Application of Pennsylvania-American Water Company for the Acquisition of the Wastewater Treatment Plant and Collection System Owned and Operated by Elizabeth Borough Municipal Authority ("EBMA")
Docket No. A-2025-3052983

66 Pa. C.S. § 1329
Application Filing Checklist – Water/Wastewater

20. Proof of Compliance. Provide proof of compliance with applicable design, construction and operation standards of DEP or of the county health department, or both, including:

e. Provide documentation evidencing a 5-year compliance history with DEP with an explanation of each violation for the seller's utilities that have been providing service as well as provide a copy of any DEP-approved corrective action plans.

RESPONSE: e. A table showing EBMA's 5-year compliance history is included in **Appendix A-20-e.1**. Documents comprising the current DEP-approved Long Term Control Plan are included in **Appendix A-20-e.2**.

pennsylvania
DEPARTMENT OF ENVIRONMENTAL PROTECTION

BUREAU OF CLEAN WATER
WATER POLLUTION CONTROL FACILITY VIOLATIONS AND ENFORCEMENTS

Appendix A-20-e.1

Violation Date From: 8/26/2019 to 8/26/2024
Region: All
County: All
Municipality: All
Facility Type: NPDES Dischargers. Non-NPDES Dischargers. Chapter 102 NPDES

CLIENT ID	CLIENT	SITE ID	SITE NAME	PF ID	PERMIT	FACILITY	REGION	COUNTY	MUNICIPALITY	MAJOR/ MINOR	FACILITY KIND	PF STATUS	CIRCUIT RIDER SYSTEM	FEE CATEGORY	PROGRAM	INSPECTION ID	INSP CATEGORY	DATE INSPECTED	INSPECTION TYPE	AGENCY	INSPECTION RESULT DESCRIPTION	VIOLATION ID	VIOLATION DATE	VIOLATION TYPE	VIOLATION TYPE DESCRIPTION	RESOLVED DATE	# OF ENFORCEMENTS
74621	ELIZABETH BORO MUNI AUTH ALLEGHENY CNTY	263592	ELIZABETH BORO STP	282821	PA0028436	ELIZABETH BORO STP	SWRO	Allegheny	Elizabeth Boro	Major	Sewage Publicly Owned (Muni)	Active	NO	Major Sewage Facility with CSO	WPCNP	3797303	PF	6/26/2024	Compliance Evaluation	CHD	Violation(s) Noted	8194424	06/26/2024	92A.44	NPDES - Violation of effluent limits in Part A of permit		1
74621	ELIZABETH BORO MUNI AUTH ALLEGHENY CNTY	263592	ELIZABETH BORO STP	282821	PA0028436	ELIZABETH BORO STP	SWRO	Allegheny	Elizabeth Boro	Major	Sewage Publicly Owned (Muni)	Active	NO	Major Sewage Facility with CSO	WPCNP	3607240	PF	8/2/2023	Compliance Evaluation	CHD	Violation(s) Noted	8157086	08/02/2023	92A.44	NPDES - Violation of effluent limits in Part A of permit	01/26/2024	1
74621	ELIZABETH BORO MUNI AUTH ALLEGHENY CNTY	263592	ELIZABETH BORO STP	282821	PA0028436	ELIZABETH BORO STP	SWRO	Allegheny	Elizabeth Boro	Major	Sewage Publicly Owned (Muni)	Active	NO	Major Sewage Facility with CSO	WPCNP	3607240	PF	8/2/2023	Compliance Evaluation	CHD	Violation(s) Noted	8157087	08/02/2023	92A.41(A)5	NPDES - Failure to properly operate and maintain all facilities which are installed or used by the permittee to achieve compliance	01/26/2024	1
74621	ELIZABETH BORO MUNI AUTH ALLEGHENY CNTY	263592	ELIZABETH BORO STP	282821	PA0028436	ELIZABETH BORO STP	SWRO	Allegheny	Elizabeth Boro	Major	Sewage Publicly Owned (Muni)	Active	NO	Major Sewage Facility with CSO	WPCNP	3387318	PF	6/22/2022	Compliance Evaluation	CHD	Violation(s) Noted	960800	06/22/2022	92A.44	NPDES - Violation of effluent limits in Part A of permit	08/19/2022	1
74621	ELIZABETH BORO MUNI AUTH ALLEGHENY CNTY	263592	ELIZABETH BORO STP	282821	PA0028436	ELIZABETH BORO STP	SWRO	Allegheny	Elizabeth Boro	Major	Sewage Publicly Owned (Muni)	Active	NO	Major Sewage Facility with CSO	WPCNP	3387318	PF	6/22/2022	Compliance Evaluation	CHD	Violation(s) Noted	960802	06/22/2022	92A.41(A)5	NPDES - Failure to properly operate and maintain all facilities which are installed or used by the permittee to achieve compliance	08/19/2022	1

SENATE ENGINEERING

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December 17, 2020

Mr. Thomas Flanagan, Sewage Planning Specialist Supervisor
Clean Water Program
Department of Environmental Protection
400 Waterfront Drive
Pittsburgh, PA 15222

RE: Elizabeth Borough Municipal Authority
Act 537 Sewage Facilities Plan Update
SENATE # 11956

Dear Mr. Flanagan,

Senate Engineering (Senate) on behalf of the Elizabeth Borough Municipal Authority (Authority) submitted to Pennsylvania Department of Environmental Protection (DEP) on December 31, 2019 a Plan of Study and Task Activity Report (TAR) for the Authority's Act 537 Plan Update. This Plan Update is part of the Authority's Long-Term Control Plan (LTCP) as approved by DEP in July 2018. On January 7, 2020 the Authority received a letter from your office stating that DEP could not approve the Act 537 Plan of Study or TAR until 2 comments were resolved.

The first item listed by DEP stated that costs associated with development of the LTCP could not be included in the TAR. This comment was addressed in a letter to DEP dated March 9, 2020 where it was confirmed that the LTCP had previously been completed and approved and that the cost of preparing the LTCP was not included in the TAR. It is our understanding that the question in regard to the LTCP cost not being included in the TAR has been resolved to the satisfaction of DEP.

The other DEP comment stated *"EBMA will need to provide Resolutions from Elizabeth and Forward Townships and Elizabeth and Lincoln Boroughs granting EBMA permission to update their respective Act 537 plans"*. Senate has received the required resolutions from 3 of the 4 municipalities including Elizabeth Borough, Lincoln Borough & Elizabeth Township, see attached. To date, no resolution has been received from Forward Township. Forward Township has indicated that they have not been holding public meetings since the start of the COVID pandemic but do intend to start again in 2021.

The Authority and Senate would like to complete the municipal Act 537 plan and submit a revised LTCP schedule, if DEP concurs that the Act 537 plan may continue without a resolution from Forward Township. The following updated LTCP schedule, assuming approval to proceed is received from DEP by January 1, 2021, is proposed as follows:

Task	Original Compliance Date	Revised Compliance Date
Submit Act 537 Update to DEP for Approval		August 30, 2021
Act 537 Sewage Facilities Planning Update Approval	July 31, 2020	December 31,2021
Complete Facilities Design	July 31, 2022	December 31, 2023
Submit WQM Permit Applications(s)	July 31, 2022	December 31, 2023
Begin Facility Construction	October 31, 2024	October 31, 2025
Submit PCCMP	March 31, 2027	March 31, 2028
Complete Facility Construction	October 31, 2027	October 31, 2028
Implement PCCMP	Upon Department Approval	Upon Department Approval

Meetings have occurred with several of the municipalities at this time to answer questions and encourage timely participation.

The Authority would like to move forward with the Plan update as soon as the TAR is approved. Please let us know if DEP will approve the TAR with 3 of 4 municipal approvals to update the Plan, or what course of action is needed to get TAR approval.

Feel free to contact me at (412) 826-5454 or rdbarnett@senateengineering.com if you need any additional information.

Sincerely,
SENATE ENGINEERING COMPANY



Rick Barnett, P.E.
Principal

Attachments

cf: Elizabeth Borough Municipal Authority w/Attachments

H:\SEN\P\011\11956\Doc\12-142020 TFlanagan DEP .docx

OFFICIAL
BOROUGH OF LINCOLN
RESOLUTION NO. 20-06

ACT 537 PLAN UPDATE
FOR
ELIZABETH BOROUGH MUNICIPAL AUTHORITY
SEWAGE AREA
ALLEGHENY COUNTY, PENNSYLVANIA

A RESOLUTION OF THE BOROUGH OF LINCOLN, ALLEGHENY COUNTY, PENNSYLVANIA, HEREBY AUTHORIZING THE ELZABETH BOROUGH MUNICIPAL AUTHORITY TO PREPARE AN ACT 537 PLAN UPDATE AS DESCRIBED IN THE TASK/ACTIVITY REPORT AND WORK PLAN SUBMITTED IN DECEMBER OF 2019

WHEREAS, sanitary wastewater flows from the Borough of Lincoln currently, or in the future may, enter the combined sewer system of the Elizabeth Borough Municipal Authority ("EBMA"); and

WHEREAS, on July 14, 2017, EBMA submitted a Long-Term Control Plan to the Pennsylvania Department of Environmental Protection ("PaDEP"), in accordance with the Pennsylvania Sewage Facilities Act ("Act 537'), which was approved on July 12, 2018, and which EBMA now intends to further investigate, analyze and refine with the preparation of an Act 537 Plan Update; and

WHEREAS, the Study by the EBMA requires the authorization of the Borough of Lincoln, which authorization the Borough desires to provide.

NOW, THEREFORE, the Lincoln Borough Council hereby resolves as follows, incorporating the above recitals by reference:

1. The EBMA is hereby authorized to prepare an Act 537 Plan Update in sanitary wastewater flow tributary to its combined sewer system.

2. Said Act 537 Plan Update shall include those elements described in the Task/Activity Report and Work Plan submitted in December of 2019, to be submitted to the PaDEP.

RESOLVED AND ADOPTED this ____ day of August 26, 2020, by the Lincoln Borough Council, Allegheny County, Pennsylvania.

LINCOLN BOROUGH COUNCIL

Attest:

Lincoln Borough Council

Mark Betzner
President of Council

OFFICIAL
TOWNSHIP OF ELIZABETH
RESOLUTION NO. 2020-16

ACT 537 PLAN SPECIAL STUDY
FOR
ELIZABETH BOROUGH MUNICIPAL AUTHORITY
SEWAGE AREA
ALLEGHENY COUNTY, PENNSYLVANIA

A RESOLUTION OF THE TOWNSHIP OF ELIZABETH, ALLEGHENY COUNTY, PENNSYLVANIA, HEREBY AUTHORIZING THE ELZABETH BOROUGH MUNICIPAL AUTHORITY TO PREPARE AN ACT 537 PLAN SPECIAL STUDY AS DESCRIBED IN THE TASK/ACTIVITY REPORT AND WORK PLAN SUBMITTED IN DECEMBER OF 2019.

WHEREAS, sanitary wastewater flows from a portion of the Township of Elizabeth enter the combined sewer system of the Elizabeth Borough Municipal Authority ("EBMA"); and

WHEREAS, on July 14, 2017, EBMA submitted a Long-Term Control Plan to the Pennsylvania Department of Environmental Protection ("PaDEP"), in accordance with the Pennsylvania Sewage Facilities Act ("Act 537'), which was approved on July 12, 2018, and which EBMA now intends to further investigate, analyze and refine with the preparation of an Act 537 Special Study; and

WHEREAS, the Study by the EBMA requires the authorization of the Township of Elizabeth, which authorization the Township desires to provide.

NOW, THEREFORE, the Elizabeth Township Board of Commissioners hereby resolves as follows, incorporating the above recitals by reference:

1. The EBMA is hereby authorized to prepare an Act 537 Plan Special Study in sanitary wastewater flow tributary to its combined sewer system.

2. Said Act 537 Plan Special Study shall include those elements described in the Task/Activity Report and Work Plan submitted December of 2019, to be submitted to the PaDEP.

RESOLVED AND ADOPTED this 14th day of September, 2020, by the Elizabeth Township Board of Commissioners, Allegheny County, Pennsylvania.

ELIZABETH TOWNSHIP BOARD OF COMMISSIONERS

Attest:

Township of Elizabeth

Kyle A. Walk

Kyle Walk
President

OFFICIAL
BOROUGH OF ELIZABETH
RESOLUTION NO. 2020-05

ACT 537 PLAN SPECIAL STUDY
FOR
ELIZABETH BOROUGH MUNICIPAL AUTHORITY
SEWAGE AREA
ALLEGHENY COUNTY, PENNSYLVANIA

A RESOLUTION OF THE BOROUGH OF ELIZABETH, ALLEGHENY COUNTY, PENNSYLVANIA, HEREBY AUTHORIZING THE ELZABETH BOROUGH MUNICIPAL AUTHORITY TO PREPARE AN ACT 537 PLAN SPECIAL STUDY AS DESCRIBED IN THE TASK/ACTIVITY REPORT AND WORK PLAN SUBMITTED IN DECEMBER OF 2019

WHEREAS, sanitary wastewater flows from the Borough of Elizabeth enter the combined sewer system of the Elizabeth Borough Municipal Authority ("EBMA"); and

WHEREAS, on July 14, 2017, EBMA submitted a Long-Term Control Plan to the Pennsylvania Department of Environmental Protection ("PaDEP"), in accordance with the Pennsylvania Sewage Facilities Act ("Act 537'), which was approved on July 12, 2018, and which EBMA now intends to further investigate, analyze and refine with the preparation of an Act 537 Special Study; and

WHEREAS, the Study by the EBMA requires the authorization of the Borough of Elizabeth, which authorization the Borough desires to provide.

NOW, THEREFORE, the Elizabeth Borough Council hereby resolves as follows, incorporating the above recitals by reference:

1. The EBMA is hereby authorized to prepare an Act 537 Plan Special Study in sanitary wastewater flow tributary to its combined sewer system.

2. Said Act 537 Plan Special Study shall include those elements described in the Task/Activity Report and Work Plan submitted in December of 2019, to be submitted to the PaDEP.

RESOLVED AND ADOPTED this 25th day of Aug, 2020, by the Elizabeth Borough Council, Allegheny County, Pennsylvania.

ELIZABETH BOROUGH COUNCIL

Attest:

Elizabeth Borough Council

Chad Rager
President of Council

pennsylvania
DEPARTMENT OF ENVIRONMENTAL PROTECTION

Southwest Regional Office 400 Waterfront Drive Pittsburgh, PA 15222

Mr. Michael Zrenchak, Operations Manager
Elizabeth Borough Municipal Authority
One Locust Street
Elizabeth, PA 15307

July 12, 2018

Re: CSO LTCP Review
NPDES PA0028436
Elizabeth Borough
Allegheny County

Dear Mr. Zrenchak:

On July 14, 2017 the Elizabeth Borough Municipal Authority (EBMA) submitted its Combined Sewer Overflow (CSO) Long Term Control Plan (LTCP) to the Department for review. The LTCP proposes concept-level facility designs intended to comply with the Presumption Approach criteria of the EPA CSO Policy's (Policy) performance standards. It proposes to meet the Policy's performance standard by limiting CSO discharges from its combined sewer system (CSS) to an average of four discharges per year during precipitation events on a system-wide annual average basis (with the possibility of two additional overflows allowed based upon Department discretion). Per the Department's May 9, 2018 meeting with EBMA, the proposed facilities should be designed to convey for full biological treatment: all Peak sanitary-only sewage received (without discharge) and a minimum of 350% of the Peak dry-weather Annual Average CSS flow. The LTCP selected Alternative B-1 as its compliance approach.

The LTCP notes some partial sewer separation has been undertaken in sewershed 008, with smaller scope separation projects completed in sewersheds 006 and 007. Additionally, the LTCP proposes to meet its Policy-related performance standards by: abandoning its existing 1.2 mgd activated sludge WWTP and replacing it with a 2.0 mgd SBR facility (with a peak capacity of 10 mgd); constructing collection and conveyance system improvements to convey most wet weather flow to the WWTP, including building new pump stations at CSO structures 008 and 005; constructing a new main STP pump station to handle both dry and wet weather flows and; constructing a 0.66 MG wet weather flow equalization and storage tank at the WWTP (where flows above 8.8 mgd will be stored for later treatment). The flow authorized from the Wylie P.S is set at 1.2 mgd which utilizes the proposed peak SBR peak design capacity of 10.0 mgd. The LTCP anticipates an implementation cost of $19.6 M. The EBMA LTCP is approved for implementation; subject to the below comments.

Following our preliminary review, on October 17, 2017 the Department requested additional information. In its March 14, 2018 reply (Response) Senate Engineers (Engineer) provided much of the information requested. The Response summarized both the peak flow values metered and those values modeled for the Forward Township and Elizabeth Township sanitary-only sewer systems (SSS). These flow values were listed in Table 3 of the Response. Unfortunately, the Table 3 presentation compares the Maximum Hour observed system flows against the Peak Instantaneous modeled flows. This presentation does not permit a direct comparison of these flow values. A summation of the Table 3 values indicates the observed Maximum Hour metered flow values are roughly 38% greater than the Peak Instantaneous modeled flow values. This difference in monitored peak flow values compared to the model developed

peak flow values could indicate the proposed designs may be insufficient to provide treatment for some wet weather related flows. EBMA states its LTCP proposals are only concept-level designs and its proposals will be refined as proposed facility installations are completed and additional information is compiled. EBMA proposes to maintain flow monitors within its system to support and refine its concept-level design as LTCP implementation progresses. Lastly, peak flow management needs, based upon a pending Act 537 Sewage Facilities Planning Update are required. EBMA proposes to augment its concept-level designs by undertaking an Act 537 Sewage Facilities Planning Update for its service area. Please contact Thomas Flanagan of the Department for more information related to this planning requirement.

The EBMA Engineer determined a flow travel-time duration of 22 minutes. This is the calculated time between the period when, after a wet weather event, flow is expected to travel its longest path within the collection sub-basin to its outfall structure. In our May 9, 2018 meeting with EBMA the parties agreed to a less restrictive travel-time allowance of four (4) hours. Since the LTCP proposes to limit the number of its annual discharges, this travel period becomes important only when characterizing discharges as either wet or a dry weather discharges. Any outfall discharges continuing after four hours shall be considered dry weather discharges – which are prohibited.

The Department does not directly evaluate any Permittee engineer's flow model. These modeled flow values, and their related facility design proposals, are the responsibility of the Permittee and its Engineer. The Department defers its Policy performance standard evaluation (flow management evaluation sufficient to verify the LTCP proposals comply with Policy requirements) until the implementation of a Post-Construction Compliance Monitoring Plan (PCCMP). The Department recommends EBMA develop its PCCMP in accordance with these guidance documents: EPA 932-B-95-002, "Guidance for Long-Term Control Plan"; EPA 832-B-99-002, "Guidance for Monitoring and Modeling" and; available Department guidance. EBMA shall submit its PCCMP for Department review in accordance with the below LTCP Task Implementation Schedule. The PCCMP shall also be designed to evaluate receiving Water Quality impacts and discharge impacts on the marina and boat launch Sensitive Areas.

The following LTCP Task Implementation Schedule is approved:

Task	Compliance Date
Act 537 Sewage Facilities Planning Update Approval	July 31, 2020
Complete Facilities Designs	July 31, 2022
Submit WQM Permit Application(s)	July 31, 2022
Begin Facility Construction	October 31, 2024
Submit PCCMP	March 31, 2027
Complete Facility Construction	October 31, 2027
Implement PCCMP	Upon Department Approval

This LTCP approval is not an authorization to construct sewerage facilities. All appropriate permit applications and approvals are required before EBMA may construct its LTCP proposed facilities.

The NPDES permit establishes specific reporting requirements regarding progress toward compliance with CSO Policy obligations including submission of an Annual CSO Status report as an addendum to

the Chapter 94 Annual Wasteload Management Report. Each Annual CSO Status Report must detail efforts undertaken to implement the Nine Minimum Controls (NMC's), efforts taken to prioritize and afford protection to environmentally Sensitive Areas, actions taken to implement the LTCP, and EBMA's adherence to the LTCP implementation schedule. Please ensure the annual report is submitted in a timely fashion and includes sufficient detail and documentation to measure LTCP compliance progress.

Nothing in this letter is intended, nor shall be considered to relieve or limit the Authority's obligation to comply with the EPA CSO Policy or any existing or subsequent statute, regulation, permit or order. In addition, this letter does not authorize any violation of any statute, regulation, order or permit issued or administered by the Department.

Any person aggrieved by this action may appeal, pursuant to Section 4 of the Environmental Hearing Board Act, 35 P.S. Section 7514, and the Administrative Agency Law, 2 Pa. C.S. Chapter 5A, to the Environmental Hearing Board, Second Floor, Rachel Carson State Office Building, 400 Market Street, PO Box 8457, Harrisburg, PA 17105-8457, 717-787-3483. TDD users may contact the Board through the Pennsylvania Relay Service, 800-654-5984. Appeals must be filed with the Environmental Hearing Board within 30 days of receipt of written notice of this action unless the appropriate statute provides a different time period. Copies of the appeal form and the Board's rules of practice and procedure may be obtained from the Board. The appeal form and the Board's rules of practice and procedure are also available in braille or on audiotape from the Secretary to the Board at 717-787-3483. This paragraph does not, in and of itself, create any right of appeal beyond that permitted by applicable statutes and decisional law.

IF YOU WANT TO CHALLENGE THIS ACTION, YOUR APPEAL MUST REACH THE BOARD WITHIN 30 DAYS. YOU DO NOT NEED A LAWYER TO FILE AN APPEAL WITH THE BOARD.

IMPORTANT LEGAL RIGHTS ARE AT STAKE, HOWEVER, SO YOU SHOULD SHOW THIS DOCUMENT TO A LAWYER AT ONCE. IF YOU CANNOT AFFORD A LAWYER, YOU MAY QUALIFY FOR FREE PRO BONO REPRESENTATION. CALL THE SECRETARY TO THE BOARD (717-787-3483) FOR MORE INFORMATION.

Please feel free to contact me at the above address, at peiswerth@pa.gov or at 412-442-4055 with questions.

Sincerely,

Paul Eiswerth

Paul Eiswerth, EIT
CSO Coordinator

Cc: Richard Barnett P.E. – Senate Engineering
Michael Moskorisin – Manager ACHD

Bcc: Regional; CSO file; ✓ T. Flanagan; D. Leone; R. Lattner P. Eiswerth

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LETTER OF TRANSMITTAL

DATE: March 15, 2018

TO: Paul Eiswerth, E.I.T.
Pennsylvania Department of Environmental Protection
Southwest Regional Office
400 Waterfront Drive
Pittsburgh, PA 15222-4745

RECEIVED
MAR 19 2018
Clean Water
DEP, Southwest Regional Office

RE: **CSO LTCP ADDITIONAL INFORMATION REQUEST**
NPDES PA0028436
ELIZABETH BOROUGH
SENATE #10165

WE ARE SENDING YOU THE FOLLOWING ITEMS:

COPIES	DATE	NO.	DESCRIPTION
1			Response to DEP 10/17/2017 Comments (Hard Copy)
1			Response to DEP 10/17/2017 Comments (Electronic Copy)

THESE ARE TRANSMITTED as checked below:

__	For approval	__	Approved as submitted	__	Resubmit ___ copies for approval
__	For your use	__	Approved as noted	__	Submit ___ copies for distribution
X	As requested	__	Returned for corrections	__	Return ___ corrected prints
__	For review and comment	__	_____		

REMARKS:

Paul –
Attached are responses to your comments dated 10/17/2017.
Please insert the updated Table of Appendices and Executive Summary following the Table of Contents into your copy of the LTCP. The detailed response letter and new attachments are included as Appendix N which can be inserted directly into your copy of the LTCP.
Thank you

COPY TO: Deborah Williamson, P.E., ACHD

FROM: Rick Barnett, P.E.

500 Fifth Avenue, Suite 502
McKeesport, PA 15132
(412) 664-7125

250 South Jefferson Street
Kittanning, PA 16201
(724) 548-1770

529 Morgantown Street
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March 14, 2018

Paul Eiswerth, E.I.T.
Pennsylvania Department of Environmental Protection, Southwest Regional Office
400 Waterfront Drive
Pittsburgh, PA 15222-4745

RE: CSO LTCP Additional Information Request
NPDES PA0028436
Elizabeth Borough
Allegheny County

Dear Mr. Eiswerth,

The following is in response to the comments provided in your letter dated October 17, 2017 regarding the Elizabeth Borough Municipal Authority (EBMA) Long Term Control Plan (LTCP). The LTCP was submitted to Pennsylvania Department of Environmental Protection (DEP) in July 2017. Each DEP comment in the letter is listed below with the response.

1. **Provide a D-scale size map of the collection and conveyance system. Include network of existing and proposed storm sewers and their associated outfalls, combined and sanitary sewer system pipe sizes, flow directions, inlet structure locations and other pertinent collection and conveyance system details.**

   A D-scale map is attached

2. **Provide a drawing detail and specific description of the sewer system and pipe network tributary to the existing Box 3 structure and provide a plan drawing of that portion of the system's proposed reconstruction. Include a discussion of the Fallen Timber Run facility improvements proposed.**

   Appendix C of the LTCP provides a drawing of the sewer system in the vicinity of CSO Structure 3 and the existing pump station. A description of the sewer system in that area can be found on page 1 of the LTCP.

   To summarize the existing conditions, there are three lines that enter the existing EBMA pump station; the Borough interceptor (15"), Sewershed 3 (12"), and the Fallen Timber Interceptor (10"). The Borough interceptor

collects flows from Elizabeth Borough and portions of Forward Township and generally runs along Water Street, through the Boat Club property, under Fallen Timber Run and onto a chamber immediately upstream of the existing pump station. Sewershed 3 collects flows from portions of Elizabeth Borough and Elizabeth Township. All flow from sewershed 3 is directed via a 48" conduit to CSO structure 3. During normal conditions, the entirety of the flow from the 48" conduit flows into a 12" line and onto a manhole where flows from CSO 3 and the Fallen Timber interceptor are directed, via a 10" line, into a chamber immediately upstream of the existing pump station. During periods of wet weather, excess flow from the 48" CSO 3 influent line is directed via a weir to the overflow chamber where it passes under a baffle and through a bar screen before being discharged into Fallen Timber Run. The Fallen Timber interceptor collects flows from Forward and Elizabeth Township and generally follows Route 51 to a manhole where flows from CSO 3 and the Fallen Timber interceptor are directed, via a 10" line, into a chamber immediately upstream of the existing pump station. In the chamber immediately upstream of the existing pump station, the EBMA interceptor enters as a 16" ductile iron pipe and the CSO 3 and Fallen Timber interceptor enter together as a 10" ductile iron pipe. Both the 16" and 10" conduits connect to a 16 X 10 X 16 X 10 ductile iron cross fitting. All flow is directed via a 16" conduit to the existing pump station wet well. During wet weather events, when the influent flow rate exceeds the capacity of the pump station, excess flow from the Borough Interceptor, Sewershed 3, and Fallen Timber interceptor has the potential to discharge through CSO 3.

As described in the LTCP and approved Act 537 Special Study, the Authority is in the process of designing a new pump station to replace the existing pump station with construction expected to start in 2019. Flow will enter the proposed pump station through an influent chamber which will allow for the connection of the EBMA interceptor, Sewershed 3, and Fallen Timber lines. It should be noted that, based on influent elevation of the conduits, the pump station invert will be approximately 10 feet 8 inches feet below the overflow weir in CSO 3. As the new pump station capacity will not be increased above the existing pump station capacity until the implementation of the LTCP, the new pump station would regularly flood during periods of wet weather. Aside from functioning as a junction for the incoming lines, the influent chamber will provide a means of throttling flow into the pump station during periods of wet weather. This will prevent flooding of the headworks and the pump station until the LTCP is approved and the future wet weather pumps are installed.

The influent chamber will be divided into two sections, the first providing connection of the Borough interceptor and Sewershed 3 lines, the second section connects the Fallen Timber interceptor to the pump station. Between the two sections will be a sluice gate with an electric actuator. In the first section an adjustable weir gate will be positioned which can adjust from an elevation of 725.15 feet (equal to the elevation of the weir in CSO 3) up to 727.50.

During periods of normal flow, the Borough and Sewershed 3 lines will be directed into section 2 and onto the headworks and pump station. During wet weather events, as the influent flow rate (as measured by a cutthroat flume in the normal flow channel of the pumps station headworks) reaches the dry weather pumping capacity, the SCADA system will close the sluice gate between sections 1 and 2. When the sluice gate is closed, the entirety of the flow from the Fallen Timber line will be directed into the pump station and conveyed onto the WWTP while the flow in section 1 backs up to the level of the CSO 3 weir. The adjustable weir gate is controlled by an electric actuator so that the SCADA system will adjust the weir level to maintain a flow rate through the headworks equal to the pumping capacity. As the influent flow rate though the pump station drops below the pumping capacity, the sluice gate between sections 1 and 2 will reopen to allow more of the wet weather flow into the pump station until flows return to normal.

The configuration and operating procedure described above will ensure that the pump station does not regularly flood while allowing all of the Fallen Timber Interceptor sanitary flow to be conveyed to the WWTP for full biological treatment. The proposed influent chamber is not expected to change the frequency, duration, or volume of combined sewer overflows at CSO 3 until the full wet weather pumping capacity of the pump station is operational. The reader is referred to the figure found in Appendix C of the LTCP and details showing plans and sections of the proposed influent chamber. The influent chamber function described above is required during the period after the pump station construction and prior to the implementation of the LTCP.

3. **Provide a system map (at a lot and block level of detail) identifying each portion of the Elizabeth Borough collection system that has been either fully or partially separated since the CSO Program requirements were established.**

Six area maps are attached

4. **Discuss the design considerations concerning the dual force main proposals for the re-built and re-designed Fallen Timber Run pump station.**

The proposed pump station must be capable of handling both existing dry and proposed LTCP wet weather flows. The dry weather flows are based on the existing pump station capacity of 1.30 mgd and, as described in the LTCP (Table 3.9), the projected wet weather flow rate is 23.23 mgd. Generally, force main velocities should be kept between 2 and 10 feet per second. Based on maintain minimum and restricting maximum velocities, the minimum and maximum force main diameters for the dry and wet weather design flow rates are shown in Table

1. Note that the force main diameters are rounding to the closest whole inch and may not represent a readily available pipe size. Actual pipe sizes will be selected based on final pumps and pipe materials selected.

Table 1

Design Flow (mgd)	Min. Forcemain Size (in.)	Max. Forcemain Size (in.)
1.30	6	12
23.23	26	57

As shown in Table 1, there is no force main diameter that would accommodate both the dry and wet weather flows. As such, the existing 8 inch ductile iron force main will be replaced, due to its age, in kind and utilized during dry weather conditions. A 30 inch force main will be installed to accommodate the anticipated wet weather flows. The 30 inch wet weather force main will be installed during the installation of the proposed pump station, prior to the full implementation of the LTCP. If will be more cost effective for the Authority to install the 30 inch force main at the same time as the 8 inch force main. As has been discussed, the Authority has installed several permanent flow meters at key locations within the collection system. The additional flow monitoring will be used to reevaluate the LTCP flows during the design phase of the project. The 30 inch force main will be capable of accommodating flows ranging from 6.30 mgd to 31.70 mgd allowing for modifications in the design flow.

5. **Provide a summary and available drawing details of the reconstruction proposals for the gravity portion of the Fallen Timber Run interceptor.**

Reference the response to Number 2 for a detailed description of the proposed pump station and Fallen Timber Run relocation. See the attached Preliminary Site Plan for the proposed Fallen Timber run and pump station layout.

6. **Provide a complete description of each LTCP-related collection system improvement and facility(ies) design proposal(s) identified in the Selected Alternative B-1.**

Alternative B1 is described in detail in Section 3.3 of the LTCP. To summarize, the alternative includes capacity upgrades to the Borough collection system, the EBMA raw sewage pump station, and the WWTP. The Borough collection system upgrades are limited to modifications to the existing CSO structures and Borough interceptor

which runs along Water Street. Excess wet weather flows from CSO 7 will be directed to a secondary diversion structure adjacent to the existing CSO structure. The secondary diversion structure will direct the required flows, via a new gravity line, to a new pump station adjacent to CSO 8. When the flow rate into the secondary diversion structure exceeds the flow rate which requires biological treatment, flow will be directed to the existing CSO outfall via a sharp crested weir. The new CSO 8 pump station will accept excess wet weather flows from CSO 7 and CSO 8 and convey them, via a new wet weather force main, to the new EBMA pump station. When the influent flow into the pump station exceeds the capacity of the pumps, excess flow will be directed to the existing CSO 3 outfall. Similar to the process described above, excess flows from CSO 6 will be directed via a secondary diversion structure, to a new pump station at CSO 5. The CSO 5 pump station will convey wet weather flows from CSO 5 and CSO 6 to the new EBMA pump station via a new wet weather force main.

Sewage facilities planning for the new EBMA pump station is provided in the Act 537 Special Study submitted to and approved by the DEP in August 2016. The pump station includes a headworks and submersible pump station. The Headworks will include a normal flow channel and bypass flow channel. The normal flow channel will consist of a mechanical bar screen and vortex grit chamber. After passing through the headworks, flow will be directed to the wet well which will be equipped with two dry weather submersible pumps and three future wet weather submersible pumps which will pump flow to the WWTP.

The existing WWTP is a conventional contact stabilization activated sludge process. To accommodate the increased wet weather flows, a new Sequencing Batch Reactor (SBR) WWTP will be constructed on the existing WWTP site. Most of the existing tankage will be demolished with some tanks remaining for use in an aerobic sludge digestion process. A portion of the peak wet weather flows may be directed to a flow equalization tank(s) on the WWTP property when needed. The flow equalization tank(s) will store flow and provide aeration until the WWTP influent flow drops below its treatment capacity at which point the tank(s) will drain by gravity into the WWTP process.

Reference the attached figures which include a concept level drawing of the secondary diversion structures and CSO pump stations and a figure showing a concept level layout of the facilities described above.

7. **Discuss more fully the additional separation and green infrastructure projects proposed under Selected Alternative B-1. As appropriate, include a Green Infrastructure implementation task within the Task Implementation Task Schedule discussed in Item 16.**

EBMA has proactively been separating sanitary sewers from the combined system since 2010. CSO 5 and CSO 6 separations have occurred in the past and due to the limited area and size of these drainage areas, no additional separations are planned. Due to the topography of CSO 8, it is not feasible, at this time, to perform additional storm sewer separations. As funding becomes available, a limited phased approach to storm water separation projects in selected CSO 3 and 7 areas of the Borough will continue. The implementation of green infrastructure is not included in the LTCP due to the limited space available, depressed real estate values and the extent of developed area within the Borough.

8. **Discuss possible regulator improvements which may be proposed to address the LTCP's performance objectives (to limit discharges to four discharges per year) and provide a detailed narrative of the existing and proposed system solids and floatables controls.**

A detailed description of the existing CSO structures is included on Page 2 of the LTCP. To summarize, flow enters the structure as a larger line (generally 18 to 30 inches). A smaller diameter discharge line (generally 8 to 15 inches) is positioned perpendicular from the influent line. During normal operation, flow enters the CSO box and is directed to the effluent line which connects to the EBMA interceptor. During periods of wet weather, as the capacity of the interceptor is reached the water level in each CSO structure rises and flow is directed to the overflow chamber via a sharp crested weir. In the overflow chamber flow passes under a baffle to retain floatables and through grating to remove solids before being discharged to the Monongahela River. The proposed modifications to the CSO structures is discussed in detail in Question 6. The CSOs are periodically cleaned to remove the retained floatables and larger solids.

9. **Provide a clearer, more detailed discussion of the process used to derive the flow values provided in Tables 3.2 and 3.3. Provide calculation examples to illustrate the process.**

As described in the LTCP, the EBMA system will be evaluated under Section II.C.4.a.i of the Combined Sewer Overflow Control Policy (Control Policy) which limits the system to no more than four overflows on an annual average basis, allowing for two additional overflow events per year. The Control Policy goes on to state that "for the purpose of this criterion, an overflow event is one or more overflows from a CSS as the result of a precipitation event that does not receive the minimum treatment". Minimum treatment (also referred to as primary treatment), according the Control Policy is considered to be primary clarification (or an equivalent process), solids and floatables disposal and disinfection. For the purpose of this analysis, when flow enters a

CSO structure there are three possible outlets; to a biological treatment process, to a primary treatment process, or direct discharge into a receiving stream.

To ensure that there are no more than four overflows per year, alternatives are designed so that no overflow occurs as a result of a 3 month, 24 hour storm event. Two CSO structures, 8 and 3, receive flow from Township systems which are separated sanitary systems. The DEP and ACHD require that alternatives are designed to handle all flows from the Township sanitary systems derived from a 2 year, 24 hour storm event.

All alternatives are designed using a 2 year storm event. To determine if an alternative meets the requirements set by the Control Policy, the DEP and the ACHD, the volume of flow that must receive biological treatment, the volume of flow that is eligible to receive primary treatment and the volume of flow that is allowed to be discharged to the receiving stream must be determined for the design storm. The three flow paths (biological treatment, primary treatment, and overflow discharge) are collectively referred to the Design Flows.

To determine the design flows for the LTCP alternatives, the Sanitary Sewer Overflow Program (SSOAP) and Stormwater Management Models (SWMM) were used to model the influent hydrographs for each CSO structure for the 2 year and 3 month storm events. A detailed discussion relating to the creation and calibration of the SSOAP and SWMM model are included in the LTCP.

The total volume entering the CSO structure during the 2 year storm event is broken into serval different volumes which are used to calculate the design flows. The following list are volumes that were used to calculate the design flows:

- Total 2 year – The total volume that enters the CSO structure during the 2 year storm event.
- Total 3 month – The total volume that enters the CSO structure during the 3 month storm event.
- 2 year sanitary – The total volume that is contributed by the separated sanitary systems during the 2 year storm event
- 3 month combined – The total volume that is contributed by the combined sewer system during the 3 month storm event.
- 2 year combined – The total volume that is contributed by the combined sewer system during the 2 year storm event.
- 350% DWF combined – 350% of the average dry weather flow contributed by the combined sewer system.

The following is a description of how each of the above volumes were calculated:

- Total 2 year – The CSO structure influent hydrograph for the 2 year storm event was exported from SWMM into an Excel file. The Hydrograph contained model flow data at 15 minute intervals. To determine the total volume, the flow rate at each 15 minute interval was multiplied by 15 minutes resulting in the total flow to enter the CSO structure during that period. The calculated volumes for each time interval were added together to determine the total event volume.
- Total 3 month – The CSO structure influent hydrograph for the 3 month storm event was exported from SWMM into an Excel file. The volume of the hydrograph was determined in the same manner as the Total 2 year volume.
- 2 year sanitary – All hydrographs which modeled flows from the separated Township systems were exported from SWMM model and imported into excel. The hydrographs were added together by adding the flow rates at each time interval to create a single hydrograph which represented the flows contributed to the CSO structure from the separated Township systems. The volume of the calculated hydrograph was calculated using the method previously discussed.
- 3 month combined – A 3 month sanitary hydrograph was calculated using the same method as the 2 year sanitary. To calculate a hydrograph which represents the flows contributed to the CSO structure from the combined system, the calculated 3 month sanitary hydrograph was subtracted from the total 3 month hydrograph. The volume of the calculated 3 month hydrograph was determined using the method previously discussed.
- 2 year combined – The 2 year combined volume was calculated in the same manner as the 3 month combined.
- 350% DWF combined – The dry weather flow hydrographs were determined for each flow meter which measured flow from a separated Township system and for the flow meter which measured flow entering the CSO structure. For a detailed discussion relating to the derivation of dry weather flow hydrographs, reference the LTCP. All DWF hydrographs from the separated Township systems were added together to create a total sanitary DWF hydrograph. To determine the combine DWF hydrograph, the sanitary DWF hydrograph was subtracted from the total hydrograph. The flow rate at each 15 minute time interval of the calculated DWF hydrograph was calculated by 3.5 to determine the 350% DWF combined hydrograph. The volume of the 350% DWF combined hydrograph was determined using the method previously discussed.

There are two general types of alternatives considered in the LTCP, alternatives that provide primary treatment to a portion of the flow derived from the combined sewer system and an alternative to provides full biological treatment to the required flows. For the primary treatment alternatives, the design flows are defined as follows:

- Biological Treatment – For primary treatment alternatives, 350% of the average dry weather flow derived from combined sewer system and the total flow from the sanitary systems derived from a 2 year, 24 hour design storm must receive full biological treatment.
- Primary Treatment – The minimum volume that must receive primary treatment is the difference between the total 3 month combined minus the 350% DWF combined volumes
- Overflow Discharge – The maximum volume of flow which is allowed to be discharged during the 2 year storm event is calculated by subtracting the 2 year combined from the 3 month combined volumes.

For the alternative that provides biological treatment to the required flows, the design flows are defined as follows:

- Biological Treatment – The minimum volume which must receive biological treatment during the 2 year storm event is the 3 month combined plus the 2 year sanitary volumes.
- Overflow Discharge – The maximum volume of flow which is allowed to be discharge during the 2 year storm event is calculated by subtracting the 2 year combined volume from the 3 month combined volumes.

The following is a detailed description of the derivation of flows for the primary treatment alternatives for CSO 8. While the method described is specific to CSO 8, it can be applied to all active CSO structures. The following table list the volumes described above:

Table 2

Description	Volume (gallons)
2 year total	1,371,000
3 month total	802,000
2 year sanitary	353,000
3 month combined	570,000
2 year combined	1,017,000
350% DWF combined	243,000

The design flows for the primary treatment alternatives are calculated as follows:

- Biological Treatment: $243{,}000 + 353{,}000 = 596{,}000$
- Primary Treatment $570{,}000 - 243{,}000 = 327{,}000$
- Overflow Volume $1{,}017{,}000 - 570{,}000 = 447{,}000$

After calculating the design flows, the next step was to create hydrographs for the three possible flow paths.

Each flow path hydrograph is described below:

- Biological Treatment – The biological treatment flow path is divided into two separate hydrographs, one describing the existing interceptor capacity, the other describing the additional capacity required to meet the biological treatment requirements. As described in the LTCP, the existing interceptor capacity is limited. Each CSO was allocated a portion of the interceptor capacity based on the size of the sewershed. To calculate the hydrograph for the existing (allocated) interceptor capacity, the allocated peak instantaneous flow rate was compared to the total 2 year CSO influent hydrograph. When the flow rate of total 2 year CSO influent hydrograph at a given time interval is less than the allocated peak instantaneous flow rate, the allocated interceptor capacity hydrograph is equal to the total 2 year CSO influent hydrograph. The volume of the allocated interceptor capacity hydrograph was then calculated and compared to the previously calculated required biological treatment volume. For all CSO structures, the allocated interceptor capacity hydrograph volume was less than the required biological treatment volume. The next step was to pick an additional capacity peak instantaneous flow rate. The hydrograph and hydrograph volume was calculated in the same manner as the allocated interceptor capacity hydrograph. The additional capacity peak instantaneous flow was adjusted until the volume of the allocated plus the additional capacity hydrographs was equal to or greater than the required biological treatment volume.
- Primary Treatment – To calculate the primary treatment hydrograph, a similar method was utilized. Instead of comparing the primary treatment peak instantaneous flow rate to the total 2 year CSO influent hydrograph, a new hydrograph was calculated. To create the new hydrograph, the allocated and additional capacity hydrographs were subtracted from the total 2 year CSO influent hydrograph to create a modified 2 year CSO influent hydrograph. The primary treatment peak instantaneous flow rate was compared to the modified 2 year CSO influent hydrograph to create a primary treatment hydrograph using the method previously described. The primary treatment peak instantaneous flow rate was adjusted until the overflow volume was less than the allowable volume.
- Overflow Volume – The overflow volume hydrograph was calculated by subtracting the allocated capacity, additional capacity and primary treatment hydrographs from the total 2 year CSO influent hydrograph.

For the biological treatment alternatives, the primary treatment peak instantaneous flow rate was set to zero. It is important to note that the sum of the allocated and additional peak flow rate (and primary peak flow rate when applicable) must be equal to or greater than the total 3 month peak flow rate entering the CSO to ensure that the overflows are limited to no more than 4 overflows per year.

10. **Propose permanent flow monitors at each critical point of the collection system, particularly at each authorized regulator (and at each significant inter-municipal connection), such that additional tributary system flow and CSO outfall discharge data can be collected for additional system hydraulic analysis.**

As part of the LTCP implementation, several permanent flow monitors have been installed in the existing CSO structures. For all CSOs, area-velocity (AV) flow meter are installed on the influent line and on the overflow discharge line to monitor any reverse flow conditions from the river to the collection system.

In addition to the CSO flow monitors, five additional permanent AV meters will collect flow data from gravity lines entering the system from surrounding Townships. To monitor flow from Elizabeth Township, AV meters will be installed at Cemetery Street, Church Street and Chicago Avenue. To monitor flows from Forward Township, one AV meter will be installed on Center Avenue. The remaining Forward Township connections collect flows from small sewersheds or the lines are too steep to reliably measure flows. To measure flows from the Fallen Timber interceptor, a flow meter will be installed in the vicinity of the existing EBMA pump station. The AV meters measuring flow from the surrounding Townships will be installed in the same location as the meters utilized during the development of the LTCP

The AV meters are connected to a cellular system which automatically uploads data from the meters. The AV meters on the overflow discharge lines have a call out alarm that alerts operators to overflow conditions. Attached is map depicting the location of the meters described above.

11. **Provide flow estimates and flow profiles for all significant Forward Township and Elizabeth Township system flows tributary to the Authority. Provide these for both a 2-year (minimum) design storm event and for a typical-year storm event.**

Table 3 list the average metered flow rate, the peak hourly metered flow rate, the 2 year modeled flow rate, and the 3 month modeled flow rate.

Table 3

	Metered Flow		Modeled Flow	
	Avg. Flow (mgd)	Max. Hour Flow (mgd)	Peak Inst. Flow (mgd)	
			2 Year	3 Month
Center Ave	0.015	0.922	0.457	0.308
Grant @ Ivory	0.018	1.124	0.595	0.401
Chicago Ave	0.012	0.324	0.166	0.116

Church Street	0.064	0.943	0.885	0.611
Cemetery @ Elks	0.186	1.118	1.543	1.070
Fallen Timber	0.085	1.369	0.545	0.380

In addition to the peak flow rates described in Table 3, Table 4 list the event volumes from the start of the rain event through 24 hours after the event. For each Township meter, the percentage of the 2 year event volume that constitutes the total design volume is listed as a point of reference.

Table 4

	Event Volume (Mgal)		% of Total
	2 yr.	3 mo.	
Center	102,000	61,000	1.8%
Grant	143,000	81,000	2.5%
Chicago	64,000	38,000	1.1%
Church	388,000	216,000	6.8%
Cemetery	912,000	489,000	15.9%
Fallen	174,000	129,000	3.0%

Attached to this letter are copies of hydrographs exported from the SWMM model for each of the significant Township meters.

12. Provide a task within the LTCP implementation schedule that may address the potential need for peak flow management from the tributary combined and sanitary-only sewer municipalities sufficient to meet PA Clean Streams Law and CSO Policy flow management objectives.

The Authority currently has long-term agreements in place with the Townships so legal remedies may be limited to those contained in the agreements. To reduce the amount of inflow and infiltration within the Township systems, the Authority will pursue several potential remedies such as:

- Request to the municipalities that each home in its service area undergo a point of sale inspection. This is currently a requirement in Elizabeth Township. This will ensure that there are no downspouts, French drains, or area drains tied into the sewer system and can be accomplished thorough visual inspection or, when required, by smoke or dye testing. The point of sale inspection can also involve an assessment of the existing sewer lateral.

- Request to the municipalities that each storm inlet in its service area undergo a smoke or dye test to determine if it is connected to the sanitary sewer system, or show proof that this has been completed previously.
- Install permanent flow monitors at several points where the Township systems connect to the Borough system. This would allow the Authority to surcharge for excess flow into the Borough system. Such monitoring will likely be met with legal challenges.

These options will be pursued during the intermunicipal coordination part of the Act 537 Plan update task shown on the Implementation Schedule.

13. **Provide a summary of the Sewage Facilities Act 537 Planning process underway. Both the ACHD and Department stressed that this process will be time consuming and we believe the process should already have begun. We suggested the Authority consider proposing additional time to allow for the completion of the planning task. In addition to other planning obligations, discuss specifically the facility needs for Elizabeth Township flows as they relate to the Lovedale P.S. and the Simpson-Howell P.S. sub-shed system flows which may be conveyed for treatment via the Wylie P.S. We suggested EBMA meet with the appropriate regulatory agency staff to solicit guidance on the planning process.**

The Authority has requested that the contributing communities provide information relating to existing flows and flow projections over a 30 year planning period. Included in the request sent to Elizabeth Township, were specific questions relating to the Lovedale and Simpson-Howell sewersheds and the Wylie pump station. The Authority will request meetings with each contributing municipality to better understand their sewage needs. The time allocated for this process has been increased to 36 months in the implementation schedule.

14. **Since the LTCP proposes to limit discharges to 4 overflows per year and since the Engineer's calculated travel time for wet weather flow to drain from the combined sewer system is only twenty-two (22) minutes, the Department re-states its Meeting position that the wet weather-related discharges shall be limited to two (2) hours following secession of a wet weather event. All discharges remaining after this wet weather discharge period expires shall be considered dry weather overflows; which are considered illegal. Please revise the LTCP to reflect this revision.**

As shown in the LTCP (reference Appendix I), CSO discharges during the design event end prior to the end of the storm event. Since the design event is a 2 year, 24 hour rain event the modeled overflows only occur during

the peak flow rates and last less than 2 hours. As the modeled overflows end well before the rain event is over, the modeled "dry weather" overflows should not be a problem.

15. Provide a detailed description of Appendix I content related to its use and interpretation.

The response to Question 9 of this letter provides additional description of the contents of Appendix I.

16. Provide additional task detail in an expanded scope proposed Task Implementation Schedule.

As shown in the LTCP text and Appendix K Financial Capability Study the EBMA will experience a High Burden financial impact from this project. The reasonable implementation period for High Burden categories is up to 15 years, or longer if justified. Based on this and the impact to the community the following revised Implementation Schedule is provided.

Table 5

Task	Subtask Duration (Months)	Task Duration (Months)
Act 537 Update		42
i. Prepare preliminary plan	9	
ii. Intermunicipal coordination	12	
iii. Prepare draft plan	6	
iv. Public comment	3	
v. Final plan	6	
vi. DEP and ACHD approval	6	
Design		30
i. Preliminary design	12	
ii. Preliminary permit approvals	4	
iii. Final design	12	
iv. Part 2 permit	2	
Part 2 permit review and approval	12	12
Funding acquisition		18
i. Applications/credit ratings	6	
ii. Award/closing	12	
Bidding	4	4
Construction		60
i. WWTP improvements	36	
ii. Collection and pumping improvements	24	
Startup	3	3
Post construction compliance monitoring plan	3	3
PCCMP review and approval	6	6
Total duration		178 months or 14 years 10 months

vii. Include a specific task within the proposed task Implementation Schedule identifying the submission of a Post-Construction Compliance Monitoring Plan which demonstrates the technology-based performance criteria are being met and the WQS are being met under the LTCP proposals.

Refer to the above Table 5 - Implementation Schedule.

viii. Provide to both the ACHD and Department a digital copy the response to this information request and the revised LTCP proposal.

Digital and printed copies of the requested information are being provided to ACHD and the Department. We request that the printed copies be inserted into the LTCP documents previously provided.

If you have any additional questions on the above information please call me at (412) 826-5454.

Sincerely,
SENATE ENGINEERING COMPANY



Rick Barnett, P.E.

Cf: Elizabeth Borough Municipal Authority
Allegheny County Health Department

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Executive Summary

The Elizabeth Borough Municipal Authority (EBMA) owns and operates a 1.2 mgd wastewater treatment plant (WWTP) located in Elizabeth Borough, in Allegheny County. The WWTP accepts flows from Elizabeth Borough (Borough), Elizabeth Township, Forward Township, and Lincoln Borough.

The EBMA collection system within Elizabeth Borough is a combined system originally built c. 1950 and currently has five combined sewer overflows (CSOs).

In 2012, the Department of Environmental Protection (DEP) required the EBMA to resubmit a Long Term Control Plan (LTCP). From 2012 thru 2014 EBMA worked to characterize, monitor, and model the flows in the EBMA collection system to determine if the system was in compliance with the Clean Water Act (CWA). Based on the criteria outlined in the Combined Sewer Overflow Policy and input from the Pennsylvania Department of Environmental Protection and Allegheny County Health Department the existing system and alternatives were evaluated based on the following criteria:

1. 350% of Dry Weather Flow must receive full biological treatment
2. There may be no more than an average of 4 CSO overflow events per year allowing for two additional overflow events per year.
3. The volume of flow derived from the contributing township's sanitary systems during a 2 year storm event must receive full biological treatment.

Based on these criteria, two categories of alternatives were considered,

1. Provide primary treatment for eligible flows,
2. A combination of increasing the WWTP capacity and providing flow equalization for excess flows.

The selected LTCP alternative requires the construction of a pump station at CSO 8 and CSO 5 and the construction of a new EBMA pump station to handle wet weather flows, increase capacity at the at existing WWTP site and the construction of a flow equalization tank at the WWTP. The estimated construction cost for the work is $ 19.6 million.

The LTCP was first submitted to DEP in July 2017 and comments were received from DEP in October 2017. Responses to those comments were provided and are included in Appendix N of this updated report.

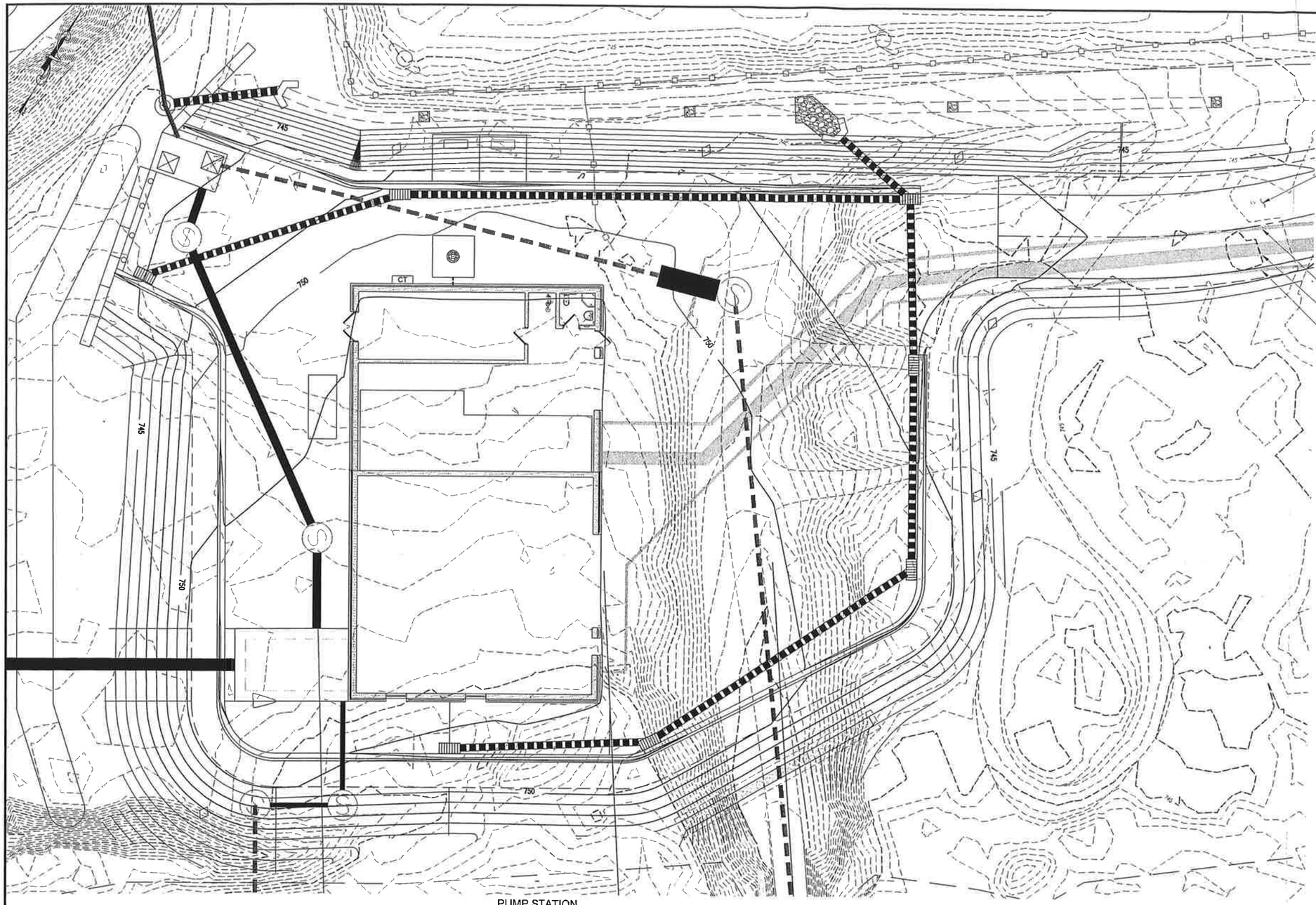
Appendices

Appendix A	Elizabeth Borough Collection System Map
Appendix B	As-Built Collection System Drawings
Appendix C	Pump Station Map
Appendix D	Drnach Flow Monitoring Report
Appendix E	Township Flow Meter Summary
Appendix F	Borough Subcatchment Parameters
Appendix G	Calibration Results
Appendix H	Travel Time Calculation
Appendix I	Design Storm Results
Appendix J	Cost Estimate
Appendix K	Financial Capability Study
Appendix L	Public Participation
Appendix M	Municipal Adoption
Appendix N	Response to DEP Comment Letter 10/17/2017

Appendix N

GIS Maps

Preliminary Site Plan



PUMP STATION

PAVING PLAN

SCALE: 1" = 10'

LEGEND:

- INDICATES PAVEMENT SLOPE DIRECTION (1/4" PER FT.)
- EXISTING MAJOR CONTOUR
- EXISTING MINOR CONTOUR
- PROPOSED MAJOR CONTOUR
- PROPOSED MINOR CONTOUR
- EDGE OF PROPOSED ENTRANCE PAVEMENT

NOTES:

1. REFER TO DWG. C__ FOR CIVIL SITE DETAILS.
2. REFERENCE DWGS. _____ FOR PIPING PROFILES IN THIS AREA.
3. MATCH ALL EDGES OF PAVEMENT TO EXISTING EDGES.
4. NEW PAVEMENT PLACED AGAINST NEW OR EXISTING STRUCTURES SHALL HAVE A 1/2" EXPANSION JOINT (FULL LENGTH) WITH SEALANT AND SHALL BE MADE WATERTIGHT.
5. CONTRACTOR SHALL RE-SEED ALL AREAS DISTURBED DURING CONSTRUCTION IN ACCORDANCE WITH THE CONTRACT SPECIFICATIONS.

GRAPHIC SCALE

10 0 5 10 20 40

(IN FEET)
1 inch = 10 ft.

1"

BAR MEASURES 1" ON ORIGINAL DRAWING. IF BAR IS OTHER THAN 1" ADJUST SCALES ACCORDINGLY

PRELIMINARY
NOT FOR CONSTRUCTION

REVISIONS	BY	DATE

JOB No.:
DESIGNED BY: M.EUSCO
DRAWN BY: J.MARCUM
CHECKED BY: K.HILLMAN
SCALE: AS NOTED
DATE: 3/15/2019

JMS Design Consulting, Inc.
A Pennsylvania Certified WBE
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C: 412.389.3033
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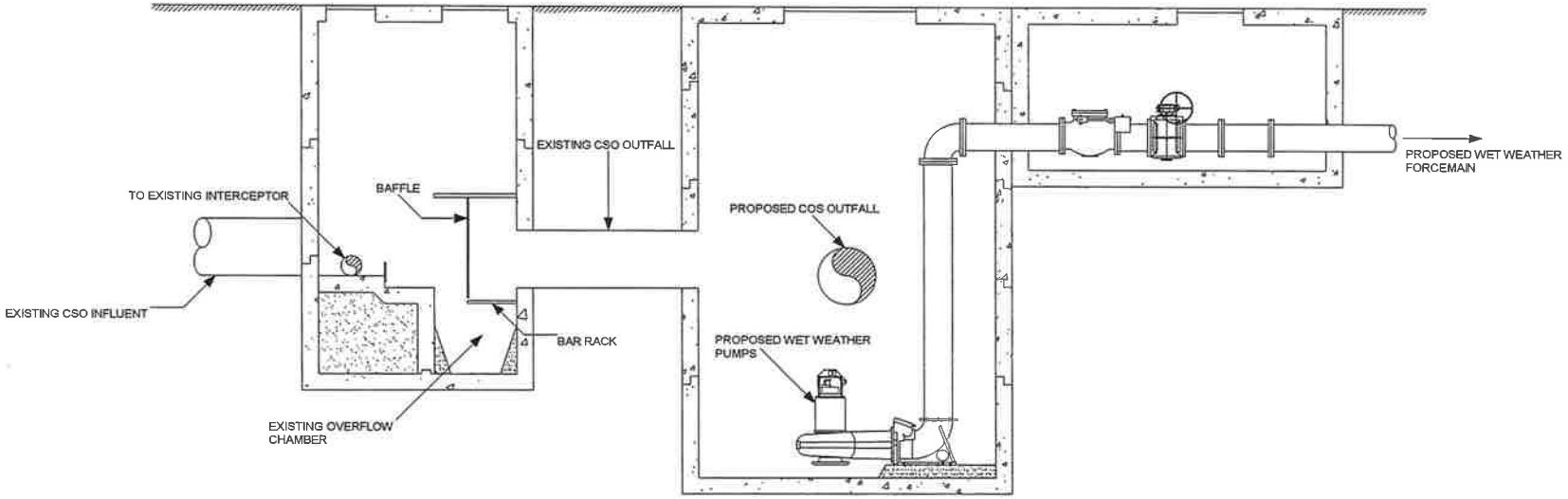
ELIZABETH BOROUGH
MUNICIPAL AUTHORITY
No. 1 LOCUST STREET
ELIZABETH, PA 15037
P: 412-384-3686
F: 412-384-3144

PUMP STATION REPLACEMENT

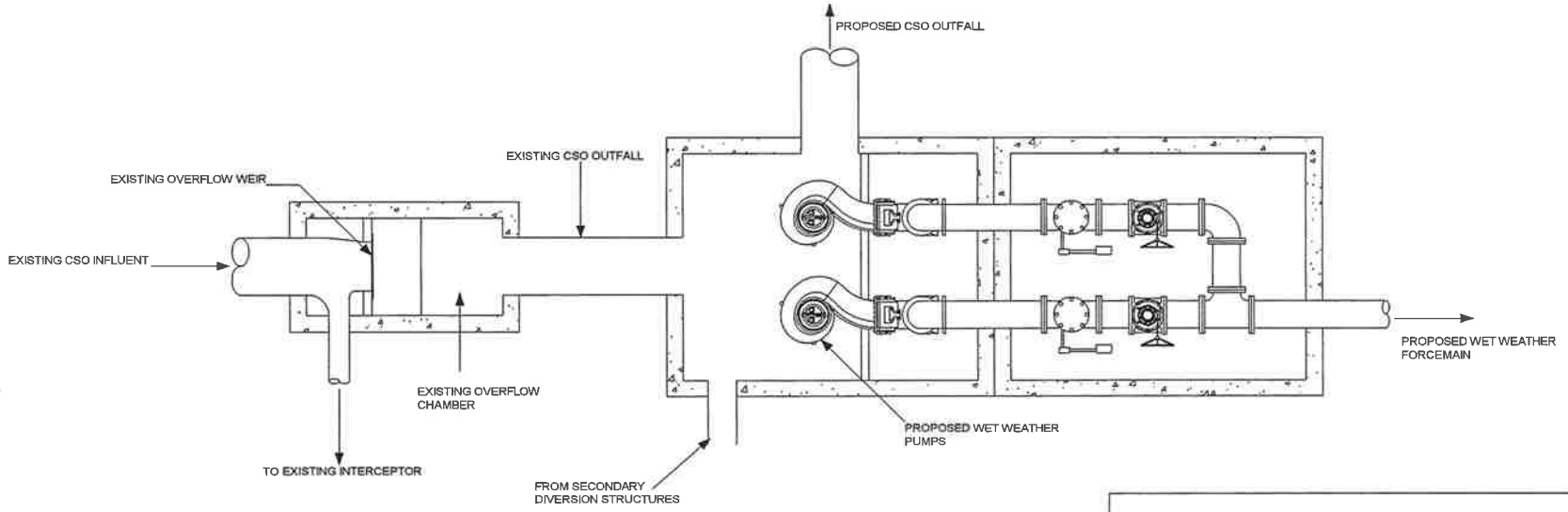
- CIVIL -
PUMP STATION
PAVING PLAN

DRAWING No.:
C06
SHEET No.:
x of xx

Concept Design Drawings

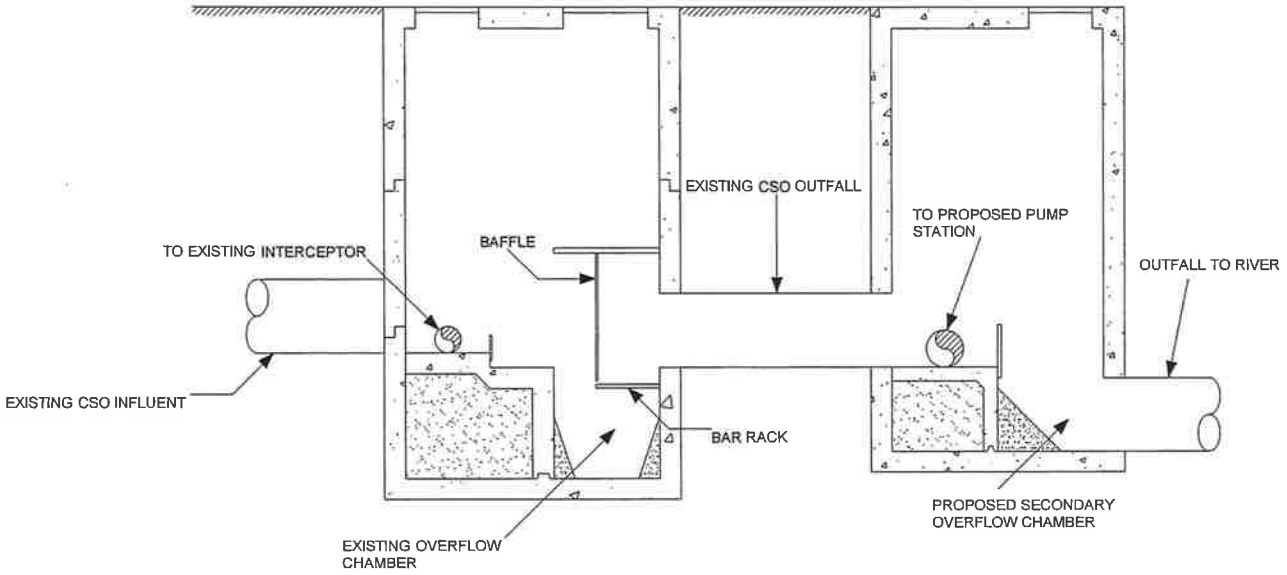


SECTION VIEW

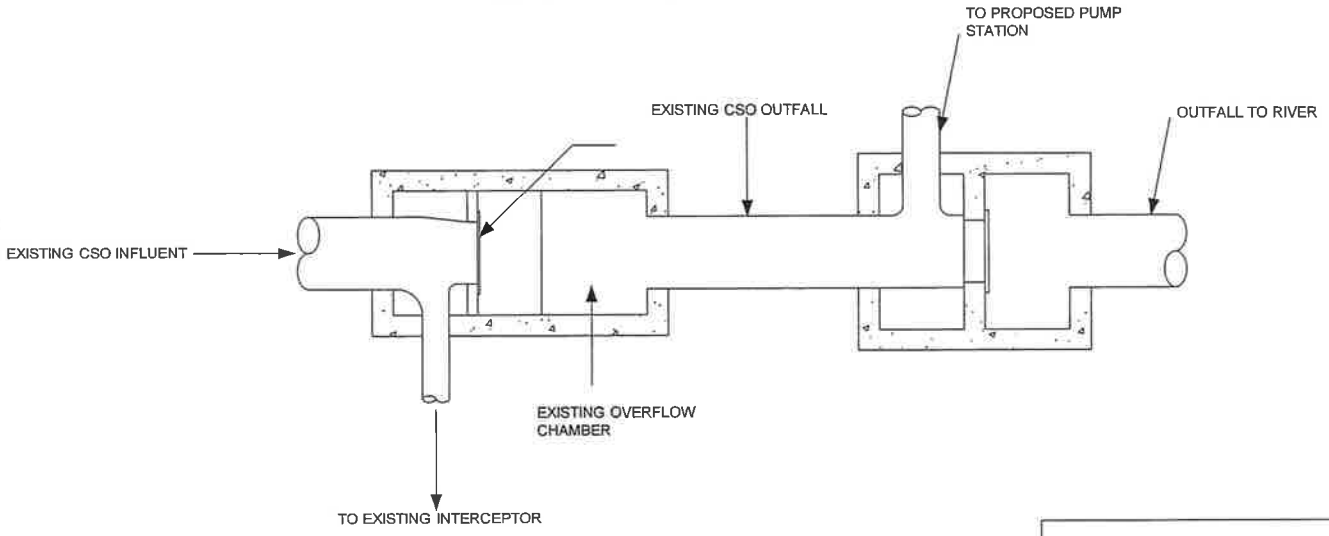


PLAN VIEW

CSO PUMP STATION
CONCEPT LEVEL DESIGN



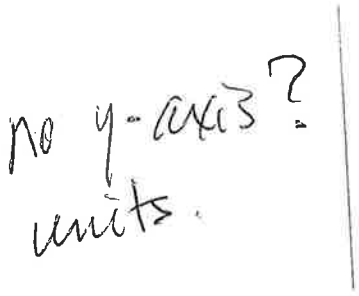
SECTION VIEW



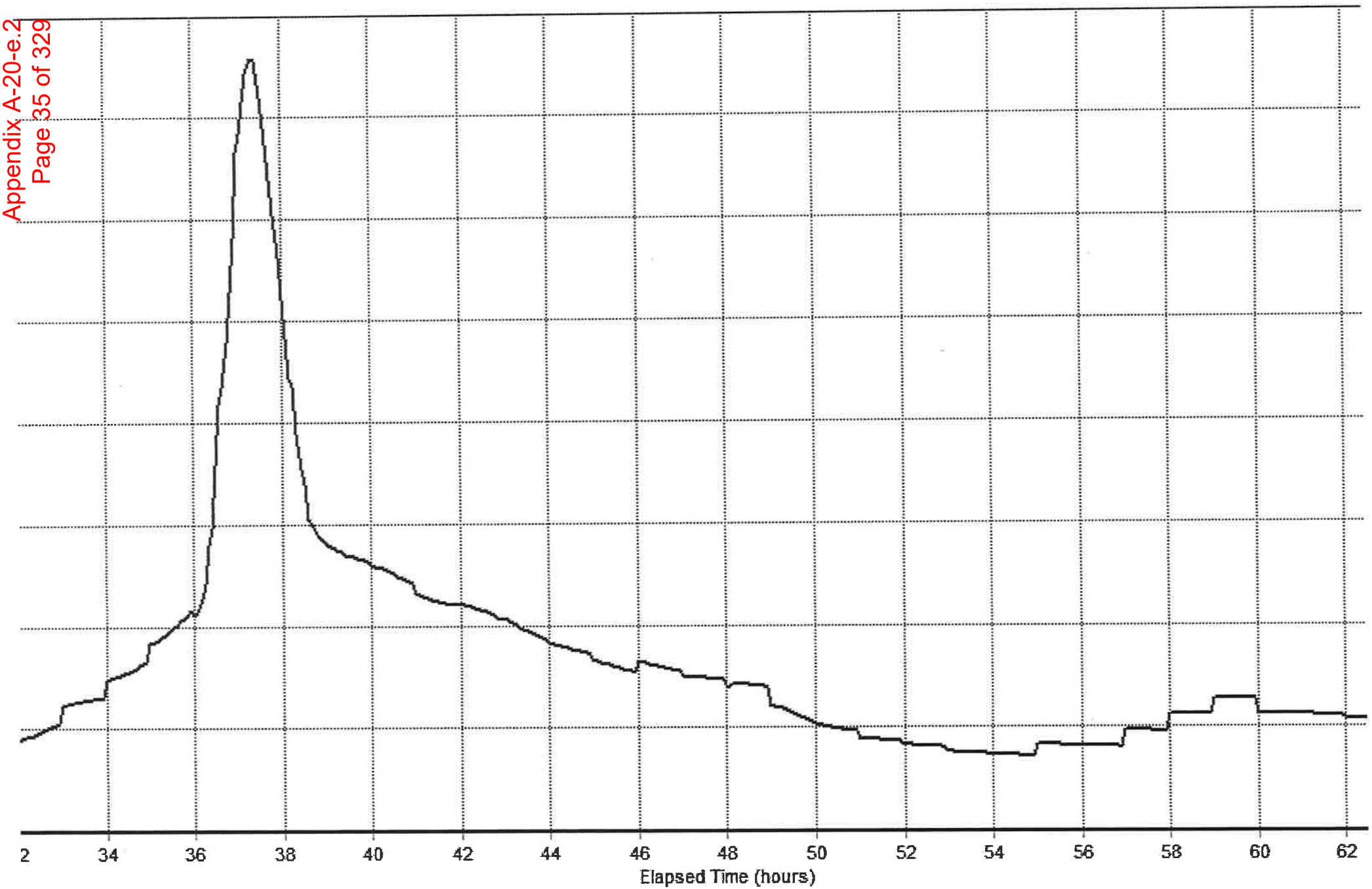
PLAN VIEW

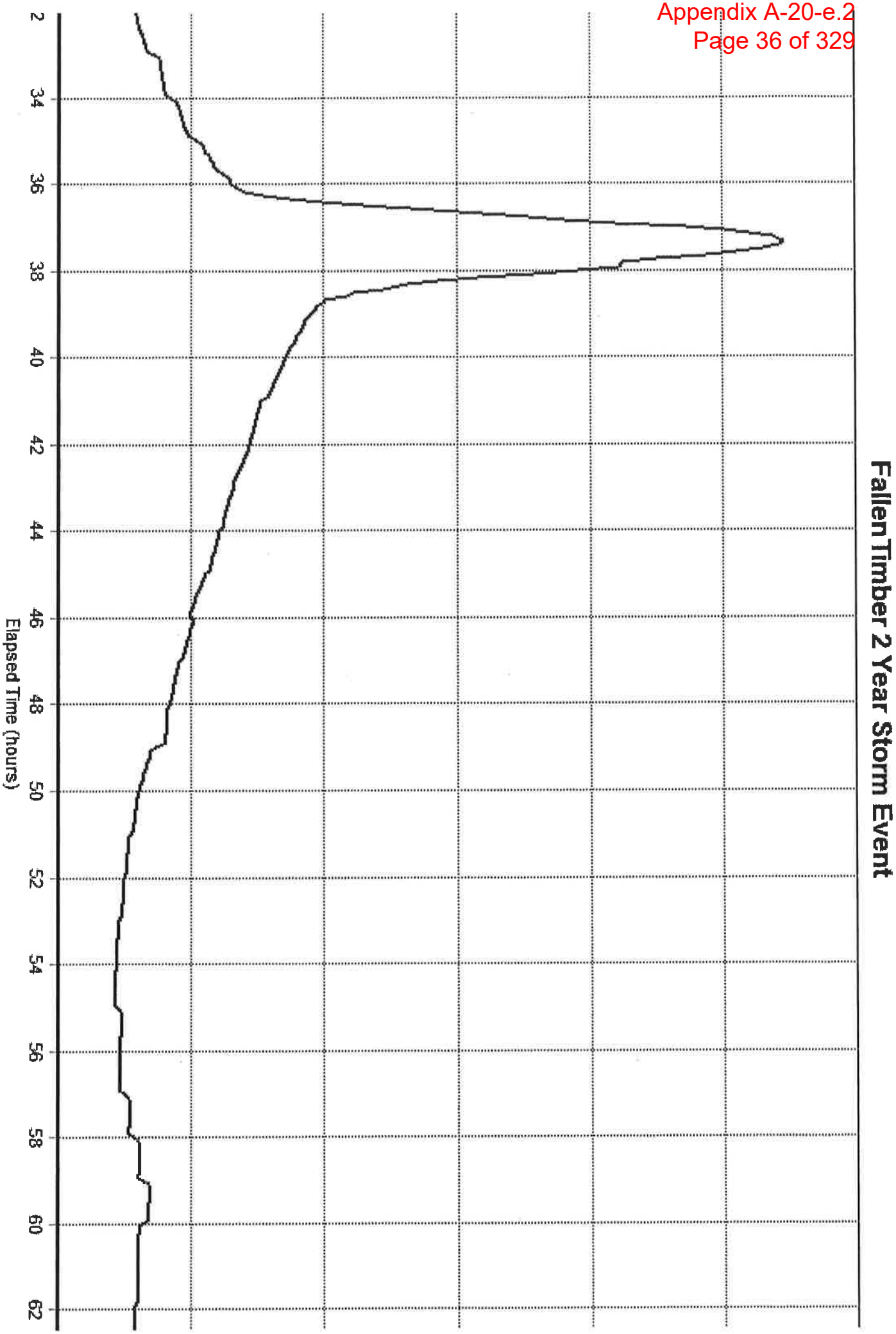
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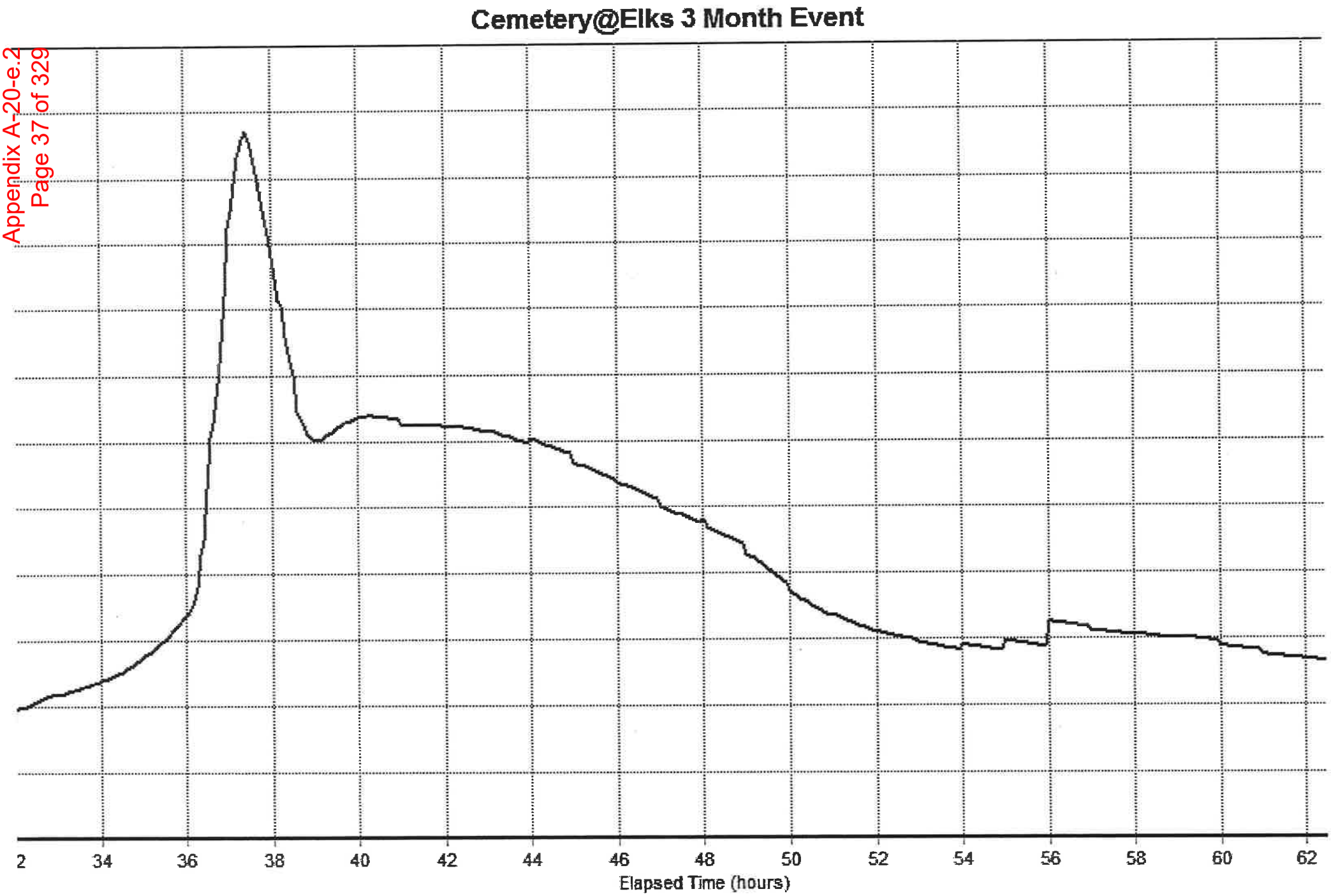
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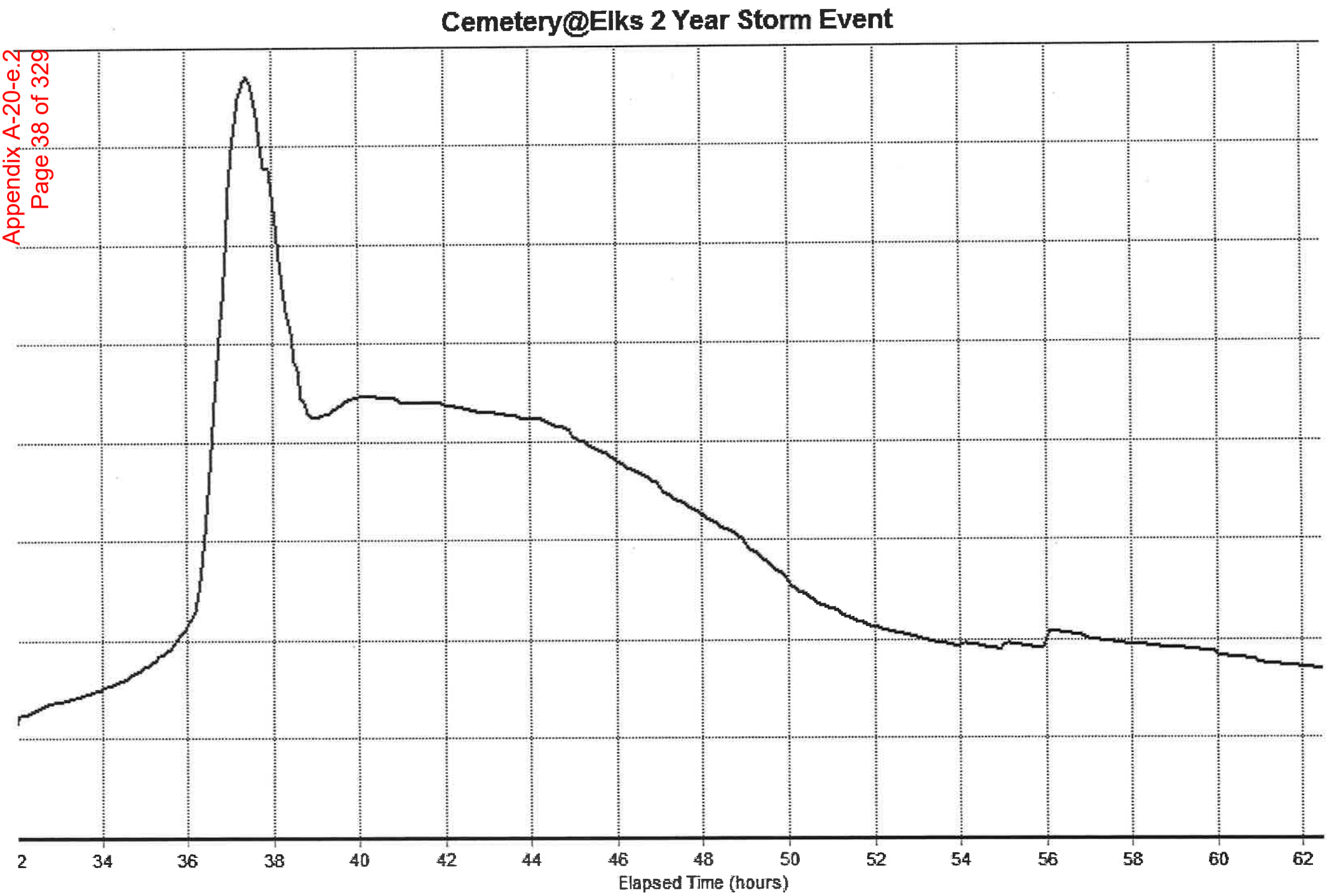


