drainage utility charges are normally based on impervious area per parcel; however, a flat-rate per parcel could be utilized to reduce the utility set-up costs and simplify the billing process. Fees would be included on the annual property tax statement issued by the County Treasurer's office and would be collected annually or semi-annually depending on the total fee amount.
- **Increased Homeowner Dues** – The homeowner associations and Grant County could enter into an agreement whereby the County would secure funding for the construction of the proposed drainage improvement utilizing loans or the issuance of general obligation debt (e.g., revenue bonds). Homeowner dues would be increased to cover the project's debt service and, if desired, the cost for the County to perform periodic maintenance of the constructed improvements. Alternatively, the homeowner associations could secure funding independent of the County to cover construction and system operation and maintenance costs.

Due to the expense of designing and constructing drainage improvements, it is important to consider a funding method that allows debt financing to build facilities, with the debt being paid back over time using reasonable payments. The currently very low interest rates increase the attractiveness of such a method.

3.3 Addressing Public Concerns

At the April 18, 2013 informational open house meeting, stakeholders reported instances of nuisance flooding or minor property damage as a result of runoff flowing through their properties during storm events (see Table 2.1). Some of these instances are able to be resolved by the preferred solution alternative; however, some issues are not caused by deficiencies in the existing storm drainage system. The subsection below presents how each stakeholder identified problem was or was not addressed.

Problem ID No. 1—7179 Bayview Avenue

New ditches were added to the south side of Bayview Avenue for the preferred solution alternative.

Problem ID No. 2—Golf Course road

The preferred solution alternative redirects much of the flow that previously contributed to this problem, thereby reducing the impact to this area and resolving this problem.

Problem ID No. 3—7160 Summit Avenue

Homeowner at 6794 Belmont St SE had a similar issue with street runoff running through his property and resolved it by installing a small ditch and culvert connected to the Nobhill Street ditch system. In this case the homeowner appears to utilize the space where a ditch might go for parking. A simple asphalt berm along the edge of the roadway could be installed to direct runoff to the Highland Drive ditch system.

Problem ID No. 4—7220 Belmont Street

The ditch system along the southern edge of Belmont Street in this area is extremely shallow and virtually non-existent. The homeowners have wide continuous driveways where the ditch system should be. This has resulted in stormwater traveling down the impervious driveways, flowing across the street, and onto the downstream properties. One solution would be to return the southern roadway edge to a ditch system with driveway culverts and raised asphalt berms to direct water into the ditch system. Another solution might be to install a raised asphalt berm diagonally across Belmont Street to direct runoff from 7229 Belmont Street into the Frontenac Road ditch system.

Problem ID No. 5—Golf Course shop

The preferred solution alternative redirects much of the flow that previously contributed to this problem, thereby reducing the impact to this area and resolving this problem.

Problem ID No. 6—Golf Course road

The preferred solution alternative redirects much of the flow that previously contributed to this problem, thereby reducing the impact to this area and resolving this problem.

Problem ID No. 7—Southeast corner of golf course

The preferred solution alternative redirects much of the flow that previously contributed to this problem, thereby reducing the impact to this area and resolving this problem.

Problem ID No. 8—6852 Canal Street

This issue appears to be associated with stormwater runoff that bypasses the intended east-west ditch drainage system by traveling down an impervious driveway, flowing across the street, and onto the downstream property. The scope of work for this project was to identify and propose solutions to address deficiencies in the existing drainage system, and it did not focus on issues related to stormwater that bypasses the ditch drainage system. However, homeowners on east-west streets with driveways that cross drainage ditches (culverts) could, at their own expense, install a raised asphalt berm at the end of their driveway to divert stormwater directly into the ditches to potentially resolve these types of issues.

Problem ID No. 9—6851 Belmont Street

This issue appears to be associated with stormwater runoff that bypasses the intended east-west ditch drainage system by traveling down an impervious driveway, flowing across the street, and onto the downstream property. The scope of work for this project was to identify and propose solutions to address deficiencies in the existing drainage system, and it did not focus on issues related to stormwater that bypasses the ditch drainage system. However, homeowners on east-west streets with driveways that cross drainage ditches (culverts) could, at their own expense, install a raised asphalt berm at the end of their driveway to divert stormwater directly into the ditches to potentially resolve these types of issues.

Problem ID No. 10—6871 Belmont Street

This issue appears to be associated with general ditch and culvert maintenance. Routine inspection and maintenance is recommended as a part of the preferred alternative.

Problem ID No. 11—7053 Bellevue Street

The preferred solution alternative will result in significantly less runoff in the Bellevue ditch system, which may resolve this problem. If not, the issue of driveway runoff undercutting the driveway itself will need to be addressed by the individual homeowner.

Problem ID No. 12—6890 Canal Street

This issue appears to be associated with stormwater runoff that bypasses the intended east-west ditch drainage system by traveling down an impervious driveway, flowing across the street, and onto the downstream property. The scope of work for this project was to identify and propose solutions to address deficiencies in the existing drainage system, and it did not focus on issues related to stormwater that bypasses the ditch drainage system. However, homeowners on east-west streets with driveways that cross drainage ditches (culverts) could, at their own expense, install a raised asphalt berm at the end of their driveway to divert stormwater directly into the ditches to potentially resolve these types of issues.

Appendix A—Drainage Basins and Existing Stormwater System Figure, Table, & Calculations

Culvert ID	Culvert Material	Culvert Diameter (ft)	Culvert Length (ft)	Culvert Slope (ft/ft)	Street Name	Sub-Basin ID
1	CMP	1.5	48.0	0.010	Nobhill Street SE	1-10
2	CMP	1.5	48.0	0.025	Nobhill Street SE	1-9
3	CMP	1.5	30.0	0.043	Nobhill Street SE	1-9
4	CMP	1.5	30.0	0.043	Nobhill Street SE	1-9
5	CMP	1.5	39.0	0.063	Nobhill Street SE	1-9
6	CMP	1.5	20.0	0.070	Nobhill Street SE	1-9
7	CMP	1.5	51.5	0.058	Nobhill Street SE	1-9
8	CMP	1.5	122.0	0.078	Nobhill Street SE	1-9
9	CMP	1.5	92.0	0.098	Nobhill Street SE	1-9
10	CMP	1.5	25.5	0.118	Nobhill Street SE	1-9
11	CMP	1.5	26.0	0.123	Nobhill Street SE	1-9
12	CMP	1.5	25.5	0.161	Nobhill Street SE	1-9
13	CMP	1.5	92.0	0.148	Nobhill Street SE	1-9
14	CMP	1.5	20.0	0.180	Nobhill Street SE	1-9
15	CMP	1.5	40.0	0.138	Nobhill Street SE	1-9
16	CMP	1.5	47.0	0.121	Nobhill Street SE	1-1
17	CMP	1.5	61.5	0.122	Nobhill Street SE	1-1
18	CMP	1.5	157.0	Not Meas.	Nobhill Street SE	1-1
19	CMP	1.5	68.0	0.137	Nobhill Street SE	1-3
20	CMP	1.5	25.0	0.108	Nobhill Street SE	1-3
21	CMP	1.5	26.5	0.113	Nobhill Street SE	1-3
22	CMP	1.5	36.0	0.092	Nobhill Street SE	1-3
23	CMP	1.5	50.0	0.076	Nobhill Street SE	1-5
24	CMP	1.5	70.0	0.060	Nobhill Street SE	1-5
25	CMP	1.5	26.0	0.073	Nobhill Street SE	1-5
26	CMP	1.5	20.0	0.080	Nobhill Street SE	1-5
27	CMP	1.5	51.0	0.027	Nobhill Street SE	1-7
28	CMP	1.5	17.5	0.051	Nobhill Street SE	1-7
29	CMP	1.5	37.5	0.037	Nobhill Street SE	1-7
30	CMP	1	20.0	0.015	Plaza Street SE	1-8
31	CMP	1	26.0	Not Meas.	Plaza Street SE	1-8
32	CMP	1	52.0	0.019	Plaza Street SE	1-8
33	CMP	1	58.0	0.003	Plaza Street SE	2-1
34	CMP	1	26.0	Not Meas.	Plaza Street SE	2-1
35	CMP	1.5	65.0	0.057	Highland Drive SE	4-24
36	CMP	1	27.6	Not Meas.	Plaza Street SE	2-1
37	CMP	1	30.7	Not Meas.	Plaza Street SE	2-1
38	CMP	1	23.5	Not Meas.	Plaza Street SE	2-1
39	CMP	1	51.8	Not Meas.	Plaza Street SE	2-1
40	CMP	1	43.5	Not Meas.	Highland Drive SE	4-2
41	CMP	1	25.8	Not Meas.	Plaza Street SE	2-1
42	CMP	1	44.8	Not Meas.	Plaza Street SE	2-1
43	CMP	1	86.8	Not Meas.	Lacona Street SE	1-6
44	CMP	1	59.0	Not Meas.	Lacona Street SE	1-6
45	CMP	1.5	19.6	Not Meas.	Lacona Street SE	1-6
46	CMP	1.5	60.6	Not Meas.	Lacona Street SE	1-6
47	CMP	1.5	23.0	Not Meas.	Lacona Street SE	1-6
48	CMP	1	25.8	Not Meas.	Lacona Street SE	1-6
49	HDPE	1	40.0	Not Meas.	Belmont Street SE	1-12
50	CMP	1	16.1	Not Meas.	Belmont Street SE	1-4
51	CMP	1	20.4	Not Meas.	Belmont Street SE	1-4
52	CMP	1	49.5	Not Meas.	Belmont Street SE	1-4
53	CMP	1	136.3	Not Meas.	Belmont Street SE	1-4
54	CMP	1	24.3	Not Meas.	Belmont Street SE	1-4
55	CMP	1	58.6	Not Meas.	Belmont Street SE	1-4
56	CMP	1	25.2	Not Meas.	Belmont Street SE	1-4
57	CMP	1	33.4	Not Meas.	Belmont Street SE	1-4
58	CMP	1	38.6	Not Meas.	El Camino Street SE	1-2
59	CMP	1	45.9	Not Meas.	El Camino Street SE	1-2
60	CMP	1	23.6	Not Meas.	El Camino Street SE	1-2
61	CMP	1	17.7	Not Meas.	El Camino Street SE	1-2
62	CMP	1	56.6	Not Meas.	El Camino Street SE	1-2
63	CMP	1	30.2	Not Meas.	El Camino Street SE	1-2
64	CMP	1	29.6	Not Meas.	El Camino Street SE	1-2
65	CMP	1	32.3	Not Meas.	El Camino Street SE	1-2
66	CMP	1	34.0	Not Meas.	Canal Street SE	1-1
67	CMP	1.5	40.7	Not Meas.	Canal Street SE	3-1
68	CMP	1.5	20.3	Not Meas.	Canal Street SE	3-1
69	CMP	1.5	23.3	Not Meas.	Canal Street SE	3-1
70	CMP	1.5	23.3	Not Meas.	Canal Street SE	3-1
71	CMP	1.5	23.9	Not Meas.	Canal Street SE	3-1
72	CMP	1.5	33.9	Not Meas.	Canal Street SE	3-1
73	CMP	1.5	21.1	Not Meas.	Canal Street SE	3-1
74	CMP	1.5	25.2	Not Meas.	Canal Street SE	3-1
75	CMP	1	28.1	Not Meas.	Canal Street SE	3-1
76	CMP	1.5	54.2	Not Meas.	Aurora Street SE	3-9
77	CMP	1.5	16.7	Not Meas.	Aurora Street SE	3-7
78	CMP	1.5	28.7	Not Meas.	Aurora Street SE	3-7
79	CMP	1.5	57.3	Not Meas.	Aurora Street SE	3-7
80	CMP	1.5	21.9	Not Meas.	Aurora Street SE	3-5
81	CMP	1.5	49.5	Not Meas.	Aurora Street SE	3-5
82	CMP	1.5	25.5	Not Meas.	Aurora Street SE	3-3
83	CMP	1.5	53.1	Not Meas.	Aurora Street SE	3-3
84	CMP	1.5	30.7	Not Meas.	Aurora Street SE	3-1
85	CMP	1.5	40.8	Not Meas.	Aurora Street SE	3-1
86	CMP	1.5	22.4	Not Meas.	Aurora Street SE	3-1
87	CMP	1.5	8.3	Not Meas.	Aurora Street SE	3-1
88	CMP	1.5	11.2	Not Meas.	Aurora Street SE	3-1
89	CMP	1.5	28.7	Not Meas.	Aurora Street SE	3-1
90	CMP	1.5	52.2	Not Meas.	Aurora Street SE	3-1
91	CMP	1	24.0	Not Meas.	Bellevue Street SE	3-8
92	CMP	1	30.1	Not Meas.	Bellevue Street SE	3-8
93	CMP	1	67.0	Not Meas.	Bellevue Street SE	3-8
94	CMP	1	52.1	Not Meas.	Bellevue Street SE	3-8
95	CMP	1	26.4	Not Meas.	Plaza Street SE	3-6
96	CMP	1	53.8	Not Meas.	Plaza Street SE	3-6
97	CMP	1	27.1	Not Meas.	Plaza Street SE	3-6
98	CMP	1	30.9	Not Meas.	Plaza Street SE	4-23

Ditch ID	Ditch Bottom Width (ft)	Ditch Top Width (ft)	Ditch Depth (ft)	Ditch Slope (ft/ft)	Ditch Length (ft)	Street Name	Sub-Basin ID
1	1.0	5.0	0.9	0.008	15.3	Nobhill Street SE	1-10
2	3.0	9.5	1.2	0.009	93.0	Nobhill Street SE	1-10
3	1.9	6.0	1.5	0.063	96.2	Nobhill Street SE	1-9
4	Not Meas.	Not Meas.	Not Meas.	Not Meas.	27.7	Nobhill Street SE	1-9
5	1.9	5.5	1.5	Not Meas.	52.3	Nobhill Street SE	1-9
6	Not Meas.	Not Meas.	Not Meas.	Not Meas.	35.7	Nobhill Street SE	1-9
7	Not Meas.	Not Meas.	Not Meas.	Not Meas.	62.5	Nobhill Street SE	1-9
8	Not Meas.	Not Meas.	Not Meas.	Not Meas.	27.7	Nobhill Street SE	1-9
9	1.9	5.7	1.4	Not Meas.	102.4	Nobhill Street SE	1-9
10	0.0	7.2	2.3	Not Meas.	20.2	Nobhill Street SE	1-9
11	Not Meas.	Not Meas.	Not Meas.	Not Meas.	22.5	Nobhill Street SE	1-9
12	Not Meas.	Not Meas.	Not Meas.	Not Meas.	5.3	Nobhill Street SE	1-9
13	1.2	6.3	1.7	Not Meas.	86.1	Nobhill Street SE	1-9
14	Not Meas.	Not Meas.	Not Meas.	Not Meas.	67.7	Nobhill Street SE	1-9
15	0.0	4.0	1.9	Not Meas.	54.5	Nobhill Street SE	1-9
16	Not Meas.	Not Meas.	Not Meas.	Not Meas.	34.9	Nobhill Street SE	1-9
17	Not Meas.	Not Meas.	Not Meas.	Not Meas.	13.1	Nobhill Street SE	1-1
18	1.0	5.4	1.3	Not Meas.	83.5	Nobhill Street SE	1-1
19	2.0	5.6	1.1	0.167	92.7	Nobhill Street SE	1-1
20	1.8	8.4	2.1	Not Meas.	30.7	Nobhill Street SE	1-3
21	Not Meas.	Not Meas.	Not Meas.	Not Meas.	10.4	Nobhill Street SE	1-3
22	Not Meas.	Not Meas.	Not Meas.	Not Meas.	10.3	Nobhill Street SE	1-3
23	1.5	9.0	2.0	Not Meas.	89.4	Nobhill Street SE	1-3
24	Not Meas.	Not Meas.	Not Meas.	Not Meas.	34.1	Nobhill Street SE	1-5
25	Not Meas.	Not Meas.	Not Meas.	Not Meas.	13.3	Nobhill Street SE	1-5
26	2.2	6.0	1.4	Not Meas.	71.9	Nobhill Street SE	1-5
27	Not Meas.	Not Meas.	Not Meas.	Not Meas.	8.2	Nobhill Street SE	1-5
28	2.0	9.3	2.0	Not Meas.	102.2	Nobhill Street SE	1-7
29	Not Meas.	Not Meas.	Not Meas.	Not Meas.	5.4	Nobhill Street SE	1-7
30	Not Meas.	Not Meas.	Not Meas.	Not Meas.	86.3	Nobhill Street SE	1-7
31	2.0	7.6	1.7	0.003	90.3	Plaza Street SE	1-8
32	Not Meas.	Not Meas.	Not Meas.	Not Meas.	7.6	Plaza Street SE	1-8
33	Not Meas.	Not Meas.	Not Meas.	Not Meas.	50.8	Plaza Street SE	1-8
34	Not Meas.	Not Meas.	Not Meas.	Not Meas.	52.7	Plaza Street SE	1-8
35	Not Meas.	Not Meas.	Not Meas.	Not Meas.	75.6	Plaza Street SE	2-1
36	2.8	6.0	1.5	Not Meas.	106.6	Plaza Street SE	2-1
37	Not Meas.	Not Meas.	Not Meas.	Not Meas.	80.7	Plaza Street SE	2-1
38	Not Meas.	Not Meas.	Not Meas.	Not Meas.	49.8	Plaza Street SE	2-1
39	Not Meas.	Not Meas.	Not Meas.	Not Meas.	54.7	Plaza Street SE	2-1
40	Not Meas.	Not Meas.	Not Meas.	Not Meas.	85.9	Plaza Street SE	2-1
41	Not Meas.	Not Meas.	Not Meas.	Not Meas.	54.5	Plaza Street SE	2-1
42	Not Meas.	Not Meas.	Not Meas.	Not Meas.	138.3	Plaza Street SE	2-1
43	2.0	8.0	1.5	Not Meas.	193.4	Lacona Street SE	1-6
44	Not Meas.	Not Meas.	Not Meas.	Not Meas.	109.8	Lacona Street SE	1-6
45	2.0	5.5	1.5	Not Meas.	86.8	Lacona Street SE	1-6
46	Not Meas.	Not Meas.	Not Meas.	Not Meas.	67.6	Lacona Street SE	1-6
47	Not Meas.	Not Meas.	Not Meas.	Not Meas.	74.8	Lacona Street SE	1-6
48	Not Meas.	Not Meas.	Not Meas.	Not Meas.	265.6	Lacona Street SE	1-6
49	1.0	5.0	1.2	Not Meas.	94.8	Lacona Street SE	1-6
50	2.0	9.0	1.0	Not Meas.	194.5	Belmont Street SE	1-12
51	2.0	7.0	2.0	Not Meas.	205.2	Belmont Street SE	1-4
52	Not Meas.	Not Meas.	Not Meas.	Not Meas.	78.6	Belmont Street SE	1-4
53	Not Meas.	Not Meas.	Not Meas.	Not Meas.	85.9	Belmont Street SE	1-4
54	Not Meas.	Not Meas.	Not Meas.	Not Meas.	77.3	Belmont Street SE	1-4
55	Not Meas.	Not Meas.	Not Meas.	Not Meas.	51.2	Belmont Street SE	1-4
56	Not Meas.	Not Meas.	Not Meas.	Not Meas.	51.2	Belmont Street SE	1-4
57	Not Meas.	Not Meas.	Not Meas.	Not Meas.	42.5	Belmont Street SE	1-4
58	Not Meas.	Not Meas.	Not Meas.	Not Meas.	134.6	Belmont Street SE	1-4
59	Not Meas.	Not Meas.	Not Meas.	Not Meas.	71.2	Belmont Street SE	1-4
60	1.7	4.5	1.4	Not Meas.	108.7	El Camino Street SE	1-2
61	1.0	3.7	1.0	Not Meas.	46.9	El Camino Street SE	1-2
62	Not Meas.	Not Meas.	Not Meas.	Not Meas.	67.4	El Camino Street SE	1-2
63	Not Meas.	Not Meas.	Not Meas.	Not Meas.	78.8	El Camino Street SE	1-2
64	Not Meas.	Not Meas.	Not Meas.	Not Meas.	73.7	El Camino Street SE	1-2
65	Not Meas.	Not Meas.	Not Meas.	Not Meas.	87.9	El Camino Street SE	1-2
66	Not Meas.	Not Meas.	Not Meas.	Not Meas.	242.0	El Camino Street SE	1-2
67	2.5	6.0	1.7	Not Meas.	89.6	El Camino Street SE	1-2
68	Not Meas.	Not Meas.	Not Meas.	Not Meas.	67.4	El Camino Street SE	1-2
69	1.7	9.0	2.1	Not Meas.	105.9	Canal Street SE	1-1
70	Not Meas.	Not Meas.	Not Meas.	Not Meas.	87.3	Canal Street SE	3-1
71	Not Meas.	Not Meas.	Not Meas.	Not Meas.	54.9	Canal Street SE	3-1
72	Not Meas.	Not Meas.	Not Meas.	Not Meas.	59.7	Canal Street SE	3-1
73	Not Meas.	Not Meas.	Not Meas.	Not Meas.	21.8	Canal Street SE	3-1
74	Not Meas.	Not Meas.	Not Meas.	Not Meas.	15.8	Canal Street SE	3-1
75	2.0	5.9	1.0	Not Meas.	99.2	Canal Street SE	3-1
76	Not Meas.	Not Meas.	Not Meas.	Not Meas.	92.4	Canal Street SE	3-1
77	Not Meas.	Not Meas.	Not Meas.	Not Meas.	69.5	Canal Street SE	3-1
78	Not Meas.	Not Meas.	Not Meas.	Not Meas.	206.8	Canal Street SE	3-1
79	1.7	5.0	1.7	Not Meas.	188.6	Canal Street SE	3-1
80	Not Meas.	Not Meas.	Not Meas.	Not Meas.	118.9	Aurora Street SE	3-9
81	1.5	6.8	2.8	Not Meas.	113.4	Aurora Street SE	3-7
82	Not Meas.	Not Meas.	Not Meas.	Not Meas.	70.3	Aurora Street SE	3-7
83	Not Meas.	Not Meas.	Not Meas.	Not Meas.	12.5	Aurora Street SE	3-7
84	Not Meas.	Not Meas.	Not Meas.	Not Meas.	104.2	Aurora Street SE	3-5
85	Not Meas.	Not Meas.	Not Meas.	Not Meas.	118.3	Aurora Street SE	3-5
86	3.0	8.0	2.3	Not Meas.	134.9	Aurora Street SE	3-3
87	3.0	8.0	2.3	Not Meas.	87.7	Aurora Street SE	3-3
88	Not Meas.	Not Meas.	Not Meas.	Not Meas.	110.7	Aurora Street SE	3-1
89	Not Meas.	Not Meas.	Not Meas.	Not Meas.	12.0	Aurora Street SE	3-1
90	Not Meas.	Not Meas.	Not Meas.	Not Meas.	4.9	Aurora Street SE	3-1
91	Not Meas.	Not Meas.	Not Meas.	Not Meas.	8.1	Aurora Street SE	3-1
92	Not Meas.	Not Meas.	Not Meas.	Not Meas.	4.2	Aurora Street SE	3-1
93	Not Meas.	Not Meas.	Not Meas.	Not Meas.	11.7	Aurora Street SE	3-1
94	1.5	5.0	1.6	Not Meas.	97.9	Aurora Street SE	3-1
95	3.3	7.0	1.9	Not Meas.	114.9	Bellevue Street SE	3-8
96	Not Meas.	Not Meas.	Not Meas.	Not Meas.	73.5	Bellevue Street SE	3-8
97	Not Meas.	Not Meas.	Not Meas.	Not Meas.	51.1	Bellevue Street SE	3-8
98	Not Meas.	Not Meas.	Not Meas.	Not Meas.	50.8	Bellevue Street SE	3-8

Culvert ID	Culvert Material	Culvert Diameter (ft)	Culvert Length (ft)	Culvert Slope (ft/ft)	Street Name	Sub-Basin ID
99	CMP	1	28.8	Not Meas.	Plaza Street SE	4-23
100	CMP	1	30.9	Not Meas.	Lacona Street SE	3-4
101	CMP	1	32.1	Not Meas.	Lacona Street SE	3-4
102	CMP	1	56.6	Not Meas.	Lacona Street SE	3-4
103	CMP	1	31.0	Not Meas.	Lacona Street SE	4-21
104	CMP	1	22.6	Not Meas.	Belmont Street SE	3-2
105	CMP	1	30.4	Not Meas.	Belmont Street SE	3-2
106	CMP	1	48.2	Not Meas.	Belmont Street SE	3-2
107	CMP	1	30.4	Not Meas.	Belmont Street SE	3-2
108	CMP	1.5	41.3	Not Meas.	Highland Drive SE	4-24
109	CMP	1.5	29.3	Not Meas.	Highland Drive SE	4-24
110	CMP	1.5	49.1	Not Meas.	Highland Drive SE	4-24
111	CMP	1.5	22.6	Not Meas.	Highland Drive SE	4-22
112	CMP	1.5	56.6	Not Meas.	Highland Drive SE	4-22
113	CMP	1.5	51.6	Not Meas.	Highland Drive SE	4-22
114	CMP	1.5	20.1	Not Meas.	Highland Drive SE	4-2
115	CMP	1.5	50.7	Not Meas.	Highland Drive SE	4-18
116	CMP	1.5	36.5	Not Meas.	Highland Drive SE	4-16
117	CMP	1.5	86.9	Not Meas.	Highland Drive SE	4-16
118	CMP	1.5	63.6	Not Meas.	Highland Drive SE	4-14
119	CMP	1.5	19.8	Not Meas.	Highland Drive SE	4-12
120	CMP	1.5	29.2	Not Meas.	Highland Drive SE	4-12
121	CMP	1.5	48.3	Not Meas.	Highland Drive SE	4-12
122	CMP	1.5	23.3	Not Meas.	Highland Drive SE	4-10
123	CMP	1.5	28.1	Not Meas.	Highland Drive SE	4-10
124	CMP	1.5	17.7	Not Meas.	Highland Drive SE	4-9
125	CMP	1.5	61.1	Not Meas.	Highland Drive SE	4-9
126	CMP	1.5	33.7	Not Meas.	Highland Drive SE	4-7
127	CMP	1.5	28.1	Not Meas.	Highland Drive SE	4-7
128	CMP	1.5	47.6	Not Meas.	Highland Drive SE	4-7
129	CMP	1.5	51.1	Not Meas.	Highland Drive SE	4-7
130	CMP	1.5	75.4	Not Meas.	Highland Drive SE	4-5
131	CMP	1.5	61.7	Not Meas.	Highland Drive SE	4-5
132	CMP	1	67.4	Not Meas.	Highland Drive SE	4-3
133	CMP	1.5	54.2	Not Meas.	Highland Drive SE	4-3
134	CMP	1	51.3	Not Meas.	Cascadia Avenue SE	4-17
135	CMP	1	40.0	Not Meas.	Cascadia Avenue SE	4-17
136	CMP	1	37.9	Not Meas.	Terrace Avenue SE	4-11
137	CMP	1	25.2	Not Meas.	Summit Avenue SE	4-8
138	CMP	1	29.0	Not Meas.	Summit Avenue SE	4-8
139	CMP	1	73.6	Not Meas.	Summit Avenue SE	4-8
140	CMP	1	30.2	Not Meas.	Summit Avenue SE	4-8
141	CMP	1	61.0	Not Meas.	Lacona Street SE	4-6
142	CMP	1	27.6	Not Meas.	Lacona Street SE	4-6
143	CMP	1	22.9	Not Meas.	Lacona Street SE	4-6
144	CMP	1	76.0	Not Meas.	Belmont Street SE	4-4
145	CMP	1	81.3	Not Meas.	Frontenac Road SE	4-6

Note: Due to time constraints, slopes could not be measured in the field for all culverts. Those culverts requiring hydraulic modeling will receive a slope based on available digital elevation model (DEM) data.

Ditch ID	Ditch Bottom Width (ft)	Ditch Top Width (ft)	Ditch Depth (ft)	Ditch Slope (ft/ft)	Ditch Length (ft)	Street Name	Sub-Basin ID
99	1.4	5.7	1.9	Not Meas.	176.3	Bellevue Street SE	3-8
100	Not Meas.	Not Meas.	Not Meas.	Not Meas.	20.0	Plaza Street SE	3-6
101	1.6	6.4	1.3	Not Meas.	148.7	Plaza Street SE	3-6
102	Not Meas.	Not Meas.	Not Meas.	Not Meas.	92.4	Plaza Street SE	3-6
103	Not Meas.	Not Meas.	Not Meas.	Not Meas.	62.5	Plaza Street SE	4-23
104	2.7	8.0	1.7	Not Meas.	81.3	Plaza Street SE	4-23
105	Not Meas.	Not Meas.	Not Meas.	Not Meas.	80.0	Plaza Street SE	4-23
106	1.4	6.0	1.5	Not Meas.	113.2	Lacona Street SE	3-4
107	Not Meas.	Not Meas.	Not Meas.	Not Meas.	76.8	Lacona Street SE	3-4
108	Not Meas.	Not Meas.	Not Meas.	Not Meas.	147.9	Lacona Street SE	3-4
109	Not Meas.	Not Meas.	Not Meas.	Not Meas.	101.7	Lacona Street SE	4-21
110	2.4	6.0	1.8	Not Meas.	56.0	Lacona Street SE	4-21
111	2.2	5.6	1.3	Not Meas.	111.7	Belmont Street SE	3-2
112	Not Meas.	Not Meas.	Not Meas.	Not Meas.	80.3	Belmont Street SE	3-2
113	Not Meas.	Not Meas.	Not Meas.	Not Meas.	156.7	Belmont Street SE	3-2
114	Not Meas.	Not Meas.	Not Meas.	Not Meas.	60.8	Belmont Street SE	3-2
115	2.3	6.6	1.7	Not Meas.	104.6	Belmont Street SE	3-2
116	Not Meas.	Not Meas.	Not Meas.	Not Meas.	165.7	El Camino Ct. SE	4-2
117	1.6	4.3	1.4	Not Meas.	1151.8	Highland Drive SE	5-1
118	1.2	5.4	2.0	Not Meas.	78.7	Highland Drive SE	4-24
119	Not Meas.	Not Meas.	Not Meas.	Not Meas.	39.6	Highland Drive SE	4-24
120	Not Meas.	Not Meas.	Not Meas.	Not Meas.	64.6	Highland Drive SE	4-24
121	Not Meas.	Not Meas.	Not Meas.	Not Meas.	99.5	Highland Drive SE	4-22
122	Not Meas.	Not Meas.	Not Meas.	Not Meas.	31.6	Highland Drive SE	4-22
123	Not Meas.	Not Meas.	Not Meas.	Not Meas.	28.1	Highland Drive SE	4-22
124	1.3	6.0	1.7	Not Meas.	243.2	Highland Drive SE	4-20
125	0.0	7.0	2.2	Not Meas.	40.6	Highland Drive SE	4-2
126	Not Meas.	Not Meas.	Not Meas.	Not Meas.	190.6	Highland Drive SE	4-2
127	2.0	6.8	1.6	Not Meas.	146.0	Highland Drive SE	4-18
128	Not Meas.	Not Meas.	Not Meas.	Not Meas.	133.0	Highland Drive SE	4-16
129	Not Meas.	Not Meas.	Not Meas.	Not Meas.	57.3	Highland Drive SE	4-16
130	Not Meas.	Not Meas.	Not Meas.	Not Meas.	256.9	Highland Drive SE	4-14
131	1.9	6.3	2.2	Not Meas.	122.6	Highland Drive SE	4-12
132	Not Meas.	Not Meas.	Not Meas.	Not Meas.	34.4	Highland Drive SE	4-12
133	Not Meas.	Not Meas.	Not Meas.	Not Meas.	60.8	Highland Drive SE	4-12
134	Not Meas.	Not Meas.	Not Meas.	Not Meas.	11.1	Highland Drive SE	4-10
135	1.4	5.8	2.0	Not Meas.	46.5	Highland Drive SE	4-10
136	1.8	5.8	2.0	Not Meas.	65.3	Highland Drive SE	4-9
137	Not Meas.	Not Meas.	Not Meas.	Not Meas.	66.7	Highland Drive SE	4-9
138	2.4	7.0	1.7	Not Meas.	83.7	Highland Drive SE	4-7
139	Not Meas.	Not Meas.	Not Meas.	Not Meas.	15.3	Highland Drive SE	4-7
140	Not Meas.	Not Meas.	Not Meas.	Not Meas.	74.7	Highland Drive SE	4-7
141	Not Meas.	Not Meas.	Not Meas.	Not Meas.	109.1	Highland Drive SE	4-7
142	2.2	7.6	1.8	Not Meas.	69.8	Highland Drive SE	4-5
143	Not Meas.	Not Meas.	Not Meas.	Not Meas.	89.6	Highland Drive SE	4-5
144	Not Meas.	Not Meas.	Not Meas.	Not Meas.	58.7	Highland Drive SE	4-3
145	Not Meas.	Not Meas.	Not Meas.	Not Meas.	71.9	Highland Drive SE	4-3
146	1.5	7.2	1.8	Not Meas.	41.3	Highland Drive SE	4-1
147	Not Meas.	Not Meas.	Not Meas.	Not Meas.	209.8	Highland Drive SE	4-1
148	Not Meas.	Not Meas.	Not Meas.	Not Meas.	348.2	Highland Drive SE	4-1
149	Not Meas.	Not Meas.	Not Meas.	Not Meas.	305.4	Cascadia Avenue SE	4-17
150	2.8	5.0	0.5	Not Meas.	120.2	Cascadia Avenue SE	4-17
151	Not Meas.	Not Meas.	Not Meas.	Not Meas.	26.4	Cascadia Avenue SE	4-17
152	Not Meas.	Not Meas.	Not Meas.	Not Meas.	174.1	Bayview Avenue SE	4-17
153	1.2	5.3	1.0	Not Meas.	76.2	Terrace Avenue SE	4-11
154	Not Meas.	Not Meas.	Not Meas.	Not Meas.	73.6	Terrace Avenue SE	4-11
155	Not Meas.	Not Meas.	Not Meas.	Not Meas.	91.2	Summit Avenue SE	4-8
156	1.7	6.0	1.3	Not Meas.	100.6	Summit Avenue SE	4-8
157	Not Meas.	Not Meas.	Not Meas.	Not Meas.	46.1	Summit Avenue SE	4-8
158	Not Meas.	Not Meas.	Not Meas.	Not Meas.	39.0	Summit Avenue SE	4-8
159	Not Meas.	Not Meas.	Not Meas.	Not Meas.	102.7	Lacona Street SE	4-6
160	Not Meas.	Not Meas.	Not Meas.	Not Meas.	83.3	Lacona Street SE	4-6
161	1.7	5.7	1.3	Not Meas.	89.1	Lacona Street SE	4-6
162	Not Meas.	Not Meas.	Not Meas.	Not Meas.	115.6	Lacona Street SE	4-6
163	Not Meas.	Not Meas.	Not Meas.	Not Meas.	247.4	Belmont Street SE	4-4
164	Not Meas.	Not Meas.	Not Meas.	Not Meas.	59.2	Frontenac Road SE	4-6
165	1.5	4.0	0.5	Not Meas.	92.2	Frontenac Road SE	4-6
166	Not Meas.	Not Meas.	Not Meas.	Not Meas.	651.6	SR 262	Null
167	Not Meas.	Not Meas.	Not Meas.	Not Meas.	124.5	Belmont Street SE	4-4

Note: Due to time constraints, cross-section data and slopes could not be measured in the field for all ditches. Those ditches requiring hydraulic modeling will receive a slope based on available digital elevation model (DEM) data and cross-section data will be estimated based on the nearest available cross-section measured in the field.

Marine View Heights Stormwater Management Review

Figure A.1

Drainage Basins and
Existing Stormwater System

- Culvert
- Ditch
- Berm
- 10 ft Contour
- Drainage Basin Outfall Flow Direction
- Drainage Sub-Basin
- Drainage Basin (1, 2, 3, 4, 5)

Aerial Imagery: 2011 NAIP

0 200 400 800 Feet

N

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Date Created: 6/20/2013

Existing Drainage Basins - Hydrologic Calculations

Stormwater Management Manual for E. WA.
Chapter 4 - Hydrologic Analysis and Design

Calculated by:	E. Pruneda	Date:	6/20/2013	Project:	Grant County
Checked by:	J. Knutson	Date:	6/21/2013	Project No:	36310174
				Sheet No:	1 of 1

SBUH Input with Calculated Flows and Volumes:

							3-Hour Short Duration Storm Event						24-Hour Type 1A Storm Event					
							10-Year (0.69 in)		25-Year (0.92 in)		100-Year (1.39 in)		10-Year (1.2 in)		25-Year (1.5 in)		100-Year (1.8 in)	
Basin ID	Area (ac)	Pervious Area (ac)	% Imp. (dec)	Imp. CN	Perv. CN	T_C (min)	Peak Flow (cfs)	Volume (ac-ft)	Peak Flow (cfs)	Volume (ac-ft)	Peak Flow (cfs)	Volume (ac-ft)	Peak Flow (cfs)	Volume (ac-ft)	Peak Flow (cfs)	Volume (ac-ft)	Peak Flow (cfs)	Volume (ac-ft)
1	35.71	17.86	0.50	98	80	13.21	14.80	0.75	22.02	1.15	39.78	2.09	4.11	1.69	5.61	2.33	7.39	3.01
2	9.53	4.76	0.50	98	80	5.00	5.81	0.20	8.56	0.31	15.48	0.56	1.22	0.45	1.66	0.62	2.19	0.80
3	24.99	12.50	0.50	98	80	16.12	9.19	0.53	13.71	0.81	24.82	1.46	2.75	1.19	3.74	1.63	4.92	2.10
4	35.51	17.75	0.50	98	80	13.19	14.73	0.75	21.91	1.15	39.60	2.08	4.09	1.68	5.58	2.32	7.35	2.99
5	3.33	1.66	0.50	98	80	5.00	2.03	0.07	2.99	0.11	5.41	0.19	0.42	0.16	0.58	0.22	0.77	0.28

Note: Land use cover was approximated as 50% pervious for all basins based on delineation of pervious area in 5 sample sub-basins.

Appendix B—Public Meeting Materials and Questionnaires

Welcome

Meeting Purpose

- Project introduction and purpose.
- Identify and confirm locations, approximate frequency, and severity of problems.
- Confirm the direction stormwater flows within the development.

Project Goals

- Identify the causes of drainage problems in the Marine View Heights development area.
- Develop several cost-effective alternatives to solve drainage problems that occur within the development.
- Reduce or eliminate the drainage impacts on adjacent properties (Potholes Reservoir Golf Resort, State Route 262).
- Lay the groundwork for the County to present the solutions and costs to Marine View Heights homeowners and begin discussions about how best to fund and implement a preferred alternative.

Known Problems

- Flooding Homes/Property
- Erosion
- Damaged Infrastructure
- Debris Build-Up
- Sediment Accumulation
- Blocked/Undersized Culverts









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Stormwater Management Review Project

Major Problem Spots

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Stormwater Management Review Project

Public Concerns

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Stormwater Management Review Project

General Flow Directions

(not meant to capture all ditches)

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Marine View Heights

Stormwater Management Review Project

Marine View Heights
Known Problems Questionnaire

Project Informational Meeting
April 18, 2013

1. **Problem Identification No.:** 1 *(place numbered sticker on the map near the problem location)*

2. **Where does the problem occur?** *(address, intersection, general location)*

7179 BAYVIEW AVE SE

3. **What type of problem(s) occurs?** *(check all that apply)*

- [x] Flooding
- [ ] Damaged Infrastructure (pipe, culvert, catch basin)
- [x] Sediment Accumulation
- [x] Erosion
- [ ] Debris Build-up
- [ ] Blocked/Undersized Culvert
- [x] Other: NO BAR DITCHES TO KEEP GROUND WATER FROM GOING THRU YARDS

4. **About how frequently does the problem occur?** *(check one)*
(We realize that this may be difficult to answer.)

- [ ] Once every 10 years
- [ ] Once every 5 years
- [x] Once every 2 years
- [ ] Once every year
- [ ] More than 2 times per year
- [ ] Other: _____

5. **May we contact you for additional information?**

Name: Richard Bennett
Phone: 346-1138
Email: ducksdonna@centurylink.net

Marine View Heights
Known Problems Questionnaire

Project Informational Meeting
April 18, 2013

1. **Problem Identification No.:** 2 *(place numbered sticker on the map near the problem location)*

2. **Where does the problem occur?** *(address, intersection, general location)*

Golf Course ~~road~~ road floods from Green Basin

3. **What type of problem(s) occurs?** *(check all that apply)*

- ☒ Flooding
- ☐ Damaged Infrastructure (pipe, culvert, catch basin)
- ☐ Sediment Accumulation
- ☐ Erosion
- ☐ Debris Build-up
- ☐ Blocked/Undersized Culvert
- ☐ Other: _____

4. **About how frequently does the problem occur?** *(check one)*
(We realize that this may be difficult to answer.)

- ☐ Once every 10 years
- ☐ Once every 5 years
- ☒ Once every 2 years
- ☐ Once every year
- ☐ More than 2 times per year
- ☐ Other: _____

5. **May we contact you for additional information?**

Name: _____

Phone: _____

Email: _____

Marine View Heights
Known Problems Questionnaire

Project Informational Meeting
April 18, 2013

1. **Problem Identification No.:** 3 *(place numbered sticker on the map near the problem location)*

2. **Where does the problem occur?** *(address, intersection, general location)*

7160 Summit AVE SE

X Runoff goes UNDER our house off of the street.

3. **What type of problem(s) occurs?** *(check all that apply)*

- ☑ Flooding
- ☐ Damaged Infrastructure (pipe, culvert, catch basin)
- ☐ Sediment Accumulation
- ☑ Erosion
- ☐ Debris Build-up
- ☐ Blocked/Undersized Culvert
- ☐ Other: _____

4. **About how frequently does the problem occur?** *(check one)*
(We realize that this may be difficult to answer.)

- ☐ Once every 10 years
- ☐ Once every 5 years
- ☐ Once every 2 years
- ☐ Once every year
- ☑ More than 2 times per year
- ☑ Other: Heavier Rain

5. **May we contact you for additional information?**

Name: Greg Bafus
Phone: 346-2648
Email: GREGBafus@Yahoo.Com

Marine View Heights
Known Problems Questionnaire

Project Informational Meeting
April 18, 2013

1. **Problem Identification No.:** 4 *(place numbered sticker on the map near the problem location)*

2. **Where does the problem occur?** *(address, intersection, general location)*

1220 Belmont St. / neighbor across St. from ~~me~~ upper side of Belmont St.

3. **What type of problem(s) occurs?** *(check all that apply)*

- [x] Flooding
- [ ] Damaged Infrastructure (pipe, culvert, catch basin)
- [ ] Sediment Accumulation
- [ ] Erosion
- [ ] Debris Build-up
- [ ] Blocked/Undersized Culvert
- [ ] Other: _____

4. **About how frequently does the problem occur?** *(check one)*
(We realize that this may be difficult to answer.)

- [ ] Once every 10 years
- [ ] Once every 5 years
- [ ] Once every 2 years
- [ ] Once every year
- [ ] More than 2 times per year
- [x] Other: Whenever Rains - big Rains

5. **May we contact you for additional information?**

Name: _____

Phone: _____

Email: _____

#

5

Marine View Heights
Known Problems Questionnaire

Project Informational Meeting
April 18, 2013

1. **Problem Identification No.:** 5 *(place numbered sticker on the map near the problem location)*

2. **Where does the problem occur?** *(address, intersection, general location)*

below the water masters building
at the shop entrance of golf course

3. **What type of problem(s) occurs?** *(check all that apply)*

- ☑ Flooding
- ☑ Damaged Infrastructure (pipe, culvert, catch basin)
- ☐ Sediment Accumulation
- ☑ Erosion
- ☐ Debris Build-up
- ☐ Blocked/Undersized Culvert
- ☐ Other: _____

4. **About how frequently does the problem occur?** *(check one)*
(We realize that this may be difficult to answer.)

- ☐ Once every 10 years
- ☐ Once every 5 years
- ☑ Once every 2 years
- ☐ Once every year
- ☐ More than 2 times per year
- ☐ Other: _____

5. **May we contact you for additional information?**

Name: Greg Haynes
Phone: 509-431-4337
Email: ghaynes@hdbllc.net

#6

Marine View Heights
Known Problems Questionnaire

Project Informational Meeting
April 18, 2013

1. **Problem Identification No.:** #6 #2 *(place numbered sticker on the map near the problem location)*

2. **Where does the problem occur?** *(address, intersection, general location)*

Highland & the House on Plaza corner - above where the chain link fence starts the House has a four-in drain going onto our cul-de-sac and takes out the bank.

3. **What type of problem(s) occurs?** *(check all that apply)*

- ☑ Flooding
- ☐ Damaged Infrastructure (pipe, culvert, catch basin)
- ☑ Sediment Accumulation
- ☑ Erosion
- ☐ Debris Build-up
- ☐ Blocked/Undersized Culvert
- ☐ Other: _____

4. **About how frequently does the problem occur?** *(check one)*
(We realize that this may be difficult to answer.)

- ☐ Once every 10 years
- ☐ Once every 5 years
- ☐ Once every 2 years
- ☐ Once every year
- ☐ More than 2 times per year
- ☐ Other: When ever we have a hard rain

5. **May we contact you for additional information?**

Name: LINDA SCHAMPERA HOA-Board Member
Phone: 509-346-2031 or 425-445-6679 cell
Email: lindaschampera@Gmail.Com

Marine View Heights
Known Problems Questionnaire

Project Informational Meeting
April 18, 2013

1. **Problem Identification No.:** #1 *(place numbered sticker on the map near the problem location)*

2. **Where does the problem occur?** *(address, intersection, general location)*

southeast corner of golf course
The county collection area

3. **What type of problem(s) occurs?** *(check all that apply)*

- ☑ Flooding
- ☑ Damaged Infrastructure (pipe, culvert, catch basin)
- ☐ Sediment Accumulation
- ☑ Erosion
- ☐ Debris Build-up
- ☐ Blocked/Undersized Culvert
- ☐ Other: _____

4. **About how frequently does the problem occur?** *(check one)*
(We realize that this may be difficult to answer.)

- ☐ Once every 10 years
- ☐ Once every 5 years
- ☑ Once every 2 years
- ☐ Once every year
- ☐ More than 2 times per year
- ☐ Other: _____

5. **May we contact you for additional information?**

Name: Greg Haynes
Phone: 509-431-4337
Email: ~~ghaynes@hdbllc.~~ ghaynes@hdbllc.net

Marine View Heights
Known Problems Questionnaire

Project Informational Meeting
April 18, 2013

1. **Problem Identification No.:** #8 *(place numbered sticker on the map neor the problem location)*

2. **Where does the problem occur?** *(address, intersection, general location)*

6852 Canal St. S.E. Othello, Wa.
(

3. **What type of problem(s) occurs?** *(check all that apply)*

☒ Flooding	☐ Damaged Infrastructure (pipe, culvert, catch basin)	☐ Sediment Accumulation
☒ Erosion	☐ Debris Build-up	☐ Blocked/Undersized Culvert

☐ Other: (driveways across road floods us goes down side access & floods neighbor below #50 on down the hill)

4. **About how frequently does the problem occur?** *(check one)*
(We realize that this may be difficult to answer.)

☐ Once every 10 years	☐ Once every 5 years	☐ Once every 2 years
☒ Once every year	☐ More than 2 times per year	

☐ Other: _____

5. **May we contact you for additional information?**

Name: Rick & Julie Nelson
Phone: Cell 425-239-6696 425.239-7162
Email: julienelson@gmail.com

Marine View Heights
Known Problems Questionnaire #9

Project Informational Meeting
April 18, 2013

1. **Problem Identification No.:** #9 *(place numbered sticker on the map near the problem location)*

2. **Where does the problem occur?** *(address, intersection, general location)*

Water Comes over El Camino thru the landscape grows driveway washes under House and on to driveway and Belmont St.

3. **What type of problem(s) occurs?** *(check all that apply)*

- [x] Flooding
- [x] Damaged Infrastructure (pipe, culvert, catch basin)
- [x] Sediment Accumulation
- [x] Erosion
- [ ] Debris Build-up
- [ ] Blocked/Undersized Culvert
- [ ] Other: _____

4. **About how frequently does the problem occur?** *(check one)*
(We realize that this may be difficult to answer.)

- [ ] Once every 10 years
- [ ] Once every 5 years
- [x] Once every 2 years
- [ ] Once every year
- [ ] More than 2 times per year
- [ ] Other: _____

5. **May we contact you for additional information?**

Name: Jon + Wilma Fay
Phone: 509-431-1632
Email: _____

Marine View Heights
Known Problems Questionnaire

Project Informational Meeting
April 18, 2013

1. **Problem Identification No.:** 10 *(place numbered sticker on the map near the problem location)*

2. **Where does the problem occur?** *(address, intersection, general location)*

5 LOTS W/ AURORA ON BELMONT

3. **What type of problem(s) occurs?** *(check all that apply)*

- ☐ Flooding
- ☐ Damaged Infrastructure (pipe, culvert, catch basin)
- ☐ Sediment Accumulation
- ☐ Erosion
- ☐ Debris Build-up
- ☑ Blocked/Undersized Culvert
- ☐ Other: CULVERT ELEVATION TOO HIGH TO CAPTURE FLOWS

4. **About how frequently does the problem occur?** *(check one)*
(We realize that this may be difficult to answer.)

- ☐ Once every 10 years
- ☐ Once every 5 years
- ☐ Once every 2 years
- ☑ Once every year
- ☐ More than 2 times per year
- ☐ Other:

5. **May we contact you for additional information?**

Name: IRVIN E WARNER
Phone: 509-346-1345 CEL 253-921-9464
Email: IRNDM@SPEEDYNET.NET

Marine View Heights
Known Problems Questionnaire

Project Informational Meeting
April 18, 2013

1. **Problem Identification No.:** 11 *(place numbered sticker on the map near the problem location)*

2. **Where does the problem occur?** *(address, intersection, general location)*

703 BELLEVUE ST

3. **What type of problem(s) occurs?** *(check all that apply)*

☐ Flooding	☐ Damaged Infrastructure (pipe, culvert, catch basin)	☐ Sediment Accumulation
☑ Erosion	☐ Debris Build-up	☐ Blocked/Undersized Culvert

☐ Other: WATER RUNS S. POOLS DRIVEWAY & UNDERCUTS D/W

4. **About how frequently does the problem occur?** *(check one)*
(We realize that this may be difficult to answer.)

☐ Once every 10 years	☐ Once every 5 years	☐ Once every 2 years
☐ Once every year	☑ More than 2 times per year	

☐ Other: _____

5. **May we contact you for additional information?**

Name: _____

Phone: _____

Email: _____

Appendix C—Drainage Deficiencies Figures and Calculations

Marine View Heights Stormwater Management Review

Figure C.1

Drainage System Deficiencies
10-Year, 3-Hour Storm Event (0.69 in)

- Culvert (Need More Capacity)
- Culvert (Adequate)
- Culvert (Not Analyzed)
- Ditch (Adequate)
- Ditch (Not Analyzed)
- Berm
- 10 ft Contour
- Drainage Basin Outfall Flow Direction
- Drainage Sub-Basin

Aerial Imagery: 2011 NAIP

0 200 400 800 Feet

N

URS

Date Created: 6/20/2013

Marine View Heights Stormwater Management Review

Figure C.2

Drainage System Deficiencies
25-Year, 3-Hour Storm Event (0.92 in)

- Culvert (Need More Capacity)
- Culvert (Adequate)
- Culvert (Not Analyzed)
- Ditch (Adequate)
- Ditch (Not Analyzed)
- Berm
- 10 ft Contour
- Drainage Basin Outfall Flow Direction
- Drainage Sub-Basin

Aerial Imagery: 2011 NAIP

0 200 400 800 Feet

N

URS

Date Created: 6/20/2013

Marine View Heights
Stormwater Management Review

Figure C.3

Drainage System Deficiencies
100-Year, 3-Hour Storm Event (1.39 in)

- Culvert (Need More Capacity)
- Culvert (Adequate)
- Culvert (Not Analyzed)
- Ditch (Adequate)
- Ditch (Not Analyzed)
- Berm
- 10 ft Contour
- Drainage Basin Outfall Flow Direction
- Drainage Sub-Basin

Aerial Imagery: 2011 NAIP

0 200 400 800 Feet

N

URS

Date Created: 6/20/2013

SR 262
Frontenac St
Highland Dr
Cascadia Ave
Bayview Ave
Aloha Ave
Terrace Ave
Summit Ave
Bellevue St
Plaza St
Lacona St
Belmont St
El Camino St
Canal St
Nobhill St
Aurora St
El Camino Ct
Frontenac Rd
1
2
3
4
5
115
134
117
118
76
91
141
1
27
43
100
144
50
104
58

Hydraulic Capacity Analysis - Existing Culvert Conditions

WSDOT Storm Sewer Design Spreadsheet and
WSDOT Hydraulics Manual - Chapter 4 Open Channel Flow

Calculated By:	E. Pruneda	Date:	6/20/2013	Project:	Grant County
Checked By:	J. Knutson	Date:	6/21/2013	Project No:	36310174
				Sheet No:	1 of 1

Existing Culvert Conditions								10-Year, 3-Hour Storm Event					25-Year, 3-Hour Storm Event					100-Year, 3-Hour Storm Event				
Culvert ID	Pipe Dia. (ft)	Manning "n"	Pipe Length (ft)	Upstr. Invert Elev. (ft) [1]	Downstr. Invert Elev. (ft) [1]	Elevation Change (ft)	Pipe Slope (ft/ft)	Total Flow (cfs)	Depth of Flow (ft)	Velocity of Flow (ft/s)	Pipe Capacity (cfs)	Pipe Capacity Check [2]	Total Flow (cfs)	Depth of Flow (ft)	Velocity of Flow (ft/s)	Pipe Capacity (cfs)	Pipe Capacity Check [2]	Total Flow (cfs)	Depth of Flow (ft)	Velocity of Flow (ft/s)	Pipe Capacity (cfs)	Pipe Capacity Check [2]
1	1.5	0.013	48.0	Slope Measured in Field			0.010	12.39	1.50	7.01	12.39	Need More Capacity	18.43	1.50	10.43	18.43	Need More Capacity	33.30	1.50	18.84	33.30	Need More Capacity
2	1.5	0.013	48.0	Slope Measured in Field			0.025	2.02	0.35	6.36	11.25	Adequate	3.01	0.43	7.13	12.61	Adequate	5.43	0.59	8.41	14.86	Adequate
19	1.5	0.013	68.0	Slope Measured in Field			0.137	5.19	0.37	15.29	27.03	Adequate	7.70	0.45	17.12	30.25	Adequate	13.90	0.62	20.16	35.62	Adequate
23	1.5	0.013	60.0	Slope Measured in Field			0.076	8.75	0.57	14.35	25.37	Adequate	12.99	0.70	15.94	28.17	Adequate	23.45	1.02	18.25	32.24	Adequate
27	1.5	0.013	51.0	Slope Measured in Field			0.028	12.02	0.92	10.63	18.79	Adequate	17.86	1.50	10.11	17.86	Need More Capacity	32.26	1.50	18.26	32.26	Need More Capacity
30	1	0.013	20.0	Slope Measured in Field			0.015	0.87	0.30	4.34	3.41	Adequate	1.29	0.37	4.84	3.80	Adequate	2.33	0.52	5.65	4.43	Adequate
35	1.5	0.013	65.0	Slope Measured in Field			0.057	2.30	0.31	8.85	15.64	Adequate	3.39	0.37	9.90	17.50	Adequate	6.13	0.50	11.72	20.71	Adequate
43	1	0.013	86.8	1161.70	1160.22	1.48	0.017	3.93	0.71	6.64	5.22	Adequate	5.82	1.00	7.41	5.82	Need More Capacity	10.51	1.00	13.38	10.51	Need More Capacity
50	1	0.013	16.1	1189.58	1188.62	0.96	0.060	3.98	0.47	10.83	8.50	Adequate	5.88	0.60	11.90	9.34	Adequate	10.62	1.00	13.52	10.62	Need More Capacity
58	1	0.013	38.6	1218.73	1216.95	1.78	0.046	4.55	0.56	10.16	7.98	Adequate	6.73	0.73	10.99	8.63	Adequate	12.15	1.00	15.46	12.15	Need More Capacity
76	1.5	0.013	54.2	1130.80	1128.77	2.03	0.037	8.36	0.67	10.94	19.33	Adequate	12.47	0.85	12.08	21.36	Adequate	22.57	1.50	12.77	22.57	Need More Capacity
79	1.5	0.013	57.3	1158.76	1156.03	2.73	0.048	6.92	0.57	11.36	20.08	Adequate	10.32	0.71	12.63	22.32	Adequate	18.66	1.03	14.46	25.55	Adequate
81	1.5	0.013	49.5	1187.58	1184.45	3.13	0.063	6.18	0.49	12.20	21.55	Adequate	9.20	0.61	13.61	24.05	Adequate	16.63	0.86	15.80	27.92	Adequate
83	1.5	0.013	53.1	1208.19	1204.55	3.64	0.069	5.11	0.44	11.90	21.03	Adequate	7.60	0.54	13.30	23.50	Adequate	13.74	0.75	15.56	27.49	Adequate
91	1	0.013	24.0	1130.90	1130.79	0.11	0.005	2.59	1.00	3.30	2.59	Need More Capacity	3.82	1.00	4.86	3.82	Need More Capacity	6.90	1.00	8.79	6.90	Need More Capacity
95	1	0.013	26.4	1159.32	1158.76	0.56	0.021	1.35	0.35	5.55	4.36	Adequate	1.98	0.43	6.17	4.84	Adequate	3.59	0.61	7.13	5.60	Adequate
100	1	0.013	30.9	1188.59	1188.39	0.20	0.006	1.74	0.56	3.82	3.00	Adequate	2.56	0.74	4.12	3.24	Adequate	4.62	1.00	5.89	4.62	Need More Capacity
104	1	0.013	22.6	1208.40	1208.32	0.08	0.004	2.98	1.00	3.79	2.98	Need More Capacity	4.38	1.00	5.58	4.38	Need More Capacity	7.93	1.00	10.10	7.93	Need More Capacity
115	1.5	0.013	50.7	1080.59	1079.96	0.63	0.012	14.29	1.50	8.09	14.29	Need More Capacity	21.25	1.50	12.03	21.25	Need More Capacity	38.39	1.50	21.73	38.39	Need More Capacity
117	1.5	0.013	86.9	1089.68	1085.68	4.00	0.046	13.20	0.82	13.25	23.42	Adequate	19.60	1.08	14.36	25.38	Adequate	35.40	1.50	20.03	35.40	Need More Capacity
118	1.5	0.013	63.6	1104.81	1101.09	3.72	0.058	11.87	0.72	14.13	24.97	Adequate	17.61	0.92	15.52	27.43	Adequate	31.79	1.50	17.99	31.79	Need More Capacity
121	1.5	0.013	48.3	1130.73	1124.70	6.03	0.125	9.73	0.52	17.69	31.25	Adequate	14.42	0.65	19.68	34.77	Adequate	26.02	0.93	22.73	40.17	Adequate
123	1.5	0.013	28.1	1143.81	1140.64	3.17	0.113	8.74	0.51	16.55	29.25	Adequate	12.94	0.63	18.43	32.56	Adequate	23.36	0.89	21.34	37.71	Adequate
125	1.5	0.013	61.1	1159.71	1156.37	3.34	0.055	6.91	0.54	11.94	21.10	Adequate	10.23	0.68	13.26	23.43	Adequate	18.46	0.97	15.26	26.97	Adequate
129	1.5	0.013	51.1	1187.88	1184.14	3.74	0.073	4.73	0.41	11.92	21.06	Adequate	6.98	0.51	13.30	23.51	Adequate	12.61	0.70	15.60	27.57	Adequate
131	1.5	0.013	61.7	1210.28	1205.51	4.77	0.077	2.69	0.31	10.32	18.24	Adequate	3.97	0.37	11.55	20.41	Adequate	7.17	0.51	13.67	24.15	Adequate
133	1.5	0.013	54.2	1234.57	1229.02	5.55	0.102	0.40	0.12	6.45	11.40	Adequate	0.59	0.14	7.26	12.84	Adequate	1.08	0.18	8.67	15.33	Adequate
134	1	0.013	51.3	1086.54	1085.48	1.06	0.021	2.12	0.45	6.21	4.88	Adequate	3.12	0.56	6.84	5.37	Adequate	5.65	1.00	7.19	5.65	Need More Capacity
136	1	0.013	37.9	1138.67	1137.09	1.58	0.042	1.28	0.28	6.98	5.48	Adequate	1.89	0.35	7.78	6.11	Adequate	3.42	0.48	9.12	7.16	Adequate
137	1	0.013	25.2	1161.34	1159.98	1.36	0.054	2.49	0.38	9.22	7.24	Adequate	3.67	0.47	10.22	8.03	Adequate	6.64	0.68	11.71	9.20	Adequate
141	1	0.013	61.0	1188.59	1188.44	0.15	0.002	2.04	1.00	2.60	2.04	Need More Capacity	3.00	1.00	3.82	3.00	Need More Capacity	5.43	1.00	6.92	5.43	Need More Capacity
144	1	0.013	76.0	1210.63	1210.54	0.09	0.001	2.10	1.00	2.67	2.10	Need More Capacity	3.09	1.00	3.93	3.09	Need More Capacity	5.58	1.00	7.11	5.58	Need More Capacity

Note: Only select "worst-case scenario" culverts were analyzed for hydraulic capacity.

[1] Elevations obtained from USGS National Elevation Dataset GIS data.

[2] Culverts that "Need More Capacity" are shown on Figures X through X.