Fallen Timber 3 Month Event

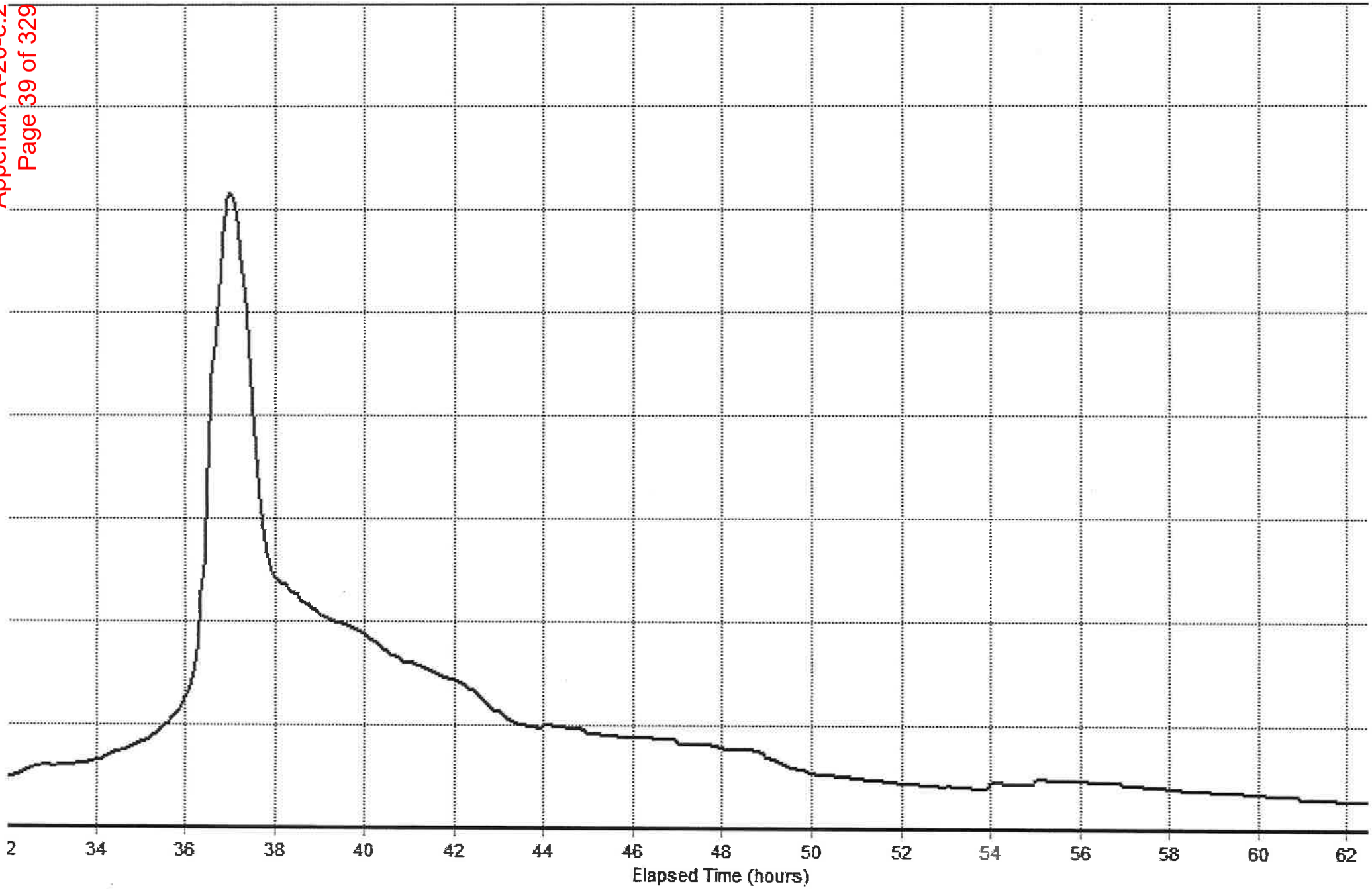


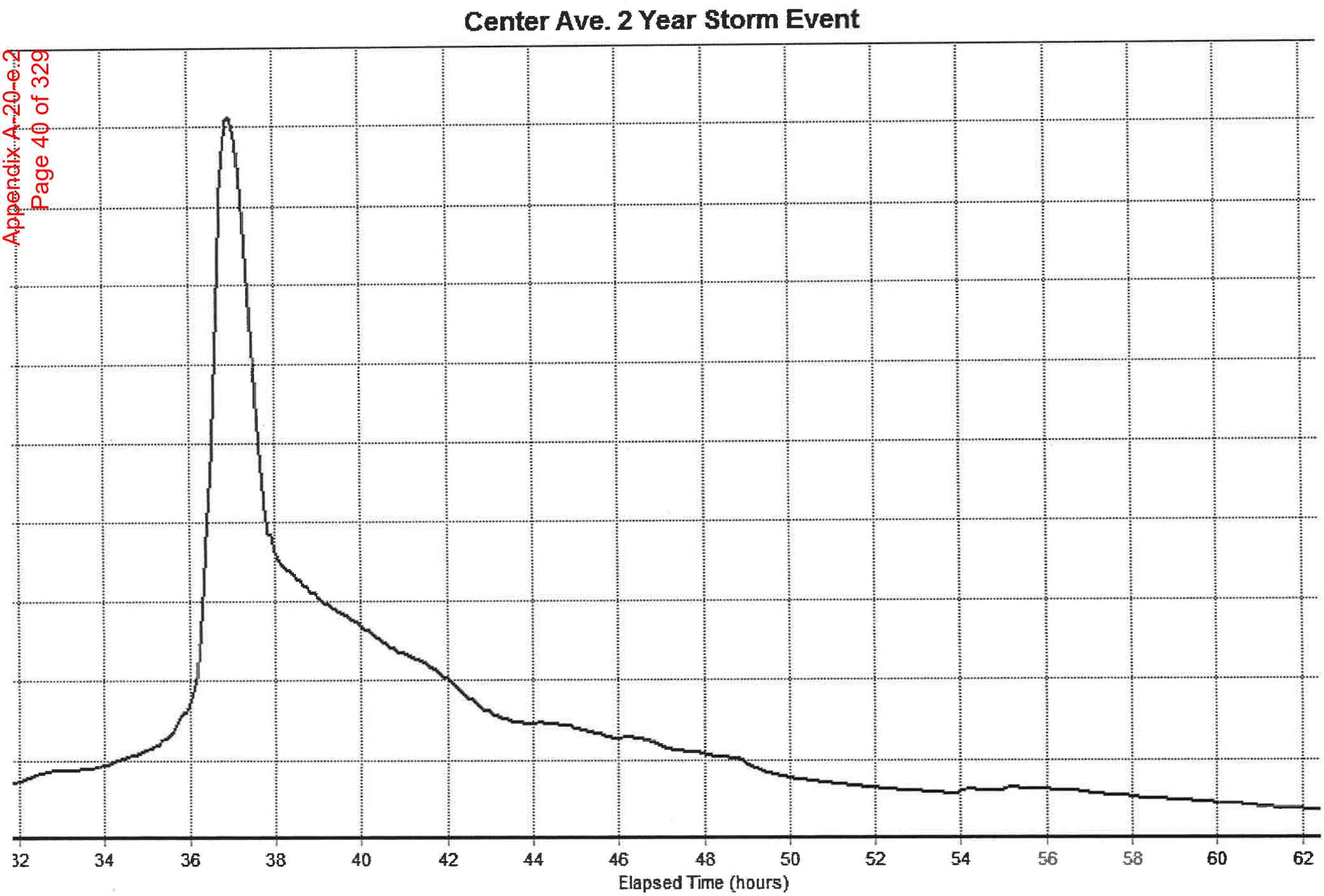

Fallen Timber 2 Year Storm Event
Elapsed Time (hours)
2
34
36
38
40
42
44
46
48
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54
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58
60
62

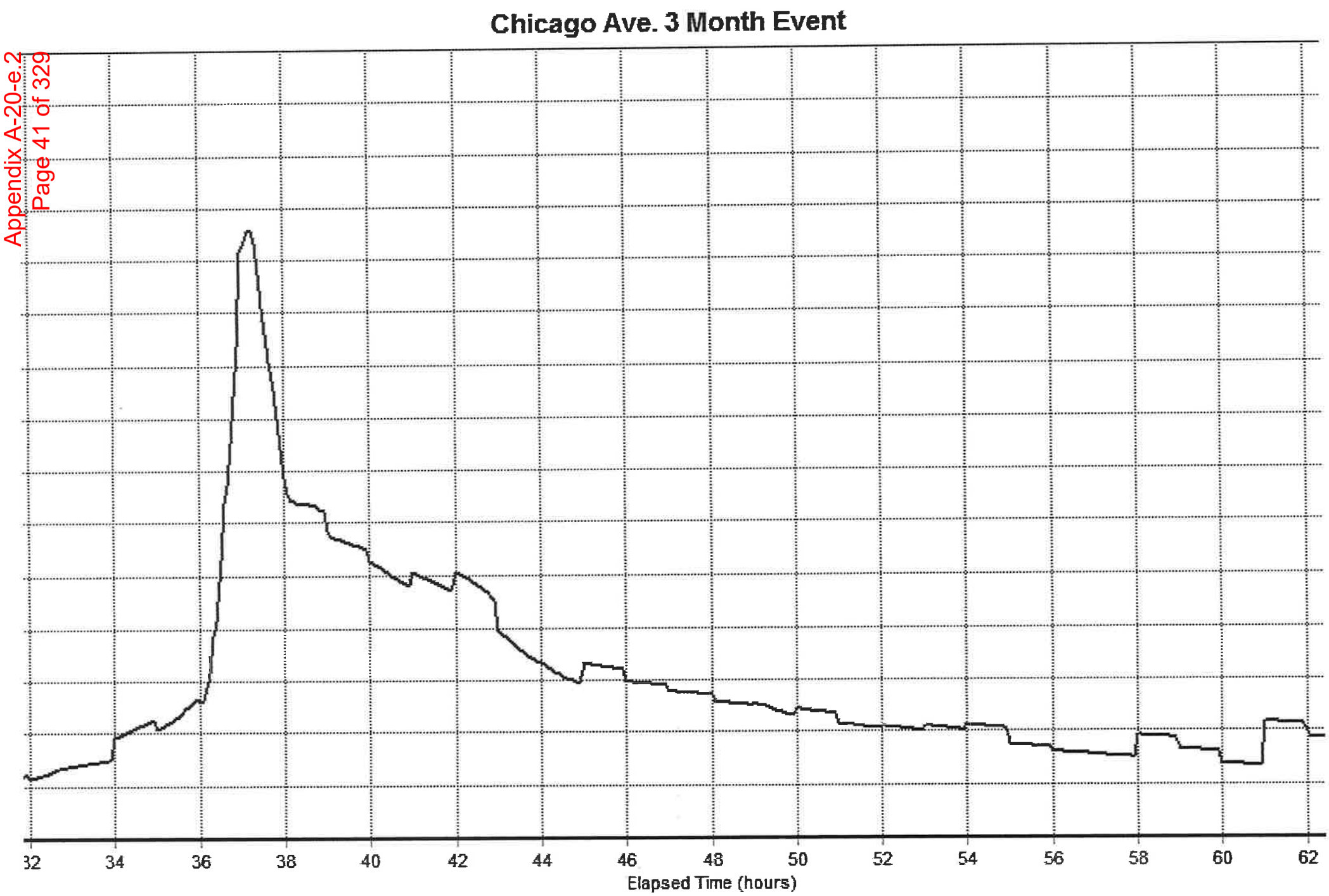

Cemetery@Elks 3 Month Event
2
34
36
38
40
42
44
46
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56
58
60
62
Elapsed Time (hours)


Cemetery@Elks 2 Year Storm Event
2
34
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58
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62
Elapsed Time (hours)

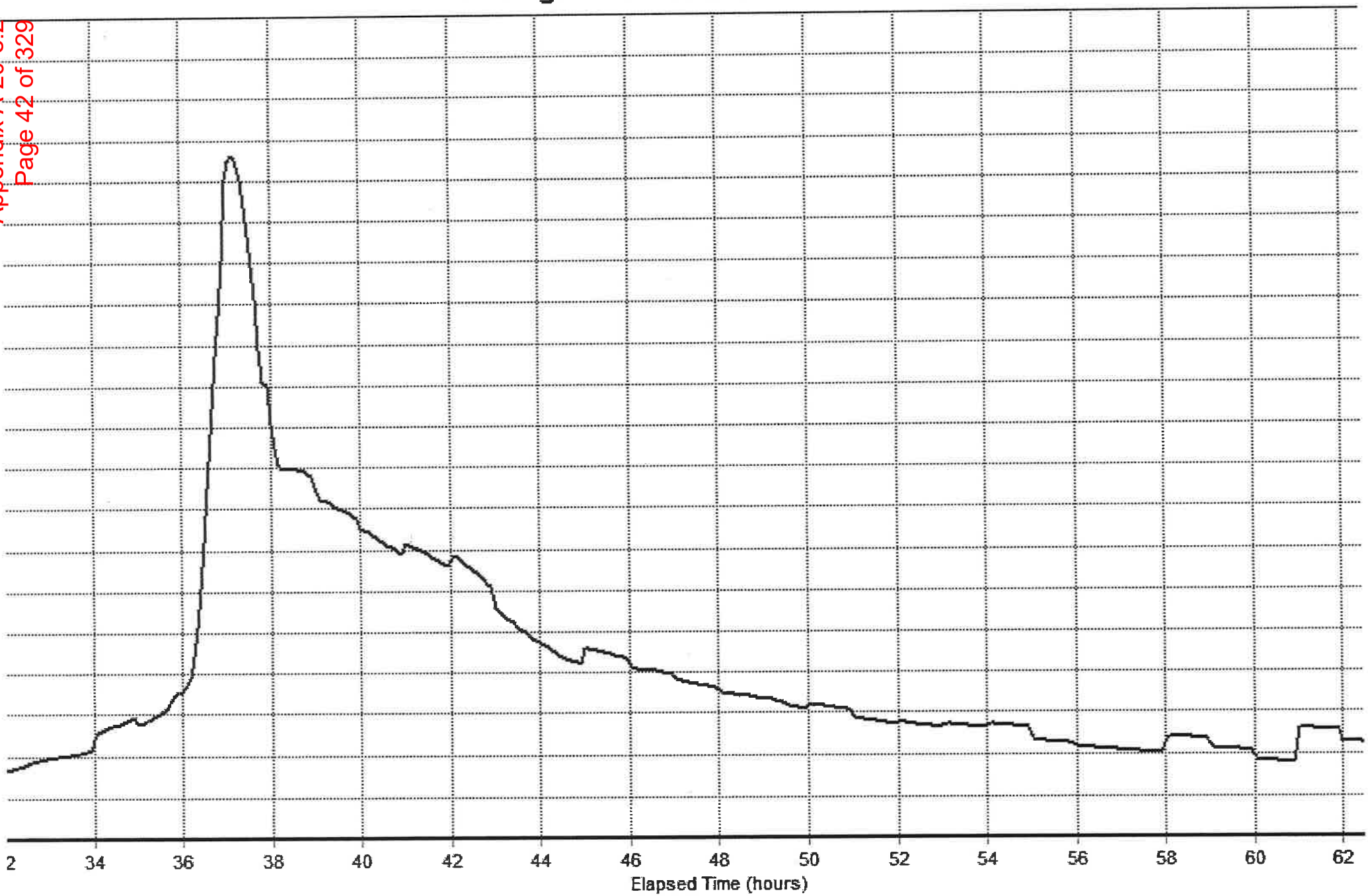
Center Ave. 3 Month Event



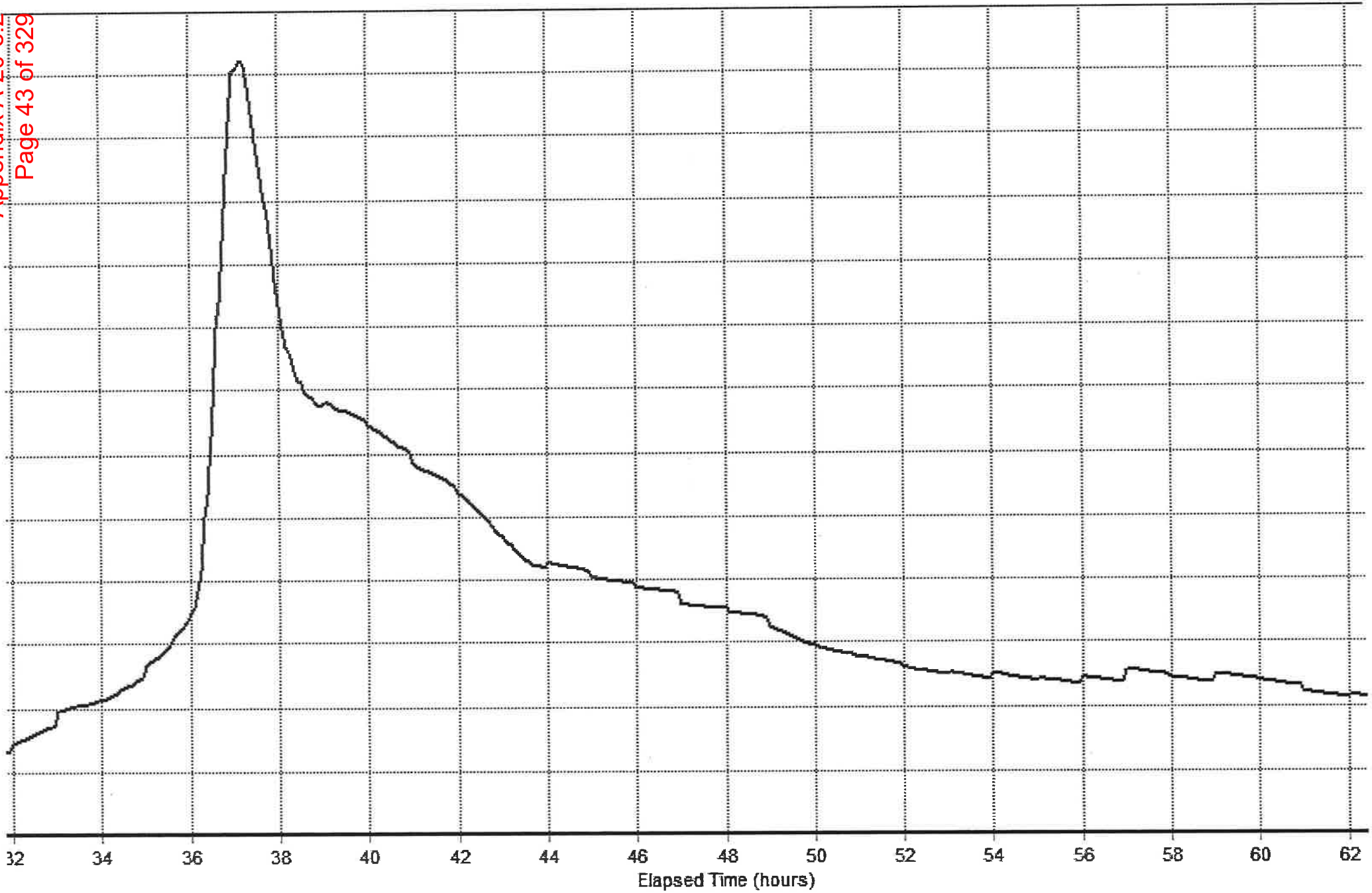

Center Ave. 2 Year Storm Event
32
34
36
38
40
42
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46
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50
52
54
56
58
60
62
Elapsed Time (hours)


Chicago Ave. 3 Month Event
32
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62
Elapsed Time (hours)

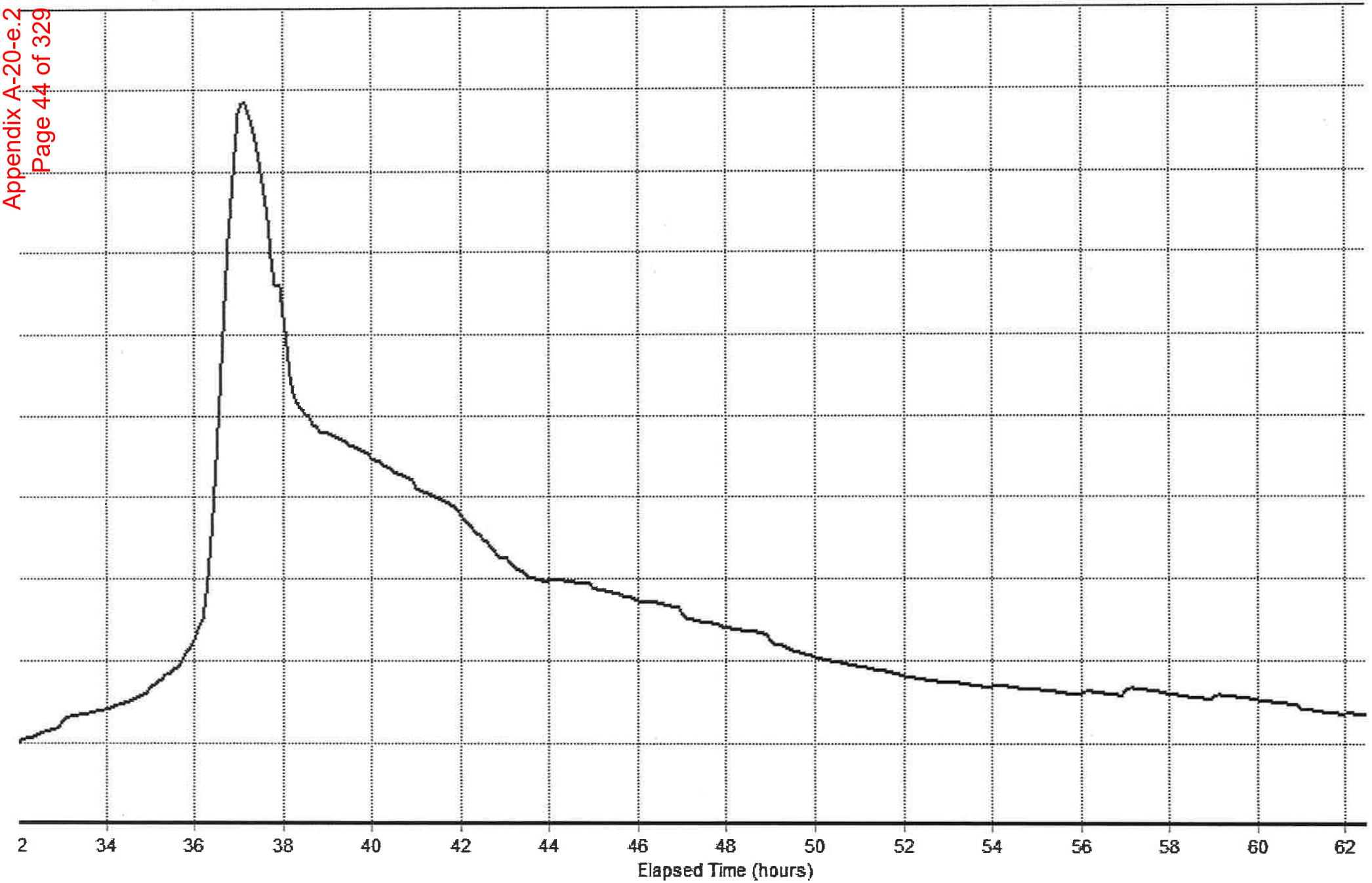
Chicago Ave. 2 Year Storm Event



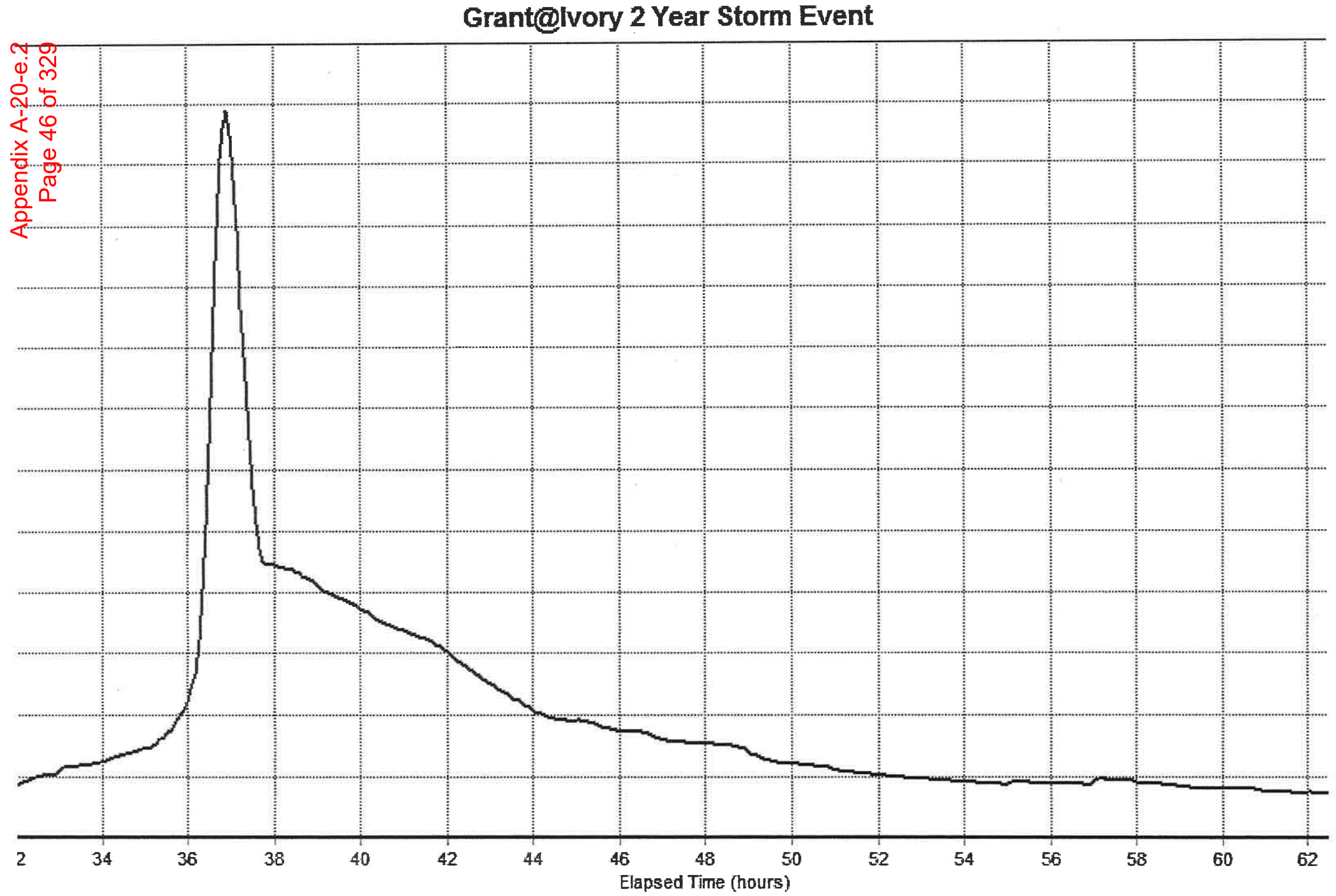
Church Street 3 Month Event



Church Street 2 Year Storm Event




Grant@Ivory 3 Month Event
2
34
36
38
40
42
44
46
48
50
52
54
56
58
60
62
Elapsed Time (hours)


Grant@Ivory 2 Year Storm Event
2
34
36
38
40
42
44
46
48
50
52
54
56
58
60
62
Elapsed Time (hours)

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LETTER OF TRANSMITTAL

DATE: July 12, 2017

RECEIVED
JUL 14 2017
Clean Water
DEP, Southwest Regional Office

TO: Paul Eiswerth
Department of Environmental Protection
400 Waterfront Drive
Pittsburgh, PA 15222

RE: **Elizabeth Borough Municipal Authority**
Long Term Control Plan
SENATE # 10165

WE ARE SENDING YOU THE FOLLOWING ITEMS:

COPIES	DATE	NO.	DESCRIPTION
1	7/12/17	1	Elizabeth Borough Municipal Authority LTCP

THESE ARE TRANSMITTED as checked below:

_X_	For approval	__	Approved as submitted	__	Resubmit ___ copies for approval
___	For your use	__	Approved as noted	__	Submit ___ copies for distribution
___	As requested	__	Returned for corrections	__	Return ___ corrected prints
___	For review and comment	__	_____		

REMARKS:

The attached is the Long Term Control Plan for the Elizabeth Borough Municipal Authority for your review and approval. Please feel free to contact me with any questions.

COPY TO:

FROM: Michael Elisco, E.I.T.

ELIZABETH BOROUGH MUNICIPAL AUTHORITY

LONG TERM CONTROL PLAN

July 2017

Prepared by:

SENATE ENGINEERING

Senate Engineering
420 William Pitt Way
Pittsburgh, PA 15238

RECEIVED
JUL 14 2017
Clean Water
DEP, Southwest Regional Office

ELIZABETH BOROUGH MUNICIPAL AUTHORITY
LONG TERM CONTROL PLAN

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Executive Summary

The Elizabeth Borough Municipal Authority (EBMA) owns and operates a 1.2 mgd wastewater treatment plant (WWTP) located in Elizabeth Borough, in Allegheny County. The WWTP accepts flows from Elizabeth Borough (Borough), Elizabeth Township, Forward Township, and Lincoln Borough.

The EBMA collection system within Elizabeth Borough is a combined system originally built c. 1950 and currently has five combined sewer overflows (CSOs).

In 2012, the Department of Environmental Protection (DEP) required the EBMA to resubmit a Long Term Control Plan (LTCP). From 2012 thru 2014 EBMA worked to characterize, monitor, and model the flows in the EBMA collection system to determine if the system was in compliance with the Clean Water Act (CWA). Based on the criteria outlined in the Combined Sewer Overflow Policy and input from the Pennsylvania Department of Environmental Protection and Allegheny County Health Department the existing system and alternatives were evaluated based on the following criteria:

1. 350% of Dry Weather Flow must receive full biological treatment
2. There may be no more than an average of 4 CSO overflow events per year allowing for two additional overflow events per year.
3. The volume of flow derived from the contributing township's sanitary systems during a 2 year storm event must receive full biological treatment.

Based on these criteria, two categories of alternatives were considered,

1. Provide primary treatment for eligible flows,
2. A combination of increasing the WWTP capacity and providing flow equalization for excess flows.

The selected LTCP alternative requires the construction of a pump station at CSO 8 and CSO 5 and the construction of a new EBMA pump station to handle wet weather flows, increase capacity at the at existing WWTP site and the construction of a flow equalization tank at the WWTP. The estimated construction cost for the work is $ 19.6 million.

1.0 Background

EBMA owns and operates a 1.2 mgd activated sludge WWTP under NPDES permit number PA-0028436. The WWTP was originally constructed in 1959 and upgraded in 1972 and 1993. The expansion of 1993 added additional tankage and replaced aging equipment to increase the permitted plant capacity from 0.6 mgd to its current 1.2 mgd.

The EBMA WWTP accepts flow from Elizabeth Borough (Borough), Forward Township, Elizabeth Township, and Lincoln Borough. Flow enters the plant's by way of both the Wylie Pump Station force main and the Elizabeth Borough Pump Station force main. No flow enters the plant by way of gravity.

The Wylie Pump Station conveys flows from Elizabeth Township and Lincoln Borough and is owned and operated by Elizabeth Township. The Wylie sewershed is a separate sanitary system with only one sanitary sewer overflow located at the pump station. The Wylie sewershed will not be directly considered in the Long Term Control Plan (LTCP) development aside from its impact on the capacity of the WWTP.

The Elizabeth Borough Pump Station, located at the junction of the Monongahela River and Fallen Timber Creek, conveys flows from the Borough, Elizabeth Township, and Forward Township to the WWTP. Three sewers enter the pump station,

1. The Borough Interceptor,
2. The 10" Fallen Timber sewer
3. The 12" Sewershed 3 sewer

The Fallen Timber line and the Sewershed 3 line meet in Manhole 9 upstream of the Pump Station dry well. A 10 inch line leaves Manhole 9, enters the drywell and is connected to a 16X10X16X10 ductile iron cross. The Borough interceptor enters the dry well as a 16 inch vitrified clay pipe (VCP) and is connected to the ductile iron tee. A 16 inch ductile iron line leaves the dry well and enters the pump station wet well.

The Borough portion of the system accepts both sanitary flow and storm flow making it a combined sewer system. The Borough is divided into six sewersheds. There are five active CSO structures and one closed CSO structure. Sewersheds 8, 7, 6, and 5 discharge into the Borough interceptor in Water Street. Sewershed 3 discharge into CSO structure 3 located several hundred feet upstream of the pump station. A map of the Borough collection system can be found in Appendix A.

The construction of the CSO structures are similar in layout. A large line from the existing system, generally 18 to 30 inches, enters the box. Under normal operation, a concrete channel directs the flow to a smaller diameter (8 to 15 inch) line positioned perpendicular to the influent pipe and leaves the structure. As the flow increases during periods of wet weather, the flow depth exceeds the depth of the concrete channel and begins to overflow a weir structure positioned perpendicular to the influent pipe. Excess wet weather flow enters a small chamber with a baffle that skims floatables before being discharged to the Monongahela River by way of a 48-inch conduit. The location of each active CSO structure is shown on the map in Appendix A.

During periods of wet weather, when the pump station and interceptor are operating at capacity, the CSO structures act as a relief, allowing surcharged flow to be discharged to the river. CSO 3, due to its elevation and proximity to the pump station often acts a relief when conditions exceed the capacity of the pump station. CSO structure 6 has only 6 inches of elevation drop to the interceptor and often receives reverse flow from the interceptor during periods when the interceptor is at or above its capacity.

The Borough Interceptor in Water Street was originally a 16 inch VCP on the banks of the Monongahela. As the river level rose during periods of wet weather, river water would enter the interceptor. In 2001 an interceptor relocation and replacement project was completed that replaced the 16 inch line with a 15 inch polyvinyl chloride (PVC) interceptor in Water Street. Much of the interceptor was bored and is housed in a steel casing. A 40 foot section of the interceptor under Fallen Timber Run leading into the pump station was not replaced. It is suspected that this portion of the interceptor is in exceedingly poor condition and a source of significant infiltration. During the replacement project the original CSO structures were replaced with the new structures positioned along Water Street. CSO structure 4 was permanently sealed in September of 2004 and is no longer active.

Portions of the Elizabeth Township and Forward Township collection systems drain by gravity into the Borough collection system. Forward Township has two major connection points, Center Ave and Grant St. at Ivory. Elizabeth Township has three connection points; Chicago Ave., Cemetery Ave. at Elks St., and Church St. All points of connection for Elizabeth Township, with the exception of the Wiley Pump Station, flow through Sewershed 3. All connection points for Forward Township flow through Sewershed 8. As a result, Sewersheds, 7, 6, and 5 are the only exclusively combined sewersheds.

Portions of the Borough collection system have been separated as shown on the collection system map in Appendix A. No Borough sewershed is comprised completely of sanitary flow. Small separation

projects have been completed in Sewersheds 6, 7, and 8 with more separation projects planned in the future.

The Fallen Timber line collects separate sanitary flows from both Elizabeth and Forward Township and is the only line connected to the Borough pump station that does not have a CSO structure. In addition to a small number of residential units in Elizabeth Township, the Fallen Timber line collects untreated pumped leachate from the Kelly Run Land Fill located on Route 51 in Forward Township.

In compliance with the Clean Water Act, a Nine Minimum Controls status report was submitted by EBMA in July of 2002 and resubmitted in February 2003. A LTCP was submitted to the DEP in 2004. In 2012 EBMA was informed by DEP that the LTCP submitted in 2004 had not been approved. In September of 2012, an effort was started to revise the previously submitted plan.

The Environmental Protection Agency's (EPA) Combined Sewer Overflow Control Policy, sets forth the criteria by which LTCPs are evaluated. EBMA will use option one of the presumptive approach as set forth in Section II.C.4.a.i of the Combined Sewer Overflow Control Policy, "No more than an average of four overflow events per year, provided that the permitting authority may allow up to two additional overflow events per year." Additional criteria mandated by the Pennsylvania Department of Environmental (DEP) and Allegheny County Health Department (ACHD) is discussed in Section 3.1.

2.0 Characterization, Monitoring, and Modeling

To assist in the development of the LTCP, a flow monitoring program was conducted from November 2012 through March 2014. A hydraulic model of the system utilizing that monitoring data was used to analyze existing conditions in the system and to plan future improvements. This section will review

1. The history of the flow monitoring program,
2. Collection system inventory
3. The construction and calibration of the collection system model, and
4. Discuss how the model is utilized as part of the LTCP and for future planning.

2.1 Collection System Inventory

To determine the extent to which the collection system could be modeled, an inventory was taken of the available collection system information. Design and as-built drawings were the primary source with three sets of drawings used;

1. The original 1950 Borough collection system design drawings,

2. The 1999 Interceptor Sewer Relocation project as-built drawings, and
3. The 1997 Fallen Timber as-built drawings.

Drawings referenced in the project can be found in Appendix B.

The original 1950 design drawings did not offer enough detail to accurately model and evaluate the hydraulic conditions at individual points in the collection system and were used mostly as reference. The EBMA interceptor relocation and Fallen Timber interceptor drawings were the main sources of information used in constructing the collection system model.

As part of the EBMA's phased approach to rehabilitate portions of the Borough collection system, surveys were made of the system. In 2012 and 2013 a complete inventory of the EBMA collection system was taken, where each known manhole was inspected and the horizontal GPS coordinates recorded. From the GPS data a map of the Borough collection system was constructed (reference Appendix A). The map was used in a 2013 cleaning and televising project (CCTV) of the entire Borough collection system. Information gathered during the CCTV work has been used by EBMA to repair or rehabilitate portions of the system most in need.

Manholes in the vicinity of the EBMA pump station were surveyed in 2013 for preliminary design of a new pump station. This survey data, supplemented with subsequent site visits was relied upon to ensure the accuracy of the piping system upstream of the pump station. The map complied from this work is found in Appendix C.

As information from these various sources was compiled, it became apparent that several different survey datums had been utilized. The interceptor elevations upstream of manhole A were adjusted down by 1.3 feet to reconcile the difference between the as-built drawings and survey data. The only pipe slope altered by the adjusted data was that of the pipe that lies upstream of Manhole 11 as shown on the pump station map in Appendix C.

2.2 Flow Monitoring

A flow monitoring program began in November of 2012 and continued until March of 2014. Due to the difficult hydraulic nature of the EBMA collection system, some meters took several months of moving and adjusting until reliable data could be collected. The final report on flow monitoring from Drnach Environmental Inc. can be found in Appendix D. In addition to the collection system meters, Drnach installed area-velocity meters in the outfall pipes of CSOs 8 and 3 to measure overflow volumes. CSOs 7, 6 and 5 used ultrasonic meters owned and operated by the Authority positioned over the weir to

measure overflow. The Authority's existing ultrasonic meters at CSOs 7, 6, and 5 only report a total event volume and do not include time series data like the Drnach meters, nor do the ultrasonic meters differentiate flow direction, i.e. whether the flow is to or from the river. Flow has been visually observed by operators to flow from the river into the CSO structure under high water conditions.

In addition to losing months of flow data due to difficult hydraulic conditions, many of the meters were moved to different locations in an attempt to isolate potentially problematic areas and optimize the use of the flow meters. With the installation of the Boat Club meter in June of 2013, sufficient meters were in place to begin collecting data to be used in building a model. Only flow data from June 2013 through February 2014 was used in the construction and calibration of the model. A summary of the data collected by the flow meters can be found in Appendix E

During the period from May 2013 through February 2014 there were 131 recorded precipitation events ranging from 0.01 inches to 2.35 inches. Graph 2.1 shows the precipitation histogram. The highest recorded peak intensity was 1.23 inches per hour with an average of 0.16 inches per hour. The average antecedent dry days was 2 with a maximum of 11 days. Table 2.1 list the average and peak hourly flows for each of the meters.

Graph 2.1 Histogram of Precipitation Events

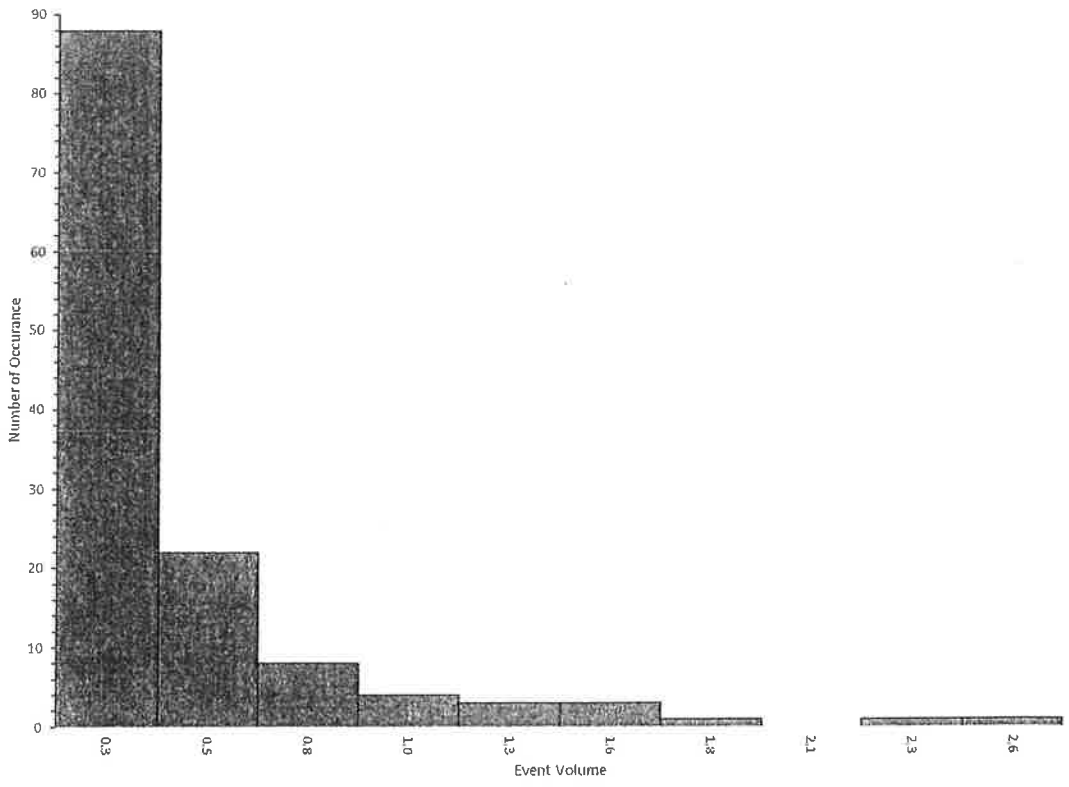


Table 2.1

Meter Name	Avg. Flow (mgd)	Max. Hourly Flow (mgd)	Peaking Factor
Chicago Ave	0.012	0.324	26.6
Church Street	0.064	0.943	14.7
Cemetery @ Elks	0.186	1.118	6.0
Grant @ Ivory	0.018	1.124	62.8
Center Ave	0.015	0.922	61.1
Fallen Timber	0.085	1.369	16.2
CSO 8	0.239	12.874	53.8
CSO 3	0.401	4.684	11.7
Boat Club	0.289	2.235	7.7

In addition to the data collected as part of the flow monitor program, WWTP operating reports were used to determine the total system flows by adding the daily flow treated at the WWTP (including those contributed from the Wiley pump station) to overflow volumes, if present. Table 2.2 list the pertinent flows for the 5 year period. Note that the values listed in Table 2.2 include overflow volumes and are meant to represent the total volume collected by the system and thus differ significantly from the flows reported by the yearly Municipal Wasteload Management Report which only considers the volume treated at the WWTP. Table 2.3 list the number of overflow events over the course of the 5 year period.

Table 2.2

Average Daily Flow (mgd)	1.129
Max Daily Flow (mgd)	15.123
Max Monthly Flow (mgd)	2.288

Table 2.3

	Yearly Overflow Events		
	Minimum	Maximum	Average
CSO 8	59	95	74
CSO 7	14	32	25
CSO 6	58	85	69
CSO 5	2	8	5
CSO 3	44	113	72

2.3 Model Construction and Calibration

To model the flows in the EBMA collection system the EPA's Storm Water Management Model (SWMM) and the Sanitary Sewer Overflow Analysis Program (SSOPA) were used. The following discussion details the approach and rational used to build and calibrate the hydraulic model.

2.3.1 Modeling Goals and Evaluation Criteria

The modeling goals dictate the manner in which the model is built and the criteria used in its validation. Ultimately the goal of the model is to first evaluate the collection system and determine if there is sufficient existing capacity to meet water quality standards, or if capacity does not exist to evaluate those alternatives required to meet those standards.

Originally, EBMA intended to evaluate the existing system and those LTCP alternatives based on the percentage of wet weather flow captured for treatment (Section II.C.4.a.ii of the Combed Sewer Overflow Policy). The hydraulic model was initially constructed and calibrated such that evaluations could be made based on the 85% capture criteria. Due to the complicated nature of the EBMA collection system, most notably to the contribution of the sanitary flows from the neighboring townships, and after several meetings with the Pennsylvania Department of Environmental Protection (DEP) and the Allegheny County Health Department (ACHD) it was determined that this criteria was not suitable. The EBMA collection system and LTCP alternatives will be evaluated based on the number of overflow events per year (Section II.C.4.a.i of the Combined Sewer Overflow Policy). The following is a summary of the criteria set forth by the Combined Sewer Overflow Policy and mandated by the DEP and ACHD:

4. 350% of Dry Weather Flow must receive full biological treatment
5. There may be no more than an average of 4 overflow events per year allowing for two additional overflow events per year.
6. The volume of flow derived from the contributing township's sanitary systems during a 2 year event must receive full biological treatment.

Based on the above criteria, the hydraulic model must adequately simulate the dry and wet hydrographs at the influent of each of the CSO structures and at the points where the Township systems enter the EBMA system. The following will briefly discuss how the model was initially developed to suit the needs of the 85% capture criteria and the subsequent modifications required to better evaluate based on overflow frequency criteria.

2.3.2 Physical Collection System Input

The first step in creating the model was to build the collection system based on the available data that would meet the modeling goal as stated above. Based on the available data compiled during the collection system characterization phase it was determined that only the interceptor could be reliably modeled. The 1950 design drawings did not contain enough of the detailed information required to accurately represent and evaluate the hydraulic conditions at individual points in the upper portions of the collection system. WWTP operators have not reported any instances of overflows in the upper collection system so that part of the system was judged less critical to perform a detailed evaluation of its capacity. The key to satisfying the modeling goals, was to recreate a hydrograph at the inlet of the CSO structures and at all points where the townships connect to the EBMA system. This could be done by routing Township flows through a simplified equivalent network that would represent the upper Borough Collection system. To ensure the proper travel time, the simplified network keeps the same approximate lengths and slopes but deletes several manholes and uses longer theoretical pipes.

When the 85% capture criteria was used to evaluate the system it was necessary to model the CSO weirs, EBMA interceptor, and EBMA pump station so that the treated volumes and overflow volumes could be determined over the course of the year. CSO structures were modeled as a junction with a weir offset from the invert. The weir was connected to a storage node that discharged into an outfall. The EBMA pump station was modeled with a storage unit acting as the wet well. The pumps were modeled using SWMM's type three pump curve and operated in a lead lag configuration.

2.3.3 SSOAP Analysis of Township Meters

SSOAP was used to order to evaluate the contribution of the sanitary flows from the Townships and to define dry weather flow patterns. The first step in completing the analysis is to define the dry weather flow (DWF) hydrographs, then to define rainfall derived inflow and infiltration (RDII) events, and finally to assign RTK parameters to match the synthetic RDII hydrograph to the observed RDII hydrograph.

DWF hydrographs were calculated using the SSOAP dry weather flow determination routine. The routine first performs an automatic dry weather flow determination based on a user defined set of parameters. Starting with the entire flow record, days are removed from consideration as a dry weather day in the following manner:

- Any day with missing flow data.
- Any day that exceeds a predetermined precipitation threshold on that day or the preceding seven days.

- Any day with an average flow significantly statistically different from the mean.

Initially the precipitation threshold was set as any day with four preceding days with no rain hence referred to as the four day definition. After completion of the model calibration, DEP indicated that they prefer to see a dry weather day defined as any day with two preceding days with no rain, a two day definition. Using a four day definition reduces the influence of rain water infiltration and could potentially result in a lower dry weather flow. With less time for the system to "dry out" the two day definition could be somewhat higher. The dry weather flow definition is more critical when using an 85% capture criteria as a lower dry weather flow pattern could artificially inflate the percent capture. When evaluating the system using an overflow frequency criteria, a single design storm is used so that minor variations in the dry weather flow volume can assumed to be negligible.

Dry weather flow hydrographs taken from the automatic day determination routine are then graphed by SSOAP and visually reviewed. Days with unusually high peak flows or other anomalies were removed. The remaining hydrographs were averaged to yield the DWF hydrograph used in the analysis.

To model the dry weather flows from each Township meter, the average weekday flow as reported by SSOAP was inputted into SWMM as the Dry Weather Average Value at each corresponding Township meter node. To create a diurnal fluctuation the SSOAP calculated dry weather flow pattern was exported into an Excel file. The flow for each hour was divided by the average daily flow to determine a hourly multiplier that could be imported into SWMM as a Dry Weather Time Pattern.

During the initial construction and calibration of the model using the 85% capture evaluation criteria, there was an attempt to ascertain seasonal fluctuations in groundwater. The Church Street meter was one of the few meters to be in place for the entire duration of the flow monitoring program and was the only meter used in evaluating groundwater fluctuations. Dry weather days for the period from January 2013 to December 2013, using a 2 day definition were identified and an average dry weather flow for each month was calculated. Each month's dry weather flow was then compared to the yearlong average to determine a dry weather flow multiplier for each month. Because only one year of data was available, some months, especially in the spring, had only 1-2 dry weather days. Initially, to address the lack of data, the monthly multipliers were averaged to yield two seasonal multipliers. For January thru July, a dry weather flow multiplier of 1.2 was used. For August thru December a multiplier of 0.7 was used. After running the model with the seasonal multipliers it became clear that there was not adequate data available to implement any variation in ground water. As previously stated, when evaluating the system using the overflow frequency criteria, relatively minor variations in dry weather flow has a negligible effect on design storm volumes and peak flows and so an average yearly dry weather flow was utilized.

To determine the amount of RDII that enters the system during wet weather the RTK method was used. As a general overview, the RTK method breaks a storm hydrograph into three separate unit hydrographs, each with three variables. R is the fraction of the total rainwater that falls onto a sewershed that enters the sanitary line. Collection system maps for the Township systems were used to determine the sewershed area for the calculation of R. T is the time to peak of the hydrograph and K is the time of recession divided by the time to peak. Each of the three hydrographs represents a different mechanism by which flow enters the sanitary line. The first hydrograph represents rapid inflow from roof drains or other illegal tie-ins and generally has a T of less than an hour. The second hydrograph represents delayed inflow and has a T of up to several hours. The third hydrograph is the flow that infiltrates through defects in manholes or broken conduits and can have a T with a magnitude of days. Both T and K are considered system characteristics and do not change from event to event. R is generally considered an event specific parameter, as it is highly dependent on antecedent conditions and rainfall intensity. To provide a better fit for some hydrographs, abstraction parameters can be used. The abstraction parameters allows for some of the rainfall volume at the beginning of the event to be removed from consideration when calculating the RDII volume. Often runoff or infiltration does not occur until surfaces are properly wetted. For each unit hydrograph there can be a maximum initial abstraction in inches, an initial abstraction recovery rate in inches per day, and a starting initial abstraction also in inches. The use of initial abstraction parameters has a higher impact on the 85% capture criteria as the model is run over the course of a year. The overflow frequency evaluation is less sensitive to antecedent conditions.

An RDII analysis was completed for each of the contributing Township meters with the exception of Kendal Street at 7th Avenue (Kendal). The Kendal meter records sanitary flow from a few Borough homes and a storm inlet that collects flow from a small watershed area in Forward Township. This meter flow was modeled using a SWMM subcatchment.

Initially, the defined RDII events were event specific, starting with the beginning of the precipitation event and ending with the return of dry weather flow. A summary of the SSOAP results can be found in Appendix E. Due to the limited amount of available flow data it was determined that the RDII hydrographs would be determined by defining a month long event. The RTK parameters (and initial abstraction parameters when necessary to achieve a better fit) were calibrated so the synthetic hydrographs were general enough to adequately match most of the events that occurred during the month. The T and K parameters determined from the event specific RDII analysis remained constant in the month long general analysis as well.

The RDII analysis was completed for two months, one summer month and one winter month. For the summer month, August was chosen as there were several small events with two larger events both of which were represented in the model calibration. The last storm in August was missing for the Box 3 flow meter. For the winter month, January was used for all the Township meters. The winter storms, while necessary for the yearlong simulation utilized in the 85% capture evaluation criteria, is not used for the overflow frequency criteria as only a single summer storm is modeled.

2.3.4 Borough Sewersheds

In order to calculate the wet weather flows derived from the Borough's combined portion of the collection system, SWMM subcatchment editor was used. A dry weather flow pattern was calculated for Box 8, Boat Club, and Box 3 using the SSOAP routine previously described. In order to determine the portion of the dry weather flows contributed by the Borough in Sewersheds 8 and 3, each total average weekday flow dry weather flows entering the CSO structure was subtracted by the total contributing Township meters average weekday dry weather flow. The calculated average flow was then applied to the previously calculated dry weather flow pattern for both Sewershed 3 and 8. The dry weather flow from sewersheds 7, 6, and 5 were determined by subtracting the Boat Club average weekday dry weather flow from the total Box 8 average weekday dry weather flow. The total flow was then divided among the three sewersheds and each given the same diurnal pattern as the Boat Club meter. The Borough dry weather flow hydrographs were applied to the node immediately before the CSO structure.

The Borough subcatchments used the SCS Curve Number to calculate runoff that entered into the combined sewer system. Other parameters that had to be determined were the area, percent impervious, and width. To determine the area and the curve number Google Earth was used. The percent impervious corresponds to the amount of sewershed area that does not use a curve number to calculate runoff. For this analysis, it was determined that the percent impervious would consist of the area of road that drains into the combined system and the roof area of buildings tied into the system. It should be noted that several of the older building in the downtown area have roof drains that are routed through internal walls in the building making separation difficult and in most cases cost prohibitive. An approximate total area was calculated for each sewershed. Then a total approximate area of road that drain into separated systems was calculated and subtracted from the total area. The remaining area of road was then the considered the minimum value for the percent impervious. This value was increased as part of the calibration process to account for roof drains that are tied to the system. The width of the sewershed affects the speed with which runoff occurs and was determined through trial and error during the

calibration process. The initial list of subcatchment parameters for each sewershed can be found in Appendix F.

2.3.5 Calibration Results

Initially, the model was calibrated and validated to satisfy the 85% capture criteria so that the model was run over the course of a year and the interceptor was modeled. The calibration portion of the process is broken into the dry weather flow calibration and the wet weather flow calibration. To ensure that the average dry weather flows were modeled correctly, the flow hydrographs calculated by SSOAP for each meter were compared to the SWMM hydrographs in each corresponding location. The main goal was to match the dry weather flow hydrograph at Box 8, Boat Club, and Box 3. As discussed previously, the Township flows were directly measured, and the Borough flows were calculated. Any discrepancy in the DWF hydrographs at Box 8, Boat Club, and Box 3, were rectified by making minor adjustments in the Borough DWF hydrographs.

Using the general RTK values for the Township meters and the subcatchment characteristics as described above, the model output was able to closely match the observed flow data for both the summer and winter storms. In order to provide a better match minor changes were made to the initial abstraction values for the Township flows. In order to adjust the Borough flows, minor adjustments were made to the width and percent impervious. The Box 8, Boat Club and Box 3 meters were further analyzed to determine the error between the observed and modeled peak flow and event volume. Not all events were within the range of accepted error but a majority were. The month of September was also modeled to verify that the calibration effort was adequate. The Box 8, Boat Club, and Box 3 hydrographs for the September run can be found in Appendix G.

The most notable anomaly is the August 9th storm in which the model predicts an increase in flow that is not seen in the flow record. The precipitation gauge used during the flow monitoring program was located at the Drnach office, approximately 1 mile from the Borough. It is assumed that the storm was very localized near the Drnach office but did not extend over the Borough sewersheds.

For a majority of the meter locations, the modeled January flow adequately reflected the observed data. The exception to this is the Box 8 meter. The Township meters flow going into the Box 8 all contained an adequate fit to the observed data. It is assumed that the discrepancy between observed and modeled for the Box 8 meter is a result of snow melt not being modeled or considered in this analysis.

An important parameter when modeling is the Manning's n value. For the simplified network representing the upper portions of the collection system a higher n valve of 0.015 was used. Most of the

upper portions of the system are VCP. For the interceptor an n value of 0.013 was used. This value is consistent with the newer PVC pipe. The only deviation to this estimate is a short section of pipe under Fallen Timber Run. The original VCP interceptor is assumed to be in serious disrepair. When crews conducted a CCTV inspection of the line they were unable to access it. In the model the pipe is modeled as partially full with a high Manning's n of 0.022. When the evaluation criteria was changed from percent capture to overflow frequency, the condition of the existing interceptor was no longer relevant.

The final check performed on the model was its ability to model the number of overflow events per year at each CSO. Reviewing operation records from 2005 thru 2013 the average number of overflow days was determined and compared to the 2003 yearlong simulation. The recorded overflow volumes at CSOs 8 and 3 were taken with less weight than the flow recorded coming into the box. The area-velocity meters in the outfalls are difficult to calibrate because flow is required to validate their operation and to enter the CSO chambers during an overflow is extremely dangerous. Table 2.4 list the average number of overflow days per year from 2005 thru 2013 and the modeled number of overflow events.

Table 2.4

	Yearly Overflow Events			
	Observed			Modeled
	Minimum	Maximum	Average	
CSO 8	59	95	74	69
CSO 7	14	32	25	32
CSO 6	58	85	69	66
CSO 5	2	8	5	8
CSO 3	44	113	72	72

A yearlong simulation was run to compare the average number of yearly overflow events to the modeled number of overflow events. Rain data collected and made available by 3 Rivers Wet Weather, Historical Rain Gauge Data was used to run the simulation. According to conversations with ALCOSAN, 2003 was an appropriately representative year to use. The National Oceanic and Atmospheric Administration (NOAA) reports that the average total yearlong precipitation for the Pittsburgh area is 38.19 inches. The 2003, 3 Rivers Wet Weather Trafford Rain gauge was the geographically closest available gauge with a reported yearlong total of 41.79 inches. The model did accurately predict the number of overflow events per year based on the calculated average number of yearly events.

To evaluate the system based on the overflow frequency criteria, a 2 year and 3 month design storm were be modeled. Table 2.5 list the peak flow rates for each of the CSO structures for the 2 year storm event.

Table 2.5

Modeled Vs Observed							
	Center	Grant	Chicago	Church	Cemetery	CSO 3	CSO 8
2 Year Peak Instantons Flow (mgd)	0.458	0.595	0.166	0.882	1.036	12.872	8.702
Metered Peak Hourly Flow (mgd)	0.922	1.124	0.324	0.943	1.118	4.684	12.874
Difference	50%	47%	49%	6%	7%	-175%	32%

The metered peak flows as shown in Table 2.5 compare to the modeled peak flows with varying degrees of accuracy. The metered peak flow for the Chicago, Grant, Center, and CSO 8 occurred on July 10, 2013. The July storm, which resulted in 4.13 inches over the course of four days, 2.53 inches on the day the peak flow occurred. The July storm was so significant that the Church, Cemetery, and CSO 3 meters were dislodged from their mounting and did not record any data. Based on the antecedent moisture conditions and total event volume it would not be appropriate to compare the modeled and metered peak flow rates. The peak metered flow rate for the Church and Cemetery meters occurred on June 13, 2013 with a total event volume of 1.83 inches and compare better to the modeled flow rates. Based on the uncertainty relating to antecedent conditions, the modeled event flow rates are likely reasonable estimates to be used for planning purposes.

The largest sources of error in modeling the EBMA collection systems stem from the short duration over which flow data was collected and the absence of influent meters on CSOs 5, 6, and 7, both which complicated the validation process. The flows derived from CSOs 5, 6, and 7 were indirectly calibrated and validated using the Boat Club meter. There is reasonable confidence that all of the flows derived from the sewersheds are accounted for, however, some sewershed may be over or under represented.

The model, as constructed and calibrated is adequate for providing the magnitude of flows expected to be required for bringing the EBMA system into compliance. It should be noted that since the conclusion of the flow monitoring program, EBMA has conducted significant system repairs including pipe linings, spot repairs, and manhole replacements.

As part of the LTCP, EBMA should install permanent area-velocity meters on the influent side of the CSOs to ascertain the reduction in wet weather flows and to confirm the flows derived from sewersheds 5, 6, and 7. The flow data collected during the estimated 1-2 year period will be used to fine tune the flows presented herein and to complete the final design of the selected alternative. As will be explained in subsequent sections, is not expected that the future collected flow data will be significantly different to the point where the chosen alternative is no longer viable.

2.3.6 Wet Weather Event Definition

The beginning of a precipitation event is clear in that it begins when the precipitation begins. The end of the event however can be defined one of two ways. The first definition is the arrival of the last rain drop to fall in the furthest reach of the sewershed at the CSO structure. The total event time would then be the total precipitation time plus the theoretical travel time of the last raindrop to fall on the furthest point of the watershed to the CSO structure. A second definition for end of the wet weather event is the time at which flow into the CSO structure returns to a predetermined percentage of the normal dry weather flow. This definition comes from discussions with DEP and was used by Authorities in previous studies.

Evaluation of the first wet weather flow definition requires the determination of the travel time. To calculate the travel time the method outlined in TR-55 Chapter 3 was used. Using a topographic map of the Borough and surrounding area, the furthest flow path was found. From there flow was broken down into three different regimes; sheet flow; shallow concentrated flow; and open channel flow. It is assumed that sheet flow occurs only for the first 100 feet of flow before turning into shallow concentrated flow. The equation set forth in TR-55 assumes a 2-year, 24-hour rainfall. The shallow concentrated flow velocity was taken from the National Engineering Handbook, Chapter 15, "Velocity versus Slope for Shallow Concentrated Flow Graph". For the LTCP, the upper portions of the collection system were not modeled in detail. Instead a simplified network was created to keep the same approximate travel time. To calculate the travel time in the Borough collection system a two year storm was modeled in SWMM. The velocities in the simplified network were averaged at the end of the rain event and travel time calculated. Reference Appendix H for the complete travel time calculation.

The total calculated travel time from the furthest point in watershed that contributes to Sewershed 8 is approximately 22 minutes. Flow data from the EBMA system shows numerous high wet weather flow events extending much longer than 22 minutes after precipitation ends which could indicate that infiltration is a large source of flow in the system. The travel time definition would not therefore described the EBMA system accurately. Instead, EBMA and DEP, in conjunction with the Allegheny Health Department have agreed to define a wet weather event as starting with the precipitation event and ending no more than 24 hours after the precipitation event has ended. Any overflows that occur more than 24 hours after rainfall will be considered a dry weather overflow. It should also be noted that while the event duration has a significant impact when utilizing the percent capture criteria, its importance is greatly diminished when evaluating based on an overflow frequency criteria.

3.0 Development and Evaluation of Alternatives

The following describes the derivation of the design flows, a brief description of all alternatives considered, and the select alternatives with detailed analysis.

3.1 Design Flow Derivation

As outlined above, EBMA will develop alternatives that ensure that no more than an average of 4 overflow event per year occur. Due to the addition of sanitary flow in some of the combined sewersheds additional criteria was mandated by DEP. Both a 2 year and 3 month 24 hour event were modeled in SWMM.

Each alternative considered must satisfy the following minimum criteria:

- The dry weather flow must receive full biological treatment.
- The full volume of flow derived from a 3 month, 24 hour storm must receive full biological treatment. The Authority may be permitted for financial reasons to provide primary treatment to the volume of flow derived from the combined portion of the sewer system in excess of the combined system dry weather flow. Primary treatment consist of primary clarification (or an equivalent process) and disinfection.
- The volume of sanitary sewer flow derived from the 2 year, 24 hour event must receive full biological treatment.

The capacity of the 15 inch EBMA interceptor is limited and as such each CSO structure located along the interceptor was allocated capacity. This was done by determining the dry weather flow using SSOAP with a dry weather day being defined as any day that had no recorded precipitation on that or the preceding day. Each CSO structure was allocated, at minimum the calculated peak dry weather flow with a 1.5 factor of safety. CSO 8 was given the remainder of the interceptor capacity allocation.

To determine the design flows, the following procedure was followed and can be modified for sewersheds only receiving combined flow.

1. The hydrograph for the 3 month and 2 year storm event for each CSO structure influent and Township meter was calculated using SWMM and imported into an Excel spreadsheet.
2. The Township hydrographs were added together into a single Sanitary Flow hydrograph.
3. The hydrograph for the 3 month and 2 year storm for the combined portion of the system was calculated by subtracting the sanitary flow hydrograph from the CSO influent hydrograph.

4. The calculated dry weather flow hydrograph (using a 1 day definition) was imported to the Excel spreadsheet and multiplied by 3.5.
5. Once flow enters a CSO structure it must be directed one of the three way:
    a. To the WWTP to receive full biological treatment
    b. Bypassed to a process that provides primary clarification (or a process shown to be equivalent to primary clarification), removal of solids, and disinfection
    c. Overflow to the Monongahela River after the removal of floatables.
6. The minimum required (or allowable) volumes for each flow path are defined as follows:
    a. Biological Treatment: At minimum, the full volume of flow from sanitary sewer portions derived from a 2 year event plus the dry weather flow in the combined portions are required to receive full biological treatment. This hydrograph is calculated by adding the 2 year sanitary flow hydrograph to the calculated combined system dry weather flow hydrograph.
    b. Bypass to Primary Treatment: The volume of the combined flow derived from the 3 month event subtracted from combined dry weather flow is eligible to receive primary treatment.
    c. Overflow Volume: The volume of flow eligible to be discharged during a 2 year event is the volume of flow from the combined portion of the collection system derived from the 2 year event minus the 3 month combined system flow.
7. After the required biological treatment volume and allowable primary and overflow volumes are calculated for each CSO structure the peak flows for each flow path are determined at each CSO structure are calculated as follows:
    a. Biological Treatment: Initially, the peak flow rate going to the interceptor is set based on the interceptor allocation as described above. If the CSO influent flow rate is less than the allocated capacity all flow goes to the WWTP to receive full biological treatment. The allocated biological treatment hydrograph is equal to the CSO influent hydrograph until the influent flow rate exceeds the allocated capacity. The volume of the calculated biological treatment hydrograph must have a volume greater than or equal to the required biological treatment volume. If the calculated volume of the biological treatment hydrograph using the allocated peak flow is less than what is required, additional capacity will be needed in the collection system. A required additional capacity peak flow rate is chosen and a required additional capacity hydrograph is calculated. To calculate the

additional capacity hydrograph, an effective influent hydrograph is calculated by subtracting the allocated capacity hydrograph from the CSO influent hydrograph. The additional capacity hydrograph is equal to the effective influent hydrograph until the effective hydrograph flow rate exceeds the chosen peak additional capacity flow rate. The required additional capacity peak flow rate must be, at minimum, equal to the 3 month event peak flow rate (to ensure no more than 4 overflow events per year) and such that the volume of the allocated and additional capacity hydrographs is greater than or equal to the required biological treatment volume as described above.

b. Primary Treatment: After the biological treatment volume requirements are met secondary control may take over to send flow to a primary treatment facility. An initial peak flow rate for the control structure is chosen. The primary treatment hydrograph is calculated by subtracting the allocated and additional capacity hydrographs from the CSO influent hydrograph to yield an effective hydrograph. The primary treatment hydrograph is equal to the effective hydrograph until the effective hydrograph flow exceeds the chosen peak primary treatment hydrograph. The peak flow rate of the primary treatment control is adjusted until the volume of the primary treatment hydrograph is less than or equal to the allowable primary treatment volume.

c. Overflow Volume: After the biological and primary treatment volumes are accounted for the remaining volume can be overflowed. The peak overflow flow rate is then the peak storm flow minus the interceptor capacity plus the primary treatment peak flow rate.

Utilizing the procedure above, preliminary design flows were calculated. Table 3.1 list the calculated required biological treatment volume and the allowable primary treatment and CSO discharge volumes for each CSO structure.

Table 3.1

	Required Biological Treatment Volume (gallons)	Allowable Primary Treatment (gallons)	Allowable CSO Discharge (gallons)
CSO 3	1,614,000	1,011,000	556,000
CSO 5	29,000	338,000	155,000
CSO 6	31,000	625,000	233,000
CSO 7	65,000	476,000	225,000
CSO 8	596,000	774,000	447,000

Σ = 2.335 MG. 3.224 MG 1.616 MG = 7.175 MG.

$\frac{7.175 - 1.616}{7.175} = 77\%$ capture.

Table 3.2 list the event volumes and peak flows for each of the three flow paths described above for all alternatives that involve primary treatment.

Table 3.2

	Allocated Capacity		Additional Capacity		Primary Treatment		Overflow Volume (Gallons)
	Peak Inst. Flow Rate (mgd)	Event Volume (Gallons)	Peak Inst. Flow Rate (mgd)	Event Volume (Gallons)	Peak Inst. Flow Rate (mgd)	Event Volume (Gallons)	
CSO 3	0.240	478,000	1.102	1,136,000	5.590	917,000	95,000
CSO 5	0.040	54,000	0.000	0	2.090	280,000	33,000
CSO 6	0.040	59,000	0.000	0	5.220	554,000	43,000
CSO 7	0.040	73,000	0.000	0	2.760	441,000	27,000
CSO 8	0.400	625,000	0.000	0	5.170	699,000	47,000

Table 3.3 list the event volumes and peaks flows for alternatives that involve providing full biological treatment to the required flows. A more detailed summary, including hydrographs can be found in Appendix I.

Table 3.3

	Allocated Capacity		Additional Capacity		
	Peak Inst. Flow Rate (mgd)	Event Volume (Gallons)	Peak Inst. Flow Rate (mgd)	Event Volume (Gallons)	Overflow Volume (Gallons)
CSO 3	0.240	478,000	6.690	2,052,000	95,000
CSO 5	0.040	54,000	2.090	280,000	33,000
CSO 6	0.040	59,000	5.220	554,000	43,000
CSO 7	0.040	73,000	2.760	441,000	27,000
CSO 8	0.400	625,000	5.170	699,000	47,000

3.2 Alternative Summary

The following outlines the general alternatives that were considered in the development of the LTCP. Several of the alternatives considered and described below were clearly infeasible and are only found in this section. Feasible alternatives will be described in greater detail in later sections. All alternatives considered provide either primary treatment to the eligible volumes, flow equalization, or full biological treatment.

Not included in the alternatives considered below is a plan to completely separate the Borough collection system. A majority of the Borough collection system occupies a dense urban environment making construction difficult and expensive. In addition, several right of way conflicts, most notably with the Pennsylvania Department of Transporting and CSX Railroad, make the installation of a dedicated storm

sewer complicated and prohibitively expensive in some areas. A complete sewer separation will remain a long term goal for EBMA though it is unlikely that a complete separation could be completed within the time frame required by the LTCP. As funding becomes available areas of the collection system will be separated and rehabilitated. These planned efforts were not included in the development of the LTCP as there is no reliable way to estimate how much flow these future projects will remove. It is likely then that flows presented herein will be conservative.

The alternatives considered in the LTCP address the wet weather flows from the Borough collection system. To properly evaluate the LTCP alternatives Act 537 planning must be completed to quantify the flows from the Wylie sewershed which is not owned or operated by EBMA. In addition, portions of the surrounding area remain unsewered and have expressed interest in connecting to the Wylie sewershed. Depending on what is agreed upon with the surrounding communities in the Act 537, a WWTP expansion may be necessary regardless of the requirement for the LTCP. The alternatives outlined in this section outline all possible alternatives considered and assume that no additional capacity is allocated to the Wylie pump station.

3.2.1 Primary Treatment

As described in Section 3.1, some flows are eligible to receive primary treatment before being discharged to the Monongahela River. Primary treatment is defined in the Combined Sewer Overflow Control Policy as follows:

- "Primary Clarification (Removal of floatables and settleable solids may be achieved by any combination of treatment technologies of methods that are shown to be equivalent to primary clarification"
- "Solids and floatable disposal"
- "Disinfection of Effluent, if necessary, to meet water quality standards, protect human health, including the removal of harmful disinfection chemicals residuals, where necessary."

A treatment structure would be designed to provide the above outlined minimum treatment. Several proprietary systems provide the required treatment outlined above and include the Strom King and the FluidSep.

Each primary treatment alternative would then require either flow equalization or a WWTP upgrade to handle excess flows from CSO 3. Several alternatives involving providing primary treatment are discussed below.

- Primary treatment at each CSO structure along the EBMA interceptor: Each CSO would be fitted with a primary treatment structure. This alternative would allow for the primary treatment volume entering each CSO structure to flow by gravity to the primary treatment structure. CSOs 5, 6, and 7 are all located in the downtown area of Elizabeth Borough. The size of the primary treatment technology would make a dedicated primary treatment structure at each CSO impractical. This alternative was not be explored in detail.
- Primary Treatment at CSO 8: Located adjacent to CSO 8 are several locations that have a reasonable potential to be acquired by the Authority and developed. This alternative would involve pumping the primary treatment volume from CSOs 5, 6, and 7 to a primary treatment structure located adjacent to CSO 8. Depending on the placement of the primary treatment structure, flow from CSO 8 would either flow by gravity or be pumped. Primary treatment would be provided at the EBMA pump station for eligible CSO 3 flows. To accommodate excess flows from CSO 3 which require full biological treatment, accomplished through either flow equalization or WWTP expansion. A concept level design was completed for this alternative.
- Primary Treatment at the EBMA Pump Station: All primary treatment flows from CSOs 5, 6, 7, and 8 will be conveyed to the new proposed EBMA pump station. This alternative is further divided into two alternatives; conveying primary treatment flows to the pump station by way of gravity or through the use of individual pump stations at each CSO structure. Gravity flow of the primary treatment volume to the EBMA pump station is difficult due to the required depth of the conduit and the limited working space. The primary treatment volume from each CSO could be pumped to the new pump station. The smaller CSO pump stations would only require a smaller diameter forcemain buried at a shallower depth potentially reducing the capital cost. The proposed pump station will have a headworks with screening and grit removal. As the primary flow enters the pump station it will enter a separate headworks train and will receive disinfection before being discharged. The flows from Borough CSO structures would have to remain segregated from the Fallen Timber line flows as the total volume of Fallen Timber must receive biological treatment. This alternative would require a larger pump station footprint but the pumping capacity would remain unchanged from the preceding two alternatives. In addition either flow equalization or WWTP expansion would be required for CSO 3 flows. A concept level design was completed for this alternative.
- Primary Treatment at the WWTP: As with the preceding alternative, collection system upgrades would be required to send primary treatment volumes from CSOs 8, 7, 6, and to the EBMA pump

station. A dedicated headworks train, wet well, pump(s), and force main would be responsible for directing wet weather combined flow to the WWTP where a portion would be sent to a full biological treatment process and a portion to the primary treatment facility. The addition of the exclusively sanitary Fallen Timber line makes this alternative infeasible. The Fallen Timber flows are not eligible for primary treatment and would require a separate headworks train, wet well, pumps and forcemain to ensure that the Fallen Timber flows received full biological treatment. Alternatives that involve primary treatment at the pump station also require separate headworks trains but not separate wet wells and pumps. As previously described, alternatives that involve primary treatment at the pump station would only require a set of dry weather pumps and a set of wet weather pumps. A WWTP primary treatment alternative would require two sets of dry weather pumps, one for the combined flows and one for Fallen Timber and a set of wet weather pumps. This would increase the number of pumps from 4-5 for a pump station primary treatment alternative (2 dry weather, 2-3 wet weather) to 6 to 9 for a WWTP primary treatment alternative (4 dry weather, 3-5 wet weather). Due to the complexity a concept level design was not completed for this alternative.

3.2.2 Flow Equalization

The second category of alternative involves the construction of flow equalization. In this set of alternatives the volume of flow eligible for primary treatment would be stored until after the storm event and sent to the WWTP to receive full biological treatment. All alternatives considered assume that flow would be pumped into the tanks and gravity flow out. No location or alterative considered allow for gravity flow into the tank. All flow equalization alternatives require aeration. The following outlines all flow equalization alternatives considered:

- Flow Equilization at Each CSO Structure: This alternative involves constructing flow equalization tanks at each of the 5 CSO structures. As with the primary treatment alternatives, space restrictions make this alternative infeasible. This alternative was not explored in detail.
- Flow Equilization at CSO 8: Flow equalization would be constructed adjacent to CSO 8 and would be sized to accommodate flows from CSOs 5, 6, 7, and 8. Collection system upgrades would be limited to the force mains required to convey flow for the CSO structures to the tank. The existing interceptor would be utilized to empty the tank after the storm event. In addition the WWTP capacity would be upgraded to handle the peak flows required for CSO 3. Due to space

constraints and the residential nature of the surrounding area, any alternative which involving the construction of flow equalization tanks at CSO 8 was not considered.

- Flow Equalization at CSO 8 and the EBMA Pump Station: This alternative would involve the same flow equalization tank at CSO 8 as the previous alternative. Instead of increasing the WWTP capacity to accommodate CSO 3 a flow equalization tank would be constructed at the pump station to store the required volume from CSO 3. As with the CSO 8 location, limited space and the residential nature of the area makes the addition of a flow equalization tank at the EBMA pump station site infeasible. This alternative was not considered.
- Flow Equalization at the EBMA Pump Station: Surplus flow from all CSO structures would be conveyed to the pump station by way of one or more force mains and then pumped again into a flow equalization tank. As with the previous alternative, site constraints make this alterative infeasible and it was not considered in detail.
- Flow Equalization at the WWTP: Surplus flow from all CSO structures would be conveyed to the pump station by way of one or more force mains. A dedicated wet well, headworks train, wet weather pump(s), and force main would convey the flow to a flow equalization tank located at the WWTP. To empty the tank at the WWTP flow would either flow by gravity back to the EBMA pump station to be pumped to the WWTP influent or a dedicated pump(s) in the flow equalization tank would empty the tank directly to the WWTP influent. Based on the required flow equalization volume it is unlikely that tank of sufficient size could be constructed on any available property. This alternative was not considered feasible and was not conserved in detail.

3.2.3 Biological Treatment

The third type of alternative is to provide biological treatment to the required biological treatment volume and the allowable primary treatment volume. The following describes all considered alternatives:

- Biological Treatment at Remote Locations: Any alternative that would require construction of a remote WWTP was not regarded as feasible. Aside from the significant space restraints within the Borough, any remote WWTP would require some amount of flow at all times to maintain a biological mass. This alternative would likely result in a high capital cost and would significantly increase the operation and maintenance cost for the Authority. This alternative was not considered in detail.
- Biological Treatment Upgrades at the Existing WWTP: This alternative would require several of the collection system upgrades outlined in the previous alternatives. Surplus flows from CSOs 5, 6, 7, and 8 would be pumped in one or more force mains to the proposed EBMA pump station.

No dedicated wet well, headworks train, pump(s), or force mains would be required in the pump station because all flow will receive biological treatment. The WWTP would be upgraded and designed to handle the peak wet weather flow. Based on the peaking factor over 12, it is unlikely that even an sequencing batch reactor (SBR) WWTP could be utilized alone. Instead, an SBR WWTP will be designed based on the average day flow with a flow equalization tank used to mitigate peak flows. A concept level design was completed for this alternative.

3.3 Evaluation of Alternatives

Table 3.2 summarizes the alternatives for which a concept level design was completed. Each alternative will then be described in detail and evaluated based on, cost, performance, and sensitive area impact assessment.

Table 3.2

Alternative Number	Description
P1-A	Primary treatment structure constructed at CSO 8 for CSOs 5, 6, 7, and 8. Primary treatment is provided for eligible CSO 3 flows at the EBMA pump station. Flow Equalization is provided at the WWTP for excess CSO 3 flows.
P1-B	Primary treatment structure constructed at CSO 8 for CSOs 5, 6, 7, and 8. Primary treatment is provided for eligible CSO 3 flows at the EBMA pump station. Increase WWTP capacity to handle CSO 3 flows
P2-A	Convey all primary treatment volume from CSOs 5, 6, 7, and 8 to the proposed pump station to provide primary treatment. Flow Equalization is provided at the WWTP for CSO 3 flows
P2-B	Convey all primary treatment volume from CSOs 5, 6, 7, and 8 to the proposed pump station to provide primary treatment. Increase WWTP capacity to handle CSO 3 flows.
B1	Upgrade the collection system and WWTP capacity to provide biological treatment to all required flows. Provide flow equalization at the WWTP for peak storm water flows.

3.3.1 Alternative description

The following is a detailed description of each of the Alternative for which a concept level design was completed. Reference Appendix J for detailed concept level design calculations for each alternative.

Alternative P1-A

This alternative involves the construction of a primary treatment facility adjacent to CSO 8 with CSOs 5, 6, and 7 pumping excess primary treatment flows to the primary treatment structure. A portion of the excess flows from CSO 3 would receive primary treatment at the pump station and a portion would be directed to a flow equalization tank at the WWTP site. The WWTP capacity would not be increased. Table 3.5 list the design flows for Alternative P-1.

Flow from Sewershed 8 above the allocated interceptor capacity will be directed from the existing CSO structure to a secondary diversion structure. For Sewersheds 5, 6, and 7, a pump station would be constructed immediately adjacent to the existing three CSO structures. Each pump stations will consist of two submersible pumps in a primary – backup configuration. Primary and emergency power for all of the pump stations will be provided from a new electrical building positioned near CSO 8 that will also house a generator.

The new EBMA pump station will have three headworks trains. The first headworks train will be the normal flow channel and will consist of a mechanical bar screen and vortex grit chamber. Flow could be diverted from the normal flow train to a bypass channel consisting of a manual bar screen. After the normal flow channel, flow will be directed to the pump station wet well. The bypass channel will only be utilized when normal flow channel required maintenance or equipment repair. The third headworks train will consist of a mechanical bar screen and vortex grit chamber and would only accept flow from CSO 3 eligible for primary treatment. After the primary treatment flow will be directed to a disinfection structure located adjacent to the pump station. The secondary diversion structure will be positioned adjacent to the pump station and will provide disinfection and dechlorination. Two separate small buildings will be constructed adjacent to the contact structure to house chemicals and pumps. Due to the elevation of the pump station, flow from the contact tank will need to be pumped out and into CSO 3 to be mixed with the overflow and discharged to the Monongahela River.

Flow from CSO 3 will be directed to a secondary diversion structure located immediately upstream of the pump station influent. During dry weather conditions, flow will be directed from the CSO 3 secondary diversion structure to the normal flow headworks train. During wet weather, flow above the allocated capacity will be directed to the primary treatment headworks train where it would undergo screening, grit removal, and disinfection. When the water surface elevation in the secondary diversion structure reaches a point above the capacity of the primary treatment headworks, flow will be directed to the Monongahela River through existing CSO 3.

As the flow through the normal flow channel exceeds the dry weather capacity of the pump station, wet weather pumps will operate simultaneously to direct a portion of the flow to the 1.1 million gallon flow equalization tank positioned at the WWTP. After wet weather flows have subsided, flow will pumped out of the flow equalization tank into the process tanks at the WWTP to receive full biological treatment.