Hydraulic Capacity Analysis - Existing Ditch Conditions

WSDOT Storm Sewer Design Spreadsheet and
WSDOT Hydraulics Manual - Chapter 4 Open Channel Flow

Calculated By:	E. Pruneda	Date:	6/20/2013	Project:	Grant County
Checked By:	J. Knutson	Date:	6/21/2013	Project No:	36310174
				Sheet No:	1 of 1

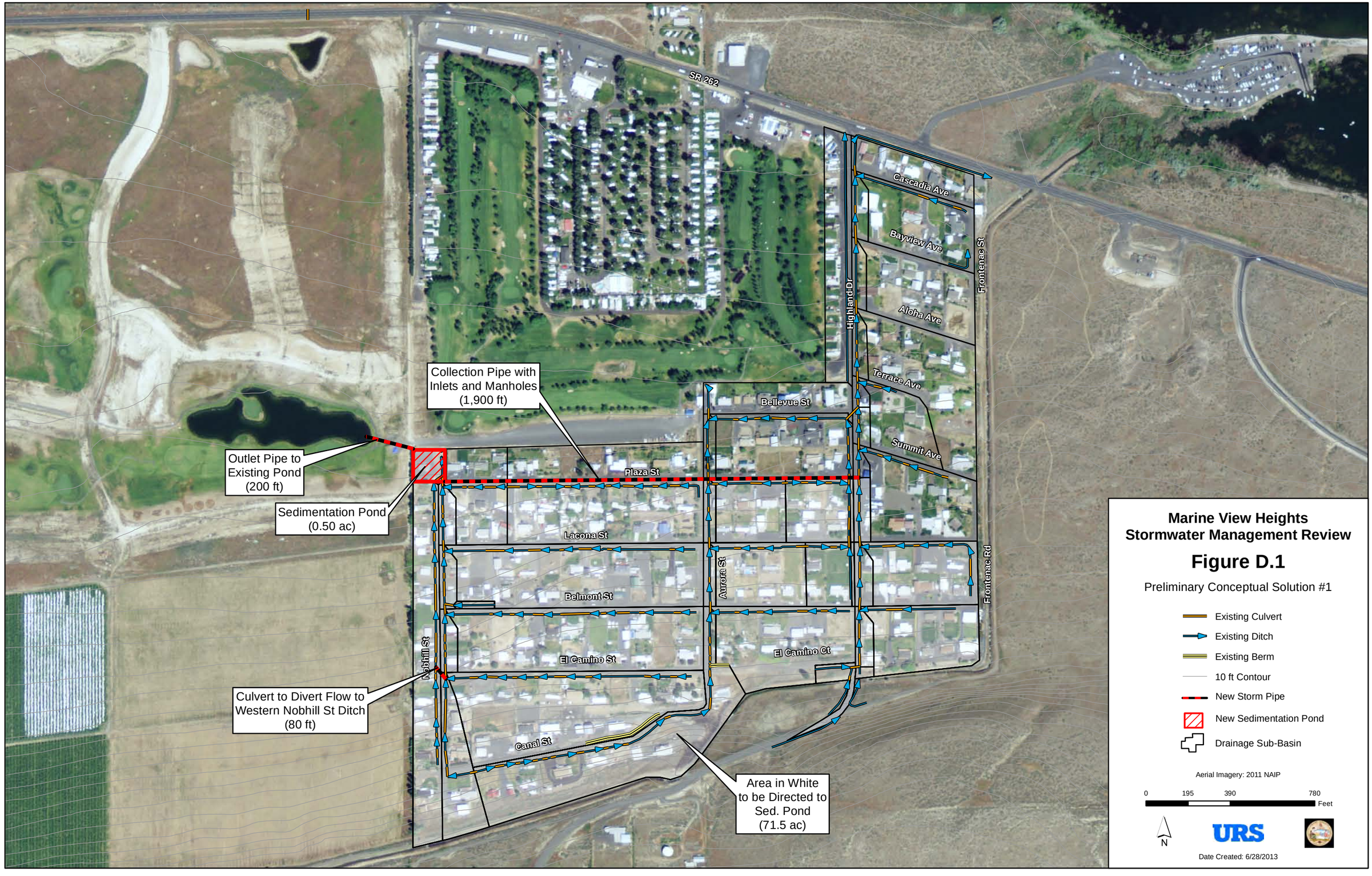
Existing Ditch Conditions												10-Year, 3-Hour Storm Event					25-Year, 3-Hour Storm Event					100-Year, 3-Hour Storm Event				
Ditch ID	Side Slope Left (ft/ft)	Side Slope Right (ft/ft)	Manning "n"	Bottom Width (ft)	Top Width (ft)	Ditch Depth (ft)	Ditch Length (ft)	Upstr. Invert Elev. (ft) [1]	Downstr. Invert Elev. (ft) [1]	Elevation Change (ft)	Ditch Slope (ft/ft)	Total Flow (cfs)	Depth of Flow (ft)	Velocity of Flow (ft/s)	Ditch Capacity (cfs)	Ditch Capacity Check [2]	Total Flow (cfs)	Depth of Flow (ft)	Velocity of Flow (ft/s)	Ditch Capacity (cfs)	Ditch Capacity Check [2]	Total Flow (cfs)	Depth of Flow (ft)	Velocity of Flow (ft/s)	Ditch Capacity (cfs)	Ditch Capacity Check [2]
2	2.708	2.708	0.022	3	9.5	1.2	93.0	Slope Measured in Field			0.010	14.38	0.71	4.11	30.81	Adequate	21.40	0.87	4.59	34.39	Adequate	38.66	1.17	5.38	40.33	Adequate
3	1.367	1.367	0.022	1.9	6	1.5	96.2	Slope Measured in Field			0.063	2.02	0.19	4.99	29.59	Adequate	3.01	0.24	5.71	33.83	Adequate	5.43	0.33	6.91	40.96	Adequate
19	1.636	1.636	0.022	2	5.6	1.1	92.7	Slope Measured in Field			0.166	1.07	0.09	5.34	22.31	Adequate	1.59	0.12	6.15	25.70	Adequate	2.87	0.17	7.56	31.58	Adequate
23	1.875	1.875	0.022	1.5	9	2	89.3	1188.25	1181.29	6.96	0.078	5.18	0.33	7.33	76.96	Adequate	7.69	0.41	8.22	86.30	Adequate	13.88	0.56	9.70	101.80	Adequate
26	1.357	1.357	0.022	2.2	6	1.4	71.9	1162.99	1159.73	3.26	0.045	8.65	0.44	6.96	39.94	Adequate	12.85	0.55	7.84	45.00	Adequate	23.21	0.77	9.30	53.40	Adequate
30	1.825	1.825	0.022	2	9.3	2	86.3	1145.79	1141.70	4.09	0.047	11.70	0.52	7.58	85.60	Adequate	17.41	0.65	8.48	95.80	Adequate	31.45	0.88	9.97	112.69	Adequate
31	1.647	1.647	0.022	2	7.6	1.7	90.3	Slope Measured in Field			0.003	0.87	0.27	1.35	10.99	Adequate	1.29	0.33	1.52	12.44	Adequate	2.33	0.46	1.82	14.88	Adequate
37	1.067	1.067	0.022	2.8	6	1.5	80.7	1148.25	1147.40	0.85	0.011	3.70	0.37	3.14	20.70	Adequate	5.46	0.46	3.56	23.51	Adequate	9.87	0.66	4.29	28.33	Adequate
43	2.000	2.000	0.022	2	8	1.5	193.4	1160.22	1158.38	1.84	0.010	3.93	0.44	3.09	23.15	Adequate	5.82	0.55	3.45	25.91	Adequate	10.51	0.74	4.07	30.53	Adequate
51	1.250	1.250	0.022	2	7	2	205.2	1189.58	1181.29	8.29	0.040	3.98	0.31	5.36	48.20	Adequate	5.88	0.39	6.07	54.60	Adequate	10.62	0.55	7.26	65.30	Adequate
60	1.000	1.000	0.022	1.7	4.5	1.4	108.7	1216.95	1211.02	5.93	0.055	4.55	0.34	6.48	28.11	Adequate	6.73	0.43	7.31	31.72	Adequate	12.15	0.61	8.69	37.73	Adequate
80	1.000	1.000	0.012	1	3	1	106.0	1128.77	1122.73	6.04	0.057	8.36	0.45	12.85	25.70	Adequate	12.47	0.56	14.33	28.65	Adequate	22.57	0.76	16.74	33.49	Adequate
81	0.946	0.946	0.022	1.5	6.8	2.8	113.3	1142.52	1130.80	11.72	0.103	6.80	0.39	9.35	108.67	Adequate	10.14	0.49	10.53	122.39	Adequate	18.36	0.69	12.46	144.83	Adequate
84	1.087	1.087	0.022	3	8	2.3	104.2	1168.00	1158.76	9.24	0.089	6.08	0.25	7.35	92.96	Adequate	9.06	0.32	8.44	106.80	Adequate	16.38	0.46	10.29	130.22	Adequate
86	1.087	1.087	0.022	3	8	2.3	134.9	1193.93	1187.58	6.35	0.047	5.05	0.27	5.61	70.91	Adequate	7.51	0.35	6.43	81.31	Adequate	13.58	0.49	7.82	98.97	Adequate
88	1.094	1.094	0.022	1.5	5	1.6	110.7	1214.43	1208.19	6.24	0.056	3.08	0.29	5.89	30.61	Adequate	4.58	0.36	6.65	34.60	Adequate	8.28	0.51	7.93	41.22	Adequate
95	0.974	0.974	0.022	3.3	7	1.9	114.9	1131.00	1130.80	0.20	0.002	2.59	0.47	1.48	14.48	Adequate	3.82	0.59	1.68	16.43	Adequate	6.90	0.83	2.02	19.78	Adequate
100	1.846	1.846	0.022	1.6	6.4	1.3	19.9	1159.06	1158.76	0.30	0.015	1.35	0.24	2.73	14.19	Adequate	1.98	0.30	3.08	15.99	Adequate	3.59	0.41	3.66	19.05	Adequate
105	1.559	1.559	0.022	2.7	8	1.7	80.0	1169.54	1169.49	0.05	0.001	1.24	0.44	0.83	7.54	Adequate	1.82	0.55	0.93	8.50	Adequate	3.29	0.76	1.11	10.13	Adequate
106	1.533	1.533	0.022	1.4	6	1.5	113.2	1188.39	1187.58	0.81	0.007	1.74	0.37	2.36	13.11	Adequate	2.56	0.46	2.64	14.65	Adequate	4.62	0.63	3.11	17.26	Adequate
110	1.000	1.000	0.022	2.4	6	1.8	55.9	1188.00	1187.92	0.08	0.001	0.87	0.31	1.03	7.80	Adequate	1.28	0.39	1.17	8.87	Adequate	2.32	0.55	1.42	10.71	Adequate
111	1.308	1.308	0.022	2.2	5.6	1.3	111.7	1208.36	1208.19	0.17	0.002	2.98	0.64	1.54	7.83	Adequate	4.38	0.79	1.73	8.75	Adequate	7.93	1.08	2.03	10.31	Adequate
117	0.964	0.964	0.022	1.6	4.3	1.4	1151.8	1129.14	1076.92	52.22	0.045	0.36	0.08	2.59	10.70	Adequate	0.53	0.11	2.98	12.31	Adequate	0.97	0.15	3.69	15.23	Adequate
118	1.050	1.050	0.022	1.2	5.4	2	78.7	1155.86	1151.49	4.37	0.056	2.30	0.28	5.56	36.70	Adequate	3.39	0.35	6.25	41.24	Adequate	6.13	0.48	7.41	48.89	Adequate
121	1.050	1.050	0.022	1.2	5.4	2	99.5	1176.76	1169.49	7.27	0.073	1.00	0.16	4.67	30.82	Adequate	1.47	0.20	5.30	35.00	Adequate	2.66	0.28	6.40	42.21	Adequate
124	1.382	1.382	0.022	1.3	6	1.7	243.2	1205.40	1187.92	17.48	0.072	0.06	0.03	1.63	10.13	Adequate	0.09	0.04	1.89	11.71	Adequate	0.16	0.05	2.36	14.65	Adequate
125	1.591	1.591	0.022	0	7	2.2	40.5	1247.82	1242.25	5.57	0.138	0.34	0.21	4.96	38.23	Adequate	0.51	0.24	5.47	42.09	Adequate	0.91	0.30	6.34	48.84	Adequate
127	1.500	1.500	0.022	2	6.8	1.6	146.0	1079.96	1078.14	1.82	0.012	13.92	0.84	5.04	35.51	Adequate	20.71	1.04	5.62	39.53	Adequate	37.42	1.39	6.56	46.20	Adequate
128	1.000	1.000	0.022	1.9	6.3	2.2	132.9	1082.65	1080.59	2.06	0.016	12.81	0.84	5.56	50.19	Adequate	19.05	1.04	6.20	55.92	Adequate	34.41	1.43	7.25	65.36	Adequate
130	1.000	1.000	0.022	1.9	6.3	2.2	256.9	1101.08	1089.68	11.4	0.044	11.50	0.59	7.86	70.91	Adequate	17.09	0.74	8.81	79.45	Adequate	30.86	1.02	10.37	93.53	Adequate
131	1.000	1.000	0.022	1.9	6.3	2.2	122.6	1114.56	1104.81	9.75	0.080	9.47	0.44	9.10	82.05	Adequate	14.06	0.56	10.25	92.41	Adequate	25.38	0.78	12.14	109.54	Adequate
135	1.100	1.100	0.022	1.4	5.8	2	46.5	1140.64	1137.73	2.91	0.063	8.69	0.52	8.39	60.42	Adequate	12.87	0.65	9.36	67.41	Adequate	23.24	0.89	10.97	79.02	Adequate
136	1.000	1.000	0.022	1.8	5.8	2	65.3	1152.98	1143.81	9.17	0.140	6.84	0.32	10.07	76.53	Adequate	10.13	0.40	11.40	86.65	Adequate	18.29	0.57	13.61	103.47	Adequate
138	1.353	1.353	0.022	2.4	7	1.7	83.7	1162.72	1159.71	3.01	0.036	4.78	0.32	5.24	41.88	Adequate	7.08	0.40	5.95	47.53	Adequate	12.78	0.57	7.14	57.02	Adequate
142	1.500	1.500	0.022	2.2	7.6	1.8	69.8	1191.63	1187.88	3.75	0.054	2.86	0.22	5.11	45.07	Adequate	4.22	0.28	5.82	51.33	Adequate	7.62	0.39	7.03	62.00	Adequate
144	1.583	1.583	0.022	1.5	7.2	1.8	58.7	1215.46	1210.22	5.24	0.089	0.67	0.10	4.03	31.56	Adequate	0.99	0.13	4.61	36.11	Adequate	1.80	0.18	5.63	44.05	Adequate
146	1.583	1.583	0.022	1.5	7.2	1.8	41.3	1247.81	1234.57	13.24	0.321	0.06	0.02	2.42	18.97	Adequate	0.09	0.02	2.83	22.18	Adequate	0.16	0.03	3.56	27.91	Adequate
149	2.200	2.200	0.022	2.8	5	0.5	305.4	1085.53	1080.59	4.94	0.016	2.12	0.23	2.85	5.56	Adequate	3.12	0.28	3.24	6.32	Adequate	5.65	0.39	3.91	7.63	Adequate
153	2.050	2.050	0.022	1.2	5.3	1	76.2	1137.10	1135.11	1.99	0.026	1.28	0.23	3.36	10.91	Adequate	1.89	0.28	3.76	12.22	Adequate	3.42	0.39	4.44	14.44	Adequate
155	1.654	1.654	0.022	1.7	6	1.3	91.2	1159.98	1159.7	0.28	0.003	2.49	0.52	1.89	9.44	Adequate	3.67	0.64	2.10	10.51	Adequate	6.64	0.86	2.47	12.35	Adequate
159	1.538	1.538	0.022	1.7	5.7	1.3	102.7	1188.44	1187.88	0.56	0.005	2.04	0.40	2.20	10.58	Adequate	3.00	0.50	2.46	11.84	Adequate	5.43	0.68	2.91	13.99	Adequate
167	1.500	1.500	0.022	1	4	1	124.5	1210.54	1210.22	0.32	0.003	2.10	0.62	1.76	4.40	Adequate	3.09	0.75	1.95	4.87	Adequate	5.58	0.99	2.27	5.67	Adequate

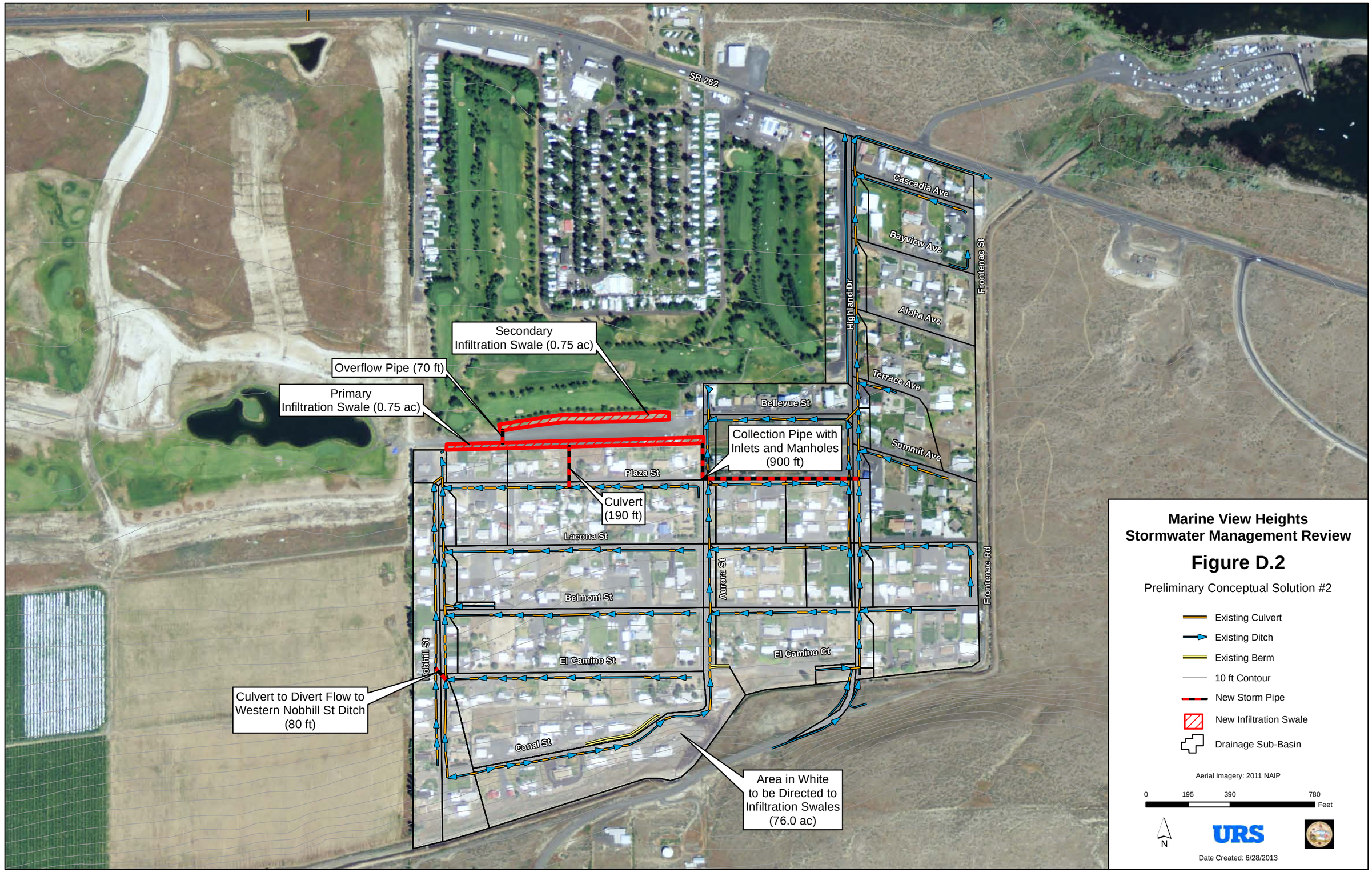
Note: Only select "worst-case scenario" ditch reaches were analyzed for hydraulic capacity.

[1] Elevations obtained from USGS National Elevation Dataset GIS data.

[2] Ditch reaches that "Need More Capacity" are shown on Figures X through X.

Appendix D—Preliminary Solution Concepts


SR 262
Cascadia Ave
Bayview Ave
Aloha Ave
Terrace Ave
Summit Ave
Highland Dr
Frontenac St
Bellevue St
Plaza St
Lacona St
Belmont St
El Camino St
El Camino Ct
Aurora St
Nobhill St
Canal St
Collection Pipe with Inlets and Manholes (1,900 ft)
Outlet Pipe to Existing Pond (200 ft)
Sedimentation Pond (0.50 ac)
Culvert to Divert Flow to Western Nobhill St Ditch (80 ft)
Area in White to be Directed to Sed. Pond (71.5 ac)
Marine View Heights
Stormwater Management Review
Figure D.1
Preliminary Conceptual Solution #1
Existing Culvert
Existing Ditch
Existing Berm
10 ft Contour
New Storm Pipe
New Sedimentation Pond
Drainage Sub-Basin
Aerial Imagery: 2011 NAIP
0
195
390
780
Feet
N
URS
Date Created: 6/28/2013



Marine View Heights Stormwater Management Review

Figure D.2

Preliminary Conceptual Solution #2

- Existing Culvert
- Existing Ditch
- Existing Berm
- 10 ft Contour
- New Storm Pipe
- New Infiltration Swale
- Drainage Sub-Basin

Aerial Imagery: 2011 NAIP

0 195 390 780 Feet

N

URS

Date Created: 6/28/2013

Marine View Heights Stormwater Management Review

Figure D.3

Preliminary Conceptual Solution #3

- Existing Culvert
- Existing Ditch
- Existing Berm
- 10 ft Contour
- New Storm Pipe
- New Open Channel or Storm Pipe
- Drainage Sub-Basin

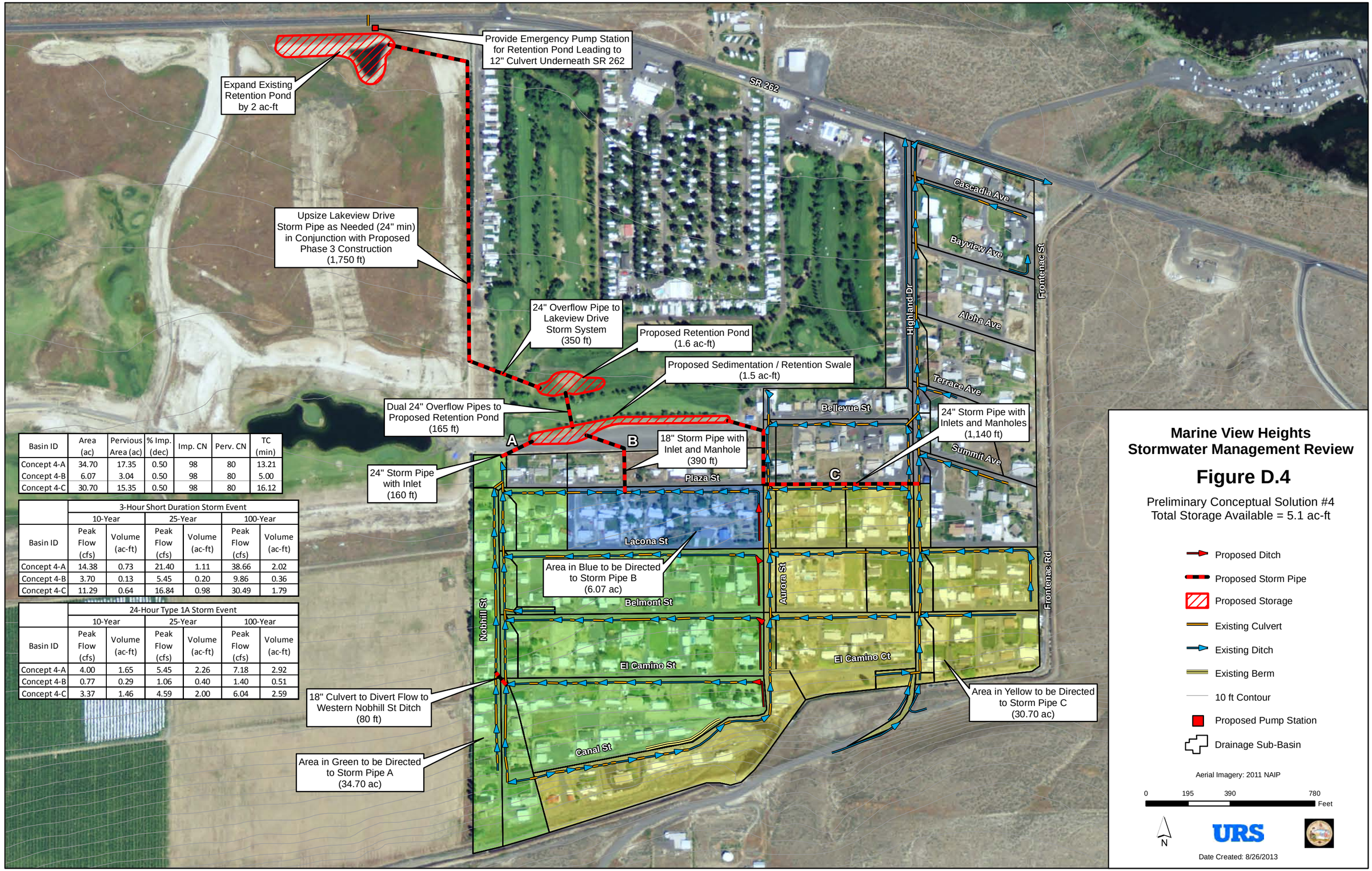
Aerial Imagery: 2011 NAIP

0 245 490 980 Feet

N

URS

Date Created: 6/28/2013



Basin ID	Area (ac)	Pervious Area (ac)	% Imp. (dec)	Imp. CN	Perv. CN	TC (min)
Concept 4-A	34.70	17.35	0.50	98	80	13.21
Concept 4-B	6.07	3.04	0.50	98	80	5.00
Concept 4-C	30.70	15.35	0.50	98	80	16.12

	3-Hour Short Duration Storm Event					
	10-Year		25-Year		100-Year	
Basin ID	Peak Flow (cfs)	Volume (ac-ft)	Peak Flow (cfs)	Volume (ac-ft)	Peak Flow (cfs)	Volume (ac-ft)
Concept 4-A	14.38	0.73	21.40	1.11	38.66	2.02
Concept 4-B	3.70	0.13	5.45	0.20	9.86	0.36
Concept 4-C	11.29	0.64	16.84	0.98	30.49	1.79

	24-Hour Type 1A Storm Event					
	10-Year		25-Year		100-Year	
Basin ID	Peak Flow (cfs)	Volume (ac-ft)	Peak Flow (cfs)	Volume (ac-ft)	Peak Flow (cfs)	Volume (ac-ft)
Concept 4-A	4.00	1.65	5.45	2.26	7.18	2.92
Concept 4-B	0.77	0.29	1.06	0.40	1.40	0.51
Concept 4-C	3.37	1.46	4.59	2.00	6.04	2.59

Marine View Heights Stormwater Management Review

Figure D.4

Preliminary Conceptual Solution #4
Total Storage Available = 5.1 ac-ft

- Proposed Ditch
- Proposed Storm Pipe
- Proposed Storage
- Existing Culvert
- Existing Ditch
- Existing Berm
- 10 ft Contour
- Proposed Pump Station
- Drainage Sub-Basin

Aerial Imagery: 2011 NAIP

0 195 390 780 Feet

N

URS

Date Created: 8/26/2013

Appendix E—Preferred Solution Alternative Figures, Calculations, and Cost Estimate

Provide Emergency Pump Station for Retention Pond Leading to 12" Culvert Underneath SR 262

Expand Existing Retention Pond by 2 ac-ft

SR 262

F

Upsize Lakeview Drive Storm Pipe as Needed (24" min) in Conjunction with Proposed Phase 3 Construction (1,575 ft)

24" Overflow Pipe to Lakeview Drive Storm System (450 ft)

Proposed Retention Pond (1.6 ac-ft)

Proposed Sedimentation / Retention Swale (1.5 ac-ft)

E

D1

D2

Dual 18" Overflow Pipes to Proposed Retention Pond (165 ft)

A

B

18" Storm Pipe with Inlet and Manhole (390 ft)

C2

C1

24" Storm Pipe with Inlets and Manhole (1,140 ft)

24" Storm Pipe with Inlet (160 ft)

Plaza St

Lacona St

Area in Blue to be Directed to Storm Pipe B (6.07 ac)

Belmont St

G

18" Culvert to Divert Flow to Western Nobhill St Ditch (80 ft)

New Ditches Along West Edge of Auroa St

El Camino St

Nobhill St

Canal St

Area in Green to be Directed to Storm Pipe A (34.70 ac)

Area in Yellow to be Directed to Storm Pipe C (30.70 ac)

New Ditch and Culvert Systems on Bayview Ave and Aloha Ave

Cascadia Ave

Bayview Ave

Aloha Ave

Terrace Ave

Bellevue St

Summit Ave

Highland Dr

Frontenac St

Aurora St

El Camino Ct

Frontenac Rd

Marine View Heights Stormwater Management Review

Figure E.1

Preferred Solution Alternative
Total Storage Available = 5.1 ac-ft

- Proposed Ditch
- Proposed Storm Pipe
- Proposed Storage
- Existing Culvert
- Existing Ditch
- Existing Berm
- 10 ft Contour
- Proposed Pump Station
- Drainage Sub-Basin

Aerial Imagery: 2011 NAIP

0 195 390 780 Feet

N

URS

Date Created: 9/16/2013

Proposed Storm Pipes - Hydrologic Calculations

Stormwater Management Manual for E. WA.

Chapter 4 - Hydrologic Analysis and Design

Calculated by:	E. Pruneda	Date:	9/16/2013	Project:	Grant County
Checked by:	J. Knutson	Date:		Project No:	36310174
				Sheet No:	1 of 1

SBUH Input with Calculated Flows and Volumes:

							3-Hour Short Duration Storm Event						24-Hour Type 1A Storm Event					
							10-Year		25-Year		100-Year		10-Year		25-Year		100-Year	
Storm Pipe	Area (ac)	Pervious Area (ac)	% Imp. (dec)	Imp. CN	Perv. CN	T_C (min)	Peak Flow (cfs)	Volume (ac-ft)	Peak Flow (cfs)	Volume (ac-ft)	Peak Flow (cfs)	Volume (ac-ft)	Peak Flow (cfs)	Volume (ac-ft)	Peak Flow (cfs)	Volume (ac-ft)	Peak Flow (cfs)	Volume (ac-ft)
A	34.70	17.35	0.50	98	80	13.21	14.38	0.73	21.40	1.12	38.66	2.03	4.00	1.65	5.45	2.26	7.18	2.92
B	6.07	3.04	0.50	98	80	5.00	3.70	0.13	5.45	0.20	9.86	0.36	0.77	0.29	1.06	0.40	1.40	0.51
C	30.70	15.35	0.50	98	80	16.12	11.29	0.65	16.84	0.99	30.49	1.80	3.37	1.46	4.59	2.00	6.04	2.59
G	18.92	9.46	0.50	98	80	10.77	8.75	0.400	12.99	0.61	23.45	1.11	2.26	0.90	3.09	1.23	4.08	1.59

Note: Land use cover was approximated as 50% pervious for all basins based on delineation of pervious area in 5 sample sub-basins.

Swale Design

Δt = 0.083 hr

Note: Columns "N" and "O" are copies used for Vlookup

													X0	Y0		X1	Y1	
					orifice #1	orifice #2	weir #1	weir #2	infiltration				Ascending Order			Decending Order		
				dia/width(in)=	4.00	0.00	48.00	48.00	0.00									
				elev(ft)=	1127.50		1128.50	1128.50		total				total			total	
elev. ft	area s.f.	storage cu.ft.	storage (ac.ft)	storage (cfs-hr)	outflow cfs	outflow cfs	outflow cfs	outflow cfs	outflow cfs	outflow cfs	(2S/Δt) cfs	(2S/Δt) +O cfs	outflow cfs	storage (cfs-hr)	(2S/Δt) +O cfs	outflow cfs	storage (cfs-hr)
1127.00	16045	0	0	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	599.070	49.627	22.802
1127.50	19817	8966	0.206	2.490	0.000	0.000	0.000	0.000	0.000	0.000	60.010	60.010	0.000	2.490	453.559	27.254	17.692
1128.00	23590	19817	0.455	5.505	0.307	0.000	0.000	0.000	0.000	0.307	132.646	132.952	0.307	5.505	325.743	9.950	13.105
1128.50	27362	32555	0.747	9.043	0.434	0.000	0.000	0.000	0.000	0.434	217.907	218.341	0.434	9.043	218.341	0.434	9.043
1129.00	31135	47180	1.083	13.105	0.532	0.000	4.709	4.709	0.000	9.950	315.793	325.743	9.950	13.105	132.952	0.307	5.505
1129.50	34907	63690	1.462	17.692	0.614	0.000	13.320	13.320	0.000	27.254	426.305	453.559	27.254	17.692	60.010	0.000	2.490
1130.00	38680	82087	1.884	22.802	0.686	0.000	24.470	24.470	0.000	49.627	549.443	599.070	49.627	22.802	0.000	0.000	0.000

Project: Grant County
Pond Routing Calculation
Inflow Data Source: 100-Year, 3-Hour Storm SBUH Excel Model Run "HydrologyCalcs_13_0826.xlsx" for drainage area contributing to Swale
Pond Name: Swale
Designed By: Erik Pruneda
Date: 9/16/2013

= Values come from "Swale Config" Tab table using (2S2/Δt) + O2

Time (min)	Inflow, I (cfs)	$I_1 + I_2$ (cfs)	Outflow, O (cfs)	Storage, S (cfs-hour)	$(2S_1/\Delta t) - O_1$ (cfs)	X $(2S_2/\Delta t) + O_2$ (cfs)
Before	0	0	0	0.000	0.00	0.00
0	0.00	0.000	0.000	0.000	0.00	0.000
5	0.00	0.000	0.000	0.000	0.00	0.000
10	0.00	0.000	0.000	0.000	0.00	0.000
15	0.00	0.000	0.000	0.000	0.00	0.000
20	0.00	0.045	0.000	0.000	0.00	0.045
25	0.04	0.637	0.000	0.002	0.04	0.682
30	0.59	2.694	0.000	0.028	0.68	3.376
35	2.10	7.786	0.000	0.140	3.38	11.162
40	5.68	17.922	0.000	0.463	11.16	29.084
45	12.24	40.551	0.000	1.207	29.08	69.635
50	28.31	86.993	0.040	2.888	69.55	156.547
55	58.68	137.661	0.342	6.482	155.86	293.523
60	78.98	154.148	7.095	11.887	279.33	433.480
65	75.17	138.571	24.536	16.971	384.41	522.980
70	63.40	113.726	37.928	20.130	447.12	560.851
75	50.32	88.548	43.751	21.460	473.35	561.897
80	38.23	67.916	43.911	21.496	474.07	541.990
85	29.69	53.192	40.851	20.797	460.29	513.481
90	23.50	42.360	36.467	19.796	440.55	482.907
95	18.86	34.103	31.766	18.722	419.37	453.478
100	15.25	27.606	27.243	17.689	398.99	426.598
105	12.36	22.478	23.604	16.724	379.39	401.869
110	10.12	18.682	20.256	15.837	361.36	380.039
115	8.56	16.043	17.301	15.054	345.44	361.480
120	7.48	14.053	14.788	14.388	331.90	345.957
125	6.58	12.385	12.687	13.831	320.58	332.969
130	5.81	11.091	10.928	13.365	311.11	322.204
135	5.28	10.194	9.637	12.972	302.93	313.125
140	4.91	9.567	8.832	12.628	295.46	305.028
145	4.65	9.127	8.115	12.322	288.80	297.926
150	4.47	8.819	7.485	12.053	282.95	291.773
155	4.35	8.603	6.940	11.821	277.89	286.496
160	4.26	8.453	6.473	11.621	273.55	282.003
165	4.20	8.349	6.075	11.451	269.85	278.203
170	4.15	8.279	5.738	11.307	266.73	275.006
175	4.13	8.232	5.455	11.186	264.10	272.329
180	4.11	7.539	5.218	11.085	261.89	269.433
185	3.43	5.768	4.961	10.976	259.51	265.279
190	2.34	3.958	4.593	10.818	256.09	260.051
195	1.62	2.759	4.130	10.621	251.79	254.551
200	1.14	1.940	3.642	10.413	247.27	249.206
205	0.80	1.371	3.169	10.211	242.87	244.240
210	0.57	0.971	2.729	10.023	238.78	239.753
215	0.40	0.689	2.331	9.853	235.09	235.780
220	0.29	0.490	1.979	9.703	231.82	232.312
225	0.20	0.349	1.672	9.572	228.97	229.317
230	0.15	0.249	1.407	9.458	226.50	226.753
235	0.10	0.177	1.179	9.361	224.39	224.572
240	0.07	0.127	0.986	9.279	222.60	222.726
245	0.05	0.091	0.823	9.209	221.08	221.172
250	0.04	0.065	0.685	9.150	219.80	219.867
255	0.03	0.047	0.569	9.101	218.73	218.775
260	0.02	0.033	0.472	9.060	217.83	217.864
265	0.01	0.024	0.433	9.023	217.00	217.021
270	0.01	0.017	0.432	8.988	216.16	216.174
275	0.01	0.012	0.431	8.953	215.31	215.325
280	0.01	0.005	0.429	8.918	214.47	214.471
285	0.00	0.000	0.428	8.883	213.62	213.615
290	0.00	0.000	0.427	8.847	212.76	212.761
295	0.00	0.000	0.426	8.812	211.91	211.910
300	0.00	0.000	0.424	8.777	211.06	211.061
305	0.00	0.000	0.423	8.741	210.21	210.215
310	0.00	0.000	0.422	8.706	209.37	209.371
315	0.00	0.000	0.421	8.671	208.53	208.530
320	0.00	0.000	0.419	8.637	207.69	207.691
325	0.00	0.000	0.418	8.602	206.85	206.855
330	0.00	0.000	0.417	8.567	206.02	206.021
335	0.00	0.000	0.416	8.533	205.19	205.190
340	0.00	0.000	0.414	8.498	204.36	204.361
345	0.00	0.000	0.413	8.464	203.53	203.535
350	0.00	0.000	0.412	8.430	202.71	202.711
355	0.00	0.000	0.411	8.395	201.89	201.889
360	0.00	0.000	0.409	8.361	201.07	201.070
365	0.00	0.000	0.408	8.327	200.25	200.254
370	0.00	0.000	0.407	8.294	199.44	199.440
375	0.00	0.000	0.406	8.260	198.63	198.628
380	0.00	0.000	0.405	8.226	197.82	197.819
385	0.00	0.000	0.403	8.193	197.01	197.012
390	0.00	0.000	0.402	8.159	196.21	196.208
395	0.00	0.000	0.401	8.126	195.41	195.405
400	0.00	0.000	0.400	8.093	194.61	194.606
405	0.00	0.000	0.399	8.060	193.81	193.809
410	0.00	0.000	0.397	8.027	193.01	193.014
415	0.00	0.000	0.396	7.994	192.22	192.221
420	0.00	0.000	0.395	7.961	191.43	191.431
425	0.00	0.000	0.394	7.928	190.64	190.643
430	0.00	0.000	0.393	7.895	189.86	189.858