Table 3.5

Alternative P1-A			
	Peak Flow Rate (mgd)	Peak Flow Rate (gpm)	Volume (gallons)
Primary Treatment at CSO 8	15.240	10,583	-
Pump Station CSO 5	2.090	1,451	-
Pump Station CSO 6	5.220	3,625	-
Pump Station CSO 7	2.760	1,917	-
Pump Station CSO 8	5.170	3,590	-
Primary Treatment at EBMA PS	5.590	3,882	
Flow Equalization	1.100	764	1,136,000
EBMA Pump Station Capacity	1.296	900	-
WWTP Capacity*	2.500	-	-
* Assumes a Wylie Capacity of 1.2 mgd			

Alternative P1-B

This alternative in the same as Alternative P1-A except that flow equalization will not be utilized at the WWTP and excess flows from CSO 3 will receive full biological treatment requiring a WWTP upgrade. Table 3.6 list the design flows for Alternative P1-B. With the exception of the WWTP Flow Equalization Tank, the concept level design and cost is the same as Alternative P1-A

The existing WWTP capacity is 2.5 mgd (based on the existing peak pumping rates of the Wylie and EBMA pump stations). According the 2015 Chapter 94 report, the average daily flow was 1.117 mgd. Further review of operating reports shows a notable difference between the month with the highest average daily flow (March at 1.856 mgd) and the month with the lowest average daily flow (August at 0.698 mgd). Given existing seasonal variations upgrading the existing conventional activated sludge process would likely lead to significant operational issues, increased operation cost and permit violations. The most prudent course of action will be to construct a sequencing batch reactor (SBR) WWTP along the north west portion of the existing WWTP site. Some of the existing tanks will be converted to an anaerobic sludge digestion tanks to allow for full treatment of waste sludge on site. The existing chlorine contact tank will be abandoned and an ultraviolet disinfection system constructed.

Based on the pump station design flow of 2.40 only one set of pumps will be required rated for 2.4 mgd peak flow but operating on VFDs.

Table 3.6

Alternative P1-B			
	Peak Flow Rate (mgd)	Peak Flow Rate (gpm)	Volume (gallons)
Primary Treatment at CSO 8	15.240	10583	-
Pump Station CSO 5	2.090	1451	-
Pump Station CSO 6	5.220	3625	-
Pump Station CSO 7	2.760	1917	-
Pump Station CSO 8	5.170	3590	-
Primary Treatment at EBMA PS	5.590	3882	-
EBMA Pump Station Capacity	2.400	1667	-
WWTP Capacity*	3.600	2500	-
* Assumes a Wylie Capacity of 1.2 mgd			

Alternative P2-A

The Primary Treatment Alternative 2 Series involves conveying all flows eligible for primary treatment to the EBMA pump station to undergo screening, grit removal, and disinfection before being discharged to the Monongahela River. The Primary Treatment Alternative 2 Series and Alternative B1 all require a secondary alternatives analysis relating to conveying flows from CSOs 8, 7, 6, and 5 to the EBMA pump station. Three alternatives were considered;

1. Gravity flow of wet weather flows through a parallel sewer
2. Pump stations located at each CSO structure that would pump wet weather flows into a common forcemain
3. A hybrid of the previous two alternatives in which flow from CSO 7 would gravity flow back to CSO 8 where a pump station will pump flows from CSO 8 and 7 to the EBMA pump station. Flows from CSO 6 would gravity flow to CSO 5 through a parallel sewer where a pump station will pump wet weather flows from each CSO to the EBMA pump station.

A concept level design and cost estimate was completed for each of the three collection system alternatives and is included in Appendix J. Due to the conduit size and depth, the parallel sewer alternative (1) is not cost effective. The pump station alternative (2) and hybrid alternative (3) were both similar in cost with the hybrid having a slightly higher capital cost. Given the operational benefits of having fewer

pump stations, the hybrid alternative (3) will be used to convey flows from the collection system to the EBMA pump station in all of the following alternatives (P2-A and P2-B).

As with the Primary Treatment 1 Series of Alternatives, flows eligible for primary treatment will be directed to a primary treatment headworks train where it will undergo screening and grit removal before being discharged to chlorine contact tank adjacent to the EBMA pump station. Based on the pump station elevation, flow will need to be pumped out of the chlorine contact tank.

Alternative P2-A will have the same flow equalization system as described in Alternative P1-A.

Table 3.7

Alternative P2-A	Peak Flow Rate (mgd)	Peak Flow Rate (gpm)	Volume (gallons)
Primary Treatment at EBMA PS	20.830	14465	-
Collection/Conveyance Upgrades CSO 5	2.090	1451	-
Collection/Conveyance Upgrades CSO 6	5.220	3625	-
Collection/Conveyance Upgrades CSO 7	2.760	1917	-
Collection/Conveyance Upgrades CSO 8	5.170	3590	-
Flow Equalization	1.100	764	1,136,000
EBMA Pump Station Capacity	1.296	900	-
WWTP Capacity*	2.500	1736	-
* Assumes a Wylie Capacity of 1.2 mgd			

Alternative P2-B

Alternative P2-B has the same hybrid collection system (3) upgrades and pump station design as described in Alternative P2-A and in Appendix J. As with Alternative P1-B, the WWTP is increased in size to handle excess flows from CSO 3.

Table 3.8

Alternative P2-B	Peak Flow Rate (mgd)	Peak Flow Rate (gpm)	Volume (gallons)
Primary Treatment at EBMA PS	20.830	14465	-
Collection/Conveyance Upgrades CSO 5	2.090	1451	-
Collection/Conveyance Upgrades CSO 6	5.220	3625	-
Collection/Conveyance Upgrades CSO 7	2.760	1917	-
Collection/Conveyance Upgrades CSO 8	5.170	3590	-
EBMA Pump Station Capacity	2.400	1667	-
WWTP Capacity*	3.600	2500	-
* Assumes a Wylie Capacity of 1.2 mgd			

Alternative B1

This alternative for which a concept level design was completed involved increasing capacity of the WWTP and providing flow equalization so that all flows, aside from the allowable discharge, would receive full biological treatment. To convey flows to the EBMA pump station, the hybrid collection system improvements as previously described will be constructed. The existing WWTP is abandoned and a SBR WWTP with an average day flow of 2.0 mgd and a peak flow of 10.0 mgd is constructed. Some of the tankage from the existing WWTP is repurposed for aerobic digestion of sludge.

When flow entered the EBMA pump station, normal dry weather flows is directed to a headworks train that provides screening and grit removal. During periods of wet weather, excess flow is directed to a bypass channel that provides manual screening and discharge to a common wet well through a separate cutthroat flume. Wet weather pumps direct flows above 8.8 mgd (assuming a 10 mgd WWTP with 1.2 mgd allocated for Wylie) to a 660,000 gallon flow equalization tank the WWTP. After an event, flow drains through the forcemain back to the pump station.

Table 3.9

Alternative B1	Peak Flow Rate (mgd)	Peak Flow Rate (gpm)	Volume (gallons)
Collection/Conveyance Upgrades CSO 5	2.090	1451	-
Collection/Conveyance Upgrades CSO 6	5.220	3625	-
Collection/Conveyance Upgrades CSO 7	2.760	1917	-
Collection/Conveyance Upgrades CSO 8	5.170	3590	-
EBMA Pump Station Capacity	23.230	16132	-
WWTP Capacity*	10.000	6944	
Flow EQ Tank	14.430	9188	660,000
* Assumes a Wylie Capacity of 1.2 mgd			

3.3.1 Cost Comparison

A full discussion related to the Construction and Operation and Maintenance cost estimates can be found in Appendix J. Table 3.10 below list the estimated cost, the calculated present worth and the uniform annual cost.

Table 3.10

	P1-A	P1-B	P2-A	P2-B	B1
Estimated Construction Cost	$ 19,660,000	$ 22,320,000	$ 21,020,000	$ 23,720,000	$ 19,590,000
Estimated Annual O&M Cost	$ 696,000	$ 697,000	$ 696,000	$ 694,000	$ 689,000
Present Worth Calculations					
Construction Present Worth	$ 19,660,000	$ 22,320,000	$ 21,020,000	$ 23,720,000	$ 19,590,000
O&M Present Worth	$ 13,467,000	$ 13,487,000	$ 3,467,000	$ 13,429,000	$ 13,332,000
Total Present Worth	$ 33,127,000	$ 35,807,000	$ 34,487,000	$ 37,149,000	$ 32,922,000
Uniform Annual Cost	**$ 1,712,000**	**$ 1,851,000**	**$ 1,782,000**	**$ 1,920,000**	**$ 1,701,000**

3.3.2 Performance

All proposed alternatives for which a concept level design was complete aim to achieve roughly the same goal; to reduce the number of raw sewage overflows to no more than 4 on an average annual basis. The primary treatment alternatives however achieve this goal to a lesser extent, providing a lower level of treatment to a portion of the flows. There are several short comings with the primary treatment alternatives that are either absent from the biological treatment alternative or are realized to a significant lesser extent. All of the primary treatment alternatives require large treatment facilities to be located within the collection system posing significant constructability, reliability, and safety concerns. Due to the depth at which the existing collection system is located, much of the excavation will be below the normal pool of the Monongahela River requiring significant dewatering. In addition, limited space at CSO 8 and in the vicinity of the proposed pump station will require sheet piling be used for much of the excavation.

Each of the primary treatment facilities in the alternatives require several raw sewage pumps, chemical metering pumps, and flow measurement devices all of which represent a failure point. The equipment required to operate the primary treatment structures will have to be tied into a SCADA system for both control and monitoring. Each of the CSO pump stations and primary treatment structures will communicate back to the main SCADA though cellular communications which are both an added cost and a point of failure. The significant number of equipment and sensors complicates the implementation and maintenance of the system making failure and the occurrence of nuisance alarms more likely.

All primary treatment structures will require the use and onsite storage of sodium hypochlorite and sodium bisulfite to achieve the required disinfection. The remote storage of these chemicals means that operators would make visual inspect at most once a day increasing the potential duration and impact of potential leaks. The sites will have to be adequately secured to prevent theft or vandalism. The use of these chemicals in remote locations is a liability to the Authority.

The biological treatment alternative localizes all treatment to the existing WWTP property and limits additional collection system facilities to two additional pump stations at CSOs 8 and 5 thus limiting the operation burden, potential of equipment failure, and public safety liabilities all while providing a much higher degree of treatment.

3.3.3 Sensitive Area Impact

There are two areas within the Borough that may be considered sensitive, a boat launch positioned next two CSO 8 and a Marina located in the vicinity of CSO 3. All proposed alternatives seek to significantly reduce the number of overflows per year which will help lessen the impact on sensitive areas. The Marina near CSO 3 is located almost 1,000 feet downstream from the closest CSO outfall and upstream of CSO 3. The position of the Marina in relation to the CSO discharges promotes mixing and reduces the impact. It should also be noted that peak discharges from the CSO structures will occur during inclement weather reducing the likelihood that the general public will be in contact. The Authority plans to further mitigate the impact of CSOs on sensitive areas through public education and the installation of signage.

4.0 Selection and Implementation of the LTCP

4.1 Public Participation

The Long Term Control Plan was advertised for public comment on May 8, 2017. All comments received during that time will be addressed and incorporated into the LTCP.

4.2 Final Selection and Development of Recommended Plan

Based on the completed alternatives analysis and a review of each alternative's performance, Alternative B1 which involves the upsizing of the WWTP and the construction of a flow equalization tank at the WWTP. Since the start of the development of the LTCP, the Authority has conducted a complete collection system inventory and inspection and has completed approximately $ 1,907,500 in repairs and replacement of portions of the sewer system most in need. In additional, the Authority plans a partial

separation of the lower portions of CSO 3 to begin in the Fall of 2016. As the Authority continues to maintain and improve their system, the flow data collected as part of the LTCP will lose it relevance. To address this, the Authority will install permanent flow meters on the influent of each CSO structure that will be in place through the approval process of the LTCP and the development of the Act 537 plan update. While the flows are expected to change, it is not expected to change the outcome of the alternative analysis completed herein. The system improvements and small separation projects may have an impact on the size of the flow equalization tank and pumps in the pump stations which will reduce the construction cost benefiting the rate payers.

4.3 Financial Capability

A Financial Capability assessment was completed in accordance with the Combined Sewer Overflows – Guidance for Financial Capability Assessment and Schedule Development (EPA 832-B-97-004) and can be found in Appendix K.

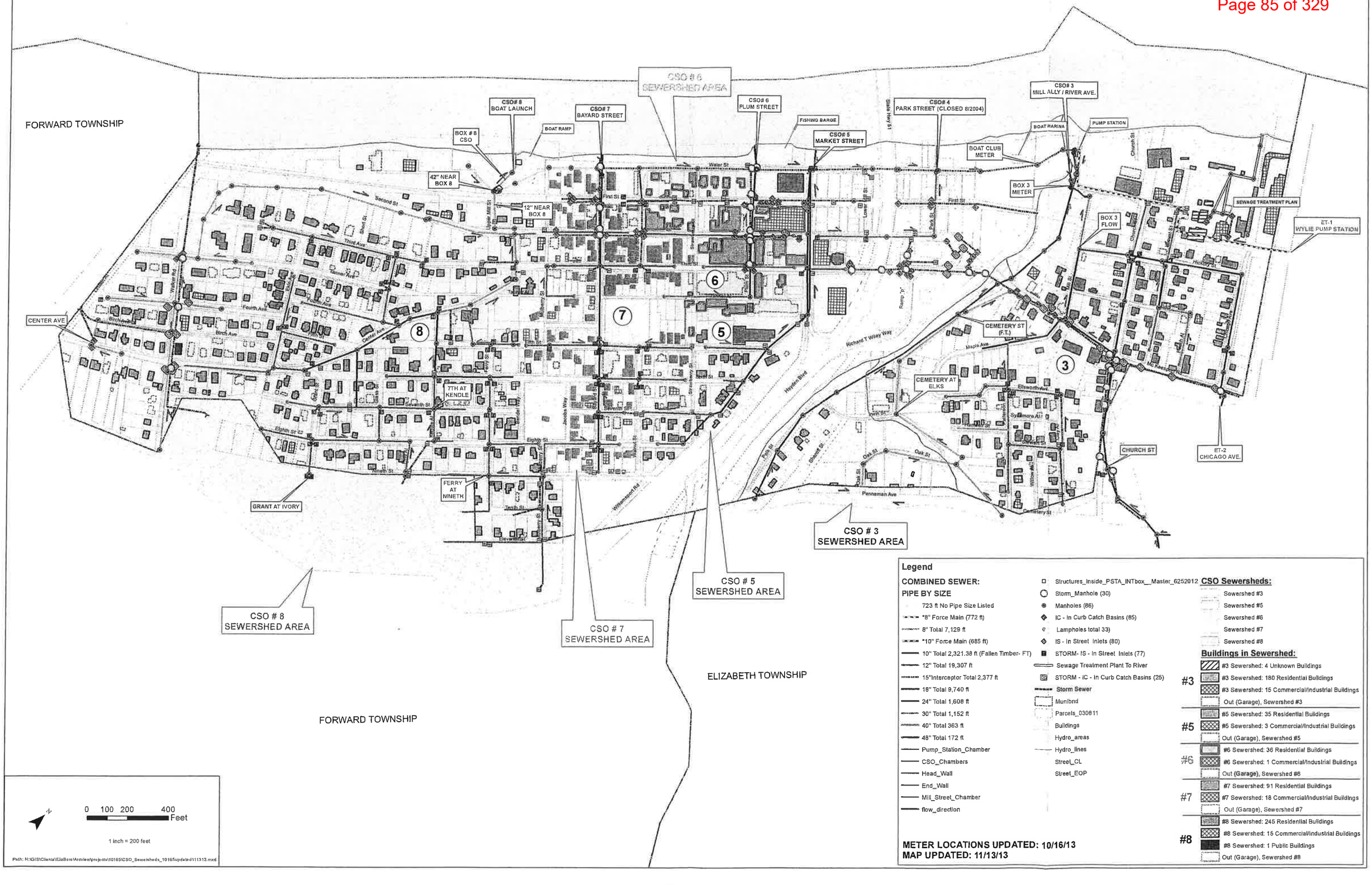
4.4 Implementation Schedule

The following is an implementation schedule for the major milestones of the project:

Table 4.1

Activity	Duration
Act 537 Plan Update	24 Months
Design	24 Months
Permitting	12 Months
Funding Acquisition	12 Months
Bidding	3 Months
Construction	36 Months
Total	9 Years, 3 Months

Appendix A



Legend

COMBINED SEWER:

PIPE BY SIZE

- 723 ft No Pipe Size Listed
- *8" Force Main (772 ft)
- 8" Total 7,129 ft
- *10" Force Main (685 ft)
- 10" Total 2,321.38 ft (Fallen Timber- FT)
- 12" Total 19,307 ft
- 15"Interceptor Total 2,377 ft
- 18" Total 9,740 ft
- 24" Total 1,608 ft
- 30" Total 1,152 ft
- 40" Total 363 ft
- 48" Total 172 ft
- Pump_Station_Chamber
- CSO_Chambers
- Head_Wall
- End_Wall
- Mill_Street_Chamber
- flow_direction

- Structures_Inside_PSTA_INTbox__Master_6252012
- Storm_Manhole (30)
- Manholes (86)
- IC - In Curb Catch Basins (85)
- Lampholes total 33)
- IS - In Street Inlets (80)
- STORM- IS - In Street Inlets (77)
- Sewage Treatment Plant To River
- STORM - IC - In Curb Catch Basins (25)
- Storm Sewer
- Municipal
- Parcels_030811
- Buildings
- Hydro_areas
- Hydro_lines
- Street_CL
- Street_EOP

CSO Sewersheds:

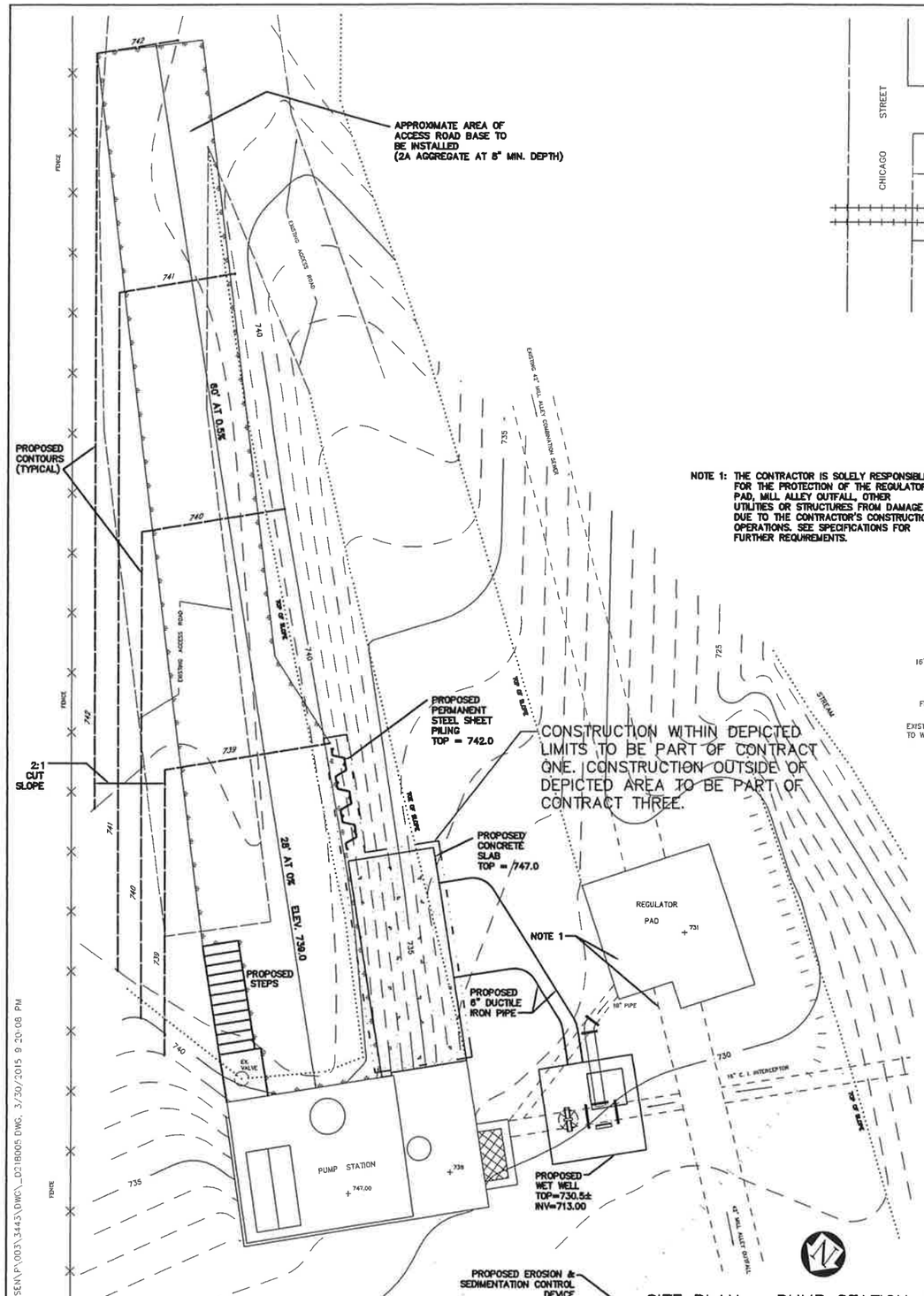
- Sewershed #3
- Sewershed #5
- Sewershed #6
- Sewershed #7
- Sewershed #8

Buildings in Sewershed:

- #3 Sewershed: 4 Unknown Buildings
- #3 Sewershed: 180 Residential Buildings
- #3 Sewershed: 15 Commercial/Industrial Buildings
- Out (Garage), Sewershed #3
- #5 Sewershed: 35 Residential Buildings
- #5 Sewershed: 3 Commercial/Industrial Buildings
- Out (Garage), Sewershed #5
- #6 Sewershed: 36 Residential Buildings
- #6 Sewershed: 1 Commercial/Industrial Buildings
- Out (Garage), Sewershed #6
- #7 Sewershed: 91 Residential Buildings
- #7 Sewershed: 18 Commercial/Industrial Buildings
- Out (Garage), Sewershed #7
- #8 Sewershed: 245 Residential Buildings
- #8 Sewershed: 15 Commercial/Industrial Buildings
- #8 Sewershed: 1 Public Buildings
- Out (Garage), Sewershed #8

METER LOCATIONS UPDATED: 10/16/13
MAP UPDATED: 11/13/13

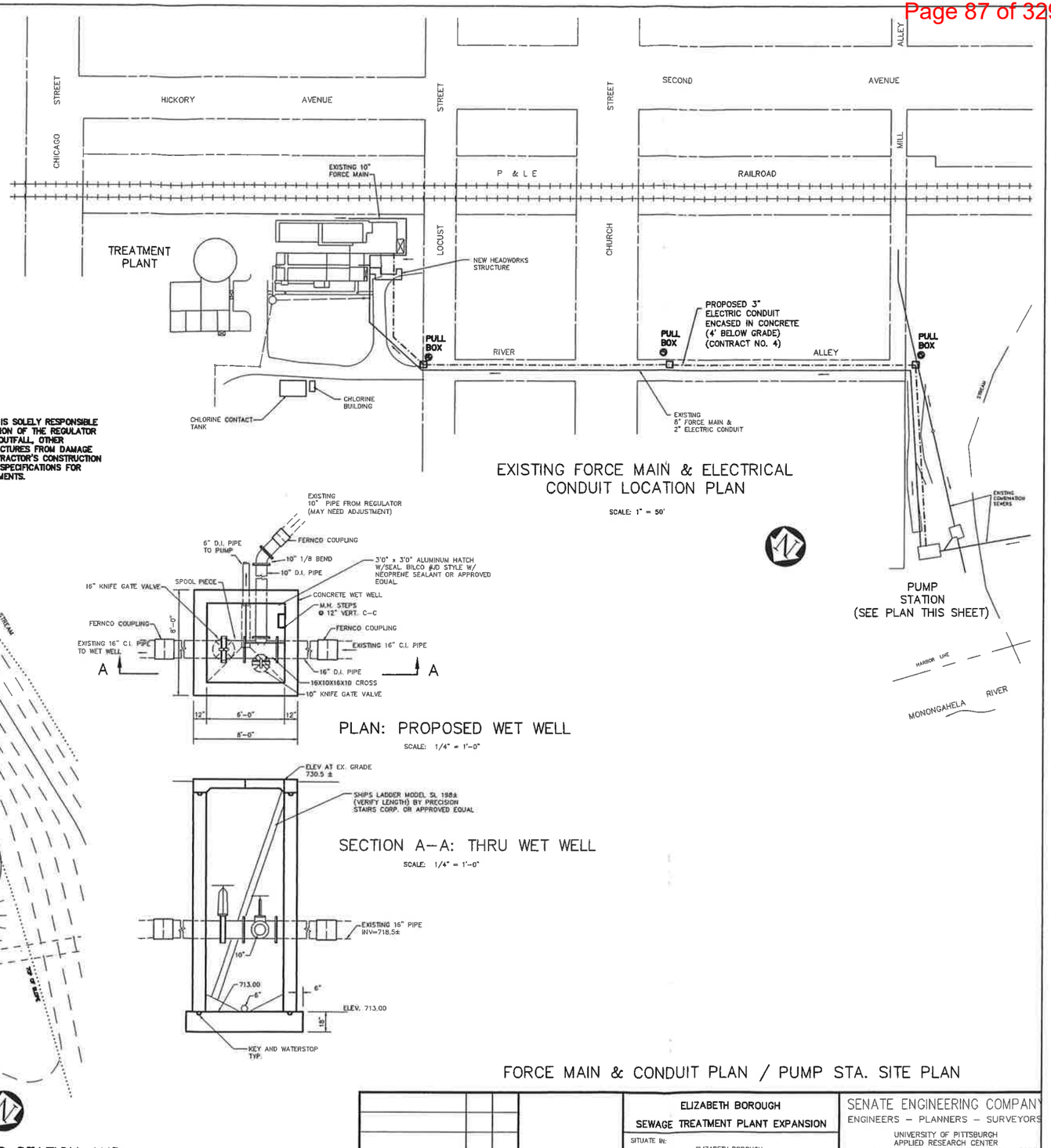
Appendix B



SITE PLAN – PUMP STATION AND EMERGENCY WET WELL CONSTRUCTION

SCALE: 1" = 5'

NOTE 1: THE CONTRACTOR IS SOLELY RESPONSIBLE FOR THE PROTECTION OF THE REGULATOR PAD, MILL ALLEY OUTFALL, OTHER UTILITIES OR STRUCTURES FROM DAMAGE DUE TO THE CONTRACTOR'S CONSTRUCTION OPERATIONS. SEE SPECIFICATIONS FOR FURTHER REQUIREMENTS.



EXISTING FORCE MAIN & ELECTRICAL CONDUIT LOCATION PLAN

SCALE: 1" = 50'

PLAN: PROPOSED WET WELL

SCALE: 1/4" = 1'-0"

SECTION A–A: THRU WET WELL

SCALE: 1/4" = 1'-0"

FORCE MAIN & CONDUIT PLAN / PUMP STA. SITE PLAN

REVISIONS	BY	DATE
ADD PULL BOXES	R.A.M.	04/17 91
BID SET	J.E.B.	03/22 91

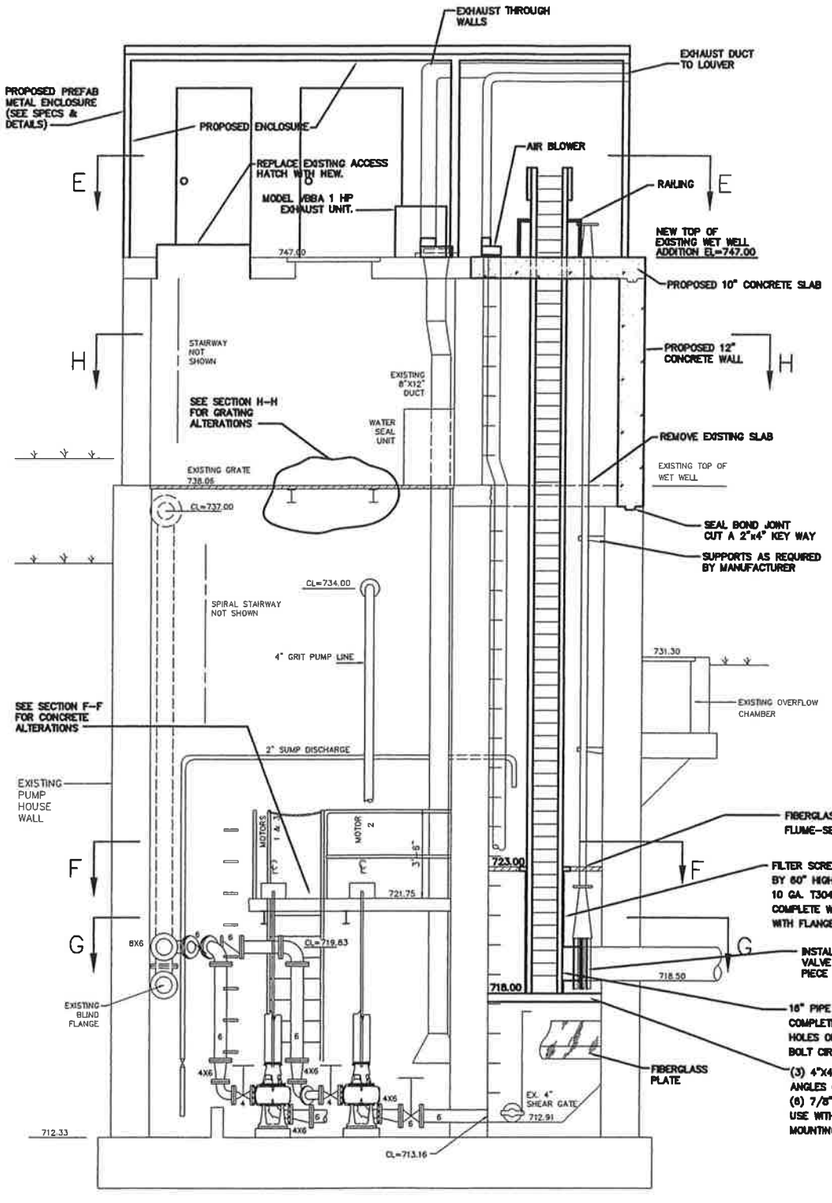
SEAL

ELIZABETH BOROUGH
SEWAGE TREATMENT PLANT EXPANSION
SITUATE IN: ELIZABETH BOROUGH, ALLEGHENY COUNTY, PA.
PREPARED FOR: ELIZABETH BOROUGH MUNICIPAL AUTHORITY

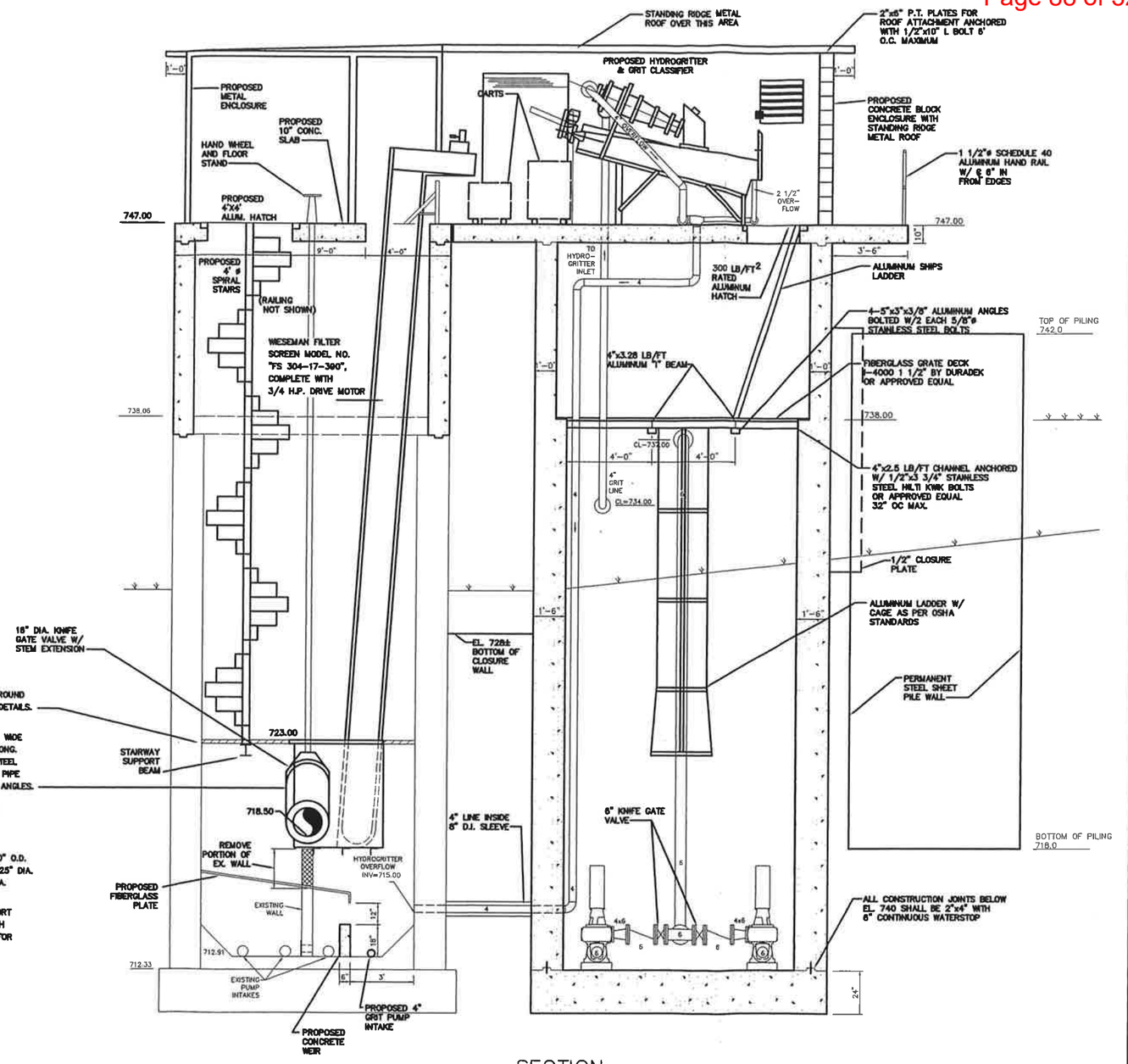
SENATE ENGINEERING COMPANY
ENGINEERS – PLANNERS – SURVEYORS
UNIVERSITY OF PITTSBURGH
APPLIED RESEARCH CENTER
420 WILLIAM PITT WAY, PITTSBURGH, PA. 15238
PHONE (412) 826-5454

DRAWN BY:	CHECKED BY:	DATE:	SCALE:
M.A.M.	V.V.D.	8/02/90	AS NOTED
JOB NUMBER: 1804	DRAWING NUMBER: D 2180 05		____ OF ____

H:\SEN\P\003\3443\DWG_D218005.DWG, 3/30/2015 9:20:08 PM



SECTION
A-A



SECTION
B-B

NOTE: FOR REINFORCEMENT, SEE DRAWINGS S-2 AND S-4

PUMP STATION - SECTIONS

			ELIZABETH BOROUGH SEWAGE TREATMENT PLANT EXPANSION	SENATE ENGINEERING COMPANY ENGINEERS - PLANNERS - SURVEYORS
			SITUATE IN: ELIZABETH BOROUGH, ALLEGHENY COUNTY, PA.	UNIVERSITY OF PITTSBURGH APPLIED RESEARCH CENTER 420 WILLIAM PITT WAY, PITTSBURGH, PA. 15238 PHONE (412) 826-5454
BID SET	J.E.B.	03/22/91	PREPARED FOR: ELIZABETH BOROUGH MUNICIPAL AUTHORITY	DRAWN BY: M.A.M. / CHECKED BY: V.V.D. / DATE: 8/02/90 / SCALE: 3/8" = 1'-0"
REVISIONS	BY	DATE	SEAL	JOB NUMBER: 1804 / DRAWING NUMBER: D 2180 04 / ____ OF ____

MONONGAHELA RIVER

UPPER MILL STREET CSO
NPDES OUTFALL #8

NORMAL WATER LINE

SILT FENCE

OPEN CHANNEL
w/RIP-RAP

EXISTING REGULATOR TO BE
USED AS ENDWALL

EXISTING INTERCEPTOR TO BE REMOVED
AFTER NEW INTERCEPTOR IS PLACED
IN OPERATION.

4" (4'ø)

AVATE AT CLEANOUT LOCATION
VERT. M.H. DEPTH SHALL BE ADJUSTED

CONSTRUCTION
ENTRANCE
20'
50'

CONCRETE RAMP

STA 15 EL 727.39

BRM EL 730.45

PROPOSED (6'ø)
MANHOLE UM-1
INV.=726.35

OUTFALL

BITUMINOUS PARKING

PROPOSED UPPER MILL STREET REGULATOR
(SEE SHEETS 15 & 16)

SEE SHEET 4

PROPOSED MANHOLE "K"
STATION 25+77.62
INV. 731.29

100 YR FLOOD LINE

BERLYN & KATHERINE LEWIS
280
LS-005/3

15" PVC 78 LF

STA 6 EL 738.40

CRF EL 752.06

SILT FENCE

6" PVC

EXISTING
MANHOLE 4
STA. 0+00

PROPOSED
GRIT TRAP
SHT.NO.29

15" PVC
35 LF

TREES

GAS TEST BOX & VENT STA 5 750.76

MH. L-1
T.C.=751.00
INV.=737.77

PK EL 752.69

MH. L
T.C.=751.00
INV.=731.50

STA 100 EL 752.26

PROPOSED MH "L-1" (4'ø)
STATION 28+70.62
INV. 731.50

PROPOSED MH "L" (4'ø)
STATION 28+42.62
INV. 731.50

STA 1 EL 751.29

BUILDING

EXISTING INTERCEPTOR TO BE REMOVED
AFTER NEW INTERCEPTOR IS PLACED
IN OPERATION. (EXCEPT UNDER PARK ST.)

EXISTING REGULATOR
TO BE USED AS END-WALL
(SEE SHEETS 15 & 16)

BAYNARD STREET CSO
NPDES OUTFALL #7

SILT FENCE

OPEN CHANNEL
w/RIP-RAP

NORMAL WATER LINE

STA 7 EL 722.15

M.H. I (4'ø)
STATION 23+17.62
INV. EL. 730.56

PROPOSED M.H. (4'ø) B-2

MH. B-2
T.C.=752.50
INV.=730.90

SEE SHEET 4

PROPOSED MANHOLE "O" (4'ø)
STATION 24+57.62

PLUG EXISTING SEWER TO EXISTING INTERCEPTOR

MH. O
T.C.=751.50
INV.=731.14

100 YR FLOOD LINE

SILT FENCE

FLAGPOLE

15" PVC 255 LF

8" PVC

152.5' 6" LATERAL

MH. I
T.C.=751.50
INV.=730.52

8" PVC

23 LF

2 TPOLE NOP 4506795

TPOLE

272 LF 6" LATERAL

SHED

PROPOSED MANHOLE "O" (4'ø)
STATION 2+57.99

STEVE & ANNA
MACKINACK
297
LS-021/3

BAYARD ST.
REGULATOR
(SEE SHTS.
17 & 18)

PROPOSED PAVING

BUILDING

BERLYN & KATHERINE LEWIS
284
LS-004/3

HOUSE # 516

MARK & DONNA GRESCZUK
289
LS-003/3

HOUSE # 515

HOUSE # 508

ELVERTA LYNN WINKELVOSS
293
LS-018

THE HELEN KOBIL
TRUST
299
LS-002/3

HOUSE # 504

STEVE & ANNA
MACKINACK
298
LS-001/3

2 TPOLE BTC 1871

CRF EL 751.64

CONCRETE WALL

MON EL 753.35

CRF EL 753.11

RR SPIKE EL 753.55

BIT. PAVEMENT

STA 17 EL 752.13

PK EL 752.40

STA 2 EL 752.42

BUILDING

14 PROFILE SHEET NUMBER

PA. ONE CALL NO. 2120937

GRAPHIC SCALE

(IN FEET)
1 inch = 20 ft.

REVISIONS	BY	DATE
AS-BUILT ELEVATION	GJZ	10/17 2002
RELOCATED BORE PIT @ 'L' ADDED CASING @ 'L' TO 'L1' 'J' TO 'I'	FJP	3/00
GENERAL REVISION	FJP	2/00

STAL

INTERCEPTOR SEWER RELOCATION
PLAN VIEW
FIRST AVENUE & BAYARD STREET

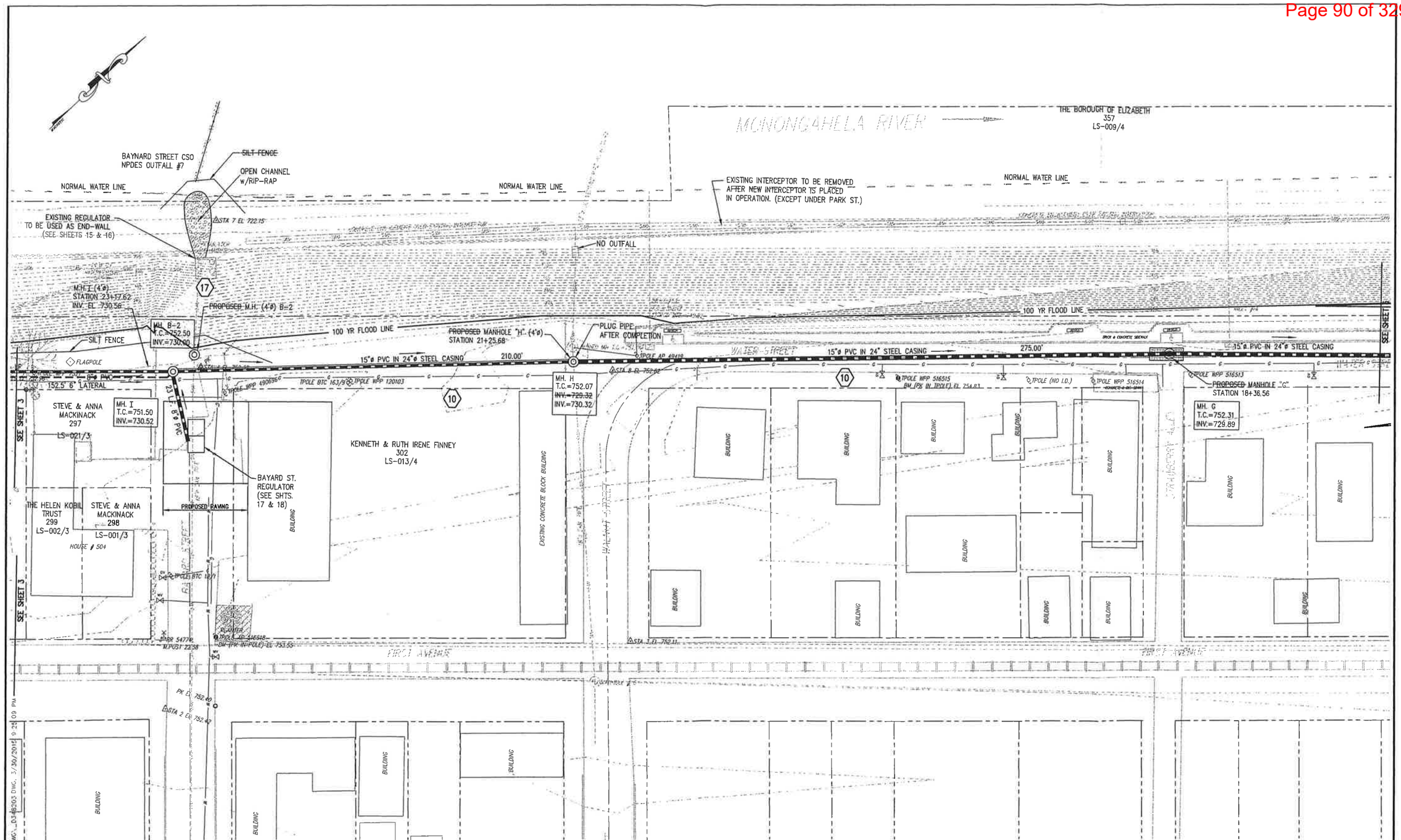
SITUATE IN:
BOROUGH OF ELIZABETH
ALLEGHENY COUNTY, PA

PREPARED FOR:
ELIZABETH BOROUGH MUNICIPAL AUTHORITY

SENATE ENGINEERING COMPANY
ENGINEERS – PLANNERS – SURVEYORS
UNIVERSITY OF PITTSBURGH
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420 WILLIAM PITT WAY, PITTSBURGH, PA. 15238-1330
PHONE (412) 826-5454
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DESIGN BY: D.E.R.	DRAWN BY: R.L.B./F.J.P.	CHECKED BY: V.V.D.
DATE: 09-30-1998	SCALE: AS SHOWN	SHEET 3 OF
JOB NUMBER 3443.01.08	DRAWING NUMBER D 3443 02	

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14 PROFILE SHEET NUMBER

PA. ONE CALL NO. 2120937

GRAPHIC SCALE

20 0 10 20 40 60

(IN FEET)
1 inch = 20 ft

REVISIONS	BY	DATE
AS-BUILT ELEVATION	GJI	10/17 2002
GENERAL REVISION	FJP	2/00

SEAL

INTERCEPTOR SEWER RELOCATION
PLAN VIEW
WATER STREET

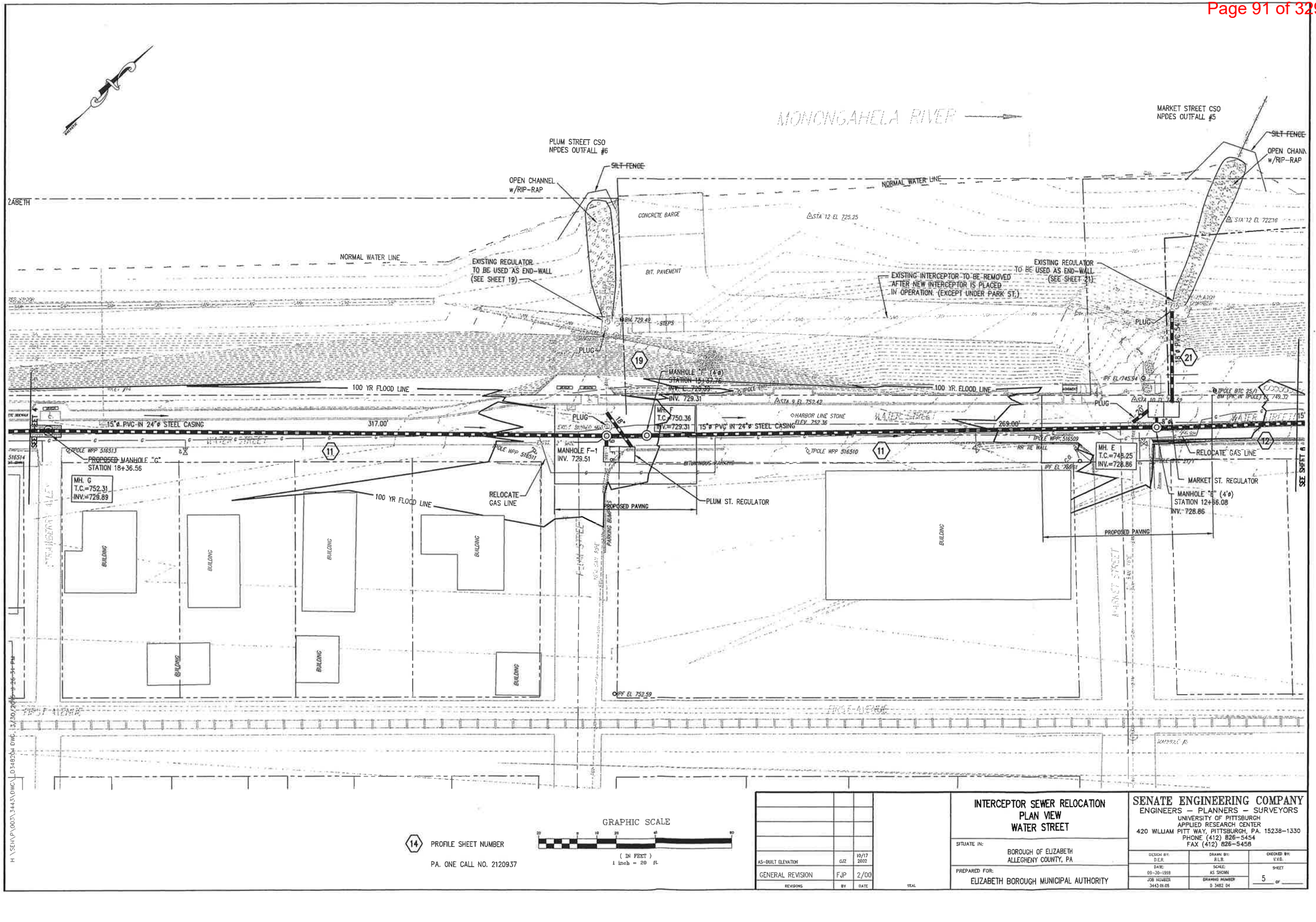
SITUATE IN:
BOROUGH OF ELIZABETH
ALLEGHENY COUNTY, PA

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FAX (412) 826-5458

DESIGN BY: D.E.R.	DRAWN BY: R.L.B.	CHECKED BY: V.V.D.
DATE: 05-30-1998	SCALE: AS SHOWN	SHEET 4 OF
JOB NUMBER 3443.01.05	DRAWING NUMBER D 3462 03	

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14 PROFILE SHEET NUMBER

PA. ONE CALL NO. 2120937

GRAPHIC SCALE

(IN FEET)
1 inch = 20 ft

REVISIONS	BY	DATE
AS-BUILT ELEVATION	GJZ	10/17 2002
GENERAL REVISION	FJP	2/00

SEAL

INTERCEPTOR SEWER RELOCATION
PLAN VIEW
WATER STREET

SITUATE IN:
BOROUGH OF ELIZABETH
ALLEGHENY COUNTY, PA

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FAX (412) 826-5456

DESIGN BY: D.E.R.	DRAWN BY: R.L.B.	CHECKED BY: V.V.B.
DATE: 09-30-1998	SCALE: AS SHOWN	SHEET 5 OF
JOB NUMBER 3443.09.05	DRAWING NUMBER D 3482 04	

MONONGAHELA RIVER

MONONGAHELA RIVER

PARK STREET CSO
NPDES OUTFALL #4

DOCK

SILT FENCE
OPEN CHANNEL
w/RIP-RAP

SILT FENCE
OPEN CHANNEL
w/RIP-RAP

NORMAL WATER LINE

NORMAL WATER LINE

MARGARET &
LEONARD BAILEY, JR.
LS-019/6

EXISTING REGULATOR
TO BE USED AS END-WALL
(SEE SHEET 23)

23

JOHN W. & ANNE HARDING GRIFFITHS
335
LS-010/5

100 YR FLOOD LINE

100 YR FLOOD LINE

PIER

PIER

2-TPOLE WPP 25/A

2-TPOLE WPP 108971

2-TPOLE WPP 108970

GRAVEL DRIVE

GRAVEL DRIVE

ASPHALT AND GRAVEL PARKING

MH. C-1
INV.=728.31

12

15"ø PVC IN 24"ø STEEL CASING

290.00'

350.00'

15"ø PVC IN 30" STEEL CASING

STA 19 EL 751.55

LEONARD R. BAILEY
365
LS-011/6

2-TPOLE WPP 13134

END OF BORED SEWER
STA. 6+29.92

HOUSES
#227 & #229

SILT FENCE

GRAVEL DRIVE

PAD

STA 18 EL 753.63

2-TPOLE WPP 254164

15"ø

13

SEE SHEET 7

SEE SHEET 6

12

2-TPOLE WPP 521688

BM (FK IN TPOLE) EL 753.36

MH. D
T.C.=748.25
INV.=728.41

PROPOSED MANHOLE "D" (4'ø)
STATION 9+76.94
INV.=728.41

PIER

GRAVEL DRIVE

MH. C-2
INV.=728.23

2-TPOLE WPP 71258

2-TPOLE BTC 25/S

BIT. PARKING

2-TPOLE WPP 716527

2-TPOLE WPP 716526

2-TPOLE WPP 716525

2-TPOLE (NO I.D.)

MH. C
T.C.=753.31
INV.=727.98

PROPOSED MANHOLE "C" (4'ø)
STATION 6+29.92

CONCRETE PAD

PROPOSED PAVING

BUILDING

BUILDING

BUILD

PARK STREET CSO
NPDES OUTFALL #4

MONONGAHELA RIVER

DOCK

~~SILT FENCE~~
OPEN CHANNEL
w/RIP-RAP

NORMAL WATER LINE

MARGARET &
LEONARD BAILEY, JR
LS-019/6

EXISTING REGULATOR
TO BE USED AS END-WALL
(SEE SHEET 23)

23

CONCRETE WALL

EXISTING INTERCEPTOR TO BE REMOVED
AFTER NEW INTERCEPTOR IS PLACED
IN OPERATION.

SEE SHEET 8

STA 19 EL 751.55

LEONARD R. BAILEY
365
LS-011/6

8"POLE WPP 13134

END OF BORED SEWER
STA. 6+29.92

HOUSES
#227 & #229

SILT FENCE

GRAVEL DRIVE

8"POLE WPP (NO I.D.)

SEE SHEET 6

STA 18 EL 753.03

8"POLE WPP 254164

8"POLE WPP 718664 W/UG

CONSTRUCTION
ENTRANCE

50'

SHED

SHED

BOATING CLUB

8"POLE WPP 786599

BITUMINOUS
PARKING

MH. B
T.C.=751.50
INV.=727.73

13

254.00'

MH. A
T.C.=738.53
INV.=727.24

148.00'

15"ø PVC

8"POLE WPP 11773

8"POLE WPP 254164
BM (PK IN 1POLE) EL 737.30

~~PROPOSED~~ MANHOLE "A" (4'ø)
STATION 1+48.08 INV. EL. 726.20

STA 25 EL 736.80

8"POLE WPP 315874

WATER STREET 191.00' ASTA 20 EL 751.63

8"POLE WPP 716527

8"POLE WPP 716526

8"POLE WPP 716525

8"POLE (NO I.D.)

8"POLE WPP 521691 EL 753.74
BM (PK IN 1POLE)

GRAVEL
PARKING

CONCRETE PAD

MH. C
T.C.=753.31
INV.=727.98

~~PROPOSED~~ MANHOLE "C" (4'ø)
STATION 6+29.92

BUILDING

BUILDING

BUILDING

BUILDING

BUILDING

GRAVEL PARKING

ELIZABETH BOAT CLUB OF ELIZABETH, PA.
349
LS-014/7

~~PROPOSED~~ MANHOLE "B" (4'ø)
STATION 5+09.16

PROPOSED PAVING

BUILDING

BUILDING

CONCRETE WALL

CONCRETE WALL

STA 21 EL 750.60

STA 26 EL 749.89

HUB EL 751.22

100 YR FLOOD LINE

14 PROFILE SHEET NUMBER

PA. ONE CALL NO. 2120937

GRAPHIC SCALE
(IN FEET)
1 inch = 20 ft.

REVISIONS	BY	DATE
AS-BUILT ELEVATION	GJZ	10/17 2002
GENERAL REVISION	FJP	2/00

SEAL

INTERCEPTOR SEWER RELOCATION
PLAN VIEW
WATER STREET TO BOAT CLUB

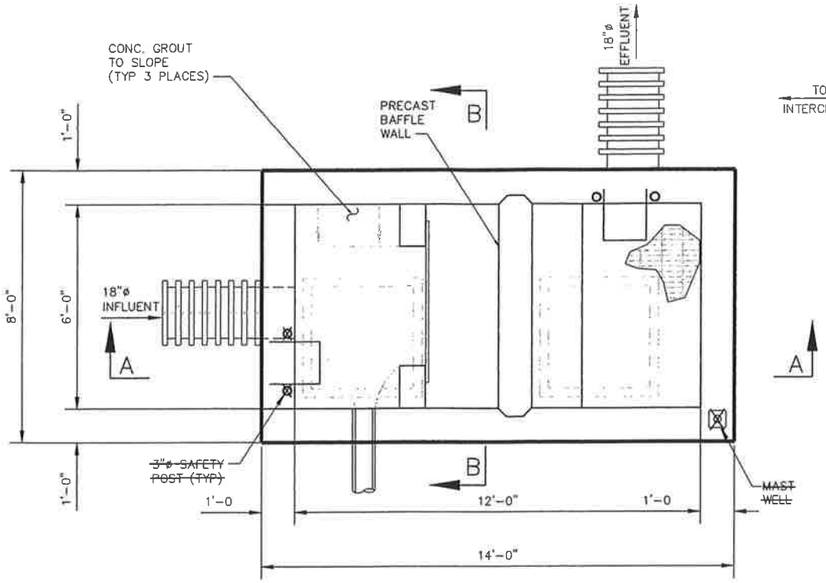
SITUATE IN:
BOROUGH OF ELIZABETH
ALLEGHENY COUNTY, PA

PREPARED FOR:
ELIZABETH BOROUGH MUNICIPAL AUTHORITY

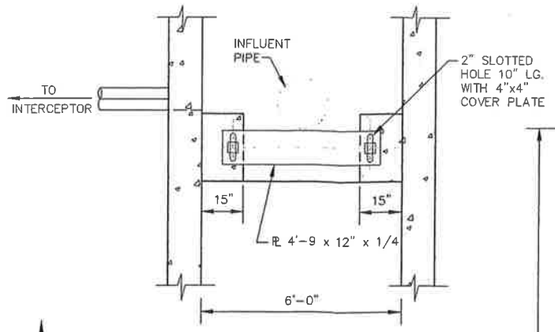
SENATE ENGINEERING COMPANY
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PHONE (412) 826-5454
FAX (412) 826-5458

DESIGN BY:	DRAWN BY:	CHECKED BY:
D.E.R.	R.L.B.	V.V.D.
DATE:	SCALE:	SHEET
09-30-1998	AS SHOWN	7 OF
JOB NUMBER	DRAWING NUMBER	
3443.01.08	D 3482 06	

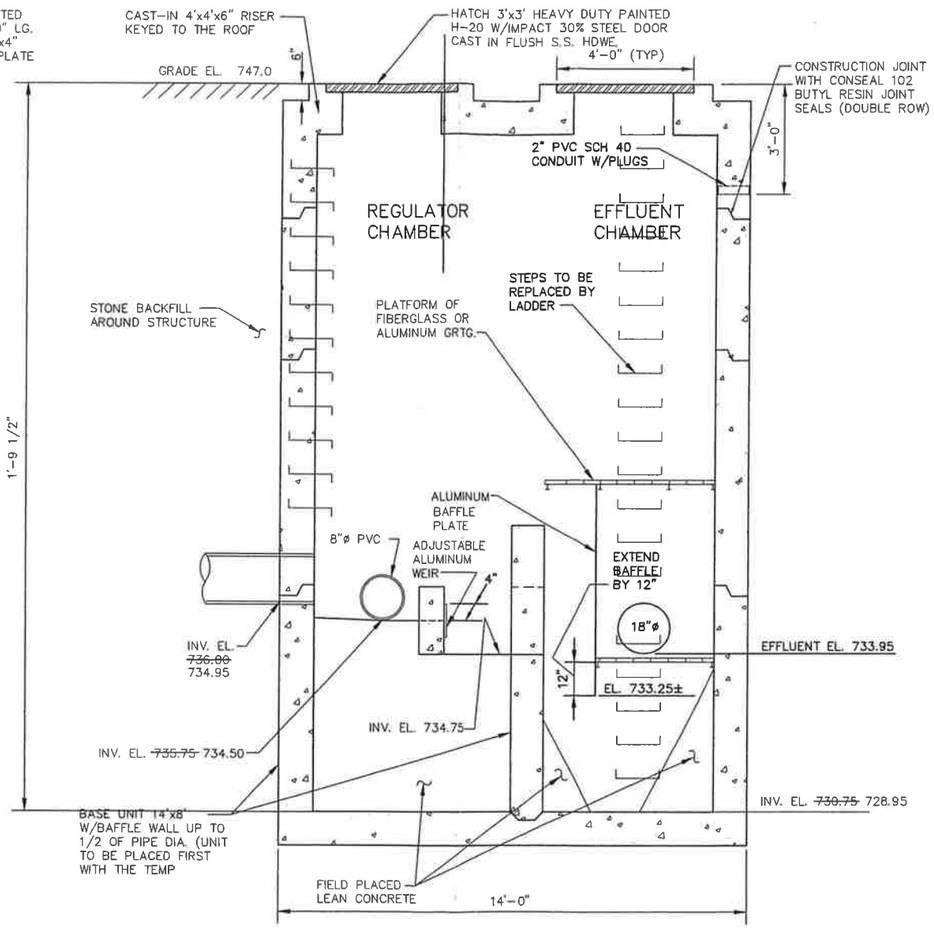
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PLAN

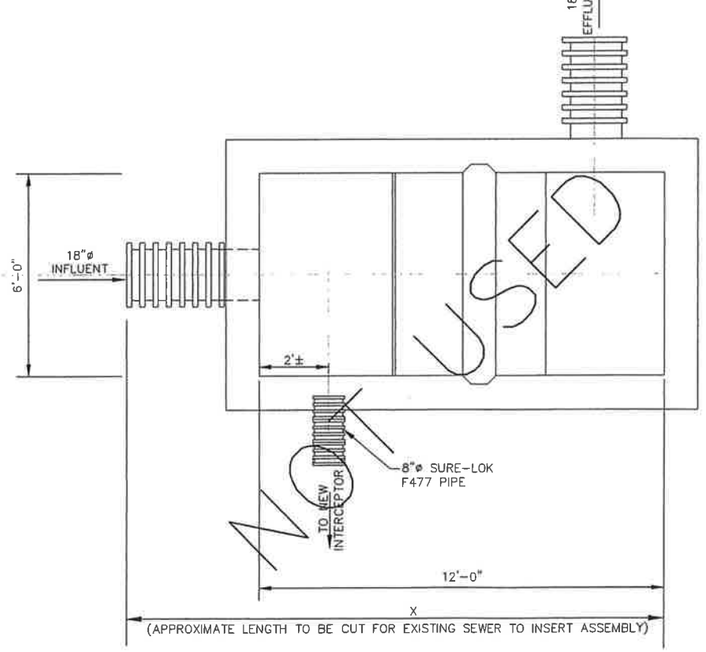


SECTION B-B



NOTE:
THE ADJUSTABLE WEIR IS CURRENTLY SET AT 4" ABOVE EFFLUENT ELEVATION.

SECTION A-A



PLAN FOR PIPE ASSEMBLY TO MAINTAIN CURRENT FLOW
DURING THE CONSTRUCTION OF THE REGULATOR STRUCTURE

PA. ONE CALL NO. 2120937

REVISIONS	BY	DATE
AS-BUILT ELEVATION	GJZ	10/17 2002

SEAL

INTERCEPTOR SEWER RELOCATION
MARKET ST REGULATOR CHAMBER
PLAN & SECTIONS

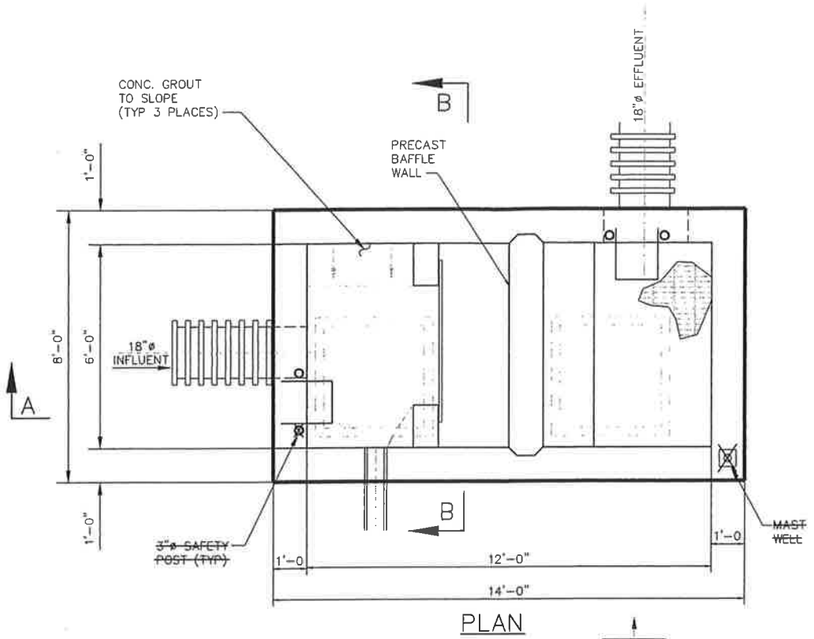
SITUATE IN:
BOROUGH OF ELIZABETH
ALLEGHENY, COUNTY

PREPARED FOR:
ELIZABETH BOROUGH MUNICIPAL AUTHORITY

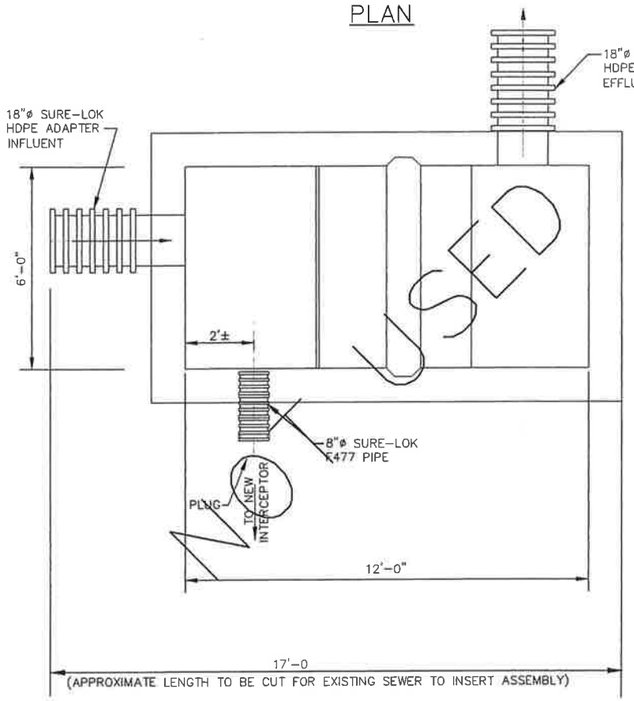
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APPLIED RESEARCH CENTER
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PHONE (412) 826-5454
FAX (412) 826-5458

DESIGN BY: V.V.D.	DRAWN BY: F.J.P.	CHECKED BY: W.S.M.
DATE: 5/3/99	SCALE: 1/2" = 1'-0	SHEET 22 OF
JOB NUMBER 3443.01.08	DRAWING NUMBER D 3482 42	

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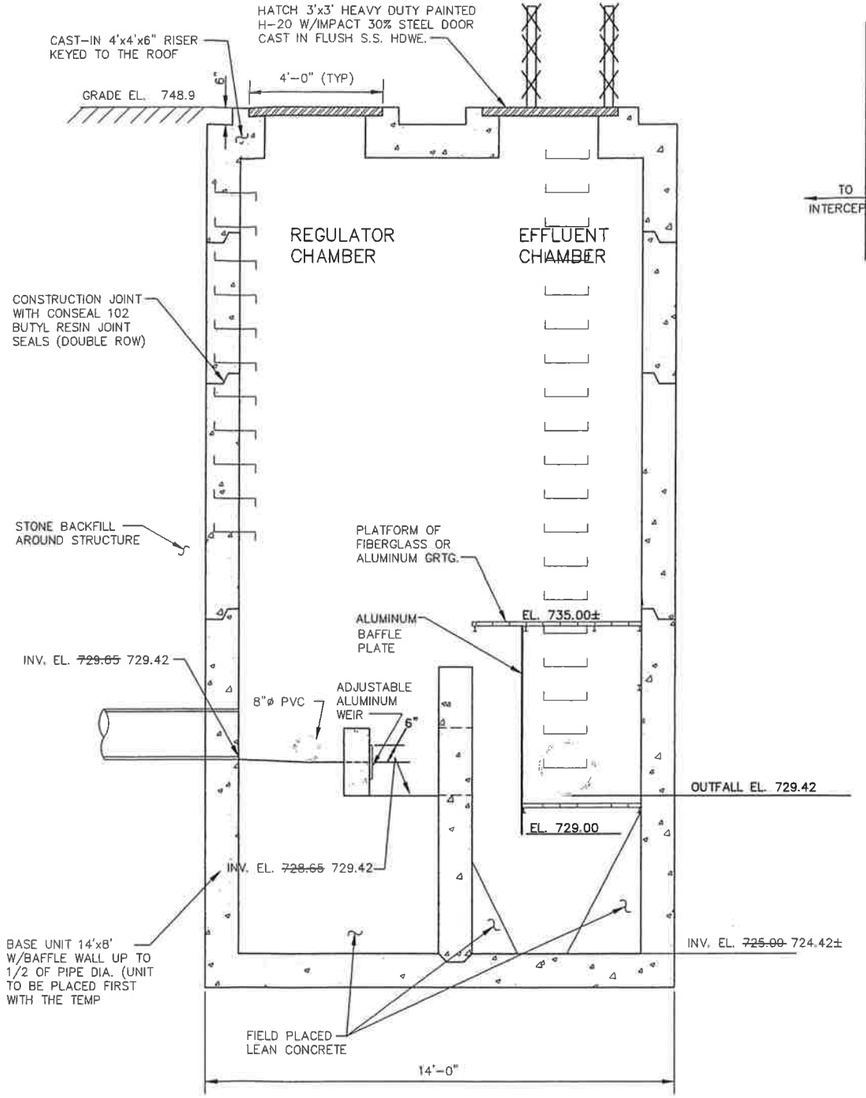


PLAN

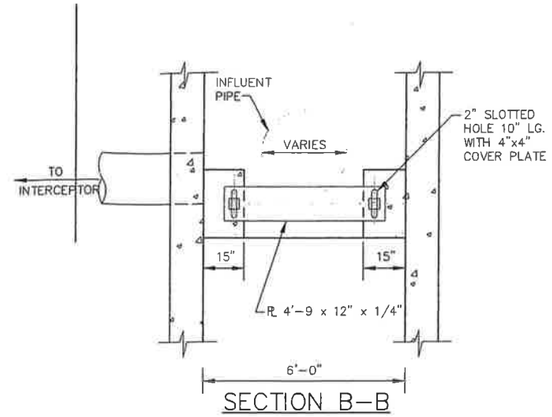


PLAN FOR PIPE ASSEMBLY TO MAINTAIN CURRENT FLOW DURING THE CONSTRUCTION OF THE REGULATOR STRUCTURE

(NOT USED)



SECTION A-A



SECTION B-B

NOTE:
THE ADJUSTABLE WEIR IS CURRENTLY SET AT 6" ABOVE EFFLUENT ELEVATION.

PA. ONE CALL NO. 2120937

AS-BUILT ELEVATION	G.Z.	10/17 2002
REVISIONS	BY	DATE

SEAL

INTERCEPTOR SEWER RELOCATION
PLUM ST REGULATOR CHAMBER
PLAN & SECTIONS

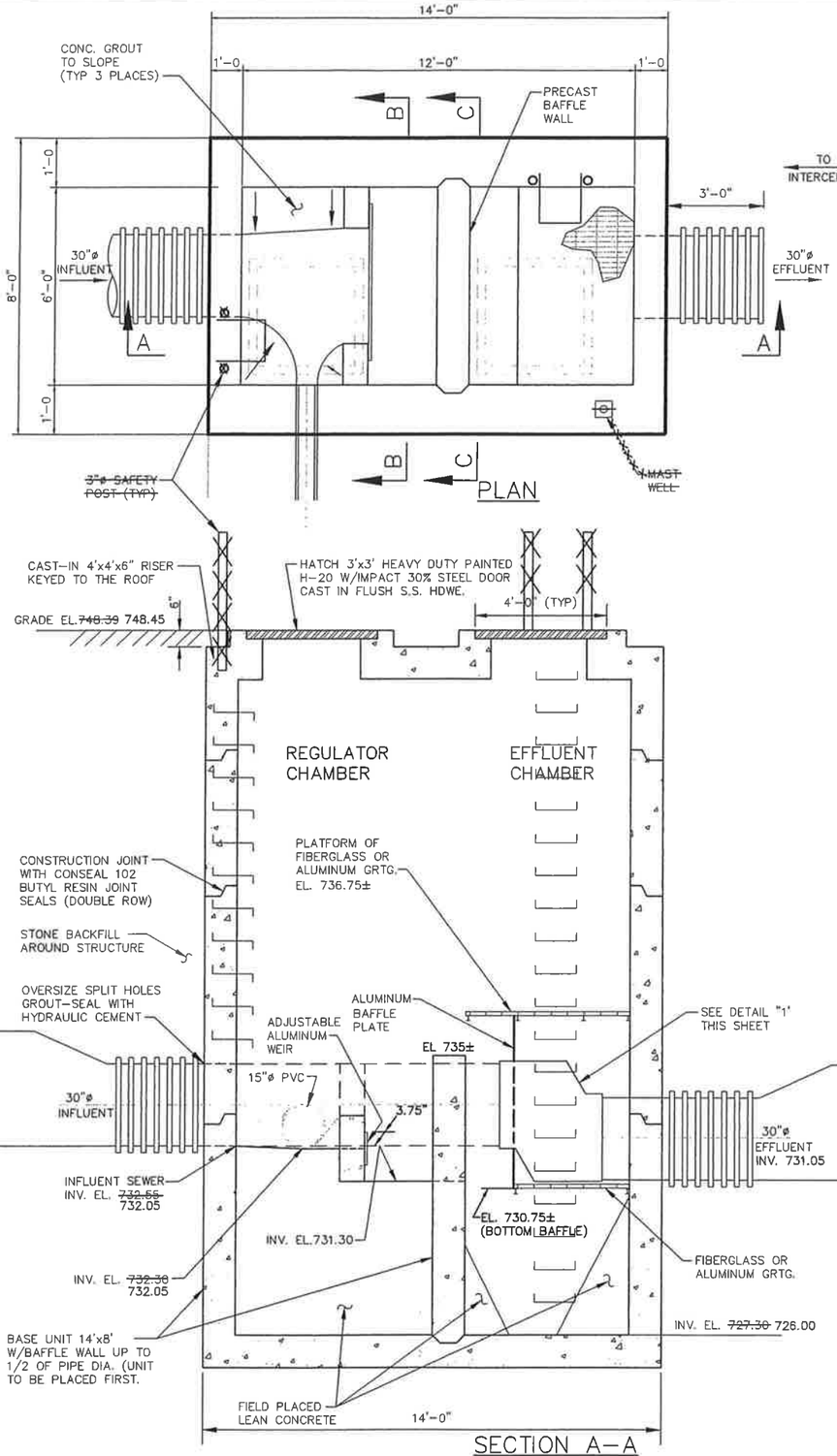
SITUATE IN:
BOROUGH OF ELIZABETH
ALLEGHENY, COUNTY

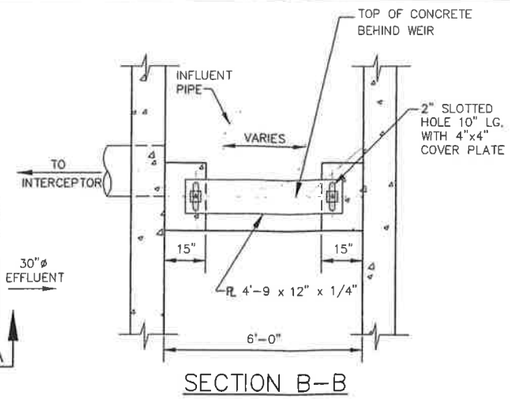
PREPARED FOR:
ELIZABETH BOROUGH MUNICIPAL AUTHORITY

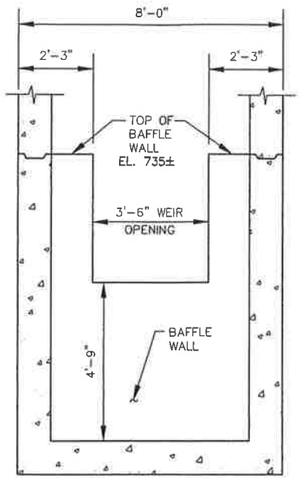
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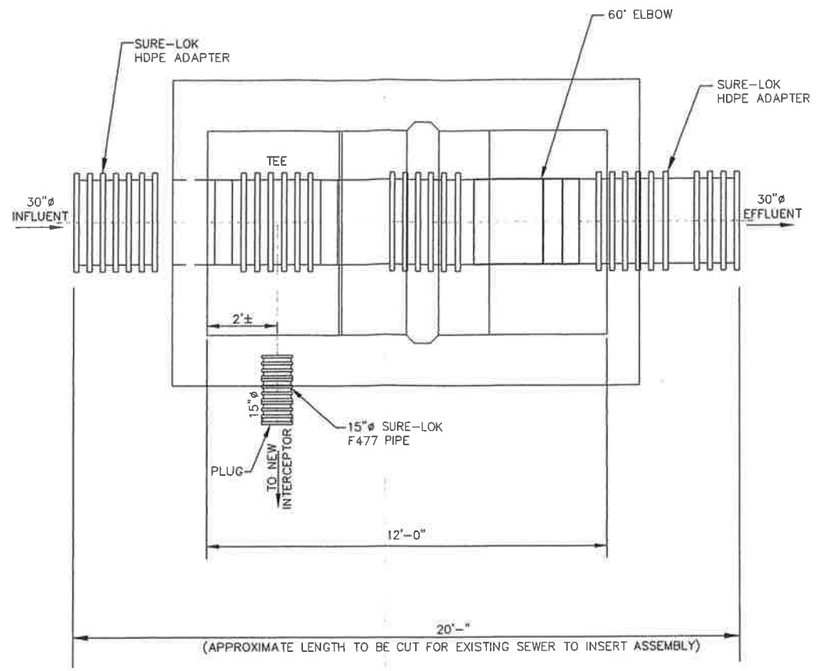
DESIGN BY: V.V.D.	DRAWN BY: F.J.P.	CHECKED BY: W.S.M.
DATE: 5/3/05	SCALE: 1/2" = 1'-0	SHEET 20 OF ____
JOB NUMBER 3443.01.08	DRAWING NUMBER D 3482 41	

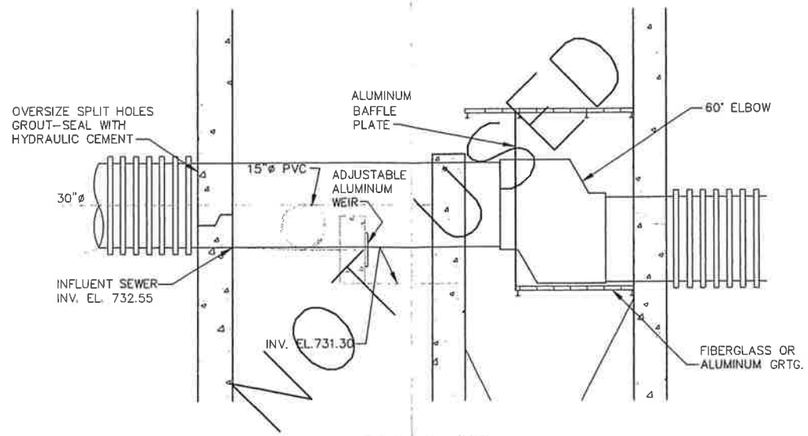
H:\SEN\P\003\3443\DWG_D3482A1.DWG, 3/31/2015 10:56:56 AM











DETAIL "1"
INTERIM PIPE ASSEMBLY (NOT USED)

NOTE:
THE ADJUSTABLE OVERFOLW WEIR IS SET AT 3.75" ABOVE EFFLUENT ELEV.

PA. ONE CALL NO. 2120937

REVISIONS	BY	DATE
AS-BUILT ELEVATION	GJZ	10/17 2002

SEAL

INTERCEPTOR SEWER RELOCATION
UPPER MILL ST REGULATOR CHAMBER
PLAN & SECTIONS

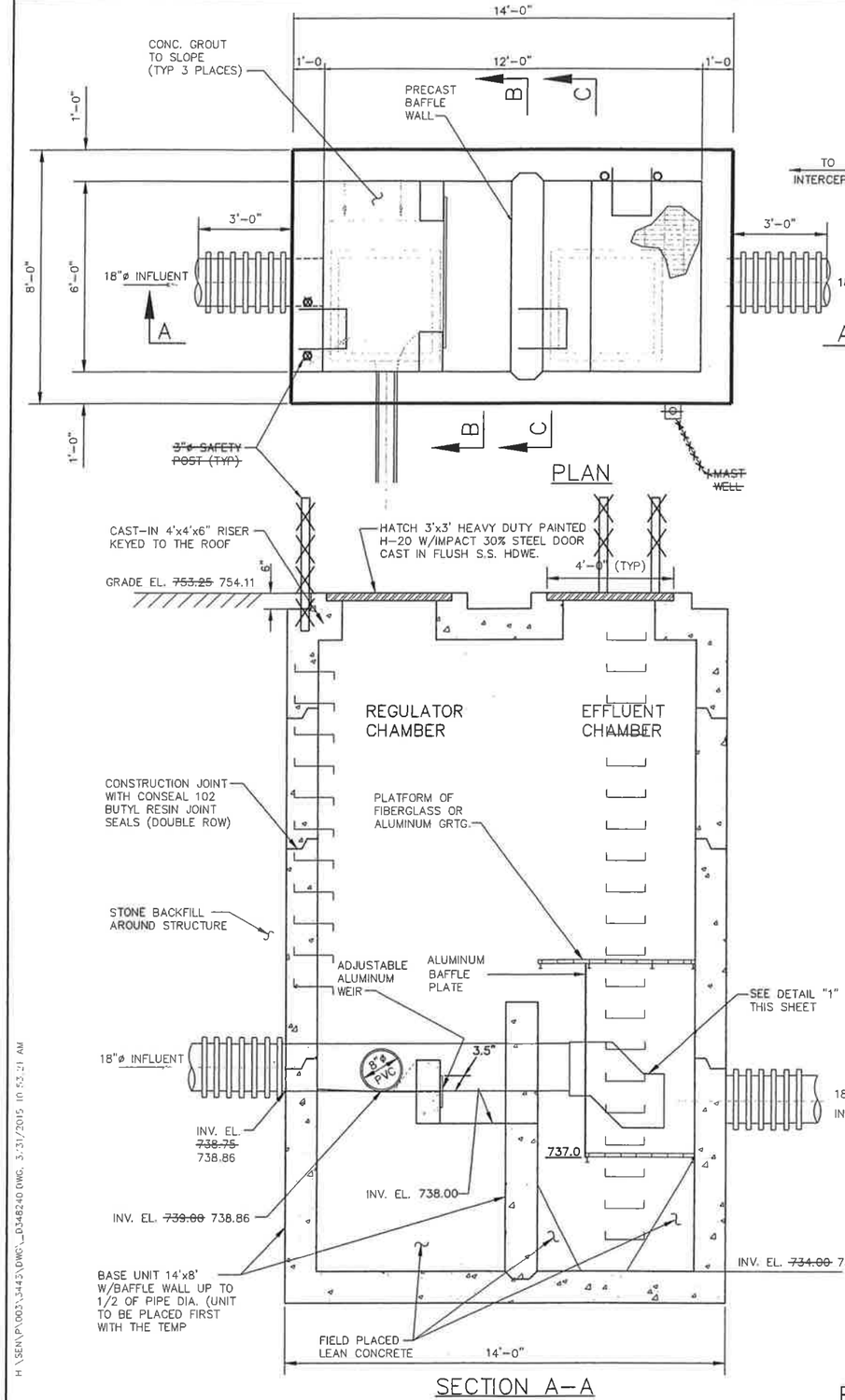
SITUATE IN:
BOROUGH OF ELIZABETH
ALLEGHENY, COUNTY

PREPARED FOR:
ELIZABETH BOROUGH MUNICIPAL AUTHORITY

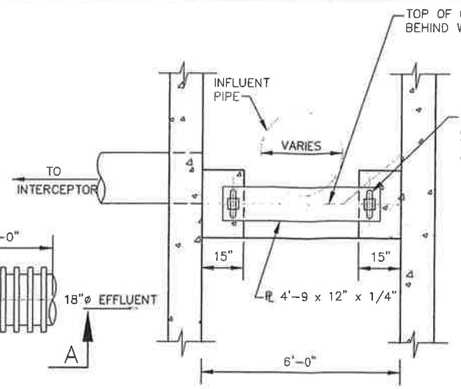
SENATE ENGINEERING COMPANY
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PHONE (412) 826-5454
FAX (412) 826-5458

DESIGN BY: V.V.D.	DRAWN BY: F.J.P.	CHECKED BY: W.S.M.
DATE: 5/3/99	SCALE: 1/2" = 1'-0	SHEET 16 OF
JOB NUMBER 3443.01.08	DRAWING NUMBER D 3482.37	

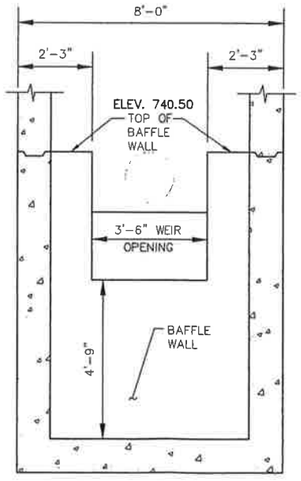
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SECTION A-A

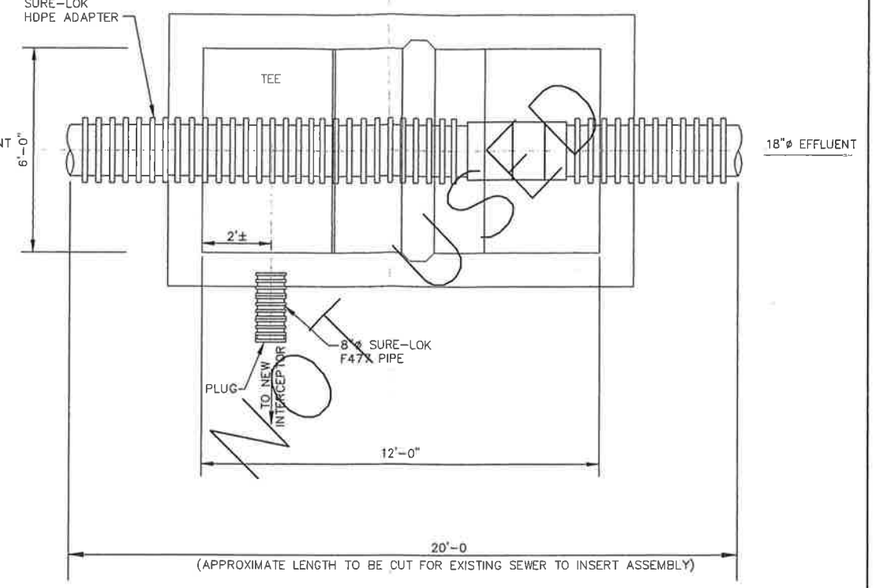


SECTION B-B

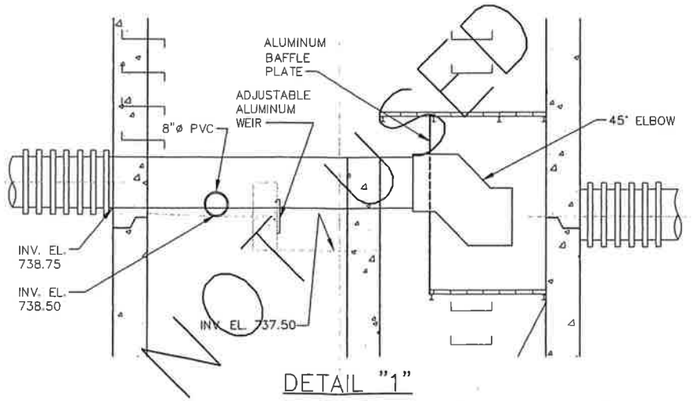


SECTION C-C

NOTE:
THE ADJUSTABLE WEIR IS SET AT 3.5" ABOVE THE EFFLUENT ELEVATION.