Time (min)	Inflow, I (cfs)	$I_1 + I_2$ (cfs)	Outflow, O (cfs)	Storage, S (cfs-hour)	$(2S_1/\Delta t) - O_1$ (cfs)	$(2S_2/\Delta t) + O_2$ (cfs)
435	0.00	0.000	0.392	7.863	189.07	189.074
440	0.00	0.000	0.390	7.830	188.29	188.294
445	0.00	0.000	0.389	7.798	187.52	187.515
450	0.00	0.000	0.388	7.766	186.74	186.739
455	0.00	0.000	0.387	7.734	185.97	185.965
460	0.00	0.000	0.386	7.702	185.19	185.194
465	0.00	0.000	0.385	7.670	184.42	184.424
470	0.00	0.000	0.383	7.638	183.66	183.657
475	0.00	0.000	0.382	7.606	182.89	182.893
480	0.00	0.000	0.381	7.574	182.13	182.130
485	0.00	0.000	0.380	7.543	181.37	181.370
490	0.00	0.000	0.379	7.511	180.61	180.612
495	0.00	0.000	0.378	7.480	179.86	179.857
500	0.00	0.000	0.377	7.448	179.10	179.103
505	0.00	0.000	0.376	7.417	178.35	178.352
510	0.00	0.000	0.374	7.386	177.60	177.603
515	0.00	0.000	0.373	7.355	176.86	176.857
520	0.00	0.000	0.372	7.324	176.11	176.112
525	0.00	0.000	0.371	7.293	175.37	175.370
530	0.00	0.000	0.370	7.262	174.63	174.630
535	0.00	0.000	0.369	7.232	173.89	173.892
540	0.00	0.000	0.368	7.201	173.16	173.156
545	0.00	0.000	0.367	7.171	172.42	172.423
550	0.00	0.000	0.366	7.140	171.69	171.692
555	0.00	0.000	0.365	7.110	170.96	170.963
560	0.00	0.000	0.363	7.080	170.24	170.236
565	0.00	0.000	0.362	7.050	169.51	169.511
570	0.00	0.000	0.361	7.020	168.79	168.789
575	0.00	0.000	0.360	6.990	168.07	168.068
580	0.00	0.000	0.359	6.960	167.35	167.350
585	0.00	0.000	0.358	6.930	166.63	166.634
590	0.00	0.000	0.357	6.900	165.92	165.920
595	0.00	0.000	0.356	6.871	165.21	165.208
600	0.00	0.000	0.355	6.841	164.50	164.498
605	0.00	0.000	0.354	6.812	163.79	163.790
610	0.00	0.000	0.353	6.783	163.08	163.085
615	0.00	0.000	0.352	6.753	162.38	162.381
620	0.00	0.000	0.351	6.724	161.68	161.680
625	0.00	0.000	0.350	6.695	160.98	160.981
630	0.00	0.000	0.349	6.666	160.28	160.284
635	0.00	0.000	0.348	6.637	159.59	159.589
640	0.00	0.000	0.347	6.609	158.90	158.896
645	0.00	0.000	0.345	6.580	158.20	158.205
650	0.00	0.000	0.344	6.551	157.52	157.516
655	0.00	0.000	0.343	6.523	156.83	156.829
660	0.00	0.000	0.342	6.494	156.14	156.144
665	0.00	0.000	0.341	6.466	155.46	155.461
670	0.00	0.000	0.340	6.438	154.78	154.780
675	0.00	0.000	0.339	6.409	154.10	154.102
680	0.00	0.000	0.338	6.381	153.43	153.425
685	0.00	0.000	0.337	6.353	152.75	152.750
690	0.00	0.000	0.336	6.325	152.08	152.078
695	0.00	0.000	0.335	6.297	151.41	151.407
700	0.00	0.000	0.334	6.270	150.74	150.738
705	0.00	0.000	0.333	6.242	150.07	150.072
710	0.00	0.000	0.332	6.214	149.41	149.407
715	0.00	0.000	0.331	6.187	148.74	148.744
720	0.00	0.000	0.330	6.159	148.08	148.084
725	0.00	0.000	0.329	6.132	147.42	147.425
730	0.00	0.000	0.328	6.104	146.77	146.768
735	0.00	0.000	0.327	6.077	146.11	146.113
740	0.00	0.000	0.326	6.050	145.46	145.460
745	0.00	0.000	0.325	6.023	144.81	144.809
750	0.00	0.000	0.325	5.996	144.16	144.160
755	0.00	0.000	0.324	5.969	143.51	143.513
760	0.00	0.000	0.323	5.942	142.87	142.868
765	0.00	0.000	0.322	5.916	142.22	142.225
770	0.00	0.000	0.321	5.889	141.58	141.583
775	0.00	0.000	0.320	5.862	140.94	140.944
780	0.00	0.000	0.319	5.836	140.31	140.306
785	0.00	0.000	0.318	5.810	139.67	139.671
790	0.00	0.000	0.317	5.783	139.04	139.037
795	0.00	0.000	0.316	5.757	138.41	138.405
800	0.00	0.000	0.315	5.731	137.78	137.775
805	0.00	0.000	0.314	5.705	137.15	137.147
810	0.00	0.000	0.313	5.679	136.52	136.521
815	0.00	0.000	0.312	5.653	135.90	135.897
820	0.00	0.000	0.311	5.627	135.27	135.274
825	0.00	0.000	0.310	5.601	134.65	134.653
830	0.00	0.000	0.309	5.575	134.03	134.035
835	0.00	0.000	0.308	5.550	133.42	133.418
840	0.00	0.000	0.308	5.524	132.80	132.803
845	0.00	0.000	0.306	5.499	132.19	132.190
850	0.00	0.000	0.304	5.473	131.58	131.583
855	0.00	0.000	0.301	5.448	130.98	130.981
860	0.00	0.000	0.299	5.423	130.38	130.383
865	0.00	0.000	0.296	5.399	129.79	129.791
870	0.00	0.000	0.294	5.374	129.20	129.204
875	0.00	0.000	0.291	5.350	128.62	128.622
880	0.00	0.000	0.289	5.326	128.04	128.045
885	0.00	0.000	0.286	5.302	127.47	127.472
890	0.00	0.000	0.284	5.278	126.90	126.905
895	0.00	0.000	0.281	5.255	126.34	126.342
900	0.00	0.000	0.279	5.232	125.78	125.784
905	0.00	0.000	0.277	5.209	125.23	125.230
910	0.00	0.000	0.274	5.186	124.68	124.682
915	0.00	0.000	0.272	5.163	124.14	124.137
920	0.00	0.000	0.270	5.141	123.60	123.598

Time (min)	Inflow, I (cfs)	$I_1 + I_2$ (cfs)	Outflow, O (cfs)	Storage, S (cfs-hour)	$(2S_1/\Delta t) - O_1$ (cfs)	$(2S_2/\Delta t) + O_2$ (cfs)
925	0.00	0.000	0.268	5.118	123.06	123.063
930	0.00	0.000	0.265	5.096	122.53	122.532
935	0.00	0.000	0.263	5.074	122.01	122.006
940	0.00	0.000	0.261	5.052	121.48	121.485
945	0.00	0.000	0.259	5.031	120.97	120.967
950	0.00	0.000	0.256	5.010	120.45	120.454
955	0.00	0.000	0.254	4.988	119.95	119.946
960	0.00	0.000	0.252	4.967	119.44	119.442
965	0.00	0.000	0.250	4.946	118.94	118.942
970	0.00	0.000	0.248	4.926	118.45	118.446
975	0.00	0.000	0.246	4.905	117.95	117.954
980	0.00	0.000	0.244	4.885	117.47	117.467
985	0.00	0.000	0.242	4.865	116.98	116.983
990	0.00	0.000	0.240	4.845	116.50	116.504
995	0.00	0.000	0.238	4.825	116.03	116.028
1000	0.00	0.000	0.236	4.805	115.56	115.557
1005	0.00	0.000	0.234	4.786	115.09	115.090
1010	0.00	0.000	0.232	4.767	114.63	114.626
1015	0.00	0.000	0.230	4.747	114.17	114.167
1020	0.00	0.000	0.228	4.728	113.71	113.711
1025	0.00	0.000	0.226	4.710	113.26	113.259
1030	0.00	0.000	0.224	4.691	112.81	112.811
1035	0.00	0.000	0.222	4.672	112.37	112.367
1040	0.00	0.000	0.220	4.654	111.93	111.926
1045	0.00	0.000	0.218	4.636	111.49	111.490
1050	0.00	0.000	0.217	4.618	111.06	111.056
1055	0.00	0.000	0.215	4.600	110.63	110.627
1060	0.00	0.000	0.213	4.582	110.20	110.201
1065	0.00	0.000	0.211	4.565	109.78	109.779
1070	0.00	0.000	0.209	4.547	109.36	109.360
1075	0.00	0.000	0.208	4.530	108.94	108.945
1080	0.00	0.000	0.206	4.513	108.53	108.533
1085	0.00	0.000	0.204	4.496	108.12	108.125
1090	0.00	0.000	0.202	4.479	107.72	107.720
1095	0.00	0.000	0.201	4.462	107.32	107.319
1100	0.00	0.000	0.199	4.445	106.92	106.920
1105	0.00	0.000	0.197	4.429	106.53	106.526
1110	0.00	0.000	0.196	4.413	106.13	106.134
1115	0.00	0.000	0.194	4.397	105.75	105.746
1120	0.00	0.000	0.192	4.380	105.36	105.361
1125	0.00	0.000	0.191	4.365	104.98	104.980
1130	0.00	0.000	0.189	4.349	104.60	104.602
1135	0.00	0.000	0.188	4.333	104.23	104.226
1140	0.00	0.000	0.186	4.318	103.85	103.854
1145	0.00	0.000	0.184	4.302	103.49	103.485
1150	0.00	0.000	0.183	4.287	103.12	103.120
1155	0.00	0.000	0.181	4.272	102.76	102.757
1160	0.00	0.000	0.180	4.257	102.40	102.397
1165	0.00	0.000	0.178	4.242	102.04	102.041
1170	0.00	0.000	0.177	4.227	101.69	101.687
1175	0.00	0.000	0.175	4.213	101.34	101.336
1180	0.00	0.000	0.174	4.198	100.99	100.989
1185	0.00	0.000	0.172	4.184	100.64	100.644
1190	0.00	0.000	0.171	4.170	100.30	100.302
1195	0.00	0.000	0.170	4.155	99.96	99.963
1200	0.00	0.000	0.168	4.141	99.63	99.627
1205	0.00	0.000	0.167	4.128	99.29	99.293
1210	0.00	0.000	0.165	4.114	98.96	98.963
1215	0.00	0.000	0.164	4.100	98.64	98.635
1220	0.00	0.000	0.162	4.087	98.31	98.310
1225	0.00	0.000	0.161	4.073	97.99	97.988
1230	0.00	0.000	0.160	4.060	97.67	97.668
1235	0.00	0.000	0.158	4.047	97.35	97.351
1240	0.00	0.000	0.157	4.034	97.04	97.037
1245	0.00	0.000	0.156	4.021	96.73	96.726
1250	0.00	0.000	0.154	4.008	96.42	96.417
1255	0.00	0.000	0.153	3.995	96.11	96.111
1260	0.00	0.000	0.152	3.982	95.81	95.807
1265	0.00	0.000	0.151	3.970	95.51	95.506
1270	0.00	0.000	0.149	3.957	95.21	95.207
1275	0.00	0.000	0.148	3.945	94.91	94.911
1280	0.00	0.000	0.147	3.933	94.62	94.617
1285	0.00	0.000	0.146	3.921	94.33	94.326
1290	0.00	0.000	0.144	3.909	94.04	94.037
1295	0.00	0.000	0.143	3.897	93.75	93.751
1300	0.00	0.000	0.142	3.885	93.47	93.467
1305	0.00	0.000	0.141	3.873	93.19	93.186
1310	0.00	0.000	0.140	3.861	92.91	92.906
1315	0.00	0.000	0.138	3.850	92.63	92.630
1320	0.00	0.000	0.137	3.838	92.36	92.355
1325	0.00	0.000	0.136	3.827	92.08	92.083
1330	0.00	0.000	0.135	3.816	91.81	91.813
1335	0.00	0.000	0.134	3.805	91.55	91.546
1340	0.00	0.000	0.133	3.794	91.28	91.280
1345	0.00	0.000	0.132	3.783	91.02	91.017
1350	0.00	0.000	0.130	3.772	90.76	90.756
1355	0.00	0.000	0.129	3.761	90.50	90.498
1360	0.00	0.000	0.128	3.750	90.24	90.241
1365	0.00	0.000	0.127	3.740	89.99	89.987
1370	0.00	0.000	0.126	3.729	89.73	89.734
1375	0.00	0.000	0.125	3.719	89.48	89.484
1380	0.00	0.000	0.124	3.708	89.24	89.236
1385	0.00	0.000	0.123	3.698	88.99	88.990
1390	0.00	0.000	0.122	3.688	88.75	88.747
1395	0.00	0.000	0.121	3.678	88.50	88.505
1400	0.00	0.000	0.120	3.668	88.27	88.265
1405	0.00	0.000	0.119	3.658	88.03	88.027
1410	0.00	0.000	0.118	3.648	87.79	87.792

Time (min)	Inflow, I (cfs)	$I_1 + I_2$ (cfs)	Outflow, O (cfs)	Storage, S (cfs-hour)	$(2S_1/\Delta t) - O_1$ (cfs)	$(2S_2/\Delta t) + O_2$ (cfs)
1415	0.00	0.000	0.117	3.639	87.56	87.558
1420	0.00	0.000	0.116	3.629	87.33	87.326
1425	0.00	0.000	0.115	3.619	87.10	87.096
1430	0.00	0.000	0.114	3.610	86.87	86.868
1435	0.00	0.000	0.113	3.600	86.64	86.642
1440	0.00	0.000	0.112	3.591	86.42	86.418
1445	0.00	0.000	0.111	3.582	86.20	86.196
1450	0.00	0.000	0.110	3.573	85.98	85.976
1455	0.00	0.000	0.109	3.563	85.76	85.757
1460	0.00	0.000	0.108	3.554	85.54	85.541
1465	0.00	0.000	0.107	3.545	85.33	85.326
1470	0.00	0.000	0.107	3.537	85.11	85.113
1475	0.00	0.000	0.106	3.528	84.90	84.902
1480	0.00	0.000	0.105	3.519	84.69	84.692
1485	0.00	0.000	0.104	3.510	84.48	84.484
1490	0.00	0.000	0.103	3.502	84.28	84.279
1495	0.00	0.000	0.102	3.493	84.07	84.074
1500	0.00	0.000	0.101	3.485	83.87	83.872
1505	0.00	0.000	0.100	3.477	83.67	83.671
1510	0.00	0.000	0.100	3.468	83.47	83.472
1515	0.00	0.000	0.099	3.460	83.27	83.275
1520	0.00	0.000	0.098	3.452	83.08	83.079
1525	0.00	0.000	0.097	3.444	82.88	82.885
1530	0.00	0.000	0.096	3.436	82.69	82.692
1535	0.00	0.000	0.095	3.428	82.50	82.501
1540	0.00	0.000	0.095	3.420	82.31	82.312
1545	0.00	0.000	0.094	3.412	82.12	82.125
1550	0.00	0.000	0.093	3.404	81.94	81.939
1555	0.00	0.000	0.092	3.397	81.75	81.754
1560	0.00	0.000	0.091	3.389	81.57	81.571
1565	0.00	0.000	0.091	3.381	81.39	81.390
1570	0.00	0.000	0.090	3.374	81.21	81.210
1575	0.00	0.000	0.089	3.367	81.03	81.031
1580	0.00	0.000	0.088	3.359	80.85	80.855
1585	0.00	0.000	0.088	3.352	80.68	80.679
1590	0.00	0.000	0.087	3.345	80.51	80.505
1595	0.00	0.000	0.086	3.337	80.33	80.333
1600	0.00	0.000	0.085	3.330	80.16	80.162
1605	0.00	0.000	0.085	3.323	79.99	79.992
1610	0.00	0.000	0.084	3.316	79.82	79.824
1615	0.00	0.000	0.083	3.309	79.66	79.657
1620	0.00	0.000	0.083	3.302	79.49	79.492
1625	0.00	0.000	0.082	3.296	79.33	79.328
1630	0.00	0.000	0.081	3.289	79.17	79.166
1635	0.00	0.000	0.081	3.282	79.00	79.004
1640	0.00	0.000	0.080	3.275	78.84	78.845
1645	0.00	0.000	0.079	3.269	78.69	78.686
1650	0.00	0.000	0.079	3.262	78.53	78.529
1655	0.00	0.000	0.078	3.256	78.37	78.373
1660	0.00	0.000	0.077	3.249	78.22	78.219
1665	0.00	0.000	0.077	3.243	78.07	78.066
1670	0.00	0.000	0.076	3.237	77.91	77.914
1675	0.00	0.000	0.075	3.230	77.76	77.763
1680	0.00	0.000	0.075	3.224	77.61	77.614
1685	0.00	0.000	0.074	3.218	77.47	77.465
1690	0.00	0.000	0.073	3.212	77.32	77.319
1695	0.00	0.000	0.073	3.206	77.17	77.173
1700	0.00	0.000	0.072	3.200	77.03	77.029
1705	0.00	0.000	0.072	3.194	76.89	76.885
1710	0.00	0.000	0.071	3.188	76.74	76.743
1715	0.00	0.000	0.070	3.182	76.60	76.603
1720	0.00	0.000	0.070	3.176	76.46	76.463
1725	0.00	0.000	0.069	3.170	76.32	76.325
1730	0.00	0.000	0.069	3.165	76.19	76.187
1735	0.00	0.000	0.068	3.159	76.05	76.051
1740	0.00	0.000	0.067	3.153	75.92	75.916
1745	0.00	0.000	0.067	3.148	75.78	75.782
1750	0.00	0.000	0.066	3.142	75.65	75.650
1755	0.00	0.000	0.066	3.137	75.52	75.518
1760	0.00	0.000	0.065	3.131	75.39	75.388
1765	0.00	0.000	0.065	3.126	75.26	75.258
1770	0.00	0.000	0.064	3.121	75.13	75.130
1775	0.00	0.000	0.064	3.115	75.00	75.003
1780	0.00	0.000	0.063	3.110	74.88	74.877
1785	0.00	0.000	0.063	3.105	74.75	74.751
1790	0.00	0.000	0.062	3.100	74.63	74.627
1795	0.00	0.000	0.061	3.094	74.50	74.504
1800	0.00	0.000	0.061	3.089	74.38	74.382
1805	0.00	0.000	0.060	3.084	74.26	74.262
1810	0.00	0.000	0.060	3.079	74.14	74.142
1815	0.00	0.000	0.059	3.074	74.02	74.023
1820	0.00	0.000	0.059	3.069	73.90	73.905
1825	0.00	0.000	0.058	3.065	73.79	73.788
1830	0.00	0.000	0.058	3.060	73.67	73.672
1835	0.00	0.000	0.057	3.055	73.56	73.557
1840	0.00	0.000	0.057	3.050	73.44	73.443
1845	0.00	0.000	0.057	3.046	73.33	73.330
1850	0.00	0.000	0.056	3.041	73.22	73.218
1855	0.00	0.000	0.056	3.036	73.11	73.107
1860	0.00	0.000	0.055	3.032	73.00	72.997
1865	0.00	0.000	0.055	3.027	72.89	72.887
1870	0.00	0.000	0.054	3.023	72.78	72.779
1875	0.00	0.000	0.054	3.018	72.67	72.672
1880	0.00	0.000	0.053	3.014	72.57	72.565
1885	0.00	0.000	0.053	3.009	72.46	72.459
1890	0.00	0.000	0.052	3.005	72.35	72.355
1895	0.00	0.000	0.052	3.001	72.25	72.251
1900	0.00	0.000	0.051	2.996	72.15	72.148

Time (min)	Inflow, I (cfs)	$I_1 + I_2$ (cfs)	Outflow, O (cfs)	Storage, S (cfs-hour)	$(2S_1/\Delta t) - O_1$ (cfs)	$(2S_2/\Delta t) + O_2$ (cfs)
1905	0.00	0.000	0.051	2.992	72.05	72.046
1910	0.00	0.000	0.051	2.988	71.94	71.944
1915	0.00	0.000	0.050	2.984	71.84	71.844
1920	0.00	0.000	0.050	2.979	71.74	71.744
1925	0.00	0.000	0.049	2.975	71.65	71.646
1930	0.00	0.000	0.049	2.971	71.55	71.548
1935	0.00	0.000	0.049	2.967	71.45	71.451
1940	0.00	0.000	0.048	2.963	71.35	71.354
1945	0.00	0.000	0.048	2.959	71.26	71.259
1950	0.00	0.000	0.047	2.955	71.16	71.164
1955	0.00	0.000	0.047	2.951	71.07	71.071
1960	0.00	0.000	0.047	2.947	70.98	70.977
1965	0.00	0.000	0.046	2.944	70.89	70.885
1970	0.00	0.000	0.046	2.940	70.79	70.794
1975	0.00	0.000	0.045	2.936	70.70	70.703
1980	0.00	0.000	0.045	2.932	70.61	70.613
1985	0.00	0.000	0.045	2.929	70.52	70.524
1990	0.00	0.000	0.044	2.925	70.44	70.435
1995	0.00	0.000	0.044	2.921	70.35	70.348
2000	0.00	0.000	0.043	2.918	70.26	70.261
2005	0.00	0.000	0.043	2.914	70.17	70.174
2010	0.00	0.000	0.043	2.910	70.09	70.089
2015	0.00	0.000	0.042	2.907	70.00	70.004
2020	0.00	0.000	0.042	2.903	69.92	69.920
2025	0.00	0.000	0.042	2.900	69.84	69.837
2030	0.00	0.000	0.041	2.897	69.75	69.754
2035	0.00	0.000	0.041	2.893	69.67	69.672
2040	0.00	0.000	0.041	2.890	69.59	69.591
2045	0.00	0.000	0.040	2.886	69.51	69.510
2050	0.00	0.000	0.040	2.883	69.43	69.430
2055	0.00	0.000	0.040	2.880	69.35	69.351
2060	0.00	0.000	0.039	2.876	69.27	69.272
2065	0.00	0.000	0.039	2.873	69.19	69.194
2070	0.00	0.000	0.039	2.870	69.12	69.117
2075	0.00	0.000	0.038	2.867	69.04	69.040
2080	0.00	0.000	0.038	2.864	68.96	68.964
2085	0.00	0.000	0.038	2.860	68.89	68.889
2090	0.00	0.000	0.037	2.857	68.81	68.814
2095	0.00	0.000	0.037	2.854	68.74	68.740
2100	0.00	0.000	0.037	2.851	68.67	68.667
2105	0.00	0.000	0.036	2.848	68.59	68.594
2110	0.00	0.000	0.036	2.845	68.52	68.522
2115	0.00	0.000	0.036	2.842	68.45	68.450
2120	0.00	0.000	0.036	2.839	68.38	68.379
2125	0.00	0.000	0.035	2.836	68.31	68.309
2130	0.00	0.000	0.035	2.833	68.24	68.239
2135	0.00	0.000	0.035	2.830	68.17	68.170
2140	0.00	0.000	0.034	2.828	68.10	68.101
2145	0.00	0.000	0.034	2.825	68.03	68.033
2150	0.00	0.000	0.034	2.822	67.97	67.965
2155	0.00	0.000	0.033	2.819	67.90	67.898
2160	0.00	0.000	0.033	2.816	67.83	67.832
2165	0.00	0.000	0.033	2.814	67.77	67.766
2170	0.00	0.000	0.033	2.811	67.70	67.701
2175	0.00	0.000	0.032	2.808	67.64	67.636
2180	0.00	0.000	0.032	2.806	67.57	67.572
2185	0.00	0.000	0.032	2.803	67.51	67.509
2190	0.00	0.000	0.032	2.800	67.45	67.445
2195	0.00	0.000	0.031	2.798	67.38	67.383
2200	0.00	0.000	0.031	2.795	67.32	67.321
2205	0.00	0.000	0.031	2.793	67.26	67.259
2210	0.00	0.000	0.030	2.790	67.20	67.198
2215	0.00	0.000	0.030	2.787	67.14	67.138
2220	0.00	0.000	0.030	2.785	67.08	67.078
2225	0.00	0.000	0.030	2.782	67.02	67.018
2230	0.00	0.000	0.029	2.780	66.96	66.959
2235	0.00	0.000	0.029	2.778	66.90	66.901
2240	0.00	0.000	0.029	2.775	66.84	66.843
2245	0.00	0.000	0.029	2.773	66.79	66.786
2250	0.00	0.000	0.029	2.770	66.73	66.729
2255	0.00	0.000	0.028	2.768	66.67	66.672
2260	0.00	0.000	0.028	2.766	66.62	66.616
2265	0.00	0.000	0.028	2.763	66.56	66.560
2270	0.00	0.000	0.028	2.761	66.51	66.505
2275	0.00	0.000	0.027	2.759	66.45	66.451
2280	0.00	0.000	0.027	2.757	66.40	66.396
2285	0.00	0.000	0.027	2.754	66.34	66.343
2290	0.00	0.000	0.027	2.752	66.29	66.289
2295	0.00	0.000	0.026	2.750	66.24	66.237
2300	0.00	0.000	0.026	2.748	66.18	66.184
2305	0.00	0.000	0.026	2.746	66.13	66.132
2310	0.00	0.000	0.026	2.743	66.08	66.081
2315	0.00	0.000	0.026	2.741	66.03	66.030
2320	0.00	0.000	0.025	2.739	65.98	65.979
2325	0.00	0.000	0.025	2.737	65.93	65.929
2330	0.00	0.000	0.025	2.735	65.88	65.879
2335	0.00	0.000	0.025	2.733	65.83	65.830
2340	0.00	0.000	0.024	2.731	65.78	65.781
2345	0.00	0.000	0.024	2.729	65.73	65.732
2350	0.00	0.000	0.024	2.727	65.68	65.684
2355	0.00	0.000	0.024	2.725	65.64	65.636
2360	0.00	0.000	0.024	2.723	65.59	65.589
2365	0.00	0.000	0.023	2.721	65.54	65.542
2370	0.00	0.000	0.023	2.719	65.50	65.495
2375	0.00	0.000	0.023	2.717	65.45	65.449
2380	0.00	0.000	0.023	2.715	65.40	65.403
2385	0.00	0.000	0.023	2.713	65.36	65.358
2390	0.00	0.000	0.022	2.711	65.31	65.313

Time (min)	Inflow, I (cfs)	$I_1 + I_2$ (cfs)	Outflow, O (cfs)	Storage, S (cfs-hour)	$(2S_1/\Delta t) - O_1$ (cfs)	$(2S_2/\Delta t) + O_2$ (cfs)
2395	0.00	0.000	0.022	2.710	65.27	65.268
2400	0.00	0.000	0.022	2.708	65.22	65.224
2405	0.00	0.000	0.022	2.706	65.18	65.180
2410	0.00	0.000	0.022	2.704	65.14	65.137
2415	0.00	0.000	0.022	2.702	65.09	65.094
2420	0.00	0.000	0.021	2.700	65.05	65.051
2425	0.00	0.000	0.021	2.699	65.01	65.008
2430	0.00	0.000	0.021	2.697	64.97	64.966
2435	0.00	0.000	0.021	2.695	64.92	64.925
2440	0.00	0.000	0.021	2.694	64.88	64.883
2445	0.00	0.000	0.021	2.692	64.84	64.842
2450	0.00	0.000	0.020	2.690	64.80	64.802
2455	0.00	0.000	0.020	2.688	64.76	64.761
2460	0.00	0.000	0.020	2.687	64.72	64.721
2465	0.00	0.000	0.020	2.685	64.68	64.682
2470	0.00	0.000	0.020	2.683	64.64	64.642
2475	0.00	0.000	0.019	2.682	64.60	64.603
2480	0.00	0.000	0.019	2.680	64.56	64.565
2485	0.00	0.000	0.019	2.679	64.53	64.527
2490	0.00	0.000	0.019	2.677	64.49	64.489
2495	0.00	0.000	0.019	2.675	64.45	64.451
2500	0.00	0.000	0.019	2.674	64.41	64.413
2505	0.00	0.000	0.019	2.672	64.38	64.376
2510	0.00	0.000	0.018	2.671	64.34	64.340
2515	0.00	0.000	0.018	2.669	64.30	64.303
2520	0.00	0.000	0.018	2.668	64.27	64.267
2525	0.00	0.000	0.018	2.666	64.23	64.231
2530	0.00	0.000	0.018	2.665	64.20	64.196
2535	0.00	0.000	0.018	2.663	64.16	64.161
2540	0.00	0.000	0.017	2.662	64.13	64.126
2545	0.00	0.000	0.017	2.660	64.09	64.091
2550	0.00	0.000	0.017	2.659	64.06	64.057
2555	0.00	0.000	0.017	2.658	64.02	64.023
2560	0.00	0.000	0.017	2.656	63.99	63.989
2565	0.00	0.000	0.017	2.655	63.96	63.955
2570	0.00	0.000	0.017	2.653	63.92	63.922
2575	0.00	0.000	0.016	2.652	63.89	63.889
2580	0.00	0.000	0.016	2.651	63.86	63.857
2585	0.00	0.000	0.016	2.649	63.82	63.824
2590	0.00	0.000	0.016	2.648	63.79	63.792
2595	0.00	0.000	0.016	2.647	63.76	63.760
2600	0.00	0.000	0.016	2.645	63.73	63.729
2605	0.00	0.000	0.016	2.644	63.70	63.698
2610	0.00	0.000	0.016	2.643	63.67	63.667
2615	0.00	0.000	0.015	2.642	63.64	63.636
2620	0.00	0.000	0.015	2.640	63.61	63.605
2625	0.00	0.000	0.015	2.639	63.57	63.575
2630	0.00	0.000	0.015	2.638	63.54	63.545
2635	0.00	0.000	0.015	2.636	63.52	63.515
2640	0.00	0.000	0.015	2.635	63.49	63.486
2645	0.00	0.000	0.015	2.634	63.46	63.457
2650	0.00	0.000	0.014	2.633	63.43	63.428
2655	0.00	0.000	0.014	2.632	63.40	63.399
2660	0.00	0.000	0.014	2.630	63.37	63.370
2665	0.00	0.000	0.014	2.629	63.34	63.342
2670	0.00	0.000	0.014	2.628	63.31	63.314
2675	0.00	0.000	0.014	2.627	63.29	63.286
2680	0.00	0.000	0.014	2.626	63.26	63.259
2685	0.00	0.000	0.014	2.625	63.23	63.231
2690	0.00	0.000	0.014	2.624	63.20	63.204
2695	0.00	0.000	0.013	2.622	63.18	63.177
2700	0.00	0.000	0.013	2.621	63.15	63.151
2705	0.00	0.000	0.013	2.620	63.12	63.124
2710	0.00	0.000	0.013	2.619	63.10	63.098
2715	0.00	0.000	0.013	2.618	63.07	63.072
2720	0.00	0.000	0.013	2.617	63.05	63.046
2725	0.00	0.000	0.013	2.616	63.02	63.021
2730	0.00	0.000	0.013	2.615	63.00	62.995
2735	0.00	0.000	0.013	2.614	62.97	62.970
2740	0.00	0.000	0.012	2.613	62.95	62.945
2745	0.00	0.000	0.012	2.612	62.92	62.921
2750	0.00	0.000	0.012	2.611	62.90	62.896
2755	0.00	0.000	0.012	2.610	62.87	62.872
2760	0.00	0.000	0.012	2.609	62.85	62.848
2765	0.00	0.000	0.012	2.608	62.82	62.824
2770	0.00	0.000	0.012	2.607	62.80	62.800
2775	0.00	0.000	0.012	2.606	62.78	62.777
2780	0.00	0.000	0.012	2.605	62.75	62.753
2785	0.00	0.000	0.012	2.604	62.73	62.730
2790	0.00	0.000	0.011	2.603	62.71	62.708
2795	0.00	0.000	0.011	2.602	62.68	62.685
2800	0.00	0.000	0.011	2.601	62.66	62.662
2805	0.00	0.000	0.011	2.600	62.64	62.640
2810	0.00	0.000	0.011	2.599	62.62	62.618
2815	0.00	0.000	0.011	2.598	62.60	62.596
2820	0.00	0.000	0.011	2.597	62.57	62.574
2825	0.00	0.000	0.011	2.596	62.55	62.553
2830	0.00	0.000	0.011	2.595	62.53	62.531
2835	0.00	0.000	0.011	2.595	62.51	62.510
2840	0.00	0.000	0.011	2.594	62.49	62.489
2845	0.00	0.000	0.010	2.593	62.47	62.468
2850	0.00	0.000	0.010	2.592	62.45	62.447
2855	0.00	0.000	0.010	2.591	62.43	62.427
2860	0.00	0.000	0.010	2.590	62.41	62.407
2865	0.00	0.000	0.010	2.589	62.39	62.386
2870	0.00	0.000	0.010	2.589	62.37	62.366
2875	0.00	0.000	0.010	2.588	62.35	62.347
2880	0.00	0.000	0.010	2.587	62.33	62.327