PLAN FOR PIPE ASSEMBLY TO MAINTAIN CURRENT FLOW
DURING THE CONSTRUCTION OF THE REGULATOR STRUCTURE



DETAIL "1"
INTERIM PIPE ASSEMBLY (NOT USED)

PA. ONE CALL NO. 2120937

REVISIONS	BY	DATE
AS-BUILT ELEVATION	GJZ	10/17 2002

SEAL

INTERCEPTOR SEWER RELOCATION
BAYARD ST REGULATOR CHAMBER
PLAN & SECTIONS

SITUATE IN:
BOROUGH OF ELIZABETH
ALLEGHENY, COUNTY

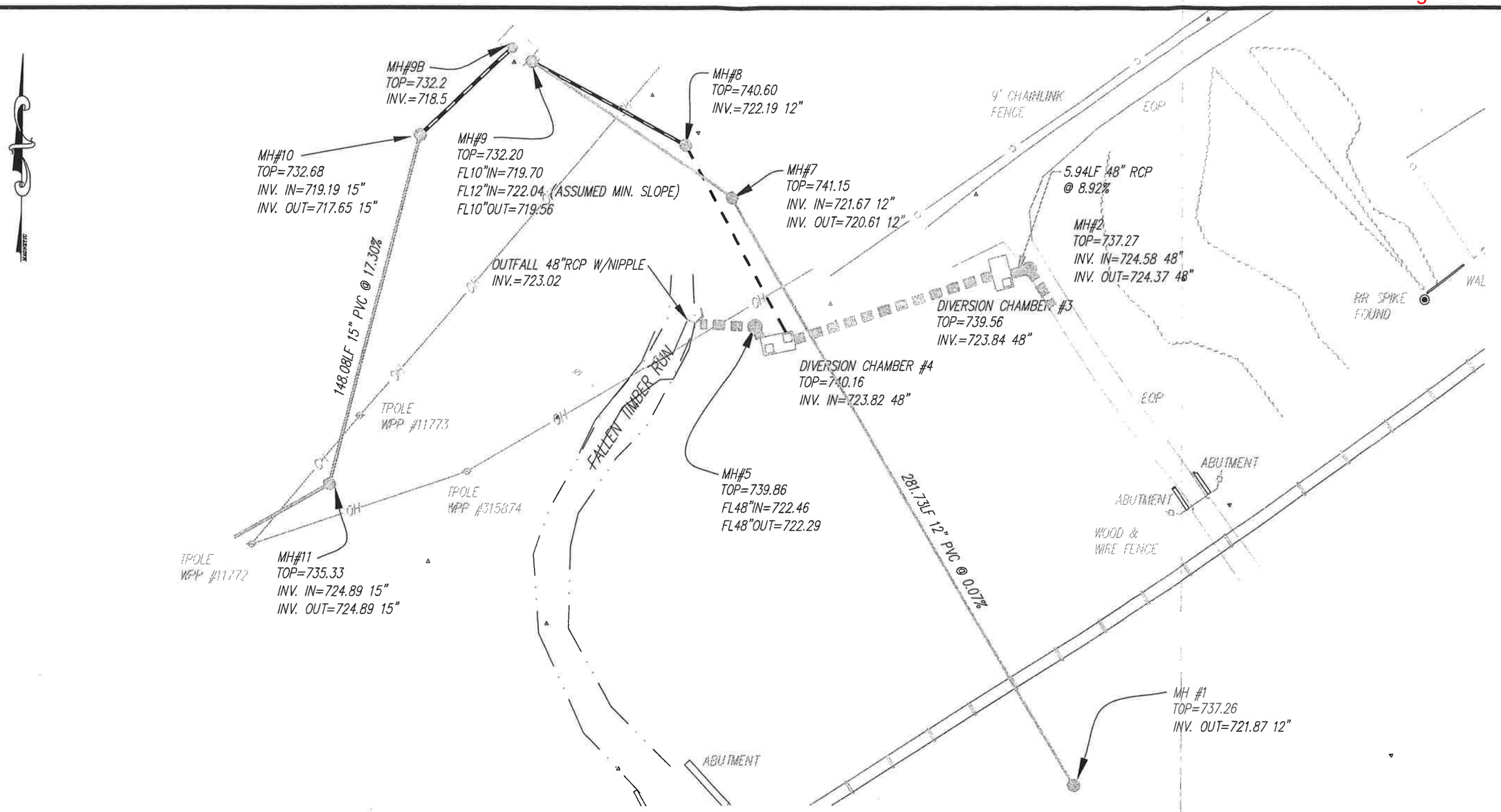
PREPARED FOR:
ELIZABETH BOROUGH MUNICIPAL AUTHORITY

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UNIVERSITY OF PITTSBURGH
APPLIED RESEARCH CENTER
420 WILLIAM PITT WAY, PITTSBURGH, PA. 15238-1330
PHONE (412) 826-5454
FAX (412) 826-5458

DESIGN BY: V.K.D.	DRAWN BY: F.J.P.	CHECKED BY: M.S.M.
DATE: 5/3/99	SCALE: 1/2" = 1'-0	SHEET 18 OF
JOB NUMBER 3443.01.08	DRAWING NUMBER D 3482 40	

H:\SENP\0003\3443\DWG_D348240.DWG, 3/31/2015 10:53:21 AM

Appendix C



GRAPHIC SCALE

40 0 20 40 80 160

(IN FEET)
1 inch = 40 ft.

ELIZABETH BOROUGH MUNICIPAL AUTHORITY
LONG TERM CONTROL PLAN

SITUATE IN:
ELIZABETH BOROUGH
ALLEGHENY COUNTY, PENNSYLVANIA

PREPARED FOR:
ELIZABETH BOROUGH MUNICIPAL AUTHORITY

SENATE ENGINEERING COMPANY
ENGINEERS – PLANNERS – SURVEYORS
UNIVERSITY OF PITTSBURGH
APPLIED RESEARCH CENTER
420 WILLIAM PITT WAY, PITTSBURGH, PA. 15238
PHONE (412) 826-5454
FAX (412) 826-5458

DRAWN BY:	CHECKED BY:	DATE:	SCALE:
EWN	RDB	5-22-14	AS SHOWN
JOB NUMBER	DRAWING NUMBER		
10013	BASE_X01(MODIFIED)		1 OF 1

Appendix D

Methods and Philosophy of Drnach Environmental's Approach to Open Channel Flow Monitoring

Accuracy of flow measurement or "the closeness of agreement between measurement and the value of the measurand" is both a function of a flow meter's precision and the ability of the measurer to recognize, avoid, and correct for bias errors. This process begins during the site investigation and monitor selection stages. Sites are chosen based on their ability to provide a hydraulic environment that would introduce as little bias error as possible. This is accomplished in part by avoiding highly turbulent flows such as those immediately downstream of bends, weirs, drop-manholes, and manholes with multiple feeds. Ideal velocities are preferred and are characterized by those sites where velocities are high enough to prohibit grit and/or silt deposition, yet not so high as to create irregular surface turbulence, which would prohibit accurate level measurements. Once the proper site is agreed upon, it is critical that the diameter of the meter installation site be measured as accurately as possible. This is a very important part of the pre-installation procedure since this measurement will be used in the final flow calculations and can be the source of a constant bias error if measured incorrectly or assumed from sewer maps and prints. At this point it is necessary to prepare the flow meter for installation.

At Drnach Environmental, we emphasize the need for attention to precision during the pre-calibration and installation stages of every flow study. Prior to installation, each flow meter is bench calibrated in a controlled flow channel to guarantee that the calibrated depth and velocities are as accurate as possible. This includes verifying meter flow readings with a 2" Parshall flume located on the controlled calibration flow channel. Following initial depth calibration, submersible pressure transducers are held in the calibration chamber for a minimum of three minutes to assure that there is no sensor drift (sometimes observed in older sensors) prior to removal for installation. Upon installation, a field measurement is taken and compared to actual meter output. If the readings of the field measurement and actual output correspond, the site is secured and left to be revisited within the week for service and a second field measurement. Following the second site visit the first week's head/velocity data is applied to one of our computerized spreadsheets where total and free flow scattergraphs, head/velocity hydrographs, and diurnal flow patterns are reviewed as part of our QA/QC program.

Total and free flow scattergraphs are viewed as each has its own story to tell. Tight and almost linear free flow head/velocity relationships are plotted and the R^2 value is determined. Although we are aware that flow variations in open channel environments are not truly linear, we have observed the tendency during free flow of many sites to exhibit an apparent linear relationship between head and velocity readings prior to that point where increasing friction, pipe capacity limitations, and downstream backwater effects are observed. For this reason, free flow data is plotted along with the total flow scattergraph. The total flow scattergraph is useful, as it will indicate not only sensor stability (repeatability), but also hydraulic changes at different heads and velocities (i.e., low flow silting, surcharges, downstream obstacles, backwater effects, and temporary

downstream bypasses). Diurnal flows are plotted in order to identify the norm and provide for the identification of abnormal flows over the course of the study.

The review and analysis of data is dynamic and ongoing following weekly site visits, measurements, and meter downloads. With the addition of precipitation data to the previously mentioned practices and procedures, we believe that our QA/QC program minimizes bias and precision errors and thus establishes the accuracy and quality of flow measurement our clients have come to expect of us.

Drnach Environmental, Inc.
Portable Flow Monitoring Protocol

A. Pre-Installation Investigation & Preparation:

- Prior to installing any flow meter, Drnach Environmental (DE) staff will visit the proposed meter site with the client and their engineer to determine if the site's hydraulic conditions are conducive for collecting accurate flow data. What DE is looking for are sites that exhibit non-turbulent flows (laminar flow) with adequate velocity to prohibit the deposition of grit or silt. DE attempts to avoid sites where true head and velocity measurements cannot be reproduced.

- All information for the meter and sensor (i.e., serial number) is recorded for tracking purposes on pre-calibration form A1.

- The meter and sensor are cleaned and all desiccants are checked.

B. Bench Calibration:

- Bench calibrations consist of entering information into the meter, such as: all site and set-up information (i.e. study name, line size, meter interval frequency, and real date and time). The sensor is zeroed and calibrated in a controlled calibration line where flows are compared to those recorded by a 2-inch Parshall flume located on that same line. The sensor is left in the calibration line and the depth is checked a second time no sooner than three minutes from the original calibration to confirm that there is no sensor drift. All information is recorded on form A1.

- The meter sensor is then connected to the appropriate size band and loaded on the truck to be installed, typically within 24 hours.

C. Installation:

- Upon identifying an "acceptable site", DE installs the bench-calibrated flow meter, preferably in the inlet line to the manhole. A site measurement is then taken of the head at the meter sensor and compared to the meter output in the field with a connected laptop computer. The meter is mounted in the manhole, which is then closed until the next site visit.

D. Site Visits:

- DE field technicians conduct all first site visits within the first ten days of installation. Data collected from these newly installed meters is reviewed by DE staff and evaluated to determine if the site has the proper hydraulic characteristics for obtaining good flow data. Of primary interest is the initial scattergraph of head/velocity data and whether the site exhibits a hydraulic "fingerprint" which can be used in conjunction with field readings to access the meter's ability to provide repeatable data throughout the study period. Flow meters are inspected and interrogated at least once per week and once every 14 days for meters in CSO's. Site visit information is recorded on DE field check sheets (field form A-2). Visits may be required more often depending on storm events and site characteristics (i.e., large amounts of grease, silting, or debris). After the first week of installation, the meter is downloaded and the head, velocity, and battery readings are recorded. An actual field measurement of the flow is taken and compared to the meter output and recorded. This is a critical Quality Control procedure and is conducted weekly as long as the manhole is accessible. An acceptable reading is one that is + or – ¼" of the actual flow depth. Weather conditions and site hydraulic conditions will be noted if they are out of the ordinary. If no corrections, calibrations, or replacements are required the site is secured and the raw data is returned to the office. The data is then imported into one of DE's many report programs and evaluated for a number of parameters. First, is the sensor getting adequate head and velocity readings to calculate flows throughout the day? Secondly, is the scattergraph typical of a free flow condition or some other condition that will lend itself to be measured? At this point, the scattergraph is printed out and provided to the field technician for use during subsequent field calibration checks. Assuming the first week of data was adequate to produce a working scattergraph (no surcharging) and the site can be metered (reproducible data was obtained), the field technician will re-visit the site weekly to perform the following tasks:

    1. The meter is downloaded to the technician's laptop computer.

    2. The technician then takes a real time/current status reading and records the head, velocity, and battery readings.

    3. The sensor is cleaned and the actual flow depth is measured and compared to the meter output. The real time head and velocity readings are then plotted on the initial scatter graph in the field to

determine if the flow meter's sensor has experienced any drift since its initial installation. If it has not, and the field measurement matches the meter output (+ or – ¼") then the meter is left to collect data until the next site visit. This procedure will continue on a weekly basis throughout the study period.

E. CSO Site Visits:

- In addition to the procedures described above, we realize CSO sites are different from sanitary sewer sites and require special consideration when attempting to monitor overflows. As part of our ongoing QA/QC program for CSO's, the following items are considered:

    1. At each site visit chalking of the overflow is performed for the purpose of identifying overflow events between visits. This is required for the physical site inspection of the CSO.

    2. Overflow data collected at each interrogation is appended to an ongoing summary scattergraph report for the purpose of identifying sensor drift over the course of the study.

The goal at Drnach Environmental is to install and manage the open channel flow meter so as to provide flow data that is as accurate as the site conditions and meter permit. We believe that we accomplish this goal through the diligent monitoring and review of data collected at stated above.

Elizabeth Site Summary

EB-94

EB-94 didn't have much flow. Flow was intermittent, and the sensor would regularly catch debris and need brushed. This meter was only in place for three months.

Grant @ Ivory 10 inch

This was the 10 inch inlet to the manhole at Grant @ Ivory. This was a low head and high velocity site. This site and the 8 inch inlet were consolidated to one meter installed in the outlet after May 2013.

Grant @ Ivory 8 inch

This was the 8 inch inlet to the manhole at Grant @ Ivory. This was a low flow site. This site and the 10 inch inlet were consolidated to one meter installed in the outlet after May 2013.

Grant @ Ivory Outlet

This is a low head and high velocity site. In June 2013, this meter replaced the meters that had been installed in the inlets.

Center Ave

The flow at Center Ave typically did not have a very high velocity. The submerged sensor would occasionally catch and hold debris and need to be brushed. This site also had an ultrasonic level sensor. This line enters the manhole slightly higher than the invert.

7th @ Kendle

7th @ Kendle typically had a low level. The line enters the manhole slightly elevated, and flow dropped down into the invert. Velocity would pick up as flows increased, helping this site to not often catch and hold debris.

Ferry @ 9th

Ferry @ 9th usually had a low level, sometimes being just a trickle of flow coming through during the site visit. The submerged sensor would occasionally catch and hold debris and need to be brushed. This site also had an ultrasonic level sensor.

Box 8

Box 8 was the overflow. This meter read well for the study.

12 inch into Box 8

12 inch to Box 8 was a site with low velocity. It would occasionally catch and hold debris and need brushed.

42 inch into Box 8

In November 2013, it was thought that this site was reading high. Upon closer inspection and review of the field notes, we agreed that it was. We added a 10 foot extension to the sensor and moved it further up the line to be sure that we were away from any ponding. The data collected from the new sensor location confirmed that the meter had been reading too high. Based on our measurements and field notes, we applied a quarter inch level reduction to the previously collected data and recalculated the flows, which seemed to bring everything back in line.

Boat Club

The meter at the boat club was impacted by line cleaning in September 2013. The sensor had been pulled and reinstalled by the cleaning crew. There were also periods where it caught and held debris. During this time, field measurements confirmed that it was reading a half inch low. When cleaning in this area was completed on October 1st 2013 we reinstalled and adjusted the meter to correct the low readings. A half inch adjustment was made to the data collected during this period, and flows were recalculated. This site was also subject to surcharging.

Cemetery @ Elks

The sensors at Cemetery @ Elks got blown out in the storm on July 10, 2013. The sensor was reinstalled on July 19th, 2013. When flows really picked up at this site, the water would spin around the manhole like a whirlpool before leaving the outlet.

Cemetery Street

Cemetery Street had good flow conditions. It did surcharge a few times and sometimes needed to be brushed.

Church Street

Church Street was a deep site. The inlet that was metered entered the manhole higher than the invert, and the flow spilled in. The band was blown out in the storm on July 10, 2013, and was reinstalled on July 19, 2013.

Chicago Ave

Chicago Ave was a low flow site with low velocity. Debris usually did not accumulate, but would occasionally interfere with velocity readings.

Box 3

The Box 3 site was installed in the outfall line below the diversion chamber of Box 3. Water would make its way into the line during wet weather, either from seeping up through the bottom of the pipe or from the stream backing up. This condition sometimes caused the meter to see more flow than what was overflowing the weir.

Flow into Box 3

The Box 3 Flow site was initially installed in the manhole just before a series of turns in the line, and it was full of debris. We were unable to locate an upstream manhole, so we installed the meter and attempted to clear the debris from the sensor area. The debris kept filling in, so we stopped metering the location. The upstream manhole was located and uncovered by Elizabeth, and the meter was moved there on July 19, 2013. During line cleaning in October 2013, the cleaning crew removed the sensor. When they reinstalled it, they put it in the wrong line. During our next site visit, we reinstalled it in the correct location.

Appendix E

Elizabeth Borough Municipal Authority
Long Term Control Plan

Meter Name	Sewershed Township	Avg. Flow (mgd)	Max. Hourly Flow (mgd)	Peaking Factor	SSOAP "R" Value	RTK Values Used in SWMM (Summer Only)								
						R_1	T_1	K_1	R_2	T_2	K_2	R_3	T_3	K_3
Chicago Ave	Elizabeth	0.012	0.324	26.6	10.7%	0.026	0.8	1.2	0.035	2.3	2.6	0.054	6.3	5.9
Church Street	Elizabeth	0.064	0.943	14.7	27.5%	0.056	0.7	1.7	0.061	1.8	3.0	0.158	5.5	6.0
Cemetery @ Elks	Elizabeth	0.186	1.118	6.0	17.6%	0.032	1.0	1.4	0.056	3.4	3.5	0.110	7.4	7.4
Grant @ Ivory	Forward	0.018	1.124	62.8	24%	0.068	0.6	1.0	0.068	2.0	3.0	0.090	6.0	6.0
Center Ave	Forward	0.015	0.922	61.1	3.2%	0.014	0.6	1.5	0.100	2.0	2.5	0.120	6.0	4.5
Fallen Timber	Forward/Elizabeth	0.085	1.369	16.2	0.4%	0.002	1.0	1.2	0.001	2.9	2.6	0.001	8.2	4.4

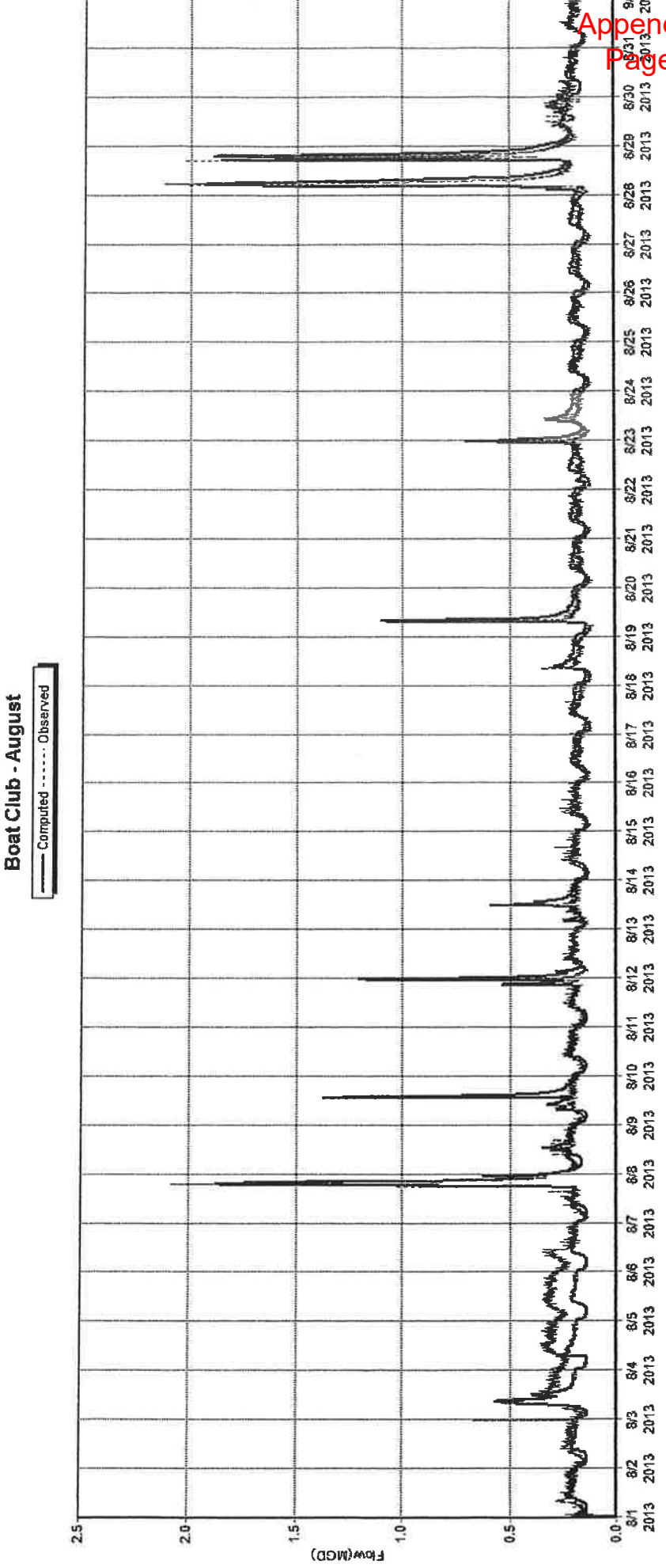
Appendix A-20-e.2
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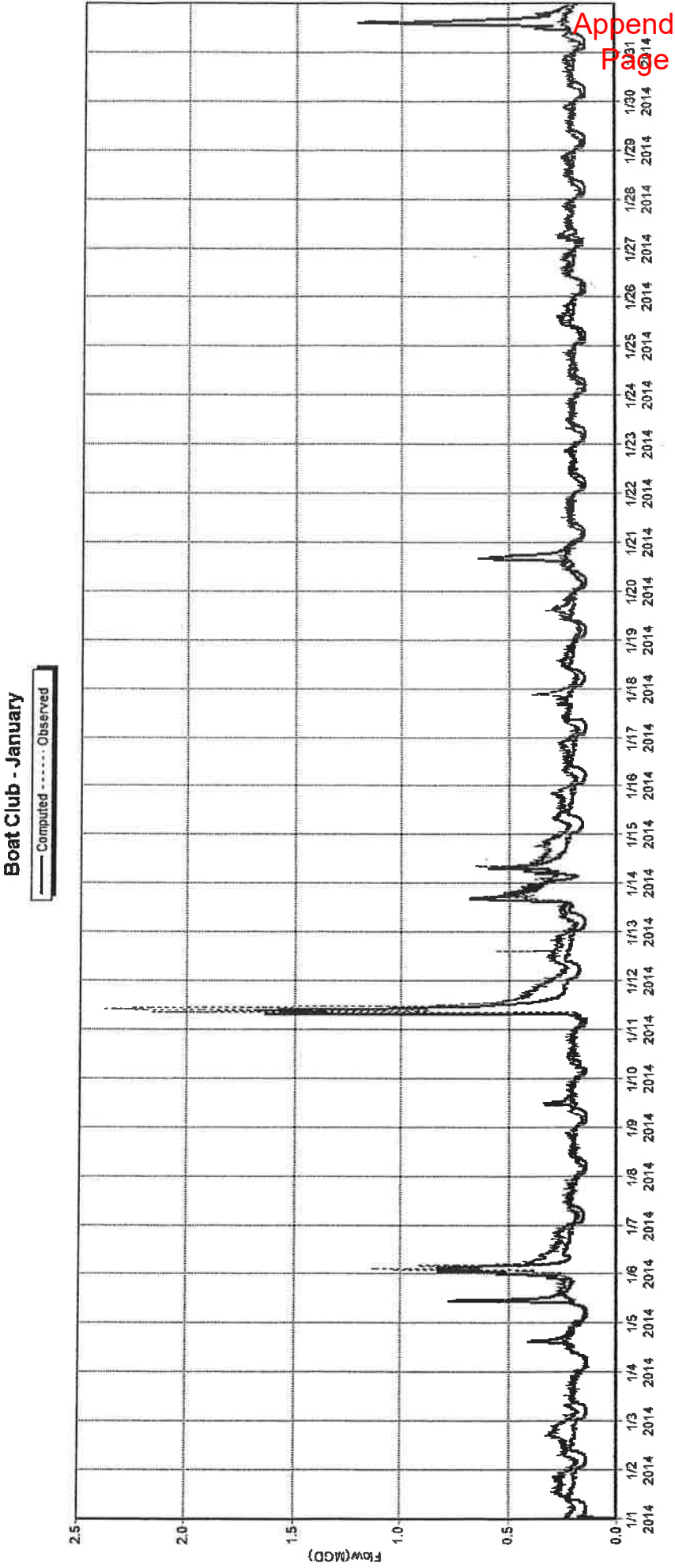
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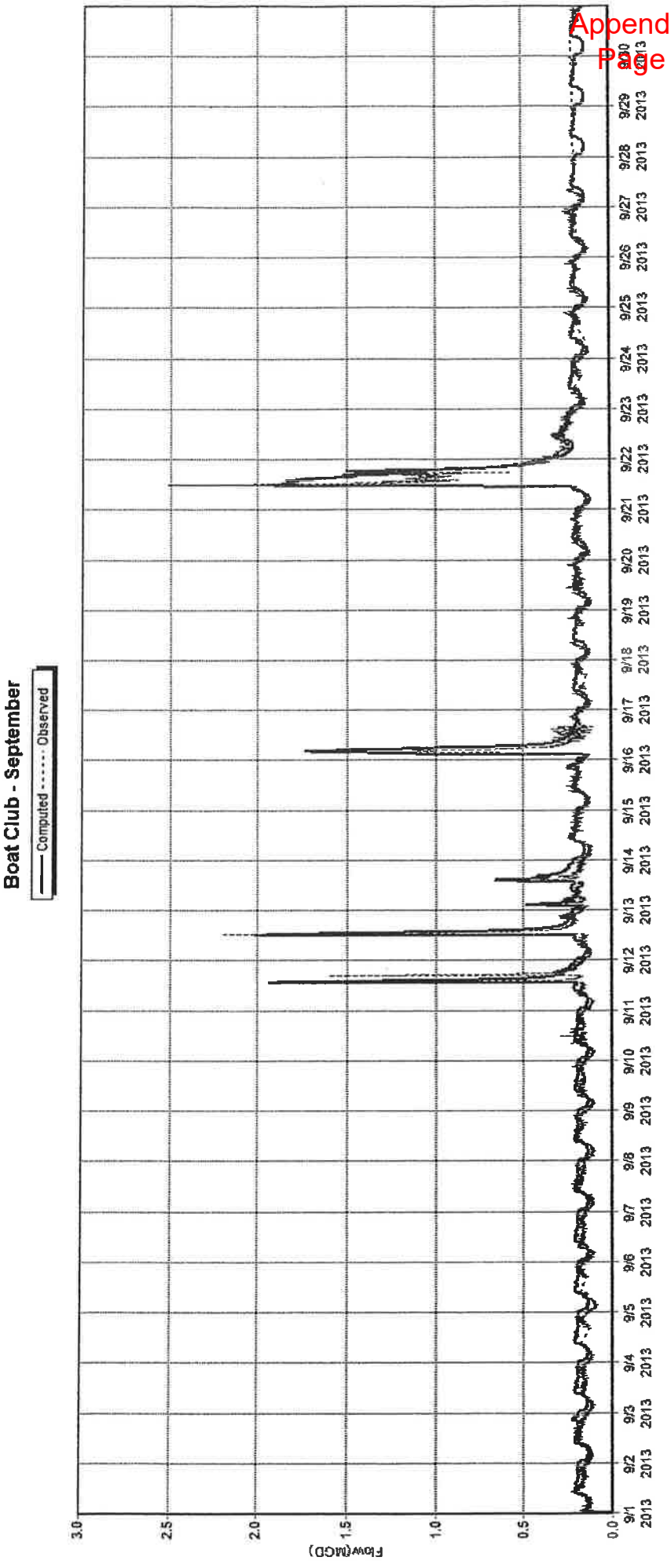
SUBCATCHMENT CHARACTERISTICS
EBMA LTCP SWMM

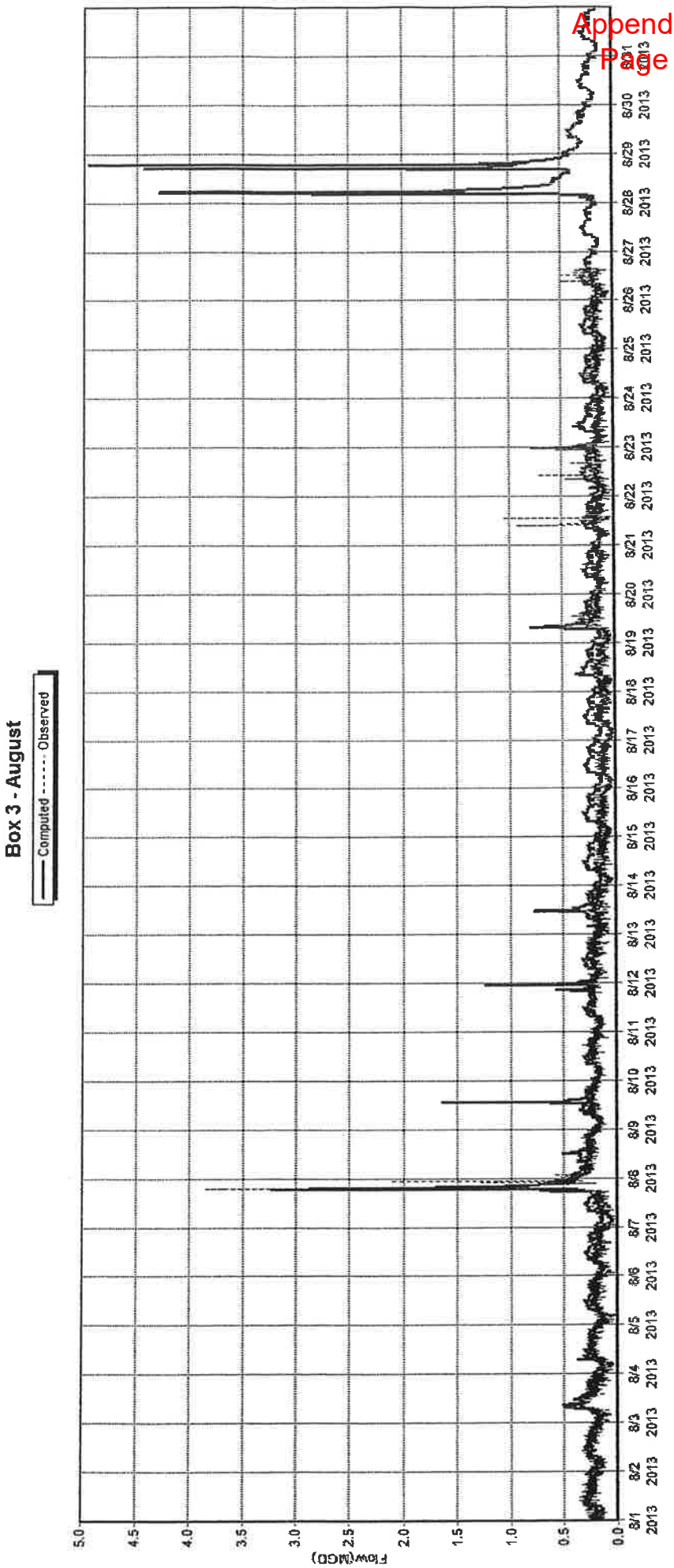
Name	Area (Acres)	Approx. Total Road Length (LF)	Approx Road Area (ac.)	Approx. Total Separated Road Length (LF)	Approx Separated Road Area (ac.)	Approx Residential Area (ac.)	Effective Area	% Imperv	Average % Slope	
									Slope	Road
Sewershed 8	53	13020	6	4000	2	53	51	8%	5%	Center
Sewershed 7	21	7035	3	2170	1	14	20	11%	7%	Bayard
Sewershed 6	12	4575	2	2700	1	4	11	8%	2%	Plum
Sewershed 5	10	2050	1	0	0	7	10	9%	8%	Willamsport
Sewershed 3	40	9210	4	2020	1	40	39	8%	4%	Church

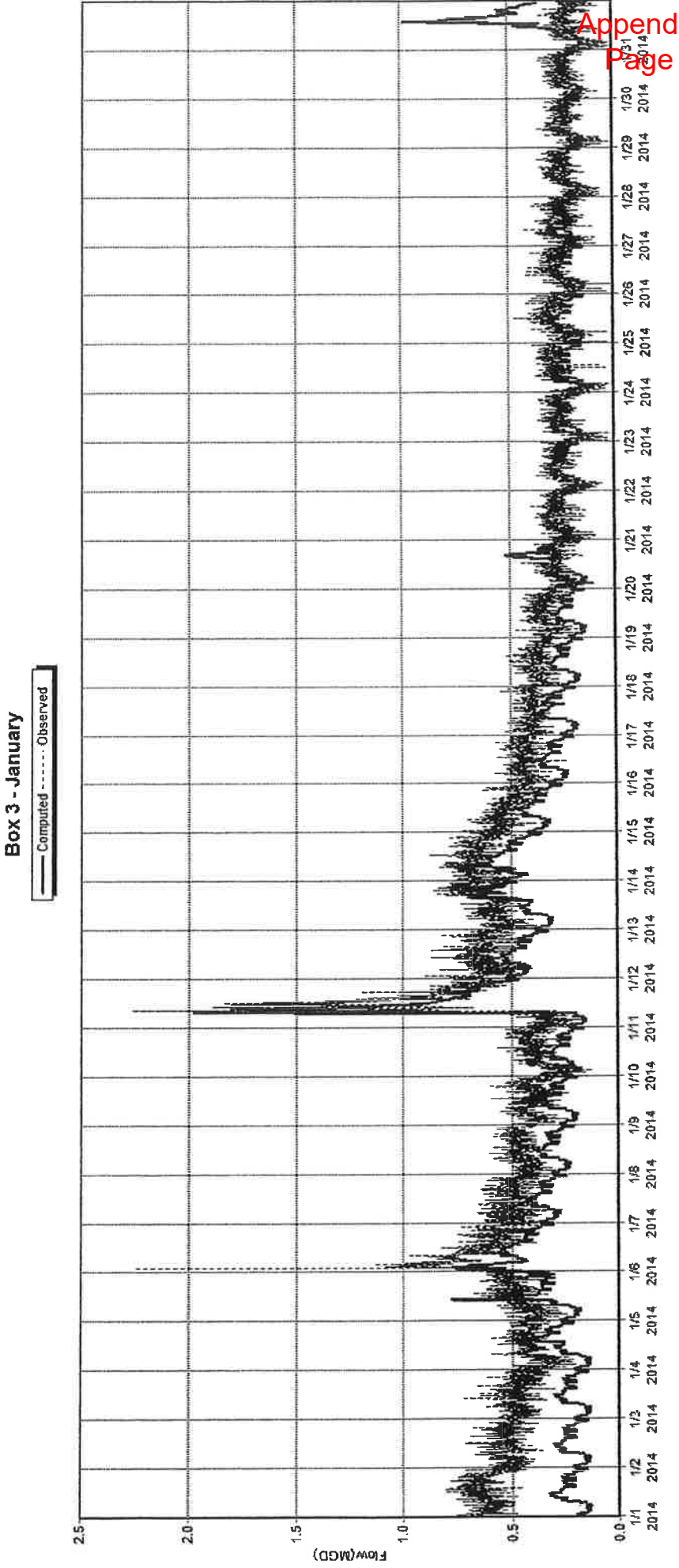
Appendix G

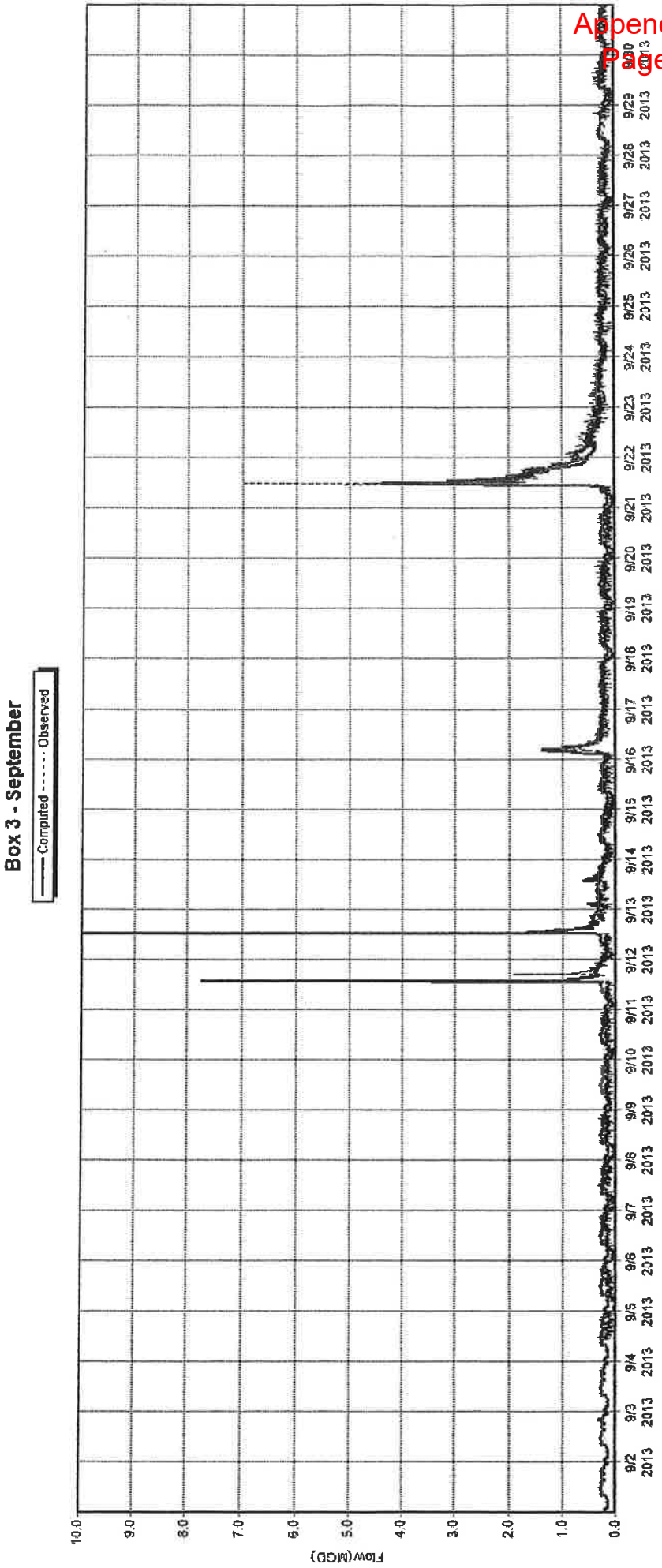

Boat Club - August
Computed
Observed
Flow(MGD)
2.5
2.0
1.5
1.0
0.5
0.0
8/1 2013
8/2 2013
8/3 2013
8/4 2013
8/5 2013
8/6 2013
8/7 2013
8/8 2013
8/9 2013
8/10 2013
8/11 2013
8/12 2013
8/13 2013
8/14 2013
8/15 2013
8/16 2013
8/17 2013
8/18 2013
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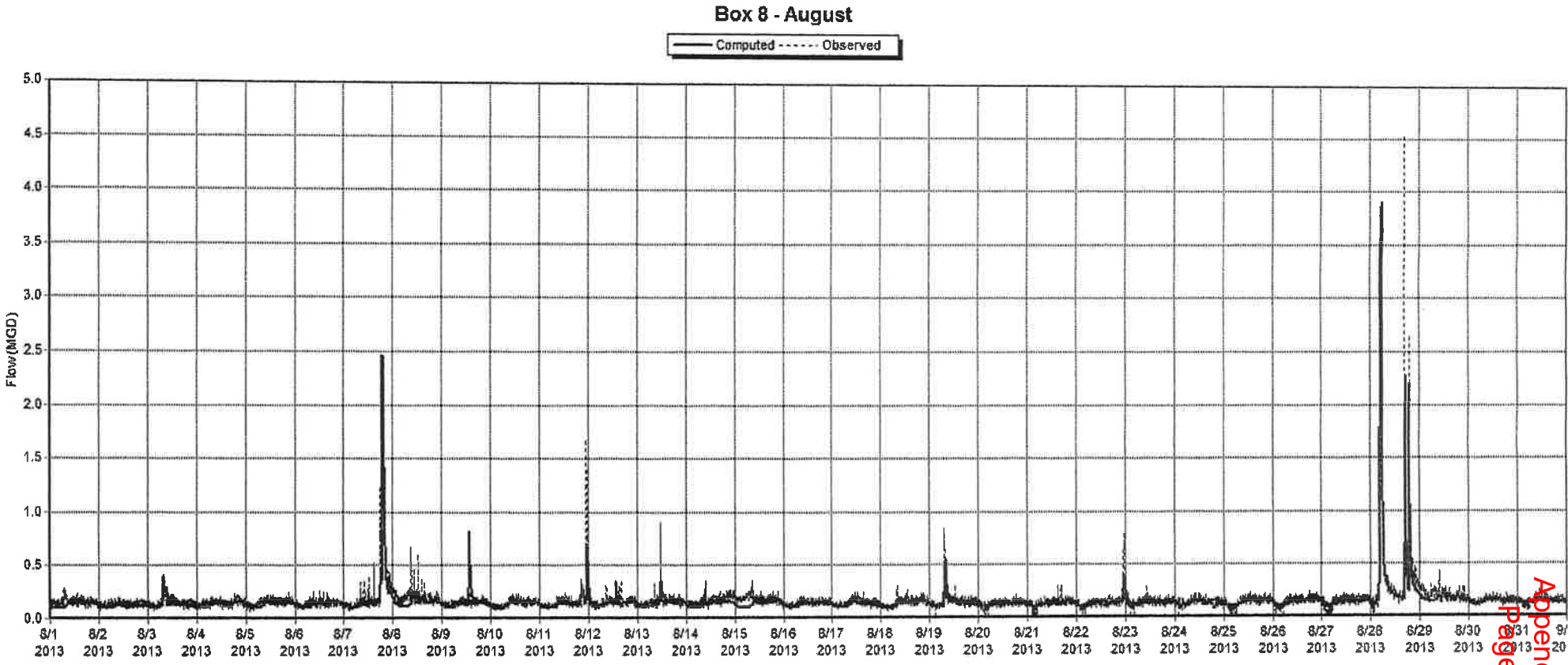

Boat Club - January
Computed
Observed
Flow(MGD)
2.5
2.0
1.5
1.0
0.5
0.0
1/1 2014
1/2 2014
1/3 2014
1/4 2014
1/5 2014
1/6 2014
1/7 2014
1/8 2014
1/9 2014
1/10 2014
1/11 2014
1/12 2014
1/13 2014
1/14 2014
1/15 2014
1/16 2014
1/17 2014
1/18 2014
1/19 2014
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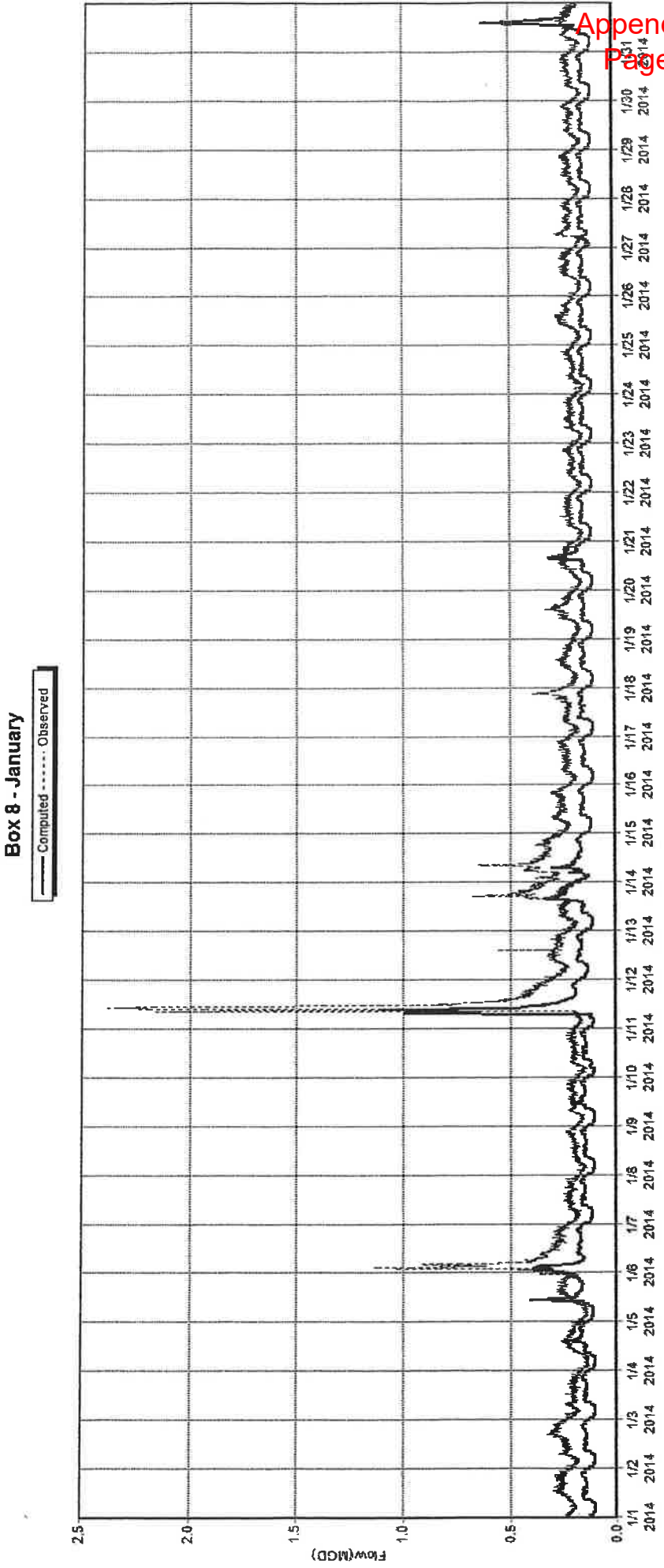

Boat Club - September
Computed
Observed
Flow(MGD)
3.0
2.5
2.0
1.5
1.0
0.5
0.0
9/1 2013
9/2 2013
9/3 2013
9/4 2013
9/5 2013
9/6 2013
9/7 2013
9/8 2013
9/9 2013
9/10 2013
9/11 2013
9/12 2013
9/13 2013
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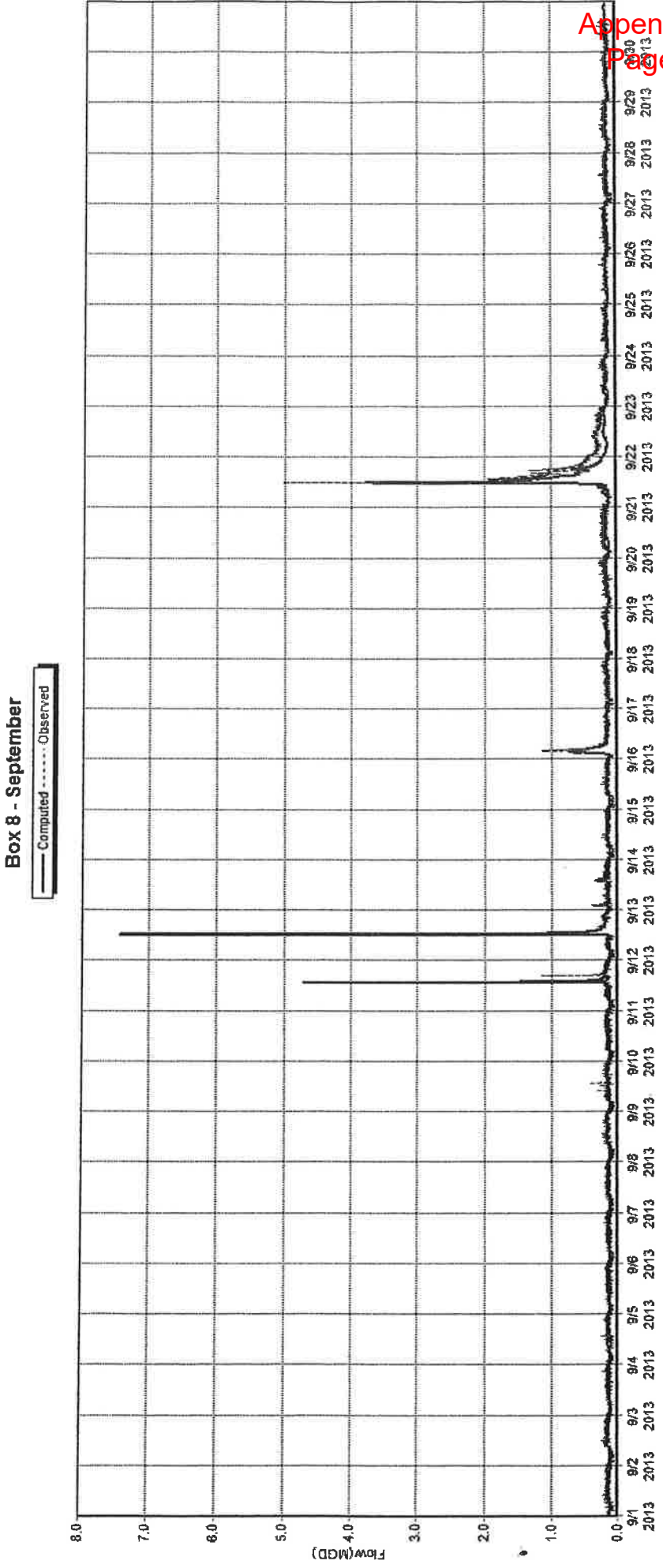

Box 3 - August
Computed
Observed
Flow(MGD)
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
8/1 2013
8/2 2013
8/3 2013
8/4 2013
8/5 2013
8/6 2013
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8/11 2013
8/12 2013
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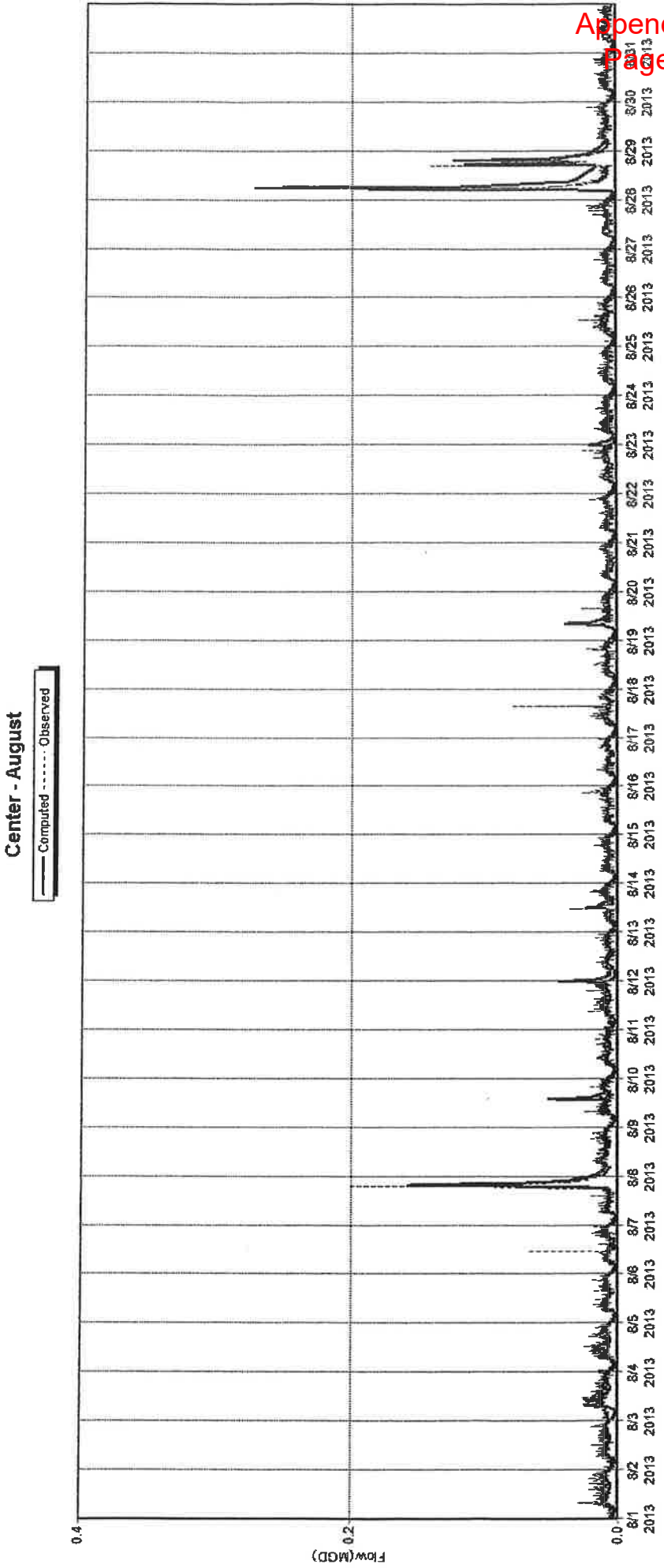

Box 3 - January
Computed
Observed
Flow(MGD)
2.5
2.0
1.5
1.0
0.5
0.0
1/1 2014
1/2 2014
1/3 2014
1/4 2014
1/5 2014
1/6 2014
1/7 2014
1/8 2014
1/9 2014
1/10 2014
1/11 2014
1/12 2014
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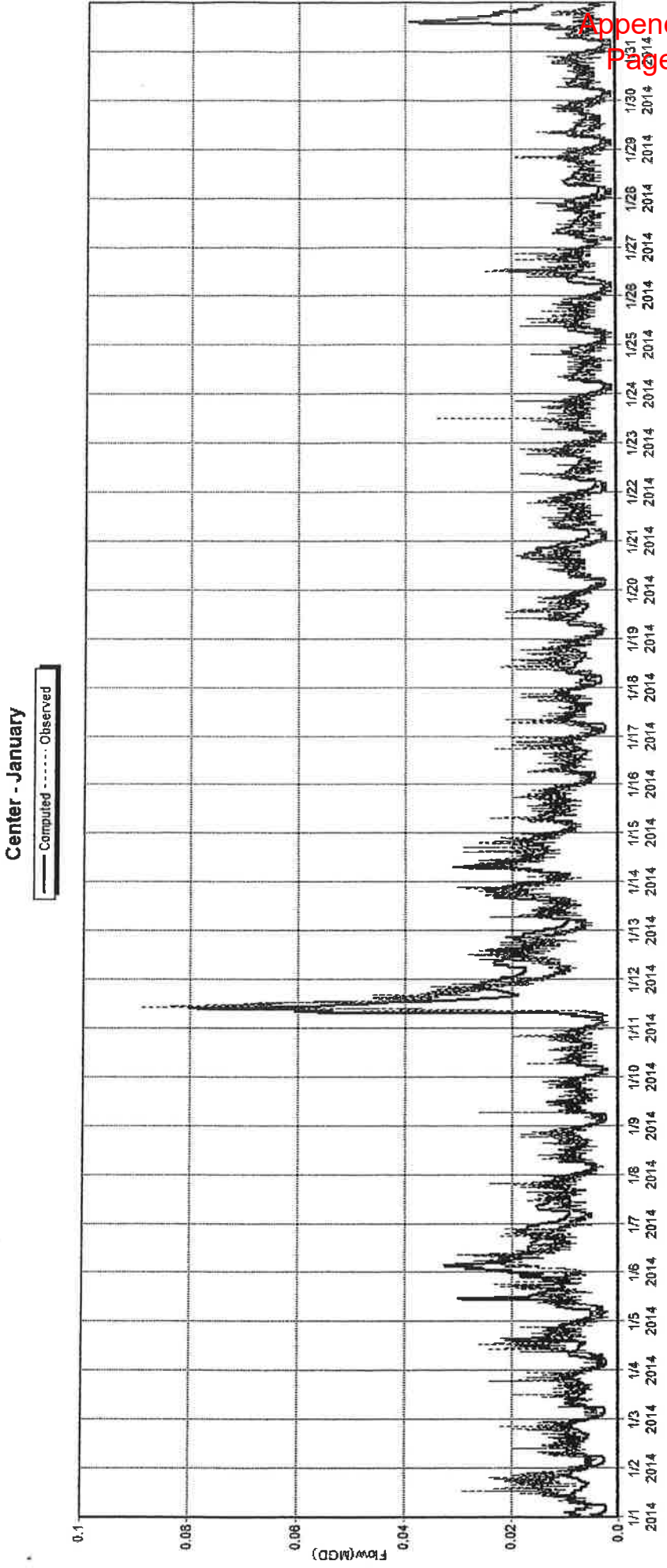

Box 3 - September
Computed
Observed
Flow (MGD)
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
9/2 2013
9/3 2013
9/4 2013
9/5 2013
9/6 2013
9/7 2013
9/8 2013
9/9 2013
9/10 2013
9/11 2013
9/12 2013
9/13 2013
9/14 2013
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9/16 2013
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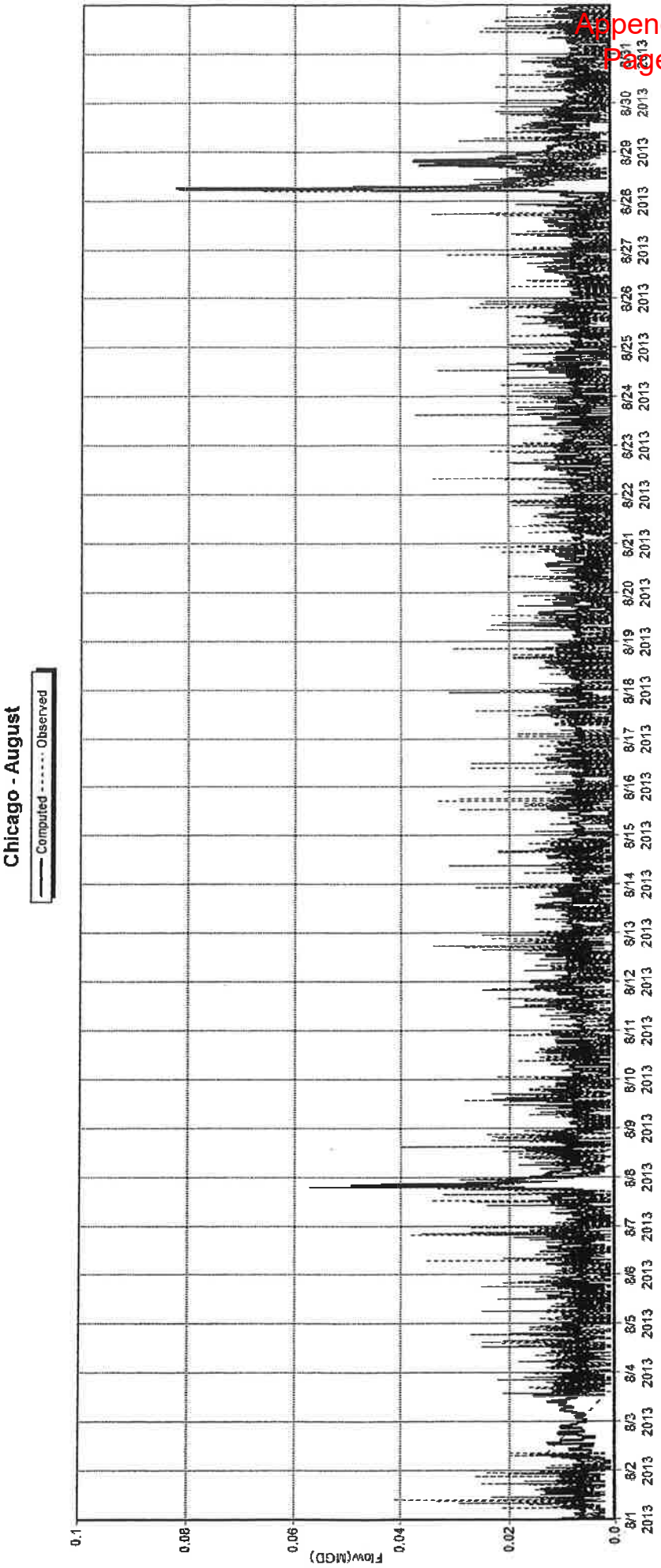

Box 8 - August
Computed
Observed
Flow (MGD)
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
8/1 2013
8/2 2013
8/3 2013
8/4 2013
8/5 2013
8/6 2013
8/7 2013
8/8 2013
8/9 2013
8/10 2013
8/11 2013
8/12 2013
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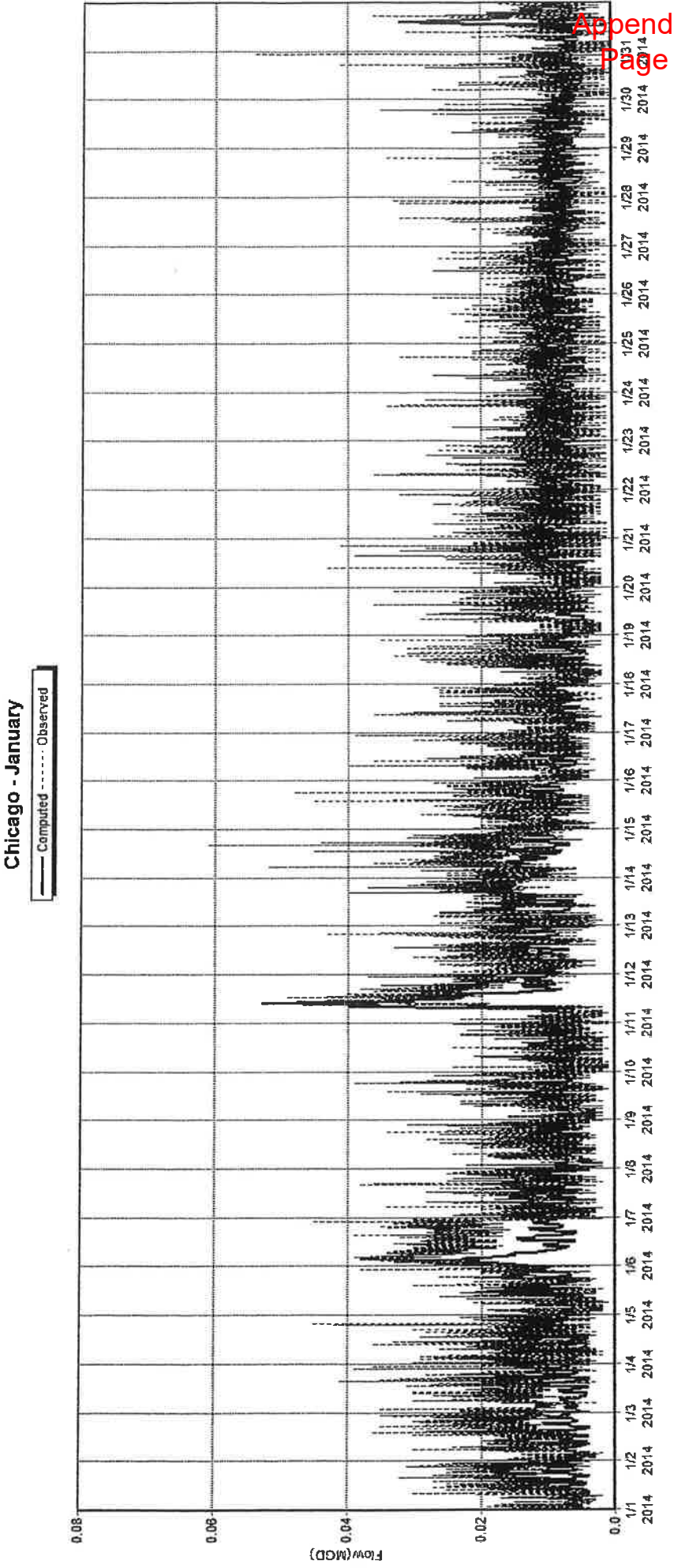

Box 8 - January
Computed
Observed
Flow(MGD)
2.5
2.0
1.5
1.0
0.5
0.0
1/1 2014
1/2 2014
1/3 2014
1/4 2014
1/5 2014
1/6 2014
1/7 2014
1/8 2014
1/9 2014
1/10 2014
1/11 2014
1/12 2014
1/13 2014
1/14 2014
1/15 2014
1/16 2014
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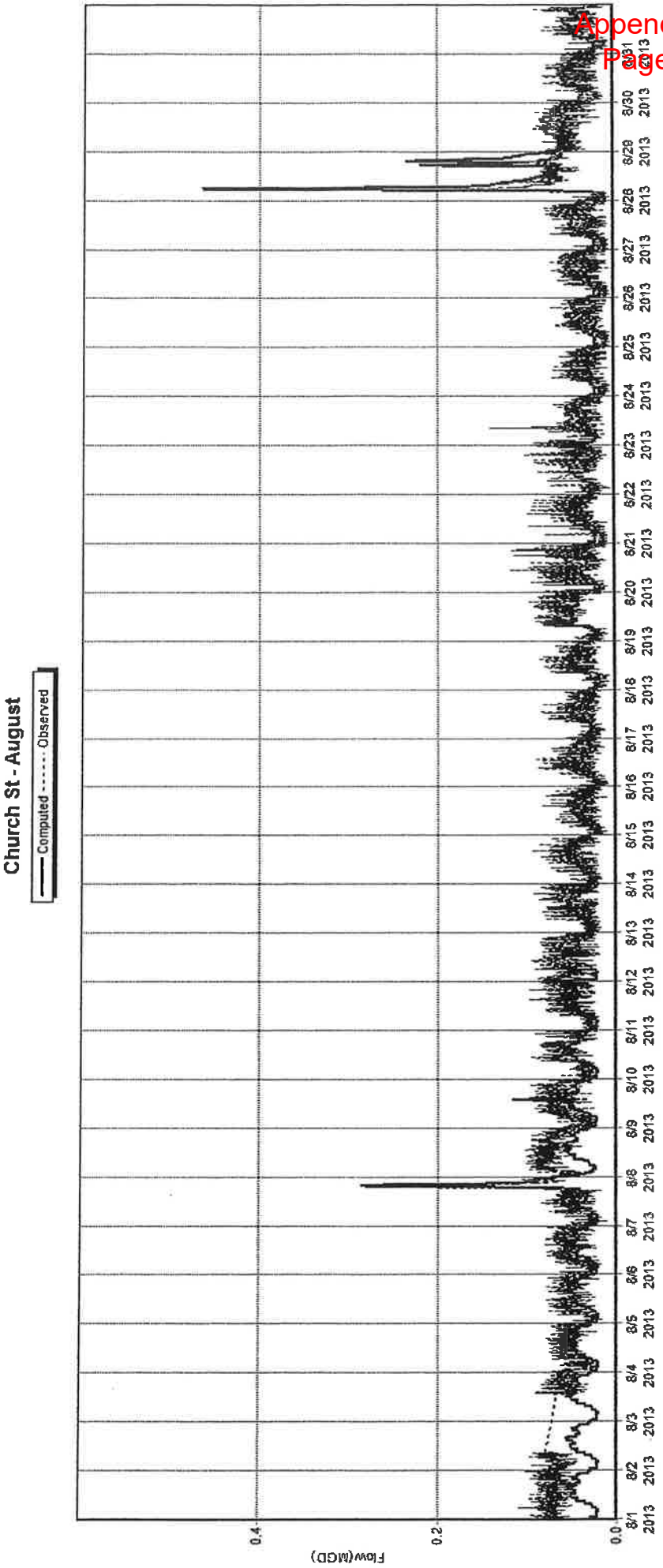

Box 8 - September
Computed
Observed
Flow (MGD)
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
9/1 2013
9/2 2013
9/3 2013
9/4 2013
9/5 2013
9/6 2013
9/7 2013
9/8 2013
9/9 2013
9/10 2013
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9/12 2013
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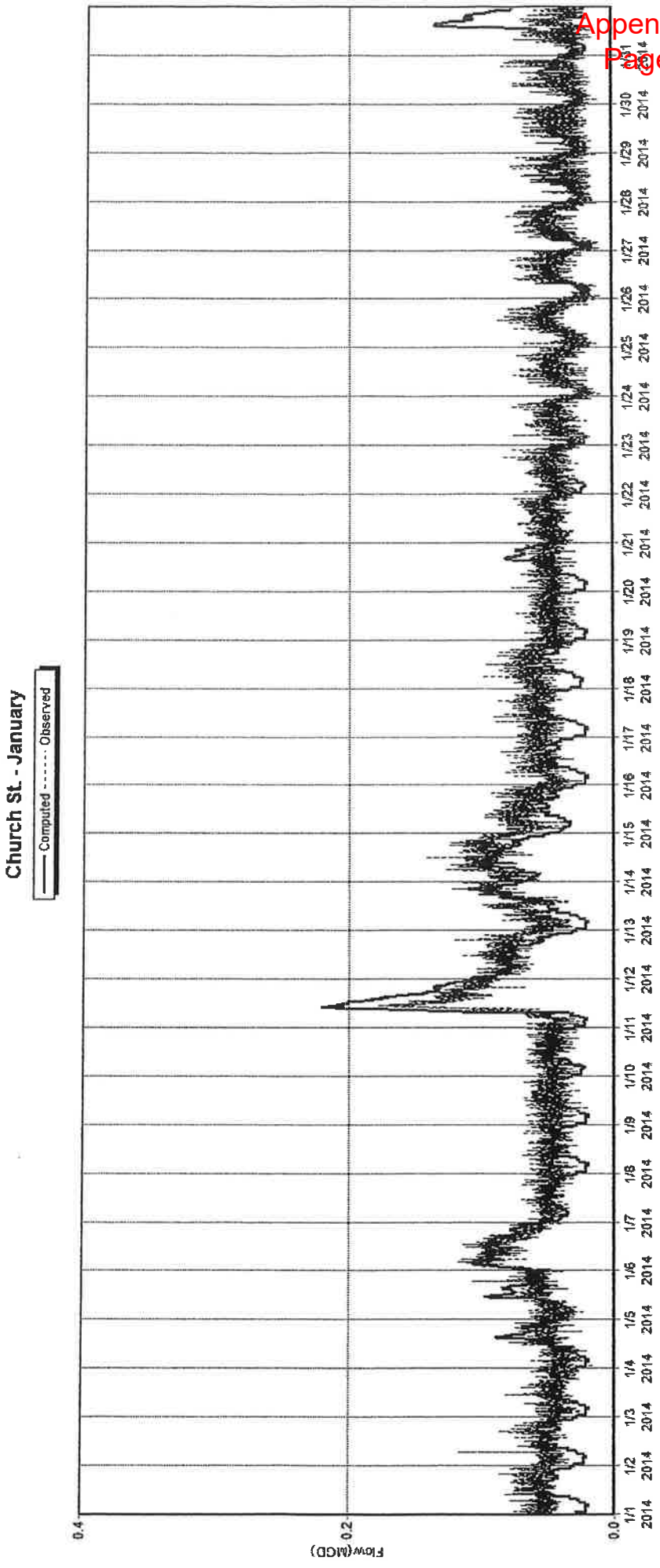

Center - August
Computed
Observed
Flow(MGD)
0.4
0.2
0.0
8/1 2013
8/2 2013
8/3 2013
8/4 2013
8/5 2013
8/6 2013
8/7 2013
8/8 2013
8/9 2013
8/10 2013
8/11 2013
8/12 2013
8/13 2013
8/14 2013
8/15 2013
8/16 2013
8/17 2013
8/18 2013
8/19 2013
8/20 2013
8/21 2013
8/22 2013
8/23 2013
8/24 2013
8/25 2013
8/26 2013
8/27 2013
8/28 2013
8/29 2013
8/30 2013
8/31 2013

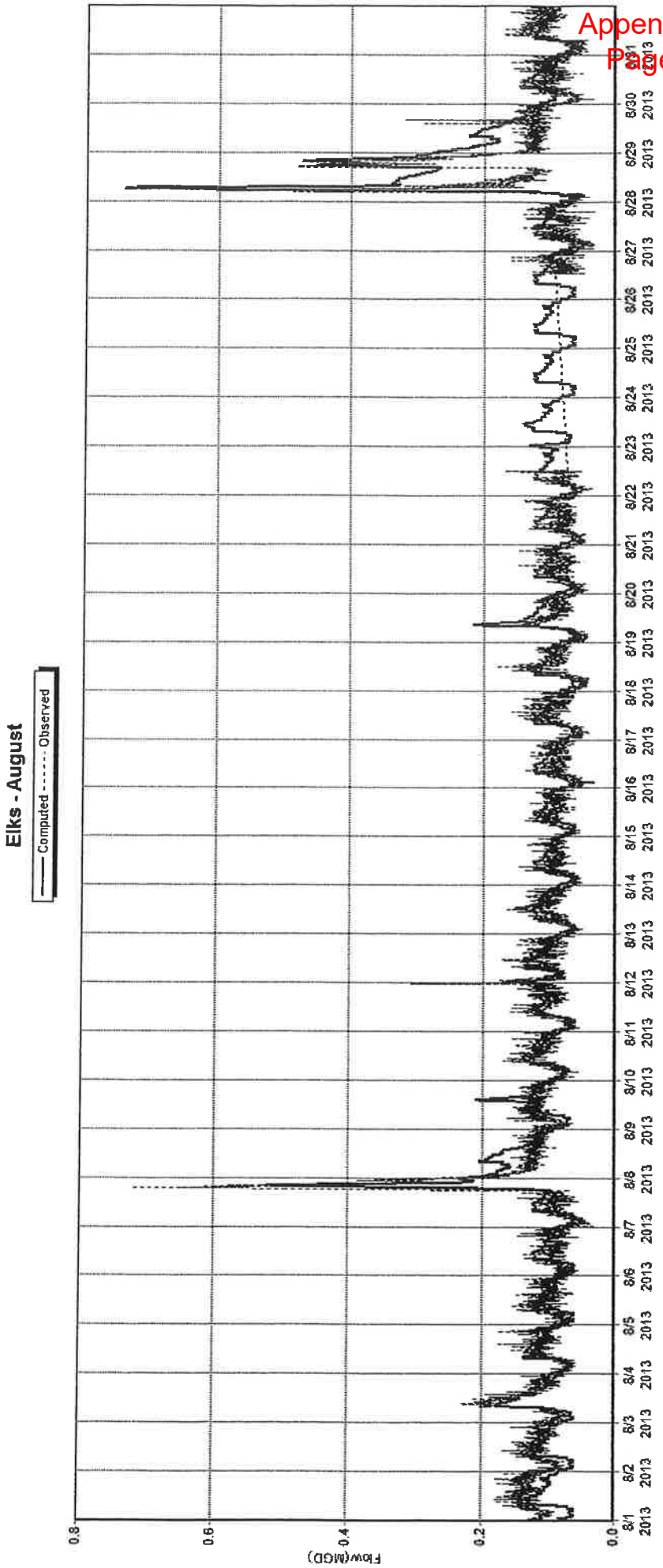

Center - January
Computed
Observed
Flow(MGD)
0.1
0.08
0.06
0.04
0.02
0.0
1/1 2014
1/2 2014
1/3 2014
1/4 2014
1/5 2014
1/6 2014
1/7 2014
1/8 2014
1/9 2014
1/10 2014
1/11 2014
1/12 2014
1/13 2014
1/14 2014
1/15 2014
1/16 2014
1/17 2014
1/18 2014
1/19 2014
1/20 2014
1/21 2014
1/22 2014
1/23 2014
1/24 2014
1/25 2014
1/26 2014
1/27 2014
1/28 2014
1/29 2014
1/30 2014
1/31 2014

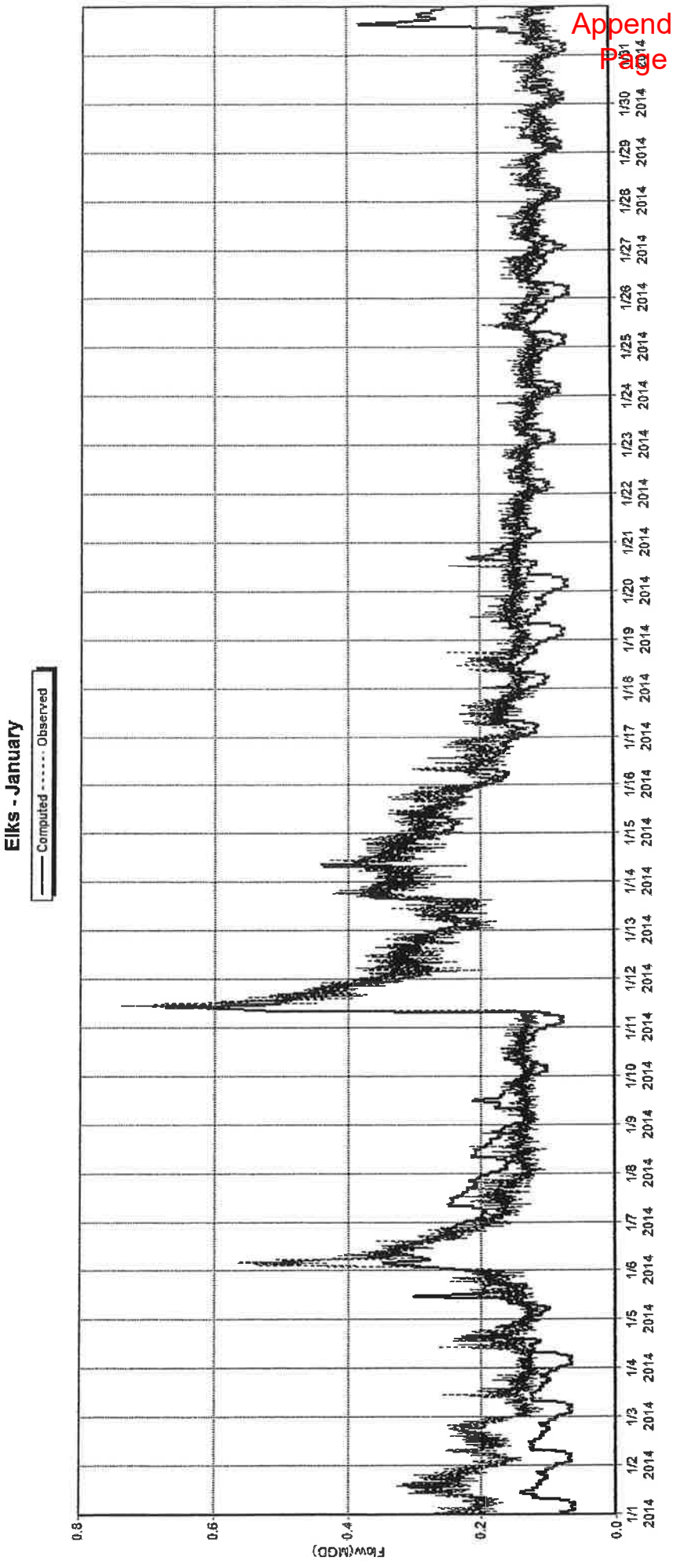

Chicago - August
Computed
Observed
Flow(MGD)
0.1
0.08
0.06
0.04
0.02
0.0
8/1 2013
8/2 2013
8/3 2013
8/4 2013
8/5 2013
8/6 2013
8/7 2013
8/8 2013
8/9 2013
8/10 2013
8/11 2013
8/12 2013
8/13 2013
8/14 2013
8/15 2013
8/16 2013
8/17 2013
8/18 2013
8/19 2013
8/20 2013
8/21 2013
8/22 2013
8/23 2013
8/24 2013
8/25 2013
8/26 2013
8/27 2013
8/28 2013
8/29 2013
8/30 2013

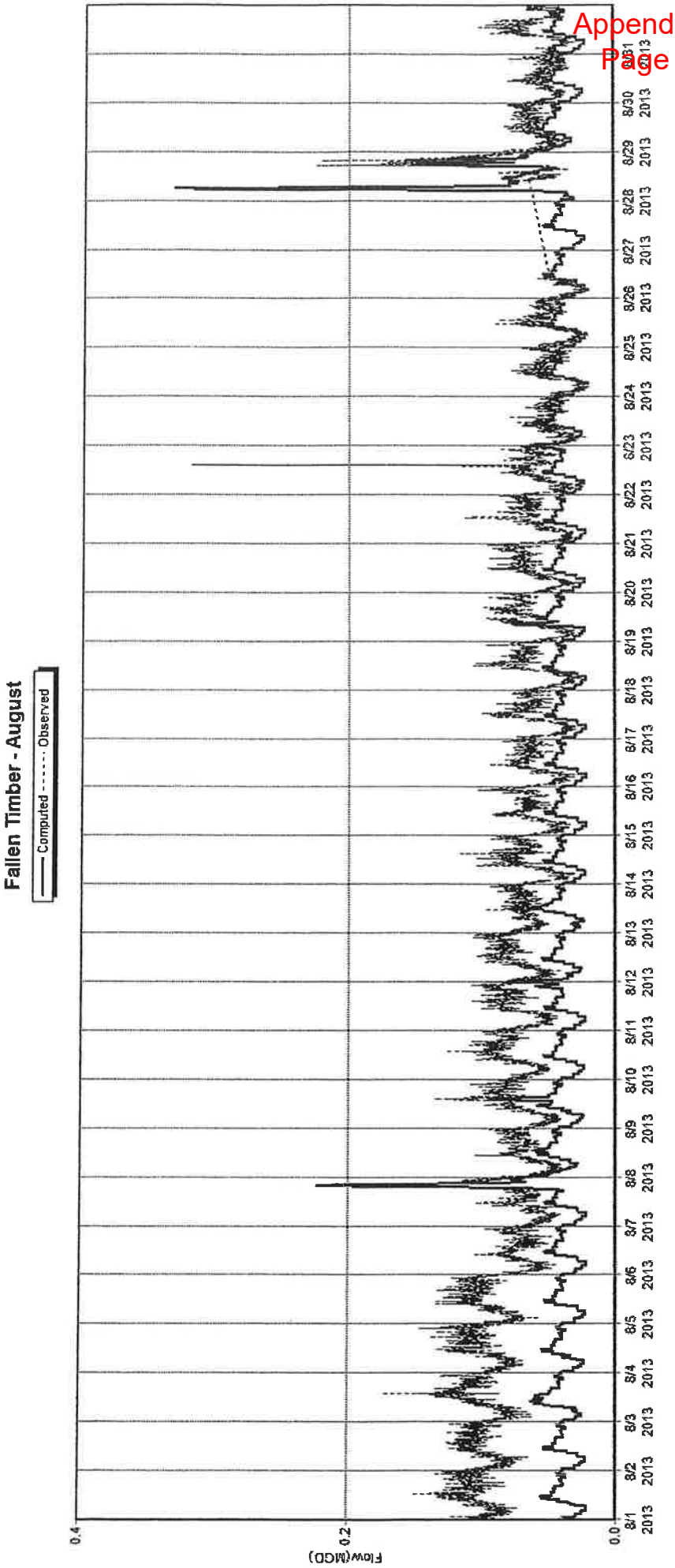

Chicago - January
Computed
Observed
Flow (MGD)
0.08
0.06
0.04
0.02
0.0
1/1 2014
1/2 2014
1/3 2014
1/4 2014
1/5 2014
1/6 2014
1/7 2014
1/8 2014
1/9 2014
1/10 2014
1/11 2014
1/12 2014
1/13 2014
1/14 2014
1/15 2014
1/16 2014
1/17 2014
1/18 2014
1/19 2014
1/20 2014
1/21 2014
1/22 2014
1/23 2014
1/24 2014
1/25 2014
1/26 2014
1/27 2014
1/28 2014
1/29 2014
1/30 2014
1/31 2014

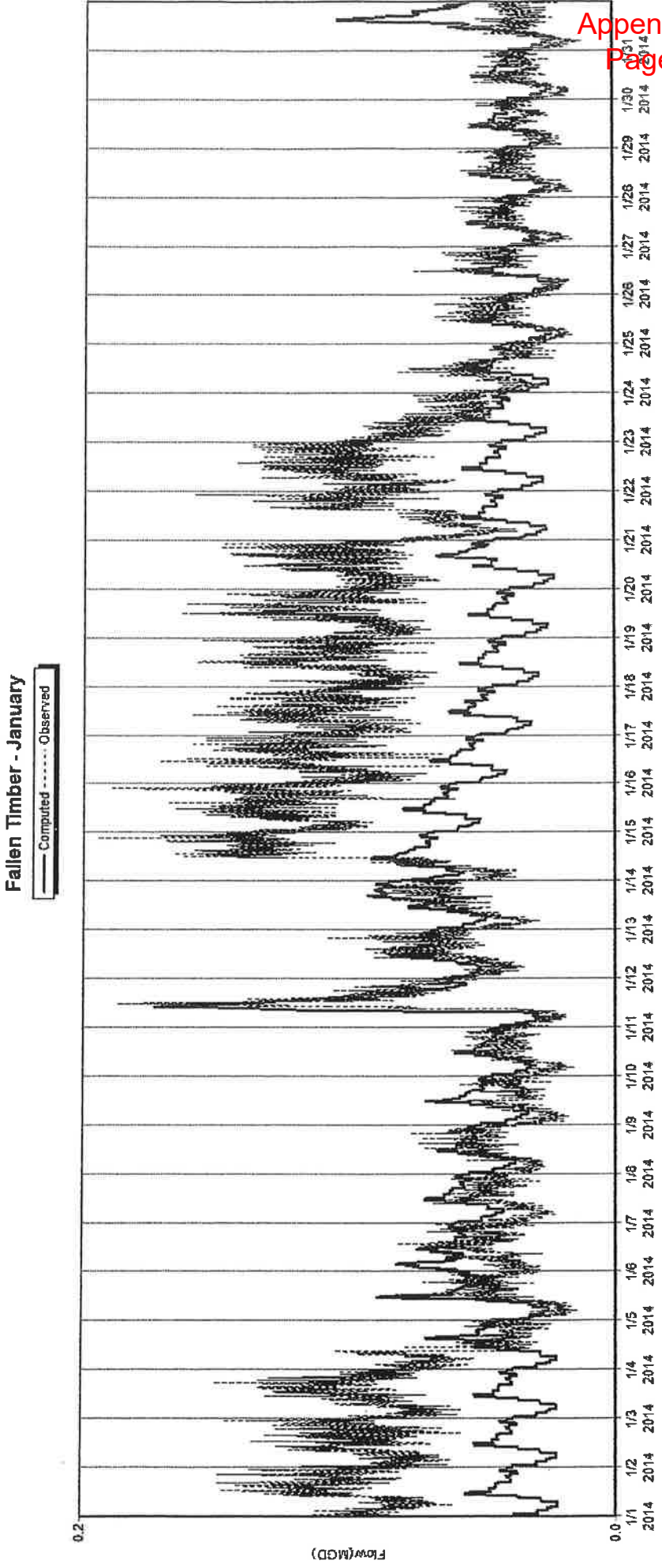

Church St - August
Computed
Observed
Flow (MGD)
0.0
0.2
0.4
8/1 2013
8/2 2013
8/3 2013
8/4 2013
8/5 2013
8/6 2013
8/7 2013
8/8 2013
8/9 2013
8/10 2013
8/11 2013
8/12 2013
8/13 2013
8/14 2013
8/15 2013
8/16 2013
8/17 2013
8/18 2013
8/19 2013
8/20 2013
8/21 2013
8/22 2013
8/23 2013
8/24 2013
8/25 2013
8/26 2013
8/27 2013
8/28 2013
8/29 2013
8/30 2013
8/31 2013

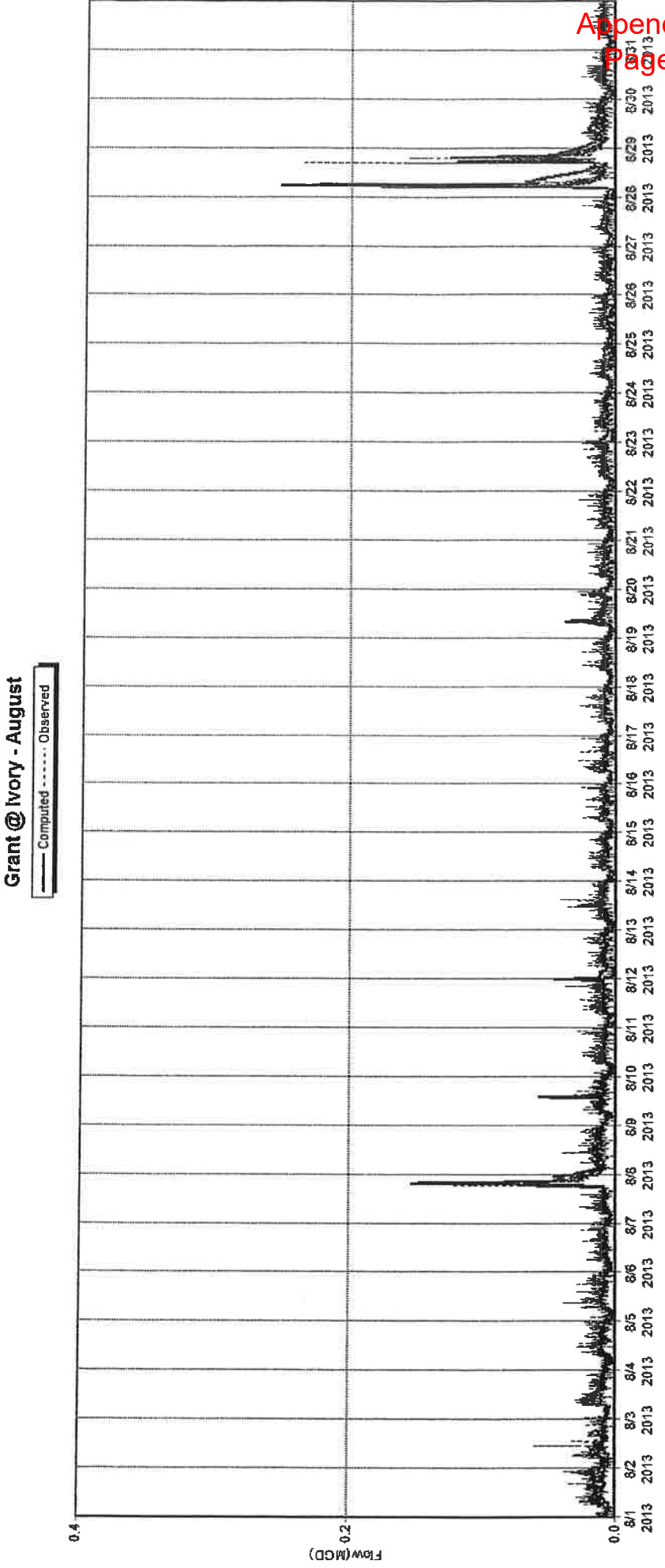

Church St. - January
Computed
Observed
Flow (MGD)
0.4
0.2
0.0
1/1 2014
1/2 2014
1/3 2014
1/4 2014
1/5 2014
1/6 2014
1/7 2014
1/8 2014
1/9 2014
1/10 2014
1/11 2014
1/12 2014
1/13 2014
1/14 2014
1/15 2014
1/16 2014
1/17 2014
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1/21 2014
1/22 2014
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1/24 2014
1/25 2014
1/26 2014
1/27 2014
1/28 2014
1/29 2014
1/30 2014
1/31 2014

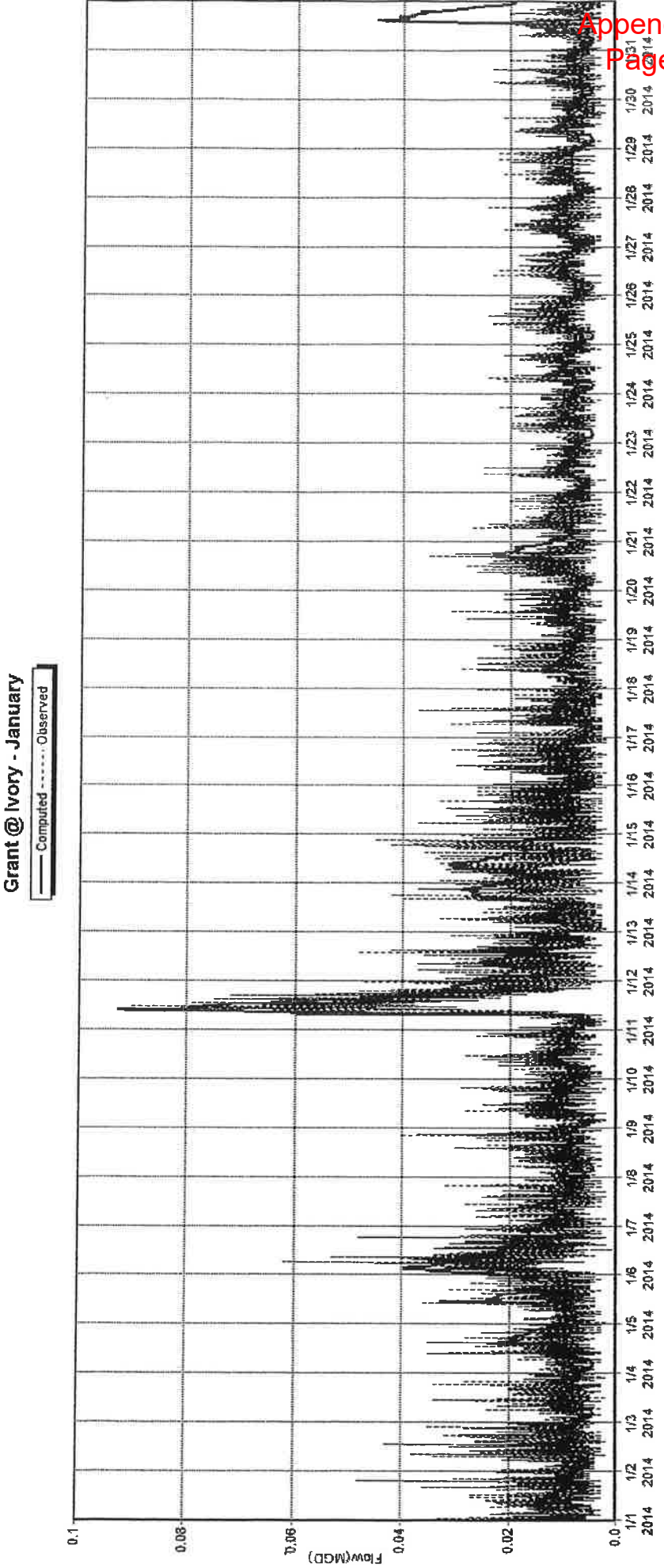

Elks - August
Computed
Observed
Flow(MGD)
0.0
0.2
0.4
0.6
0.8
8/1 2013
8/2 2013
8/3 2013
8/4 2013
8/5 2013
8/6 2013
8/7 2013
8/8 2013
8/9 2013
8/10 2013
8/11 2013
8/12 2013
8/13 2013
8/14 2013
8/15 2013
8/16 2013
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8/21 2013
8/22 2013
8/23 2013
8/24 2013
8/25 2013
8/26 2013
8/27 2013
8/28 2013
8/29 2013
8/30 2013
8/31 2013

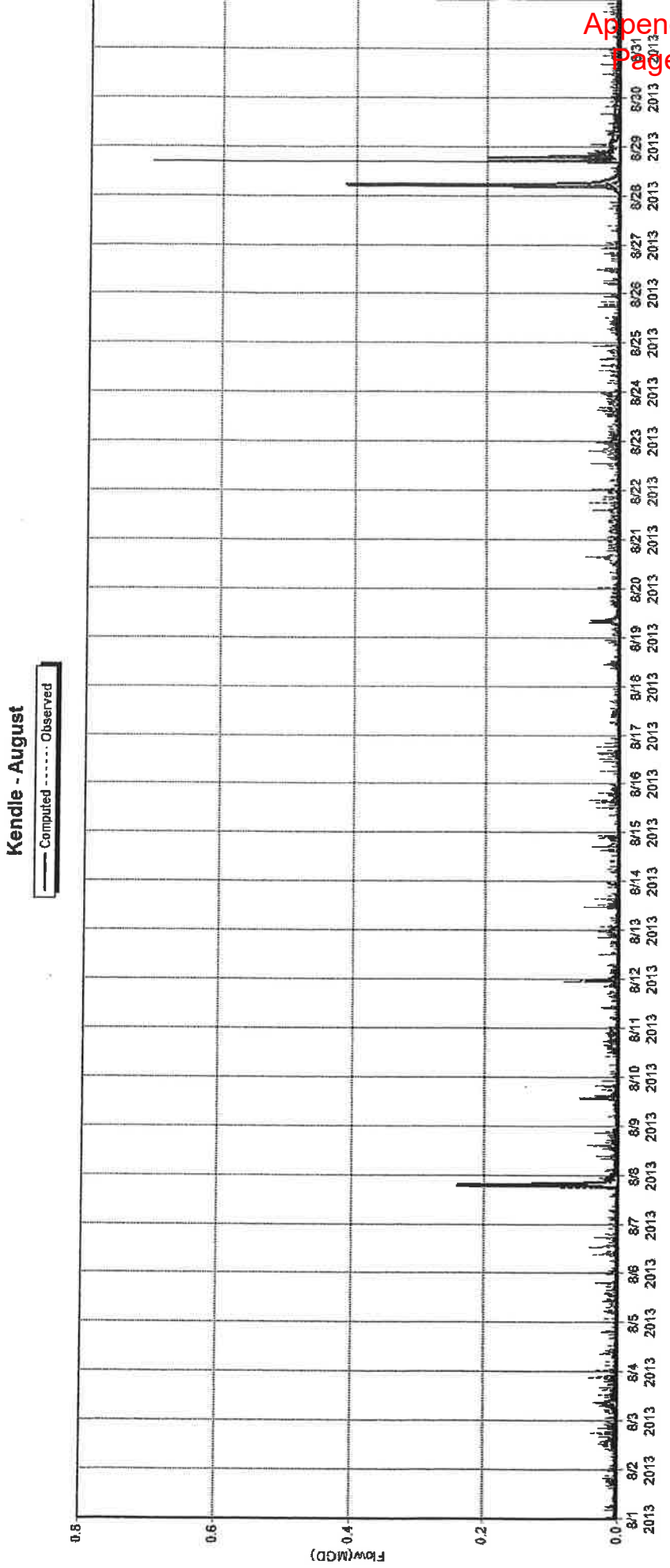

Elks - January
Computed
Observed
Flow(MGD)
0.0
0.2
0.4
0.6
0.8
1/1 2014
1/2 2014
1/3 2014
1/4 2014
1/5 2014
1/6 2014
1/7 2014
1/8 2014
1/9 2014
1/10 2014
1/11 2014
1/12 2014
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1/26 2014
1/27 2014
1/28 2014
1/29 2014
1/30 2014

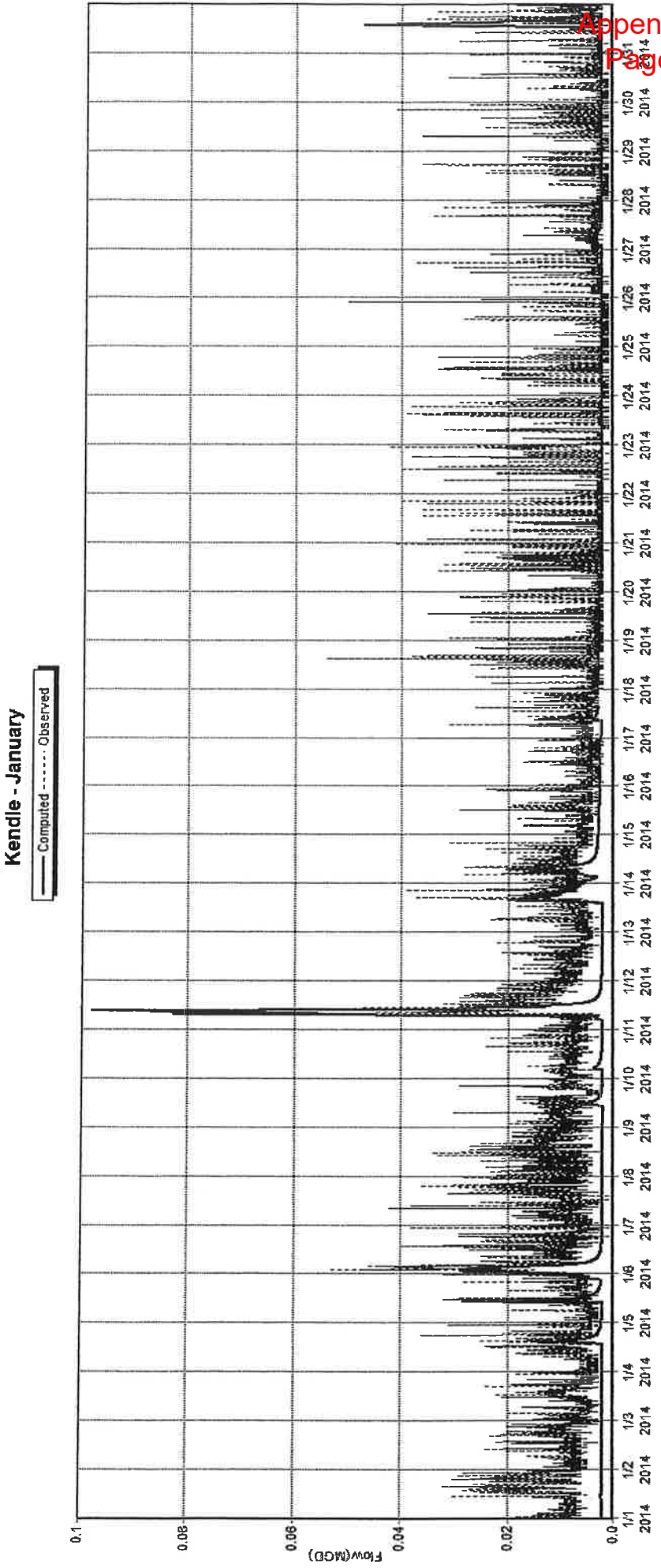

Fallen Timber - August
Computed
Observed
Flow (MGD)
0.4
0.2
0.0
8/1 2013
8/2 2013
8/3 2013
8/4 2013
8/5 2013
8/6 2013
8/7 2013
8/8 2013
8/9 2013
8/10 2013
8/11 2013
8/12 2013
8/13 2013
8/14 2013
8/15 2013
8/16 2013
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8/27 2013
8/28 2013
8/29 2013
8/30 2013
8/31 2013


Fallen Timber - January
Computed
Observed
Flow(MGD)
0.2
0.0
1/1 2014
1/2 2014
1/3 2014
1/4 2014
1/5 2014
1/6 2014
1/7 2014
1/8 2014
1/9 2014
1/10 2014
1/11 2014
1/12 2014
1/13 2014
1/14 2014
1/15 2014
1/16 2014
1/17 2014
1/18 2014
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1/21 2014
1/22 2014
1/23 2014
1/24 2014
1/25 2014
1/26 2014
1/27 2014
1/26 2014
1/29 2014
1/30 2014
1/31 2014


Grant @ Ivory - August
Computed
Observed
Flow (M3CD)
0.4
0.2
0.0
8/1 2013
8/2 2013
8/3 2013
8/4 2013
8/5 2013
8/6 2013
8/7 2013
8/8 2013
8/9 2013
8/10 2013
8/11 2013
8/12 2013
8/13 2013
8/14 2013
8/15 2013
8/16 2013
8/17 2013
8/18 2013
8/19 2013
8/20 2013
8/21 2013
8/22 2013
8/23 2013
8/24 2013
8/25 2013
8/26 2013
8/27 2013
8/28 2013
8/29 2013
8/30 2013
8/31 2013


Grant @ Ivory - January
Computed
Observed
Flow(MGD)
0.1
0.08
0.06
0.04
0.02
0.0
1/1 2014
1/2 2014
1/3 2014
1/4 2014
1/5 2014
1/6 2014
1/7 2014
1/8 2014
1/9 2014
1/10 2014
1/11 2014
1/12 2014
1/13 2014
1/14 2014
1/15 2014
1/16 2014
1/17 2014
1/18 2014
1/19 2014
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1/21 2014
1/22 2014
1/23 2014
1/24 2014
1/25 2014
1/26 2014
1/27 2014
1/28 2014
1/29 2014
1/30 2014
1/31 2014


Kendle - August
Computed
Observed
Flow(MGD)
0.0
0.2
0.4
0.6
0.8
8/1 2013
8/2 2013
8/3 2013
8/4 2013
8/5 2013
8/6 2013
8/7 2013
8/8 2013
8/9 2013
8/10 2013
8/11 2013
8/12 2013
8/13 2013
8/14 2013
8/15 2013
8/16 2013
8/17 2013
8/18 2013
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8/20 2013
8/21 2013
8/22 2013
8/23 2013
8/24 2013
8/25 2013
8/26 2013
8/27 2013
8/28 2013
8/29 2013
8/30 2013
8/31 2013


Kendle - January
Computed
Observed
Flow(MGD)
0.1
0.08
0.06
0.04
0.02
0.0
1/1 2014
1/2 2014
1/3 2014
1/4 2014
1/5 2014
1/6 2014
1/7 2014
1/8 2014
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1/11 2014
1/12 2014
1/13 2014
1/14 2014
1/15 2014
1/16 2014
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1/28 2014
1/29 2014
1/30 2014
1/31 2014

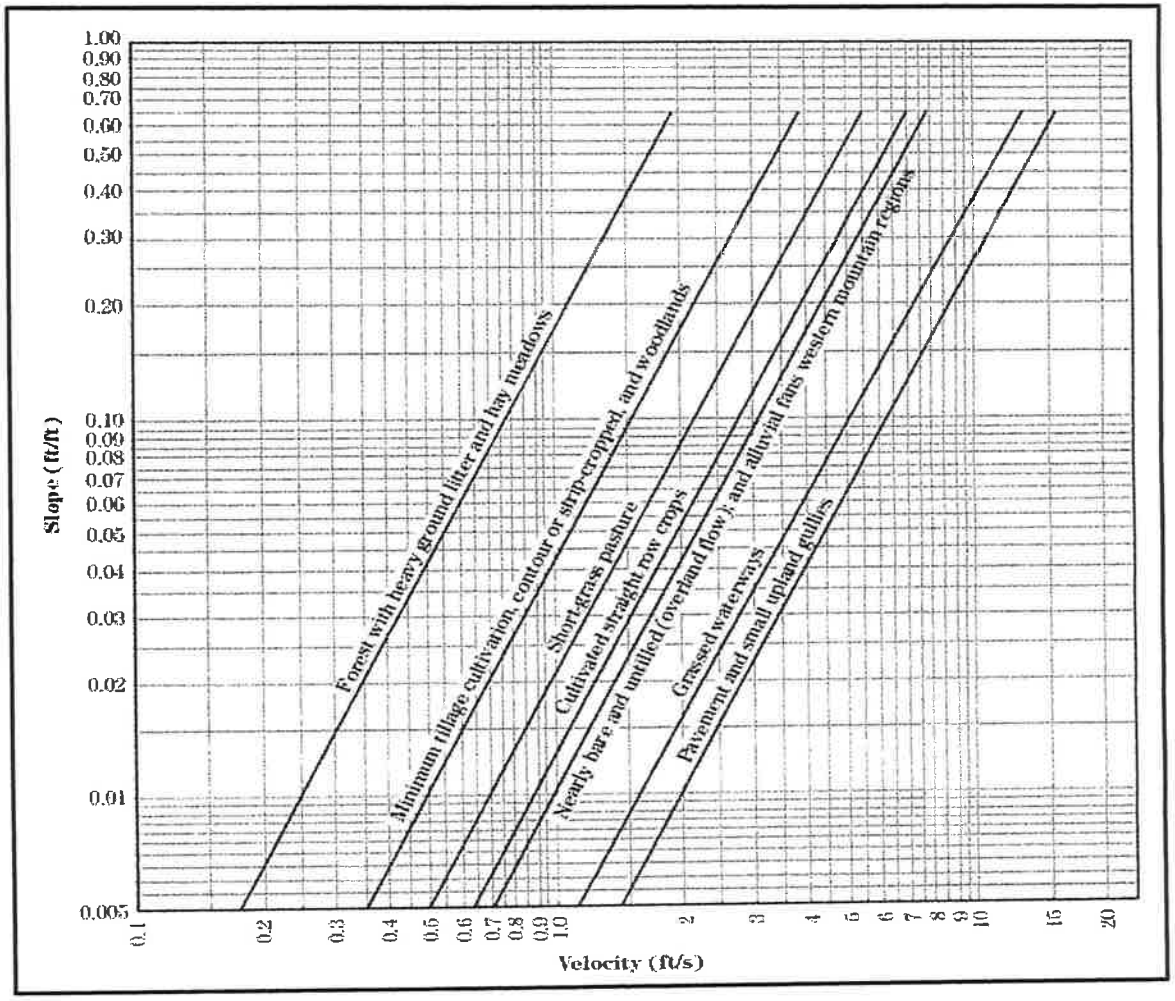
Appendix H

Travel Time Calculation
EBMA LTCP

Sheet Flow		
* Assumed to be the first 100 feet of flow as per The National Enginering Handbook, Chapter 15		
$T_{t,sheet} = \frac{0.007(nL)^{0.8}}{(P_2)^{0.5}\, s^{0.4}}$		
$T_{t,sheet}$	**0.12**	Travel Time (hr)
n	0.15	Roughness
L	100	Length (ft)
P_2	2.3	2-Year, 24-hour rainfall (in.)
s	0.06	Slope (ft/ft)

Shallow Concentrated Flow		
* Velocity is taken from The National Engineering Handbook, Chapter 15 "Velocity versus slope for shallow concentrated flow" graph		
$T_{t,shallow} = \frac{L}{3600\, V}$		
$T_{t,Shallow}$	**0.08**	Travel Time (hr)
L	665	Length (ft)
V	2.2	Velocity (ft/s)
s	0.11	Slope (ft/ft)

Open Channel Flow		
* Velocity is an average of the simplified equivalent system modeld in SWMM as part of the LTCP		
$T_{t,shallow} = \frac{L}{3600\, V}$		
$T_{t,Shallow}$	**0.15**	Travel Time (hr)
L	2000	Length (ft)
V	3.6	Velocity (ft/s)
Total Time (hr.) = 0.36 hours = 22 minutes		



Appendix I

Biological Treatment Alternatives

CSO 3

Peak Required	6.93

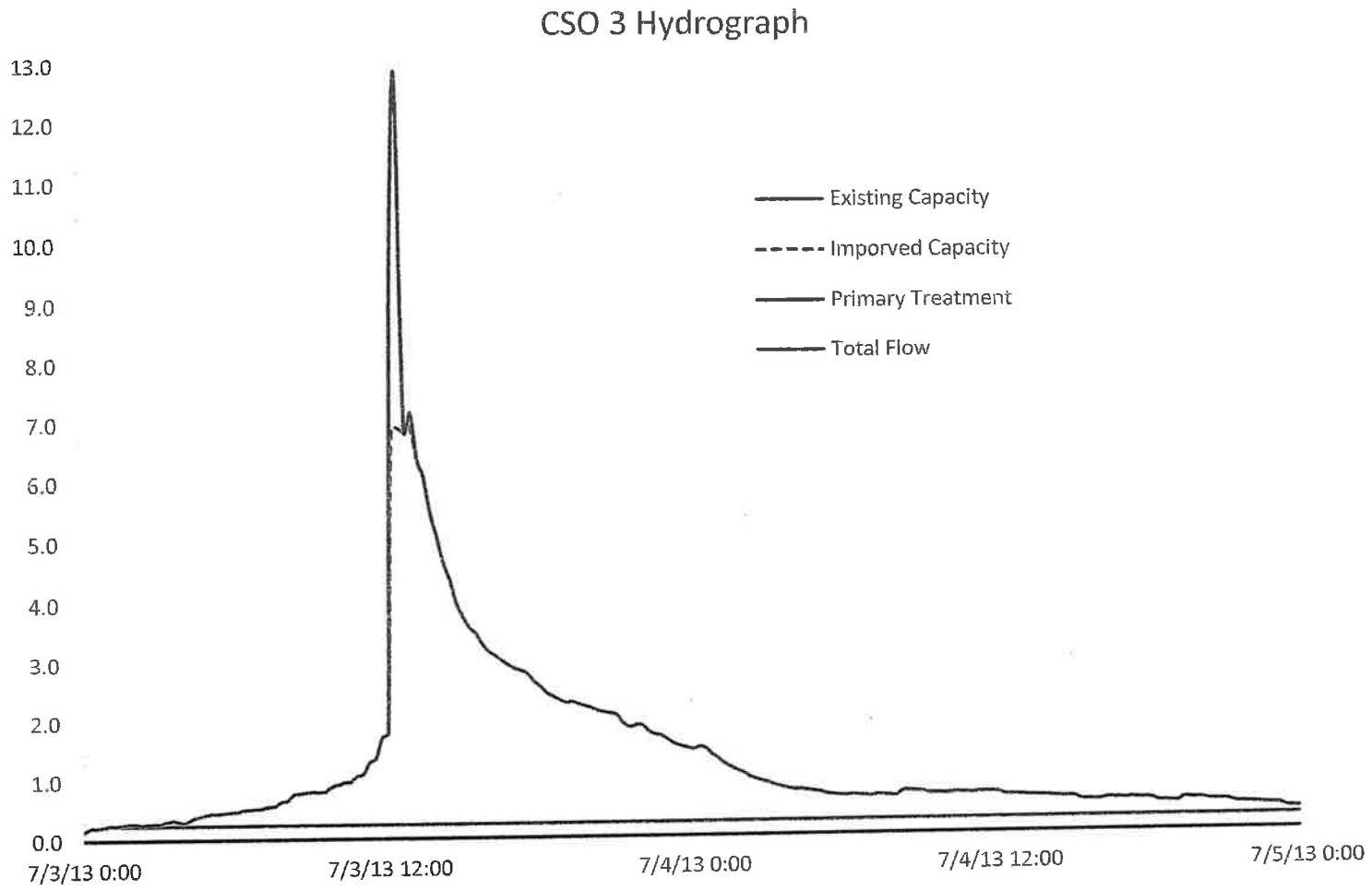
	Peak Inst.	Peak Hour
Allocated Collection/Conveance Capacity (mgd)	0.24	0.24
Additional Collection/Conveance Capacity (mgd)	6.69	6.67
Primary Treatment Capacity (mgd)	0.00	0.00
Total (mgd)	6.93	

Event Volumes						
	A	B	C	D	E	F
	2 Year Total	3 Month Total	2 Year Sanitary	3 Month Combined	2 Year Combined	DWF Combined
Peak (mgd)	12.872	6.933	2.041	6.093	11.731	0.160
Volume (gal.)	2,625,000	1,737,000	1,340,000	729,000	1,285,000	274,000

	Req. Bio. Treatment		Allowable Pri. Treatment	Allowable Discharge
	Inter. Cap.	Impro. Cap.		
Equation	C+F		E-F	E-D
Required Volumes (gal.)	1,614,000		1,011,000	556,000
Proposed Volumes (gal.)	478,000	2,052,000	0	95,000
Total (gal.)	2,530,000		0	95,000
Standards Met?	**YES**		**YES**	**YES**

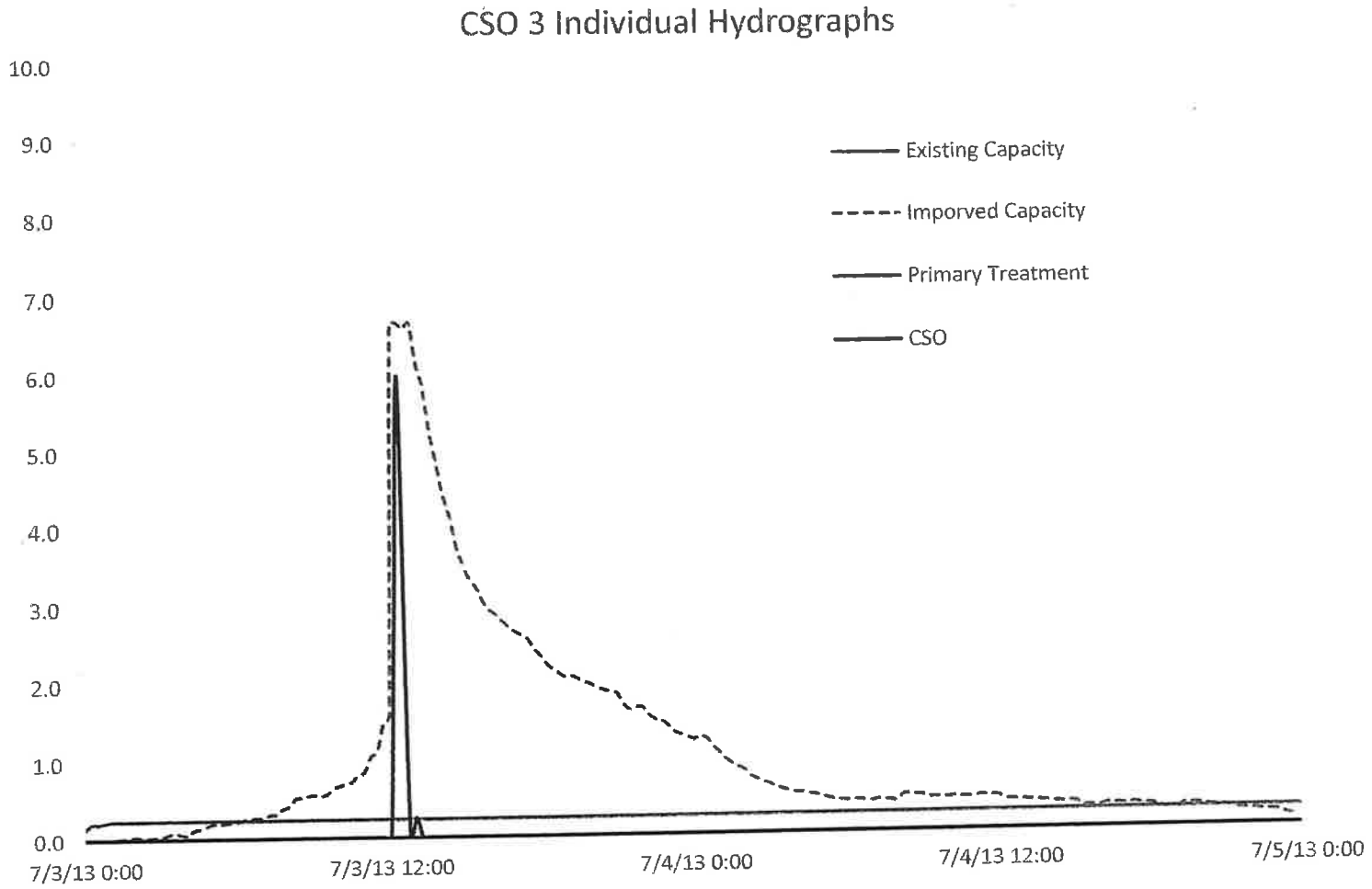
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Biological Treatment Alternatives



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Biological Treatment Alternatives



Appendix A-20-e.2
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Primary Treatment Alternatives

CSO 3

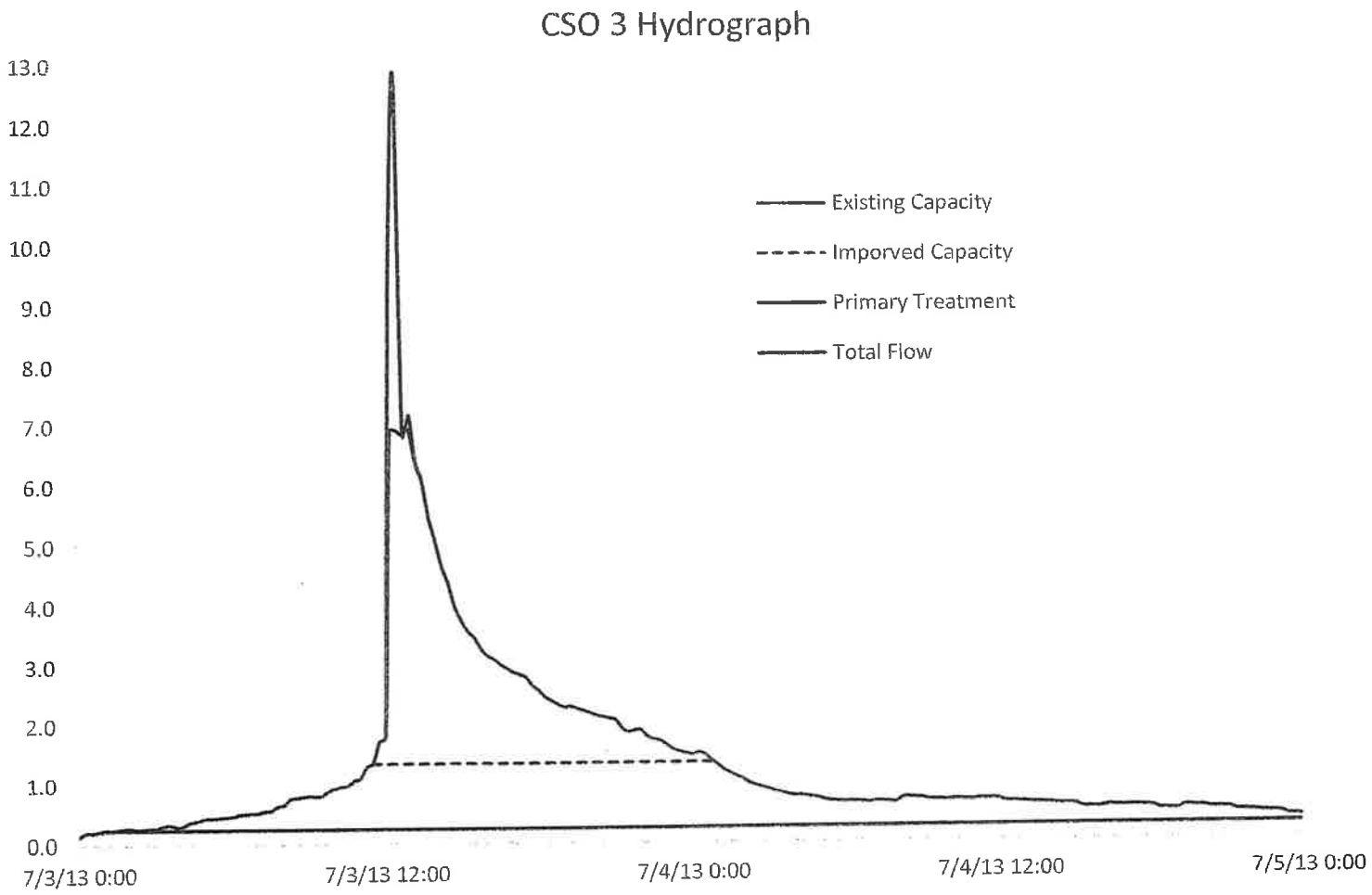
Peak Required	6.93

	Peak Inst.	Peak Hour
Allocated Collection/Conveance Capacity (mgd)	0.24	0.24
Additional Collection/Conveance Capacity (mgd)	1.10	1.10
Primary Treatment Capacity (mgd)	5.59	5.57
Total (mgd)	6.93	

Event Volumes						
	A	B	C	D	E	F
	2 Year Total	3 Month Total	2 Year Sanitary	3 Month Combined	2 Year Combined	DWF Combined
Peak (mgd)	12.872	6.933	2.041	6.093	11.731	0.160
Volume (gal.)	2,625,000	1,737,000	1,340,000	729,000	1,285,000	274,000

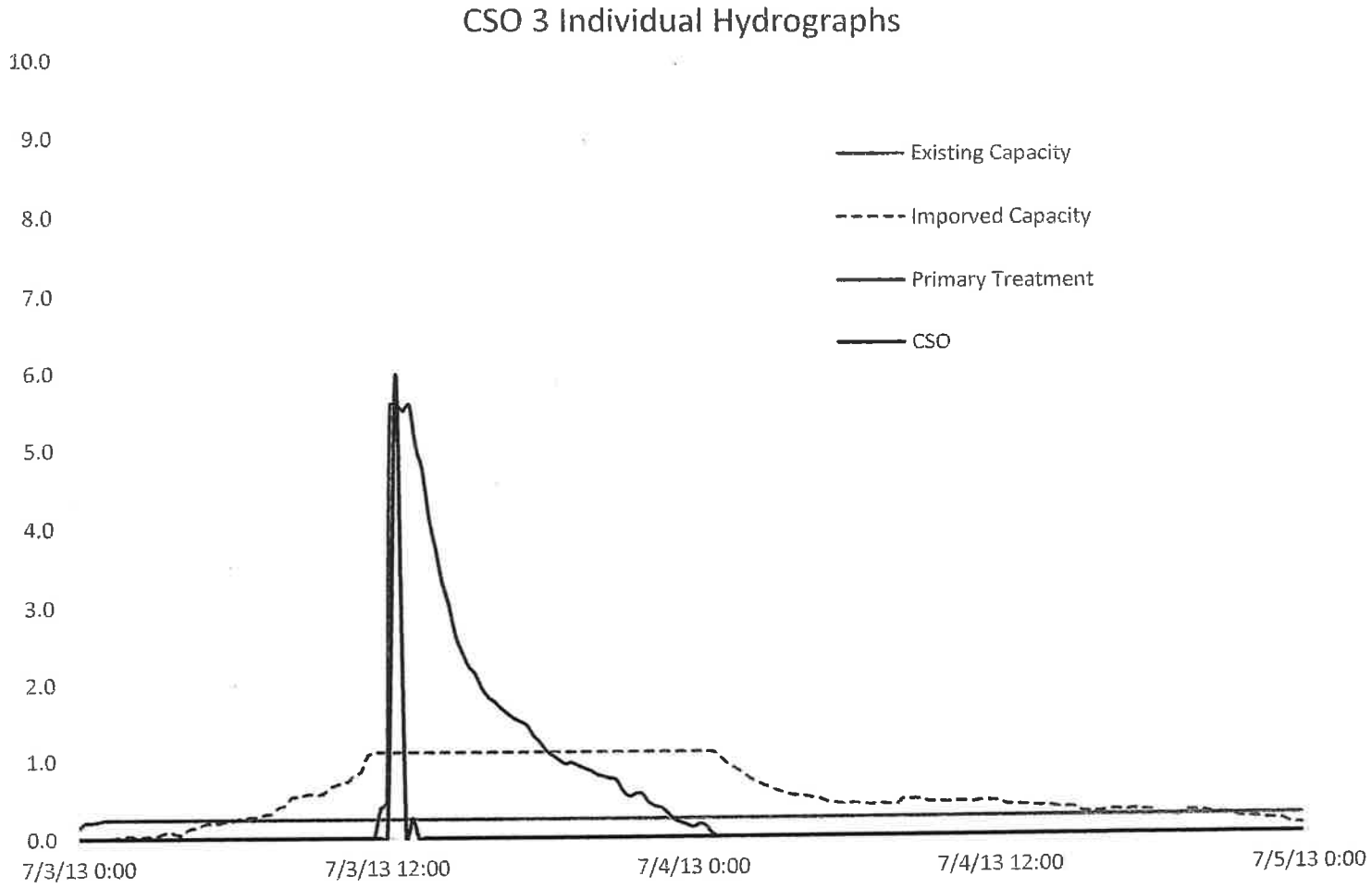
	Req. Bio. Treatment		Allowable Pri. Treatment	Allowable Discharge
	Inter. Cap.	Impro. Cap.		
Equation	C+F		E-F	E-D
Required Volumes (gal.)	1,614,000		1,011,000	556,000
Proposed Volumes (gal.)	478,000	1,136,000	917,000	95,000
Total (gal.)	1,614,000		917,000	95,000
Standards Met?	**YES**		**YES**	**YES**

Primary Treatment Alternatives



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Primary Treatment Alternatives



Appendix A-20-e.2
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Biological Treatment Alternatives

CSO 5

Peak Required	2.13

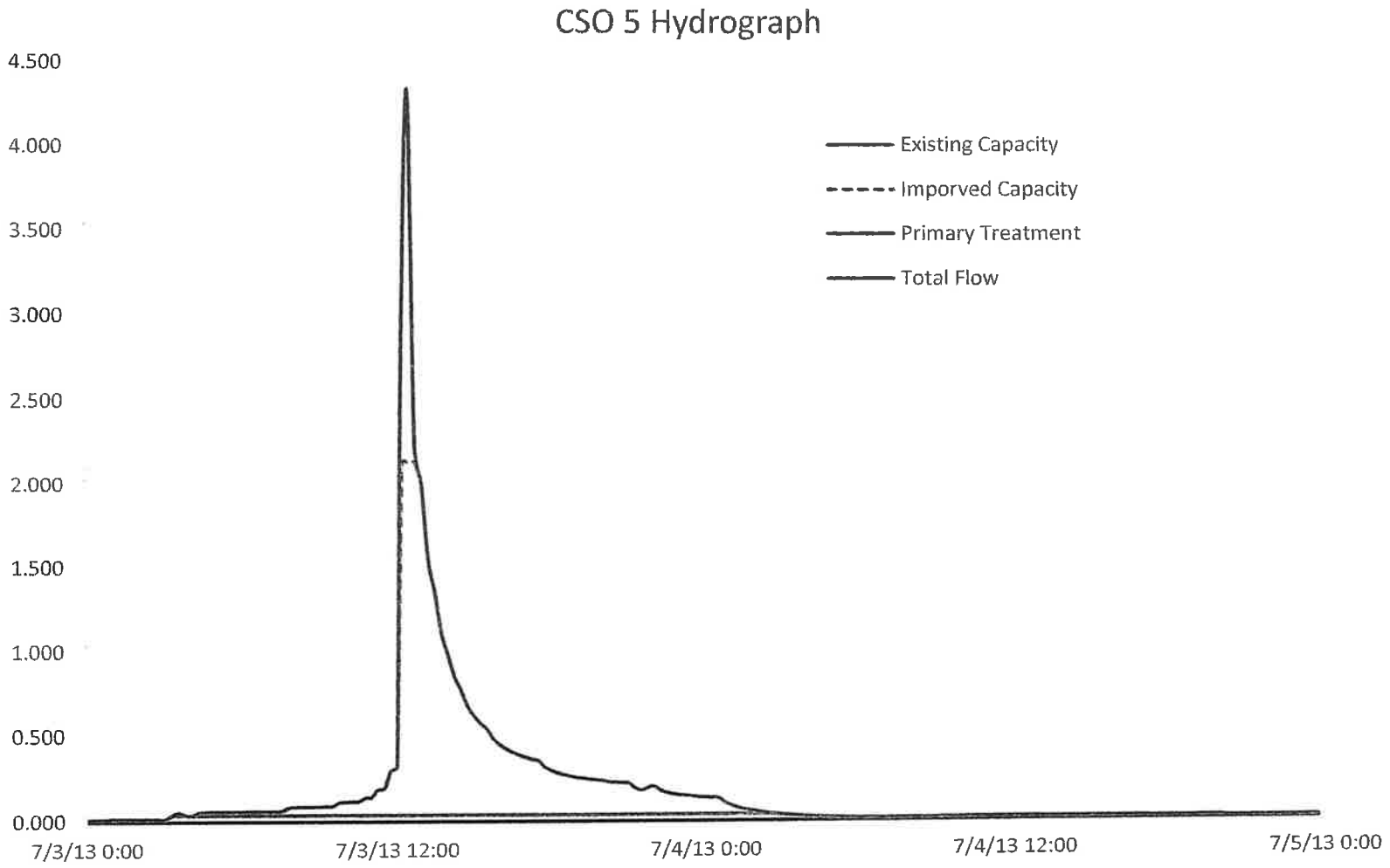
	Peak Inst.	Peak Hour
Allocated Collection/Conveance Capacity (mgd)	0.04	0.04
Additional Collection/Conveance Capacity (mgd)	2.09	2.06
Primary Treatment Capacity (mgd)	0.00	0.00
Total (mgd)	2.13	

Event Volumes						
	A	B	C	D	E	F
	2 Year Total	3 Month Total	2 Year Sanitary	3 Month Combined	2 Year Combined	DWF Combined
Peak (mgd)	4.337	2.133	0.000	2.133	4.337	0.020
Volume (gal.)	367,000	212,000	-	212,000	367,000	33,000

	Req. Bio. Treatment		Allowable Pri. Treatment	Allowable Discharge
	Inter. Cap.	Impro. Cap.		
Equation	C+F		E-F	E-D
Required Volumes (gal.)	33,000		334,000	155,000
Proposed Volumes (gal.)	54,000	280,000	0	33,000
Total (gal.)	334,000		0	33,000
Standards Met?	**YES**		**YES**	**YES**

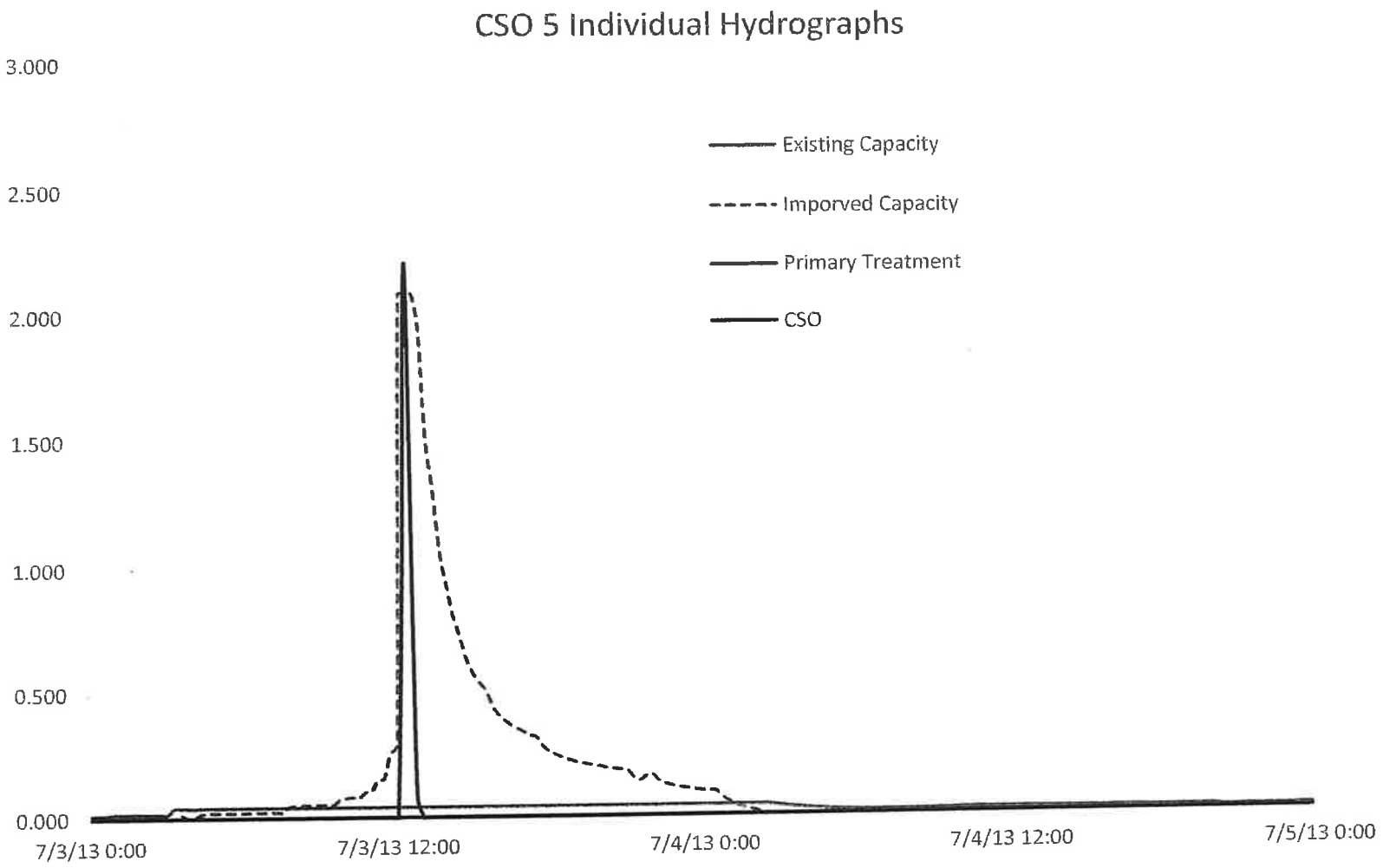
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Biological Treatment Alternatives



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Biological Treatment Alternatives



Appendix A-20-e.2
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Primary Treatment Alternatives

CSO 5

Peak Required	2.13

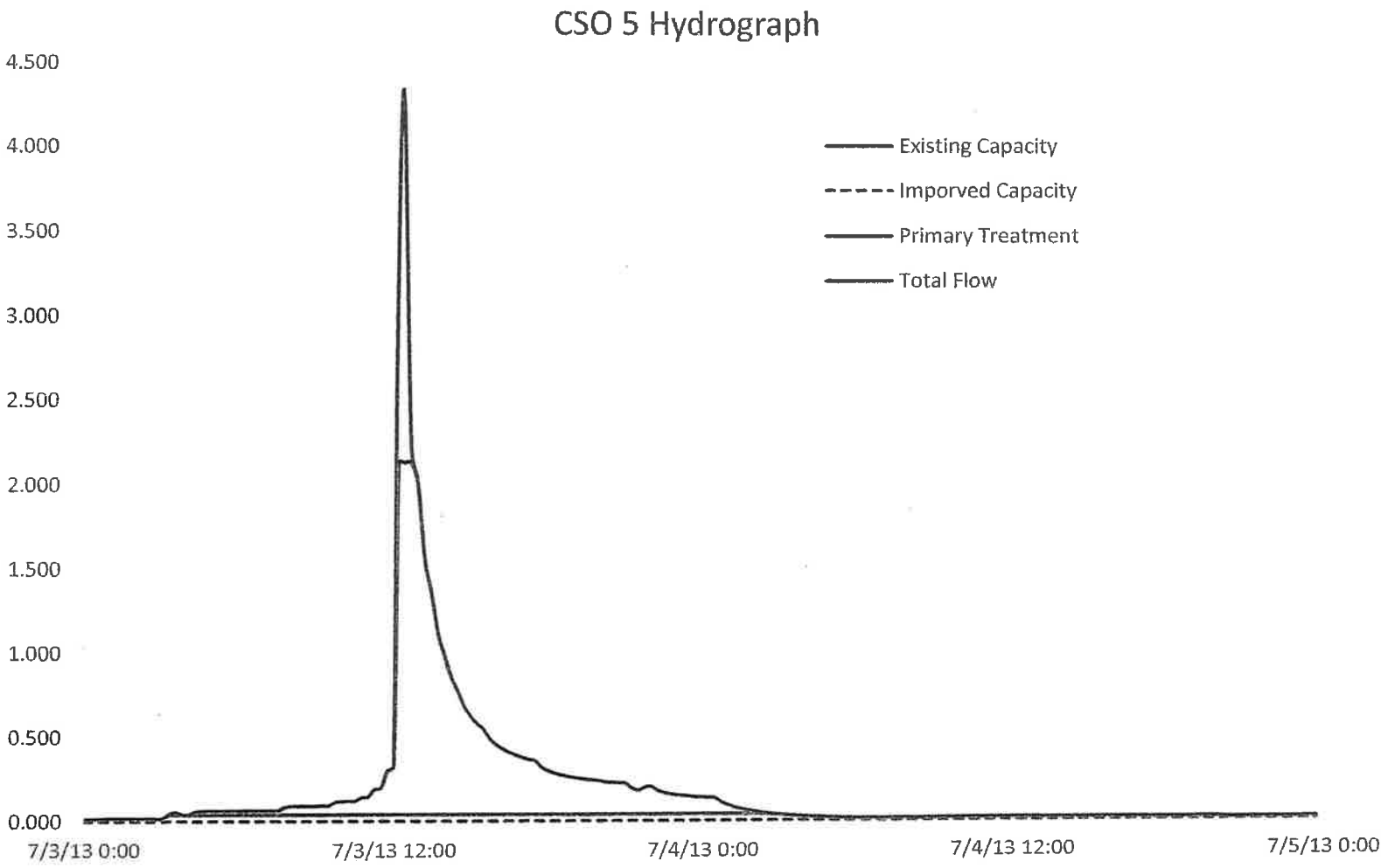
	Peak Inst.	Peak Hour
Allocated Collection/Conveance Capacity (mgd)	0.04	0.04
Additional Collection/Conveance Capacity (mgd)	0.00	0.00
Primary Treatment Capacity (mgd)	2.09	2.06
Total (mgd)	2.13	

Event Volumes						
	A	B	C	D	E	F
	2 Year Total	3 Month Total	2 Year Sanitary	3 Month Combined	2 Year Combined	DWF Combined
Peak (mgd)	4.337	2.133	0.000	2.133	4.337	0.020
Volume (gal.)	367,000	212,000	-	212,000	367,000	33,000

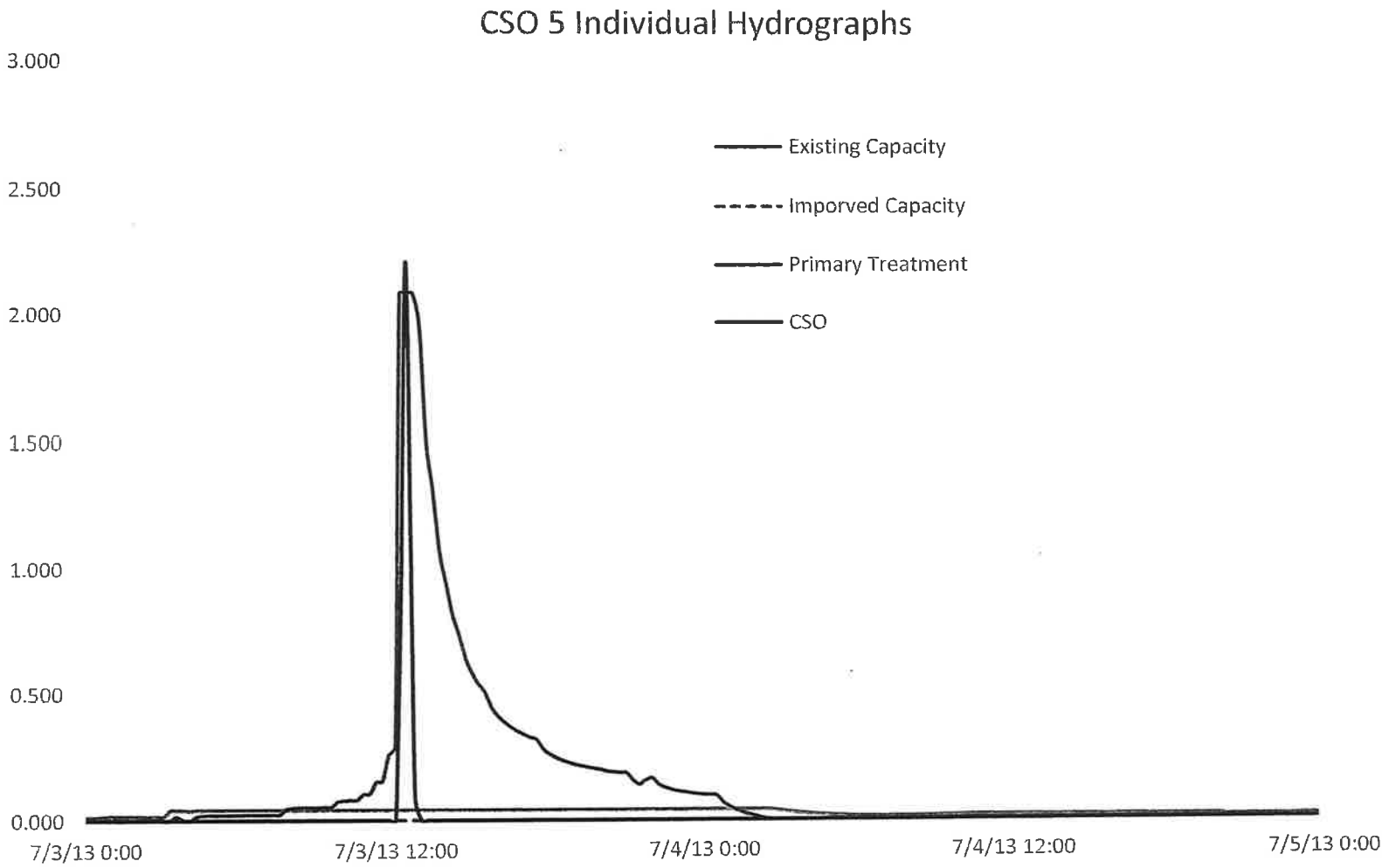
	Req. Bio. Treatment		Allowable Pri. Treatment	Allowable Discharge
	Inter. Cap.	Impro. Cap.		
Equation	C+F		E-F	E-D
Required Volumes (gal.)	33,000		334,000	155,000
Proposed Volumes (gal.)	54,000	0	280,000	33,000
Total (gal.)	54,000		280,000	33,000
Standards Met?	**YES**		**YES**	**YES**

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Primary Treatment Alternatives



Primary Treatment Alternatives



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Biological Treatment Alternatives

CSO 6

Peak Required	5.26

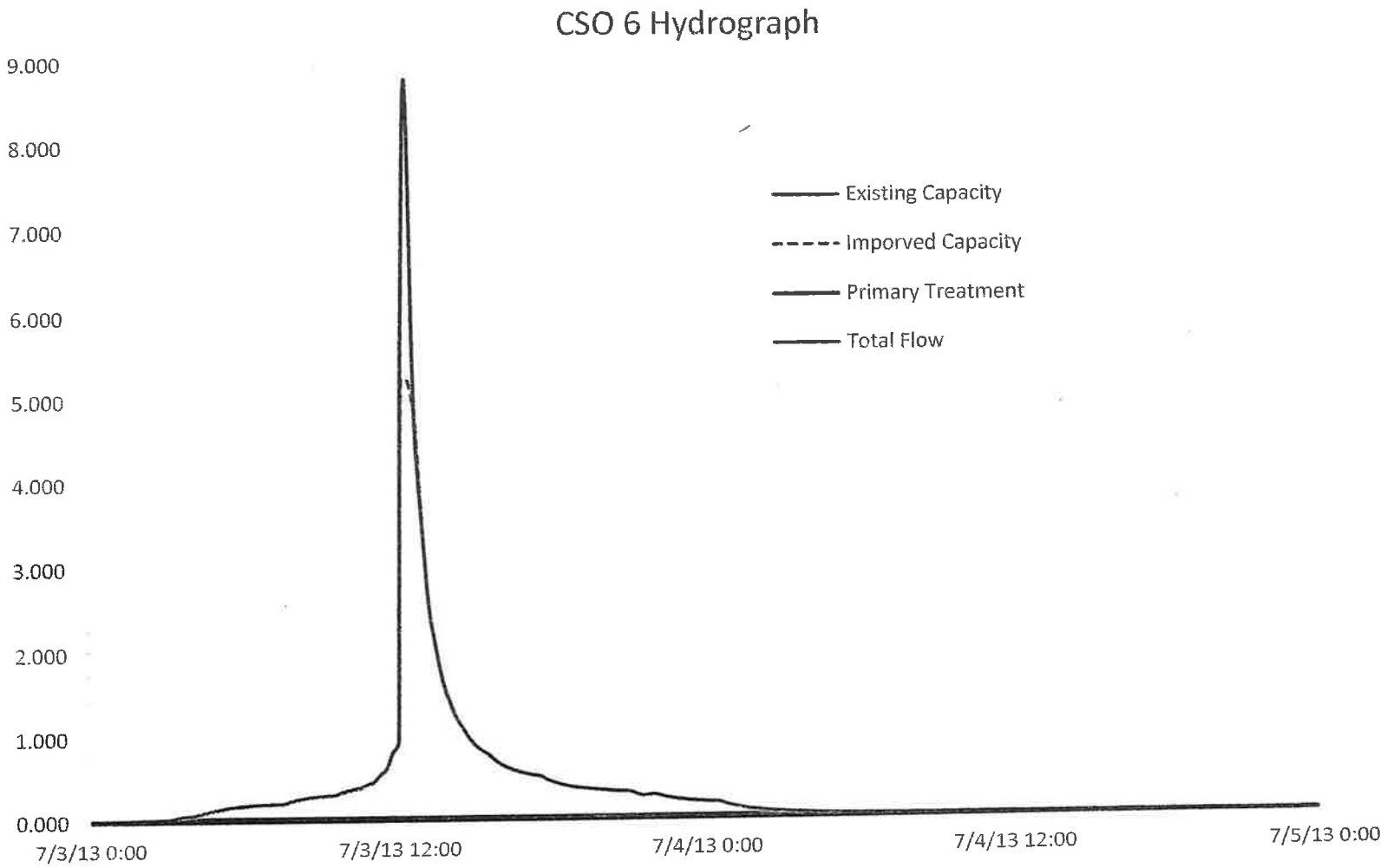
	Peak Inst.	Peak Hour
Allocated Collection/Conveance Capacity (mgd)	0.04	0.04
Additional Collection/Conveance Capacity (mgd)	5.22	4.69
Primary Treatment Capacity (mgd)	0.00	0.00
Total (mgd)	5.26	

Event Volumes						
	A	B	C	D	E	F
	2 Year Total	3 Month Total	2 Year Sanitary	3 Month Combined	2 Year Combined	DWF Combined
Peak (mgd)	8.830	5.264	0.000	5.264	8.830	0.020
Volume (gal.)	656,000	423,000	-	423,000	656,000	33,000

	Req. Bio. Treatment		Allowable Pri. Treatment	Allowable Discharge
	Inter. Cap.	Impro. Cap.		
Equation	C+F		E-F	E-D
Required Volumes (gal.)	33,000		623,000	233,000
Proposed Volumes (gal.)	59,000	554,000	0	43,000
Total (gal.)	613,000		0	43,000
Standards Met?	**YES**		**YES**	**YES**

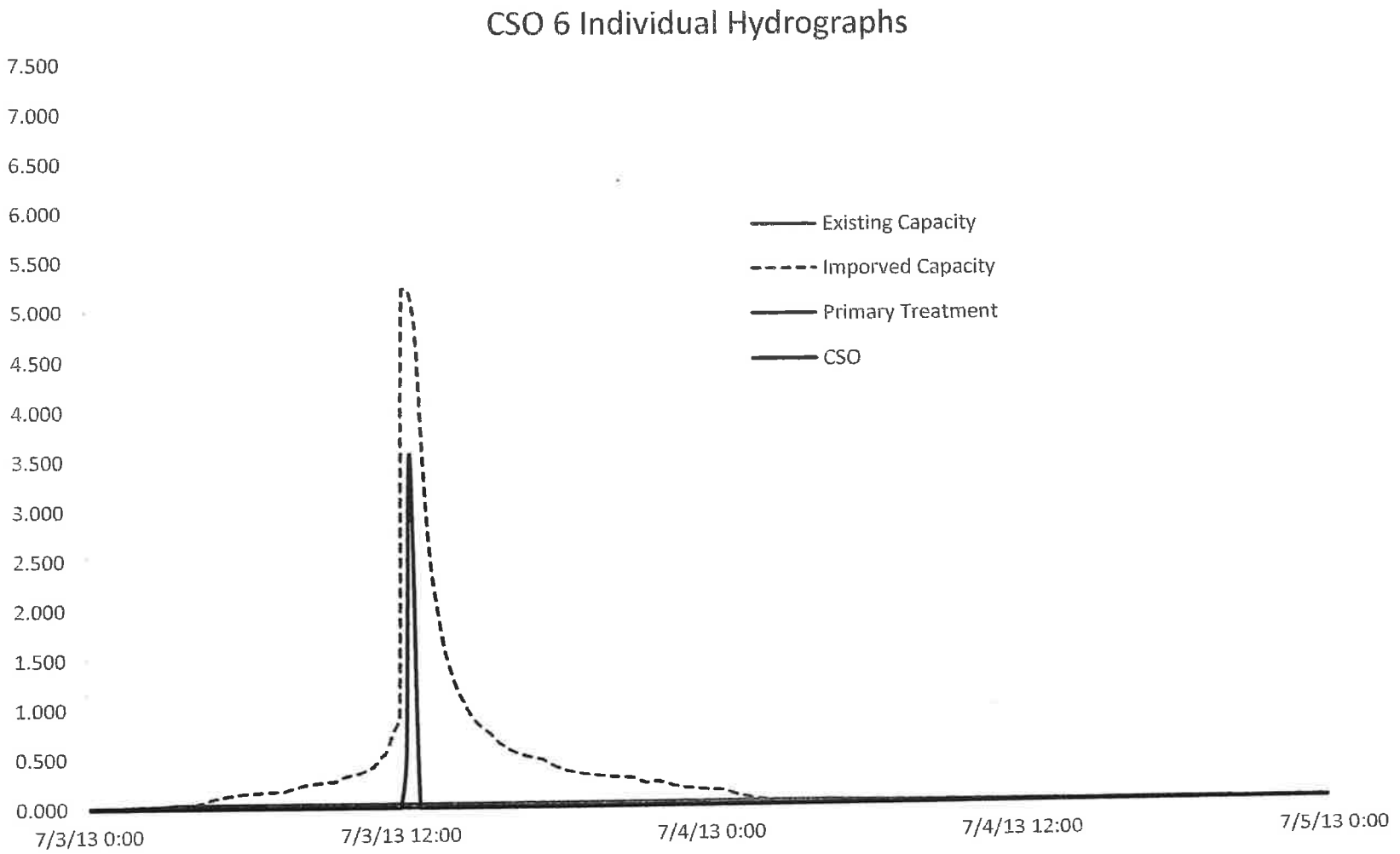
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Biological Treatment Alternatives



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Biological Treatment Alternatives



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Primary Treatment Alternatives

CSO 6

Peak Required	5.26

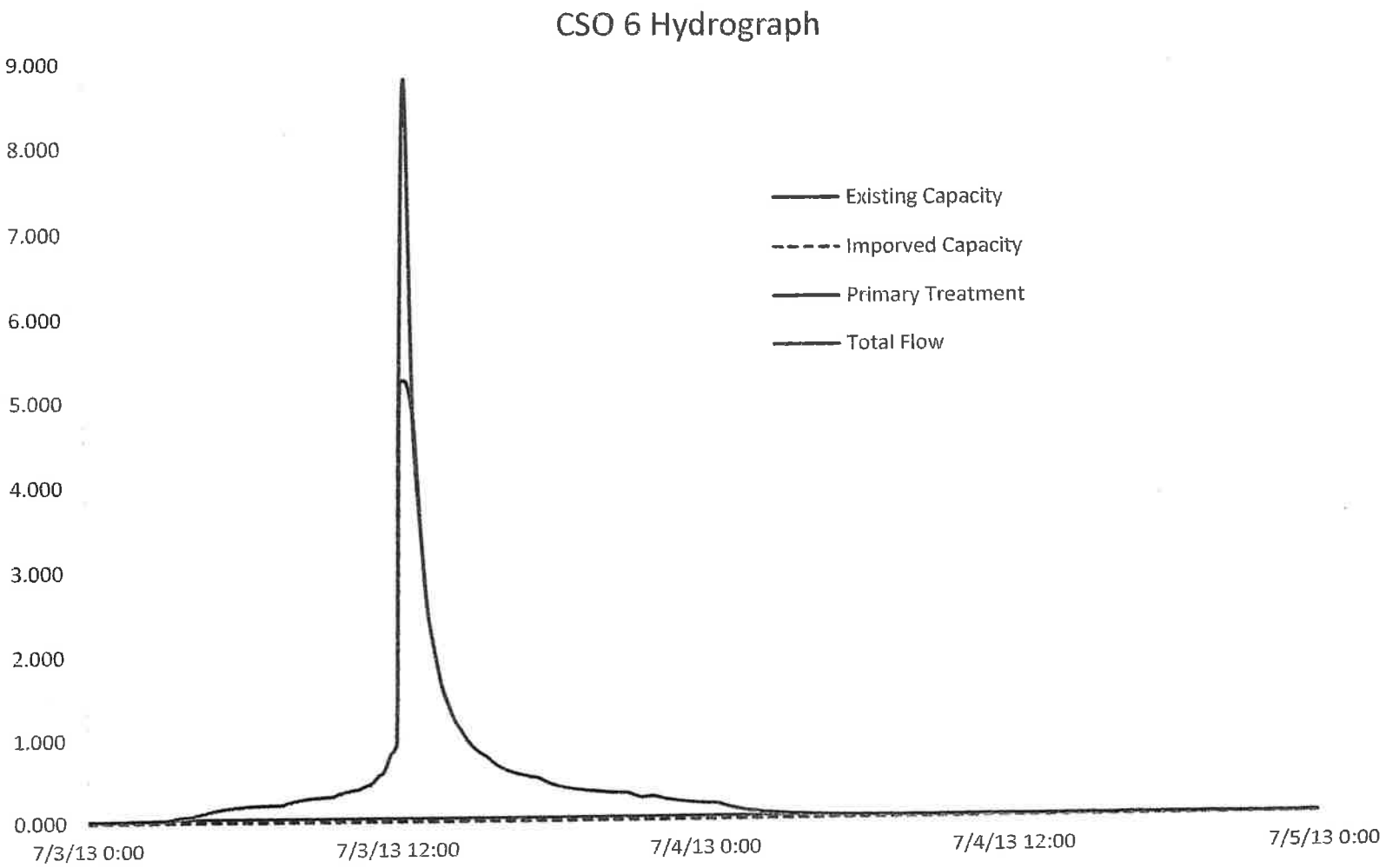
	Peak Inst.	Peak Hour
Allocated Collection/Conveance Capacity (mgd)	0.04	0.04
Additional Collection/Conveance Capacity (mgd)	0.00	0.00
Primary Treatment Capacity (mgd)	5.22	4.69
Total (mgd)	5.26	

Event Volumes						
	A	B	C	D	E	F
	2 Year Total	3 Month Total	2 Year Sanitary	3 Month Combined	2 Year Combined	DWF Combined
Peak (mgd)	8.830	5.264	0.000	5.264	8.830	0.020
Volume (gal.)	656,000	423,000	-	423,000	656,000	33,000

	Req. Bio. Treatment		Allowable Pri. Treatment	Allowable Discharge
	Inter. Cap.	Impro. Cap.		
Equation	C+F		E-F	E-D
Required Volumes (gal.)	33,000		623,000	233,000
Proposed Volumes (gal.)	59,000	0	554,000	43,000
Total (gal.)	59,000		554,000	43,000
Standards Met?	**YES**		**YES**	**YES**

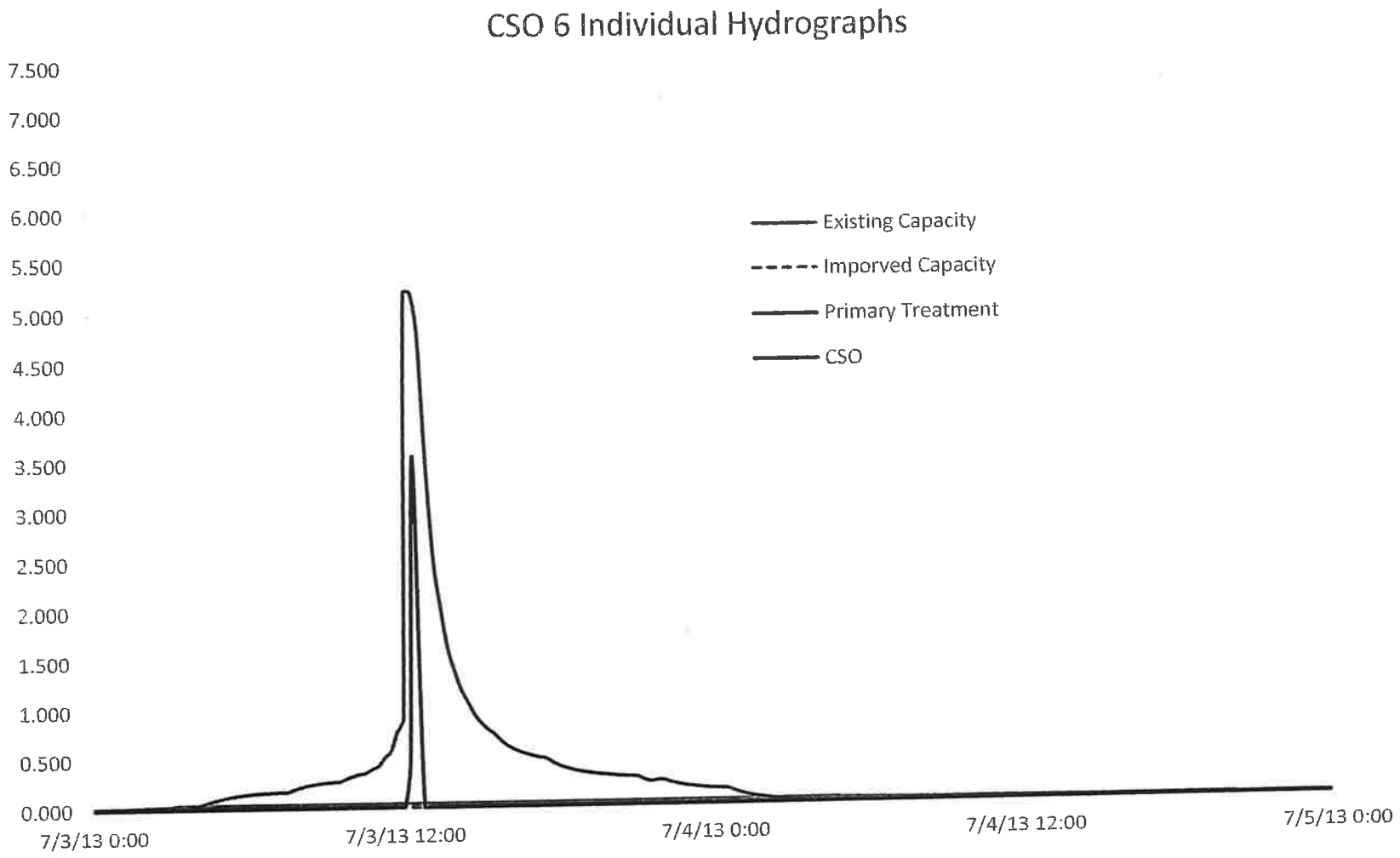
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Primary Treatment Alternatives



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Primary Treatment Alternatives



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Biological Treatment Alternatives

CSO 7

Peak Required	2.80

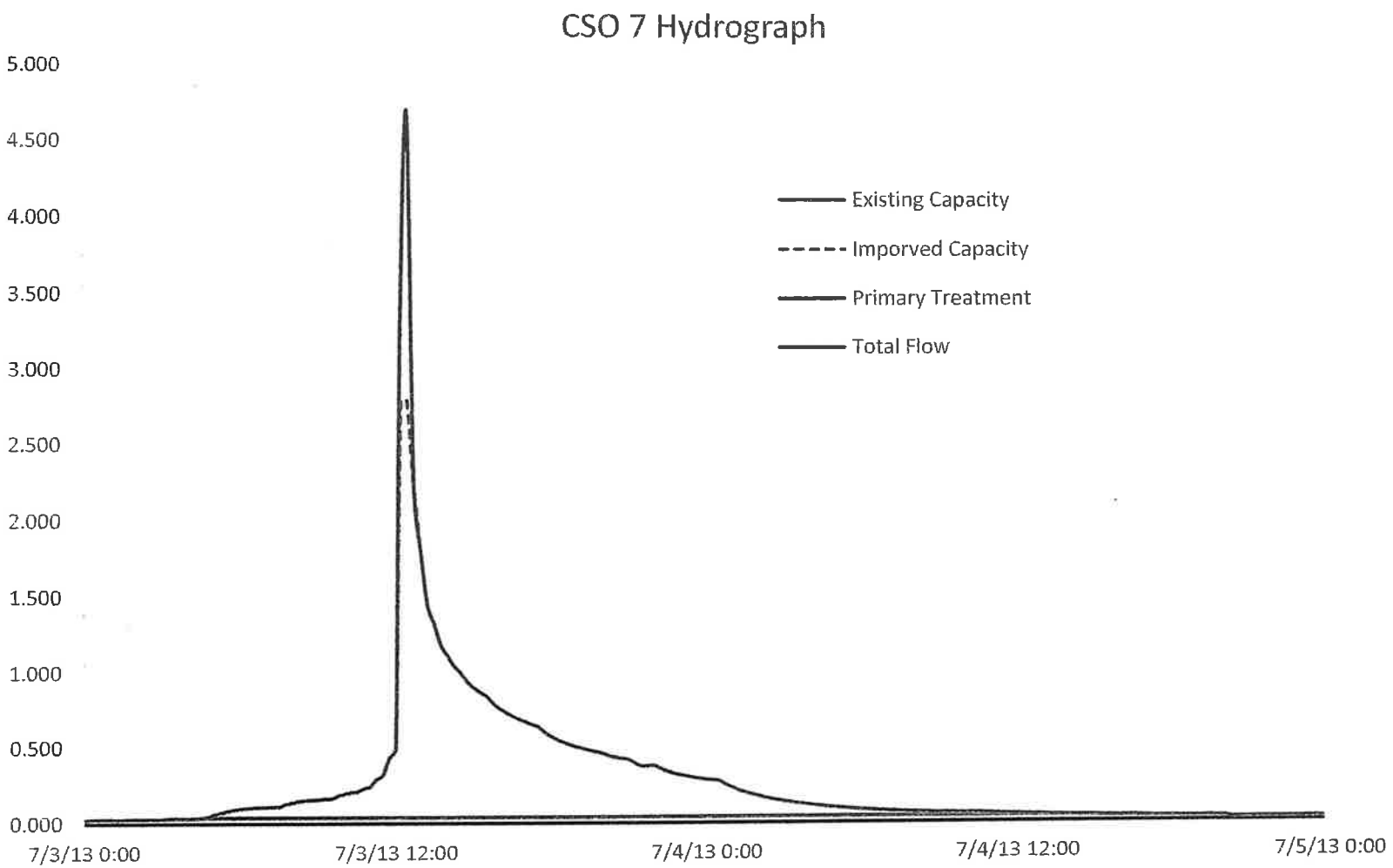
	Peak Inst.	Peak Hour
Allocated Collection/Conveance Capacity (mgd)	0.04	0.04
Additional Collection/Conveance Capacity (mgd)	2.76	2.37
Primary Treatment Capacity (mgd)	0.00	0.00
Total (mgd)	2.80	