Time (min)	Inflow, I (cfs)	$I_1 + I_2$ (cfs)	Outflow, O (cfs)	Storage, S (cfs-hour)	$(2S_1/\Delta t) - O_1$ (cfs)	$(2S_2/\Delta t) + O_2$ (cfs)
2885	0.00	0.000	0.010	2.586	62.31	62.307
2890	0.00	0.000	0.010	2.585	62.29	62.288
2895	0.00	0.000	0.010	2.585	62.27	62.269
2900	0.00	0.000	0.010	2.584	62.25	62.250
2905	0.00	0.000	0.009	2.583	62.23	62.231
2910	0.00	0.000	0.009	2.582	62.21	62.212
2915	0.00	0.000	0.009	2.581	62.19	62.194
2920	0.00	0.000	0.009	2.581	62.18	62.175
2925	0.00	0.000	0.009	2.580	62.16	62.157
2930	0.00	0.000	0.009	2.579	62.14	62.139
2935	0.00	0.000	0.009	2.578	62.12	62.121
2940	0.00	0.000	0.009	2.578	62.10	62.104
2945	0.00	0.000	0.009	2.577	62.09	62.086
2950	0.00	0.000	0.009	2.576	62.07	62.068
2955	0.00	0.000	0.009	2.575	62.05	62.051
2960	0.00	0.000	0.009	2.575	62.03	62.034
2965	0.00	0.000	0.009	2.574	62.02	62.017
2970	0.00	0.000	0.008	2.573	62.00	62.000
2975	0.00	0.000	0.008	2.573	61.98	61.983
2980	0.00	0.000	0.008	2.572	61.97	61.967
2985	0.00	0.000	0.008	2.571	61.95	61.950
2990	0.00	0.000	0.008	2.571	61.93	61.934
2995	0.00	0.000	0.008	2.570	61.92	61.918
3000	0.00	0.000	0.008	2.569	61.90	61.902
3005	0.00	0.000	0.008	2.569	61.89	61.886
3010	0.00	0.000	0.008	2.568	61.87	61.870
3015	0.00	0.000	0.008	2.567	61.85	61.854
3020	0.00	0.000	0.008	2.567	61.84	61.839
3025	0.00	0.000	0.008	2.566	61.82	61.823
3030	0.00	0.000	0.008	2.565	61.81	61.808
3035	0.00	0.000	0.008	2.565	61.79	61.793
3040	0.00	0.000	0.008	2.564	61.78	61.778
3045	0.00	0.000	0.007	2.563	61.76	61.763
3050	0.00	0.000	0.007	2.563	61.75	61.748
3055	0.00	0.000	0.007	2.562	61.73	61.734
3060	0.00	0.000	0.007	2.562	61.72	61.719
3065	0.00	0.000	0.007	2.561	61.70	61.705
3070	0.00	0.000	0.007	2.560	61.69	61.691
3075	0.00	0.000	0.007	2.560	61.68	61.676
3080	0.00	0.000	0.007	2.559	61.66	61.662
3085	0.00	0.000	0.007	2.559	61.65	61.649
3090	0.00	0.000	0.007	2.558	61.63	61.635
3095	0.00	0.000	0.007	2.558	61.62	61.621
3100	0.00	0.000	0.007	2.557	61.61	61.608
3105	0.00	0.000	0.007	2.556	61.59	61.594
3110	0.00	0.000	0.007	2.556	61.58	61.581
3115	0.00	0.000	0.007	2.555	61.57	61.568
3120	0.00	0.000	0.007	2.555	61.55	61.554
3125	0.00	0.000	0.006	2.554	61.54	61.541
3130	0.00	0.000	0.006	2.554	61.53	61.529
3135	0.00	0.000	0.006	2.553	61.52	61.516
3140	0.00	0.000	0.006	2.553	61.50	61.503
3145	0.00	0.000	0.006	2.552	61.49	61.491
3150	0.00	0.000	0.006	2.552	61.48	61.478
3155	0.00	0.000	0.006	2.551	61.47	61.466
3160	0.00	0.000	0.006	2.551	61.45	61.454
3165	0.00	0.000	0.006	2.550	61.44	61.441
3170	0.00	0.000	0.006	2.550	61.43	61.429
3175	0.00	0.000	0.006	2.549	61.42	61.417
3180	0.00	0.000	0.006	2.549	61.41	61.406
3185	0.00	0.000	0.006	2.548	61.39	61.394
3190	0.00	0.000	0.006	2.548	61.38	61.382
3195	0.00	0.000	0.006	2.547	61.37	61.371
3200	0.00	0.000	0.006	2.547	61.36	61.359
3205	0.00	0.000	0.006	2.546	61.35	61.348
3210	0.00	0.000	0.006	2.546	61.34	61.337
3215	0.00	0.000	0.006	2.545	61.33	61.325
3220	0.00	0.000	0.006	2.545	61.31	61.314
3225	0.00	0.000	0.005	2.544	61.30	61.303
3230	0.00	0.000	0.005	2.544	61.29	61.292
3235	0.00	0.000	0.005	2.543	61.28	61.282
3240	0.00	0.000	0.005	2.543	61.27	61.271
3245	0.00	0.000	0.005	2.543	61.26	61.260
3250	0.00	0.000	0.005	2.542	61.25	61.250
3255	0.00	0.000	0.005	2.542	61.24	61.239
3260	0.00	0.000	0.005	2.541	61.23	61.229
3265	0.00	0.000	0.005	2.541	61.22	61.219
3270	0.00	0.000	0.005	2.540	61.21	61.209
3275	0.00	0.000	0.005	2.540	61.20	61.199
3280	0.00	0.000	0.005	2.540	61.19	61.189
3285	0.00	0.000	0.005	2.539	61.18	61.179
3290	0.00	0.000	0.005	2.539	61.17	61.169
3295	0.00	0.000	0.005	2.538	61.16	61.159
3300	0.00	0.000	0.005	2.538	61.15	61.149
3305	0.00	0.000	0.005	2.538	61.14	61.140
3310	0.00	0.000	0.005	2.537	61.13	61.130
3315	0.00	0.000	0.005	2.537	61.12	61.121
3320	0.00	0.000	0.005	2.536	61.11	61.112
3325	0.00	0.000	0.005	2.536	61.10	61.102
3330	0.00	0.000	0.005	2.536	61.09	61.093
3335	0.00	0.000	0.005	2.535	61.08	61.084
3340	0.00	0.000	0.005	2.535	61.07	61.075
3345	0.00	0.000	0.004	2.534	61.07	61.066
3350	0.00	0.000	0.004	2.534	61.06	61.057
3355	0.00	0.000	0.004	2.534	61.05	61.048
3360	0.00	0.000	0.004	2.533	61.04	61.040
3365	0.00	0.000	0.004	2.533	61.03	61.031
3370	0.00	0.000	0.004	2.533	61.02	61.022

Time (min)	Inflow, I (cfs)	$I_1 + I_2$ (cfs)	Outflow, O (cfs)	Storage, S (cfs-hour)	$(2S_1/\Delta t) - O_1$ (cfs)	$(2S_2/\Delta t) + O_2$ (cfs)
3375	0.00	0.000	0.004	2.532	61.01	61.014
3380	0.00	0.000	0.004	2.532	61.01	61.005
3385	0.00	0.000	0.004	2.532	61.00	60.997
3390	0.00	0.000	0.004	2.531	60.99	60.989
3395	0.00	0.000	0.004	2.531	60.98	60.980
3400	0.00	0.000	0.004	2.531	60.97	60.972
3405	0.00	0.000	0.004	2.530	60.96	60.964
3410	0.00	0.000	0.004	2.530	60.96	60.956
3415	0.00	0.000	0.004	2.530	60.95	60.948
3420	0.00	0.000	0.004	2.529	60.94	60.940
3425	0.00	0.000	0.004	2.529	60.93	60.932
3430	0.00	0.000	0.004	2.529	60.92	60.925
3435	0.00	0.000	0.004	2.528	60.92	60.917
3440	0.00	0.000	0.004	2.528	60.91	60.909
3445	0.00	0.000	0.004	2.528	60.90	60.902
3450	0.00	0.000	0.004	2.527	60.89	60.894
3455	0.00	0.000	0.004	2.527	60.89	60.887
3460	0.00	0.000	0.004	2.527	60.88	60.879
3465	0.00	0.000	0.004	2.526	60.87	60.872
3470	0.00	0.000	0.004	2.526	60.86	60.865
3475	0.00	0.000	0.004	2.526	60.86	60.858
3480	0.00	0.000	0.004	2.525	60.85	60.851
3485	0.00	0.000	0.004	2.525	60.84	60.844
3490	0.00	0.000	0.004	2.525	60.84	60.836
3495	0.00	0.000	0.003	2.525	60.83	60.830
3500	0.00	0.000	0.003	2.524	60.82	60.823
3505	0.00	0.000	0.003	2.524	60.82	60.816
3510	0.00	0.000	0.003	2.524	60.81	60.809
3515	0.00	0.000	0.003	2.523	60.80	60.802
3520	0.00	0.000	0.003	2.523	60.80	60.796
3525	0.00	0.000	0.003	2.523	60.79	60.789
3530	0.00	0.000	0.003	2.523	60.78	60.782
3535	0.00	0.000	0.003	2.522	60.78	60.776
3540	0.00	0.000	0.003	2.522	60.77	60.770
3545	0.00	0.000	0.003	2.522	60.76	60.763
3550	0.00	0.000	0.003	2.522	60.76	60.757
3555	0.00	0.000	0.003	2.521	60.75	60.751
3560	0.00	0.000	0.003	2.521	60.74	60.744
3565	0.00	0.000	0.003	2.521	60.74	60.738
3570	0.00	0.000	0.003	2.521	60.73	60.732
3575	0.00	0.000	0.003	2.520	60.73	60.726
3580	0.00	0.000	0.003	2.520	60.72	60.720
3585	0.00	0.000	0.003	2.520	60.71	60.714
3590	0.00	0.000	0.003	2.520	60.71	60.708
3595	0.00	0.000	0.003	2.519	60.70	60.702
3600	0.00	0.000	0.003	2.519	60.70	60.696
3605	0.00	0.000	0.003	2.519	60.69	60.691
3610	0.00	0.000	0.003	2.519	60.68	60.685
3615	0.00	0.000	0.003	2.518	60.68	60.679
3620	0.00	0.000	0.003	2.518	60.67	60.673
3625	0.00	0.000	0.003	2.518	60.67	60.668
3630	0.00	0.000	0.003	2.518	60.66	60.662
3635	0.00	0.000	0.003	2.517	60.66	60.657
3640	0.00	0.000	0.003	2.517	60.65	60.651
3645	0.00	0.000	0.003	2.517	60.65	60.646
3650	0.00	0.000	0.003	2.517	60.64	60.641
3655	0.00	0.000	0.003	2.516	60.64	60.635
3660	0.00	0.000	0.003	2.516	60.63	60.630
3665	0.00	0.000	0.003	2.516	60.62	60.625
3670	0.00	0.000	0.003	2.516	60.62	60.620
3675	0.00	0.000	0.003	2.516	60.61	60.615
3680	0.00	0.000	0.003	2.515	60.61	60.610
3685	0.00	0.000	0.003	2.515	60.60	60.604
3690	0.00	0.000	0.003	2.515	60.60	60.599
3695	0.00	0.000	0.002	2.515	60.59	60.595
3700	0.00	0.000	0.002	2.515	60.59	60.590
3705	0.00	0.000	0.002	2.514	60.58	60.585
3710	0.00	0.000	0.002	2.514	60.58	60.580
3715	0.00	0.000	0.002	2.514	60.58	60.575
3720	0.00	0.000	0.002	2.514	60.57	60.570
3725	0.00	0.000	0.002	2.514	60.57	60.566
3730	0.00	0.000	0.002	2.513	60.56	60.561
3735	0.00	0.000	0.002	2.513	60.56	60.556
3740	0.00	0.000	0.002	2.513	60.55	60.552
3745	0.00	0.000	0.002	2.513	60.55	60.547
3750	0.00	0.000	0.002	2.513	60.54	60.543
3755	0.00	0.000	0.002	2.512	60.54	60.538
3760	0.00	0.000	0.002	2.512	60.53	60.534
3765	0.00	0.000	0.002	2.512	60.53	60.529
3770	0.00	0.000	0.002	2.512	60.52	60.525
3775	0.00	0.000	0.002	2.512	60.52	60.521
3780	0.00	0.000	0.002	2.512	60.52	60.516
3785	0.00	0.000	0.002	2.511	60.51	60.512
3790	0.00	0.000	0.002	2.511	60.51	60.508
3795	0.00	0.000	0.002	2.511	60.50	60.504
3800	0.00	0.000	0.002	2.511	60.50	60.499
3805	0.00	0.000	0.002	2.511	60.50	60.495
3810	0.00	0.000	0.002	2.510	60.49	60.491
3815	0.00	0.000	0.002	2.510	60.49	60.487
3820	0.00	0.000	0.002	2.510	60.48	60.483
3825	0.00	0.000	0.002	2.510	60.48	60.479
3830	0.00	0.000	0.002	2.510	60.48	60.475
3835	0.00	0.000	0.002	2.510	60.47	60.471
3840	0.00	0.000	0.002	2.509	60.47	60.467
3845	0.00	0.000	0.002	2.509	60.46	60.464
3850	0.00	0.000	0.002	2.509	60.46	60.460
3855	0.00	0.000	0.002	2.509	60.46	60.456
3860	0.00	0.000	0.002	2.509	60.45	60.452

Time (min)	Inflow, I (cfs)	$I_1 + I_2$ (cfs)	Outflow, O (cfs)	Storage, S (cfs-hour)	$(2S_1/\Delta t) - O_1$ (cfs)	$(2S_2/\Delta t) + O_2$ (cfs)
3865	0.00	0.000	0.002	2.509	60.45	60.449
3870	0.00	0.000	0.002	2.509	60.44	60.445
3875	0.00	0.000	0.002	2.508	60.44	60.441
3880	0.00	0.000	0.002	2.508	60.44	60.438
3885	0.00	0.000	0.002	2.508	60.43	60.434
3890	0.00	0.000	0.002	2.508	60.43	60.430
3895	0.00	0.000	0.002	2.508	60.43	60.427
3900	0.00	0.000	0.002	2.508	60.42	60.423
3905	0.00	0.000	0.002	2.507	60.42	60.420
3910	0.00	0.000	0.002	2.507	60.42	60.416
3915	0.00	0.000	0.002	2.507	60.41	60.413
3920	0.00	0.000	0.002	2.507	60.41	60.410
3925	0.00	0.000	0.002	2.507	60.41	60.406
3930	0.00	0.000	0.002	2.507	60.40	60.403
3935	0.00	0.000	0.002	2.507	60.40	60.400
3940	0.00	0.000	0.002	2.507	60.40	60.396
3945	0.00	0.000	0.002	2.506	60.39	60.393
3950	0.00	0.000	0.002	2.506	60.39	60.390
3955	0.00	0.000	0.002	2.506	60.39	60.387
3960	0.00	0.000	0.002	2.506	60.38	60.384
3965	0.00	0.000	0.002	2.506	60.38	60.380
3970	0.00	0.000	0.002	2.506	60.38	60.377
3975	0.00	0.000	0.002	2.506	60.37	60.374
3980	0.00	0.000	0.002	2.505	60.37	60.371
3985	0.00	0.000	0.002	2.505	60.37	60.368
3990	0.00	0.000	0.002	2.505	60.37	60.365
3995	0.00	0.000	0.001	2.505	60.36	60.362
4000	0.00	0.000	0.001	2.505	60.36	60.359
4005	0.00	0.000	0.001	2.505	60.36	60.356
4010	0.00	0.000	0.001	2.505	60.35	60.353
4015	0.00	0.000	0.001	2.505	60.35	60.350
4020	0.00	0.000	0.001	2.504	60.35	60.348
4025	0.00	0.000	0.001	2.504	60.34	60.345
4030	0.00	0.000	0.001	2.504	60.34	60.342
4035	0.00	0.000	0.001	2.504	60.34	60.339
4040	0.00	0.000	0.001	2.504	60.34	60.336
4045	0.00	0.000	0.001	2.504	60.33	60.334
4050	0.00	0.000	0.001	2.504	60.33	60.331
4055	0.00	0.000	0.001	2.504	60.33	60.328
4060	0.00	0.000	0.001	2.504	60.33	60.325
4065	0.00	0.000	0.001	2.503	60.32	60.323
4070	0.00	0.000	0.001	2.503	60.32	60.320
4075	0.00	0.000	0.001	2.503	60.32	60.318
4080	0.00	0.000	0.001	2.503	60.31	60.315
4085	0.00	0.000	0.001	2.503	60.31	60.312
4090	0.00	0.000	0.001	2.503	60.31	60.310
4095	0.00	0.000	0.001	2.503	60.31	60.307
4100	0.00	0.000	0.001	2.503	60.30	60.305
4105	0.00	0.000	0.001	2.503	60.30	60.302
4110	0.00	0.000	0.001	2.502	60.30	60.300
4115	0.00	0.000	0.001	2.502	60.30	60.297
4120	0.00	0.000	0.001	2.502	60.30	60.295
4125	0.00	0.000	0.001	2.502	60.29	60.293
4130	0.00	0.000	0.001	2.502	60.29	60.290
4135	0.00	0.000	0.001	2.502	60.29	60.288
4140	0.00	0.000	0.001	2.502	60.29	60.286
4145	0.00	0.000	0.001	2.502	60.28	60.283
4150	0.00	0.000	0.001	2.502	60.28	60.281
4155	0.00	0.000	0.001	2.502	60.28	60.279
4160	0.00	0.000	0.001	2.502	60.28	60.276
4165	0.00	0.000	0.001	2.501	60.27	60.274
4170	0.00	0.000	0.001	2.501	60.27	60.272
4175	0.00	0.000	0.001	2.501	60.27	60.270
4180	0.00	0.000	0.001	2.501	60.27	60.268
4185	0.00	0.000	0.001	2.501	60.27	60.265
4190	0.00	0.000	0.001	2.501	60.26	60.263
4195	0.00	0.000	0.001	2.501	60.26	60.261
4200	0.00	0.000	0.001	2.501	60.26	60.259
4205	0.00	0.000	0.001	2.501	60.26	60.257
4210	0.00	0.000	0.001	2.501	60.25	60.255
4215	0.00	0.000	0.001	2.501	60.25	60.253
4220	0.00	0.000	0.001	2.500	60.25	60.251
4225	0.00	0.000	0.001	2.500	60.25	60.249
4230	0.00	0.000	0.001	2.500	60.25	60.247
4235	0.00	0.000	0.001	2.500	60.24	60.245
4240	0.00	0.000	0.001	2.500	60.24	60.243
4245	0.00	0.000	0.001	2.500	60.24	60.241
4250	0.00	0.000	0.001	2.500	60.24	60.239
4255	0.00	0.000	0.001	2.500	60.24	60.237
4260	0.00	0.000	0.001	2.500	60.23	60.235
4265	0.00	0.000	0.001	2.500	60.23	60.233
4270	0.00	0.000	0.001	2.500	60.23	60.231
4275	0.00	0.000	0.001	2.500	60.23	60.229
4280	0.00	0.000	0.001	2.499	60.23	60.228
4285	0.00	0.000	0.001	2.499	60.23	60.226
4290	0.00	0.000	0.001	2.499	60.22	60.224
4295	0.00	0.000	0.001	2.499	60.22	60.222
4300	0.00	0.000	0.001	2.499	60.22	60.220
4305	0.00	0.000	0.001	2.499	60.22	60.219
4310	0.00	0.000	0.001	2.499	60.22	60.217
4315	0.00	0.000	0.001	2.499	60.22	60.215
4320	0.00	0.000	0.001	2.499	60.21	60.213

New Pond Design

Δt = 0.083 hr

Note: Columns "N" and "O" are copies used for Vlookup

													X0	Y0		X1	Y1	
					orifice #1	orifice #2	weir #1	weir #2	infiltration				Ascending Order			Decending Order		
				dia/width(in)=	4.00	0.00	48.00	0.00	0.00									
				elev(ft)=	1114.00		1118.00											
elev. ft	area s.f.	storage cu.ft.	storage (ac.ft)	storage (cfs-hr)	outflow cfs	outflow cfs	outflow cfs	outflow cfs	outflow cfs	total outflow cfs	(2S/Δt) cfs	(2S/Δt) +O cfs	total outflow cfs	storage (cfs-hr)	(2S/Δt) +O cfs	total outflow cfs	storage (cfs-hr)
1114.00	8027	0	0	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	664.248	38.738	25.959
1114.50	9285	4328	0.099	1.202	0.307	0.000	0.000	0.000	0.000	0.307	28.969	29.276	0.307	1.202	575.709	25.488	22.834
1115.00	10543	9285	0.213	2.579	0.434	0.000	0.000	0.000	0.000	0.434	62.149	62.583	0.434	2.579	493.440	14.290	19.885
1115.50	11801	14871	0.341	4.131	0.532	0.000	0.000	0.000	0.000	0.532	99.538	100.070	0.532	4.131	417.919	5.630	17.110
1116.00	13059	21086	0.484	5.857	0.614	0.000	0.000	0.000	0.000	0.614	141.138	141.752	0.614	5.857	350.506	0.868	14.510
1116.50	14317	27930	0.641	7.758	0.686	0.000	0.000	0.000	0.000	0.686	186.948	187.634	0.686	7.758	292.010	0.812	12.085
1117.00	15575	35403	0.813	9.834	0.752	0.000	0.000	0.000	0.000	0.752	236.968	237.720	0.752	9.834	237.720	0.752	9.834
1117.50	16833	43505	0.999	12.085	0.812	0.000	0.000	0.000	0.000	0.812	291.198	292.010	0.812	12.085	187.634	0.686	7.758
1118.00	18091	52236	1.199	14.510	0.868	0.000	0.000	0.000	0.000	0.868	349.639	350.506	0.868	14.510	141.752	0.614	5.857
1118.50	19349	61596	1.414	17.110	0.921	0.000	4.709	0.000	0.000	5.630	412.289	417.919	5.630	17.110	100.070	0.532	4.131
1119.00	20607	71585	1.643	19.885	0.970	0.000	13.320	0.000	0.000	14.290	479.150	493.440	14.290	19.885	62.583	0.434	2.579
1119.50	21865	82203	1.887	22.834	1.018	0.000	24.470	0.000	0.000	25.488	550.221	575.709	25.488	22.834	29.276	0.307	1.202
1120.00	23128	93451	2.145	25.959	1.063	0.000	37.675	0.000	0.000	38.738	625.510	664.248	38.738	25.959	0.000	0.000	0.000

Project: Grant County
Pond Routing Calculation
Inflow Data Source: Swale Outflow from tab "Swale Routing"
Pond Name: NewPond
Designed By: Erik Pruneda
Date: 9/16/2013

= Values come from "NewPond Config" Tab table using (2S2/Δt) + O2

						X
Time (min)	Inflow, I (cfs)	$I_1 + I_2$ (cfs)	Outflow, O (cfs)	Storage, S (cfs-hour)	$(2S_1/\Delta t) - O_1$ (cfs)	$(2S_2/\Delta t) + O_2$ (cfs)
Before	0	0	0	0.000	0.00	0.00
0	0.000	0.000	0.000	0.000	0.00	0.000
5	0.000	0.000	0.000	0.000	0.00	0.000
10	0.000	0.000	0.000	0.000	0.00	0.000
15	0.000	0.000	0.000	0.000	0.00	0.000
20	0.000	0.000	0.000	0.000	0.00	0.000
25	0.000	0.000	0.000	0.000	0.00	0.000
30	0.000	0.000	0.000	0.000	0.00	0.000
35	0.000	0.000	0.000	0.000	0.00	0.000
40	0.000	0.000	0.000	0.000	0.00	0.000
45	0.000	0.040	0.000	0.000	0.00	0.040
50	0.040	0.382	0.000	0.000	0.00	0.382
55	0.342	7.437	0.000	0.000	0.00	7.437
60	7.095	31.631	0.000	0.000	0.00	31.631
65	24.536	62.463	0.316	1.300	31.00	93.462
70	37.928	81.678	0.514	3.857	92.43	174.112
75	43.751	87.662	0.665	7.198	172.78	260.444
80	43.911	84.762	0.777	10.776	258.89	343.653
85	40.851	77.318	0.861	14.226	341.93	419.248
90	36.467	68.233	5.782	17.159	407.68	475.916
95	31.766	59.009	12.281	19.241	451.35	510.364
100	27.243	50.847	16.594	20.491	477.18	528.022
105	23.604	43.860	18.997	21.125	490.03	533.887
110	20.256	37.557	19.796	21.335	494.30	531.853
115	17.301	32.089	19.519	21.262	492.82	524.904
120	14.788	27.475	18.573	21.013	487.76	515.233
125	12.687	23.615	17.257	20.666	480.72	504.335
130	10.928	20.565	15.773	20.275	472.79	493.353
135	9.637	18.469	14.280	19.882	464.79	483.261
140	8.832	16.947	13.123	19.511	457.01	473.962
145	8.115	15.600	12.057	19.169	449.85	465.449
150	7.485	14.426	11.080	18.856	443.29	457.713
155	6.940	13.413	10.193	18.572	437.33	450.740
160	6.473	12.547	9.394	18.316	431.95	444.500
165	6.075	11.813	8.678	18.087	427.14	438.956
170	5.738	11.193	8.042	17.883	422.87	434.064
175	5.455	10.672	7.481	17.703	419.10	429.774
180	5.218	10.178	6.989	17.546	415.79	425.973
185	4.961	9.554	6.554	17.406	412.87	422.420
190	4.593	8.722	6.146	17.275	410.13	418.850
195	4.130	7.772	5.737	17.144	407.38	415.149
200	3.642	6.811	5.434	17.003	404.28	411.091
205	3.169	5.897	5.148	16.847	400.80	406.694
210	2.729	5.060	4.837	16.677	397.02	402.080
215	2.331	4.310	4.511	16.499	393.06	397.368
220	1.979	3.651	4.178	16.317	389.01	392.662
225	1.672	3.078	3.846	16.136	384.97	388.049
230	1.407	2.586	3.520	15.958	381.01	383.595
235	1.179	2.165	3.205	15.786	377.18	379.350
240	0.986	1.809	2.905	15.622	373.54	375.348
245	0.823	1.507	2.623	15.468	370.10	371.610
250	0.685	1.254	2.359	15.324	366.89	368.146
255	0.569	1.042	2.114	15.190	363.92	364.960
260	0.472	0.906	1.889	15.067	361.18	362.088
265	0.433	0.865	1.686	14.957	358.72	359.581
270	0.432	0.863	1.509	14.860	356.56	357.426
275	0.431	0.860	1.357	14.777	354.71	355.573
280	0.429	0.858	1.226	14.705	353.12	353.979
285	0.428	0.855	1.113	14.644	351.75	352.607
290	0.427	0.853	1.016	14.591	350.57	351.427
295	0.426	0.850	0.933	14.546	349.56	350.411
300	0.424	0.848	0.868	14.506	348.68	349.523
305	0.423	0.845	0.867	14.469	347.79	348.634
310	0.422	0.842	0.866	14.432	346.90	347.744
315	0.421	0.840	0.865	14.395	346.01	346.854
320	0.419	0.837	0.864	14.359	345.12	345.962
325	0.418	0.835	0.864	14.322	344.24	345.070
330	0.417	0.833	0.863	14.285	343.34	344.177
335	0.416	0.830	0.862	14.248	342.45	343.284
340	0.414	0.828	0.861	14.211	341.56	342.389
345	0.413	0.825	0.860	14.173	340.67	341.494
350	0.412	0.823	0.859	14.136	339.78	340.598
355	0.411	0.820	0.858	14.099	338.88	339.701
360	0.409	0.818	0.858	14.062	337.99	338.804
365	0.408	0.815	0.857	14.025	337.09	337.906
370	0.407	0.813	0.856	13.988	336.19	337.007
375	0.406	0.810	0.855	13.950	335.30	336.107
380	0.405	0.808	0.854	13.913	334.40	335.207
385	0.403	0.806	0.853	13.876	333.50	334.306
390	0.402	0.803	0.852	13.838	332.60	333.404
395	0.401	0.801	0.852	13.801	331.70	332.502
400	0.400	0.798	0.851	13.764	330.80	331.599
405	0.399	0.796	0.850	13.726	329.90	330.696
410	0.397	0.794	0.849	13.689	329.00	329.792
415	0.396	0.791	0.848	13.651	328.10	328.887
420	0.395	0.789	0.847	13.614	327.19	327.981
425	0.394	0.787	0.846	13.576	326.29	327.075
430	0.393	0.784	0.845	13.539	325.38	326.169