Event Volumes						
	A	B	C	D	E	F
	2 Year Total	3 Month Total	2 Year Sanitary	3 Month Combined	2 Year Combined	DWF Combined
Peak (mgd)	4.689	2.801	0.000	2.801	4.689	0.042
Volume (gal.)	541,000	316,000	-	316,000	541,000	70,000

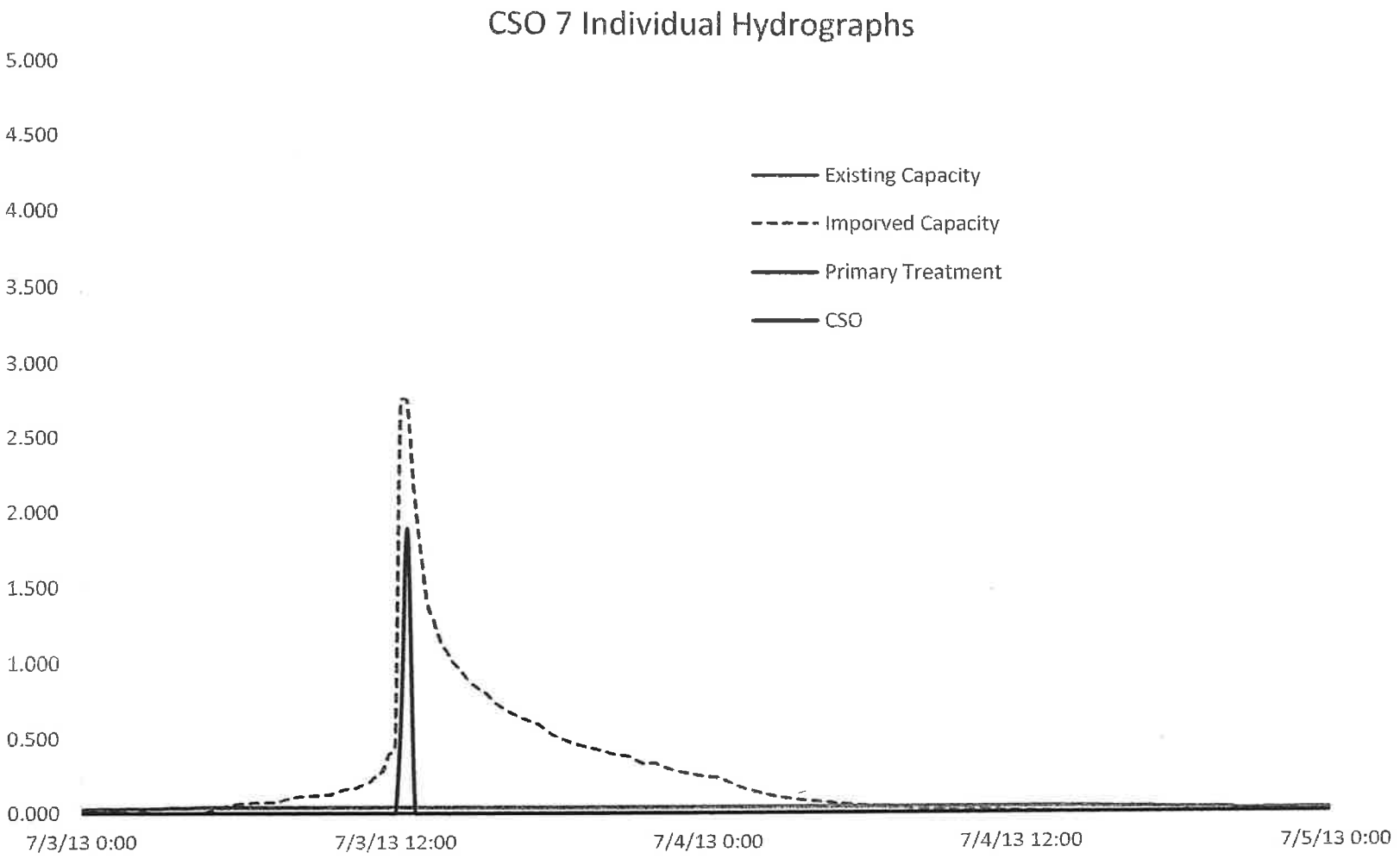
	Req. Bio. Treatment		Allowable Pri. Treatment	Allowable Discharge
	Inter. Cap.	Impro. Cap.		
Equation	C+F		E-F	E-D
Required Volumes (gal.)	70,000		471,000	225,000
Proposed Volumes (gal.)	73,000	441,000	0	27,000
Total (gal.)	514,000		0	27,000
Standards Met?	**YES**		**YES**	**YES**

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Biological Treatment Alternatives



Biological Treatment Alternatives



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Primary Treatment Alternatives

CSO 7

Peak Required	2.80

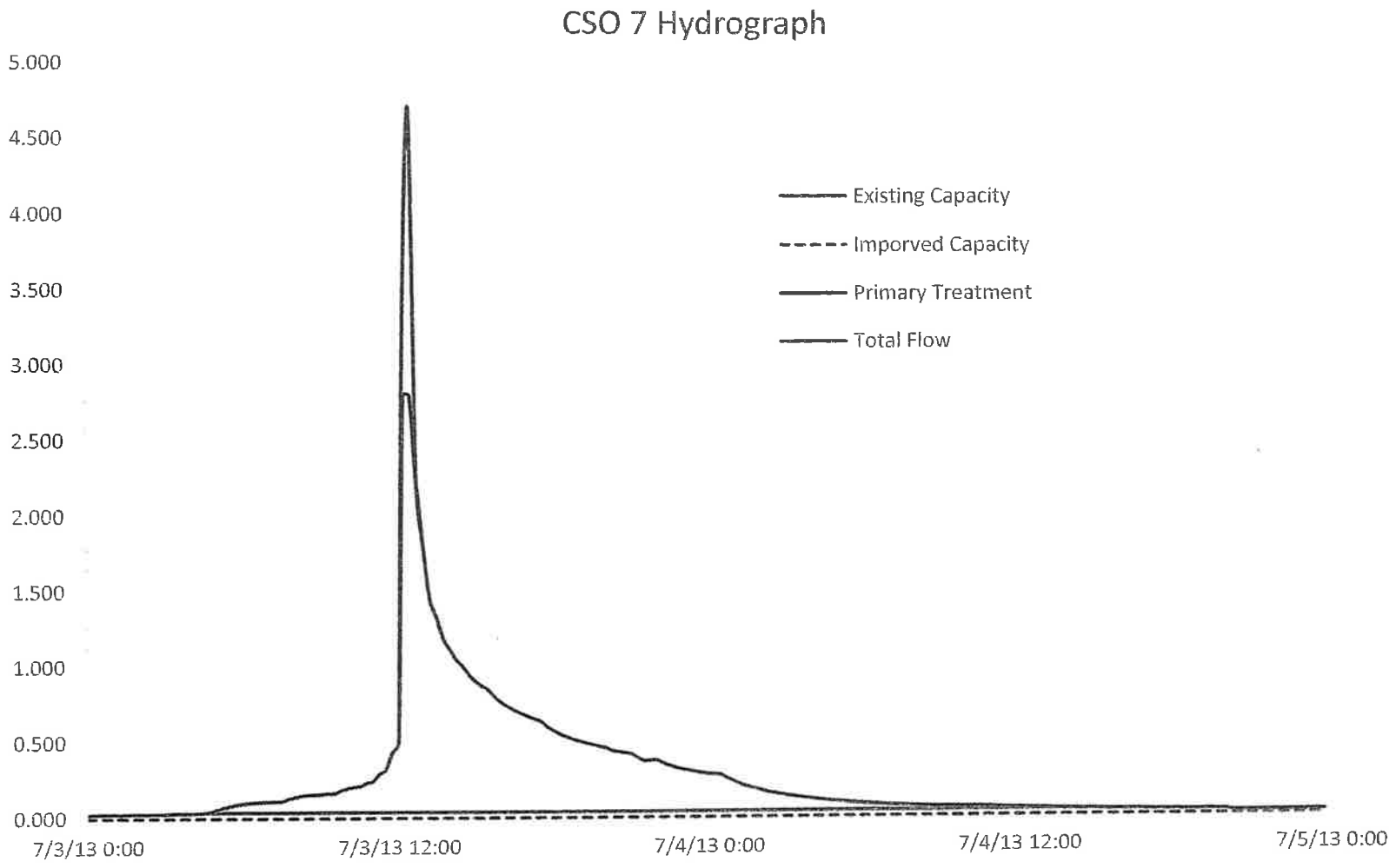
	Peak Inst.	Peak Hour
Allocated Collection/Conveance Capacity (mgd)	0.04	0.04
Additional Collection/Conveance Capacity (mgd)	0.00	0.00
Primary Treatment Capacity (mgd)	2.76	2.37
Total (mgd)	2.80	

Event Volumes						
	A	B	C	D	E	F
	2 Year Total	3 Month Total	2 Year Sanitary	3 Month Combined	2 Year Combined	DWF Combined
Peak (mgd)	4.689	2.801	0.000	2.801	4.689	0.042
Volume (gal.)	541,000	316,000	-	316,000	541,000	70,000

	Req. Bio. Treatment		Allowable Pri. Treatment	Allowable Discharge
	Inter. Cap.	Impro. Cap.		
Equation	C+F		E-F	E-D
Required Volumes (gal.)	70,000		471,000	225,000
Proposed Volumes (gal.)	73,000	0	441,000	27,000
Total (gal.)	73,000		441,000	27,000
Standards Met?	**YES**		**YES**	**YES**

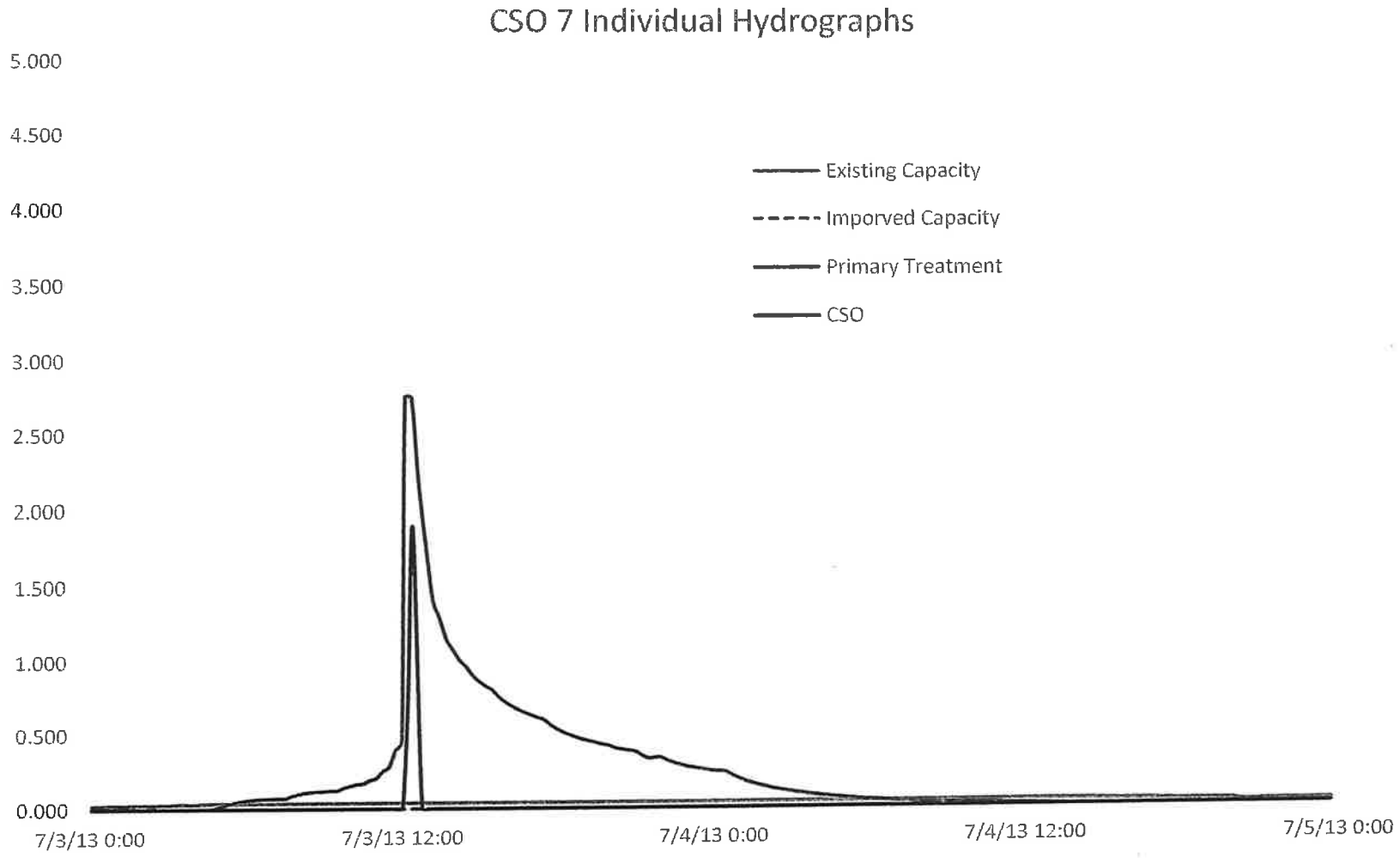
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Biological Treatment Alternatives

CSO 8

Peak Required	5.57

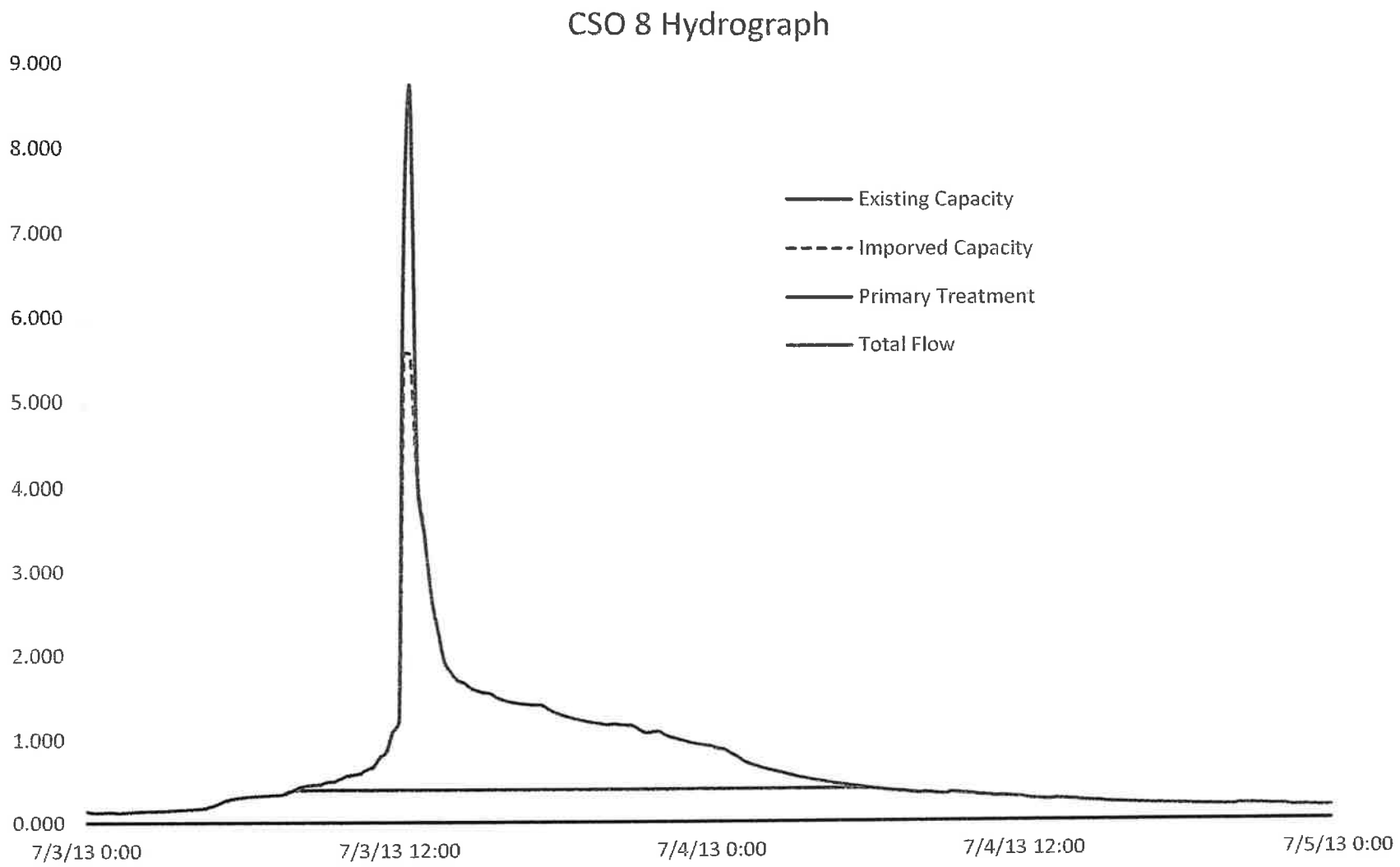
	Peak Inst.	Peak Hour
Allocated Collection/Conveance Capacity (mgd)	0.40	0.40
Additional Collection/Conveance Capacity (mgd)	5.17	4.27
Primary Treatment Capacity (mgd)	0.00	0.00
Total (mgd)	5.57	

Event Volumes						
	A	B	C	D	E	F
	2 Year Total	3 Month Total	2 Year Sanitary	3 Month Combined	2 Year Combined	DWF Combined
Peak (mgd)	8.702	5.574	1.467	4.625	7.235	0.137
Volume (gal.)	1,371,000	802,000	353,000	570,000	1,017,000	243,000

	Req. Bio. Treatment		Allowable Pri. Treatment	Allowable Discharge
	Inter. Cap.	Impro. Cap.		
Equation	C+F		E-F	E-D
Required Volumes (gal.)	596,000		774,000	447,000
Proposed Volumes (gal.)	625,000	699,000	0	47,000
Total (gal.)	1,324,000		0	47,000
Standards Met?	**YES**		**YES**	**YES**

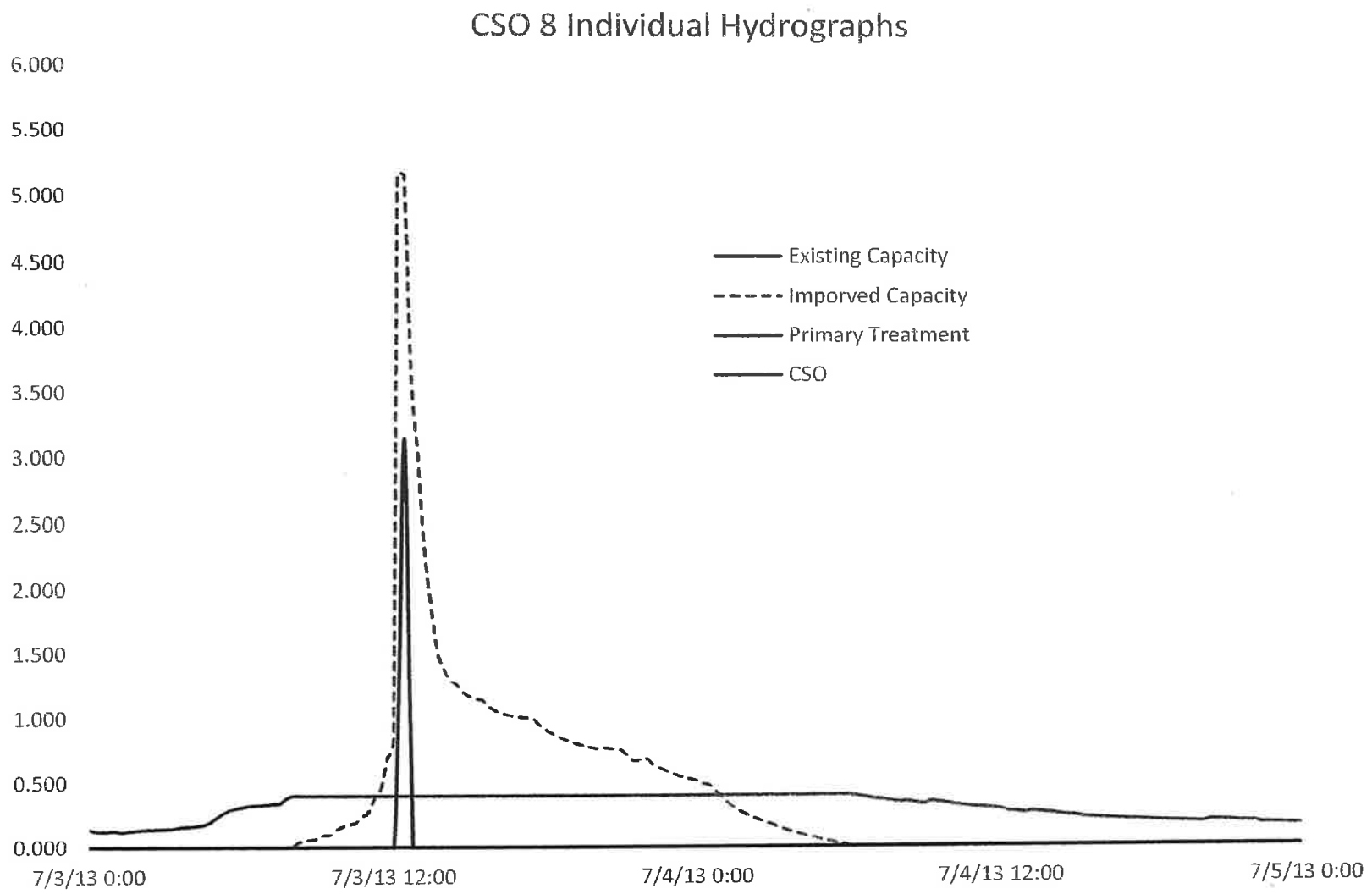
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Primary Treatment Alternatives

CSO 8

Peak Required	5.57

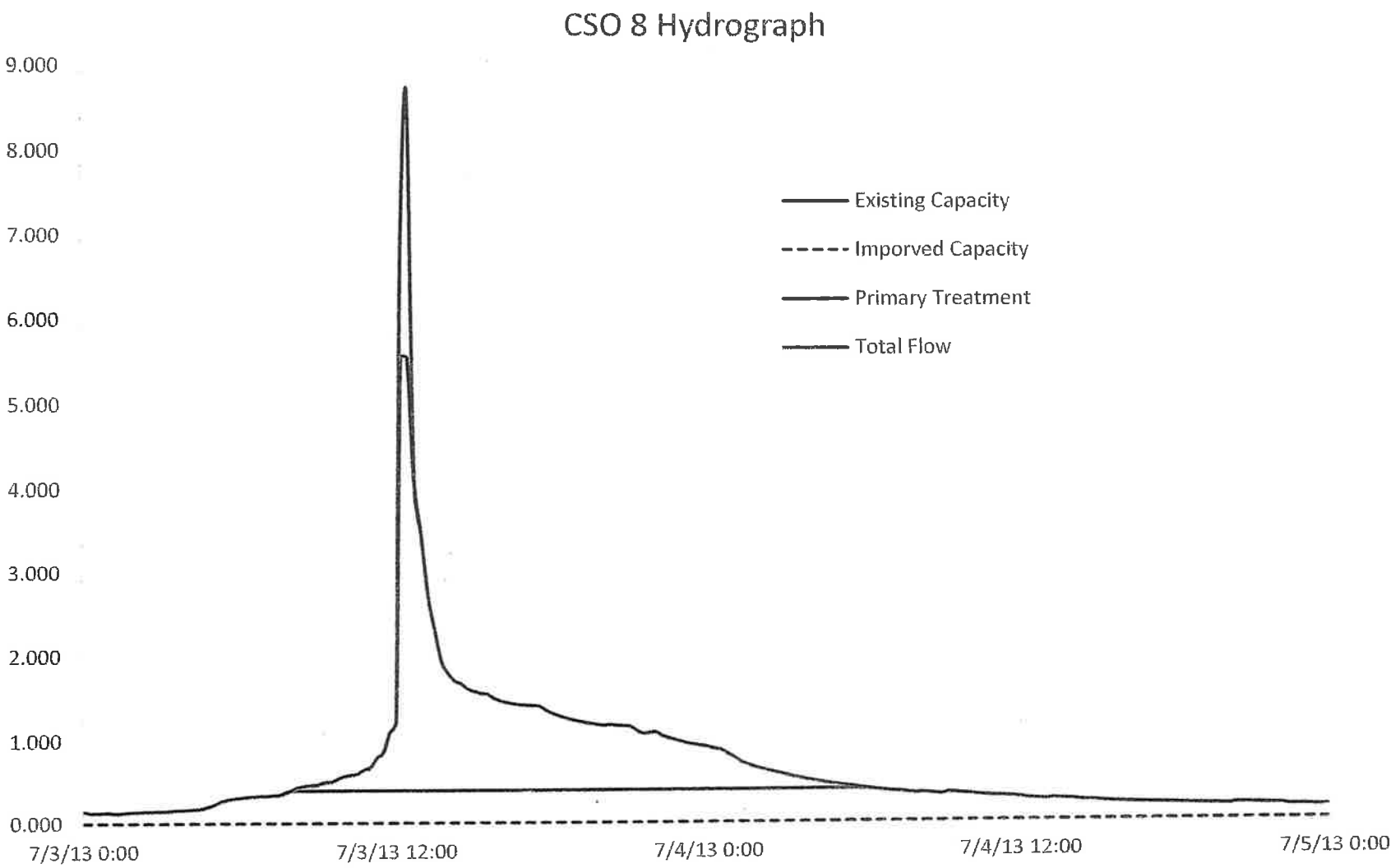
	Peak Inst.	Peak Hour
Allocated Collection/Conveance Capacity (mgd)	0.40	0.40
Additional Collection/Conveance Capacity (mgd)	0.00	0.00
Primary Treatment Capacity (mgd)	5.17	4.27
Total (mgd)	5.57	

Event Volumes						
	A	B	C	D	E	F
	2 Year Total	3 Month Total	2 Year Sanitary	3 Month Combined	2 Year Combined	DWF Combined
Peak (mgd)	8.702	5.574	1.467	4.625	7.235	0.137
Volume (gal.)	1,371,000	802,000	353,000	570,000	1,017,000	243,000

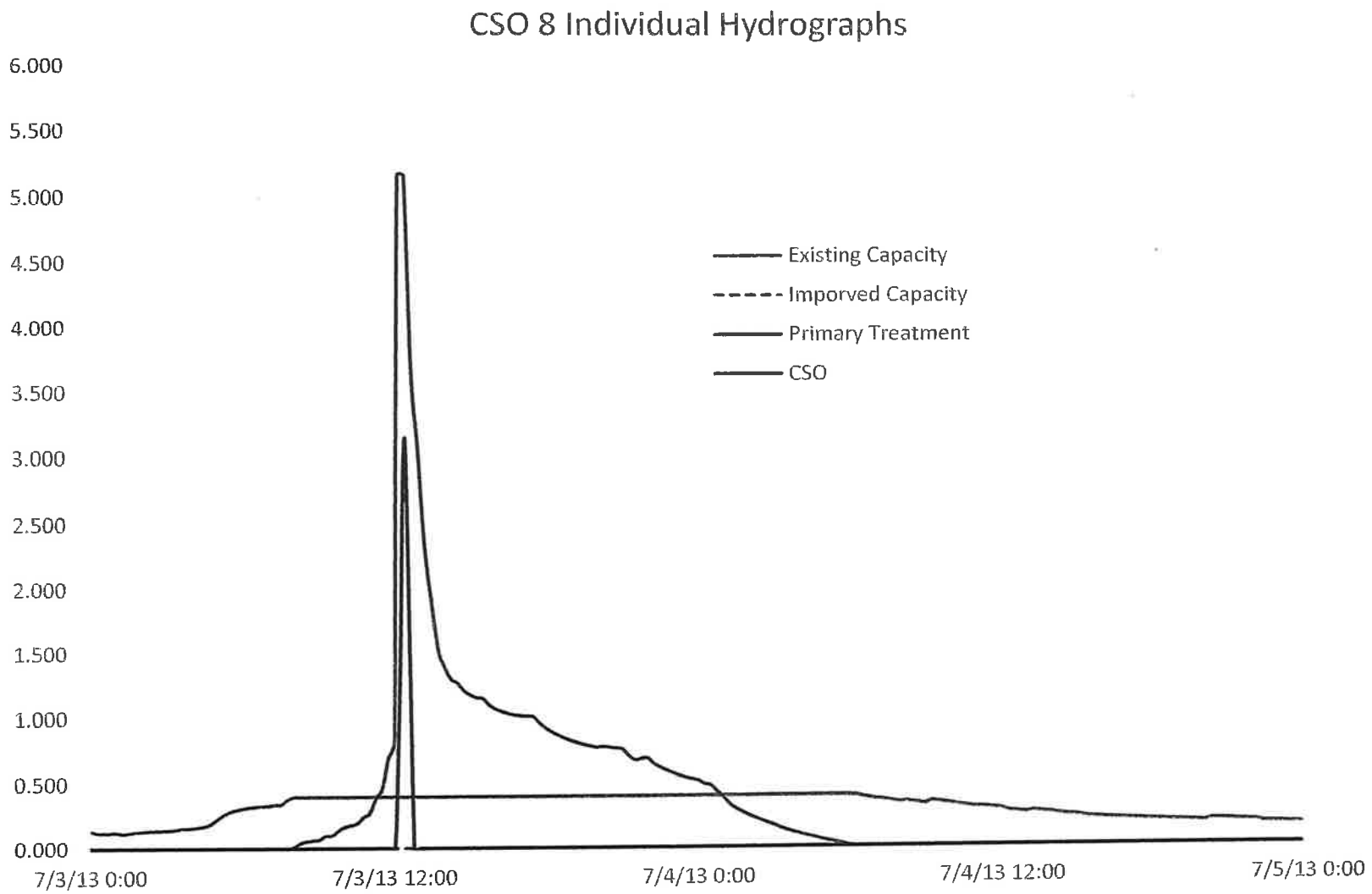
	Req. Bio. Treatment		Allowable Pri. Treatment	Allowable Discharge
	Inter. Cap.	Impro. Cap.		
Equation	C+F		E-F	E-D
Required Volumes (gal.)	596,000		774,000	447,000
Proposed Volumes (gal.)	625,000	0	699,000	47,000
Total (gal.)	625,000		699,000	47,000
Standards Met?	**YES**		**YES**	**YES**

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Primary Treatment Alternatives



Primary Treatment Alternatives



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Hydrograph Table
Design Flow Derivation
2 Year Recurrance Interval Storm

Time	Precip	Exported From SWMM													Calculated												
		Total					Forward Township			Elizabeth Township					Sanitary Flow						Combined Flow						
		SS 8	SS 7	SS 6	SS 5	SS 3	Boro.	Center	Grant	Kendle	Chicago	Church	Cemetary	Fallen	SS 8	SS 7	SS 6	SS 5	SS 3	Boro.	SS 8	SS 7	SS 6	SS 5	SS 3	Boro.
7/3/13 0:00	0	0.14378	0.02253	0.01081	0.01081	0.14344	0.04415	0.00672	0.00731	0.002	0.00693	0.03136	0.08586	0.040647	0.01603	0	0	0	0.12415	0	0.12775	0.02253	0.01081	0.01081	0.01929	0.04415
7/3/13 0:15	0	0.12669	0.027	0.01296	0.01296	0.20832	0.05292	0.00546	0.00797	0.002	0.00564	0.02871	0.08333	0.03848	0.01543	0	0	0	0.11768	0	0.11126	0.027	0.01296	0.01296	0.09064	0.05292
7/3/13 0:30	0.02	0.12573	0.027	0.01296	0.01296	0.20591	0.05292	0.00518	0.00797	0.002	0.00548	0.02871	0.08298	0.038478	0.01515	0	0	0	0.11717	0	0.11058	0.027	0.01296	0.01296	0.08874	0.05292
7/3/13 0:45	0.02	0.12723	0.02771	0.01365	0.0151	0.22166	0.05646	0.00521	0.00825	0.00211	0.00546	0.02902	0.08364	0.038618	0.01557	0	0	0	0.11812	0	0.11166	0.02771	0.01365	0.0151	0.10354	0.05646
7/3/13 1:00	0.02	0.13176	0.02909	0.01518	0.01757	0.24854	0.06184	0.00598	0.00986	0.00234	0.00569	0.03063	0.08522	0.039324	0.01818	0	0	0	0.12154	0	0.11358	0.02909	0.01518	0.01757	0.127	0.06184
7/3/13 1:15	0.02	0.12084	0.02627	0.01503	0.01661	0.24518	0.05791	0.00631	0.01063	0.00264	0.00662	0.02677	0.07591	0.031982	0.01958	0	0	0	0.1093	0	0.10126	0.02627	0.01503	0.01661	0.13588	0.05791
7/3/13 1:30	0.02	0.12736	0.02786	0.01726	0.01707	0.25669	0.06219	0.00815	0.01319	0.00295	0.00734	0.03049	0.08043	0.033921	0.02429	0	0	0	0.11826	0	0.10307	0.02786	0.01726	0.01707	0.13843	0.06219
7/3/13 1:45	0.02	0.13396	0.02925	0.01955	0.01723	0.26778	0.06603	0.00982	0.01441	0.00324	0.00798	0.03363	0.08631	0.036246	0.02747	0	0	0	0.12792	0	0.10649	0.02925	0.01955	0.01723	0.13986	0.06603
7/3/13 2:00	0.02	0.13817	0.03037	0.02176	0.01728	0.2777	0.06941	0.01087	0.01477	0.00351	0.0085	0.0362	0.09156	0.038156	0.02915	0	0	0	0.13626	0	0.10902	0.03037	0.02176	0.01728	0.14144	0.06941
7/3/13 2:15	0.02	0.14183	0.02829	0.02238	0.01587	0.25672	0.06654	0.0106	0.01576	0.00375	0.01028	0.03853	0.08752	0.039235	0.03011	0	0	0	0.13633	0	0.11172	0.02829	0.02238	0.01587	0.12039	0.06654
7/3/13 2:30	0.02	0.1437	0.02899	0.02426	0.01587	0.26374	0.06912	0.01085	0.01625	0.00395	0.01057	0.03993	0.09095	0.040205	0.03105	0	0	0	0.14145	0	0.11265	0.02899	0.02426	0.01587	0.12229	0.06912
7/3/13 2:45	0.02	0.14537	0.02951	0.02592	0.01588	0.26867	0.07131	0.01122	0.01678	0.00411	0.01077	0.04106	0.09363	0.040705	0.03211	0	0	0	0.14546	0	0.11326	0.02951	0.02592	0.01588	0.12321	0.07131
7/3/13 3:00	0.04	0.14686	0.02989	0.02737	0.01588	0.27217	0.07314	0.0116	0.0173	0.00424	0.01097	0.04217	0.09546	0.040914	0.03314	0	0	0	0.1486	0	0.11372	0.02989	0.02737	0.01588	0.12357	0.07314
7/3/13 3:15	0.04	0.15026	0.03339	0.03963	0.03878	0.30392	0.1118	0.01194	0.01629	0.00602	0.00951	0.04323	0.10233	0.037668	0.03425	0	0	0	0.15507	0	0.11601	0.03339	0.03963	0.03878	0.14885	0.1118
7/3/13 3:30	0.02	0.15948	0.0362	0.05903	0.05489	0.32823	0.15012	0.01317	0.01843	0.00878	0.00983	0.04593	0.10525	0.038648	0.04038	0	0	0	0.16101	0	0.1191	0.0362	0.05903	0.05489	0.16722	0.15012
7/3/13 3:45	0.02	0.16244	0.03465	0.06589	0.04168	0.29953	0.14222	0.01534	0.02162	0.00951	0.01044	0.04969	0.10922	0.040114	0.04647	0	0	0	0.16935	0	0.11597	0.03465	0.06589	0.04168	0.13018	0.14222
7/3/13 4:00	0.04	0.16489	0.03349	0.07185	0.03743	0.29294	0.14277	0.01685	0.02295	0.01011	0.01108	0.05276	0.11446	0.041604	0.04991	0	0	0	0.1783	0	0.11498	0.03349	0.07185	0.03743	0.11464	0.14277
7/3/13 4:15	0.04	0.17205	0.03613	0.09385	0.05394	0.35799	0.18392	0.01695	0.02171	0.01299	0.01193	0.05251	0.11813	0.041535	0.05165	0	0	0	0.18257	0	0.1204	0.03613	0.09385	0.05394	0.17542	0.18392
7/3/13 4:30	0.04	0.17773	0.03817	0.11511	0.05959	0.38118	0.21287	0.01707	0.02164	0.01557	0.01218	0.05397	0.12181	0.042461	0.05428	0	0	0	0.18796	0	0.12345	0.03817	0.11511	0.05959	0.19322	0.21287
7/3/13 4:45	0.04	0.19911	0.04621	0.13396	0.06104	0.40829	0.24121	0.01816	0.02429	0.01767	0.01251	0.05681	0.12533	0.043156	0.06012	0	0	0	0.19465	0	0.13899	0.04621	0.13396	0.06104	0.21364	0.24121
7/3/13 5:00	0.04	0.23373	0.05957	0.15005	0.06139	0.4362	0.27101	0.01992	0.02733	0.01931	0.01307	0.06027	0.13024	0.044399	0.06656	0	0	0	0.20358	0	0.16717	0.05957	0.15005	0.06139	0.23262	0.27101
7/3/13 5:15	0.04	0.26667	0.07293	0.16339	0.06147	0.43186	0.29779	0.02202	0.02927	0.02056	0.01466	0.06573	0.13342	0.04384	0.07185	0	0	0	0.21381	0	0.19482	0.07293	0.16339	0.06147	0.21805	0.29779
7/3/13 5:30	0.04	0.28976	0.08412	0.17419	0.06149	0.44559	0.3198	0.0233	0.03004	0.02149	0.01535	0.06887	0.13878	0.045213	0.07483	0	0	0	0.223	0	0.21493	0.08412	0.17419	0.06149	0.22259	0.3198
7/3/13 5:45	0.04	0.30511	0.09259	0.18282	0.0615	0.45584	0.33691	0.02394	0.03078	0.02217	0.01585	0.07166	0.1438	0.046606	0.07689	0	0	0	0.23131	0	0.22822	0.09259	0.18282	0.0615	0.22453	0.33691
7/3/13 6:00	0.04	0.31522	0.09865	0.18962	0.0615	0.46459	0.34977	0.02448	0.03157	0.02266	0.01619	0.07383	0.14887	0.047832	0.07871	0	0	0	0.23889	0	0.23651	0.09865	0.18962	0.0615	0.2257	0.34977
7/3/13 6:15	0.04	0.32263	0.10452	0.19578	0.06234	0.49644	0.36264	0.02834	0.03256	0.02302	0.01751	0.08063	0.1622	0.048563	0.08392	0	0	0	0.26034	0	0.23871	0.10452	0.19578	0.06234	0.2361	0.36264
7/3/13 6:30	0.04	0.32807	0.10729	0.19992	0.06234	0.50573	0.36955	0.02909	0.03336	0.02327	0.01788	0.08243	0.16616	0.048971	0.08572	0	0	0	0.26647	0	0.24235	0.10729	0.19992	0.06234	0.23926	0.36955
7/3/13 6:45	0.04	0.33144	0.10912	0.20311	0.06234	0.51217	0.37457	0.02961	0.03412	0.02345	0.01821	0.08414	0.16958	0.049384	0.08718	0	0	0	0.27193	0	0.24426	0.10912	0.20311	0.06234	0.24024	0.37457
7/3/13 7:00	0.04	0.33387	0.11032	0.20557	0.06234	0.5178	0.37823	0.03008	0.03485	0.02358	0.01852	0.08579	0.173	0.049818	0.08851	0	0	0	0.27731	0	0.24536	0.11032	0.20557	0.06234	0.24049	0.37823
7/3/13 7:15	0.04	0.34161	0.11236	0.20807	0.06295	0.55068	0.38338	0.03325	0.0382	0.02367	0.01601	0.08901	0.19163	0.056052	0.09512	0	0	0	0.29665	0	0.24649	0.11236	0.20807	0.06295	0.25403	0.38338
7/3/13 7:30	0.06	0.34395	0.11286	0.20952	0.06295	0.55661	0.38533	0.0338	0.03885	0.02374	0.01617	0.0905	0.19536	0.056469	0.09639	0	0	0	0.30203	0	0.24756	0.11286	0.20952	0.06295	0.25458	0.38533
7/3/13 7:45	0.06	0.37901	0.12957	0.23466	0.08295	0.62606	0.44718	0.03434	0.03978	0.02699	0.01647	0.09224	0.1999	0.057012	0.10111	0	0	0	0.30861	0	0.2779	0.12957	0.23466	0.08295	0.31745	0.44718
7/3/13 8:00	0.06	0.40549	0.14102	0.25515	0.08786	0.65633	0.48403	0.03571	0.04203	0.02943	0.01696	0.09526	0.20482	0.058126	0.10717	0	0	0	0.31704	0	0.29832	0.14102	0.25515	0.08786	0.33929	0.48403
7/3/13 8:15	0.06	0.43913	0.15021	0.27177	0.08975	0.75524	0.51173	0.03824	0.04652	0.03115	0.01693	0.10524	0.24957	0.060206	0.11591	0	0	0	0.37174	0	0.32322	0.15021	0.27177	0.08975	0.3835	0.51173
7/3/13 8:30	0.06	0.45326	0.15465	0.28362	0.08993	0.77309	0.5282	0.04068	0.04952	0.03235	0.0178	0.11026	0.25814	0.062525	0.12255	0	0	0	0.3862	0	0.33071	0.15465	0.28362	0.08993	0.38689	0.5282
7/3/13 8:45	0.06	0.46196	0.15735	0.29246	0.08996	0.78928	0.53977	0.04252	0.05117	0.03316	0.01864	0.11468	0.26757	0.0652	0.12685	0	0	0	0.40089	0	0.33511	0.15735	0.29246	0.08996	0.38839	0.53977
7/3/13 9:00	0.06	0.46693	0.159	0.29901	0.08997	0.80351	0.54798	0.04373	0.05199	0.03372	0.01932	0.1185	0.27631	0.067455	0.12944	0	0	0	0.41413	0	0.33749	0.159	0.29901	0.08997	0.38938	0.54798
7/3/13 9:15	0.06	0.49753	0.16394	0.30574	0.09189	0.79102	0.56157	0.04338	0.05765	0.03409	0.0197	0.13222	0.27947	0.077201	0.13512	0	0	0	0.43139	0	0.36241	0.16394	0.30574	0.09189	0.35963	0.56157
7/3/13 9:30	0.08	0.50028	0.16452	0.30926	0.09189	0.80666	0.56567	0.04394	0.05855	0.03434	0.02008	0.13476	0.28634	0.078478	0.13683	0	0	0	0.44118	0	0.36345	0.16452	0.30926	0.09189	0.36548	0.56567
7/3/13 9:45	0.08	0.54041	0.18339	0.33934	0.1131	0.8856	0.63583	0.04473	0.05979	0.03815	0.02048	0.13732	0.29318	0.07941	0.14267	0	0	0	0.45098	0	0.39774	0.18339	0.33934	0.1131	0.43462	0.63583
7/3/13 10:00	0.08	0.56816	0.1952	0.36249	0.11721	0.91572	0.6749	0.04638	0.06237	0.04081	0.02109	0.14112	0.29954	0.080628	0.14956	0	0	0	0.46175	0	0.4186	0.1952	0.36249	0.11721	0.45397	0.6749
7/3/13 10:15	0.08	0.58221	0.20579	0.38113	0.11964	0.95231	0.70656	0.04825	0.06437	0.04258	0.02595	0.1446	0.30933	0.09081	0.1552	0	0	0	0.47988	0	0.42701	0.20579	0.38113	0.11964	0.47243	0.70656
7/3/13 10:30	0.1	0.59534	0.20971	0.39323	0.11974	0.96876	0.72268	0.05087	0.06769	0.04374	0.02711	0.15035	0.31888	0.093268	0.1623	0	0	0	0.49634	0	0.43304	0.20971	0.39323	0.11974	0.47242	0.72268
7/3/13 10:45	0.1	0.64507	0.23202	0.43186	0.14182	1.05876	0.8057	0.0531	0.06996	0.04844	0.02813	0.1558	0.3304	0.096231	0.1715	0	0	0	0.51433	0	0.47357	0.23202	0.43186	0.14182	0.54443	0.8057
7/3/13 11:00	0.14	0.67595	0.24503	0.46066	0.1453	1.09491	0.85099	0.05556	0.07275	0.05157	0.02917	0.16197	0.34193	0.099347	0.17988	0	0	0	0.53307	0	0.49607	0.24503	0.46066	0.1453	0.56184	0.85099
7/3/13 11:15	0.14	0.78992	0.29315	0.5469	0.19053	1.29303	1.03058	0.05871	0.07607	0.06213	0.02831	0.17675	0.35853	0.110841	0.19691	0	0	0	0.56359	0	0.59301	0.29315	0.5469	0.19053	0.72944	1.03058
7/3/13 11:30	0.22	0.85656	0.3213	0.61339	0.19627	1.35319	1.13096	0.06375	0.08311	0.06906	0.02991	0.18695	0.3747	0.115649	0.21592	0	0	0	0.59156	0	0.64064	0.3213	0.61339	0.19627	0.76163	1.13096
7/3/13 11:45	0.22	1.09533	0.43525	0.81117	0.29956	1.71506	1.54598	0.07093	0.09287	0.09263	0.03213	0.20034	0.39596	0.122131	0.25643	0	0	0	0.62843	0	0.8389	0.43525	0.81117	0.29956	1.08663	1.54598
7/3/13 12:00	1.8	1.22669	0.49853	0.95643	0.32953	1.80951	1.78449	0.08119	0.10611	0.10731	0.03544	0.21975	0.4243	0.131452	0.29461	0	0	0	0.67949	0	0.93208	0.49853	0.95643	0.32953	1.13002	1.78449
7/3/13 12:15	1.8	6.95901	3.51314	5.78064	3.03602	9.81416	12.3298	0.10779	0.1485	0.70189	0.04049	0.26697	0.4775	0.147513	0.95818	0	0	0	0.78496	0	6.00083	3.51314	5.78064	3.03602	9.0292	12.32981
7/3/13 12:30	0.34	8.70155	4.68949	8.83038	4.33675	12.87224	17.85662	0.20919	0.2946	0.96282	0.06486	0.42029	0.65609	0.217553	1.46661	0	0	0	1.14124	0	7.23494	4.68949	8.83038	4.33675	11.731	17.85662
7/3/13 12:45	0.34	4.05873	2.21438	4.85844	2.21719	6.85895	9.29001	0.37456	0.51966	0.44641	0.1049	0.6578	0.94763	0.326225	1.34063	0	0	0	1.71033	0	2.71181	2.21438	4.85844	2.21719	5.14862	9.29001
7/3/13 13:00	0.18	3.47472	1.81074	3.54941	2.00931	7.19104	7.36946	0.458	0.59535	0.32312	0.14397	0.84873	0.99189	0.438249	1.37647	0	0	0	1.98459	0	2.09825	1.81074	3.54941	2.00931	5.20645	7.36946
7/3/13 13:15	0.18	2.72834	1.45251	2.5527	1.54801	6.38836	5.55322	0.41573	0.46415	0.23364	0.16638	0.88249	0.9926	0.530941	1.11352	0	0	0	2.04147	0	1.61482	1.45251	2.5527	1.54801	4.34689	5.55322

Hydrograph Table
Design Flow Derivation
2 Year Recurrance Interval Storm

7/3/13 13:30	0.12	2.30904	1.33416	2.07332	1.35671	6.08837	4.76419	0.32628	0.30199	0.20034	0.15137	0.81293	1.01358	0.539222	0.82861	0	0	0	1.97788	0	1.48043	1.33416	2.07332	1.35671	4.11049	4.76419
7/3/13 13:45	0.12	1.93108	1.19177	1.66537	1.11096	5.48023	3.9681	0.23523	0.22946	0.17002	0.12875	0.72659	1.03625	0.475836	0.63471	0	0	0	1.89159	0	1.29637	1.19177	1.66537	1.11096	3.58864	3.9681
7/3/13 14:00	0.1	1.79022	1.12125	1.42693	0.98024	5.08779	3.52842	0.18494	0.22169	0.15621	0.10542	0.62458	1.02787	0.397405	0.56284	0	0	0	1.75787	0	1.22738	1.12125	1.42693	0.98024	3.32992	3.52842
7/3/13 14:15	0.1	1.69731	1.05034	1.23352	0.85219	4.65343	3.13605	0.17354	0.21973	0.14466	0.09087	0.54509	1.01514	0.309401	0.53793	0	0	0	1.6511	0	1.15938	1.05034	1.23352	0.85219	3.00233	3.13605
7/3/13 14:30	0.08	1.66739	1.00573	1.10695	0.77216	4.37823	2.88484	0.16661	0.21784	0.13889	0.08966	0.5061	0.98109	0.235627	0.52334	0	0	0	1.57685	0	1.14405	1.00573	1.10695	0.77216	2.80138	2.88484
7/3/13 14:45	0.08	1.60553	0.94562	0.97992	0.67778	3.97711	2.60332	0.16024	0.21274	0.13121	0.08923	0.48937	0.88408	0.199976	0.50419	0	0	0	1.46268	0	1.10134	0.94562	0.97992	0.67778	2.51443	2.60332
7/3/13 15:00	0.08	1.57435	0.90378	0.89167	0.61973	3.75837	2.41518	0.15429	0.20813	0.12697	0.0878	0.4768	0.85033	0.191007	0.48939	0	0	0	1.41493	0	1.08496	0.90378	0.89167	0.61973	2.34344	2.41518
7/3/13 15:15	0.08	1.55157	0.87079	0.82795	0.57658	3.57559	2.27532	0.1483	0.20034	0.12468	0.08203	0.47417	0.85508	0.184949	0.47332	0	0	0	1.41128	0	1.07825	0.87079	0.82795	0.57658	2.16431	2.27532
7/3/13 15:30	0.06	1.54483	0.84551	0.78169	0.54397	3.47845	2.17117	0.14348	0.1959	0.12352	0.08042	0.46581	0.87091	0.180131	0.4629	0	0	0	1.41714	0	1.08193	0.84551	0.78169	0.54397	2.06131	2.17117
7/3/13 15:45	0.06	1.49497	0.79732	0.71038	0.48424	3.29348	1.99194	0.13935	0.19212	0.11843	0.07894	0.45892	0.885	0.175459	0.4499	0	0	0	1.42286	0	1.04507	0.79732	0.71038	0.48424	1.87062	1.99194
7/3/13 16:00	0.06	1.46424	0.76138	0.65778	0.44986	3.17051	1.86902	0.13486	0.18765	0.11523	0.07741	0.45175	0.89186	0.171667	0.43774	0	0	0	1.42102	0	1.0265	0.76138	0.65778	0.44986	1.74949	1.86902
7/3/13 16:15	0.06	1.444	0.73445	0.61925	0.42558	3.10764	1.77928	0.12967	0.1814	0.11319	0.07383	0.44097	0.89194	0.167253	0.42426	0	0	0	1.40674	0	1.01974	0.73445	0.61925	0.42558	1.7009	1.77928
7/3/13 16:30	0.06	1.42862	0.71094	0.58932	0.40596	3.02285	1.70622	0.12461	0.17586	0.11188	0.07204	0.43296	0.89056	0.163589	0.41235	0	0	0	1.39556	0	1.01627	0.71094	0.58932	0.40596	1.62729	1.70622
7/3/13 16:45	0.06	1.41804	0.69084	0.56607	0.39017	2.94997	1.64708	0.12007	0.17154	0.11102	0.07033	0.42567	0.88835	0.159931	0.40263	0	0	0	1.38435	0	1.01541	0.69084	0.56607	0.39017	1.56562	1.64708
7/3/13 17:00	0.06	1.41075	0.67319	0.54773	0.37732	2.88815	1.59824	0.11613	0.16801	0.11045	0.06873	0.4188	0.87913	0.156914	0.39459	0	0	0	1.36666	0	1.01616	0.67319	0.54773	0.37732	1.52149	1.59824
7/3/13 17:15	0.06	1.40749	0.65462	0.53167	0.36542	2.84578	1.55171	0.11396	0.16569	0.11008	0.07031	0.40487	0.8789	0.149965	0.38973	0	0	0	1.35408	0	1.01776	0.65462	0.53167	0.36542	1.4917	1.55171
7/3/13 17:30	0.04	1.40231	0.64058	0.51982	0.35683	2.79836	1.51723	0.11053	0.16194	0.10984	0.06899	0.3989	0.8788	0.147792	0.38231	0	0	0	1.34669	0	1.02	0.64058	0.51982	0.35683	1.45167	1.51723
7/3/13 17:45	0.04	1.35185	0.60329	0.47803	0.31842	2.66225	1.39974	0.10684	0.15778	0.10547	0.06757	0.39226	0.87888	0.145922	0.37009	0	0	0	1.33871	0	0.98176	0.60329	0.47803	0.31842	1.32354	1.39974
7/3/13 18:00	0.04	1.31419	0.57486	0.44591	0.29871	2.57659	1.31948	0.10222	0.15221	0.10236	0.06591	0.38222	0.87585	0.143741	0.35679	0	0	0	1.32398	0	0.9574	0.57486	0.44591	0.29871	1.25261	1.31948
7/3/13 18:15	0.04	1.2847	0.5522	0.42131	0.28506	2.46088	1.25857	0.09702	0.1454	0.10009	0.0678	0.36511	0.87153	0.141632	0.34251	0	0	0	1.30444	0	0.94219	0.5522	0.42131	0.28506	1.15644	1.25857
7/3/13 18:30	0.04	1.25907	0.53335	0.40214	0.27431	2.39708	1.2098	0.09109	0.13842	0.09838	0.06569	0.35093	0.86664	0.138145	0.32789	0	0	0	1.28326	0	0.93118	0.53335	0.40214	0.27431	1.11382	1.2098
7/3/13 18:45	0.04	1.23767	0.51718	0.38696	0.26547	2.33901	1.16961	0.08549	0.13235	0.09703	0.06344	0.33719	0.86209	0.134273	0.31487	0	0	0	1.26272	0	0.9228	0.51718	0.38696	0.26547	1.07629	1.16961
7/3/13 19:00	0.04	1.21974	0.50304	0.37479	0.25808	2.28689	1.13591	0.0805	0.12702	0.09594	0.06112	0.3241	0.86268	0.130809	0.30346	0	0	0	1.2479	0	0.91628	0.50304	0.37479	0.25808	1.03899	1.13591
7/3/13 19:15	0.04	1.20464	0.49189	0.36561	0.25258	2.30321	1.11008	0.07743	0.12035	0.09503	0.054	0.31442	0.8574	0.129257	0.29281	0	0	0	1.22582	0	0.91183	0.49189	0.36561	0.25258	1.07739	1.11008
7/3/13 19:30	0.04	1.1907	0.48052	0.3575	0.24732	2.26224	1.08534	0.07467	0.11489	0.09424	0.05184	0.30432	0.85323	0.126719	0.2838	0	0	0	1.20939	0	0.9069	0.48052	0.3575	0.24732	1.05285	1.08534
7/3/13 19:45	0.04	1.1786	0.47017	0.35079	0.24287	2.22602	1.06383	0.07317	0.10946	0.09356	0.04974	0.29843	0.84943	0.124642	0.27619	0	0	0	1.1976	0	0.90241	0.47017	0.35079	0.24287	1.02842	1.06383
7/3/13 20:00	0.04	1.16759	0.46064	0.34517	0.23908	2.1942	1.04489	0.07207	0.10417	0.09294	0.04764	0.29527	0.84772	0.12284	0.26918	0	0	0	1.19063	0	0.89841	0.46064	0.34517	0.23908	1.00357	1.04489
7/3/13 20:15	0.04	1.17548	0.44252	0.33592	0.23133	2.14423	1.00977	0.07302	0.09974	0.09238	0.04613	0.29799	0.84506	0.119546	0.26514	0	0	0	1.18918	0	0.91034	0.44252	0.33592	0.23133	0.95505	1.00977
7/3/13 20:30	0.04	1.16747	0.43449	0.33191	0.22861	2.11945	0.99501	0.07233	0.09669	0.09186	0.04422	0.29592	0.83653	0.117605	0.26088	0	0	0	1.17667	0	0.90659	0.43449	0.33191	0.22861	0.94278	0.99501
7/3/13 20:45	0.04	1.16118	0.42707	0.3285	0.22629	2.09518	0.98186	0.0717	0.09511	0.09137	0.04289	0.29413	0.82894	0.115475	0.25818	0	0	0	1.16596	0	0.903	0.42707	0.3285	0.22629	0.92922	0.98186
7/3/13 21:00	0.02	1.1558	0.42025	0.32558	0.22435	2.07283	0.97018	0.07113	0.09393	0.09092	0.0422	0.29251	0.80901	0.113219	0.25598	0	0	0	1.14372	0	0.89982	0.42025	0.32558	0.22435	0.92911	0.97018
7/3/13 21:15	0.02	1.107	0.39494	0.29743	0.19593	1.93049	0.8883	0.0687	0.09433	0.08676	0.04553	0.2855	0.80096	0.108281	0.24979	0	0	0	1.13199	0	0.85721	0.39494	0.29743	0.19593	0.7985	0.8883
7/3/13 21:30	0.04	1.07125	0.37364	0.27314	0.18095	1.86075	0.82773	0.06713	0.09185	0.08356	0.04495	0.28254	0.78778	0.105294	0.24254	0	0	0	1.11527	0	0.82871	0.37364	0.27314	0.18095	0.74548	0.82773
7/3/13 21:45	0.04	1.08014	0.37682	0.28042	0.19816	1.88921	0.8554	0.06483	0.08846	0.08455	0.0442	0.2786	0.77566	0.101844	0.23784	0	0	0	1.09846	0	0.8423	0.37682	0.28042	0.19816	0.79075	0.8554
7/3/13 22:00	0.02	1.0873	0.37821	0.28683	0.20454	1.89175	0.86958	0.06342	0.08706	0.08527	0.04349	0.27539	0.76429	0.098393	0.23575	0	0	0	1.08317	0	0.85155	0.37821	0.28683	0.20454	0.80858	0.86958
7/3/13 22:15	0.02	1.04138	0.35727	0.26539	0.17926	1.7834	0.80192	0.06368	0.08636	0.08211	0.0408	0.27094	0.74921	0.101258	0.23215	0	0	0	1.06095	0	0.80923	0.35727	0.26539	0.17926	0.72245	0.80192
7/3/13 22:30	0.02	1.01573	0.34069	0.24789	0.16698	1.73195	0.75556	0.06349	0.08635	0.07958	0.04054	0.26943	0.74547	0.098464	0.22942	0	0	0	1.05544	0	0.78631	0.34069	0.24789	0.16698	0.67651	0.75556
7/3/13 22:45	0.02	0.99309	0.32726	0.23402	0.15911	1.70988	0.72039	0.06224	0.08364	0.07753	0.04017	0.26658	0.7489	0.096233	0.22341	0	0	0	1.05565	0	0.76968	0.32726	0.23402	0.15911	0.65423	0.72039
7/3/13 23:00	0.02	0.97227	0.316	0.22285	0.15314	1.64576	0.69199	0.06042	0.08064	0.07581	0.0396	0.26312	0.71727	0.094166	0.21687	0	0	0	1.01999	0	0.7554	0.316	0.22285	0.15314	0.62577	0.69199
7/3/13 23:15	0.02	0.95144	0.30877	0.21493	0.14942	1.56394	0.67312	0.05692	0.0781	0.07434	0.03786	0.25041	0.69372	0.089663	0.20936	0	0	0	0.98199	0	0.74208	0.30877	0.21493	0.14942	0.58195	0.67312
7/3/13 23:30	0.02	0.93727	0.30023	0.20742	0.14524	1.52689	0.65289	0.05568	0.07739	0.07305	0.03722	0.24728	0.68068	0.08805	0.20612	0	0	0	0.96518	0	0.73115	0.30023	0.20742	0.14524	0.56171	0.65289
7/3/13 23:45	0.02	0.92538	0.2926	0.20116	0.14161	1.49575	0.63537	0.05505	0.07672	0.0719	0.03675	0.24451	0.66811	0.086504	0.20367	0	0	0	0.94937	0	0.72171	0.2926	0.20116	0.14161	0.54638	0.63537
7/4/13 0:00	0.02	0.91456	0.28574	0.19592	0.13846	1.46698	0.62012	0.05449	0.076	0.07086	0.03646	0.24238	0.65538	0.085169	0.20135	0	0	0	0.93422	0	0.71321	0.28574	0.19592	0.13846	0.53276	0.62012
7/4/13 0:15	0.02	0.88647	0.28391	0.19365	0.13784	1.50341	0.6154	0.05236	0.07592	0.06991	0.03474	0.23793	0.64019	0.082192	0.19819	0	0	0	0.91286	0	0.68828	0.28391	0.19365	0.13784	0.59055	0.6154
7/4/13 0:30	0	0.87656	0.27813	0.18988	0.13541	1.47797	0.60342	0.05175	0.07521	0.06902	0.03442	0.23618	0.62868	0.08174	0.19598	0	0	0	0.89928	0	0.68058	0.27813	0.18988	0.13541	0.57869	0.60342
7/4/13 0:45	0	0.82935	0.25404	0.16432	0.10781	1.37452	0.52617	0.05106	0.07421	0.06475	0.03409	0.23418	0.61653	0.081163	0.19002	0	0	0	0.8848	0	0.63933	0.25404	0.16432	0.10781	0.48972	0.52617
7/4/13 1:00	0	0.78812	0.23462	0.14353	0.09127	1.29906	0.46942	0.0495	0.07187	0.06121	0.03357	0.23088	0.60404	0.079997	0.18258	0	0	0	0.86849	0	0.60554	0.23462	0.14353	0.09127	0.43057	0.46942
7/4/13 1:15	0	0.73199	0.21419	0.12459	0.0773	1.21022	0.41608	0.04524	0.06598	0.05821	0.03338	0.2193	0.57734	0.069523	0.16943	0	0	0	0.83002	0	0.56256	0.21419	0.12459	0.0773	0.3802	0.41608
7/4/13 1:30	0	0.69878	0.20056	0.11086	0.06801	1.15028	0.37943	0.04264	0.06292	0.05561	0.03246	0.21398	0.56139	0.067164	0.16117	0	0	0	0.80783	0	0.53761	0.20056	0.11086	0.06801	0.34245	0.37943
7/4/13 1:45	0	0.67084	0.18867	0.09946	0.06028	1.09666	0.34841	0.04065	0.0612	0.0533	0.03161	0.20924	0.54441	0.064452	0.15515	0	0	0	0.78526	0	0.51569	0.18867	0.09946	0.06028	0.3114	0.34841
7/4/13 2:00	0	0.64687	0.17809	0.08987	0.05374	1.04872	0.3217	0.03928	0.06031	0.05121	0.03092	0.20509	0.52808	0.062174	0.1508	0	0	0	0.76409	0	0.49607	0.17809	0.08987	0.05374	0.28463	0.3217
7/4/13 2:15	0	0.6263	0.16561	0.0803	0.0467	0.97709	0.29261	0.03757	0.05996	0.0493	0.03189	0.20186	0.50415	0.060024	0.14683	0	0	0	0.7379	0	0.47947	0.16561	0.0803	0.0467	0.23919	0.29261
7/4/13 2:30	0	0.60623	0.15698	0.0733	0.04184	0.93868	0.27212	0.03675	0.05897	0.04753	0.03152	0.19892	0.48974	0.05872	0.14325	0	0	0	0.72018	0	0.46298	0.15698	0.0733	0.04184	0.2185	0.27212
7/4/13 2:45	0	0.58743	0.14908	0.06723	0.03759	0.90381	0.2539	0.03594	0.05795	0.04587	0.03113	0.19627	0.47636	0.057901	0.13976	0	0	0	0.70376	0	0.44767	0.14908	0.06723	0.03759	0.20005	0.2539
7/4/13 3:00	0	0.56955	0.14182	0.06193	0.03386	0.87217	0.23761	0.03515	0.05694	0.04432	0.03072	0.19369	0.46403	0.057381	0.13641	0	0	0	0.68844	0	0.43314	0.14182	0.06193	0.03386	0.18373	0.23761
7/4/13 3:15	0	0.54734	0.13509	0.05727	0.03058	0.83078	0.22294	0.03422	0.05415	0.04286	0.02854	0.19084	0.45702	0.053224	0.13123	0	0	0	0.6764	0	0.41611	0.13509	0.05727	0.03058	0.15438	0.22294
7/4/13 3:30	0	0.53103	0.12884	0.05315	0.02769	0.80318	0.20968	0.03348	0.05322	0.04147	0.0281	0.18836	0.44574	0.052687	0.12817	0	0	0	0.6622	0	0.40286	0.12884	0.05315	0.02769	0.14098	0.20968
7/4/13 3:45	0	0.51567	0.12303	0.04948	0.02512	0.77933	0.19763	0.03279	0.05232	0.04015	0.02772	0.18593	0.43668	0.052156	0.12526	0	0	0	0.65033	0	0.39041	0.12303	0.04948	0.02512	0.129	0.19763

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Hydrograph Table
Design Flow Derivation
2 Year Recurrance Interval Storm

7/4/13 4:00	0	0.50102	0.1176	0.04621	0.02283	0.7592	0.18664	0.03212	0.05145	0.03889	0.02735	0.18355	0.43013	0.051645	0.12246	0	0	0	0.64103	0	0.37856	0.1176	0.04621	0.02283	0.11817	0.18664
7/4/13 4:15	0	0.48684	0.11251	0.04327	0.0208	0.76177	0.17658	0.03148	0.05044	0.03769	0.02747	0.17961	0.42255	0.049703	0.11961	0	0	0	0.62963	0	0.36723	0.11251	0.04327	0.0208	0.13214	0.17658
7/4/13 4:30	0	0.47339	0.10774	0.04063	0.01899	0.7445	0.16736	0.03085	0.04964	0.03654	0.02714	0.17735	0.41732	0.049221	0.11703	0	0	0	0.62181	0	0.35636	0.10774	0.04063	0.01899	0.12269	0.16736
7/4/13 4:45	0	0.4605	0.10326	0.03823	0.01738	0.72897	0.15887	0.03023	0.04887	0.03543	0.0268	0.17512	0.4124	0.048752	0.11453	0	0	0	0.61432	0	0.34597	0.10326	0.03823	0.01738	0.11465	0.15887
7/4/13 5:00	0	0.44813	0.09904	0.03607	0.01595	0.71458	0.15106	0.02965	0.04813	0.03437	0.02649	0.17293	0.40772	0.048295	0.11215	0	0	0	0.60714	0	0.33598	0.09904	0.03607	0.01595	0.10744	0.15106
7/4/13 5:15	0	0.43792	0.09506	0.03409	0.01468	0.67903	0.14383	0.02943	0.04768	0.03335	0.02713	0.17311	0.4004	0.045675	0.11046	0	0	0	0.60064	0	0.32746	0.09506	0.03409	0.01468	0.07839	0.14383
7/4/13 5:30	0	0.42662	0.09132	0.0323	0.01357	0.66754	0.13719	0.02891	0.04699	0.03236	0.02686	0.17103	0.39602	0.045244	0.10826	0	0	0	0.59391	0	0.31836	0.09132	0.0323	0.01357	0.07363	0.13719
7/4/13 5:45	0	0.41565	0.08777	0.03064	0.01259	0.65583	0.131	0.02838	0.04632	0.03141	0.02658	0.16898	0.39178	0.044827	0.10611	0	0	0	0.58734	0	0.30954	0.08777	0.03064	0.01259	0.06849	0.131
7/4/13 6:00	0	0.40508	0.08442	0.02913	0.01175	0.64472	0.1253	0.02787	0.04569	0.0305	0.0263	0.16695	0.38768	0.044423	0.10406	0	0	0	0.58093	0	0.30102	0.08442	0.02913	0.01175	0.06379	0.1253
7/4/13 6:15	0	0.39562	0.08299	0.02857	0.01186	0.65964	0.12342	0.03068	0.04525	0.02961	0.02705	0.16988	0.39231	0.044032	0.10554	0	0	0	0.58924	0	0.29008	0.08299	0.02857	0.01186	0.0704	0.12342
7/4/13 6:30	0	0.38646	0.07997	0.02729	0.01127	0.65212	0.11853	0.0304	0.04467	0.02876	0.02682	0.16791	0.38839	0.043654	0.10383	0	0	0	0.58312	0	0.28263	0.07997	0.02729	0.01127	0.069	0.11853
7/4/13 6:45	0	0.37705	0.07712	0.02611	0.01079	0.64322	0.11402	0.02994	0.04409	0.02793	0.02658	0.16599	0.38458	0.04329	0.10196	0	0	0	0.57715	0	0.27509	0.07712	0.02611	0.01079	0.06607	0.11402
7/4/13 7:00	0	0.36794	0.07441	0.02501	0.01045	0.63467	0.10987	0.02949	0.04355	0.02713	0.02633	0.16412	0.38089	0.042945	0.10017	0	0	0	0.57134	0	0.26777	0.07441	0.02501	0.01045	0.06333	0.10987
7/4/13 7:15	0	0.36502	0.0731	0.0246	0.01087	0.65427	0.10857	0.03175	0.04567	0.02636	0.02326	0.16394	0.39246	0.048412	0.10378	0	0	0	0.57966	0	0.26124	0.0731	0.0246	0.01087	0.07461	0.10857
7/4/13 7:30	0	0.35731	0.07065	0.02366	0.01085	0.6473	0.10516	0.0315	0.04516	0.02561	0.02294	0.16216	0.38898	0.048094	0.10227	0	0	0	0.57408	0	0.25504	0.07065	0.02366	0.01085	0.07322	0.10516
7/4/13 7:45	0	0.34917	0.06832	0.02278	0.01085	0.64082	0.10195	0.0311	0.04467	0.02488	0.02271	0.16042	0.38549	0.047784	0.10065	0	0	0	0.56862	0	0.24852	0.06832	0.02278	0.01085	0.0722	0.10195
7/4/13 8:00	0	0.34128	0.0661	0.02197	0.01085	0.63501	0.09892	0.0307	0.04421	0.02418	0.0225	0.15873	0.38209	0.04748	0.09909	0	0	0	0.56332	0	0.24219	0.0661	0.02197	0.01085	0.07169	0.09892
7/4/13 8:15	0	0.34823	0.06595	0.02216	0.01179	0.71305	0.0999	0.03047	0.04467	0.0235	0.02156	0.16262	0.41685	0.047549	0.09864	0	0	0	0.60103	0	0.24959	0.06595	0.02216	0.01179	0.11202	0.0999
7/4/13 8:30	0	0.34116	0.06393	0.02145	0.01179	0.71053	0.09717	0.03008	0.04424	0.02284	0.02133	0.16091	0.41369	0.047269	0.09716	0	0	0	0.59593	0	0.244	0.06393	0.02145	0.01179	0.1146	0.09717
7/4/13 8:45	0	0.33403	0.06201	0.02079	0.01179	0.70591	0.09459	0.02968	0.04383	0.02219	0.02115	0.15921	0.41053	0.047	0.0957	0	0	0	0.59089	0	0.23833	0.06201	0.02079	0.01179	0.11502	0.09459
7/4/13 9:00	0	0.32711	0.06019	0.02017	0.01179	0.70097	0.09215	0.02928	0.04343	0.02157	0.02097	0.15752	0.40747	0.046743	0.09428	0	0	0	0.58596	0	0.23283	0.06019	0.02017	0.01179	0.11501	0.09215
7/4/13 9:15	0	0.3478	0.06242	0.02151	0.01371	0.6718	0.09764	0.02788	0.04783	0.02097	0.02065	0.16635	0.39983	0.054469	0.09668	0	0	0	0.58683	0	0.25112	0.06242	0.02151	0.01371	0.08497	0.09764
7/4/13 9:30	0	0.34177	0.06074	0.02097	0.0137	0.67165	0.09541	0.02741	0.04742	0.02038	0.02047	0.16464	0.39686	0.054225	0.09521	0	0	0	0.58197	0	0.24656	0.06074	0.02097	0.0137	0.08968	0.09541
7/4/13 9:45	0	0.33543	0.05914	0.02046	0.0137	0.66768	0.0933	0.02701	0.04701	0.01981	0.02029	0.16294	0.39398	0.053987	0.09383	0	0	0	0.57721	0	0.2416	0.05914	0.02046	0.0137	0.09047	0.0933
7/4/13 10:00	0	0.32929	0.05763	0.01999	0.0137	0.66305	0.09132	0.02661	0.0466	0.01926	0.02012	0.16123	0.39119	0.053764	0.09247	0	0	0	0.57254	0	0.23682	0.05763	0.01999	0.0137	0.09051	0.09132
7/4/13 10:15	0	0.31874	0.0599	0.02134	0.0155	0.67818	0.09674	0.02548	0.04429	0.01872	0.02392	0.15787	0.39042	0.061888	0.08849	0	0	0	0.57221	0	0.23025	0.0599	0.02134	0.0155	0.10597	0.09674
7/4/13 10:30	0	0.3126	0.05849	0.02092	0.0155	0.6736	0.09491	0.02504	0.04388	0.0182	0.02388	0.15617	0.38773	0.061674	0.08712	0	0	0	0.56778	0	0.22548	0.05849	0.02092	0.0155	0.10582	0.09491
7/4/13 10:45	0	0.30695	0.05715	0.02053	0.0155	0.66886	0.09318	0.02464	0.04347	0.01769	0.0237	0.15446	0.38515	0.061471	0.0858	0	0	0	0.56331	0	0.22115	0.05715	0.02053	0.0155	0.10555	0.09318
7/4/13 11:00	0	0.30148	0.05586	0.02016	0.0155	0.66442	0.09152	0.02424	0.04306	0.0172	0.02353	0.15277	0.38263	0.06128	0.0845	0	0	0	0.55893	0	0.21698	0.05586	0.02016	0.0155	0.10549	0.09152
7/4/13 11:15	0	0.3015	0.05239	0.01874	0.01442	0.68188	0.08555	0.02373	0.04116	0.01672	0.02133	0.15831	0.38309	0.069072	0.08161	0	0	0	0.56273	0	0.21989	0.05239	0.01874	0.01442	0.11915	0.08555
7/4/13 11:30	0	0.29627	0.05121	0.01841	0.01441	0.68048	0.08403	0.02333	0.04075	0.01625	0.02108	0.1566	0.38067	0.06888	0.08033	0	0	0	0.55835	0	0.21594	0.05121	0.01841	0.01441	0.12213	0.08403
7/4/13 11:45	0	0.29123	0.05009	0.01811	0.01441	0.67689	0.08261	0.02294	0.04034	0.0158	0.02089	0.15489	0.37833	0.068689	0.07908	0	0	0	0.55411	0	0.21215	0.05009	0.01811	0.01441	0.12278	0.08261
7/4/13 12:00	0	0.28634	0.04901	0.01783	0.01441	0.6728	0.08125	0.02255	0.03994	0.01535	0.02071	0.15318	0.37606	0.068493	0.07784	0	0	0	0.54995	0	0.2085	0.04901	0.01783	0.01441	0.12285	0.08125
7/4/13 12:15	0	0.26874	0.04797	0.01756	0.01441	0.6312	0.07994	0.02188	0.04061	0.01492	0.01833	0.15082	0.36621	0.06141	0.07741	0	0	0	0.53536	0	0.19133	0.04797	0.01756	0.01441	0.09584	0.07994
7/4/13 12:30	0	0.26394	0.04698	0.01732	0.01441	0.62643	0.07871	0.02147	0.0402	0.01451	0.01806	0.14911	0.3641	0.061219	0.07618	0	0	0	0.53127	0	0.18776	0.04698	0.01732	0.01441	0.09516	0.07871
7/4/13 12:45	0	0.25943	0.04602	0.01709	0.01441	0.62247	0.07752	0.02108	0.03979	0.0141	0.01787	0.14741	0.36201	0.061028	0.07497	0	0	0	0.52729	0	0.18446	0.04602	0.01709	0.01441	0.09518	0.07752
7/4/13 13:00	0	0.25505	0.04509	0.01687	0.01441	0.61854	0.07637	0.0207	0.03937	0.0137	0.01771	0.14567	0.35994	0.060837	0.07377	0	0	0	0.52332	0	0.18128	0.04509	0.01687	0.01441	0.09522	0.07637
7/4/13 13:15	0	0.26468	0.04273	0.01596	0.01369	0.61191	0.07238	0.01949	0.03756	0.01332	0.0257	0.1397	0.35135	0.060646	0.07037	0	0	0	0.51675	0	0.19431	0.04273	0.01596	0.01369	0.09516	0.07238
7/4/13 13:30	0	0.26044	0.04189	0.01577	0.01369	0.60759	0.07135	0.01904	0.03715	0.01294	0.02579	0.13799	0.34932	0.060455	0.06913	0	0	0	0.5131	0	0.19131	0.04189	0.01577	0.01369	0.09449	0.07135
7/4/13 13:45	0	0.25638	0.04109	0.0156	0.01369	0.60314	0.07038	0.01865	0.03674	0.01258	0.02562	0.13629	0.34743	0.060264	0.06797	0	0	0	0.50934	0	0.18841	0.04109	0.0156	0.01369	0.0938	0.07038
7/4/13 14:00	0	0.25244	0.04032	0.01545	0.01369	0.59924	0.06946	0.01826	0.03634	0.01222	0.02544	0.1346	0.34557	0.060069	0.06682	0	0	0	0.50561	0	0.18562	0.04032	0.01545	0.01369	0.09363	0.06946
7/4/13 14:15	0	0.24257	0.03958	0.01531	0.01369	0.58483	0.06858	0.01788	0.03676	0.01187	0.02283	0.13551	0.34278	0.058068	0.06651	0	0	0	0.50112	0	0.17606	0.03958	0.01531	0.01369	0.08371	0.06858
7/4/13 14:30	0	0.23882	0.03887	0.01519	0.01369	0.58193	0.06775	0.01751	0.03635	0.01154	0.02257	0.13381	0.34099	0.057877	0.0654	0	0	0	0.49737	0	0.17342	0.03887	0.01519	0.01369	0.08456	0.06775
7/4/13 14:45	0	0.2352	0.03819	0.01508	0.01369	0.5786	0.06696	0.01713	0.03594	0.01121	0.02239	0.1321	0.33922	0.057686	0.06428	0	0	0	0.49371	0	0.17092	0.03819	0.01508	0.01369	0.08489	0.06696
7/4/13 15:00	0	0.23167	0.03752	0.01498	0.01368	0.57498	0.06618	0.01676	0.03552	0.01089	0.0222	0.13044	0.33748	0.057495	0.06317	0	0	0	0.49012	0	0.1685	0.03752	0.01498	0.01368	0.08486	0.06618
7/4/13 15:15	0	0.2212	0.03541	0.01419	0.01297	0.52133	0.06257	0.01585	0.0328	0.01058	0.01801	0.13595	0.33194	0.057304	0.05923	0	0	0	0.4859	0	0.16197	0.03541	0.01419	0.01297	0.03543	0.06257
7/4/13 15:30	0	0.21741	0.03481	0.01414	0.01297	0.5204	0.06192	0.01542	0.03239	0.01027	0.01767	0.13424	0.33032	0.057113	0.05808	0	0	0	0.48223	0	0.15933	0.03481	0.01414	0.01297	0.03817	0.06192
7/4/13 15:45	0	0.21415	0.03424	0.0141	0.01297	0.51772	0.06131	0.01505	0.03198	0.00998	0.01748	0.13255	0.32866	0.056922	0.05701	0	0	0	0.47869	0	0.15714	0.03424	0.0141	0.01297	0.03903	0.0613
7/4/13 16:00	0	0.21099	0.03372	0.01406	0.01297	0.5144	0.06075	0.01468	0.03157	0.00969	0.0173	0.13083	0.32705	0.056729	0.05594	0	0	0	0.47518	0	0.15505	0.03372	0.01406	0.01297	0.03922	0.0608
7/4/13 16:15	0	0.20873	0.03467	0.01474	0.01369	0.54792	0.0631	0.0142	0.03092	0.00941	0.01527	0.12619	0.32733	0.055814	0.05453	0	0	0	0.46879	0	0.1542	0.03467	0.01474	0.01369	0.07913	0.063
7/4/13 16:30	0	0.20571	0.03418	0.01471	0.01369	0.54257	0.06258	0.01383	0.03051	0.00913	0.015	0.1245	0.32573	0.055623	0.05347	0	0	0	0.46523	0	0.15224	0.03418	0.01471	0.01369	0.07734	0.0608
7/4/13 16:45	0	0.20282	0.0337	0.01467	0.01369	0.53887	0.06206	0.01348	0.0301	0.00887	0.01481	0.12281	0.32414	0.055432	0.05245	0	0	0	0.46176	0	0.15037	0.0337	0.01467	0.01369	0.07711	0.06206
7/4/13 17:00	0	0.2	0.03321	0.01463	0.01368	0.53543	0.06152	0.01312	0.0297	0.00861	0.01464	0.12108	0.32254	0.055232	0.05143	0	0	0	0.45826	0	0.14857	0.03321	0.01463	0.01368	0.07717	0.06152
7/4/13 17:15	0	0.19934	0.02982	0.01317	0.01225	0.54452	0.05524	0.01391	0.03061	0.00835	0.01739	0.11187	0.31332	0.050696	0.05287	0	0	0	0.44258	0	0.14647	0.02982	0.01317	0.01225	0.10194	0.0552
7/4/13 17:30	0	0.19719	0.0294	0.01314	0.01225	0.53805	0.05479	0.01369	0.03021	0.00811	0.01735	0.11019	0.31167	0.050504	0.05201	0	0	0	0.43921	0	0.14518	0.0294	0.01314	0.01225	0.09884	0.0547
7/4/13 17:45	0	0.19466	0.02902	0.01311	0.01224	0.53367	0.05437	0.01337	0.0298	0.00787	0.01717	0.10852	0.3101	0.050313	0.05104	0	0	0	0.43579	0	0.14362	0.02902	0.01311	0.01224	0.09788	0.05437
7/4/13 18:00	0	0.19217	0.02865	0.01309	0.01224	0.53002	0.05398	0.01302	0.02939	0.00763	0.017	0.10684	0.3085	0.050123	0.05004	0	0	0	0.43234	0	0.14213	0.02865	0.01309	0.01224	0.09768	0.05398
7/4/13 18:15	0	0.1903	0.0283	0.01306	0.01224	0.48019	0.0536	0.01309	0.02923	0.00741	0.02052	0.10125	0.30306	0.050656	0.04973	0	0	0	0.42483	0	0.14057	0.0283	0.01306	0.01224	0.05536	0.0536