Time (min)	Inflow, I (cfs)	$I_1 + I_2$ (cfs)	Outflow, O (cfs)	Storage, S (cfs-hour)	$(2S_1/\Delta t) - O_1$ (cfs)	$(2S_2/\Delta t) + O_2$ (cfs)
435	0.392	0.782	0.845	13.501	324.48	325.261
440	0.390	0.780	0.844	13.463	323.57	324.353
445	0.389	0.777	0.843	13.426	322.67	323.445
450	0.388	0.775	0.842	13.388	321.76	322.536
455	0.387	0.773	0.841	13.350	320.85	321.626
460	0.386	0.770	0.840	13.313	319.95	320.716
465	0.385	0.768	0.839	13.275	319.04	319.806
470	0.383	0.766	0.839	13.237	318.13	318.894
475	0.382	0.764	0.838	13.199	317.22	317.983
480	0.381	0.761	0.837	13.162	316.31	317.070
485	0.380	0.759	0.836	13.124	315.40	316.158
490	0.379	0.757	0.835	13.086	314.49	315.244
495	0.378	0.754	0.834	13.048	313.58	314.330
500	0.377	0.752	0.833	13.010	312.66	313.416
505	0.376	0.750	0.832	12.972	311.75	312.501
510	0.374	0.748	0.832	12.934	310.84	311.586
515	0.373	0.746	0.831	12.896	309.92	310.670
520	0.372	0.743	0.830	12.858	309.01	309.754
525	0.371	0.741	0.829	12.820	308.10	308.837
530	0.370	0.739	0.828	12.782	307.18	307.920
535	0.369	0.737	0.827	12.744	306.27	307.003
540	0.368	0.735	0.826	12.706	305.35	306.085
545	0.367	0.732	0.825	12.668	304.43	305.166
550	0.366	0.730	0.824	12.630	303.52	304.248
555	0.365	0.728	0.824	12.592	302.60	303.328
560	0.363	0.726	0.823	12.554	301.68	302.409
565	0.362	0.724	0.822	12.516	300.76	301.489
570	0.361	0.721	0.821	12.478	299.85	300.568
575	0.360	0.719	0.820	12.440	298.93	299.647
580	0.359	0.717	0.819	12.401	298.01	298.726
585	0.358	0.715	0.818	12.363	297.09	297.805
590	0.357	0.713	0.817	12.325	296.17	296.883
595	0.356	0.711	0.817	12.287	295.25	295.960
600	0.355	0.709	0.816	12.249	294.33	295.038
605	0.354	0.707	0.815	12.210	293.41	294.115
610	0.353	0.704	0.814	12.172	292.49	293.191
615	0.352	0.702	0.813	12.134	291.57	292.268
620	0.351	0.700	0.812	12.095	290.64	291.344
625	0.350	0.698	0.811	12.057	289.72	290.420
630	0.349	0.696	0.810	12.019	288.80	289.496
635	0.348	0.694	0.809	11.980	287.88	288.571
640	0.347	0.692	0.808	11.942	286.96	287.647
645	0.345	0.690	0.807	11.904	286.03	286.723
650	0.344	0.688	0.806	11.866	285.11	285.799
655	0.343	0.686	0.805	11.827	284.19	284.875
660	0.342	0.684	0.804	11.789	283.27	283.951
665	0.341	0.682	0.803	11.751	282.34	283.026
670	0.340	0.680	0.802	11.712	281.42	282.102
675	0.339	0.678	0.801	11.674	280.50	281.178
680	0.338	0.676	0.800	11.636	279.58	280.254
685	0.337	0.674	0.799	11.597	278.66	279.330
690	0.336	0.672	0.798	11.559	277.73	278.406
695	0.335	0.670	0.797	11.521	276.81	277.482
700	0.334	0.668	0.796	11.482	275.89	276.558
705	0.333	0.666	0.795	11.444	274.97	275.635
710	0.332	0.664	0.794	11.406	274.05	274.711
715	0.331	0.662	0.793	11.368	273.13	273.787
720	0.330	0.660	0.792	11.329	272.20	272.864
725	0.329	0.658	0.791	11.291	271.28	271.940
730	0.328	0.656	0.790	11.253	270.36	271.017
735	0.327	0.654	0.789	11.214	269.44	270.093
740	0.326	0.652	0.788	11.176	268.52	269.170
745	0.325	0.650	0.787	11.138	267.60	268.247
750	0.325	0.648	0.786	11.100	266.68	267.324
755	0.324	0.646	0.785	11.061	265.76	266.401
760	0.323	0.644	0.783	11.023	264.83	265.478
765	0.322	0.642	0.782	10.985	263.91	264.556
770	0.321	0.640	0.781	10.947	262.99	263.633
775	0.320	0.638	0.780	10.908	262.07	262.711
780	0.319	0.637	0.779	10.870	261.15	261.789
785	0.318	0.635	0.778	10.832	260.23	260.867
790	0.317	0.633	0.777	10.794	259.31	259.945
795	0.316	0.631	0.776	10.755	258.39	259.023
800	0.315	0.629	0.775	10.717	257.47	258.102
805	0.314	0.627	0.774	10.679	256.55	257.180
810	0.313	0.625	0.773	10.641	255.63	256.259
815	0.312	0.623	0.772	10.603	254.71	255.338
820	0.311	0.622	0.771	10.565	253.80	254.417
825	0.310	0.620	0.770	10.526	252.88	253.496
830	0.309	0.618	0.769	10.488	251.96	252.576
835	0.308	0.616	0.768	10.450	251.04	251.656
840	0.308	0.614	0.767	10.412	250.12	250.735
845	0.306	0.610	0.766	10.374	249.20	249.813
850	0.304	0.605	0.765	10.335	248.28	248.888
855	0.301	0.600	0.764	10.297	247.36	247.959
860	0.299	0.595	0.763	10.259	246.43	247.028
865	0.296	0.590	0.762	10.220	245.50	246.093
870	0.294	0.585	0.761	10.181	244.57	245.156
875	0.291	0.580	0.760	10.142	243.64	244.216
880	0.289	0.575	0.759	10.103	242.70	243.273
885	0.286	0.570	0.758	10.064	241.76	242.328
890	0.284	0.565	0.757	10.025	240.81	241.379
895	0.281	0.560	0.756	9.986	239.87	240.428
900	0.279	0.556	0.755	9.946	238.92	239.475
905	0.277	0.551	0.754	9.907	237.97	238.519
910	0.274	0.546	0.753	9.867	237.01	237.560
915	0.272	0.542	0.751	9.828	236.06	236.599
920	0.270	0.537	0.750	9.788	235.10	235.636

Time (min)	Inflow, I (cfs)	$I_1 + I_2$ (cfs)	Outflow, O (cfs)	Storage, S (cfs-hour)	$(2S_1/\Delta t) - O_1$ (cfs)	$(2S_2/\Delta t) + O_2$ (cfs)
925	0.268	0.533	0.749	9.748	234.14	234.671
930	0.265	0.528	0.748	9.708	233.18	233.704
935	0.263	0.524	0.746	9.668	232.21	232.735
940	0.261	0.519	0.745	9.628	231.24	231.764
945	0.259	0.515	0.744	9.587	230.28	230.791
950	0.256	0.511	0.743	9.547	229.31	229.817
955	0.254	0.506	0.741	9.507	228.33	228.840
960	0.252	0.502	0.740	9.466	227.36	227.863
965	0.250	0.498	0.739	9.426	226.38	226.883
970	0.248	0.494	0.737	9.385	225.41	225.902
975	0.246	0.490	0.736	9.344	224.43	224.919
980	0.244	0.485	0.735	9.304	223.45	223.935
985	0.242	0.481	0.734	9.263	222.47	222.949
990	0.240	0.477	0.732	9.222	221.48	221.961
995	0.238	0.473	0.731	9.181	220.50	220.973
1000	0.236	0.469	0.730	9.140	219.51	219.982
1005	0.234	0.465	0.728	9.099	218.53	218.991
1010	0.232	0.461	0.727	9.058	217.54	217.998
1015	0.230	0.458	0.726	9.017	216.55	217.004
1020	0.228	0.454	0.725	8.976	215.55	216.008
1025	0.226	0.450	0.723	8.934	214.56	215.012
1030	0.224	0.446	0.722	8.893	213.57	214.014
1035	0.222	0.442	0.721	8.852	212.57	213.015
1040	0.220	0.439	0.719	8.810	211.58	212.015
1045	0.218	0.435	0.718	8.769	210.58	211.014
1050	0.217	0.431	0.717	8.727	209.58	210.012
1055	0.215	0.428	0.715	8.686	208.58	209.009
1060	0.213	0.424	0.714	8.644	207.58	208.004
1065	0.211	0.421	0.713	8.603	206.58	206.999
1070	0.209	0.417	0.711	8.561	205.58	205.993
1075	0.208	0.413	0.710	8.519	204.57	204.986
1080	0.206	0.410	0.709	8.478	203.57	203.979
1085	0.204	0.407	0.708	8.436	202.56	202.970
1090	0.202	0.403	0.706	8.394	201.56	201.961
1095	0.201	0.400	0.705	8.352	200.55	200.951
1100	0.199	0.396	0.704	8.310	199.54	199.940
1105	0.197	0.393	0.702	8.268	198.54	198.929
1110	0.196	0.390	0.701	8.226	197.53	197.916
1115	0.194	0.386	0.700	8.184	196.52	196.904
1120	0.192	0.383	0.698	8.143	195.51	195.890
1125	0.191	0.380	0.697	8.101	194.50	194.876
1130	0.189	0.377	0.696	8.058	193.48	193.862
1135	0.188	0.374	0.694	8.016	192.47	192.847
1140	0.186	0.370	0.693	7.974	191.46	191.831
1145	0.184	0.367	0.692	7.932	190.45	190.815
1150	0.183	0.364	0.690	7.890	189.43	189.799
1155	0.181	0.361	0.689	7.848	188.42	188.782
1160	0.180	0.358	0.688	7.806	187.41	187.765
1165	0.178	0.355	0.686	7.764	186.39	186.747
1170	0.177	0.352	0.685	7.722	185.38	185.730
1175	0.175	0.349	0.683	7.679	184.36	184.713
1180	0.174	0.346	0.682	7.637	183.35	183.696
1185	0.172	0.343	0.680	7.595	182.34	182.679
1190	0.171	0.340	0.678	7.553	181.32	181.663
1195	0.170	0.338	0.677	7.511	180.31	180.647
1200	0.168	0.335	0.675	7.469	179.30	179.632
1205	0.167	0.332	0.674	7.427	178.28	178.617
1210	0.165	0.329	0.672	7.385	177.27	177.602
1215	0.164	0.326	0.670	7.343	176.26	176.588
1220	0.162	0.324	0.669	7.301	175.25	175.574
1225	0.161	0.321	0.667	7.259	174.24	174.560
1230	0.160	0.318	0.666	7.217	173.23	173.547
1235	0.158	0.316	0.664	7.175	172.22	172.535
1240	0.157	0.313	0.662	7.133	171.21	171.523
1245	0.156	0.310	0.661	7.091	170.20	170.512
1250	0.154	0.308	0.659	7.049	169.19	169.501
1255	0.153	0.305	0.658	7.007	168.19	168.491
1260	0.152	0.302	0.656	6.965	167.18	167.482
1265	0.151	0.300	0.654	6.923	166.17	166.473
1270	0.149	0.297	0.653	6.882	165.17	165.465
1275	0.148	0.295	0.651	6.840	164.16	164.458
1280	0.147	0.292	0.650	6.798	163.16	163.451
1285	0.146	0.290	0.648	6.756	162.15	162.445
1290	0.144	0.288	0.646	6.715	161.15	161.440
1295	0.143	0.285	0.645	6.673	160.15	160.435
1300	0.142	0.283	0.643	6.631	159.15	159.431
1305	0.141	0.280	0.642	6.590	158.15	158.428
1310	0.140	0.278	0.640	6.548	157.15	157.426
1315	0.138	0.276	0.638	6.507	156.15	156.425
1320	0.137	0.273	0.637	6.465	155.15	155.424
1325	0.136	0.271	0.635	6.424	154.15	154.425
1330	0.135	0.269	0.634	6.382	153.16	153.426
1335	0.134	0.266	0.632	6.341	152.16	152.428
1340	0.133	0.264	0.631	6.300	151.17	151.431
1345	0.132	0.262	0.629	6.258	150.17	150.435
1350	0.130	0.260	0.627	6.217	149.18	149.440
1355	0.129	0.258	0.626	6.176	148.19	148.446
1360	0.128	0.255	0.624	6.135	147.20	147.453
1365	0.127	0.253	0.623	6.093	146.21	146.461
1370	0.126	0.251	0.621	6.052	145.22	145.469
1375	0.125	0.249	0.620	6.011	144.23	144.479
1380	0.124	0.247	0.618	5.970	143.24	143.490
1385	0.123	0.245	0.616	5.929	142.26	142.502
1390	0.122	0.243	0.615	5.888	141.27	141.515
1395	0.121	0.241	0.613	5.847	140.29	140.529
1400	0.120	0.239	0.611	5.807	139.31	139.545
1405	0.119	0.237	0.609	5.766	138.33	138.563
1410	0.118	0.235	0.607	5.725	137.35	137.583

Time (min)	Inflow, I (cfs)	$I_1 + I_2$ (cfs)	Outflow, O (cfs)	Storage, S (cfs-hour)	$(2S_1/\Delta t) - O_1$ (cfs)	$(2S_2/\Delta t) + O_2$ (cfs)
1415	0.117	0.233	0.606	5.685	136.37	136.605
1420	0.116	0.231	0.604	5.644	135.40	135.629
1425	0.115	0.229	0.602	5.604	134.43	134.654
1430	0.114	0.227	0.600	5.563	133.45	133.682
1435	0.113	0.225	0.598	5.523	132.49	132.711
1440	0.112	0.223	0.596	5.483	131.52	131.742
1445	0.111	0.221	0.594	5.443	130.55	130.776
1450	0.110	0.219	0.592	5.403	129.59	129.811
1455	0.109	0.218	0.590	5.363	128.63	128.848
1460	0.108	0.216	0.588	5.323	127.67	127.887
1465	0.107	0.214	0.586	5.283	126.71	126.929
1470	0.107	0.212	0.584	5.243	125.76	125.972
1475	0.106	0.210	0.583	5.204	124.81	125.017
1480	0.105	0.209	0.581	5.164	123.86	124.064
1485	0.104	0.207	0.579	5.125	122.91	123.113
1490	0.103	0.205	0.577	5.085	121.96	122.164
1495	0.102	0.203	0.575	5.046	121.01	121.217
1500	0.101	0.202	0.573	5.007	120.07	120.272
1505	0.100	0.200	0.571	4.968	119.13	119.330
1510	0.100	0.198	0.569	4.929	118.19	118.389
1515	0.099	0.197	0.568	4.890	117.25	117.450
1520	0.098	0.195	0.566	4.851	116.32	116.514
1525	0.097	0.193	0.564	4.812	115.39	115.579
1530	0.096	0.192	0.562	4.773	114.45	114.646
1535	0.095	0.190	0.560	4.735	113.53	113.716
1540	0.095	0.188	0.558	4.696	112.60	112.788
1545	0.094	0.187	0.557	4.658	111.67	111.861
1550	0.093	0.185	0.555	4.619	110.75	110.937
1555	0.092	0.184	0.553	4.581	109.83	110.015
1560	0.091	0.182	0.551	4.543	108.91	109.095
1565	0.091	0.181	0.549	4.505	108.00	108.177
1570	0.090	0.179	0.547	4.467	107.08	107.261
1575	0.089	0.178	0.546	4.429	106.17	106.347
1580	0.088	0.176	0.544	4.391	105.26	105.436
1585	0.088	0.175	0.542	4.353	104.35	104.526
1590	0.087	0.173	0.540	4.315	103.45	103.619
1595	0.086	0.172	0.539	4.278	102.54	102.713
1600	0.085	0.170	0.537	4.240	101.64	101.810
1605	0.085	0.169	0.535	4.203	100.74	100.909
1610	0.084	0.167	0.533	4.166	99.84	100.010
1615	0.083	0.166	0.531	4.128	98.95	99.113
1620	0.083	0.165	0.529	4.091	98.06	98.220
1625	0.082	0.163	0.527	4.054	97.17	97.330
1630	0.081	0.162	0.524	4.017	96.28	96.443
1635	0.081	0.160	0.522	3.981	95.40	95.559
1640	0.080	0.159	0.520	3.944	94.52	94.679
1645	0.079	0.158	0.517	3.908	93.64	93.802
1650	0.079	0.156	0.515	3.871	92.77	92.928
1655	0.078	0.155	0.513	3.835	91.90	92.057
1660	0.077	0.154	0.511	3.799	91.04	91.190
1665	0.077	0.153	0.508	3.763	90.17	90.325
1670	0.076	0.151	0.506	3.728	89.31	89.464
1675	0.075	0.150	0.504	3.692	88.46	88.607
1680	0.075	0.149	0.502	3.656	87.60	87.752
1685	0.074	0.147	0.499	3.621	86.75	86.901
1690	0.073	0.146	0.497	3.586	85.91	86.052
1695	0.073	0.145	0.495	3.551	85.06	85.207
1700	0.072	0.144	0.493	3.516	84.22	84.365
1705	0.072	0.143	0.491	3.481	83.38	83.527
1710	0.071	0.141	0.488	3.446	82.55	82.691
1715	0.070	0.140	0.486	3.412	81.72	81.859
1720	0.070	0.139	0.484	3.377	80.89	81.030
1725	0.069	0.138	0.482	3.343	80.07	80.204
1730	0.069	0.137	0.480	3.309	79.24	79.381
1735	0.068	0.136	0.478	3.274	78.43	78.561
1740	0.067	0.134	0.476	3.241	77.61	77.744
1745	0.067	0.133	0.473	3.207	76.80	76.931
1750	0.066	0.132	0.471	3.173	75.99	76.120
1755	0.066	0.131	0.469	3.140	75.18	75.313
1760	0.065	0.130	0.467	3.106	74.38	74.508
1765	0.065	0.129	0.465	3.073	73.58	73.707
1770	0.064	0.128	0.463	3.040	72.78	72.909
1775	0.064	0.127	0.461	3.007	71.99	72.114
1780	0.063	0.126	0.459	2.974	71.20	71.322
1785	0.063	0.125	0.457	2.941	70.41	70.533
1790	0.062	0.124	0.455	2.908	69.62	69.748
1795	0.061	0.122	0.453	2.876	68.84	68.965
1800	0.061	0.121	0.451	2.843	68.06	68.185
1805	0.060	0.120	0.449	2.811	67.29	67.408
1810	0.060	0.119	0.447	2.779	66.52	66.635
1815	0.059	0.118	0.445	2.747	65.75	65.864
1820	0.059	0.117	0.443	2.715	64.98	65.097
1825	0.058	0.116	0.441	2.683	64.22	64.332
1830	0.058	0.115	0.439	2.652	63.45	63.570
1835	0.057	0.114	0.437	2.620	62.70	62.812
1840	0.057	0.114	0.435	2.589	61.94	62.056
1845	0.057	0.113	0.432	2.557	61.19	61.305
1850	0.056	0.112	0.429	2.526	60.45	60.558
1855	0.056	0.111	0.426	2.495	59.71	59.816
1860	0.055	0.110	0.423	2.465	58.97	59.079
1865	0.055	0.109	0.421	2.434	58.24	58.347
1870	0.054	0.108	0.418	2.404	57.51	57.619
1875	0.054	0.107	0.415	2.374	56.79	56.896
1880	0.053	0.106	0.412	2.344	56.07	56.178
1885	0.053	0.105	0.410	2.314	55.36	55.464
1890	0.052	0.104	0.407	2.285	54.65	54.754
1895	0.052	0.103	0.404	2.256	53.95	54.050
1900	0.051	0.103	0.401	2.226	53.25	53.349

Time (min)	Inflow, I (cfs)	$I_1 + I_2$ (cfs)	Outflow, O (cfs)	Storage, S (cfs-hour)	$(2S_1/\Delta t) - O_1$ (cfs)	$(2S_2/\Delta t) + O_2$ (cfs)
1905	0.051	0.102	0.399	2.197	52.55	52.654
1910	0.051	0.101	0.396	2.169	51.86	51.962
1915	0.050	0.100	0.393	2.140	51.18	51.275
1920	0.050	0.099	0.391	2.112	50.49	50.593
1925	0.049	0.098	0.388	2.083	49.82	49.915
1930	0.049	0.097	0.386	2.055	49.14	49.241
1935	0.049	0.097	0.383	2.028	48.47	48.572
1940	0.048	0.096	0.381	2.000	47.81	47.906
1945	0.048	0.095	0.378	1.972	47.15	47.246
1950	0.047	0.094	0.375	1.945	46.49	46.589
1955	0.047	0.093	0.373	1.918	45.84	45.936
1960	0.047	0.093	0.370	1.891	45.20	45.288
1965	0.046	0.092	0.368	1.864	44.55	44.644
1970	0.046	0.091	0.366	1.838	43.91	44.004
1975	0.045	0.090	0.363	1.811	43.28	43.369
1980	0.045	0.090	0.361	1.785	42.65	42.737
1985	0.045	0.089	0.358	1.759	42.02	42.109
1990	0.044	0.088	0.356	1.733	41.40	41.486
1995	0.044	0.087	0.353	1.707	40.78	40.866
2000	0.043	0.087	0.351	1.681	40.16	40.250
2005	0.043	0.086	0.349	1.656	39.55	39.639
2010	0.043	0.085	0.346	1.631	38.95	39.031
2015	0.042	0.084	0.344	1.606	38.34	38.427
2020	0.042	0.084	0.342	1.581	37.74	37.828
2025	0.042	0.083	0.339	1.556	37.15	37.232
2030	0.041	0.082	0.337	1.531	36.56	36.640
2035	0.041	0.082	0.335	1.507	35.97	36.051
2040	0.041	0.081	0.333	1.482	35.39	35.467
2045	0.040	0.080	0.330	1.458	34.81	34.886
2050	0.040	0.080	0.328	1.434	34.23	34.309
2055	0.040	0.079	0.326	1.410	33.66	33.736
2060	0.039	0.078	0.324	1.387	33.09	33.166
2065	0.039	0.078	0.322	1.363	32.52	32.601
2070	0.039	0.077	0.320	1.340	31.96	32.038
2075	0.038	0.076	0.317	1.316	31.40	31.480
2080	0.038	0.076	0.315	1.293	30.85	30.925
2085	0.038	0.075	0.313	1.270	30.30	30.374
2090	0.037	0.074	0.311	1.248	29.75	29.826
2095	0.037	0.074	0.309	1.225	29.21	29.282
2100	0.037	0.073	0.307	1.202	28.67	28.741
2105	0.036	0.073	0.301	1.180	28.14	28.211
2110	0.036	0.072	0.296	1.158	27.62	27.692
2115	0.036	0.071	0.290	1.137	27.11	27.183
2120	0.036	0.071	0.285	1.116	26.61	26.683
2125	0.035	0.070	0.280	1.096	26.12	26.194
2130	0.035	0.070	0.275	1.076	25.64	25.715
2135	0.035	0.069	0.270	1.056	25.18	25.244
2140	0.034	0.068	0.265	1.037	24.72	24.784
2145	0.034	0.068	0.260	1.018	24.26	24.332
2150	0.034	0.067	0.255	0.999	23.82	23.889
2155	0.033	0.067	0.250	0.981	23.39	23.455
2160	0.033	0.066	0.246	0.963	22.96	23.029
2165	0.033	0.066	0.241	0.946	22.55	22.612
2170	0.033	0.065	0.237	0.929	22.14	22.203
2175	0.032	0.064	0.233	0.912	21.74	21.802
2180	0.032	0.064	0.229	0.895	21.34	21.409
2185	0.032	0.063	0.224	0.879	20.96	21.023
2190	0.032	0.063	0.220	0.863	20.58	20.645
2195	0.031	0.062	0.216	0.848	20.21	20.275
2200	0.031	0.062	0.213	0.833	19.85	19.912
2205	0.031	0.061	0.209	0.818	19.49	19.555
2210	0.030	0.061	0.205	0.803	19.15	19.206
2215	0.030	0.060	0.201	0.789	18.80	18.864
2220	0.030	0.060	0.198	0.775	18.47	18.528
2225	0.030	0.059	0.194	0.761	18.14	18.199
2230	0.029	0.059	0.191	0.747	17.82	17.876
2235	0.029	0.058	0.187	0.734	17.50	17.560
2240	0.029	0.058	0.184	0.721	17.19	17.249
2245	0.029	0.057	0.181	0.708	16.89	16.945
2250	0.029	0.057	0.178	0.696	16.59	16.646
2255	0.028	0.056	0.174	0.684	16.30	16.354
2260	0.028	0.056	0.171	0.672	16.01	16.067
2265	0.028	0.055	0.168	0.660	15.73	15.785
2270	0.028	0.055	0.165	0.648	15.45	15.509
2275	0.027	0.054	0.163	0.637	15.18	15.239
2280	0.027	0.054	0.160	0.626	14.92	14.973
2285	0.027	0.054	0.157	0.615	14.66	14.713
2290	0.027	0.053	0.154	0.604	14.40	14.457
2295	0.026	0.053	0.152	0.594	14.15	14.207
2300	0.026	0.052	0.149	0.583	13.91	13.961
2305	0.026	0.052	0.146	0.573	13.67	13.720
2310	0.026	0.051	0.144	0.563	13.43	13.484
2315	0.026	0.051	0.141	0.554	13.20	13.252
2320	0.025	0.050	0.139	0.544	12.97	13.025
2325	0.025	0.050	0.137	0.535	12.75	12.802
2330	0.025	0.050	0.134	0.526	12.53	12.583
2335	0.025	0.049	0.132	0.517	12.32	12.368
2340	0.024	0.049	0.130	0.508	12.11	12.158
2345	0.024	0.048	0.127	0.499	11.90	11.951
2350	0.024	0.048	0.125	0.491	11.70	11.749
2355	0.024	0.048	0.123	0.482	11.50	11.550
2360	0.024	0.047	0.121	0.474	11.31	11.355
2365	0.023	0.047	0.119	0.466	11.12	11.164
2370	0.023	0.046	0.117	0.458	10.93	10.976
2375	0.023	0.046	0.115	0.451	10.75	10.792
2380	0.023	0.046	0.113	0.443	10.57	10.611
2385	0.023	0.045	0.111	0.436	10.39	10.434
2390	0.022	0.045	0.109	0.428	10.22	10.260

Time (min)	Inflow, I (cfs)	$I_1 + I_2$ (cfs)	Outflow, O (cfs)	Storage, S (cfs-hour)	$(2S_1/\Delta t) - O_1$ (cfs)	$(2S_2/\Delta t) + O_2$ (cfs)
2395	0.022	0.044	0.108	0.421	10.04	10.089
2400	0.022	0.044	0.106	0.414	9.88	9.922
2405	0.022	0.044	0.104	0.407	9.71	9.758
2410	0.022	0.043	0.102	0.401	9.55	9.596
2415	0.022	0.043	0.101	0.394	9.40	9.438
2420	0.021	0.043	0.099	0.388	9.24	9.283
2425	0.021	0.042	0.097	0.381	9.09	9.130
2430	0.021	0.042	0.096	0.375	8.94	8.981
2435	0.021	0.042	0.094	0.369	8.79	8.834
2440	0.021	0.041	0.093	0.363	8.65	8.690
2445	0.021	0.041	0.091	0.357	8.51	8.549
2450	0.020	0.040	0.090	0.351	8.37	8.410
2455	0.020	0.040	0.088	0.345	8.23	8.274
2460	0.020	0.040	0.087	0.340	8.10	8.140
2465	0.020	0.039	0.085	0.334	7.97	8.009
2470	0.020	0.039	0.084	0.329	7.84	7.880
2475	0.019	0.039	0.083	0.324	7.72	7.754
2480	0.019	0.038	0.081	0.318	7.59	7.630
2485	0.019	0.038	0.080	0.313	7.47	7.508
2490	0.019	0.038	0.079	0.308	7.35	7.389
2495	0.019	0.038	0.077	0.303	7.23	7.271
2500	0.019	0.037	0.076	0.299	7.12	7.156
2505	0.019	0.037	0.075	0.294	7.01	7.043
2510	0.018	0.037	0.074	0.289	6.90	6.932
2515	0.018	0.036	0.073	0.285	6.79	6.823
2520	0.018	0.036	0.072	0.280	6.68	6.716
2525	0.018	0.036	0.070	0.276	6.57	6.611
2530	0.018	0.035	0.069	0.271	6.47	6.507
2535	0.018	0.035	0.068	0.267	6.37	6.406
2540	0.017	0.035	0.067	0.263	6.27	6.307
2545	0.017	0.034	0.066	0.259	6.17	6.209
2550	0.017	0.034	0.065	0.255	6.08	6.113
2555	0.017	0.034	0.064	0.251	5.98	6.019
2560	0.017	0.034	0.063	0.247	5.89	5.926
2565	0.017	0.033	0.062	0.243	5.80	5.835
2570	0.017	0.033	0.061	0.240	5.71	5.746
2575	0.016	0.033	0.060	0.236	5.63	5.658
2580	0.016	0.033	0.059	0.232	5.54	5.572
2585	0.016	0.032	0.058	0.229	5.46	5.487
2590	0.016	0.032	0.058	0.225	5.37	5.404
2595	0.016	0.032	0.057	0.222	5.29	5.323
2600	0.016	0.031	0.056	0.219	5.21	5.243
2605	0.016	0.031	0.055	0.215	5.13	5.164
2610	0.016	0.031	0.054	0.212	5.06	5.087
2615	0.015	0.031	0.053	0.209	4.98	5.011
2620	0.015	0.030	0.053	0.206	4.91	4.936
2625	0.015	0.030	0.052	0.203	4.83	4.863
2630	0.015	0.030	0.051	0.200	4.76	4.790
2635	0.015	0.030	0.050	0.197	4.69	4.720
2640	0.015	0.029	0.049	0.194	4.62	4.650
2645	0.015	0.029	0.049	0.191	4.55	4.582
2650	0.014	0.029	0.048	0.188	4.49	4.515
2655	0.014	0.029	0.047	0.185	4.42	4.449
2660	0.014	0.028	0.047	0.183	4.36	4.384
2665	0.014	0.028	0.046	0.180	4.29	4.320
2670	0.014	0.028	0.045	0.177	4.23	4.257
2675	0.014	0.028	0.045	0.175	4.17	4.196
2680	0.014	0.027	0.044	0.172	4.11	4.135
2685	0.014	0.027	0.043	0.170	4.05	4.076
2690	0.014	0.027	0.043	0.167	3.99	4.017
2695	0.013	0.027	0.042	0.165	3.93	3.960
2700	0.013	0.027	0.042	0.163	3.88	3.903
2705	0.013	0.026	0.041	0.160	3.82	3.848
2710	0.013	0.026	0.040	0.158	3.77	3.793
2715	0.013	0.026	0.040	0.156	3.71	3.740
2720	0.013	0.026	0.039	0.154	3.66	3.687
2725	0.013	0.025	0.039	0.151	3.61	3.635
2730	0.013	0.025	0.038	0.149	3.56	3.584
2735	0.013	0.025	0.038	0.147	3.51	3.534
2740	0.012	0.025	0.037	0.145	3.46	3.485
2745	0.012	0.025	0.037	0.143	3.41	3.436
2750	0.012	0.024	0.036	0.141	3.36	3.389
2755	0.012	0.024	0.036	0.139	3.32	3.342
2760	0.012	0.024	0.035	0.137	3.27	3.296
2765	0.012	0.024	0.035	0.135	3.23	3.250
2770	0.012	0.024	0.034	0.133	3.18	3.206
2775	0.012	0.023	0.034	0.132	3.14	3.162
2780	0.012	0.023	0.033	0.130	3.10	3.119
2785	0.012	0.023	0.033	0.128	3.05	3.076
2790	0.011	0.023	0.032	0.126	3.01	3.035
2795	0.011	0.023	0.032	0.125	2.97	2.994
2800	0.011	0.022	0.031	0.123	2.93	2.953
2805	0.011	0.022	0.031	0.121	2.89	2.914
2810	0.011	0.022	0.031	0.120	2.85	2.875
2815	0.011	0.022	0.030	0.118	2.81	2.836
2820	0.011	0.022	0.030	0.116	2.78	2.798
2825	0.011	0.021	0.029	0.115	2.74	2.761
2830	0.011	0.021	0.029	0.113	2.70	2.725
2835	0.011	0.021	0.029	0.112	2.67	2.689
2840	0.011	0.021	0.028	0.110	2.63	2.653
2845	0.010	0.021	0.028	0.109	2.60	2.618
2850	0.010	0.021	0.027	0.108	2.56	2.584
2855	0.010	0.020	0.027	0.106	2.53	2.550
2860	0.010	0.020	0.027	0.105	2.50	2.517
2865	0.010	0.020	0.026	0.103	2.46	2.484
2870	0.010	0.020	0.026	0.102	2.43	2.452
2875	0.010	0.020	0.026	0.101	2.40	2.421
2880	0.010	0.020	0.025	0.099	2.37	2.389

Time (min)	Inflow, I (cfs)	$I_1 + I_2$ (cfs)	Outflow, O (cfs)	Storage, S (cfs-hour)	$(2S_1/\Delta t) - O_1$ (cfs)	$(2S_2/\Delta t) + O_2$ (cfs)
2885	0.010	0.019	0.025	0.098	2.34	2.359
2890	0.010	0.019	0.025	0.097	2.31	2.329
2895	0.010	0.019	0.024	0.096	2.28	2.299
2900	0.010	0.019	0.024	0.094	2.25	2.270
2905	0.009	0.019	0.024	0.093	2.22	2.241
2910	0.009	0.019	0.023	0.092	2.19	2.212
2915	0.009	0.018	0.023	0.091	2.17	2.184
2920	0.009	0.018	0.023	0.090	2.14	2.157
2925	0.009	0.018	0.023	0.089	2.11	2.130
2930	0.009	0.018	0.022	0.087	2.09	2.103
2935	0.009	0.018	0.022	0.086	2.06	2.077
2940	0.009	0.018	0.022	0.085	2.03	2.051
2945	0.009	0.018	0.021	0.084	2.01	2.026
2950	0.009	0.017	0.021	0.083	1.98	2.001
2955	0.009	0.017	0.021	0.082	1.96	1.976
2960	0.009	0.017	0.021	0.081	1.93	1.952
2965	0.009	0.017	0.020	0.080	1.91	1.928
2970	0.008	0.017	0.020	0.079	1.89	1.904
2975	0.008	0.017	0.020	0.078	1.86	1.881
2980	0.008	0.017	0.020	0.077	1.84	1.858
2985	0.008	0.016	0.019	0.076	1.82	1.835
2990	0.008	0.016	0.019	0.075	1.80	1.813
2995	0.008	0.016	0.019	0.074	1.78	1.791
3000	0.008	0.016	0.019	0.074	1.75	1.770
3005	0.008	0.016	0.019	0.073	1.73	1.748
3010	0.008	0.016	0.018	0.072	1.71	1.727
3015	0.008	0.016	0.018	0.071	1.69	1.707
3020	0.008	0.015	0.018	0.070	1.67	1.687
3025	0.008	0.015	0.018	0.069	1.65	1.666
3030	0.008	0.015	0.017	0.068	1.63	1.647
3035	0.008	0.015	0.017	0.068	1.61	1.627
3040	0.008	0.015	0.017	0.067	1.59	1.608
3045	0.007	0.015	0.017	0.066	1.57	1.589
3050	0.007	0.015	0.017	0.065	1.56	1.571
3055	0.007	0.015	0.016	0.064	1.54	1.552
3060	0.007	0.014	0.016	0.064	1.52	1.534
3065	0.007	0.014	0.016	0.063	1.50	1.516
3070	0.007	0.014	0.016	0.062	1.48	1.499
3075	0.007	0.014	0.016	0.062	1.47	1.481
3080	0.007	0.014	0.016	0.061	1.45	1.464
3085	0.007	0.014	0.015	0.060	1.43	1.447
3090	0.007	0.014	0.015	0.059	1.42	1.431
3095	0.007	0.014	0.015	0.059	1.40	1.414
3100	0.007	0.013	0.015	0.058	1.38	1.398
3105	0.007	0.013	0.015	0.057	1.37	1.382
3110	0.007	0.013	0.014	0.057	1.35	1.367
3115	0.007	0.013	0.014	0.056	1.34	1.351
3120	0.007	0.013	0.014	0.055	1.32	1.336
3125	0.006	0.013	0.014	0.055	1.31	1.321
3130	0.006	0.013	0.014	0.054	1.29	1.306
3135	0.006	0.013	0.014	0.054	1.28	1.291
3140	0.006	0.013	0.014	0.053	1.26	1.277
3145	0.006	0.013	0.013	0.052	1.25	1.263
3150	0.006	0.012	0.013	0.052	1.24	1.249
3155	0.006	0.012	0.013	0.051	1.22	1.235
3160	0.006	0.012	0.013	0.051	1.21	1.221
3165	0.006	0.012	0.013	0.050	1.20	1.207
3170	0.006	0.012	0.013	0.050	1.18	1.194
3175	0.006	0.012	0.013	0.049	1.17	1.181
3180	0.006	0.012	0.012	0.048	1.16	1.168
3185	0.006	0.012	0.012	0.048	1.14	1.155
3190	0.006	0.012	0.012	0.047	1.13	1.143
3195	0.006	0.011	0.012	0.047	1.12	1.130
3200	0.006	0.011	0.012	0.046	1.11	1.118
3205	0.006	0.011	0.012	0.046	1.09	1.106
3210	0.006	0.011	0.012	0.045	1.08	1.094
3215	0.006	0.011	0.011	0.045	1.07	1.082
3220	0.006	0.011	0.011	0.044	1.06	1.070
3225	0.005	0.011	0.011	0.044	1.05	1.059
3230	0.005	0.011	0.011	0.043	1.04	1.047
3235	0.005	0.011	0.011	0.043	1.03	1.036
3240	0.005	0.011	0.011	0.043	1.01	1.025
3245	0.005	0.011	0.011	0.042	1.00	1.014
3250	0.005	0.010	0.011	0.042	0.99	1.003
3255	0.005	0.010	0.011	0.041	0.98	0.993
3260	0.005	0.010	0.010	0.041	0.97	0.982
3265	0.005	0.010	0.010	0.040	0.96	0.972
3270	0.005	0.010	0.010	0.040	0.95	0.962
3275	0.005	0.010	0.010	0.039	0.94	0.952
3280	0.005	0.010	0.010	0.039	0.93	0.942
3285	0.005	0.010	0.010	0.039	0.92	0.932
3290	0.005	0.010	0.010	0.038	0.91	0.922
3295	0.005	0.010	0.010	0.038	0.90	0.912
3300	0.005	0.010	0.010	0.037	0.89	0.903
3305	0.005	0.010	0.009	0.037	0.88	0.893
3310	0.005	0.009	0.009	0.037	0.87	0.884
3315	0.005	0.009	0.009	0.036	0.87	0.875
3320	0.005	0.009	0.009	0.036	0.86	0.866
3325	0.005	0.009	0.009	0.036	0.85	0.857
3330	0.005	0.009	0.009	0.035	0.84	0.848
3335	0.005	0.009	0.009	0.035	0.83	0.840
3340	0.005	0.009	0.009	0.034	0.82	0.831
3345	0.004	0.009	0.009	0.034	0.81	0.822
3350	0.004	0.009	0.009	0.034	0.81	0.814
3355	0.004	0.009	0.009	0.033	0.80	0.806
3360	0.004	0.009	0.008	0.033	0.79	0.798
3365	0.004	0.009	0.008	0.033	0.78	0.789
3370	0.004	0.009	0.008	0.032	0.77	0.781