Hydrograph Table
Design Flow Derivation
2 Year Recurrance Interval Storm

7/4/13 18:30	0	0.18812	0.02797	0.01304	0.01224	0.47579	0.05325	0.0128	0.02882	0.00718	0.02048	0.0996	0.30147	0.050466	0.0488	0	0	0	0.42155	0	0.13932	0.02797	0.01304	0.01224	0.05424	0.05325
7/4/13 18:45	0	0.18587	0.02766	0.01301	0.01224	0.47177	0.05291	0.01247	0.02841	0.00697	0.02031	0.09795	0.29988	0.050275	0.04785	0	0	0	0.41614	0	0.13802	0.02766	0.01301	0.01224	0.05363	0.05291
7/4/13 19:00	0	0.18368	0.02738	0.01299	0.01225	0.46827	0.05262	0.01213	0.028	0.00676	0.02012	0.09632	0.29829	0.050086	0.04689	0	0	0	0.41473	0	0.13679	0.02738	0.01299	0.01225	0.05354	0.05262
7/4/13 19:15	0	0.18238	0.0286	0.01369	0.01296	0.52816	0.05525	0.01278	0.02635	0.00655	0.01521	0.09732	0.30147	0.051344	0.04568	0	0	0	0.414	0	0.1367	0.0286	0.01369	0.01296	0.11416	0.05525
7/4/13 19:30	0	0.18051	0.02835	0.01367	0.01296	0.5248	0.05498	0.01258	0.02595	0.00635	0.01482	0.09569	0.29986	0.051154	0.04488	0	0	0	0.41037	0	0.13563	0.02835	0.01367	0.01296	0.11443	0.05498
7/4/13 19:45	0	0.17859	0.02812	0.01365	0.01296	0.52187	0.05473	0.01227	0.02554	0.00616	0.01463	0.09407	0.29826	0.050964	0.04397	0	0	0	0.40696	0	0.13462	0.02812	0.01365	0.01296	0.11491	0.05473
7/4/13 20:00	0	0.17671	0.02783	0.01362	0.01295	0.51859	0.0544	0.01195	0.02514	0.00597	0.01445	0.09249	0.29666	0.05077	0.04306	0	0	0	0.4036	0	0.13365	0.02783	0.01362	0.01295	0.11499	0.0544
7/4/13 20:15	0	0.19226	0.01822	0.00905	0.0084	0.49221	0.03567	0.01323	0.02507	0.00579	0.0148	0.09614	0.30457	0.04913	0.04409	0	0	0	0.41551	0	0.14817	0.01822	0.00905	0.0084	0.0767	0.03567
7/4/13 20:30	0	0.19136	0.01805	0.00904	0.0084	0.49173	0.03549	0.01313	0.02467	0.00561	0.01465	0.09454	0.30302	0.048939	0.04341	0	0	0	0.41221	0	0.14795	0.01805	0.00904	0.0084	0.07952	0.03549
7/4/13 20:45	0	0.18978	0.01791	0.00902	0.0084	0.48901	0.03533	0.01286	0.02426	0.00543	0.01448	0.09295	0.30139	0.048748	0.04255	0	0	0	0.40882	0	0.14723	0.01791	0.00902	0.0084	0.08019	0.03533
7/4/13 21:00	0	0.18824	0.0178	0.00901	0.00841	0.48572	0.03522	0.01256	0.02387	0.00527	0.01431	0.09135	0.29978	0.048552	0.0417	0	0	0	0.40544	0	0.14654	0.0178	0.00901	0.00841	0.08028	0.03522
7/4/13 21:15	0	0.18361	0.02019	0.01019	0.0096	0.44723	0.03998	0.01074	0.02512	0.0051	0.01787	0.08452	0.28674	0.045827	0.04096	0	0	0	0.38913	0	0.14265	0.02019	0.01019	0.0096	0.0581	0.03998
7/4/13 21:30	0	0.18196	0.02012	0.01017	0.0096	0.44227	0.03989	0.0103	0.02473	0.00494	0.01786	0.08295	0.28511	0.045635	0.03997	0	0	0	0.38592	0	0.14199	0.02012	0.01017	0.0096	0.05635	0.03989
7/4/13 21:45	0	0.18071	0.02008	0.01016	0.0096	0.43817	0.03984	0.01011	0.02433	0.00479	0.01769	0.08139	0.28352	0.045446	0.03923	0	0	0	0.3826	0	0.14148	0.02008	0.01016	0.0096	0.05557	0.03984
7/4/13 22:00	0	0.17967	0.02008	0.01014	0.0096	0.4346	0.03982	0.00998	0.02393	0.00464	0.01751	0.07981	0.28192	0.045272	0.03855	0	0	0	0.37924	0	0.14112	0.02008	0.01014	0.0096	0.05536	0.03982
7/4/13 22:15	0	0.16629	0.02008	0.01013	0.0096	0.41996	0.03981	0.01007	0.0218	0.00449	0.01513	0.07532	0.2774	0.051237	0.03636	0	0	0	0.36785	0	0.12993	0.02008	0.01013	0.0096	0.05211	0.03981
7/4/13 22:30	0	0.16506	0.02008	0.01012	0.0096	0.41457	0.0398	0.01	0.02141	0.00435	0.01486	0.07379	0.27584	0.05105	0.03576	0	0	0	0.36449	0	0.1293	0.02008	0.01012	0.0096	0.05008	0.0398
7/4/13 22:45	0	0.16443	0.02008	0.0101	0.0096	0.41085	0.03978	0.00991	0.02102	0.00421	0.01468	0.07227	0.27426	0.050862	0.03514	0	0	0	0.36121	0	0.12929	0.02008	0.0101	0.0096	0.04964	0.03978
7/4/13 23:00	0	0.16382	0.0201	0.0101	0.00961	0.40748	0.03981	0.00982	0.02062	0.00408	0.0145	0.07068	0.27265	0.050668	0.03452	0	0	0	0.35783	0	0.1293	0.0201	0.0101	0.00961	0.04965	0.03981
7/4/13 23:15	0	0.16021	0.02257	0.01128	0.0108	0.36269	0.04465	0.00824	0.01933	0.00395	0.01327	0.05968	0.2614	0.047946	0.03152	0	0	0	0.33435	0	0.12869	0.02257	0.01128	0.0108	0.02834	0.04465
7/4/13 23:30	0	0.15888	0.02257	0.01127	0.0108	0.35452	0.04464	0.00792	0.01894	0.00383	0.01305	0.05819	0.25985	0.04776	0.03069	0	0	0	0.33109	0	0.12819	0.02257	0.01127	0.0108	0.02343	0.04464
7/4/13 23:45	0	0.1582	0.02257	0.01126	0.0108	0.34963	0.04463	0.0078	0.01856	0.00371	0.01287	0.05671	0.2583	0.047574	0.03007	0	0	0	0.32788	0	0.12813	0.02257	0.01126	0.0108	0.02175	0.04463

Hydrograph Table
Design Flow Derivation
3 Month Recurrance Interval Storm

Time	Precip	Exported From SWMM												Calculated											
		Total						Forward Township			Elizabeth Township			Sanitary Flow						Combined Flow					
		SS 8	SS 7	SS 6	SS 5	SS 3	Boro.	Center	Grant	Kendle	Chicago	Church	Cemetary	SS 8	SS 7	SS 6	SS 5	SS 3	Boro.	SS 8	SS 7	SS 6	SS 5	SS 3	Boro.
7/3/13 0:00	0	0.14378	0.02253	0.01081	0.01081	0.14344	0.04415	0.00672	0.00731	0.002	0.00693	0.03136	0.08586	0.01603	0	0	0	0.12415	0	0.12775	0.02253	0.01081	0.01081	0.01929	0.04415
7/3/13 0:15	0	0.12669	0.027	0.01296	0.01296	0.20832	0.05292	0.00546	0.00797	0.002	0.00564	0.02871	0.08333	0.01543	0	0	0	0.11768	0	0.11126	0.027	0.01296	0.01296	0.09064	0.05292
7/3/13 0:30	0.02	0.12573	0.027	0.01296	0.01296	0.20591	0.05292	0.00518	0.00797	0.002	0.00548	0.02871	0.08298	0.01515	0	0	0	0.11717	0	0.11058	0.027	0.01296	0.01296	0.08874	0.05292
7/3/13 0:45	0.02	0.12723	0.02771	0.01365	0.0151	0.22166	0.05646	0.00521	0.00825	0.00211	0.00546	0.02902	0.08364	0.01557	0	0	0	0.11812	0	0.11166	0.02771	0.01365	0.0151	0.10354	0.05646
7/3/13 1:00	0.02	0.13176	0.02909	0.01518	0.01757	0.24854	0.06184	0.00598	0.00986	0.00234	0.00569	0.03063	0.08522	0.01818	0	0	0	0.12154	0	0.11358	0.02909	0.01518	0.01757	0.127	0.06184
7/3/13 1:15	0.02	0.12084	0.02627	0.01503	0.01661	0.24518	0.05791	0.00631	0.01063	0.00264	0.00662	0.02677	0.07591	0.01958	0	0	0	0.1093	0	0.10126	0.02627	0.01503	0.01661	0.13588	0.05791
7/3/13 1:30	0.02	0.12736	0.02786	0.01726	0.01707	0.25669	0.06219	0.00815	0.01319	0.00295	0.00734	0.03049	0.08043	0.02429	0	0	0	0.11826	0	0.10307	0.02786	0.01726	0.01707	0.13843	0.06219
7/3/13 1:45	0.02	0.13396	0.02925	0.01955	0.01723	0.26778	0.06603	0.00982	0.01441	0.00324	0.00798	0.03363	0.08631	0.02747	0	0	0	0.12792	0	0.10649	0.02925	0.01955	0.01723	0.13986	0.06603
7/3/13 2:00	0.02	0.13817	0.03037	0.02176	0.01728	0.2777	0.06941	0.01087	0.01477	0.00351	0.0085	0.0362	0.09156	0.02915	0	0	0	0.13626	0	0.10902	0.03037	0.02176	0.01728	0.14144	0.06941
7/3/13 2:15	0.02	0.14183	0.02829	0.02238	0.01587	0.25672	0.06654	0.0106	0.01576	0.00375	0.01028	0.03853	0.08752	0.03011	0	0	0	0.13633	0	0.11172	0.02829	0.02238	0.01587	0.12039	0.06654
7/3/13 2:30	0.02	0.1437	0.02899	0.02426	0.01587	0.26374	0.06912	0.01085	0.01625	0.00395	0.01057	0.03993	0.09095	0.03105	0	0	0	0.14145	0	0.11265	0.02899	0.02426	0.01587	0.12229	0.06912
7/3/13 2:45	0.02	0.14537	0.02951	0.02592	0.01588	0.26867	0.07131	0.01122	0.01678	0.00411	0.01077	0.04106	0.09363	0.03211	0	0	0	0.14546	0	0.11326	0.02951	0.02592	0.01588	0.12321	0.07131
7/3/13 3:00	0.02	0.14686	0.02989	0.02737	0.01588	0.27217	0.07314	0.0116	0.0173	0.00424	0.01097	0.04217	0.09546	0.03314	0	0	0	0.1486	0	0.11372	0.02989	0.02737	0.01588	0.12357	0.07314
7/3/13 3:15	0.02	0.14336	0.03017	0.03073	0.02239	0.26314	0.08329	0.01181	0.01599	0.00469	0.00947	0.04292	0.1015	0.03249	0	0	0	0.15389	0	0.11087	0.03017	0.03073	0.02239	0.10925	0.08329
7/3/13 3:30	0.02	0.14447	0.03038	0.03647	0.02981	0.26548	0.09666	0.01215	0.01648	0.00549	0.00957	0.04397	0.10318	0.03412	0	0	0	0.15672	0	0.11035	0.03038	0.03647	0.02981	0.10876	0.09666
7/3/13 3:45	0.02	0.14629	0.03053	0.04341	0.03336	0.26835	0.1073	0.01248	0.01695	0.00644	0.00976	0.045	0.10487	0.03587	0	0	0	0.15963	0	0.11042	0.03053	0.04341	0.03336	0.10872	0.1073
7/3/13 4:00	0.02	0.14816	0.03063	0.05085	0.03471	0.27146	0.11619	0.01281	0.01741	0.00742	0.00995	0.046	0.10669	0.03764	0	0	0	0.16264	0	0.11052	0.03063	0.05085	0.03471	0.10882	0.11619
7/3/13 4:15	0.02	0.14982	0.03071	0.05832	0.03518	0.29573	0.12421	0.01312	0.01769	0.00835	0.0106	0.04534	0.10676	0.03916	0	0	0	0.1627	0	0.11066	0.03071	0.05832	0.03518	0.13303	0.12421
7/3/13 4:30	0.02	0.15147	0.03077	0.06546	0.03534	0.29803	0.13157	0.01342	0.01812	0.00919	0.01081	0.0463	0.10855	0.04073	0	0	0	0.16566	0	0.11074	0.03077	0.06546	0.03534	0.13237	0.13157
7/3/13 4:45	0.02	0.153	0.03081	0.07207	0.0354	0.30071	0.13828	0.0137	0.01854	0.00992	0.01098	0.04724	0.11043	0.04216	0	0	0	0.16865	0	0.11084	0.03081	0.07207	0.0354	0.13206	0.13828
7/3/13 5:00	0.02	0.15439	0.03083	0.07802	0.03542	0.30359	0.14427	0.01398	0.01894	0.01053	0.01115	0.04815	0.11231	0.04345	0	0	0	0.17161	0	0.11094	0.03083	0.07802	0.03542	0.13198	0.14427
7/3/13 5:15	0.02	0.15719	0.03085	0.08328	0.03543	0.28362	0.14956	0.01455	0.01957	0.01103	0.01224	0.05134	0.11133	0.04515	0	0	0	0.17491	0	0.11204	0.03085	0.08328	0.03543	0.10871	0.14956
7/3/13 5:30	0.02	0.15846	0.03087	0.08786	0.03543	0.28795	0.15416	0.01483	0.01993	0.01144	0.01245	0.05221	0.11318	0.0462	0	0	0	0.17784	0	0.11226	0.03087	0.08786	0.03543	0.11011	0.15416
7/3/13 5:45	0.02	0.16415	0.03301	0.09176	0.03543	0.29694	0.1602	0.01505	0.02029	0.01177	0.0126	0.05305	0.11514	0.04711	0	0	0	0.18079	0	0.11704	0.03301	0.09176	0.03543	0.11615	0.1602
7/3/13 6:00	0.02	0.17444	0.0373	0.09508	0.03543	0.30821	0.16781	0.01527	0.02062	0.01203	0.01275	0.05387	0.11698	0.04792	0	0	0	0.1836	0	0.12652	0.0373	0.09508	0.03543	0.12461	0.16781
7/3/13 6:15	0.02	0.18584	0.04397	0.09871	0.03627	0.34003	0.17895	0.01867	0.02111	0.01223	0.01389	0.0596	0.1273	0.05201	0	0	0	0.20079	0	0.13383	0.04397	0.09871	0.03627	0.13924	0.17895
7/3/13 6:30	0.02	0.19651	0.04874	0.10105	0.03627	0.34827	0.18606	0.01915	0.02142	0.01239	0.01407	0.06033	0.12918	0.05296	0	0	0	0.20358	0	0.14355	0.04874	0.10105	0.03627	0.14469	0.18606
7/3/13 6:45	0.02	0.2045	0.05293	0.10299	0.03627	0.35304	0.19219	0.01935	0.0217	0.01252	0.0142	0.06102	0.13096	0.05357	0	0	0	0.20618	0	0.15093	0.05293	0.10299	0.03627	0.14686	0.19219
7/3/13 7:00	0.02	0.21052	0.05636	0.1046	0.03627	0.35637	0.19723	0.0195	0.02198	0.01262	0.01432	0.06166	0.13276	0.0541	0	0	0	0.20874	0	0.15642	0.05636	0.1046	0.03627	0.14763	0.19723
7/3/13 7:15	0.02	0.22036	0.06033	0.10653	0.03688	0.38652	0.20374	0.02228	0.02487	0.01269	0.01166	0.06389	0.14965	0.05984	0	0	0	0.2252	0	0.16052	0.06033	0.10653	0.03688	0.16132	0.20374
7/3/13 7:30	0.04	0.22472	0.0624	0.10762	0.03688	0.38942	0.2069	0.0226	0.0251	0.01275	0.01161	0.06443	0.15163	0.06045	0	0	0	0.22767	0	0.16427	0.0624	0.10762	0.03688	0.16175	0.2069
7/3/13 7:45	0.04	0.25383	0.07682	0.12726	0.05469	0.44695	0.25877	0.02286	0.0256	0.01533	0.01173	0.06523	0.15442	0.06379	0	0	0	0.23138	0	0.19004	0.07682	0.12726	0.05469	0.21557	0.25877
7/3/13 8:00	0.04	0.27938	0.08841	0.14485	0.06086	0.47807	0.29412	0.02393	0.02744	0.01751	0.01205	0.06735	0.15743	0.06888	0	0	0	0.23683	0	0.2105	0.08841	0.14485	0.06086	0.24124	0.29412
7/3/13 8:15	0.04	0.31409	0.09874	0.16049	0.06339	0.57641	0.32262	0.02617	0.03156	0.0192	0.01186	0.07643	0.20017	0.07693	0	0	0	0.28846	0	0.23716	0.09874	0.16049	0.06339	0.28795	0.32262
7/3/13 8:30	0.04	0.33026	0.10452	0.1724	0.06378	0.59251	0.3407	0.02838	0.0342	0.02048	0.01256	0.08059	0.20691	0.08306	0	0	0	0.30006	0	0.2472	0.10452	0.1724	0.06378	0.29245	0.3407
7/3/13 8:45	0.04	0.34033	0.10841	0.18194	0.06387	0.60652	0.35422	0.03002	0.03551	0.02143	0.01325	0.08418	0.21447	0.08696	0	0	0	0.3119	0	0.25337	0.10841	0.18194	0.06387	0.29462	0.35422
7/3/13 9:00	0.04	0.3462	0.11103	0.18948	0.0639	0.61827	0.36441	0.03104	0.03599	0.02213	0.01378	0.08723	0.22137	0.08916	0	0	0	0.32238	0	0.25704	0.11103	0.18948	0.0639	0.29589	0.36441
7/3/13 9:15	0.04	0.3772	0.11666	0.19729	0.06582	0.6025	0.37977	0.03054	0.04132	0.02263	0.01403	0.10019	0.22269	0.09449	0	0	0	0.33691	0	0.28271	0.11666	0.19729	0.06582	0.26559	0.37977
7/3/13 9:30	0.06	0.38023	0.11776	0.20188	0.06582	0.61593	0.38546	0.03091	0.04192	0.023	0.01428	0.10202	0.22776	0.09583	0	0	0	0.34406	0	0.2844	0.11776	0.20188	0.06582	0.27187	0.38546
7/3/13 9:45	0.06	0.41601	0.13482	0.22913	0.08582	0.68753	0.44977	0.03152	0.04288	0.02643	0.01455	0.10389	0.23281	0.10083	0	0	0	0.35125	0	0.31518	0.13482	0.22913	0.08582	0.33628	0.44977
7/3/13 10:00	0.06	0.44309	0.14656	0.25151	0.09074	0.71773	0.48881	0.033	0.04519	0.02903	0.01504	0.10705	0.23736	0.10722	0	0	0	0.35945	0	0.33587	0.14656	0.25151	0.09074	0.35828	0.48881
7/3/13 10:15	0.06	0.45788	0.15767	0.27053	0.09347	0.75312	0.52167	0.03472	0.04694	0.03087	0.01974	0.10995	0.24531	0.11253	0	0	0	0.375	0	0.34535	0.15767	0.27053	0.09347	0.37812	0.52167
7/3/13 10:30	0.08	0.4718	0.16223	0.2836	0.09365	0.76762	0.53948	0.03722	0.05004	0.03215	0.02084	0.11514	0.25304	0.11941	0	0	0	0.38902	0	0.35239	0.16223	0.2836	0.09365	0.3786	0.53948
7/3/13 10:45	0.08	0.51867	0.18339	0.32028	0.11489	0.85124	0.61856	0.03933	0.05212	0.03662	0.02176	0.12004	0.26288	0.12807	0	0	0	0.40468	0	0.3906	0.18339	0.32028	0.11489	0.44656	0.61856
7/3/13 11:00	0.1	0.54996	0.19668	0.34884	0.11899	0.88738	0.66451	0.04168	0.05472	0.03978	0.02271	0.1257	0.2726	0.13618	0	0	0	0.42101	0	0.41378	0.19668	0.34884	0.11899	0.46637	0.66451
7/3/13 11:15	0.1	0.61708	0.22215	0.39805	0.14063	1.00273	0.76083	0.04456	0.05757	0.04579	0.02174	0.13968	0.28669	0.14792	0	0	0	0.44811	0	0.46916	0.22215	0.39805	0.14063	0.55462	0.76083
7/3/13 11:30	0.16	0.65795	0.23854	0.43583	0.14421	1.04665	0.81858	0.04845	0.06276	0.04986	0.02301	0.14779	0.2999	0.16107	0	0	0	0.4707	0	0.49688	0.23854	0.43583	0.14421	0.57595	0.81858
7/3/13 11:45	0.16	0.81898	0.31325	0.55991	0.21422	1.30605	1.08738	0.05328	0.06899	0.06537	0.02463	0.15738	0.31575	0.18764	0	0	0	0.49776	0	0.63134	0.31325	0.55991	0.21422	0.80829	1.08738
7/3/13 12:00	1.2	0.91611	0.35521	0.65254	0.22221	1.3845	1.22996	0.0602	0.07791	0.07557	0.02694	0.171	0.33589	0.21368	0	0	0	0.53383	0	0.70243	0.35521	0.65254	0.22221	0.85067	1.22996
7/3/13 12:15	1.2	4.38781	2.08492	3.34953	1.66919	6.1695	7.10364	0.07781	0.10726	0.42132	0.02951	0.2032	0.36929	0.60639	0	0	0	0.602	0	3.78142	2.08492	3.34953	1.66919	5.5675	7.10364
7/3/13 12:30	0.22	5.5737	2.80065	5.26365	2.13312	6.93329	10.19742	0.1444	0.20469	0.59932	0.04578	0.30573	0.48862	0.94841	0	0	0	0.84013	0	4.62529	2.80065	5.26365	2.13312	6.09316	10.19742
7/3/13 12:45	0.22	2.6732	1.27531	3.07399	0.90871	3.09652	5.25801	0.25373	0.3532	0.29426	0.07199	0.46307	0.67259	0.90119	0	0	0	1.20765	0	1.77201	1.27531	3.07399	0.90871	1.88887	5.25801
7/3/13 13:00	0.12	2.1493	0.95308	2.24294	0.87988	3.37686	4.0759	0.30925	0.40194	0.20445	0.09815	0.5885	0.83892	0.91564	0	0	0	1.52557	0	1.23366	0.95308	2.24294	0.87988	1.85129	4.0759

Hydrograph Table
Design Flow Derivation
3 Month Recurrance Interval Storm

Time	Precip	Exported From SWMM												Calculated											
		Total						Forward Township			Elizabeth Township			Sanitary Flow						Combined Flow					
		SS 8	SS 7	SS 6	SS 5	SS 3	Boro.	Center	Grant	Kendle	Chicago	Church	Cemetary	SS 8	SS 7	SS 6	SS 5	SS 3	Boro.	SS 8	SS 7	SS 6	SS 5	SS 3	Boro.
7/3/13 13:15	0.12	1.63511	0.71959	1.62725	0.71091	3.23105	3.05775	0.28034	0.3128	0.14271	0.11573	0.60771	0.95947	0.73585	0	0	0	1.68291	0	0.89926	0.71959	1.62725	0.71091	1.54814	3.05775
7/3/13 13:30	0.08	1.31217	0.63876	1.31838	0.66241	3.18388	2.61955	0.22038	0.20444	0.11641	0.10559	0.55974	0.95734	0.54123	0	0	0	1.62267	0	0.77094	0.63876	1.31838	0.66241	1.56121	2.61955
7/3/13 13:45	0.08	1.04128	0.5567	1.06275	0.56652	2.94395	2.18597	0.15997	0.15678	0.09432	0.09043	0.50153	0.94631	0.41107	0	0	0	1.53827	0	0.63021	0.5567	1.06275	0.56652	1.40568	2.18597
7/3/13 14:00	0.06	0.92637	0.51975	0.91105	0.52112	2.79446	1.95192	0.12638	0.1523	0.08313	0.07518	0.43366	0.89277	0.36181	0	0	0	1.40161	0	0.56456	0.51975	0.91105	0.52112	1.39285	1.95192
7/3/13 14:15	0.06	0.83743	0.47813	0.77773	0.45826	2.50756	1.71412	0.11867	0.15138	0.07282	0.06457	0.38183	0.80816	0.34287	0	0	0	1.25456	0	0.49456	0.47813	0.77773	0.45826	1.253	1.71412
7/3/13 14:30	0.06	0.79845	0.4556	0.68993	0.42212	2.35059	1.56765	0.11377	0.14948	0.06705	0.06361	0.35561	0.7283	0.3303	0	0	0	1.14752	0	0.46815	0.4556	0.68993	0.42212	1.20307	1.56765
7/3/13 14:45	0.06	0.77652	0.44279	0.62992	0.39585	2.20142	1.46856	0.10889	0.14519	0.06378	0.06322	0.34384	0.6321	0.31786	0	0	0	1.03916	0	0.45866	0.44279	0.62992	0.39585	1.16226	1.46856
7/3/13 15:00	0.06	0.76544	0.43512	0.58732	0.37519	2.14179	1.39763	0.10487	0.14235	0.06196	0.0622	0.33531	0.60592	0.30918	0	0	0	1.00343	0	0.45626	0.43512	0.58732	0.37519	1.13836	1.39763
7/3/13 15:15	0.06	0.75429	0.4289	0.55557	0.35785	2.0724	1.34232	0.10153	0.13798	0.06101	0.05705	0.33685	0.60626	0.30052	0	0	0	1.00016	0	0.45377	0.4289	0.55557	0.35785	1.07224	1.34232
7/3/13 15:30	0.04	0.75461	0.42587	0.53244	0.34434	2.06672	1.30265	0.09933	0.1365	0.0606	0.05625	0.33279	0.61787	0.29643	0	0	0	1.00691	0	0.45818	0.42587	0.53244	0.34434	1.05981	1.30265
7/3/13 15:45	0.04	0.71702	0.40156	0.48293	0.3042	1.97724	1.18869	0.09731	0.13445	0.05664	0.05553	0.32941	0.62876	0.2884	0	0	0	1.0137	0	0.42862	0.40156	0.48293	0.3042	0.96354	1.18869
7/3/13 16:00	0.04	0.6927	0.38536	0.44569	0.28313	1.92891	1.11418	0.09437	0.13092	0.05412	0.05465	0.32522	0.6352	0.27941	0	0	0	1.01507	0	0.41329	0.38536	0.44569	0.28313	0.91384	1.11418
7/3/13 16:15	0.04	0.67677	0.37548	0.41894	0.26908	1.92905	1.0635	0.09026	0.12569	0.05254	0.05158	0.31686	0.63837	0.26849	0	0	0	1.00681	0	0.40828	0.37548	0.41894	0.26908	0.92224	1.0635
7/3/13 16:30	0.04	0.66501	0.36707	0.39761	0.25742	1.89618	1.0221	0.08624	0.12125	0.05155	0.05018	0.3107	0.63779	0.25904	0	0	0	0.99867	0	0.40597	0.36707	0.39761	0.25742	0.89751	1.0221
7/3/13 16:45	0.04	0.65811	0.36052	0.38096	0.24782	1.86645	0.9893	0.08278	0.1181	0.05095	0.04886	0.30503	0.63574	0.25183	0	0	0	0.98963	0	0.40628	0.36052	0.38096	0.24782	0.87682	0.9893
7/3/13 17:00	0.04	0.65462	0.35516	0.36777	0.23978	1.84014	0.96271	0.07993	0.11574	0.05062	0.04769	0.2998	0.63382	0.24629	0	0	0	0.98131	0	0.40833	0.35516	0.36777	0.23978	0.85883	0.96271
7/3/13 17:15	0.04	0.65529	0.34773	0.35575	0.23159	1.82824	0.93507	0.07885	0.1146	0.05046	0.04969	0.28754	0.62481	0.24391	0	0	0	0.96204	0	0.41138	0.34773	0.35575	0.23159	0.8662	0.93507
7/3/13 17:30	0.04	0.65431	0.34387	0.34717	0.22587	1.80582	0.91691	0.07653	0.11203	0.05042	0.0488	0.2833	0.62403	0.23898	0	0	0	0.95613	0	0.41533	0.34387	0.34717	0.22587	0.84969	0.91691
7/3/13 17:45	0.04	0.65343	0.34045	0.34013	0.22102	1.78833	0.9016	0.07414	0.10938	0.05047	0.04786	0.27891	0.62399	0.23399	0	0	0	0.95076	0	0.41944	0.34045	0.34013	0.22102	0.83757	0.9016
7/3/13 18:00	0.02	0.65275	0.33739	0.33431	0.21691	1.77263	0.88861	0.07176	0.10671	0.05058	0.0469	0.27314	0.62473	0.22905	0	0	0	0.94477	0	0.4237	0.33739	0.33431	0.21691	0.82786	0.88861
7/3/13 18:15	0.02	0.61709	0.3148	0.30243	0.18735	1.63154	0.80458	0.06962	0.10388	0.04731	0.04966	0.26202	0.62104	0.22081	0	0	0	0.93272	0	0.39628	0.3148	0.30243	0.18735	0.69882	0.80458
7/3/13 18:30	0.02	0.58966	0.29831	0.27732	0.17244	1.57283	0.74807	0.06596	0.09912	0.04498	0.04845	0.25332	0.62037	0.21006	0	0	0	0.92214	0	0.3796	0.29831	0.27732	0.17244	0.65069	0.74807
7/3/13 18:45	0.02	0.56736	0.28577	0.25772	0.16254	1.528	0.70603	0.06112	0.09273	0.04332	0.04685	0.24315	0.61774	0.19717	0	0	0	0.90774	0	0.37019	0.28577	0.25772	0.16254	0.62026	0.70603
7/3/13 19:00	0.02	0.54912	0.2758	0.2422	0.15491	1.48719	0.67291	0.05631	0.08687	0.0421	0.0449	0.23238	0.61324	0.18528	0	0	0	0.89052	0	0.36384	0.2758	0.2422	0.15491	0.59667	0.67291
7/3/13 19:15	0.02	0.53647	0.26902	0.23039	0.14932	1.51191	0.64873	0.05338	0.08109	0.04119	0.0381	0.22498	0.61216	0.17566	0	0	0	0.87524	0	0.36081	0.26902	0.23039	0.14932	0.63667	0.64873
7/3/13 19:30	0.02	0.52715	0.26198	0.22015	0.14395	1.47824	0.62608	0.05086	0.07739	0.04049	0.03629	0.21662	0.60675	0.16874	0	0	0	0.85966	0	0.35841	0.26198	0.22015	0.14395	0.61858	0.62608
7/3/13 19:45	0.02	0.52052	0.25586	0.2117	0.13931	1.44826	0.60687	0.04969	0.07368	0.03995	0.0347	0.21144	0.60119	0.16332	0	0	0	0.84733	0	0.3572	0.25586	0.2117	0.13931	0.60093	0.60687
7/3/13 20:00	0.02	0.51526	0.25029	0.20463	0.13524	1.42189	0.59016	0.04885	0.07001	0.03952	0.03324	0.2087	0.59485	0.15838	0	0	0	0.83679	0	0.35688	0.25029	0.20463	0.13524	0.5851	0.59016
7/3/13 20:15	0.02	0.52865	0.23603	0.19417	0.1272	1.37693	0.5574	0.04991	0.06697	0.03917	0.03236	0.21184	0.59789	0.15605	0	0	0	0.84209	0	0.3726	0.23603	0.19417	0.1272	0.53484	0.5574
7/3/13 20:30	0.02	0.52585	0.23158	0.18915	0.1241	1.35845	0.54483	0.04933	0.06474	0.03889	0.03102	0.21005	0.59198	0.15296	0	0	0	0.83305	0	0.37289	0.23158	0.18915	0.1241	0.5254	0.54483
7/3/13 20:45	0.02	0.52409	0.2275	0.18488	0.12138	1.33986	0.53376	0.04876	0.0635	0.03866	0.03004	0.20843	0.58618	0.15092	0	0	0	0.82465	0	0.37317	0.2275	0.18488	0.12138	0.51521	0.53376
7/3/13 21:00	0.02	0.52299	0.22376	0.18121	0.11898	1.32235	0.52395	0.04823	0.06252	0.03846	0.02949	0.20693	0.58009	0.14921	0	0	0	0.81651	0	0.37378	0.22376	0.18121	0.11898	0.50584	0.52395
7/3/13 21:15	0.02	0.51884	0.22271	0.17924	0.11805	1.27003	0.52	0.04602	0.06336	0.03829	0.03291	0.20029	0.5623	0.14767	0	0	0	0.7955	0	0.37117	0.22271	0.17924	0.11805	0.47453	0.52
7/3/13 21:30	0.02	0.5181	0.21944	0.17648	0.11618	1.25239	0.5121	0.0455	0.06264	0.03815	0.03267	0.19899	0.55567	0.14629	0	0	0	0.78733	0	0.37181	0.21944	0.17648	0.11618	0.46506	0.5121
7/3/13 21:45	0.02	0.51771	0.21637	0.17408	0.11451	1.23677	0.50496	0.04508	0.06201	0.03802	0.03239	0.19776	0.54893	0.14511	0	0	0	0.77908	0	0.3726	0.21637	0.17408	0.11451	0.45769	0.50496
7/3/13 22:00	0.02	0.51744	0.21348	0.17198	0.11304	1.22213	0.4985	0.04468	0.06143	0.03791	0.03213	0.19657	0.54212	0.14402	0	0	0	0.77082	0	0.37342	0.21348	0.17198	0.11304	0.45131	0.4985
7/3/13 22:15	0.02	0.50447	0.21077	0.17013	0.11173	1.19582	0.49263	0.04455	0.05917	0.0378	0.02965	0.19251	0.53237	0.14152	0	0	0	0.75453	0	0.36295	0.21077	0.17013	0.11173	0.44129	0.49263
7/3/13 22:30	0.02	0.50422	0.2082	0.16849	0.11057	1.18093	0.48726	0.04422	0.05868	0.03771	0.02939	0.19146	0.52547	0.14061	0	0	0	0.74632	0	0.36361	0.2082	0.16849	0.11057	0.43461	0.48726
7/3/13 22:45	0.02	0.50422	0.20578	0.16704	0.10954	1.16787	0.48236	0.04392	0.05823	0.03762	0.02919	0.19048	0.51849	0.13977	0	0	0	0.73816	0	0.36445	0.20578	0.16704	0.10954	0.42971	0.48236
7/3/13 23:00	0.02	0.50427	0.20352	0.16575	0.10863	1.15526	0.4779	0.04362	0.0578	0.03754	0.02901	0.1895	0.51143	0.13896	0	0	0	0.72994	0	0.36531	0.20352	0.16575	0.10863	0.42532	0.4779
7/3/13 23:15	0.02	0.50086	0.20382	0.16579	0.10901	1.09905	0.47862	0.04163	0.05651	0.03746	0.02775	0.17905	0.49475	0.1356	0	0	0	0.70155	0	0.36526	0.20382	0.16579	0.10901	0.3975	0.47862
7/3/13 23:30	0.02	0.50068	0.20176	0.16475	0.10829	1.0832	0.4748	0.04128	0.05616	0.03739	0.02757	0.17815	0.48772	0.13483	0	0	0	0.69344	0	0.36585	0.20176	0.16475	0.10829	0.38976	0.4748
7/3/13 23:45	0.02	0.50086	0.19981	0.16382	0.10765	1.07121	0.47128	0.04103	0.05584	0.03732	0.02742	0.17727	0.48068	0.13419	0	0	0	0.68537	0	0.36667	0.19981	0.16382	0.10765	0.38584	0.47128
7/4/13 0:00	0.02	0.50108	0.19799	0.16298	0.10709	1.06008	0.46806	0.04079	0.05554	0.03726	0.02729	0.17643	0.4736	0.13359	0	0	0	0.67732	0	0.36749	0.19799	0.16298	0.10709	0.38276	0.46806
7/4/13 0:15	0.02	0.48355	0.2007	0.16437	0.10874	1.11244	0.47381	0.03902	0.05591	0.0372	0.02574	0.17299	0.46368	0.13213	0	0	0	0.66241	0	0.35142	0.2007	0.16437	0.10874	0.45003	0.47381
7/4/13 0:30	0	0.48341	0.19903	0.16369	0.1083	1.10057	0.47102	0.03873	0.05564	0.03714	0.02558	0.17224	0.4566	0.13151	0	0	0	0.65442	0	0.3519	0.19903	0.16369	0.1083	0.44615	0.47102
7/4/13 0:45	0	0.45063	0.17991	0.14169	0.08369	1.01505	0.40529	0.03837	0.05507	0.03397	0.02543	0.17121	0.4485	0.12741	0	0	0	0.64514	0	0.32322	0.17991	0.14169	0.08369	0.36991	0.40529
7/4/13 1:00	0	0.4229	0.16491	0.12355	0.06969	0.95528	0.35815	0.03717	0.05316	0.03143	0.02509	0.16887	0.43992	0.12176	0	0	0	0.63388	0	0.30114	0.16491	0.12355	0.06969	0.3214	0.35815
7/4/13 1:15	0	0.37971	0.1485	0.10681	0.05779	0.88133	0.3131	0.0333	0.04768	0.02938	0.02507	0.15831	0.41731	0.11036	0	0	0	0.60069	0	0.26935	0.1485	0.10681	0.05779	0.28064	0.3131
7/4/13 1:30	0	0.35832	0.13853	0.09486	0.05019	0.83445	0.28358	0.031	0.045	0.02766	0.02432	0.15399	0.40555	0.10366	0	0	0	0.58386	0	0.25466	0.13853	0.09486	0.05019	0.25059	0.28358
7/4/13 1:45	0	0.34176	0.12998	0.08496	0.04395	0.793	0.25889	0.0293	0.04365	0.02619	0.02362	0.15024	0.39278	0.09914	0	0	0	0.56664	0	0.24262	0.12998	0.08496	0.04395	0.22636	0.25889
7/4/13 2:00	0	0.32867	0.12245	0.07665	0.03869	0.7565	0.23779	0.02821	0.04314	0.0249	0.02307	0.14706	0.3807	0.09625	0	0	0	0.55083	0	0.23242	0.12245	0.07665	0.03869	0.20567	0.23779
7/4/13 2:15	0	0.31864	0.11281	0.06811	0.03275	0.6951	0.21367	0.02678	0.04317	0.02375	0.02418	0.14477	0.36099	0.0937	0	0	0	0.52994	0	0.22494	0.11281	0.06811	0.03275	0.16516	0.21367

Hydrograph Table
Design Flow Derivation
3 Month Recurrance Interval Storm

Time	Precip	Exported From SWMM												Calculated											
		Total						Forward Township			Elizabeth Township			Sanitary Flow						Combined Flow					
		SS 8	SS 7	SS 6	SS 5	SS 3	Boro.	Center	Grant	Kendle	Chicago	Church	Cemetary	SS 8	SS 7	SS 6	SS 5	SS 3	Boro.	SS 8	SS 7	SS 6	SS 5	SS 3	Boro.
7/4/13 2:30	0	0.30858	0.10679	0.06202	0.02889	0.66692	0.1977	0.02621	0.04255	0.02271	0.02397	0.14275	0.35076	0.09147	0	0	0	0.51748	0	0.21711	0.10679	0.06202	0.02889	0.14944	0.1977
7/4/13 2:45	0	0.29928	0.10131	0.05674	0.02553	0.64173	0.18358	0.02566	0.04188	0.02176	0.02373	0.141	0.34156	0.0893	0	0	0	0.50629	0	0.20998	0.10131	0.05674	0.02553	0.13544	0.18358
7/4/13 3:00	0	0.29058	0.09628	0.05213	0.02259	0.61928	0.171	0.02512	0.04122	0.02088	0.02346	0.13928	0.33335	0.08722	0	0	0	0.49609	0	0.20336	0.09628	0.05213	0.02259	0.12319	0.171
7/4/13 3:15	0	0.27725	0.09165	0.04809	0.02004	0.58685	0.15978	0.02442	0.03875	0.02006	0.02145	0.13724	0.33041	0.08323	0	0	0	0.4891	0	0.19402	0.09165	0.04809	0.02004	0.09775	0.15978
7/4/13 3:30	0	0.26924	0.08734	0.04451	0.01782	0.56749	0.14967	0.02389	0.03812	0.01929	0.02112	0.13555	0.32306	0.0813	0	0	0	0.47973	0	0.18794	0.08734	0.04451	0.01782	0.08776	0.14967
7/4/13 3:45	0	0.26189	0.08333	0.04133	0.0159	0.5512	0.14056	0.02338	0.03751	0.01857	0.02086	0.13388	0.3171	0.07946	0	0	0	0.47184	0	0.18243	0.08333	0.04133	0.0159	0.07936	0.14056
7/4/13 4:00	0	0.25491	0.07958	0.03849	0.01425	0.53742	0.13232	0.02289	0.0369	0.01789	0.02061	0.13223	0.31277	0.07768	0	0	0	0.46561	0	0.17723	0.07958	0.03849	0.01425	0.07181	0.13232
7/4/13 4:15	0	0.2481	0.07606	0.03595	0.01285	0.54593	0.12486	0.02241	0.03615	0.01724	0.02084	0.12896	0.30713	0.0758	0	0	0	0.45693	0	0.1723	0.07606	0.03595	0.01285	0.089	0.12486
7/4/13 4:30	0	0.24171	0.07276	0.03366	0.01168	0.53412	0.1181	0.02195	0.03558	0.01662	0.02062	0.12736	0.30367	0.07415	0	0	0	0.45165	0	0.16756	0.07276	0.03366	0.01168	0.08247	0.1181
7/4/13 4:45	0	0.23561	0.06966	0.0316	0.01074	0.52396	0.112	0.02151	0.03502	0.01602	0.02038	0.12577	0.30044	0.07255	0	0	0	0.44659	0	0.16306	0.06966	0.0316	0.01074	0.07737	0.112
7/4/13 5:00	0	0.22977	0.06673	0.02972	0.01003	0.5149	0.10648	0.02107	0.03448	0.01546	0.02016	0.12422	0.29735	0.07101	0	0	0	0.44173	0	0.15876	0.06673	0.02972	0.01003	0.07317	0.10648
7/4/13 5:15	0	0.22576	0.06397	0.02802	0.00957	0.48444	0.10156	0.02097	0.0342	0.01491	0.02088	0.12497	0.29155	0.07008	0	0	0	0.4374	0	0.15568	0.06397	0.02802	0.00957	0.04704	0.10156
7/4/13 5:30	0	0.22053	0.06136	0.02646	0.00945	0.47865	0.09727	0.02059	0.03369	0.01439	0.02069	0.12345	0.28868	0.06867	0	0	0	0.43282	0	0.15186	0.06136	0.02646	0.00945	0.04583	0.09727
7/4/13 5:45	0	0.21537	0.05889	0.02504	0.00944	0.47283	0.09337	0.0202	0.03319	0.01389	0.02048	0.12195	0.28588	0.06728	0	0	0	0.42831	0	0.14809	0.05889	0.02504	0.00944	0.04452	0.09337
7/4/13 6:00	0	0.21041	0.05658	0.02375	0.00944	0.46813	0.08977	0.01982	0.03271	0.0134	0.02028	0.1205	0.28317	0.06593	0	0	0	0.42395	0	0.14448	0.05658	0.02375	0.00944	0.04418	0.08977
7/4/13 6:15	0	0.20614	0.05608	0.02339	0.01027	0.48857	0.08974	0.0227	0.03241	0.01294	0.02108	0.12396	0.28914	0.06805	0	0	0	0.43418	0	0.13809	0.05608	0.02339	0.01027	0.05439	0.08974
7/4/13 6:30	0	0.20238	0.05398	0.02229	0.01026	0.48692	0.08653	0.02259	0.03195	0.01249	0.02092	0.12255	0.28651	0.06703	0	0	0	0.42998	0	0.13535	0.05398	0.02229	0.01026	0.05694	0.08653
7/4/13 6:45	0	0.19807	0.05198	0.02129	0.01025	0.48323	0.08352	0.02227	0.03151	0.01205	0.02074	0.12118	0.28396	0.06583	0	0	0	0.42588	0	0.13224	0.05198	0.02129	0.01025	0.05735	0.08352
7/4/13 7:00	0	0.19386	0.05011	0.02036	0.01025	0.47924	0.08072	0.02195	0.03111	0.01163	0.02054	0.11987	0.28151	0.06469	0	0	0	0.42192	0	0.12917	0.05011	0.02036	0.01025	0.05732	0.08072
7/4/13 7:15	0	0.19542	0.04956	0.02012	0.01086	0.50279	0.08054	0.02431	0.03335	0.01122	0.01756	0.12024	0.29427	0.06888	0	0	0	0.43207	0	0.12654	0.04956	0.02012	0.01086	0.07072	0.08054
7/4/13 7:30	0	0.19261	0.04785	0.01933	0.01085	0.49928	0.07803	0.02421	0.03298	0.01083	0.01727	0.11901	0.29196	0.06802	0	0	0	0.42824	0	0.12459	0.04785	0.01933	0.01085	0.07104	0.07803
7/4/13 7:45	0	0.18899	0.04622	0.0186	0.01085	0.49579	0.07567	0.02395	0.03262	0.01045	0.0171	0.11783	0.28961	0.06702	0	0	0	0.42454	0	0.12197	0.04622	0.0186	0.01085	0.07125	0.07567
7/4/13 8:00	0	0.18549	0.0447	0.01794	0.01085	0.49224	0.07349	0.02368	0.03229	0.01008	0.01695	0.11672	0.28733	0.06605	0	0	0	0.421	0	0.11944	0.0447	0.01794	0.01085	0.07124	0.07349
7/4/13 8:15	0	0.19649	0.04517	0.01826	0.01179	0.57149	0.07522	0.02358	0.03288	0.00972	0.01607	0.12113	0.32313	0.06618	0	0	0	0.46033	0	0.13031	0.04517	0.01826	0.01179	0.11116	0.07522
7/4/13 8:30	0	0.19379	0.04377	0.01769	0.01179	0.57077	0.07325	0.02332	0.03259	0.00938	0.0159	0.11998	0.32102	0.06529	0	0	0	0.4569	0	0.1285	0.04377	0.01769	0.01179	0.11387	0.07325
7/4/13 8:45	0	0.19072	0.04243	0.01717	0.01179	0.56796	0.07139	0.02305	0.03231	0.00904	0.01577	0.11883	0.31887	0.0644	0	0	0	0.45347	0	0.12632	0.04243	0.01717	0.01179	0.11449	0.07139
7/4/13 9:00	0	0.18778	0.04121	0.01669	0.01179	0.56466	0.06969	0.02278	0.03206	0.00872	0.01565	0.11774	0.3168	0.06356	0	0	0	0.45019	0	0.12422	0.04121	0.01669	0.01179	0.11447	0.06969
7/4/13 9:15	0	0.21219	0.04395	0.01816	0.01371	0.53636	0.07582	0.02152	0.03657	0.0084	0.01539	0.12708	0.31013	0.06649	0	0	0	0.4526	0	0.1457	0.04395	0.01816	0.01371	0.08376	0.07582
7/4/13 9:30	0	0.21012	0.0428	0.01776	0.0137	0.53814	0.07426	0.02117	0.03629	0.0081	0.01527	0.12593	0.30814	0.06556	0	0	0	0.44934	0	0.14456	0.0428	0.01776	0.0137	0.0888	0.07426
7/4/13 9:45	0	0.20752	0.0417	0.0174	0.0137	0.53606	0.0728	0.0209	0.03602	0.0078	0.01515	0.12478	0.3062	0.06472	0	0	0	0.44613	0	0.1428	0.0417	0.0174	0.0137	0.08993	0.0728
7/4/13 10:00	0	0.20505	0.04071	0.01707	0.01371	0.53305	0.07149	0.02062	0.03574	0.00752	0.01503	0.12362	0.30433	0.06388	0	0	0	0.44298	0	0.14117	0.04071	0.01707	0.01371	0.09007	0.07149
7/4/13 10:15	0	0.19813	0.04342	0.01857	0.0155	0.5496	0.07749	0.01965	0.03355	0.00724	0.01885	0.12082	0.30445	0.06044	0	0	0	0.44412	0	0.13769	0.04342	0.01857	0.0155	0.10548	0.07749
7/4/13 10:30	0	0.19549	0.04248	0.01831	0.0155	0.54662	0.07629	0.01932	0.03328	0.00697	0.0189	0.11967	0.30259	0.05957	0	0	0	0.44116	0	0.13592	0.04248	0.01831	0.0155	0.10546	0.07629
7/4/13 10:45	0	0.19335	0.04159	0.01809	0.0155	0.54328	0.07518	0.01904	0.03301	0.00671	0.01879	0.11852	0.30082	0.05876	0	0	0	0.43813	0	0.13459	0.04159	0.01809	0.0155	0.10515	0.07518
7/4/13 11:00	0	0.19135	0.04071	0.01789	0.01549	0.54021	0.07409	0.01878	0.03273	0.00646	0.01867	0.11741	0.2991	0.05797	0	0	0	0.43518	0	0.13338	0.04071	0.01789	0.01549	0.10503	0.07409
7/4/13 11:15	0	0.19483	0.03769	0.01668	0.01442	0.55863	0.06879	0.0184	0.03096	0.00622	0.01655	0.12347	0.3003	0.05558	0	0	0	0.44032	0	0.13925	0.03769	0.01668	0.01442	0.11831	0.06879
7/4/13 11:30	0	0.193	0.03693	0.01658	0.01441	0.55865	0.06792	0.01813	0.03069	0.00598	0.01633	0.12232	0.29862	0.0548	0	0	0	0.43727	0	0.1382	0.03693	0.01658	0.01441	0.12138	0.06792
7/4/13 11:45	0	0.19137	0.03622	0.01648	0.01441	0.55655	0.06711	0.01787	0.03041	0.00575	0.01621	0.12117	0.29695	0.05403	0	0	0	0.43433	0	0.13734	0.03622	0.01648	0.01441	0.12222	0.06711
7/4/13 12:00	0	0.18988	0.03554	0.0164	0.01441	0.55376	0.06635	0.0176	0.03014	0.00553	0.01609	0.12001	0.29533	0.05327	0	0	0	0.43143	0	0.13661	0.03554	0.0164	0.01441	0.12233	0.06635
7/4/13 12:15	0	0.17577	0.03491	0.01631	0.01441	0.51359	0.06563	0.01707	0.03094	0.00532	0.01379	0.1182	0.28609	0.05333	0	0	0	0.41808	0	0.12244	0.03491	0.01631	0.01441	0.09551	0.06563
7/4/13 12:30	0	0.17436	0.03431	0.01623	0.01441	0.5099	0.06495	0.01678	0.03066	0.00511	0.01355	0.11705	0.28458	0.05255	0	0	0	0.41518	0	0.12181	0.03431	0.01623	0.01441	0.09472	0.06495
7/4/13 12:45	0	0.17336	0.03375	0.01616	0.01441	0.50711	0.06432	0.01652	0.03039	0.00491	0.01342	0.1159	0.28308	0.05182	0	0	0	0.4124	0	0.12154	0.03375	0.01616	0.01441	0.09471	0.06432
7/4/13 13:00	0	0.1726	0.03322	0.01609	0.01441	0.50438	0.06372	0.01626	0.03011	0.00472	0.01331	0.11472	0.2816	0.05109	0	0	0	0.40963	0	0.12151	0.03322	0.01609	0.01441	0.09475	0.06372
7/4/13 13:15	0	0.18577	0.03125	0.0153	0.01369	0.49886	0.06024	0.0152	0.02842	0.00454	0.02131	0.1093	0.27359	0.04816	0	0	0	0.4042	0	0.13761	0.03125	0.0153	0.01369	0.09466	0.06024
7/4/13 13:30	0	0.18493	0.03081	0.01524	0.01369	0.49591	0.05974	0.01486	0.02815	0.00436	0.02151	0.10815	0.27206	0.04737	0	0	0	0.40172	0	0.13756	0.03081	0.01524	0.01369	0.09419	0.05974
7/4/13 13:45	0	0.18419	0.0304	0.01518	0.01369	0.4925	0.05927	0.01459	0.02787	0.00418	0.0214	0.107	0.27069	0.04664	0	0	0	0.39909	0	0.13755	0.0304	0.01518	0.01369	0.09341	0.05927
7/4/13 14:00	0	0.18348	0.03003	0.01512	0.01369	0.48967	0.05884	0.01434	0.0276	0.00402	0.02128	0.10585	0.26935	0.04596	0	0	0	0.39648	0	0.13752	0.03003	0.01512	0.01369	0.09319	0.05884
7/4/13 14:15	0	0.17673	0.0297	0.01507	0.01369	0.4763	0.05846	0.01408	0.02815	0.00386	0.01874	0.10733	0.26707	0.04609	0	0	0	0.39314	0	0.13064	0.0297	0.01507	0.01369	0.08316	0.05846
7/4/13 14:30	0	0.17602	0.02941	0.01502	0.01369	0.47448	0.05812	0.01383	0.02788	0.00371	0.01853	0.10618	0.26581	0.04542	0	0	0	0.39052	0	0.1306	0.02941	0.01502	0.01369	0.08396	0.05812
7/4/13 14:45	0	0.17533	0.02916	0.01497	0.01369	0.47235	0.05782	0.01358	0.0276	0.00356	0.0184	0.10503	0.26456	0.04474	0	0	0	0.38799	0	0.13059	0.02916	0.01497	0.01369	0.08436	0.05782
7/4/13 15:00	0	0.17466	0.02895	0.01493	0.01369	0.46993	0.05757	0.01333	0.02732	0.00342	0.01828	0.10389	0.26334	0.04407	0	0	0	0.38551	0	0.13059	0.02895	0.01493	0.01369	0.08442	0.05757
7/4/13 15:15	0	0.16717	0.0273	0.01416	0.01297	0.41712	0.05443	0.01256	0.02472	0.00329	0.01418	0.10998	0.25831	0.04057	0	0	0	0.38247	0	0.1266	0.0273	0.01416	0.01297	0.03465	0.05443
7/4/13 15:30	0	0.16584	0.0272	0.01412	0.01297	0.41731	0.05429	0.01224	0.02445	0.00316	0.01386	0.10884	0.25723	0.03985	0	0	0	0.37993	0	0.12599	0.0272	0.01412	0.01297	0.03738	0.05429

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Hydrograph Table
Design Flow Derivation
3 Month Recurrance Interval Storm

Time	Precip	Exported From SWMM												Calculated											
		Total						Forward Township			Elizabeth Township			Sanitary Flow						Combined Flow					
		SS 8	SS 7	SS 6	SS 5	SS 3	Boro.	Center	Grant	Kendle	Chicago	Church	Cemetary	SS 8	SS 7	SS 6	SS 5	SS 3	Boro.	SS 8	SS 7	SS 6	SS 5	SS 3	Boro.
7/4/13 15:45	0	0.16515	0.02718	0.01408	0.01297	0.4159	0.05423	0.01198	0.02417	0.00304	0.01373	0.10769	0.25608	0.03919	0	0	0	0.3775	0	0.12596	0.02718	0.01408	0.01297	0.0384	0.05423
7/4/13 16:00	0	0.1645	0.02718	0.01405	0.01297	0.41375	0.0542	0.01173	0.0239	0.00292	0.0136	0.10654	0.25499	0.03855	0	0	0	0.37513	0	0.12595	0.02718	0.01405	0.01297	0.03862	0.0542
7/4/13 16:15	0	0.16469	0.02867	0.01473	0.01369	0.44863	0.05709	0.01138	0.02337	0.00281	0.01165	0.10244	0.2558	0.03756	0	0	0	0.36989	0	0.12713	0.02867	0.01473	0.01369	0.07874	0.05709
7/4/13 16:30	0	0.16401	0.02866	0.01469	0.01369	0.4443	0.05704	0.01112	0.0231	0.00271	0.01141	0.10131	0.25471	0.03693	0	0	0	0.36743	0	0.12708	0.02866	0.01469	0.01369	0.07687	0.05704
7/4/13 16:45	0	0.16338	0.02865	0.01466	0.01369	0.44165	0.057	0.01087	0.02282	0.00262	0.01129	0.10018	0.25365	0.03631	0	0	0	0.36512	0	0.12707	0.02865	0.01466	0.01369	0.07653	0.057
7/4/13 17:00	0	0.16276	0.02863	0.01463	0.01368	0.43931	0.05694	0.01063	0.02255	0.00253	0.01117	0.09903	0.25257	0.03571	0	0	0	0.36277	0	0.12705	0.02863	0.01463	0.01368	0.07654	0.05694
7/4/13 17:15	0	0.1641	0.02564	0.01316	0.01225	0.4497	0.05105	0.01151	0.0236	0.00244	0.01394	0.09034	0.24389	0.03755	0	0	0	0.34817	0	0.12655	0.02564	0.01316	0.01225	0.10153	0.05105
7/4/13 17:30	0	0.16411	0.02564	0.01313	0.01225	0.44435	0.05102	0.01143	0.02332	0.00237	0.01399	0.08922	0.24274	0.03712	0	0	0	0.34595	0	0.12699	0.02564	0.01313	0.01225	0.0984	0.05102
7/4/13 17:45	0	0.16358	0.02563	0.01311	0.01224	0.44103	0.05098	0.01122	0.02305	0.0023	0.01388	0.0881	0.24169	0.03657	0	0	0	0.34367	0	0.12701	0.02563	0.01311	0.01224	0.09736	0.05098
7/4/13 18:00	0	0.163	0.02563	0.01308	0.01224	0.43854	0.05095	0.01098	0.02277	0.00223	0.01376	0.08699	0.24061	0.03598	0	0	0	0.34136	0	0.12702	0.02563	0.01308	0.01224	0.09718	0.05095
7/4/13 18:15	0	0.16295	0.02563	0.01305	0.01224	0.38978	0.05092	0.01116	0.02275	0.00218	0.01732	0.08193	0.23568	0.03609	0	0	0	0.33493	0	0.12686	0.02563	0.01305	0.01224	0.05485	0.05092
7/4/13 18:30	0	0.16256	0.02562	0.01303	0.01224	0.38668	0.05089	0.01098	0.02247	0.00213	0.01736	0.08082	0.23462	0.03558	0	0	0	0.3328	0	0.12698	0.02562	0.01303	0.01224	0.05388	0.05089
7/4/13 18:45	0	0.16203	0.02562	0.01301	0.01224	0.38367	0.05087	0.01076	0.02219	0.00209	0.01725	0.07972	0.23354	0.03504	0	0	0	0.33051	0	0.12699	0.02562	0.01301	0.01224	0.05316	0.05087
7/4/13 19:00	0	0.16149	0.02562	0.01299	0.01225	0.38119	0.05086	0.01053	0.02192	0.00207	0.01712	0.07863	0.23247	0.03452	0	0	0	0.32822	0	0.12697	0.02562	0.01299	0.01225	0.05297	0.05086
7/4/13 19:15	0	0.1618	0.02711	0.01368	0.01296	0.44235	0.05375	0.01127	0.0204	0.00205	0.0123	0.08017	0.23619	0.03372	0	0	0	0.32866	0	0.12808	0.02711	0.01368	0.01296	0.11369	0.05375
7/4/13 19:30	0	0.16143	0.02711	0.01366	0.01296	0.43984	0.05373	0.01119	0.02013	0.00205	0.01193	0.07908	0.23509	0.03337	0	0	0	0.3261	0	0.12806	0.02711	0.01366	0.01296	0.11374	0.05373
7/4/13 19:45	0	0.16098	0.02711	0.01364	0.01296	0.43807	0.05371	0.01099	0.01986	0.00204	0.0118	0.07799	0.23401	0.03289	0	0	0	0.3238	0	0.12809	0.02711	0.01364	0.01296	0.11427	0.05371
7/4/13 20:00	0	0.16049	0.02707	0.01362	0.01296	0.43597	0.05365	0.01077	0.01959	0.00204	0.01168	0.07692	0.23292	0.0324	0	0	0	0.32152	0	0.12809	0.02707	0.01362	0.01296	0.11445	0.05365
7/4/13 20:15	0	0.17721	0.0176	0.00905	0.0084	0.41033	0.03505	0.01215	0.01965	0.00204	0.01208	0.08111	0.24133	0.03384	0	0	0	0.33452	0	0.14337	0.0176	0.00905	0.0084	0.07581	0.03505
7/4/13 20:30	0	0.1777	0.0176	0.00903	0.0084	0.41109	0.03503	0.01216	0.01938	0.00204	0.012	0.08004	0.24033	0.03358	0	0	0	0.33237	0	0.14412	0.0176	0.00903	0.0084	0.07872	0.03503
7/4/13 20:45	0	0.1773	0.01759	0.00901	0.0084	0.40965	0.035	0.01199	0.01911	0.00204	0.01188	0.07897	0.23922	0.03314	0	0	0	0.33007	0	0.14416	0.01759	0.00901	0.0084	0.07958	0.035
7/4/13 21:00	0	0.17683	0.01762	0.009	0.00841	0.40748	0.03503	0.01179	0.01885	0.00204	0.01177	0.07786	0.23812	0.03268	0	0	0	0.32775	0	0.14415	0.01762	0.009	0.00841	0.07973	0.03503
7/4/13 21:15	0	0.17319	0.02009	0.01018	0.0096	0.37018	0.03987	0.01008	0.02024	0.00204	0.01536	0.07155	0.22563	0.03236	0	0	0	0.31254	0	0.14083	0.02009	0.01018	0.0096	0.05764	0.03987
7/4/13 21:30	0	0.17245	0.02009	0.01017	0.0096	0.36637	0.03986	0.0097	0.01997	0.00204	0.01543	0.07049	0.22449	0.03171	0	0	0	0.31041	0	0.14074	0.02009	0.01017	0.0096	0.05596	0.03986
7/4/13 21:45	0	0.17198	0.02008	0.01015	0.0096	0.36316	0.03983	0.00956	0.0197	0.00204	0.01532	0.06943	0.22343	0.0313	0	0	0	0.30818	0	0.14068	0.02008	0.01015	0.0096	0.05498	0.03983
7/4/13 22:00	0	0.1716	0.02008	0.01014	0.0096	0.36064	0.03982	0.00947	0.01944	0.00203	0.0152	0.06837	0.22236	0.03094	0	0	0	0.30593	0	0.14066	0.02008	0.01014	0.0096	0.05471	0.03982
7/4/13 22:15	0	0.15881	0.02008	0.01012	0.0096	0.34722	0.0398	0.00959	0.01743	0.00203	0.0129	0.06436	0.21836	0.02905	0	0	0	0.29562	0	0.12976	0.02008	0.01012	0.0096	0.0516	0.0398
7/4/13 22:30	0	0.15791	0.02008	0.01011	0.0096	0.34283	0.03979	0.00956	0.01717	0.00203	0.01267	0.06332	0.21731	0.02876	0	0	0	0.2933	0	0.12915	0.02008	0.01011	0.0096	0.04953	0.03979
7/4/13 22:45	0	0.15759	0.02008	0.0101	0.0096	0.34013	0.03978	0.0095	0.01691	0.00203	0.01254	0.06228	0.21625	0.02844	0	0	0	0.29107	0	0.12915	0.02008	0.0101	0.0096	0.04906	0.03978
7/4/13 23:00	0	0.15726	0.02009	0.01009	0.0096	0.33784	0.03978	0.00944	0.01665	0.00203	0.01243	0.06123	0.21517	0.02812	0	0	0	0.28883	0	0.12914	0.02009	0.01009	0.0096	0.04901	0.03978
7/4/13 23:15	0	0.15397	0.02257	0.01127	0.0108	0.29441	0.04464	0.00788	0.01548	0.00203	0.01126	0.05067	0.20444	0.02539	0	0	0	0.26637	0	0.12858	0.02257	0.01127	0.0108	0.02804	0.04464
7/4/13 23:30	0	0.15289	0.02257	0.01126	0.0108	0.28721	0.04463	0.00758	0.01522	0.00203	0.01108	0.04965	0.20339	0.02483	0	0	0	0.26412	0	0.12806	0.02257	0.01126	0.0108	0.02309	0.04463
7/4/13 23:45	0	0.15247	0.02257	0.01125	0.0108	0.28317	0.04462	0.00749	0.01496	0.00203	0.01096	0.04865	0.20236	0.02448	0	0	0	0.26197	0	0.12799	0.02257	0.01125	0.0108	0.0212	0.04462

Appendix J

Elizabeth Borough Municipal Authority
Long Term Control Plan
Uniform Annual Cost

Federal Discount Rate	**3.10%**
Design Life (years)	30

	P1-A	P1-B	P2-A	P2-B	B1
Estimated Construction Cost	$ 19,660,000	$ 22,320,000	$ 21,020,000	$ 23,720,000	$ 19,590,000
Estimated Annual O&M Cost	$ 696,000	$ 697,000	$ 696,000	$ 694,000	$ 689,000
Present Worth Calculations					
Construction Present Worth	$ 19,660,000	$ 22,320,000	$ 21,020,000	$ 23,720,000	$ 19,590,000
O&M Present Worth	$ 13,467,000	$ 13,487,000	$ 13,467,000	$ 13,429,000	$ 13,332,000
Total Present Worth	$ 33,127,000	$ 35,807,000	$ 34,487,000	$ 37,149,000	$ 32,922,000
Uniform Annual Cost	**$ 1,712,000**	**$ 1,851,000**	**$ 1,782,000**	**$ 1,920,000**	**$ 1,701,000**

1 $PW_C = C_{CON}$

2 $$PW_{O\&M} = C_{O\&M}\left(\frac{(1+i)^n - 1}{i(1+i)^n}\right)$$

3 $PW_S = S(1+i)^{-n}$

4 $$PW_T = PW_C + PW_{O\&M} + PW_S$$

5 $$UAC = PW_T\left(\frac{i(1+i)^n}{(1+i)^n - 1}\right)$$

PW_C	Construction Cost Present Worth
$PW_{O\&M}$	Operation and Maintenance Cost Present Worth
PW_S	Salvage Value Present Worth
PW_T	Total Present Worth
C_{CON}	Construction Cost
$C_{O\&M}$	Operation and Maintenance Cost
S	Salvage Value
i	Interest Rate
n	Number of Periods
UAC	Uniform Annual Cost

Elizabeth Borough Municipal Authority
Long Term Control Plan
Debt Service Calculation - Bond

Number of EDUs		2,191
Average User Rate	$	39.14

Bond	
Interest Rate	4.25%
Loan Term	30

	Alternative				
	P1-A	**P1-B**	**P2-A**	**P2-B**	**B1**
Financed Amount	$ 19,660,000	$ 22,320,000	$ 21,020,000	$ 23,720,000	$ 19,590,000
Annual Debt Service	$ 1,172,000	$ 1,330,200	$ 1,252,800	$ 1,413,700	$ 1,167,500
Monthly Payment	$ 98,000	$ 111,000	$ 104,000	$ 118,000	$ 97,000
Estimated Rate Increase	$ 44.70	$ 50.70	$ 47.50	$ 53.90	$ 44.30
Rate Increase	114%	130%	121%	138%	113%

Alternative P1-A

Primary Treatment at CSO 8, WWTP Flow EQ

Summary		
Primary Treatment Facility		$ 3,036,375
CSO 8, 7, 6, & 5 Electrical Building		$ 590,000
CSO 5 Pump Station		$ 436,810
CSO 6 Pump Station		$ 621,220
CSO 7 Pump Station		$ 463,110
Forcemain		$ 357,125
EBMA Pump Station		$ 5,680,195
Disinfection Tank		$ 2,192,990
Flow Equalization Tank		$ 1,485,000
Sub-Total		$ 14,862,825
15% Engineering, Legal, Property Acquisition		$ 2,229,424
Contingency	15%	$ 2,563,837
Total		$ 19,660,000

Primary Treatment Facility				
Item	Quantity	Unit	Unit Price	Total Price
Reinforced Concrete	550	CY	$ 1,000	$ 550,000
Stone	175	CY	$ 50	$ 8,750
Excavation	2900	CY	$ 50	$ 145,000
Sheet Pile	8075	SF	$ 85	$ 686,375
Storm King Unit	1	LS	$ 1,500,000	$ 1,500,000
30" PVC Conduit	90	LF	$ 300	$ 27,000
36" PVC Conduit	20	LF	$ 350	$ 7,000
42" PVC Conduit	65	LF	$ 400	$ 26,000
16" DIP and Fittings	45	LF	$ 250	$ 11,250
Property Acquisition	1	LS	$ 15,000	$ 15,000
Dewatering	1	LS	$ 10,000	$ 10,000
6' Manhole	2	EA	$ 15,000	$ 30,000
Electrical Connection	1	LS	$ 20,000	$ 20,000
Total				$ 3,036,375

CSO 8, 7, 6, & 5 Electrical Building				
Item	Quantity	Unit	Unit Price	Total Price
Generator (150 Kw) w/ Transfer Switch	1	LS	$ 200,000	$ 200,000
Generator Building (25 ft X 25 ft)	1	LS	$ 250,000	$ 250,000
Transformer	1	LS	$ 10,000	$ 10,000
RTU	1	LS	$ 30,000	$ 30,000
Electrical Connection to Pump Stations	1	LS	$ 100,000	$ 100,000
Total				$ 590,000

Alternative P1-A

Primary Treatment at CSO 8, WWTP Flow EQ

CSO 5 Pump Station				
Item	Quantity	Unit	Unit Price	Total Price
Submersible Pump, 1451 gpm @ 63 ft.	2	EA	$ 42,600	$ 85,200
Reinforced Concrete	61	CY	$ 1,000	$ 61,000
Stone	100	CY	$ 50	$ 5,000
Excavation	205	CY	$ 30	$ 6,150
Sheet Pile	2076	SF	$ 85	$ 176,460
Dewatering	1	LS	$ 10,000	$ 10,000
Access Hatch	1	LS	$ 3,000	$ 3,000
Ladder	1	LS	$ 5,000	$ 5,000
10" Discharge Piping and Fittings	1	EA	$ 20,000	$ 20,000
Hoist	1	LS	$ 10,000	$ 10,000
Valve Vault	1	LS	$ 15,000	$ 15,000
Electrical Connection	1	LS	$ 10,000	$ 10,000
RTU	1	LS	$ 30,000	$ 30,000
Total				$ 436,810

CSO 6 Pump Station				
Item	Quantity	Unit	Unit Price	Total Price
Submersible Pump,3,625 gpm @ 50 ft.	2	EA	$ 63,000	$ 126,000
Reinforced Concrete	113	CY	$ 1,000	$ 113,000
Stone	170	CY	$ 50	$ 8,500
Excavation	421	CY	$ 30	$ 12,630
Sheet Pile	3154	SF	$ 85	$ 268,090
Dewatering	1	LS	$ 10,000	$ 10,000
Access Hatch	1	LS	$ 3,000	$ 3,000
Ladder	1	LS	$ 5,000	$ 5,000
16" Discharge Piping and Fittings	1	LS	$ 30,000	$ 30,000
Hoist	1	LS	$ 10,000	$ 10,000
Valve Vault	1	LS	$ 15,000	$ 15,000
Electrical Connection	1	LS	$ 10,000	$ 10,000
RTU	1	LS	$ 10,000	$ 10,000
Total				$ 621,220

Alternative P1-A

Primary Treatment at CSO 8, WWTP Flow EQ

CSO 7 Pump Station				
Item	Quantity	Unit	Unit Price	Total Price
Submersible Pump,1,917 gpm @ 29 ft.	2	EA	$ 38,000	$ 76,000
Reinforced Concrete	71	CY	$ 1,000	$ 71,000
Stone	118	CY	$ 50	$ 5,900
Excavation	243	CY	$ 30	$ 7,290
Sheet Pile	2352	SF	$ 85	$ 199,920
Dewatering	1	LS	$ 10,000	$ 10,000
Access Hatch	1	LS	$ 3,000	$ 3,000
Ladder	1	LS	$ 5,000	$ 5,000
12" Discharge Piping and Fittings	1	LS	$ 20,000	$ 20,000
Valve Vault	1	LS	$ 15,000	$ 15,000
Hoist	1	LS	$ 10,000	$ 10,000
Electrical Connection	1	LS	$ 10,000	$ 10,000
RTU	1	LS	$ 30,000	$ 30,000
Total				$ 463,110

Forcemain				
Item	Quantity	Unit	Unit Price	Total Price
8 Inch Forcemain	300	LF	$ 55	$ 16,500
20 Inch Forcemain	500	LF	$ 150	$ 75,000
24 Inch Forcemain	775	LF	$ 175	$ 135,625
Valve Boxes	3	EA	$ 10,000	$ 30,000
Paving and Restoration	1	LS	$ 100,000	$ 100,000
Total				$ 357,125

Alternative P1-A

Primary Treatment at CSO 8, WWTP Flow EQ

EBMA Pump Station				
Item	Quantity	Unit	Unit Price	Total Price
Mechanical Bar Screen (1'-3")	1	EA	$ 286,000	$ 286,000
Mechanical Bar Screen (2')	1	EA	$ 288,000	$ 288,000
Bar Rack	1	EA	$ 5,000	$ 5,000
Grit Chamber (7' Dia)	1	EA	$ 195,000	$ 195,000
Grit Chamber (10' Dia)	1	EA	$ 220,000	$ 220,000
Conveyor/Dumpster	1	EA	$ 20,000	$ 20,000
Slide and Sluice Gates	1	LS	$ 50,000	$ 50,000
Dry Weather Raw Sewage Pumps	2	EA	$ 16,000	$ 32,000
Piping	1	LS	$ 120,000	$ 120,000
Sump Pumps	2	EA	$ 9,000	$ 18,000
HVAC	1	LS	$ 100,000	$ 100,000
Electrical	1	LS	$ 450,000	$ 450,000
Controls/SCADA	1	LS	$ 115,000	$ 115,000
Property Acquisition	1	LS	$ 50,000.00	$ 50,000
Excavation	21568	CY	$ 30	$ 647,040
Stone Fill	9183	CY	$ 25	$ 229,575
Site Grading	8000	CY	$ 10	$ 80,000
Excess Excavation Disposal	9183	CY	$ 10	$ 91,830
Pavement	1	LS	$ 50,000	$ 50,000
Utilities	1	LS	$ 15,000	$ 15,000
Process Water	600	LF	$ 40	$ 24,000
Plumbing	1	LS	$ 30,000	$ 30,000
Sheet Piling	9750	SF	$ 85	$ 828,750
Top Level Structure	3000	SF	$ 120	$ 360,000
Concrete Below Grade	925	CY	$ 1,000	$ 925,000
Yard Piping (Gravity Sewer and Manholes)	1	LS	$ 185,000	$ 185,000
Stream Crossing	1	LS	$ 90,000	$ 90,000
Rock Anchors	1	LS	$ 100,000	$ 100,000
Dewatering	1	LS	$ 50,000	$ 50,000
Bypass Pumping	1	LS	$ 20,000	$ 20,000
Forcemain Tie in	1	LS	$ 5,000	$ 5,000
Total				$ 5,680,195

Alternative P1-A

Primary Treatment at CSO 8, WWTP Flow EQ

Disinfection Tank				
Item	Quantity	Unit	Unit Price	Total Price
Concrete	660	CY	$ 1,000	$ 660,000
Stone	1,833	CY	$ 30	$ 54,990
Sheet Piling	9,600	SF	$ 85	$ 816,000
Excavation	3,600	CY	$ 50	$ 180,000
Sodium Hypochlorite Building (20' x 20')	1	LS	$ 100,000	$ 100,000
Sodium Bisulfite Building (20' x 20')	1	LS	$ 100,000	$ 100,000
Sodium Hypochlorite Pump Skid (48 gph)	1	LS	$ 12,000	$ 12,000
Sodium Bisulfite Pump Skid (13 gph)	1	LS	$ 10,000	$ 10,000
Effluent Pump (3,880 gpm @ 15 ft)	2	EA	$ 50,000	$ 100,000
Discharge Piping/Outfall	1	LS	$ 100,000	$ 100,000
RTU	1	LS	$ 30,000	$ 30,000
Electrical Connection	1	LS	$ 30,000	$ 30,000
Total				$ 2,192,990

Flow Equalization Tank				
Item	Quantity	Unit	Unit Price	Total Price
Flow Equalization Tanks	1	LS	$ 1,000,000	$ 1,000,000
Aeration Diffusers	1	LS	$ 80,000	$ 80,000
Blowers	1	LS	$ 100,000	$ 100,000
Blower Building	1	LS	$ 120,000	$ 120,000
Aeration Piping	1	LS	$ 20,000	$ 20,000
Valve Pit	1	EA	$ 15,000	$ 15,000
Electrical Connection	1	LS	$ 50,000	$ 50,000
Piping and Valves	1	LS	$ 100,000	$ 100,000
Total				$ 1,485,000

Alternative P1-B

Primary Treatment at CSO 8, WWTP Expansion

Summary		
Primary Treatment Facility		$ 2,943,375
CSO 8, 7, 6, & 5 Electrical Building		$ 590,000
CSO 5 Pump Station		$ 436,810
CSO 6 Pump Station		$ 621,220
CSO 7 Pump Station		$ 463,110
Forcemain		$ 357,125
EBMA Pump Station		$ 5,676,195
Disinfection Tank		$ 2,191,640
WWTP Expansion		$ 3,594,900
Sub-Total		$ 16,874,375
15% Engineering, Legal, Property Acquisition		$ 2,531,156
Contingency	15%	$ 2,910,830
Total		$ 22,320,000

Primary Treatment Facility				
Item	Quantity	Unit	Unit Price	Total Price
Reinforced Concrete	550	CY	$ 1,000	$ 550,000
Stone	175	CY	$ 50	$ 8,750
Excavation	2900	CY	$ 30	$ 87,000
Sheet Pile	8075	SF	$ 85	$ 686,375
Storm King Unit	1	LS	$ 1,500,000	$ 1,500,000
30" PVC Conduit	90	LF	$ 100	$ 9,000
36" PVC Conduit	20	LF	$ 150	$ 3,000
42" PVC Conduit	65	LF	$ 200	$ 13,000
16" DIP and Fittings	45	LF	$ 250	$ 11,250
Property Acquisition	1	LS	$ 15,000	$ 15,000
Dewatering	1	LS	$ 10,000	$ 10,000
6' Manhole	2	EA	$ 15,000	$ 30,000
Electrical Connection	1	LS	$ 20,000	$ 20,000
Total				$ 2,943,375

CSO 8, 7, 6, & 5 Electrical Building				
Item	Quantity	Unit	Unit Price	Total Price
Generator (150 Kw) w/ Transfer Switch	1	LS	$ 200,000	$ 200,000
Generator Building (25 ft X 25 ft)	1	LS	$ 250,000	$ 250,000
Transformer	1	LS	$ 10,000	$ 10,000
Electrical Connection to Pump Stations	1	LS	$ 100,000	$ 100,000
RTU	1	LS	$ 30,000	$ 30,000
Total				$ 590,000

Alternative P1-B

Primary Treatment at CSO 8, WWTP Expansion

CSO 5 Pump Station				
Item	Quantity	Unit	Unit Price	Total Price
Submersible Pump, 1451 gpm @ 63 ft.	2	EA	$ 42,600	$ 85,200
Reinforced Concrete	61	CY	$ 1,000	$ 61,000
Stone	100	CY	$ 50	$ 5,000
Excavation	205	CY	$ 30	$ 6,150
Sheet Pile	2076	SF	$ 85	$ 176,460
Dewatering	1	LS	$ 10,000	$ 10,000
Access Hatch	1	LS	$ 3,000	$ 3,000
Ladder	1	LS	$ 5,000	$ 5,000
10" Discharge Piping and Fittings	1	LS	$ 20,000	$ 20,000
Hoist	1	LS	$ 10,000	$ 10,000
Valve Vault	1	LS	$ 15,000	$ 15,000
Electrical Connection	1	LS	$ 10,000	$ 10,000
RTU	1	LS	$ 30,000	$ 30,000
Total				$ 436,810

CSO 6 Pump Station				
Item	Quantity	Unit	Unit Price	Total Price
Submersible Pump,3,625 gpm @ 50 ft.	2	EA	$ 63,000	$ 126,000
Reinforced Concrete	113	CY	$ 1,000	$ 113,000
Stone	170	CY	$ 50	$ 8,500
Excavation	421	CY	$ 30	$ 12,630
Sheet Pile	3154	SF	$ 85	$ 268,090
Dewatering	1	LS	$ 10,000	$ 10,000
Access Hatch	1	LS	$ 3,000	$ 3,000
Ladder	1	LS	$ 5,000	$ 5,000
16" Discharge Piping and Fittings	1	LS	$ 30,000	$ 30,000
Hoist	1	LS	$ 10,000	$ 10,000
Valve Vault	1	LS	$ 15,000	$ 15,000
Electrical Connection	1	LS	$ 10,000	$ 10,000
RTU	1	LS	$ 10,000	$ 10,000
Total				$ 621,220

Alternative P1-B

Primary Treatment at CSO 8, WWTP Expansion

CSO 7 Pump Station				
Item	Quantity	Unit	Unit Price	Total Price
Submersible Pump,1,917 gpm @ 29 ft.	2	EA	$ 38,000	$ 76,000
Reinforced Concrete	71	CY	$ 1,000	$ 71,000
Stone	118	CY	$ 50	$ 5,900
Excavation	243	CY	$ 30	$ 7,290
Sheet Pile	2352	SF	$ 85	$ 199,920
Dewatering	1	LS	$ 10,000	$ 10,000
Access Hatch	1	LS	$ 3,000	$ 3,000
Ladder	1	LS	$ 5,000	$ 5,000
12" Discharge Piping and Fittings	1	LS	$ 20,000	$ 20,000
Hoist	1	LS	$ 10,000	$ 10,000
Valve Vault	1	LS	$ 15,000	$ 15,000
Electrical Connection	1	LS	$ 10,000	$ 10,000
RTU	1	LS	$ 30,000	$ 30,000
Total				$ 463,110

Forcemain				
Item	Quantity	Unit	Unit Price	Total Price
8 Inch Forcemain	300	LF	$ 55	$ 16,500
20 Inch Forcemain	500	LF	$ 150	$ 75,000
24 Inch Forcemain	775	LF	$ 175	$ 135,625
Valve Boxes	3	EA	$ 10,000	$ 30,000
Paving and Restoration	1	LS	$ 100,000	$ 100,000
Total				$ 357,125

Alternative P1-B

Primary Treatment at CSO 8, WWTP Expansion

EBMA Pump Station				
Item	Quantity	Unit	Unit Price	Total Price
Mechanical Bar Screen (1'-3")	1	EA	$ 286,000	$ 286,000
Mechanical Bar Screen (2')	1	EA	$ 288,000	$ 288,000
Bar Rack	1	EA	$ 5,000	$ 5,000
Grit Chamber (7' Dia)	1	EA	$ 195,000	$ 195,000
Grit Chamber (10' Dia)	1	EA	$ 220,000	$ 220,000
Conveyor/Dumpster	1	EA	$ 20,000	$ 20,000
Slide and Sluice Gates	1	LS	$ 50,000	$ 50,000
Dry Weather Raw Sewage Pumps	2	EA	$ 16,000	$ 32,000
Piping	1	LS	$ 120,000	$ 120,000
Sump Pumps	2	EA	$ 9,000	$ 18,000
HVAC	1	LS	$ 100,000	$ 100,000
Electrical	1	LS	$ 450,000	$ 450,000
Controls/SCADA	1	LS	$ 115,000	$ 115,000
Property Acquisition	1	LS	$ 50,000.00	$ 50,000
Excavation	21568	CY	$ 30	$ 647,040
Stone Fill	9183	CY	$ 25	$ 229,575
Site Grading	8000	CY	$ 10	$ 80,000
Excess Excavation Disposal	9183	CY	$ 10	$ 91,830
Pavement	1	LS	$ 50,000	$ 50,000
Utilities	1	LS	$ 15,000	$ 15,000
Process Water	600	LF	$ 40	$ 24,000
Plumbing	1	LS	$ 30,000	$ 30,000
Sheet Piling	9750	SF	$ 85	$ 828,750
Top Level Structure	3000	SF	$ 120	$ 360,000
Concrete Below Grade	921	CY	$ 1,000	$ 921,000
Yard Piping (Gravity Sewer and Manholes)	1	LS	$ 185,000	$ 185,000
Stream Crossing	1	LS	$ 90,000	$ 90,000
Rock Anchors	1	LS	$ 100,000	$ 100,000
Dewatering	1	LS	$ 50,000	$ 50,000
Bypass Pumping	1	LS	$ 20,000	$ 20,000
Forcemain Tie in	1	LS	$ 5,000	$ 5,000
Total				$ 5,676,195