Time (min)	Inflow, I (cfs)	$I_1 + I_2$ (cfs)	Outflow, O (cfs)	Storage, S (cfs-hour)	$(2S_1/\Delta t) - O_1$ (cfs)	$(2S_2/\Delta t) + O_2$ (cfs)
3375	0.004	0.008	0.008	0.032	0.77	0.774
3380	0.004	0.008	0.008	0.032	0.76	0.766
3385	0.004	0.008	0.008	0.031	0.75	0.758
3390	0.004	0.008	0.008	0.031	0.74	0.750
3395	0.004	0.008	0.008	0.031	0.73	0.743
3400	0.004	0.008	0.008	0.031	0.73	0.735
3405	0.004	0.008	0.008	0.030	0.72	0.728
3410	0.004	0.008	0.008	0.030	0.71	0.721
3415	0.004	0.008	0.008	0.030	0.71	0.714
3420	0.004	0.008	0.007	0.029	0.70	0.707
3425	0.004	0.008	0.007	0.029	0.69	0.700
3430	0.004	0.008	0.007	0.029	0.68	0.693
3435	0.004	0.008	0.007	0.028	0.68	0.686
3440	0.004	0.008	0.007	0.028	0.67	0.679
3445	0.004	0.008	0.007	0.028	0.66	0.672
3450	0.004	0.007	0.007	0.028	0.66	0.666
3455	0.004	0.007	0.007	0.027	0.65	0.659
3460	0.004	0.007	0.007	0.027	0.65	0.653
3465	0.004	0.007	0.007	0.027	0.64	0.646
3470	0.004	0.007	0.007	0.027	0.63	0.640
3475	0.004	0.007	0.007	0.026	0.63	0.634
3480	0.004	0.007	0.007	0.026	0.62	0.627
3485	0.004	0.007	0.007	0.026	0.61	0.621
3490	0.004	0.007	0.007	0.026	0.61	0.615
3495	0.003	0.007	0.006	0.025	0.60	0.609
3500	0.003	0.007	0.006	0.025	0.60	0.603
3505	0.003	0.007	0.006	0.025	0.59	0.598
3510	0.003	0.007	0.006	0.025	0.59	0.592
3515	0.003	0.007	0.006	0.024	0.58	0.586
3520	0.003	0.007	0.006	0.024	0.57	0.580
3525	0.003	0.007	0.006	0.024	0.57	0.575
3530	0.003	0.007	0.006	0.024	0.56	0.569
3535	0.003	0.006	0.006	0.023	0.56	0.564
3540	0.003	0.006	0.006	0.023	0.55	0.558
3545	0.003	0.006	0.006	0.023	0.55	0.553
3550	0.003	0.006	0.006	0.023	0.54	0.548
3555	0.003	0.006	0.006	0.022	0.54	0.543
3560	0.003	0.006	0.006	0.022	0.53	0.537
3565	0.003	0.006	0.006	0.022	0.53	0.532
3570	0.003	0.006	0.006	0.022	0.52	0.527
3575	0.003	0.006	0.006	0.022	0.52	0.522
3580	0.003	0.006	0.005	0.021	0.51	0.517
3585	0.003	0.006	0.005	0.021	0.51	0.512
3590	0.003	0.006	0.005	0.021	0.50	0.508
3595	0.003	0.006	0.005	0.021	0.50	0.503
3600	0.003	0.006	0.005	0.021	0.49	0.498
3605	0.003	0.006	0.005	0.020	0.49	0.493
3610	0.003	0.006	0.005	0.020	0.48	0.489
3615	0.003	0.006	0.005	0.020	0.48	0.484
3620	0.003	0.006	0.005	0.020	0.47	0.480
3625	0.003	0.006	0.005	0.020	0.47	0.475
3630	0.003	0.006	0.005	0.020	0.47	0.471
3635	0.003	0.005	0.005	0.019	0.46	0.466
3640	0.003	0.005	0.005	0.019	0.46	0.462
3645	0.003	0.005	0.005	0.019	0.45	0.458
3650	0.003	0.005	0.005	0.019	0.45	0.453
3655	0.003	0.005	0.005	0.019	0.44	0.449
3660	0.003	0.005	0.005	0.018	0.44	0.445
3665	0.003	0.005	0.005	0.018	0.44	0.441
3670	0.003	0.005	0.005	0.018	0.43	0.437
3675	0.003	0.005	0.005	0.018	0.43	0.433
3680	0.003	0.005	0.005	0.018	0.42	0.429
3685	0.003	0.005	0.004	0.018	0.42	0.425
3690	0.003	0.005	0.004	0.017	0.42	0.421
3695	0.002	0.005	0.004	0.017	0.41	0.417
3700	0.002	0.005	0.004	0.017	0.41	0.413
3705	0.002	0.005	0.004	0.017	0.40	0.409
3710	0.002	0.005	0.004	0.017	0.40	0.405
3715	0.002	0.005	0.004	0.017	0.40	0.402
3720	0.002	0.005	0.004	0.016	0.39	0.398
3725	0.002	0.005	0.004	0.016	0.39	0.394
3730	0.002	0.005	0.004	0.016	0.39	0.391
3735	0.002	0.005	0.004	0.016	0.38	0.387
3740	0.002	0.005	0.004	0.016	0.38	0.384
3745	0.002	0.005	0.004	0.016	0.38	0.380
3750	0.002	0.005	0.004	0.016	0.37	0.377
3755	0.002	0.004	0.004	0.015	0.37	0.373
3760	0.002	0.004	0.004	0.015	0.37	0.370
3765	0.002	0.004	0.004	0.015	0.36	0.366
3770	0.002	0.004	0.004	0.015	0.36	0.363
3775	0.002	0.004	0.004	0.015	0.36	0.360
3780	0.002	0.004	0.004	0.015	0.35	0.357
3785	0.002	0.004	0.004	0.015	0.35	0.353
3790	0.002	0.004	0.004	0.015	0.35	0.350
3795	0.002	0.004	0.004	0.014	0.34	0.347
3800	0.002	0.004	0.004	0.014	0.34	0.344
3805	0.002	0.004	0.004	0.014	0.34	0.341
3810	0.002	0.004	0.004	0.014	0.33	0.338
3815	0.002	0.004	0.004	0.014	0.33	0.335
3820	0.002	0.004	0.004	0.014	0.33	0.332
3825	0.002	0.004	0.003	0.014	0.32	0.329
3830	0.002	0.004	0.003	0.013	0.32	0.326
3835	0.002	0.004	0.003	0.013	0.32	0.323
3840	0.002	0.004	0.003	0.013	0.32	0.320
3845	0.002	0.004	0.003	0.013	0.31	0.317
3850	0.002	0.004	0.003	0.013	0.31	0.314
3855	0.002	0.004	0.003	0.013	0.31	0.311
3860	0.002	0.004	0.003	0.013	0.30	0.309

Time (min)	Inflow, I (cfs)	$I_1 + I_2$ (cfs)	Outflow, O (cfs)	Storage, S (cfs-hour)	$(2S_1/\Delta t) - O_1$ (cfs)	$(2S_2/\Delta t) + O_2$ (cfs)
3865	0.002	0.004	0.003	0.013	0.30	0.306
3870	0.002	0.004	0.003	0.013	0.30	0.303
3875	0.002	0.004	0.003	0.012	0.30	0.300
3880	0.002	0.004	0.003	0.012	0.29	0.298
3885	0.002	0.004	0.003	0.012	0.29	0.295
3890	0.002	0.004	0.003	0.012	0.29	0.292
3895	0.002	0.004	0.003	0.012	0.29	0.290
3900	0.002	0.003	0.003	0.012	0.28	0.287
3905	0.002	0.003	0.003	0.012	0.28	0.285
3910	0.002	0.003	0.003	0.012	0.28	0.282
3915	0.002	0.003	0.003	0.012	0.28	0.280
3920	0.002	0.003	0.003	0.011	0.27	0.277
3925	0.002	0.003	0.003	0.011	0.27	0.275
3930	0.002	0.003	0.003	0.011	0.27	0.272
3935	0.002	0.003	0.003	0.011	0.27	0.270
3940	0.002	0.003	0.003	0.011	0.26	0.267
3945	0.002	0.003	0.003	0.011	0.26	0.265
3950	0.002	0.003	0.003	0.011	0.26	0.263
3955	0.002	0.003	0.003	0.011	0.26	0.260
3960	0.002	0.003	0.003	0.011	0.25	0.258
3965	0.002	0.003	0.003	0.011	0.25	0.256
3970	0.002	0.003	0.003	0.011	0.25	0.253
3975	0.002	0.003	0.003	0.010	0.25	0.251
3980	0.002	0.003	0.003	0.010	0.25	0.249
3985	0.002	0.003	0.003	0.010	0.24	0.247
3990	0.002	0.003	0.003	0.010	0.24	0.245
3995	0.001	0.003	0.003	0.010	0.24	0.243
4000	0.001	0.003	0.003	0.010	0.24	0.240
4005	0.001	0.003	0.003	0.010	0.24	0.238
4010	0.001	0.003	0.002	0.010	0.23	0.236
4015	0.001	0.003	0.002	0.010	0.23	0.234
4020	0.001	0.003	0.002	0.010	0.23	0.232
4025	0.001	0.003	0.002	0.010	0.23	0.230
4030	0.001	0.003	0.002	0.009	0.23	0.228
4035	0.001	0.003	0.002	0.009	0.22	0.226
4040	0.001	0.003	0.002	0.009	0.22	0.224
4045	0.001	0.003	0.002	0.009	0.22	0.222
4050	0.001	0.003	0.002	0.009	0.22	0.220
4055	0.001	0.003	0.002	0.009	0.22	0.218
4060	0.001	0.003	0.002	0.009	0.21	0.216
4065	0.001	0.003	0.002	0.009	0.21	0.214
4070	0.001	0.003	0.002	0.009	0.21	0.212
4075	0.001	0.003	0.002	0.009	0.21	0.211
4080	0.001	0.003	0.002	0.009	0.21	0.209
4085	0.001	0.003	0.002	0.009	0.20	0.207
4090	0.001	0.003	0.002	0.008	0.20	0.205
4095	0.001	0.003	0.002	0.008	0.20	0.203
4100	0.001	0.002	0.002	0.008	0.20	0.202
4105	0.001	0.002	0.002	0.008	0.20	0.200
4110	0.001	0.002	0.002	0.008	0.20	0.198
4115	0.001	0.002	0.002	0.008	0.19	0.196
4120	0.001	0.002	0.002	0.008	0.19	0.195
4125	0.001	0.002	0.002	0.008	0.19	0.193
4130	0.001	0.002	0.002	0.008	0.19	0.191
4135	0.001	0.002	0.002	0.008	0.19	0.190
4140	0.001	0.002	0.002	0.008	0.19	0.188
4145	0.001	0.002	0.002	0.008	0.18	0.186
4150	0.001	0.002	0.002	0.008	0.18	0.185
4155	0.001	0.002	0.002	0.008	0.18	0.183
4160	0.001	0.002	0.002	0.008	0.18	0.182
4165	0.001	0.002	0.002	0.007	0.18	0.180
4170	0.001	0.002	0.002	0.007	0.18	0.178
4175	0.001	0.002	0.002	0.007	0.17	0.177
4180	0.001	0.002	0.002	0.007	0.17	0.175
4185	0.001	0.002	0.002	0.007	0.17	0.174
4190	0.001	0.002	0.002	0.007	0.17	0.172
4195	0.001	0.002	0.002	0.007	0.17	0.171
4200	0.001	0.002	0.002	0.007	0.17	0.169
4205	0.001	0.002	0.002	0.007	0.17	0.168
4210	0.001	0.002	0.002	0.007	0.16	0.166
4215	0.001	0.002	0.002	0.007	0.16	0.165
4220	0.001	0.002	0.002	0.007	0.16	0.164
4225	0.001	0.002	0.002	0.007	0.16	0.162
4230	0.001	0.002	0.002	0.007	0.16	0.161
4235	0.001	0.002	0.002	0.007	0.16	0.159
4240	0.001	0.002	0.002	0.007	0.16	0.158
4245	0.001	0.002	0.002	0.006	0.15	0.157
4250	0.001	0.002	0.002	0.006	0.15	0.155
4255	0.001	0.002	0.002	0.006	0.15	0.154
4260	0.001	0.002	0.002	0.006	0.15	0.153
4265	0.001	0.002	0.002	0.006	0.15	0.151
4270	0.001	0.002	0.002	0.006	0.15	0.150
4275	0.001	0.002	0.002	0.006	0.15	0.149
4280	0.001	0.002	0.002	0.006	0.15	0.147
4285	0.001	0.002	0.002	0.006	0.14	0.146
4290	0.001	0.002	0.002	0.006	0.14	0.145
4295	0.001	0.002	0.002	0.006	0.14	0.144
4300	0.001	0.002	0.002	0.006	0.14	0.142
4305	0.001	0.002	0.001	0.006	0.14	0.141
4310	0.001	0.002	0.001	0.006	0.14	0.140
4315	0.001	0.002	0.001	0.006	0.14	0.139
4320	0.001	0.001	0.001	0.006	0.14	0.137

Hydraulic Capacity Analysis - Proposed Storm Pipe Conditions

WSDOT Storm Sewer Design Spreadsheet and
WSDOT Hydraulics Manual - Chapter 4 Open Channel Flow

Calculated By:	E. Pruneda	Date:	9/16/2013	Project:	Grant County
Checked By:	J. Knutson	Date:		Project No:	36310174
				Sheet No:	1 of 1

Proposed Storm Pipe Conditions								10-Year, 3-Hour Storm Event					25-Year, 3-Hour Storm Event					100-Year, 3-Hour Storm Event				
Culvert ID	Pipe Dia. (ft)	Manning "n"	Pipe Length (ft)	Upstr. Invert Elev. (ft) [2]	Downstr. Invert Elev. (ft) [2]	Elevation Change (ft)	Pipe Slope (ft/ft)	Total Flow (cfs)	Depth of Flow (ft)	Velocity of Flow (ft/s)	Pipe Capacity (cfs)	Pipe Capacity Check	Total Flow (cfs)	Depth of Flow (ft)	Velocity of Flow (ft/s)	Pipe Capacity (cfs)	Pipe Capacity Check	Total Flow (cfs)	Depth of Flow (ft)	Velocity of Flow (ft/s)	Pipe Capacity (cfs)	Pipe Capacity Check
A	2	0.013	160.0	1133.00	1127.00	6.00	0.038	14.38	0.79	12.49	39.24	Adequate	21.40	0.99	13.86	43.55	Adequate	38.66	1.46	15.74	49.45	Adequate
B	1.5	0.013	390.0	1143.00	1127.00	16.00	0.041	3.70	0.42	9.04	15.97	Adequate	5.45	0.52	10.08	17.81	Adequate	9.86	0.72	11.81	20.87	Adequate
C1	2	0.013	715.0	1163.00	1152.00	11.00	0.015	6.58	0.66	7.29	22.90	Adequate	9.73	0.81	8.12	25.51	Adequate	17.56	1.15	9.43	29.62	Adequate
C2	2	0.013	425.0	1152.00	1127.00	25.00	0.059	11.29	0.62	13.74	43.18	Adequate	16.84	0.76	15.36	48.26	Adequate	30.49	1.07	17.92	56.31	Adequate
D1 [1]	1.5	0.013	165.0	1125.00	1115.00	10.00	0.061	Flows Only Calculated for 100-Year Storm Event					Flows Only Calculated for 100-Year Storm Event					21.95	1.06	16.42	29.02	Adequate
D2 [1]	1.5	0.013	165.0	1125.00	1115.00	10.00	0.061	Flows Only Calculated for 100-Year Storm Event					Flows Only Calculated for 100-Year Storm Event					21.95	1.06	16.42	29.02	Adequate
E [1]	2	0.013	350.0	1114.00	1109.00	5.00	0.014	Flows Only Calculated for 100-Year Storm Event					Flows Only Calculated for 100-Year Storm Event					19.80	1.27	9.40	29.53	Adequate
F [1]	2	0.013	1750.0	1109.00	1072.00	37.00	0.021	Flows Only Calculated for 100-Year Storm Event					Flows Only Calculated for 100-Year Storm Event					19.80	1.12	10.95	34.40	Adequate
G	1.5	0.013	80.0	1211.00	1206.00	5.00	0.063	8.75	0.60	13.36	23.61	Adequate	12.99	0.75	14.82	26.19	Adequate	23.45	1.11	16.80	29.69	Adequate

[1] Total flow based on flow routing analysis (see Attachment E).

[2] Elevations based on USGS National Elevation Dataset GIS data and assumed depth of structures/facilities.

Hydraulic Capacity Analysis - Proposed Culvert Conditions

WSDOT Storm Sewer Design Spreadsheet and
WSDOT Hydraulics Manual - Chapter 4 Open Channel Flow

Calculated By:	E. Pruneda	Date:	9/16/2013	Project:	Grant County
Checked By:	J. Knutson	Date:		Project No:	36310174
				Sheet No:	1 of 1

Proposed Culvert Conditions (Upgrades are Shown in Red)								10-Year, 3-Hour Storm Event					25-Year, 3-Hour Storm Event					100-Year, 3-Hour Storm Event				
Culvert ID	Pipe Dia. (ft) [1]	Manning "n"	Pipe Length (ft)	Upstr. Invert Elev. (ft) [2]	Downstr. Invert Elev. (ft) [2]	Elevation Change (ft)	Pipe Slope (ft/ft)	Total Flow (cfs)	Depth of Flow (ft)	Velocity of Flow (ft/s)	Pipe Capacity (cfs)	Pipe Capacity Check	Total Flow (cfs)	Depth of Flow (ft)	Velocity of Flow (ft/s)	Pipe Capacity (cfs)	Pipe Capacity Check	Total Flow (cfs)	Depth of Flow (ft)	Velocity of Flow (ft/s)	Pipe Capacity (cfs)	Pipe Capacity Check [3]
1	2	0.013	48.0	Slope Measured in Field			0.010	5.62	0.67	6.06	19.04	Adequate	8.31	0.83	6.75	21.19	Adequate	13.97	1.12	7.69	24.16	Adequate
2	2	0.013	48.0	Slope Measured in Field			0.025	9.88	0.72	9.73	30.57	Adequate	14.71	0.89	10.83	34.02	Adequate	26.57	1.28	12.47	39.18	Adequate
19	1.5	0.013	68.0	Slope Measured in Field			0.137	5.19	0.37	15.29	27.03	Adequate	7.70	0.45	17.12	30.25	Adequate	13.90	0.62	20.16	35.62	Adequate
23	Flows to be directed to new culvert (Storm Pipe G)																					
27	1.5	0.013	51.0	Slope Measured in Field			0.028	4.96	0.55	8.49	15.01	Adequate	7.31	0.68	9.42	16.65	Adequate	13.20	0.98	10.84	19.16	Adequate
30	1.5	0.013	20.0	Slope Measured in Field			0.015	0.87	0.26	4.15	7.34	Adequate	1.29	0.32	4.66	8.24	Adequate	2.33	0.43	5.53	9.77	Adequate
35	1.5	0.013	65.0	Slope Measured in Field			0.057	0.07	0.06	3.03	5.35	Adequate	0.10	0.07	3.40	6.02	Adequate	0.17	0.09	4.08	7.20	Adequate
43	1.5	0.013	86.8	1161.70	1160.22	1.48	0.017	3.93	0.55	6.70	11.84	Adequate	5.82	0.68	7.44	13.15	Adequate	10.51	0.98	8.55	15.12	Adequate
50	1.5	0.013	16.1	1189.58	1188.62	0.96	0.060	3.98	0.40	10.54	18.63	Adequate	5.88	0.49	11.78	20.81	Adequate	10.62	0.67	13.83	24.44	Adequate
58	1.5	0.013	38.6	1218.73	1216.95	1.78	0.046	4.55	0.46	9.99	17.65	Adequate	6.73	0.56	11.14	19.69	Adequate	12.15	0.78	13.00	22.97	Adequate
76	1.5	0.013	54.2	1130.80	1128.77	2.03	0.037	2.82	0.38	8.09	14.30	Adequate	4.16	0.46	9.04	15.98	Adequate	7.52	0.63	10.64	18.81	Adequate
79	Culvert to be replaced with inlet and directed to Storm Pipe C2																					
81	1.5	0.013	49.5	1187.58	1184.45	3.13	0.063	6.18	0.49	12.20	21.55	Adequate	9.20	0.61	13.61	24.05	Adequate	16.63	0.86	15.80	27.92	Adequate
83	1.5	0.013	53.1	1208.19	1204.55	3.64	0.069	5.11	0.44	11.90	21.03	Adequate	7.60	0.54	13.30	23.50	Adequate	13.74	0.75	15.56	27.49	Adequate
91	1.5	0.013	24.0	1130.90	1130.79	0.11	0.005	2.59	0.63	3.71	6.55	Adequate	3.82	0.78	4.09	7.24	Adequate	6.90	1.19	4.59	8.10	Adequate
95	1.5	0.013	26.4	1159.32	1158.76	0.56	0.021	1.35	0.30	5.34	9.43	Adequate	1.98	0.36	5.97	10.55	Adequate	3.59	0.49	7.07	12.50	Adequate
100	1.5	0.013	30.9	1188.59	1188.39	0.20	0.006	1.74	0.46	3.76	6.65	Adequate	2.56	0.57	4.19	7.40	Adequate	4.62	0.79	4.89	8.64	Adequate
104	1.5	0.013	22.6	1208.40	1208.32	0.08	0.004	2.98	0.73	3.49	6.17	Adequate	4.38	0.93	3.83	6.77	Adequate	7.93	1.50	4.49	7.93	Need More Capacity
115	2	0.013	50.7	1080.59	1079.96	0.63	0.012	9.32	0.84	7.42	23.32	Adequate	13.84	1.06	8.21	25.80	Adequate	24.99	1.62	9.15	28.75	Adequate
117	1.5	0.013	86.9	1089.68	1085.68	4.00	0.046	7.89	0.61	11.62	20.54	Adequate	11.71	0.77	12.87	22.75	Adequate	21.14	1.15	14.50	25.62	Adequate
118	1.5	0.013	63.6	1104.81	1101.09	3.72	0.058	6.19	0.50	11.87	20.97	Adequate	9.17	0.62	13.21	23.35	Adequate	16.56	0.88	15.31	27.06	Adequate
121	1.5	0.013	48.3	1130.73	1124.70	6.03	0.125	3.63	0.32	13.34	23.58	Adequate	5.37	0.39	14.96	26.43	Adequate	9.70	0.52	17.68	31.24	Adequate
123	1.5	0.013	28.1	1143.81	1140.64	3.17	0.113	3.61	0.32	12.85	22.71	Adequate	5.34	0.39	14.40	25.44	Adequate	9.64	0.54	17.01	30.06	Adequate
125	1.5	0.013	61.1	1159.71	1156.37	3.34	0.055	2.35	0.31	8.78	15.51	Adequate	3.47	0.38	9.83	17.37	Adequate	6.27	0.52	11.62	20.53	Adequate
129	1.5	0.013	51.1	1187.88	1184.14	3.74	0.073	4.73	0.41	11.92	21.06	Adequate	6.98	0.51	13.30	23.51	Adequate	12.61	0.70	15.60	27.57	Adequate
131	1.5	0.013	61.7	1210.28	1205.51	4.77	0.077	2.69	0.31	10.32	18.24	Adequate	3.97	0.37	11.55	20.41	Adequate	7.17	0.51	13.67	24.15	Adequate
133	1.5	0.013	54.2	1234.57	1229.02	5.55	0.102	0.40	0.12	6.45	11.40	Adequate	0.59	0.14	7.26	12.84	Adequate	1.08	0.18	8.67	15.33	Adequate
134	1.5	0.013	51.3	1086.54	1085.48	1.06	0.021	2.12	0.38	6.03	10.66	Adequate	3.12	0.46	6.73	11.90	Adequate	5.65	0.64	7.93	14.01	Adequate
136	1.5	0.013	37.9	1138.67	1137.09	1.58	0.042	1.28	0.25	6.67	11.79	Adequate	1.89	0.30	7.48	13.22	Adequate	3.42	0.41	8.88	15.70	Adequate
137	1.5	0.013	25.2	1161.34	1159.98	1.36	0.054	2.49	0.32	8.89	15.70	Adequate	3.67	0.39	9.94	17.57	Adequate	6.64	0.53	11.75	20.77	Adequate
141	1.5	0.013	61.0	1188.59	1188.44	0.15	0.002	2.04	0.65	2.77	4.89	Adequate	3.00	0.82	3.05	5.39	Adequate	5.43	1.50	3.07	5.43	Need More Capacity
144	1.5	0.013	76.0	1210.63	1210.54	0.09	0.001	2.10	0.82	2.12	3.75	Adequate	3.09	1.07	2.30	4.06	Adequate	5.58	1.50	3.16	5.58	Need More Capacity

Note: Only select "worst-case scenario" culverts were analyzed for hydraulic capacity.

[1] All east-west culverts should be upsized to 18" (see report text for more details).

[2] Elevations obtained from USGS National Elevation Dataset GIS data.

[3] Culverts that "Need More Capacity" are east-west culverts with shallow slopes.

PHASE 1 - Marine View Storm Structures, Access Road Swale, & Golf Course Pond

Item	Unit	Quantity	Unit Price	Total Price
Marine View Storm Structures				**$215,609**
Excavation	Cubic Yard	1,574.82	$12.00	$18,898
Manhole Type 1, 48 Diam.	Each	5	$3,500.00	$17,500
Drop Inlet Type 1	Each	4	$3,500.00	$14,000
Catch Basin Type 2	Each	1	$3,500.00	$3,500
24" SD Pipe (HDPE)	Lineal Foot	1,300.00	$60.00	$78,000
24" SD Pipe (CMP)	Lineal Foot	207.00	$30.00	$6,210
18" SD Pipe (HDPE)	Lineal Foot	390.00	$40.00	$15,600
18" SD Pipe (CMP)	Lineal Foot	275.00	$25.00	$6,875
Pipe Bedding (5/8"-0 crushed aggregate)	Ton	321.78	$30.00	$9,653
Pipe Zone Backfill	Cubic Yard	907.46	$50.00	$45,373
Access Road Swale				**$69,592**
Excavation	Cubic Yard	2,691.85	$12.00	$32,302
Catch Basin Type 2, 48" Diam.	Each	2	$3,500.00	$7,000
18" SD Pipe (HDPE)	Lineal Foot	330.00	$40.00	$13,200
4" SD Pipe (PVC, Sch 80)	Lineal Foot	5.00	$20.00	$100
Debris Cage, 48" Diam.	Each	2	$500.00	$1,000
4" Slide Gate	Each	1	$500.00	$500
Animal Guard, 24"	Each	2	$160.00	$320
Animal Guard, 18"	Each	1	$90.00	$90
Animal Guard, 4"	Each	1	$10.00	$10
Pipe Bedding (5/8"-0 crushed aggregate)	Ton	49.63	$30.00	$1,489
Pipe Zone Backfill	Cubic Yard	225.43	$50.00	$11,272
Rip Rap	Cubic Yard	7.11	$100.00	$711
Woven Geotextile Lining	Square Yard	21.33	$4.00	$85
Hydroseed	Acre	0.89	$1,700.00	$1,513
Golf Course Pond				**$85,904**
Excavation	Cubic Yard	2,921.78	$12.00	$35,061
Manhole Type 1, 48 Diam.	Each	1	$3,500.00	$3,500
Catch Basin Type 2, 48" Diam.	Each	1	$3,500.00	$3,500
24" SD Pipe (HDPE)	Lineal Foot	450.00	$60.00	$27,000
4" SD Pipe (PVC, Sch 80)	Lineal Foot	12.00	$20.00	$240
Debris Cage, 48" Diam.	Each	1	$500.00	$500
Animal Guard, 18"	Each	2	$90.00	$180
Animal Guard, 4"	Each	1	$10.00	$10
Pipe Bedding (5/8"-0 crushed aggregate)	Ton	68.44	$30.00	$2,053
Pipe Zone Backfill	Cubic Yard	253.85	$50.00	$12,693
Rip Rap	Cubic Yard	2.37	$100.00	$237
Woven Geotextile Lining	Square Yard	7.11	$4.00	$28
Hydroseed	Acre	0.53	$1,700.00	$901
			Sub-Total	***$371,105***
			Mobilization (7%)	$25,977
			Engineering / Admin (20%, incl. Mobilization)	$79,416
			Drainage Easement Acquisition	$5,000
			Sub-Total	***$481,499***
			Contingency (50%)	**$240,749**
			PHASE 1 TOTAL	**$722,248**

PHASE 2 - Legacy Resort Storm Structures, Overflow Pond, & Pump Station

Item	Unit	Quantity	Unit Price	Total Price
Legacy Resort Storm Structures				**$79,188**
Excavation	Cubic Yard	933.33	$12.00	$11,200
Manhole Type 1, 48 Diam.	Each	4	$3,500.00	$14,000
24" SD Pipe (HDPE)	Linear Foot	1,575.00	$60.00	$94,500
Pipe Bedding (5/8"-0 crushed aggregate)	Ton	233.33	$30.00	$7,000
Pipe Zone Backfill	Cubic Yard	633.50	$50.00	$31,675
Cost Share with Legacy Resort (-50%)	LS	1	-$79,187.50	-$79,188
Overflow Pond & Pump Station				**$48,154**
Excavation	Cubic Yard	3,226.67	$12.00	$38,720
Rip Rap	Cubic Yard	2.37	$100.00	$237
Woven Geotextile Lining	Square Yard	7.11	$4.00	$28
Hydroseed	Acre	1.57	$1,700.00	$2,669
Emergency Pump Station	LS	1	$6,500.00	$6,500
			Sub-Total	***$127,342***
			Mobilization (7%)	$8,914
			Engineering / Admin (20%, incl. Mobilization)	$27,251
			Drainage Easement Acquisition	$5,000
			Sub-Total	***$168,507***
			Contingency (50%)	**$84,254**
			PHASE 2 TOTAL	**$252,761**
			GRAND TOTAL (Phase 1 and Phase 2)	**$975,009**
			Annual Operations and Maintenance Costs	***$10,000***

Assumptions:

1. Only 13 east-west culverts are upgraded to 18" CMP.
2. Excavated soil assumed to not be suitable for pipe zone backfill.
3. Phase 2 Legacy Resort storm structures assumed to have a cost share of 50% with Legacy Resort.
4. A contingency of 50% was added to each phase of the project to account for unknowns such as excavation through basalt, utility conflicts, and additional energy dissipation measures.

Appendix F—Recommended Maintenance Criteria

Appendix 5A – Recommended Maintenance Criteria

The facility-specific maintenance standards contained in this section are intended to be conditions for determining if maintenance actions are required as identified through inspection. They are not intended to be measures of the facility's required condition at all times between inspections. In other words, exceedance of these conditions at any time between inspections and/or maintenance does not automatically constitute a violation of these standards. However, based upon inspection observations, the inspection and maintenance schedules shall be adjusted to minimize the length of time that a facility is in a condition that requires a maintenance action.

No. 1 – Wetponds

Maintenance Component	Defect	Conditions When Maintenance Is Needed	Results Expected When Maintenance Is Performed
General	Trash & Debris	Any trash and debris which exceed 5 cubic feet per 1,000 square feet (this is about equal to the amount of trash it would take to fill up one standard size garbage can). In general, there should be no visual evidence of dumping. If less than threshold, all trash and debris will be removed as part of next scheduled maintenance.	Trash and debris cleared from site.
	Poisonous Vegetation and Noxious Weeds	Any poisonous or nuisance vegetation which may constitute a hazard to maintenance personnel or the public. Any evidence of noxious weeds as defined by state or local regulations. (Apply requirements of adopted IPM policies for the use of herbicides).	No danger of poisonous vegetation where maintenance personnel or the public might normally be. (Coordinate with local health department) Complete eradication of noxious weeds may not be possible. Compliance with state or local eradication policies required.
	Contaminants and Pollution	Any evidence of oil, gasoline, contaminants or other pollutants (Coordinate removal/cleanup with local water quality response agency).	No contaminants or pollutants present.
	Rodent Holes	Any evidence of rodent holes if facility is acting as a dam or berm, or any evidence of water piping through dam or berm via rodent holes.	Rodents destroyed and dam or berm repaired. (Coordinate with local health department; coordinate with Ecology Dam Safety Office if pond exceeds 10 acre-feet.)

No. 1 – Wetponds

Maintenance Component	Defect	Conditions When Maintenance Is Needed	Results Expected When Maintenance Is Performed
	Beaver Dams	Dam results in change or function of the facility.	Facility is returned to design function. (Coordinate trapping of beavers and removal of dams with appropriate permitting agencies.)
	Insects	When insects such as wasps and hornets interfere with maintenance activities.	Insects destroyed or removed from site. Apply insecticides in compliance with adopted IPM policies.
	Tree Growth and Hazard Trees	Tree growth does not allow maintenance access or interferes with maintenance activity (i.e., slope mowing, silt removal, vactoring, or equipment movements). If trees are not interfering with access or maintenance, do not remove. If dead, diseased, or dying trees are identified. (Use a certified Arborist to determine health of tree or removal requirements.)	Trees do not hinder maintenance activities. Harvested trees should be recycled into mulch or other beneficial uses (e.g., alders for firewood). Remove hazard trees.
Side Slopes of Pond	Erosion	Eroded damage over 2 inches deep where cause of damage is still present or where there is potential for continued erosion. Any erosion observed on a compacted berm embankment.	Slopes should be stabilized using appropriate erosion control measure(s); e.g., rock reinforcement, planting of grass, compaction. If erosion is occurring on compacted berms, a licensed civil engineer should be consulted to resolve source of erosion.
Storage Area	Sediment	Accumulated sediment that exceeds 10% of the designed pond depth unless otherwise specified or affects inletting or outletting condition of the facility.	Sediment cleaned out to designed pond shape and depth; pond reseeded if necessary to control erosion.
	Liner (If Applicable)	Liner is visible and has more than three 1/4-inch holes in it.	Liner repaired or replaced. Liner is fully covered.

No. 1 – Wetponds

Maintenance Component	Defect	Conditions When Maintenance Is Needed	Results Expected When Maintenance Is Performed
Pond Berms (Dikes)	Settlements	Any part of berm which has settled 4 inches lower than the design elevation. If settlement is apparent, measure berm to determine amount of settlement. Settling can be an indication of more severe problems with the berm or outlet works. A licensed civil engineer should be consulted to determine the source of the settlement.	Dike is built back to the design elevation.
	Piping	Discernable water flow through pond berm. Ongoing erosion with potential for erosion to continue. (Recommend a Goethechnical engineer be called in to inspect and evaluate condition and recommend repair of condition.)	Piping eliminated. Erosion potential resolved.
Emergency Overflow/ Spillway and Berms over 4 feet in height.	Tree Growth	Tree growth on emergency spillways creates blockage problems and may cause failure of the berm due to uncontrolled overtopping. Tree growth on berms over 4 feet in height may lead to piping through the berm which could lead to failure of the berm.	Trees should be removed. If root system is small (base less than 4 inches) the root system may be left in place. Otherwise the roots should be removed and the berm restored. A licensed civil engineer should be consulted for proper berm/spillway restoration.
	Piping	Discernable water flow through pond berm. Ongoing erosion with potential for erosion to continue. (Recommend a Goethechnical engineer be called in to inspect and evaluate condition and recommend repair of condition.)	Piping eliminated. Erosion potential resolved.

No. 1 – Wetponds

Maintenance Component	Defect	Conditions When Maintenance Is Needed	Results Expected When Maintenance Is Performed
Emergency Overflow/ Spillway	Emergency Overflow/ Spillway	Only one layer of rock exists above native soil in area five square feet or larger, or any exposure of native soil at the top of out flow path of spillway. (Rip-rap on inside slopes need not be replaced.)	Rocks and pad depth are restored to design standards.
General	Water level	First cell is empty, doesn't hold water.	Line the first cell to maintain at least 4 feet of water. Although the second cell may drain, the first cell must remain full to control turbulence of the incoming flow and reduce sediment resuspension.
	Trash and Debris	Accumulation that exceeds 1 CF per 1000-SF of pond area.	Trash and debris removed from pond.
	Inlet/Outlet Pipe	Inlet/Outlet pipe clogged with sediment and/or debris material.	No clogging or blockage in the inlet and outlet piping.
	Sediment Accumulation in Pond Bottom	Sediment accumulations in pond bottom that exceeds the depth of sediment zone plus 6-inches, usually in the first cell.	Sediment removed from pond bottom.
	Oil Sheen on Water	Prevalent and visible oil sheen.	Oil removed from water using oil-absorbent pads or vactor truck. Source of oil located and corrected. If chronic low levels of oil persist, plant wetland plants such as Juncus effusus (soft rush) which can uptake small concentrations of oil.
	Erosion	Erosion of the pond's side slopes and/or scouring of the pond bottom, that exceeds 6-inches, or where continued erosion is prevalent.	Slopes stabilized using proper erosion control measures and repair methods.
	Settlement of Pond Dike/Berm	Any part of these components that has settled 4-inches or lower than the design elevation, or inspector determines dike/berm is unsound.	Dike/berm is repaired to specifications.
	Internal Berm	Berm dividing cells should be level.	Berm surface is leveled so that water flows evenly over entire length of berm.
	Overflow Spillway	Rock is missing and soil is exposed at top of spillway or outside slope.	Rocks replaced to specifications.

No. 2 – Bio-infiltration/Infiltration Trenches/Basins

Maintenance Component	Defect	Conditions When Maintenance Is Needed	Results Expected When Maintenance Is Performed
General	Trash & Debris	See "Wetponds" (No. 1).	See "Wetponds" (No. 1).
	Poisonous/Noxious Vegetation	See "Wetponds" (No. 1).	See "Wetponds" (No. 1).
	Contaminants and Pollution	See "Wetponds" (No. 1).	See "Wetponds" (No. 1).
	Rodent Holes	See "Wetponds" (No. 1).	See "Wetponds" (No. 1).
Storage Area	Sediment	Water ponding in infiltration pond after rainfall ceases and appropriate time allowed for infiltration. (A percolation test pit or test of facility indicates facility is only working at 90% of its designed capabilities. If two inches or more sediment is present, remove).	Sediment is removed and/or facility is cleaned so that infiltration system works according to design.
Rock Filters	Sediment and Debris	By visual inspection, little or no water flows through filter during heavy rain storms.	Gravel in rock filter is replaced.
Side Slopes of Pond	Erosion	See "Wetponds" (No. 1).	See "Wetponds" (No. 1).
Emergency Overflow Spillway and Berms over 4 feet in height.	Tree Growth	See "Wetponds" (No. 1).	See "Wetponds" (No. 1).
	Piping	See "Wetponds" (No. 1).	See "Wetponds" (No. 1).
Emergency Overflow Spillway	Rock Missing	See "Wetponds" (No. 1).	See "Wetponds" (No. 1).
	Erosion	See "Wetponds" (No. 1).	See "Wetponds" (No. 1).
Pre-Settling Ponds and Vaults	Facility or sump filled with Sediment and/or debris	6" or designed sediment trap depth of sediment.	Sediment is removed.

No. 4 – Control Structure/Flow Restrictor for Wetponds

Maintenance Component	Defect	Condition When Maintenance is Needed	Results Expected When Maintenance is Performed
General	Trash and Debris (Includes Sediment)	Material exceeds 25% of sump depth or 1 foot below orifice plate.	Control structure orifice is not blocked. All trash and debris removed.
	Structural Damage	Structure is not securely attached to manhole wall.	Structure securely attached to wall and outlet pipe.
		Structure is not in upright position (allow up to 10% from plumb).	Structure in correct position.
		Connections to outlet pipe are not watertight and show signs of rust.	Connections to outlet pipe are water tight; structure repaired or replaced and works as designed.
		Any holes--other than designed holes--in the structure.	Structure has no holes other than designed holes.
Cleanout Gate	Damaged or Missing	Cleanout gate is not watertight or is missing.	Gate is watertight and works as designed.
		Gate cannot be moved up and down by one maintenance person.	Gate moves up and down easily and is watertight.
		Chain/rod leading to gate is missing or damaged.	Chain is in place and works as designed.
		Gate is rusted over 50% of its surface area.	Gate is repaired or replaced to meet design standards.
Orifice Plate	Damaged or Missing	Control device is not working properly due to missing, out of place, or bent orifice plate.	Plate is in place and works as designed.
	Obstructions	Any trash, debris, sediment, or vegetation blocking the plate.	Plate is free of all obstructions and works as designed.
Overflow Pipe	Obstructions	Any trash or debris blocking (or having the potential of blocking) the overflow pipe.	Pipe is free of all obstructions and works as designed.
Manhole	See “Closed Treatment Systems” (No. 3).	See “Closed Treatment Systems” (No. 3).	See “Closed Treatment Systems” (No. 3).
Catch Basin	See “Catch Basins” (No. 5).	See “Catch Basins” (No. 5).	See “Catch Basins” (No. 5).

No. 5 – Catch Basins

Maintenance Component	Defect	Conditions When Maintenance is Needed	Results Expected When Maintenance is performed
General	Trash & Debris	Trash or debris which is located immediately in front of the catch basin opening or is blocking inletting capacity of the basin by more than 10%.	No Trash or debris located immediately in front of catch basin or on grate opening.
		Trash or debris (in the basin) that exceeds 60% of the sump depth as measured from the bottom of basin to invert of the lowest pipe into or out of the basin, but in no case less than a minimum of 6 inches clearance from the debris surface to the invert of the lowest pipe.	No trash or debris in the catch basin.
		Trash or debris in any inlet or outlet pipe blocking more than 1/3 of its height.	Inlet and outlet pipes free of trash or debris.
		Dead animals or vegetation that could generate odors that could cause complaints or dangerous gases (e.g., methane).	No dead animals or vegetation present within the catch basin.
	Sediment	Sediment (in the basin) that exceeds 60 percent of the sump depth as measured from the bottom of basin to invert of the lowest pipe into or out of the basin, but in no case less than a minimum of 6 inches clearance from the sediment surface to the invert of the lowest pipe.	No sediment in the catch basin
	Structure Damage to Frame and/or Top Slab	Top slab has holes larger than 2 square inches or cracks wider than 1/4 inch (Intent is to make sure no material is running into basin).	Top slab is free of holes and cracks.
		Frame not sitting flush on top slab, i.e., separation of more than 3/4 inch of the frame from the top slab. Frame not securely attached	Frame is sitting flush on the riser rings or top slab and firmly attached.
	Fractures or Cracks in Basin Walls/ Bottom	Maintenance person judges that structure is unsound.	Basin replaced or repaired to design standards.
		Grout fillet has separated or cracked wider than 1/2 inch and longer than 1 foot at the joint of any inlet/outlet pipe or any evidence of soil particles entering catch basin through cracks.	Pipe is regrouted and secure at basin wall.
	Settlement/ Misalignment	If failure of basin has created a safety, function, or design problem.	Basin replaced or repaired to design standards.
	Vegetation	Vegetation growing across and blocking more than 10% of the basin opening.	No vegetation blocking opening to basin.
		Vegetation growing in inlet/outlet pipe joints that is more than six inches tall and less than six inches apart.	No vegetation or root growth present.

No. 5 – Catch Basins

Maintenance Component	Defect	Conditions When Maintenance is Needed	Results Expected When Maintenance is performed
	Contamination and Pollution	See "Wetponds" (No. 1).	No pollution present.
Catch Basin Cover	Cover Not in Place	Cover is missing or only partially in place. Any open catch basin requires maintenance.	Catch basin cover is closed
	Locking Mechanism Not Working	Mechanism cannot be opened by one maintenance person with proper tools. Bolts into frame have less than 1/2 inch of thread.	Mechanism opens with proper tools.
	Cover Difficult to Remove	One maintenance person cannot remove lid after applying normal lifting pressure. (Intent is keep cover from sealing off access to maintenance.)	Cover can be removed by one maintenance person.
Ladder	Ladder Rungs Unsafe	Ladder is unsafe due to missing rungs, not securely attached to basin wall, misalignment, rust, cracks, or sharp edges.	Ladder meets design standards and allows maintenance person safe access.
Metal Grates (If Applicable)	Grate opening Unsafe	Grate with opening wider than 7/8 inch.	Grate opening meets design standards.
	Trash and Debris	Trash and debris that is blocking more than 20% of grate surface inletting capacity.	Grate free of trash and debris.
	Damaged or Missing.	Grate missing or broken member(s) of the grate.	Grate is in place and meets design standards.

No. 6 – Debris Barriers (e.g., Trash Racks)

Maintenance Components	Defect	Condition When Maintenance is Needed	Results Expected When Maintenance is Performed
General	Trash and Debris	Trash or debris that is plugging more than 20% of the openings in the barrier.	Barrier cleared to design flow capacity.
Metal	Damaged/ Missing Bars.	Bars are bent out of shape more than 3 inches.	Bars in place with no bends more than 3/4 inch.
		Bars are missing or entire barrier missing.	Bars in place according to design.
		Bars are loose and rust is causing 50% deterioration to any part of barrier.	Barrier replaced or repaired to design standards.
	Inlet/Outlet Pipe	Debris barrier missing or not attached to pipe	Barrier firmly attached to pipe

No. 7 – Energy Dissipators

Maintenance Components	Defect	Conditions When Maintenance is Needed	Results Expected When Maintenance is Performed
External:			
Rock Pad	Missing or Moved Rock	Only one layer of rock exists above native soil in area five square feet or larger, or any exposure of native soil.	Rock pad replaced to design standards.
	Erosion	Soil erosion in or adjacent to rock pad.	Rock pad replaced to design standards.
Dispersion Trench	Pipe Plugged with Sediment	Accumulated sediment that exceeds 20% of the design depth.	Pipe cleaned/flushed so that it matches design.
	Not Discharging Water Properly	Visual evidence of water discharging at concentrated points along trench (normal condition is a "sheet flow" of water along trench). Intent is to prevent erosion damage.	Trench redesigned or rebuilt to standards.
	Perforations Plugged.	Over 1/2 of perforations in pipe are plugged with debris and sediment.	Perforated pipe cleaned or replaced.
	Water Flows Out Top of "Distributor" Catch Basin.	Maintenance person observes or receives credible report of water flowing out during any storm less than the design storm or is causing or appears likely to cause damage.	Facility rebuilt or redesigned to standards.
	Receiving Area Over-Saturated	Water in receiving area is causing or has potential of causing landslide problems.	No danger of landslides.
Internal:			
Manhole/Chamber	Worn or Damaged Post, Baffles, Side of Chamber	Structure dissipating flow deteriorates to 1/2 of original size or any concentrated worn spot exceeding one square foot which would make structure unsound.	Structure replaced to design standards.
	Other Defects	See "Catch Basins" (No. 5).	See "Catch Basins" (No. 5).

No. 8 – Biofiltration Swale

Maintenance Component	Defect or Problem	Condition When Maintenance is Needed	Recommended Maintenance to Correct Problem
General	Sediment Accumulation on Grass	Sediment depth exceeds 2 inches.	Remove sediment deposits on grass treatment area of the bio-swale. When finished, swale should be level from side to side and drain freely toward outlet. There should be no areas of standing water once inflow has ceased.
	Standing Water	When water stands in the swale between storms and does not drain freely.	Any of the following may apply: remove sediment or trash blockages, improve grade from head to foot of swale, remove clogged check dams, add underdrains or convert to a wet biofiltration swale.
	Flow spreader	Flow spreader uneven or clogged so that flows are not uniformly distributed through entire swale width.	Level the spreader and clean so that flows are spread evenly over entire swale width.
	Constant Baseflow	When small quantities of water continually flow through the swale, even when it has been dry for weeks, and an eroded, muddy channel has formed in the swale bottom.	Add a low-flow pea-gravel drain the length of the swale or by-pass the baseflow around the swale.
	Poor Vegetation Coverage	When grass is sparse or bare or eroded patches occur in more than 10% of the swale bottom.	Determine why grass growth is poor and correct that condition. Re-plant with plugs of grass from the upper slope: plant in the swale bottom at 8-inch intervals. Or re-seed into loosened, fertile soil.
	Vegetation	When the grass becomes excessively tall (greater than 10 inches); when nuisance weeds and other vegetation start to take over.	Mow vegetation or remove nuisance vegetation so that flow not impeded. Grass should be mowed to a height of 3 to 4 inches. Remove grass clippings.
	Excessive Shading	Grass growth is poor because sunlight does not reach swale.	If possible, trim back over-hanging limbs and remove brushy vegetation on adjacent slopes.
	Inlet/Outlet	Inlet/outlet areas clogged with sediment and/or debris.	Remove material so that there is no clogging or blockage in the inlet and outlet area.
	Trash and Debris Accumulation	Trash and debris accumulated in the bio-swale.	Remove trash and debris from bioswale.
	Erosion/Scouring	Eroded or scoured swale bottom due to flow channelization, or higher flows.	For ruts or bare areas less than 12 inches wide, repair the damaged area by filling with crushed gravel. If bare areas are large, generally greater than 12 inches wide, the swale should be re-graded and re-seeded. For smaller bare areas, overseed when bare spots are evident, or take plugs of grass from the upper slope and plant in the swale bottom at 8-inch intervals.

Maintenance Requirements for Detention Ponds

Maintenance Component	Defect	Conditions When Maintenance Is Needed	Results Expected When Maintenance Is Performed
General	Trash & Debris	**Any trash and debris which exceed 5 cubic feet per 1,000 square feet (this is about equal to the amount of trash it would take to fill up one standard size garbage can). In general, there should be no visual evidence of dumping.** If less than threshold all trash and debris will be removed as part of next scheduled maintenance.	Trash and debris cleared from site.
	Poisonous Vegetation and noxious weeds	Any poisonous or nuisance vegetation which may constitute a hazard to maintenance personnel or the public. Any evidence of noxious weeds as defined by State or local regulations. (Apply requirements of adopted Integrated Pest Management (IPM) policies for the use of herbicides).	No danger of poisonous vegetation where maintenance personnel or the public might normally be. (Coordinate with local health department) Complete eradication of noxious weeds may not be possible. Compliance with State or local eradication policies required
	Contaminants and Pollution	Any evidence of oil, gasoline, contaminants or other pollutants (Coordinate removal/cleanup with local water quality response agency).	No contaminants or pollutants present.
	Rodent Holes	Any evidence of rodent holes if facility is acting as a dam or berm, or any evidence of water piping through dam or berm via rodent holes.	Rodents destroyed and dam or berm repaired. (Coordinate with local health department and Ecology Dam Safety Office if pone exceeds 10 acre feet)
	Beaver Dams	Dam results in change or function of the facility.	Facility is returned to design function. (Coordinate trapping of beavers and removal of dams with appropriate permitting agencies)
	Insects	When insects such as wasps and hornets interfere with maintenance activities.	Insects destroyed or removed from site. Apply insecticides in compliance with adopted IPM policies.

Maintenance Component	Defect	Conditions When Maintenance Is Needed	Results Expected When Maintenance Is Performed
	Tree Growth and Hazard Trees	Tree growth does not allow maintenance access or interferes with maintenance activity (i.e., slope mowing, silt removal, vactoring, or equipment movements). If trees are not interfering with access or maintenance, do not remove If dead, diseased, or dying trees are identified (Use a certified Arborist to determine health of tree or removal requirements)	Trees do not hinder maintenance activities. Harvested trees should be recycled into mulch or other beneficial uses (e.g., alders for firewood). Remove hazard trees
Side Slopes of Pond	Erosion	Eroded damage over 2 inches deep where cause of damage is still present or where there is potential for continued erosion. Any erosion observed on a compacted berm embankment.	Slopes should be stabilized using appropriate erosion control measure(s); e.g., rock reinforcement, planting of grass, compaction. If erosion is occurring on compacted berms a licensed civil engineer should be consulted to resolve source of erosion.
Storage Area	Sediment	Accumulated sediment that exceeds 10% of the designed pond depth unless otherwise specified or affects inletting or outletting condition of the facility.	Sediment cleaned out to designed pond shape and depth; pond reseeded if necessary to control erosion.
	Liner (If Applicable)	Liner is visible and has more than three 1/4-inch holes in it.	Liner repaired or replaced. Liner is fully covered.
Pond Berms (Dikes)	Settlements	Any part of berm which has settled 4 inches lower than the design elevation. If settlement is apparent measure berm to determine amount of settlement. Settling can be an indication of more severe problems with the berm or outlet works. A licensed civil engineer should be consulted to determine the source of the settlement.	Dike is built back to the design elevation.
	Piping	Discernable water flow through pond berm. Ongoing erosion with potential for erosion to continue. (Recommend a Goethechnical engineer be called in to inspect and evaluate condition and recommend repair of condition.	Piping eliminated. Erosion potential resolved.

Maintenance Component	Defect	Conditions When Maintenance Is Needed	Results Expected When Maintenance Is Performed
Emergency Overflow/Spillway and Berms over 4 feet in height	Tree Growth	Tree growth on emergency spillways create blockage problems and may cause failure of the berm due to uncontrolled overtopping. Tree growth on berms over 4 feet in height may lead to piping through the berm which could lead to failure of the berm.	Trees should be removed. If root system is small (base less than 4 inches) the root system may be left in place. Otherwise the roots should be removed and the berm restored. A licensed civil engineer should be consulted for proper berm/spillway restoration.
	Piping	Discernible water flow through pond berm. Ongoing erosion with potential for erosion to continue. (Recommend a Goethechnical engineer be called in to inspect and evaluate condition and recommend repair of condition.	Piping eliminated. Erosion potential resolved.
Emergency Overflow/Spillway	Emergency Overflow/ Spillway	Only one layer of rock exists above native soil in area five square feet or larger, or any exposure of native soil at the top of out flow path of spillway. (Rip-rap on inside slopes need not be replaced.)	Rocks and pad depth are restored to design standards.
	Erosion	See “Side slopes of Pond”	

Maintenance of Control Structures

Maintenance Component	Defect	Condition When Maintenance is Needed	Results Expected When Maintenance is Performed
General	Trash and Debris (Includes Sediment)	Material exceeds 25% of sump depth or 1 foot below orifice plate.	Control structure orifice is not blocked. All trash and debris removed.
	Structural Damage	Structure is not securely attached to manhole wall.	Structure securely attached to wall and outlet pipe.
		Structure is not in upright position (allow up to 10% from plumb).	Structure in correct position.
		Connections to outlet pipe are not watertight and show signs of rust.	Connections to outlet pipe are water tight; structure repaired or replaced and works as designed.
		Any holes--other than designed holes--in the structure.	Structure has no holes other than designed holes.
Cleanout Gate	Damaged or Missing	Cleanout gate is not watertight or is missing.	Gate is watertight and works as designed.
		Gate cannot be moved up and down by one maintenance person.	Gate moves up and down easily and is watertight.
		Chain/rod leading to gate is missing or damaged.	Chain is in place and works as designed.
		Gate is rusted over 50% of its surface area.	Gate is repaired or replaced to meet design standards.
Orifice Plate	Damaged or Missing	Control device is not working properly due to missing, out of place, or bent orifice plate.	Plate is in place and works as designed.
	Obstructions	Any trash, debris, sediment, or vegetation blocking the plate.	Plate is free of all obstructions and works as designed.
Overflow Pipe	Obstructions	Any trash or debris blocking (or having the potential of blocking) the overflow pipe.	Pipe is free of all obstructions and works as designed.

Maintenance Component	Defect	Condition When Maintenance is Needed	Results Expected When Maintenance is Performed
Manhole	See requirements for vaults/tanks		
General	Trash & Debris	Trash or debris which is located immediately in front of the catch basin opening or is blocking inletting capacity of the basin by more than 10%.	No Trash or debris located immediately in front of catch basin or on grate opening.
		Trash or debris (in the basin) that exceeds 60 percent of the sump depth as measured from the bottom of basin to invert of the lowest pipe into or out of the basin, but in no case less than a minimum of six inches clearance from the debris surface to the invert of the lowest pipe.	No trash or debris in the catch basin.
		Trash or debris in any inlet or outlet pipe blocking more than 1/3 of its height.	Inlet and outlet pipes free of trash or debris.
		Dead animals or vegetation that could generate odors that could cause complaints or dangerous gases (e.g., methane).	No dead animals or vegetation present within the catch basin.
	Sediment	Sediment (in the basin) that exceeds 60 percent of the sump depth as measured from the bottom of basin to invert of the lowest pipe into or out of the basin, but in no case less than a minimum of 6 inches clearance from the sediment surface to the invert of the lowest pipe. Measured from the bottom of basin to invert of the lowest pipe into or out of the basin.	No sediment in the catch basin
	Structure Damage to Frame and/or Top Slab	Top slab has holes larger than 2 square inches or cracks wider than 1/4 inch (Intent is to make sure no material is running into basin).	Top slab is free of holes and cracks.
		Frame not sitting flush on top slab, i.e., separation of more than 3/4 inch of the frame from the top slab. Frame not securely attached	Frame is sitting flush on the riser rings or top slab and firmly attached.
	Fractures or Cracks in	Maintenance person judges that structure is unsound.	Basin replaced or repaired to design standards.

Maintenance Component	Defect	Condition When Maintenance is Needed	Results Expected When Maintenance is Performed
	Basin Walls/ Bottom	Grout fillet has separated or cracked wider than 1/2 inch and longer than 1 foot at the joint of any inlet/outlet pipe or any evidence of soil particles entering catch basin through cracks.	Pipe is regrouted and secure at basin wall.
	Settlement/ Misalignment	If failure of basin has created a safety, function, or design problem.	Basin replaced or repaired to design standards.
	Vegetation	Vegetation growing across and blocking more than 10% of the basin opening.	No vegetation blocking opening to basin.
		Vegetation growing in inlet/outlet pipe joints that is more than six inches tall and less than six inches apart.	No vegetation or root growth present.
	Contamination and Pollution	See "Detention Ponds"	No pollution present.
Catch Basin Cover	Cover Not in Place	Cover is missing or only partially in place. Any open catch basin requires maintenance.	Catch basin cover is closed
	Locking Mechanism Not Working	Mechanism cannot be opened by one maintenance person with proper tools. Bolts into frame have less than 1/2 inch of thread.	Mechanism opens with proper tools.
	Cover Difficult to Remove	One maintenance person cannot remove lid after applying normal lifting pressure. (Intent is keep cover from sealing off access to maintenance.)	Cover can be removed by one maintenance person.
Ladder	Ladder Rungs Unsafe	Ladder is unsafe due to missing rungs, not securely attached to basin wall, misalignment, rust, cracks, or sharp edges.	Ladder meets design standards and allows maintenance person safe access.
Metal Grates (if applicable)	Grate opening Unsafe	Grate with opening wider than 7/8 inch.	Grate opening meets design standards.
	Trash and Debris	Trash and debris that is blocking more than 20% of grate surface inletting capacity.	Grate free of trash and debris.
	Damaged or Missing.	Grate missing or broken member(s) of the grate.	Grate is in place and meets design standards.

Maintenance Requirements for Infiltration Ponds

Maintenance Component	Defect	Condition When Maintenance is Needed	Results Expected When Maintenance is Performed
General	Trash & Debris	See "Detention Ponds".	See "Detention Ponds".
	Poisonous/Noxious Vegetation	See "Detention Ponds".	See "Detention Ponds".
	Contaminants and Pollution	See "Detention Ponds".	See "Detention Ponds".
	Rodent Holes	See "Detention Ponds".	See "Detention Ponds".
Storage Area	Sediment	Water ponding in infiltration pond after rainfall ceases and appropriate time allowed for infiltration. (A percolation test pit or test of facility indicates facility is only working at 90% of its designed capabilities. If two inches or more sediment is present, remove).	Sediment is removed and/or facility is cleaned so that infiltration system works according to design.
Filter Bags (if applicable)	Filled with Sediment and Debris	Sediment and debris fill bag more than 1/2 full.	Filter bag is replaced or system is redesigned.
Rock Filters	Sediment and Debris	By visual inspection, little or no water flows through filter during heavy rain storms.	Gravel in rock filter is replaced.
Side Slopes of Pond	Erosion	See "Detention Ponds".	See "Detention Ponds".
Emergency Overflow Spillway and Berms over 4 feet in height.	Tree Growth	See "Detention Ponds".	See "Detention Ponds".
	Piping	See "Detention Ponds".	See "Detention Ponds".
Emergency Overflow Spillway	Rock Missing	See "Detention Ponds".	See "Detention Ponds".
	Erosion	See "Detention Ponds".	See "Detention Ponds".
Pre-settling Ponds and Vaults	Facility or sump filled with Sediment and/or debris	6" or designed sediment trap depth of sediment.	Sediment is removed.

Maintenance Requirements for Evaporation Ponds

Maintenance Component	Defect	Condition When Maintenance is Needed	Results Expected When Maintenance is Performed
General	Trash & Debris	See "Detention Ponds".	See "Detention Ponds".
	Poisonous/Noxious Vegetation	See "Detention Ponds".	See "Detention Ponds".
	Contaminants and Pollution	See "Detention Ponds".	See "Detention Ponds".
	Rodent Holes	See "Detention Ponds".	See "Detention Ponds".
Side Slopes of Pond	Erosion	See "Detention Ponds".	See "Detention Ponds".
Storage Area	Sediment	Accumulated sediment that exceeds 10% of the designed pond depth unless otherwise specified or affects inletting or outletting condition of the facility.	Sediment cleaned out to designed pond shape and depth; pond reseeded if necessary to control erosion.
	Liner (If Applicable)	Liner is visible and has more than three 1/4-inch holes in it.	Liner repaired or replaced. Liner is fully covered.
Pond Berms (Dikes)	Settlements	Any part of berm which has settled 4 inches lower than the design elevation. If settlement is apparent, measure berm to determine amount of settlement. Settling can be an indication of more severe problems with the berm or outlet works. A licensed civil engineer should be consulted to determine the source of the settlement.	Dike is built back to the design elevation.
	Piping	Discernable water flow through pond berm. Ongoing erosion with potential for erosion to continue. (Recommend a Goethechnical engineer be called in to inspect and evaluate condition and recommend repair of condition.	Piping eliminated. Erosion potential resolved.
General	Inlet Pipe	Inlet pipe clogged with sediment and/or debris material.	No clogging or blockage in the inlet and outlet piping.
	Oil Sheen on Water	Prevalent and visible oil sheen.	Oil removed from water using oil-absorbent pads or vactor truck. Source of oil located and corrected. If chronic low levels of oil persist, plant wetland plants such as Juncus effusus (soft rush) which can uptake small concentrations of oil.
	Erosion	Erosion of the pond's side slopes and/or scouring of the pond bottom, that exceeds 6-inches, or where continued erosion is prevalent.	Slopes stabilized using proper erosion control measures and repair methods.
	Overflow Spillway	Rock is missing and soil is exposed at top of spillway or outside slope.	Rocks replaced to specifications.

Maintenance Requirements for Evaporation Ponds

Maintenance Component	Defect	Condition When Maintenance is Needed	Results Expected When Maintenance is Performed
General (cont'd)	Snow	Snow removal operations deposit snow into evaporative system	This added factor must be considered in the water budget, especially if snow from another basin is put into the system. Temporary sediment ponds should be included in the design, to prevent sediment-laden runoff from entering the pond and storm disposal system during construction.