Elizabeth Borough Municipal Authority
Long Term Control Plan

Alternative P1-B

Primary Treatment at CSO 8, WWTP Expansion

Disinfection Tank				
Item	Quantity	Unit	Unit Price	Total Price
Concrete	659	CY	$ 1,000	$ 659,000
Stone	1,833	CY	$ 30	$ 54,990
Sheet Piling	9,600	SF	$ 85	$ 816,000
Excavation	3,593	CY	$ 50	$ 179,650
Sodium Hypochlorite Building (20' x 20')	1	LS	$ 100,000	$ 100,000
Sodium Bisulfite Building (20' x 20')	1	LS	$ 100,000	$ 100,000
Sodium Hypochlorite Pump Skid (48 gph)	1	LS	$ 12,000	$ 12,000
Sodium Bisulfite Pump Skid (13 gph)	1	LS	$ 10,000	$ 10,000
Effluent Pump (3,880 gpm @ 15 ft)	2	EA	$ 50,000	$ 100,000
Discharge Piping/Outfall	1	LS	$ 100,000	$ 100,000
Electrical Connection	1	LS	$ 30,000	$ 30,000
RTU	1	LS	$ 30,000	$ 30,000
Total				$ 2,191,640

WWTP Expansion				
Item	Quantity	Unit	Unit Price	Total Price
SBR Equipment	1	LS	$ 850,000	$ 850,000
Excavation	12380	CY	$ 30	$ 371,400
Stone	450	CY	$ 30	$ 13,500
Reinforced Concrete	765	CY	$ 1,000	$ 765,000
Chlorine Tank and Building Demo	1	LS	$ 100,000	$ 100,000
Overhead Electric Utility Relocation	1	LS	$ 200,000	$ 200,000
Aeration Tank to Sludge Digestion Conversion	1	LS	$ 20,000	$ 20,000
Sludge Handling Building	1	LS	$ 200,000	$ 200,000
UV Disinfection Facilities	1	EA	$ 350,000	$ 350,000
Electrical Work	1	LS	$ 100,000	$ 100,000
SCADA	1	LS	$ 100,000	$ 100,000
Yard Piping	1	LS	$ 200,000	$ 200,000
Pavement	1	LS	$ 75,000	$ 75,000
Garage	1	LS	$ 250,000	$ 250,000
Total				$ 3,594,900

Elizabeth Borough Municipal Authority
Long Term Control Plan

Alternative P2-A

Primary Treatment at EBMA Pump Station, WWTP Flow EQ

Summary		
CSO 5 Pump Station		$ 729,540
CSO 8 Pump Station		$ 730,330
Gravity Sewer		$ 652,000
CSO 8 and 5 Electrical Building		$ 690,000
Forcemain		$ 478,750
EBMA Pump Station		$ 6,193,005
Disinfection Tank		$ 4,941,575
Flow Equlization Tank		$ 1,476,400
Sub-Total		$ 15,891,600
15% Engineering, Legal, Property Acquisition		$ 2,383,740
Contingency	15%	$ 2,741,301.00
Total		$ 21,020,000

CSO 5 Pump Station				
Item	Quantity	Unit	Unit Price	Total Price
Submersible Pump (5,100 gpm @ 55 ft)	2	EA	$ 77,000	$ 154,000
Reinforced Concrete	126	CY	$ 1,000	$ 126,000
Stone	239	CY	$ 50	$ 11,950
Excavation	545	CY	$ 30	$ 16,350
Sheet Pile	3744	SF	$ 85	$ 318,240
Dewatering	1	LS	$ 10,000	$ 10,000
Access Hatch	1	LS	$ 3,000	$ 3,000
Ladder	1	LS	$ 5,000	$ 5,000
10" Discharge Pipe and Fittings	1	LS	$ 20,000	$ 20,000
Hoist	1	LS	$ 10,000	$ 10,000
Valve Vault	1	LS	$ 15,000	$ 15,000
Electrical Connection	1	LS	$ 10,000	$ 10,000
RTU	1	LS	$ 30,000	$ 30,000
Total				$ 729,540

Alternative P2-A

Primary Treatment at EBMA Pump Station, WWTP Flow EQ

CSO 8 Pump Station				
Item	Quantity	Unit	Unit Price	Total Price
Submersible Pump (5,500 gpm @ 50 ft)	2	EA	$ 82,000	$ 164,000
Reinforced Concrete	121	CY	$ 1,000	$ 121,000
Stone	230	CY	$ 50	$ 11,500
Excavation	517	CY	$ 30	$ 15,510
Sheet Pile	3592	SF	$ 85	$ 305,320
Dewatering	1	LS	$ 10,000	$ 10,000
Access Hatch	1	LS	$ 3,000	$ 3,000
Ladder	1	LS	$ 5,000	$ 5,000
16" DIP and Fittings	1	LS	$ 30,000	$ 30,000
Hoist	1	LS	$ 10,000	$ 10,000
Valve Vault	1	LS	$ 15,000	$ 15,000
Electrical Connection	1	LS	$ 10,000	$ 10,000
RTU	1	LS	$ 30,000	$ 30,000
Total				$ 730,330

Gravity Sewer				
Item	Quantity	Unit	Unit Price	Total Price
18 in. Gravity, 17 ft. Deep	270	LF	$ 200	$ 54,000
21 in. Gravity, 25. ft Deep	470	LF	$ 400	$ 188,000
Manholes	8	EA	$ 20,000	$ 160,000
Yard Restoration	1	LS	$ 100,000	$ 100,000
Street Restoration	1	LS	$ 150,000	$ 150,000
Total				$ 652,000

CSO 8, 5 Electrical Building				
Item	Quantity	Unit	Unit Price	Total Price
Generator (250 Kw) w/ Transfer Switch	1	LS	$ 300,000	$ 300,000
Generator Building (25 ft X 25 ft)	1	LS	$ 250,000	$ 250,000
Transformer	1	LS	$ 10,000	$ 10,000
RTU	1	LS	$ 30,000	$ 30,000
Electrical Connection to Pump Stations	1	LS	$ 100,000	$ 100,000
Total				$ 690,000

Forcemain				
Item	Quantity	Unit	Unit Price	Total Price
24 Inch Forcemain	700	LF	$ 175	$ 122,500
16 Inch Forcemain	1890	LF	$ 125	$ 236,250
Valve Boxes	2	EA	$ 10,000	$ 20,000
Paving and Restoration	1	LS	$ 100,000	$ 100,000
Total				$ 478,750

Alternative P2-A

Primary Treatment at EBMA Pump Station, WWTP Flow EQ

EBMA Pump Station				
Item	Quantity	Unit	Unit Price	Total Price
Mechanical Bar Screen (1'-3")	1	EA	$ 286,000	$ 286,000
Mechanical Bar Screen (4')	1	EA	$ 335,000	$ 335,000
Bar Rack	1	EA	$ 5,000	$ 5,000
Grit Chamber (7' Dia)	1	EA	$ 195,000	$ 195,000
Grit Chamber (16' Dia)	1	EA	$ 250,000	$ 250,000
Conveyor/Dumpster	1	EA	$ 20,000	$ 20,000
Slide and Sluice Gates	1	LS	$ 50,000	$ 50,000
Dry Weather Raw Sewage Pumps	2	EA	$ 16,000	$ 32,000
Piping	1	LS	$ 120,000	$ 120,000
Sump Pumps	2	EA	$ 9,000	$ 18,000
HVAC	1	LS	$ 100,000	$ 100,000
Electrical	1	LS	$ 450,000	$ 450,000
Controls/SCADA	1	LS	$ 115,000	$ 115,000
Property Acquisition	1	LS	$ 50,000.00	$ 50,000
Excavation	24485	CY	$ 30	$ 734,550
Stone Fill	10324	CY	$ 25	$ 258,100
Site Grading	8000	CY	$ 10	$ 80,000
Excess Excavation Disposal	10324	CY	$ 10	$ 103,240
Pavement	1	LS	$ 50,000	$ 50,000
Utilities	1	LS	$ 15,000	$ 15,000
Process Water	600	LF	$ 40	$ 24,000
Plumbing	1	LS	$ 30,000	$ 30,000
Sheet Piling	10719	SF	$ 85	$ 911,115
Top Level Structure	4275	SF	$ 120	$ 513,000
Concrete Below Grade	998	CY	$ 1,000	$ 998,000
Yard Piping (Gravity Sewer and Manholes)	1	LS	$ 185,000	$ 185,000
Stream Crossing	1	LS	$ 90,000	$ 90,000
Rock Anchors	1	LS	$ 100,000	$ 100,000
Dewatering	1	LS	$ 50,000	$ 50,000
Bypass Pumping	1	LS	$ 20,000	$ 20,000
Forcemain Tie in	1	LS	$ 5,000	$ 5,000
Total				$ 6,193,005

Alternative P2-A

Primary Treatment at EBMA Pump Station, WWTP Flow EQ

Disinfection Tank				
Item	Quantity	Unit	Unit Price	Total Price
Concrete	1551	CY	$ 1,000	$ 1,551,000
Stone	5,753	CY	$ 25	$ 143,825
Sheet Piling	24,400	SF	$ 85	$ 2,074,000
Excavation	11,815	CY	$ 50	$ 590,750
Sodium Hypochlorite Building (20' x 20')	1	LS	$ 100,000	$ 100,000
Sodium Bisulfite Building (20' x 20')	1	LS	$ 100,000	$ 100,000
Sodium Hypochlorite Pump Skid (180 gph)	1	LS	$ 20,000	$ 20,000
Sodium Bisulfite Pump Skid (49 gph)	1	LS	$ 12,000	$ 12,000
Effluent Pump (14,465 gpm @ 16 ft)	2	EA	$ 60,000	$ 120,000
Discharge Piping/Outfall	1	LS	$ 100,000	$ 100,000
Electrical Connection	1	LS	$ 100,000	$ 100,000
RTU	1	LS	$ 30,000	$ 30,000
Total				$ 4,941,575

Flow Equalization Tank				
Item	Quantity	Unit	Unit Price	Total Price
Flow Equalization Tank	1	LS	$ 1,000,000	$ 1,000,000
Aeration Diffusers	1	LS	$ 80,000	$ 80,000
Blowers	1	LS	$ 96,400	$ 96,400
Blower Building	1	LS	$ 120,000	$ 120,000
Aeration Piping	1	LS	$ 15,000	$ 15,000
Valve Pit	1	EA	$ 15,000	$ 15,000
Piping and Valves	1	LS	$ 80,000	$ 80,000
Pumps (Tank Emptying)	1	LS	$ 20,000	$ 20,000
Electrical Connection	1	LS	$ 50,000	$ 50,000
Total				$ 1,476,400

Elizabeth Borough Municipal Authority
Long Term Control Plan

Alternative P2-B

Primary Treatment at EBMA Pump Station, WWTP Expansion

Summary		
CSO 5 Pump Station		$ 724,240
CSO 8 Pump Station		$ 730,330
Gravity Sewer		$ 652,000
CSO 8 and 5 Electrical Building		$ 690,000
Forcemain		$ 478,750
EBMA Pump Station		$ 6,193,005
Disinfection Tank		$ 4,871,575
WWTP Expansion		$ 3,594,900
Sub-Total		$ 17,934,800
15% Engineering, Legal, Property Acquisition		$ 2,690,220
Contingency	15%	$ 3,093,753
Total		$ 23,720,000

CSO 5 Pump Station				
Item	Quantity	Unit	Unit Price	Total Price
Submersible Pump (5,100 gpm @ 55 ft)	2	EA	$ 77,000	$ 154,000
Reinforced Concrete	126	CY	$ 1,000	$ 126,000
Stone	239	CY	$ 50	$ 11,950
Excavation	545	CY	$ 30	$ 16,350
Sheet Pile	3744	SF	$ 85	$ 318,240
Dewatering	1	LS	$ 10,000	$ 10,000
Access Hatch	1	LS	$ 1,500	$ 1,500
Ladder	1	LS	$ 1,200	$ 1,200
10" Discharge Pipe and Fittings	1	LS	$ 20,000	$ 20,000
Hoist	1	LS	$ 10,000	$ 10,000
Valve Vault	1	LS	$ 15,000	$ 15,000
Electrical Connection	1	LS	$ 10,000	$ 10,000
RTU	1	LS	$ 30,000	$ 30,000
Total				$ 724,240

Alternative P2-B

Primary Treatment at EBMA Pump Station, WWTP Expansion

CSO 8 Pump Station				
Item	Quantity	Unit	Unit Price	Total Price
Submersible Pump (5,500 gpm @ 50 ft)	2	EA	$ 82,000	$ 164,000
Reinforced Concrete	121	CY	$ 1,000	$ 121,000
Stone	230	CY	$ 50	$ 11,500
Excavation	517	CY	$ 30	$ 15,510
Sheet Pile	3592	SF	$ 85	$ 305,320
Dewatering	1	LS	$ 10,000	$ 10,000
Access Hatch	1	LS	$ 3,000	$ 3,000
Ladder	1	LS	$ 5,000	$ 5,000
16" DIP and Fittings	1	LS	$ 30,000	$ 30,000
Hoist	1	LS	$ 10,000	$ 10,000
Valve Vault	1	LS	$ 15,000	$ 15,000
Electrical Connection	1	LS	$ 10,000	$ 10,000
SCADA Connection	1	LS	$ 30,000	$ 30,000
Total				$ 730,330

Gravity Sewer				
Item	Quantity	Unit	Unit Price	Total Price
18 in. Gravity, 17 ft. Deep	270	LF	$ 200	$ 54,000
21 in. Gravity, 25. ft Deep	470	LF	$ 400	$ 188,000
Manholes	8	EA	$ 20,000	$ 160,000
Yard Restoration	1	LS	$ 100,000	$ 100,000
Street Restoration	1	LS	$ 150,000	$ 150,000
Total				$ 652,000

CSO 8 & 5 Electrical Building				
Item	Quantity	Unit	Unit Price	Total Price
Generator (250 Kw) w/ Transfer Switch	1	LS	$ 300,000	$ 300,000
Generator Building (25 ft X 25 ft)	1	LS	$ 250,000	$ 250,000
Transformer	1	LS	$ 10,000	$ 10,000
Electrical Connection to Pump Stations	1	LS	$ 100,000	$ 100,000
RTU	1	LS	$ 30,000	$ 30,000
Total				$ 690,000

Forcemain				
Item	Quantity	Unit	Unit Price	Total Price
24 Inch Forcemain	700	LF	$ 175	$ 122,500
16 Inch Forcemain	1890	LF	$ 125	$ 236,250
Valve Boxes	2	EA	$ 10,000	$ 20,000
Paving and Restoration	1	LS	$ 100,000	$ 100,000
Total				$ 478,750

Alternative P2-B

Primary Treatment at EBMA Pump Station, WWTP Expansion

EBMA Pump Station				
Item	Quantity	Unit	Unit Price	Total Price
Mechanical Bar Screen (1'-3")	1	EA	$ 286,000	$ 286,000
Mechanical Bar Screen (4')	1	EA	$ 335,000	$ 335,000
Bar Rack	1	EA	$ 5,000	$ 5,000
Grit Chamber (7' Dia)	1	EA	$ 195,000	$ 195,000
Grit Chamber (16' Dia)	1	EA	$ 250,000	$ 250,000
Conveyor/Dumpster	1	EA	$ 20,000	$ 20,000
Slide and Sluice Gates	1	LS	$ 50,000	$ 50,000
Dry Weather Raw Sewage Pumps	2	EA	$ 16,000	$ 32,000
Piping	1	LS	$ 120,000	$ 120,000
Sump Pumps	2	EA	$ 9,000	$ 18,000
HVAC	1	LS	$ 100,000	$ 100,000
Electrical	1	LS	$ 450,000	$ 450,000
Controls	1	LS	$ 115,000	$ 115,000
Property Acquisition	1	LS	$ 50,000.00	$ 50,000
Excavation	24485	CY	$ 30	$ 734,550
Stone Fill	10324	CY	$ 25	$ 258,100
Site Grading	8000	CY	$ 10	$ 80,000
Excess Excavation Disposal	10324	CY	$ 10	$ 103,240
Pavement	1	LS	$ 50,000	$ 50,000
Utilities	1	LS	$ 15,000	$ 15,000
Process Water	600	LF	$ 40	$ 24,000
Plumbing	1	LS	$ 30,000	$ 30,000
Sheet Piling	10719	SF	$ 85	$ 911,115
Top Level Structure	4275	SF	$ 120	$ 513,000
Concrete Below Grade	998	CY	$ 1,000	$ 998,000
Yard Piping (Gravity Sewer and Manholes)	1	LS	$ 185,000	$ 185,000
Stream Crossing	1	LS	$ 90,000	$ 90,000
Rock Anchors	1	LS	$ 100,000	$ 100,000
Dewatering	1	LS	$ 50,000	$ 50,000
Bypass Pumping	1	LS	$ 20,000	$ 20,000
Forcemain Tie in	1	LS	$ 5,000	$ 5,000
Total				$ 6,193,005

Alternative P2-B

Primary Treatment at EBMA Pump Station, WWTP Expansion

Disinfection Tank				
Item	Quantity	Unit	Unit Price	Total Price
Concrete	1551	CY	$ 1,000	$ 1,551,000
Stone	5,753	CY	$ 25	$ 143,825
Sheet Piling	24,400	SF	$ 85	$ 2,074,000
Excavation	11,815	CY	$ 50	$ 590,750
Sodium Hypochlorite Building (20' x 20')	1	LS	$ 100,000	$ 100,000
Sodium Bisulfite Building (20' x 20')	1	LS	$ 100,000	$ 100,000
Sodium Hypochlorite Pump Skid (180 gph)	1	LS	$ 20,000	$ 20,000
Sodium Bisulfite Pump Skid (49 gph)	1	LS	$ 12,000	$ 12,000
Effluent Pump (14,465 gpm @ 16 ft)	2	EA	$ 60,000	$ 120,000
Discharge Piping	1	LS	$ 100,000	$ 100,000
Electrical Connection	1	LS	$ 30,000	$ 30,000
RTU	1	LS	$ 30,000	$ 30,000
Total				$ 4,871,575

WWTP Expansion				
Item	Quantity	Unit	Unit Price	Total Price
SBR Equipment	1	LS	$ 850,000	$ 850,000
Excavation	12380	CY	$ 30	$ 371,400
Stone	450	CY	$ 30	$ 13,500
Reinforced Concrete	765	CY	$ 1,000	$ 765,000
Chlorine Tank and Building Demo	1	LS	$ 100,000	$ 100,000
Overhead Electric Utility Relocation	1	LS	$ 200,000	$ 200,000
Aeration Tank to Sludge Digestion Conversion	1	LS	$ 20,000	$ 20,000
Sludge Handling Building	1	LS	$ 200,000	$ 200,000
UV Disinfection Facilities	1	EA	$ 350,000	$ 350,000
Electrical Work	1	LS	$ 100,000	$ 100,000
SCADA	1	LS	$ 100,000	$ 100,000
Yard Piping	1	LS	$ 200,000	$ 200,000
Pavement	1	LS	$ 75,000	$ 75,000
Garage	1	LS	$ 250,000	$ 250,000
Total				$ 3,594,900

Elizabeth Borough Municipal Authority
Long Term Control Plan

Alternative B1

WWTP Expansion, Flow EQ Tanks

Summary		
CSO 5 Pump Station		$ 729,540
CSO 8 Pump Station		$ 730,330
Gravity Sewer		$ 652,000
CSO 8 and 5 Electrical Building		$ 690,000
Forcemain		$ 478,750
EBMA Pump Station		$ 5,209,760
Flow Equlization Tank		$ 1,075,000
WWTP Expansion		$ 5,248,800
Sub-Total		$ 14,814,180
15% Engineering, Legal, Property Acquisition		$ 2,222,127
Contingency	15%	$ 2,555,446
Total		$ 19,590,000

CSO 5 Pump Station				
Item	Quantity	Unit	Unit Price	Total Price
Submersible Pump (5,100 gpm @ 55 ft)	2	EA	$ 77,000	$ 154,000
Reinforced Concrete	126	CY	$ 1,000	$ 126,000
Stone	239	CY	$ 50	$ 11,950
Excavation	545	CY	$ 30	$ 16,350
Sheet Pile	3744	SF	$ 85	$ 318,240
Dewatering	1	LS	$ 10,000	$ 10,000
Access Hatch	1	LS	$ 3,000	$ 3,000
Ladder	1	LS	$ 5,000	$ 5,000
10" Discharge Pipe and Fittings	1	LS	$ 20,000	$ 20,000
Hoist	1	LS	$ 10,000	$ 10,000
Valve Vault	1	LS	$ 15,000	$ 15,000
Electrical Connection	1	LS	$ 10,000	$ 10,000
SCADA Connection	1	LS	$ 30,000	$ 30,000
Total				$ 729,540

Alternative B1

WWTP Expansion, Flow EQ Tanks

CSO 8 Pump Station				
Item	Quantity	Unit	Unit Price	Total Price
Submersible Pump (5,500 gpm @ 50 ft)	2	EA	$ 82,000	$ 164,000
Reinforced Concrete	121	CY	$ 1,000	$ 121,000
Stone	230	CY	$ 50	$ 11,500
Excavation	517	CY	$ 30	$ 15,510
Sheet Pile	3592	SF	$ 85	$ 305,320
Dewatering	1	LS	$ 10,000	$ 10,000
Access Hatch	1	LS	$ 3,000	$ 3,000
Ladder	1	LS	$ 5,000	$ 5,000
16" DIP and Fittings	1	LS	$ 30,000	$ 30,000
Hoist	1	LS	$ 10,000	$ 10,000
Valve Vault	1	LS	$ 15,000	$ 15,000
Electrical Connection	1	LS	$ 10,000	$ 10,000
SCADA Connection	1	LS	$ 30,000	$ 30,000
Total				$ 730,330

Gravity Sewer				
Item	Quantity	Unit	Unit Price	Total Price
18 in. Gravity, 17 ft. Deep	270	LF	$ 200	$ 54,000
21 in. Gravity, 25. ft Deep	470	LF	$ 400	$ 188,000
Manholes	8	EA	$ 20,000	$ 160,000
Yard Restoration	1	LS	$ 100,000	$ 100,000
Street Restoration	1	LS	$ 150,000	$ 150,000
Total				$ 652,000

CSO 8 & 5 Electrical Building				
Item	Quantity	Unit	Unit Price	Total Price
Generator (250 Kw) w/ Transfer Switch	1	LS	$ 300,000	$ 300,000
Generator Building (25 ft X 25 ft)	1	LS	$ 250,000	$ 250,000
Transformer	1	LS	$ 10,000	$ 10,000
Electrical Connection to Pump Stations	1	LS	$ 100,000	$ 100,000
RTU	1	LS	$ 30,000	$ 30,000
Total				$ 690,000

Forcemain				
Item	Quantity	Unit	Unit Price	Total Price
24 Inch Forcemain	700	LF	$ 175	$ 122,500
16 Inch Forcemain	1890	LF	$ 125	$ 236,250
Valve Boxes	2	EA	$ 10,000	$ 20,000
Pavement and Restoration	1	LS	$ 100,000	$ 100,000
Total				$ 478,750

Alternative B1

WWTP Expansion, Flow EQ Tanks

EBMA Pump Station				
Item	Quantity	Unit	Unit Price	Total Price
Mechanical Bar Screen (1'-3")	1	EA	$ 286,000	$ 286,000
Bar Rack	1	EA	$ 10,000	$ 10,000
Grit Chamber (7' Dia)	1	EA	$ 195,000	$ 195,000
Conveyor/Dumpster	1	EA	$ 20,000	$ 20,000
Slide and Sluice Gates	1	LS	$ 50,000	$ 50,000
Dry Weather Raw Sewage Pumps	2	EA	$ 26,000	$ 52,000
Wet Weather Raw Sewage Pumps	3	EA	$ 85,000	$ 255,000
Piping	1	LS	$ 200,000	$ 200,000
Sump Pumps	2	EA	$ 9,000	$ 18,000
HVAC	1	LS	$ 100,000	$ 100,000
Electrical	1	LS	$ 450,000	$ 450,000
Controls	1	LS	$ 115,000	$ 115,000
Property Acquisition	1	LS	$ 50,000.00	$ 50,000
Excavation	19380	CY	$ 30	$ 581,400
Stone Fill	3145	CY	$ 25	$ 78,625
Site Grading	8000	CY	$ 10	$ 80,000
Excess Excavation Disposal	3145	CY	$ 10	$ 31,450
Pavement	1	LS	$ 50,000	$ 50,000
Utilities	1	LS	$ 15,000	$ 15,000
Process Water	600	LF	$ 40	$ 24,000
Plumbing	1	LS	$ 30,000	$ 30,000
Sheet Piling	9021	SF	$ 85	$ 766,785
Top Level Structure	2700	SF	$ 120	$ 324,000
Concrete Below Grade	852	CY	$ 1,000	$ 852,000
Yard Piping (Gravity Sewer and Manholes)	1	LS	$ 185,000	$ 185,000
Stream Crossing	1	LS	$ 90,000	$ 90,000
Rock Anchors	1	LS	$ 100,000	$ 100,000
Dewatering	1	LS	$ 50,000	$ 50,000
Bypass Pumping	1	LS	$ 20,000	$ 20,000
Dry Weather Forcemain	675	LF	$ 80	$ 54,000
Wet Weather Forcemain	850	LF	$ 90	$ 76,500
Total				$ 5,209,760

Flow Equalization Tank				
Item	Quantity	Unit	Unit Price	Total Price
Flow Equalization Tanks	1	LS	$ 700,000	$ 700,000.00
Aeration Diffusers	1	LS	$ 60,000	$ 60,000.00
Blowers	1	LS	$ 75,000	$ 75,000.00
Blower Building	1	LS	$ 100,000	$ 100,000.00
Aeration Piping	1	LS	$ 15,000	$ 15,000.00
Valve Pit	1	EA	$ 15,000	$ 15,000.00
Piping and Valves	1	LS	$ 80,000	$ 80,000.00
Electrical Connection	1	LS	$ 30,000	$ 30,000.00
Total				$ 1,075,000

Alternative B1

WWTP Expansion, Flow EQ Tanks

WWTP Expansion				
Item	Quantity	Unit	Unit Price	Total Price
SBR Equipment	1	LS	$ 1,275,000	$ 1,275,000
Excavation	15710	CY	$ 30	$ 471,300
Stone	1050	CY	$ 30	$ 31,500
Reinforced Concrete	1876	CY	$ 1,000	$ 1,876,000
Chlorine Tank and Building Demo	1	LS	$ 100,000	$ 100,000
Overhead Electric Utility Relocation	1	LS	$ 200,000	$ 200,000
Aeration Tank to Sludge Digestion Conversion	1	LS	$ 20,000	$ 20,000
Sludge Handling Building	1	LS	$ 200,000	$ 200,000
UV Disinfection Facilities	1	EA	$ 350,000	$ 350,000
Electrical Work	1	LS	$ 100,000	$ 100,000
SCADA	1	LS	$ 100,000	$ 100,000
Yard Piping	1	LS	$ 200,000	$ 200,000
Pavement	1	LS	$ 75,000	$ 75,000
Garage	1	LS	$ 250,000	$ 250,000
Total				$ 5,248,800

Elizabeth Borough Municipal Authority
Long Term Control Plan
Operation and Maintenance Cost
Alternative P1-A

Primary Treatment Facility, CSO 8

Line #		
	Sodium Hypochlorite	
1	Cost per Gallon	$ 1.60
2	Total Volume	1622
3	Annual Cost	$ 2,595
	Sodium Bisulfite	
3	Cost per Gallon	$ 3.50
4	Total Volume	515
5	Annual Cost	$ 1,803
6	General Maintenance	$ 2,000
	Total (Line 3 + 5 +6)	$ 6,398

CSO 7 Pump Station

Line #		
	Pump Electrical Cost	
1	Flow Rate (gpm)	1,920
2	Head (ft)	30
3	Efficiency	65%
4	Power (kW)	16.7
5	Total Flow	0.711
6	Electricity Cost ($/kWhr)	$ 0.12
7	Estimated Electrical Cost	$ 12
8	General Maintenance	$ 500
	Total (Line 7 + 8)	$ 512

CSO 6 Pump Station

Line #		
	Pump Electrical Cost	
1	Flow Rate (gpm)	3,625
2	Head (ft)	50
3	Efficiency	65%
4	Power (kW)	52.5
5	Total Flow	7.049
6	Electricity Cost ($/kWhr)	$ 0.12
7	Estimated Electrical Cost	$ 204
8	General Maintenance	$ 500
	Total (Line 7 +13 + 17)	$ 704

EBMA Pump Station

Line #		
	Pump Electrical Cost	
1	Flow Rate (gpm)	920
2	Head (ft)	70
3	Efficiency	65%
4	Power (kW)	18.7
5	Total Flow	440.1
6	Electricity Cost ($/kWhr)	$ 0.12
7	Estimated Electrical Cost	$ 17,850
8	General Maintenance	$ 2,000
	Total (Line 7 + 8)	$ 19,850

CSO 5 Pump Station

Line #		
	Pump Electrical Cost	
1	Flow Rate (gpm)	1,450
2	Head (ft)	65
3	Efficiency	65%
4	Power (kW)	27.3
5	Total Flow	0.145
6	Electricity Cost ($/kWhr)	$ 0.12
7	Estimated Electrical Cost	$ 5
6	General Maintenance	$ 500
	Total (Line 3 + 5 +6)	$ 505

Primary Treatment Facility, CSO 3

Line #		
	Sodium Hypochlorite	
1	Cost per Gallon	$ 1.60
2	Total Volume	1590
3	Annual Cost	$ 2,544
	Sodium Bisulfite	
3	Cost per Gallon	$ 3.50
4	Total Volume	505
5	Annual Cost	$ 1,768
6	General Maintenance	$ 2,000
	Total (Line 3 + 5 +6)	$ 3,768

WWTP

Line #		
	Biological Treatment	
1	Cost per 1000 Gallons	$ 0.43
2	Total Volume (Mgal)	423.9
3	Annual Cost	$ 182,277
4	Flow EQ Tank Maintenance	$ 1,500.00
	Total (Line 3 + 4)	$ 183,777

Summary	
Primary Treatment Facility, CSO 8	$ 6,398
CSO 7 Pump Station	$ 512
CSO 6 Pump Station	$ 704
CSO 5 Pump Station	$ 505
Primary Treatment Facility, CSO 3	$ 3,768
EBMA Pump Station	$ 19,850
WWTP	$ 183,777
Administrative Cost	$ 130,000
Laborator Cost	$ 10,000
Payroll	$ 280,000
Professional Fees	$ 50,000
System Maintenace	$ 10,000
Total Estimated Annual Operating Cost	$ 696,000

Elizabeth Borough Municipal Authority
Long Term Control Plan
Opearation and Maintenance Cost
Alternative P1-B

Primary Treatment Facility, CSO 8

Line #		
	Sodium Hypochlorite	
1	Cost per Gallon	$ 1.60
2	Total Volume	1622
3	Annual Cost	$ 2,595
	Sodium Bisulfite	
3	Cost per Gallon	$ 3.50
4	Total Volume	515
5	Annual Cost	$ 1,803
6	General Maintenance	$ 2,000
	Total (Line 3+5+6)	$ 6,398

CSO 7 Pump Station

Line #		
	Pump Electrical Cost	
1	Flow Rate (gpm)	1,920
2	Head (ft)	30
3	Efficiency	65%
4	Power (kW)	16.7
5	Total Flow	0.711
6	Electricity Cost ($/kWhr)	$ 0.12
7	Estimated Electrical Cost	$ 12
8	General Maintenance	$ 500
	Total (Line 7 + 8)	$ 512

CSO 6 Pump Station

Line #		
	Pump Electrical Cost	
1	Flow Rate (gpm)	3,625
2	Head (ft)	50
3	Efficiency	65%
4	Power (kW)	52.5
5	Total Flow	7.049
6	Electricity Cost ($/kWhr)	$ 0.12
7	Estimated Electrical Cost	$ 204
8	General Maintenance	$ 500
	Total (Line 7 + 8)	$ 704

EBMA Pump Station

Line #		
	Pump Electrical Cost	
1	Flow Rate (gpm)	920
2	Head (ft)	70
3	Efficiency	65%
4	Power (kW)	18.7
5	Total Flow	423.4
6	Electricity Cost ($/kWhr)	$ 0.12
7	Estimated Electrical Cost	$ 17,173
8	General Maintenance	$ 2,000
	Total (Line 7 + 8)	$ 19,173

CSO 5 Pump Station

Line #		
	Pump Electrical Cost	
1	Flow Rate (gpm)	1,450
2	Head (ft)	65
3	Efficiency	65%
4	Power (kW)	27.3
5	Total Flow	0.145
6	Electricity Cost ($/kWhr)	$ 0.12
7	Estimated Electrical Cost	$ 5
8	General Maintenance	$ 2,000
	Total (Line 7 + 8)	$ 2,005

Primary Treatment Facility, CSO 3

Line #		
	Sodium Hypochlorite	
1	Cost per Gallon	$ 1.60
2	Total Volume	1590
3	Annual Cost	$ 2,544
	Sodium Bisulfite	
3	Cost per Gallon	$ 3.50
4	Total Volume	505
5	Annual Cost	$ 1,768
6	General Maintenance	$ 2,000
	Total (Line 6 + 7)	$ 6,312

WWTP

Line #		
	Biological Treatment	
1	Cost per 1000 Gallons	$ 0.43
2	Total Volume (Mgal)	423.9
3	Annual Cost	$ 182,277
	Total (Line 3)	$ 182,277

Summary	
Primary Treatment Facility, CSO 8	$ 6,398
CSO 7 Pump Station	$ 512
CSO 6 Pump Station	$ 704
CSO 5 Pump Station	$ 2,005
Primary Treatment Facility, CSO 3	$ 6,312
EBMA Pump Staion	$ 19,173
WWTP	$ 182,277
Administrative Cost	$ 130,000
Laborator Cost	$ 10,000
Payroll	$ 280,000
Professional Fees	$ 50,000
System Maintenace	$ 10,000
Total Estimated Annual Operating Cost	**$ 697,000**

Elizabeth Borough Municipal Authority
Long Term Control Plan
Operation and Maintenace Cost
Alternative P2-A

Primary Treatment Facility

Line #		
	Sodium Hypochlorite	
1	Cost per Gallon	$ 1.60
2	Total Volume	3212
3	Annual Cost	$ 5,139
	Sodium Bisulfite	
3	Cost per Gallon	$ 3.50
4	Total Volume	1020
5	Annual Cost	$ 3,570
6	General Maintenance	$ 2,000
	Total (Line 3 + 5 + 6)	$ 10,709

CSO 8 Pump Station

Line #		
	Pump Electrical Cost	
1	Flow Rate (gpm)	5,500
2	Head (ft)	50
3	Efficiency	65%
4	Power (kW)	79.7
5	Total Flow	12.286
6	Electricity Cost ($/kWhr)	$ 0.12
7	Estimated Electrical Cost	$ 356
8	General Maintenance	$ 500
	Total (Line 7 + 8)	$ 856

CSO 5 Pump Station

Line #		
	Pump Electrical Cost	
1	Flow Rate (gpm)	5,100
2	Head (ft)	55
3	Efficiency	65%
4	Power (kW)	81.3
5	Total Flow	7.194
6	Electricity Cost ($/kWhr)	$ 0.12
7	Estimated Electrical Cost	$ 229
8	General Maintenance	$ 500
	Total (Line 7 + 8)	$ 729

Summary	
Primary Treatment Facility, CSO 8	$ 10,709
CSO 8 Pump Station	$ 856
CSO 7 Pump Station	$ 729
EBMA Pump Station	$ 19,850
WWTP	$ 183,777
Administrative Cost	$ 130,000
Laborator Cost	$ 10,000
Payroll	$ 280,000
Professional Fees	$ 50,000
System Maintenace	$ 10,000
Total Estimated Annual Operating Cost	**$ 696,000**

EBMA Pump Station

Line #		
	Pump Electrical Cost	
1	Flow Rate (gpm)	920
2	Head (ft)	70
3	Efficiency	65%
4	Power (kW)	18.7
5	Total Flow	440.1
6	Electricity Cost ($/kWhr)	$ 0.12
7	Estimated Electrical Cost	$ 17,850
8	General Maintenance	$ 2,000
	Total (Line 7 + 8)	$ 19,850

WWTP

Line #		
	Biological Treatment	
1	Cost per 1000 Gallons	$ 0.43
2	Total Volume (Mgal)	423.9
3	Annual Cost	$ 182,277
4	Flow EQ Tank Maintenance	$ 1,500.00
	Total (Line 3 + 4)	$ 183,777

Elizabeth Borough Municipal Authority
Long Term Control Plan
Operation and Maintenace Cost
Alternative P2-B

Primary Treatment Facility

Line #		
	Sodium Hypochlorite	
1	Cost per Gallon	$ 1.60
2	Total Volume	3212
3	Annual Cost	$ 5,139
	Sodium Bisulfite	
3	Cost per Gallon	$ 3.50
4	Total Volume	1020
5	Annual Cost	$ 3,570
6	General Maintenance	$ 2,000
	Total (Line 3 + 5 + 6)	$ 10,709

CSO 8 Pump Station

Line #		
	Pump Electrical Cost	
1	Flow Rate (gpm)	5,500
2	Head (ft)	50
3	Efficiency	65%
4	Power (kW)	79.7
5	Total Flow	12.286
6	Electricity Cost ($/kWhr)	$ 0.12
7	Estimated Electrical Cost	$ 356
8	General Maintenance	$ 500
	Total (Line 7 + 8)	$ 856

CSO 5 Pump Station

Line #		
	Pump Electrical Cost	
1	Flow Rate (gpm)	5,100
2	Head (ft)	55
3	Efficiency	65%
4	Power (kW)	81.3
5	Total Flow	7.194
6	Electricity Cost ($/kWhr)	$ 0.12
7	Estimated Electrical Cost	$ 229
8	General Maintenance	$ 500
	Total (Line 7 + 8)	$ 729

Summary	
Primary Treatment Facility, CSO 8	$ 10,709
CSO 8 Pump Station	$ 856
CSO 5 Pump Station	$ 729
EBMA Pump Station	$ 19,173
WWTP	$ 182,277
Administrative Cost	$ 130,000
Laborator Cost	$ 10,000
Payroll	$ 280,000
Professional Fees	$ 50,000
System Maintenace	$ 10,000
Total Estimated Annual Operating Cost	**$ 694,000**

EBMA Pump Station

Line #		
	Pump Electrical Cost	
1	Flow Rate (gpm)	920
2	Head (ft)	70
3	Efficiency	65%
4	Power (kW)	18.7
5	Total Flow	423.4
6	Electricity Cost ($/kWhr)	$ 0.12
7	Estimated Electrical Cost	$ 17,173
8	General Maintenance	$ 2,000
	Total (Line 7 + 8)	$ 19,173

WWTP

Line #		
	Biological Treatment	
1	Cost per 1000 Gallons	$ 0.43
2	Total Volume (Mgal)	423.9
3	Annual Cost	$ 182,277
	Total (Line 6 + 9)	$ 182,277

CSO 8 Pump Station

Line #	Pump Electrical Cost	
1	Flow Rate (gpm)	5,500
2	Head (ft)	50
3	Efficiency	65%
4	Power (kW)	79.7
5	Total Flow	12.286
6	Electricity Cost ($/kWhr)	$ 0.12
7	Estimated Electrical Cost	$ 356
8	General Maintenance	$ 2,000
	Total (Line 7 + 8)	$ 2,356

CSO 5 Pump Station

Line #	Pump Electrical Cost	
1	Flow Rate (gpm)	5,100
2	Head (ft)	55
3	Efficiency	65%
4	Power (kW)	81.3
5	Total Flow	7.194
6	Electricity Cost ($/kWhr)	$ 0.12
7	Estimated Electrical Cost	$ 229
8	General Maintenance	$ 2,000
	Total (Line 7 + 8)	$ 2,229

EBMA Pump Station

Line #	Pump Electrical Cost	
1	Flow Rate (gpm)	920
2	Head (ft)	70
3	Efficiency	65%
4	Power (kW)	18.7
5	Total Flow	459.53
6	Electricity Cost ($/kWhr)	$ 0.12
7	Estimated Electrical Cost	$ 18,638
8	General Maintenance	$ 2,000
	Total (Line 7 + 8)	$ 20,638

Summary	
CSO 8 Pump Station	$ 2,356
CSO 5 Pump Station	$ 2,229
EBMA Pump Station	$ 20,638
WWTP	$ 183,777
Administrative Cost	$ 130,000
Laborator Cost	$ 10,000
Payroll	$ 280,000
Professional Fees	$ 50,000
System Maintenace	$ 10,000
Total Estimated Annual Operating Cost	**$ 689,000**

WWTP

Line #	Biological Treatment	
1	Cost per 1000 Gallons	$ 0.43
2	Total Volume (Mgal)	423.9
3	Annual Cost	$ 182,277
4	Flow EQ Tank Maintenance	$ 1,500
	Total (Line 3 + 4)	$ 183,777

Alternative P1-A, P1-B

Concept Level Design Calculations

SENATE ENGINEERING COMPANY
U-PARC
420 William Pitt Way
Pittsburgh PA 15238-1330
Tel: (412) 826-5454
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SECO No. 10165

Subject: LTCP Alternative Design
Alternative P1-A, P1-B

Drawing No.

Calculated By: MJE Checked By: _____ Date: July 2016

The following summarizes the design flows for Alternative P1-A

Alternative P1-A			
	Peak Flow Rate (mgd)	Peak Flow Rate (gpm)	Volume (gallons)
Primary Treatment at CSO 8	15.240	10583	-
Pump Station CSO 5	2.090	1451	-
Pump Station CSO 6	5.220	3625	-
Pump Station CSO 7	2.760	1917	-
Pump Station CSO 8	5.170	3590	-
Primary Treatment at EBMA PS	5.590	3882	
Flow Equalization	1.100	764	1,136,000
EBMA Pump Station Capacity	1.296	900	-
WWTP Capacity*	2.500	-	-
* Assumes a Wylie Capacity of 1.2 mgd			

CSO 8 Primary Treatment

Locate the Primary Treatment Facility adjacent to CSO 8 and Boat Launch

Existing Grade ≈ 738 ft.

Determine which is more cost effective:

- Allow CSO 8 to flow by gravity to Primary Treatment Facility
- Pump CSO 8 to the Primary Treatment Facility

As per the design flows, the Primary Treatment Facility should be sized for ≈ 15 mgd

Gravity Flow Alternative:

To direct flow from the CSO structure to the Primary Treatment Facility, a second diversion structure will be required to separate flows eligible for primary treatment from the allowable discharge flows.

Set the Primary Treatment Facility maximum water surface elevation so that it does not impact the flow of the weir in the secondary diversion structure.

Construct the secondary diversion structure on top of the existing CSO discharge line.

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According the elevations taken from Drawing Number D348237 and D348202 the CSO discharge elevation is 731.05 and the next discharge manhole, 100 feet away, has an invert is 726.35. Calculate the slope;

$$S = \frac{731.05\ ft - 726.35\ ft}{100\ ft}$$

S = 0.047%

Calculate the existing capacity of the CSO discharge line:

Note: The drawings list the CSO discharge as a 42 inch line. It appears that the line leaving the existing CSO regulator was constructed with a 30 inch line leaving the structure with an increaser to connect to the preexisting 42 inch line. To calculate the capacity of the CSO discharge line, it will be assumed that the line has a 30 inch diameter.

$$Q = \frac{1.49}{n} R^{2/3} \sqrt{S}(A)$$

Where:

n = Roughness

R = Hydraulic Radius, (ft.)

S = Slope, (ft./ft.)

A = Area, (ft^2)

$$Q = \frac{1.49}{0.013} (0.625)^{2/3} \sqrt{0.047}(4.91)$$

Q = 89.16 cfs

The secondary diversion structure will be designed so that it will direct up to the required primary treatment peak flow rate to the Primary Treatment Facility. A side flow weir will direct the remainder of the flow to the river to be discharged.

Figure 1 and 2 below show a plan and profile of the secondary diversion structure:

Place the secondary diversion structure 20 ft away from the existing CSO 8 structure.

Secondary diversion structure invert elevation ($Z_{D\text{-}IN}$)

$$\boldsymbol{Z_{D-IN} = 730.50\ ft}$$

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SECO No. 10165

Subject: LTCP Alternative Design
Alternative P1-A, P1-B

Drawing No.

Calculated By: MJE Checked By: _____ Date: July 2016

Figure 1: Secondary Diversion Structure, Plan View, NTS

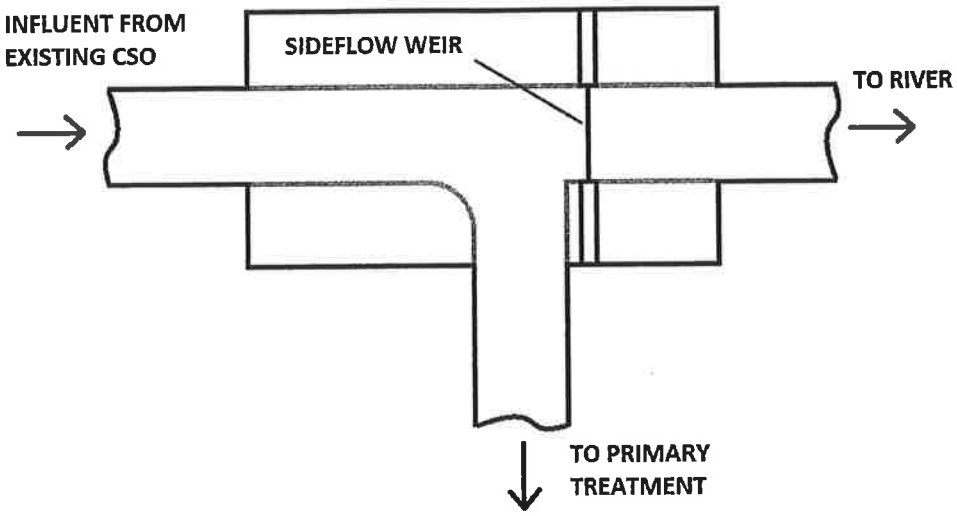
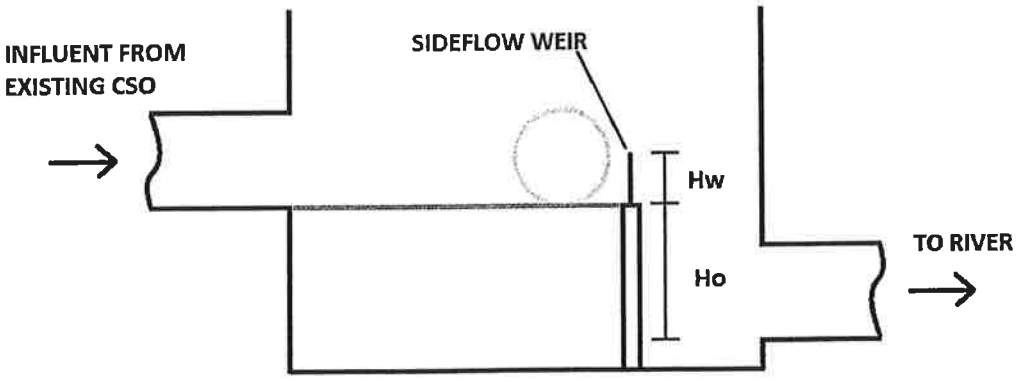


Figure 2: Secondary Diversion Structure, Profile View, NTS



Replace existing 42 inch line with 36 inch line from CSO 8 to the Secondary Diversion Structure.

Determine the capacity of new 36 inch line:

$$S = \frac{731.05\ ft - 730.5\ ft}{20\ ft}$$

S = 0.0275

$$Q = \frac{1.49}{0.013}(0.75)^{2/3}\sqrt{0.0275}(7.07)$$

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SECO No. 10165

Subject: LTCP Alternative Design
Alternative P1-A, P1-B

Drawing No.

Calculated By: MJE Checked By: _____ Date: July 2016

Q = 110.90 cfs > 89.16 cfs –OK

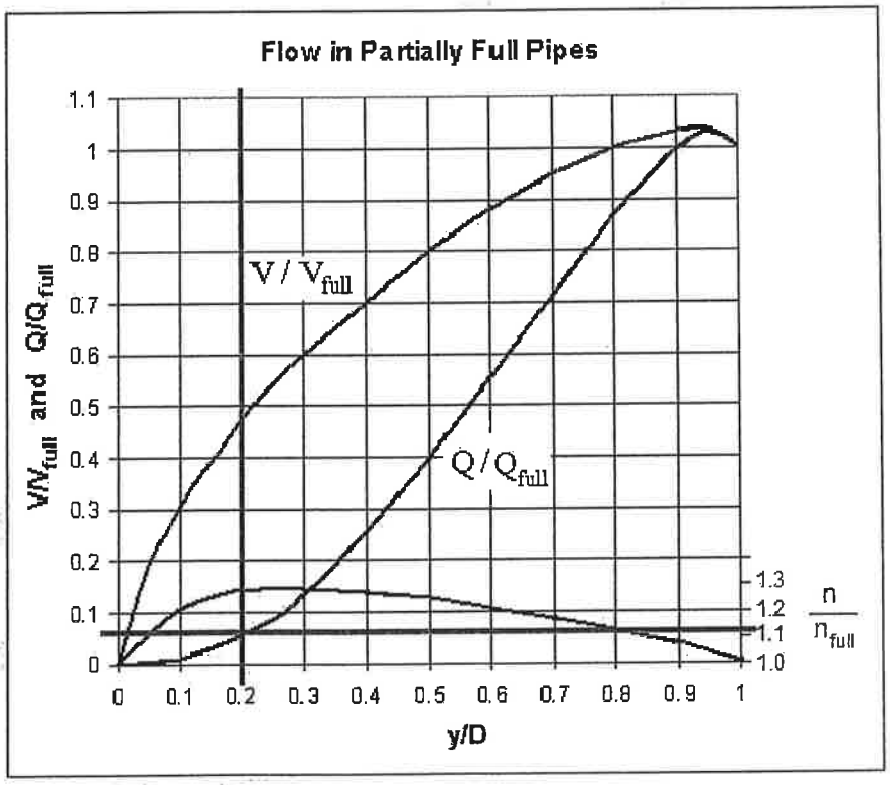
Determine the height of the side flow weir (H_W):

The allowable primary treatment peak flow rate ($Q_{P\text{-}PRI}$) from CSO 8 is **5.17 mgd**, set the weir elevation 5% higher than the calculated normal flow depth at $Q_{P\text{-}PRI}$.

Determine ratio of design flow to full flow:

$$Q/Q_{full} = 5.17\ cfs / 110.90\ cfs = 0.07$$

Use the below graph to determine the ratio of design flow depth to full flow depth (y/D):



y/D ≈ 0.20

Calculate the normal depth (y)

$$y = (y/D)D = 0.20 * 36\ in.$$

y = 7.34 in. = 0.61 ft

Calculate H_W:

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$$H_W = y * 1.05 = 0.61\ ft * 1.05$$

Set H_W = 7 – 5/8"

Set the effluent of the secondary diversion structure ($Z_{D\text{-}OUT}$) 3.0 feet below the influent invert

$Z_{D\text{-}OUT}$ = 727.50 ft

Determine the Slope of the new line from the Secondary Diversion Structure to the existing manhole (Invert Elev. 726.36 ft) 70 ft away.

$$S = \frac{727.5ft - 726.35\ ft}{70\ ft}$$

S = 0.0164

Use a 42 inch line on the discharge. Determine the capacity:

$$Q = \frac{1.49}{0.013}(0.875)^{2/3}\sqrt{0.0164}(9.62)$$

Q = 129.19 cfs > 89.16 cfs –OK

Determine the normal flow depth at the existing pipe capacity as calculated above (89.16 cfs)

Determine ratio of design flow to full flow:

$$Q/_{Q_{full}} = {89.16\ cfs}/_{129.19\ cfs} = 0.69$$

Use the below graph to determine the ratio of design flow depth to full flow depth (y/D):

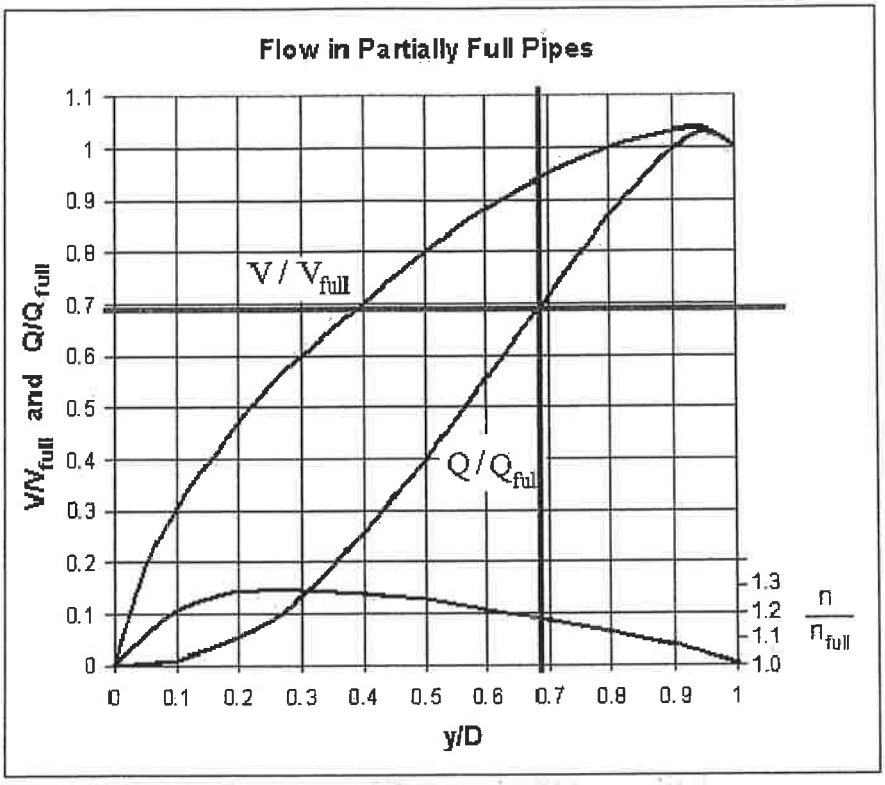
y/D ≈ 0.69, See next page

Calculate the normal depth (y)

$$y = ({}^{y}/_{D})D = 0.69 * 42\ in.$$

y = 28.98 in. = 2.40 ft

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At a flow depth of 2.40 ft, it is unlikely that the downstream water surface elevation will impact the flow upstream of the weir to the primary treatment facility.

H_O = 3.0 ft

Note: The above calculation assumes that the river level is not elevated to a point where it develops a backwater, at which point the water surface elevation would exceed the above calculated normal flow depth. The river level may reach a point whereas flows from CSO 8 in excess of the $Q_{P\text{-}PRI}$ would be directed to the primary treatment facility or, in extreme cases, river water would be directed to the primary treatment facility.

Flow eligible for primary treatment will be directed to MH-P1 (as shown in Figure 3 below) before being set to the Primary Treatment Facility. The force main from CSO 5, 6, and 7 will also discharge into MH-P1.

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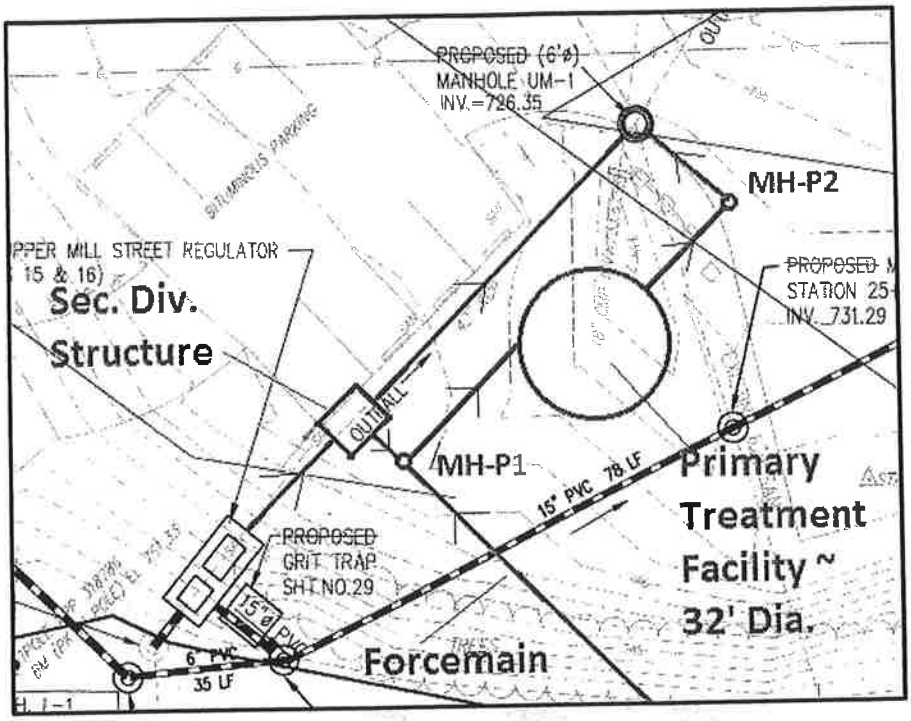
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Figure 3: Primary Treatment Facility, Plan View, NTS



Determine the elevation of MH-P1:

Set the maximum water surface elevation of the Primary Treatment Facility to 1 ft below the influent invert of the Secondary Diversion Structure. Figure 4, below, is taken from the Hydro International drawing number 14-3225-02 and list the critical dimensions.

Based on dimensions in Figure 4, set the Primary Treatment Facility influent ($Z_{P\text{-}IN}$) ≈ 13 ft below the maximum water level elevation

$$Z_{P-IN} = 730.5ft - 1ft - 13ft$$

$Z_{P\text{-}IN}$ = 716.50 ft

Based on influent level, the maximum water surface elevation is 728.65 ft.

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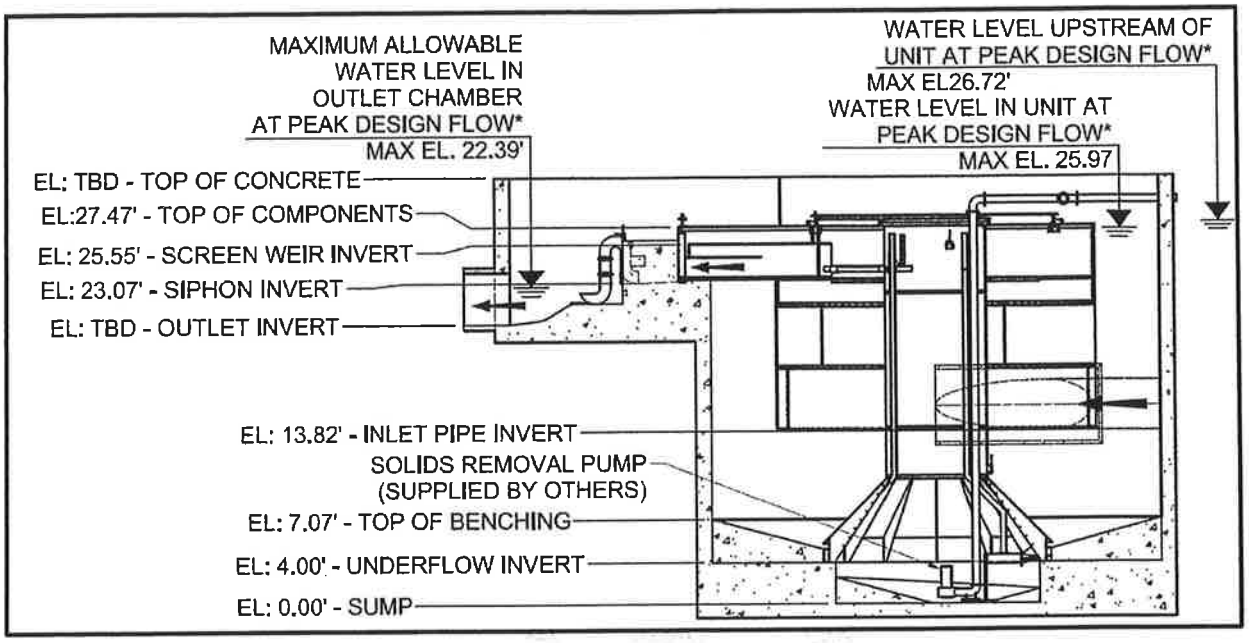
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Figure 4: Primary Treatment Facility, Profile View, Taken From Hydro International Drawing #14-3225-02, NTS



Based on Figure 4, the sump elevation (Z_{Sump}) is

$$Z_{Sump} = 716.50ft - 14\ ft$$

Z_{Sump} = 702.50 ft

Assume a Primary Treatment Facility effluent elevation ($Z_{P\text{-}OUT}$)

$Z_{P\text{-}OUT}$ = 724.50 ft

Determine the Invert of manhole P1:

Primary Treatment Facility influent is 30 influent as per Hydo International Drawings.

Set MH-P1 Invert ($Z_{MH\text{-}P1}$)

$Z_{MH\text{-}P1}$ = 716.65 ft

Check capacity of 30 inch influent, assume a conduit length of 30 ft

Calculate slope:

$$S = \frac{716.65ft - 716.50ft}{30ft}$$

S = 0.005

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Check the capacity:

$$Q = \frac{1.49}{0.013}(0.625)^{2/3}\sqrt{0.005}(4.91)$$

Q = 34.37 cfs = 22.21 mgd > 15 mgd req. – OK

Determine the size and slope of the line from Secondary Diversion Structure to MH-P1. Peak flow rate of 5.17 mgd.

Use a 16 inch conduit at a 0.015 ft/ft slope. Assume a 20 ft conduit length.

Determine the influent elevation of the 16 inch line at MH-P1 ($Z_{P1\text{-}16}$)

$$Z_{P1-16} = 730.50\,ft - (0.015 * 20ft)$$

$Z_{P1\text{-}16}$ = 730.20 ft

Check the capacity of the 16 inch line:

$$Q = \frac{1.49}{0.013}(0.33)^{2/3}\sqrt{0.015}(1.40)$$

Q = 11.14 cfs = 7.20 mgd > 5.17 mgd req. – OK

The influent elevation of the 16 inch line is 13.55 ft above the invert and will therefore require a drop connection. The height and size of the drop connection will required ductile iron pipe with mechanical joints.

Determine the Invert elevation of MH-P2. Use, 30 inch pipe at 0.005 ft/ft slope, same as influent. Assume 30 feet from Primary Treatment Facility to MH-P2. The invert of MH-P2 (Z_{P2}) is

$$Z_{P2} = 724.50ft - (0.005 * 30ft)$$

Z_{P2} = 724.35 ft

Calculate the quantity take-off for the gravity flow alternative

Outline the Materials and Quantities for the Secondary Diversion Structure:

Reinforced Concrete –

- Assume 5 ft by 5 ft internal dimensions
- Assume 18" thick walls
- Assume 2 ft thick foundation.

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- Determine the height of the structure. Structure will be below 100 year flood plain, use a watertight lid. Set top of structure to existing grade, 738 ft.

$$H = 738.00\ ft - (727.50ft - 2ft)$$

H = 12.50 ft

Calculate the volume of concrete required:

Foundation:

$$V = 8ft * 8ft * 2ft$$

V = 128 ft^3 = 5 yd^2

Walls

$$V = [(8ft * 8ft) - (5ft * 5ft)] * 12.50ft$$

V = 488 ft^3 = 18 yd^3

Total Concrete Volume, Secondary Diversion Structure = 23 yd^3

Determine the amount of backfill under and around the structure, assume 2 ft under, and 2 feet around.

- Volume under structure:

$$V = 12ft * 12ft * 2ft$$

V = 288 ft^3 = 11 yd^3

- Volume around structure:

$$V = [(12ft * 12ft) - (8ft * 8ft)] * 12.5\ ft$$

V = 1000 ft^3 = 37 yd^3

Total Stone Volume, Secondary Diversion Structure = 48 yd^3

Estimate the excavation volume:

- Excavate to a depth of 725.50 ft, existing grade is approx. 738 ft. Total excavation depth is 13 ft. Excavate 5 feet on either side structure.

$$V = 18\ ft * 18ft * 13ft$$

V = 4,212 ft^3 = 156 yd^3

- Assume the top 9 feet is cut back at a 1:1 slope. Estimate the total cut back volume:

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$$V = 108ft * (9ft * 9ft * 0.5)$$

$$V = 4{,}374\ ft^3 = 162\ yd^3$$

Total Excavation Volume, Secondary Diversion Structure = 318 yd^3

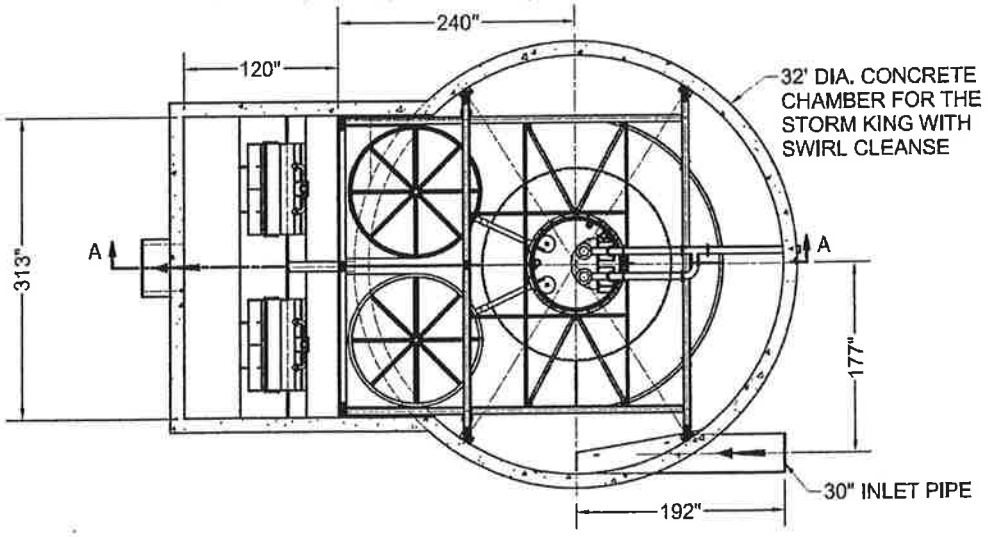
Determine the Length of Conduit required for the influent and effluent of the structure;

- 36 inch Influent –
  - 20 ft of Sch 35 gasketed PVC
- 42 inch Effluent to River
  - 65 ft of Sch 35 gsketed PVC
- 16 inch Effluent to Primary Treatment Structure
  - 35 ft mechanical joint ductile iron pipe
  - 2, 90 deg elbows

Estimate the volume of reinforced concrete

- Use general dimensions as shown on the Hydo International drawing. See Figure 5, taken from Hydo International Drawing Number 14-3225-02

Figure 5: Primary Treatment Facility, Plan View, Taken From Hydro International Drawing #14-3225-02, NTS



- Assume a wall thickness of 18 inches, foundation thickness of 2 feet

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- Estimate the volume of concrete in the foundation. Assume the foundation extends 2 feet.

$$V = \pi\left(\frac{39ft}{2}\right)^2 * 2ft$$

V = 2,389 ft^3 = 88 yd^3

- Estimate the volume of concrete in circular section. The primary treatment structure needs to be above the 100 year flood plain, set the top to 751.50 ft so that the total height to the top of the foundation is 49 ft

$$V = \left[\left(\pi\left(\frac{35ft}{2}\right)^2\right) - \left(\pi\left(\frac{32ft}{2}\right)^2\right)\right] * 49ft$$

V = 7,742 ft^3 = 287 yd^3

- Estimate the volume of concrete in the discharge channel. Estimate as a three sided box with internal dimensions of 26 ft by 14 ft by 27 ft tall.
  - Estimate the channel foundation volume:

$$V = 29ft * 17ft * 2ft$$

V = 986 ft^3 = 37 yd^3

  - Estimate the channel wall volume:

$$V = 66ft * 1.5ft * 27ft$$

V = 2673 ft^3 = 99 yd^3

Total Concrete Volume, Primary Treatment Structure = 511 yd^3

- Estimate the volume of stone under the structure, assume an area of 38 ft by 42 ft by 2 ft thick:

$$V = 38ft * 42ft * 2ft$$

V = 3,192 ft^3 = 118 yd^3

Total Stone Volume, Primary Treatment Structure = 118 yd^3

- Estimate Length of influent and effluent conduit –
  - 60 feet of PVC

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- Based on the location adjacent to the river and the required depth, the excavation will require sheet piling and dewatering. Assume area, 40 ft by 45 ft by 47.5 ft (738 ft-700.5 ft = 37.5 ft + 10 ft below excavation). The total surface area is as follows:

$$SA = (40ft + 40ft + 45ft + 45ft) * 47.5ft$$

$$SA = 8075\ ft^2$$

Total Sheet Piling, Primary Treatment Structure = 8075 ft^2

- Estimate excavation:

$$V = 40ft * 45ft * 38ft$$

$$V = 68{,}400\ ft^3 = 2{,}533\ yd^3$$

Total Excavation Volume Primary Treatment Structure = 2,533 yd^3

Item	Quantity	Unit	Unit Price	Total Price
Primary Treatment Facility - CSO 8 Gravity				
Reinforced Concrete	550	CY	$ 800	$ 440,000
Stone	175	CY	$ 15	$ 2,625
Excavation	2900	CY	$ 30	$ 87,000
Sheet Pile	8075	SF	$ 85	$ 686,375
30" PVC Conduit	90	LF	$ 100	$ 9,000
36" PVC Conduit	20	LF	$ 150	$ 3,000
42" PVC Conduit	65	LF	$ 200	$ 13,000
16" DIP and Fittings	45	LF	$ 250	$ 11,250
Dewatering	1	LS	$ 10,000	$ 10,000
6' Manhole	2	EA	$ 15,000	$ 30,000
Total				$ 1,292,250

Pump Station Alternative

Determine the critical elevations for the Primary Treatment Alternative based on site conditions. Set the maximum water surface elevation 1 ft below existing grade (≈738 ft). Based on the dimensions in Figure 4, the Primary Treatment Facility influent ($Z_{P\text{-}IN}$), sump elevation (Z_{Sump}), and effluent elevation ($Z_{P\text{-}OUT}$) are as follows

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$Z_{P\text{-}IN}$ = 724.00 ft

Z_{Sump} = 710.00 ft

$Z_{P\text{-}OUT}$ = 728.00 ft

Based on the elevation of the primary treatment structure, the flows from CSO 8 will be required to be pumped into MH-P1.

The pump design flow (Q_P) is:

Q_P = 5.2 mgd = 3,610 gpm

Set the operating volume of the wet well so that the pump doesn't start more than 10 times per hour.

$$V = 1.5Q_P = 1.5 * 3610\ gpm$$

V = 5,415 gallons = 724 ft^3

- Assume the wet well low level is 3 feet above the pump station floor
- Assume 12 ft by 12 ft internal dimensions
- Set the maximum wet well high level 1 ft below the existing CSO outfall elevation (≈731.00 ft) so that when the influent flow rate exceeds Q_P flow will be directed to Monongahela River.
- Based on the internal dimensions and the required wet well volume, the wet well operating height is as follows:

$$h = \frac{V}{A} = \frac{724\ ft^3}{144\ ft^2}$$

$$h = 5\ ft$$

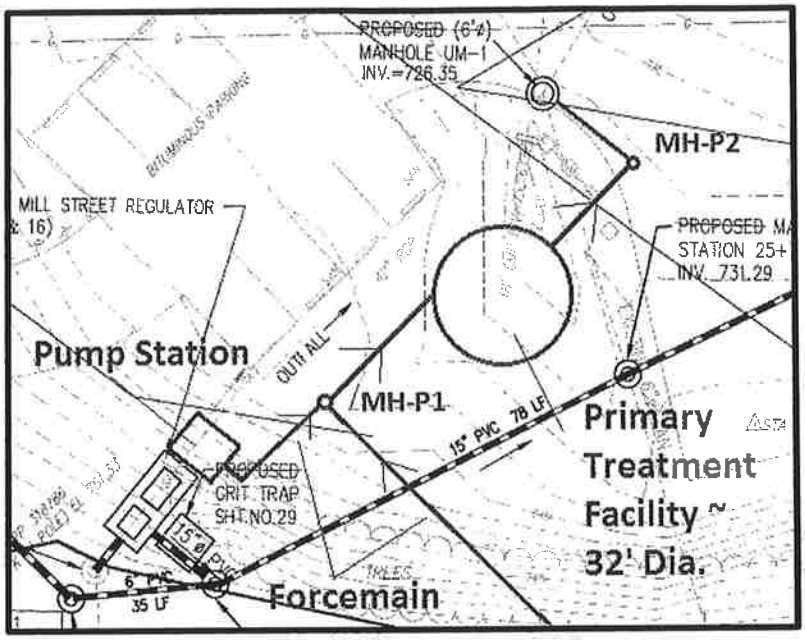
- Based on the above, the following are the critical levels:
  - Pump Station floor = 722 ft
  - Low Level = 725 ft
  - High Level = 730 ft

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Figure 5: Primary Treatment Facility, Plan View, NTS



Calculate the quantity take-off for the pump station alternative

Estimated Quantities for the CSO 8 pump station:

Reinforced Concrete –

- Assume 18" thick walls
- Assume 2 ft thick foundation.
- Determine the height of the structure. The pump station will be constructed adjacent to the existing CSO structure which has a rim elevation of 748.45 ft.

$$H = 748.45\ ft - 722\ ft$$

H = 26.45 ft

Calculate the volume of concrete required:

Foundation:

$$V = 15ft * 15ft * 2ft$$

V = 450 ft^3 = 17 yd^3

Walls:

$$V = [(15ft * 15ft) - (12ft * 12ft)] * 26.45ft$$

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$V = 2145\ ft^3 = 79\ yd^3$

Roof:

*Assume 10" thick, two 3 ft by 3 ft hatches

$$V = [(15ft * 15ft) - 2 * (3ft * 3ft)] * \left({}^{10"}/_{12}\right)$$

$V = 173\ ft^3 = 6\ yd^3$

Total Concrete Volume, CSO 8 Pump Station = 102 yd^3

Determine the amount of backfill under and around the structure, assume 2 ft under, and 2 feet around.

- Volume under structure:

$$V = 19\ ft * 19\ ft * 2\ ft$$

$V = 722\ ft^3 = 27\ yd^3$

- Volume around structure:

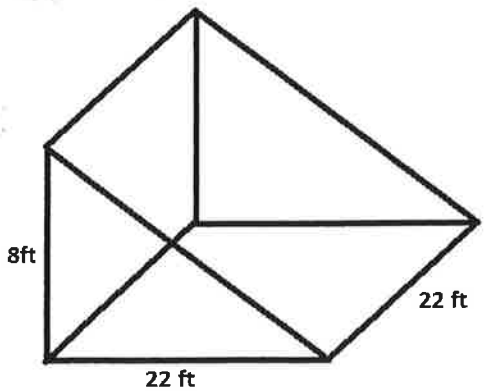
$$V = [(19ft * 19ft) - (15ft * 15ft)] * 26.45\ ft$$

$V = 3{,}597\ ft^3 = 133\ yd^3$

Total Stone Volume, CSO 8 Pump Station = 160 yd^3

Estimate the excavation volume:

- Excavate to a depth of 718 ft, existing grade is approx. 748 ft. Note that the ground adjacent to the CSO structure drops off quickly to an elevation of approximately 740. Assume the first 8 feet of excavation is a triangle as roughly depicted below:



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$$V = \left[{}^{1}/_{2}\,(8ft * 22ft)\right] * 22ft$$

V = 1936 ft^3 = 72 yd^3

- Assume an area of 22 ft by 22 ft of excavation is required to install the pump station. Based on location near the river, assume that sheet piling is used on three sides. Start sheet piling at an elevation at 740 ft and goes to an elevation of 717 ft.

$$V = 22ft * 22ft * 23ft$$

V = 11,132 ft^3 = 412 yd^3

Total Excavation Volume, CSO 8 Pump Station = 484 yd^3

Estimate the required quantity of sheet piling:

$$SA = 23ft * (3 * 22ft)$$

SA = 1,518 ft^2

Total Sheet Piling Surface for CSO 8 Pump Station Area = 1,518 ft^2

Estimated Quantities for the Primary Treatment Structure:

Estimate the volume of reinforced concrete

- Use general dimensions as shown on the Hydo International drawing. See Figure 5, taken from Hydo International Drawing Number 14-3225-02
- Assume a wall thickness of 18 inches, foundation thickness of 2 feet
- Estimate the volume of concrete in the foundation. Assume the foundation extends 2 feet.

$$V = \pi\left(\frac{39ft}{2}\right)^2 * 2ft$$

V = 2,389 ft^3 = 88 yd^3

- Estimate the volume of concrete in circular section. The primary treatment structure needs to be above the 100 year flood plain, set the top to 751.50 ft so that the total height to the top of the foundation is 41.50 ft

$$V = \left[\left(\pi\left(\frac{35ft}{2}\right)^2\right) - \left(\pi\left(\frac{32ft}{2}\right)^2\right)\right] * 41.50ft$$

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$V = 6{,}557\ ft^3 = 243\ yd^3$

- Estimate the volume of concrete in the discharge channel. Estimate as a three sided box with internal dimensions of 26 ft by 14 ft by 23.5 ft tall.
  - Estimate the channel foundation volume:

$$V = 29ft * 17ft * 2ft$$

$V = 986\ ft^3 = 37\ yd^3$

  - Estimate the channel wall volume:

$$V = 66ft * 1.5ft * 23.5ft$$

$V = 2{,}327\ ft^3 = 86\ yd^3$

Total Concrete Volume, Primary Treatment Structure = 454 yd^3

- Estimate the volume of stone under the structure, assume an area of 38 ft by 42 ft by 2 ft thick:

$$V = 38ft * 42ft * 2ft$$

$V = 3{,}192\ ft^3 = 118\ yd^3$

Total Stone Volume, Primary Treatment Structure = 118 yd^3

- Based on the location adjacent to the river and the required depth, the excavation will require sheet piling and dewatering. Assume area, 40 ft by 45 ft by 42 ft (738 ft-706 ft = 32 ft + 10 ft below excavation). The total surface area is as follows:

$$SA = (40ft + 40ft + 45ft + 45ft) * 42ft$$

$SA = 7140\ ft^2$

- Estimate excavation:

$$V = 40ft * 45ft * 32ft$$

$V = 57{,}600\ ft^3 = 2{,}133\ yd^3$

Total Excavation Volume Primary Treatment Structure = 2,133 yd^3

Determine the elevation of the MH-P1. Assume that the manhole is 25 ft upstream of the primary treatment structure. The 30 inch influent pipe is at a 0.005 ft/ft slope as calculated previously.

$$Z_{MH-P1} = 724.00\ ft + (0.005 * 25\ ft)$$

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Z_{MH-P1} = 724.13 ft

Determine the elevation of MH-P2, assuming the manhole is 25 ft downstream of the primary treatment structure mileage.

$$Z_{MH-P2} = 728.00\ ft + (0.005 * 25\ ft)$$

Z_{MH-P1} = 727.87 ft

Determine the size of the forcemain from CSO 8 so that the velocity at peak flow is around 10 ft/sec.

Q = 3,610 gpm = 8.0 cfs

$$A = \frac{Q}{v} = \frac{8.0\ cfs}{10\ fps} = 0.8\ ft^2$$

$$r = \sqrt{\frac{A}{\pi}} = \sqrt{\frac{0.8\ ft^2}{\pi}}$$

r = 0.50

Use a 12 inch forcemain

Calculate the design point for the pump in CSO 8. Determine the friction head (H_f) losses, assume a forcemain length of 40 ft:

$$H_f = 0.2083\left(\frac{100}{C}\right)^{1.85}\frac{q^{1.85}}{d^{4.8655}}\left(\frac{L}{100}\right)$$

Where:

f = Friction Head per 100 feet of pipe, ft.

d = Inside Diameter, in.

q = Pipe Flow, gpm

C = Pipe Roughness

L = Force Main Length

$$H_f = 0.2083\left(\frac{100}{110}\right)^{1.85}\frac{(3160)^{1.85}}{(12)^{4.8655}}\left(\frac{40}{100}\right)$$

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H_f = 1 ft

Pump intake is at an approximate elevation of 723 ft., Set high point of the forcemain 0.5 ft above the high water elevation in the primary treatment facility (elevation 737.50 ft). Determine the static head H_s:

$$H_s = 737.50ft - 723.00ft$$

H_s = 14.5 ft

Assume the minor losses are negligible. The total dynamic head (THD) is:

$$TDH = H_s + H_f = 14.5ft + 1ft$$

TDH = 15.5 ft

Primary Treatment Facility - CSO 8 Pump Station				
Item	Quantity	Unit	Unit Price	Total Price
Reinforced Concrete	556	CY	$ 800	$ 444,800
Stone	278	CY	$ 15	$ 4,170
Excavation	2620	CY	$ 30	$ 78,600
Sheet Pile	8660	SF	$ 85	$ 736,100
30" PVC Conduit	75	LF	$ 100	$ 7,500
12" DIP and Fittings	40	LF	$ 200	$ 8,000
Pumps	1	LS	$ 40,000	$ 40,000
Dewatering	1	LS	$ 10,000	$ 10,000
6' Manhole	2	EA	$ 15,000	$ 30,000
Total				$ 1,359,170

Based on the cost estimate above, it would be more cost effective in the long term to divert flow from CSO 8 by way of gravity,

CSO 5, 6, and 7 Pump Station Design

Design pump stations for CSOs 5, 6, and 7 similar to the pump station design at CSO 8 above. Table 1 list the design flows for each of the pump stations:

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Table 1: Design Flows

	Q (mgd)	Q (gpm)	Q (cfs)
Pump Station CSO 5	2.090	1451	3.23
Pump Station CSO 6	5.220	3625	8.08
Pump Station CSO 7	2.760	1917	4.27

Each of the pump stations will pump into the same forcemain.

Calculate the size of the wetwell for each of the pump stations. As previously stated, the wet well should be sized so that the pump does not cycle more than 10 times per hour:

- CSO 5:

$$V = 1.5Q_P = 1.5 * 1451\ gpm$$

V = 2177 gallons = 291 ft^3

- CSO 6:

$$V = 1.5Q_P = 1.5 * 3625\ gpm$$

V = 5438 gallons = 727 ft^3

- CSO 7:

$$V = 1.5Q_P = 1.5 * 1917\ gpm$$

V = 2875 gallons = 384 ft^3

Determine the elevation of each of the pump station floors. Set the floor elevation based on the following assumptions;

- Set the low water level 3 feet above the floor
- Set the high water level 1 foot below the outfall so that when the influent flow rate exceeds the pump capacity, flow will be directed to the river.

Determine the operating height based on the previously calculated above.

- CSO 5, assume internal dimensions of 8 ft by 8 ft:

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$$h = \frac{V}{A} = \frac{291\ ft^3}{(8\ ft * 8\ ft)}$$

h = 4.5 ft

- CSO 6, assume internal dimensions of 12 ft by 12 ft:

$$h = \frac{V}{A} = \frac{727\ ft^3}{(12\ ft * 12\ ft)}$$

h = 5.0 ft

- CSO 7, assume internal dimensions of 8 ft by 8 ft:

$$h = \frac{V}{A} = \frac{384\ ft^3}{(8\ ft * 8\ ft)}$$

h = 6.0 ft

Based on calculated operated height, determine the elevation of the pump station floor:

- CSO 5, effluent elevation = 733.95 ft

$$Z_{5-F} = 733.95\ ft - 1\ ft - 4.5\ ft - 3\ ft$$

$Z_{5\text{-}F}$ = 725.4 ft

- CSO 6, effluent elevation = 729.42 ft

$$Z_{6-F} = 729.42\ ft - 1\ ft - 5.0\ ft - 3\ ft$$

$Z_{6\text{-}F}$ = 720.40 ft

- CSO 7, effluent elevation = 737.86 ft

$$Z_{7-F} = 737.86\ ft - 1\ ft - 6.0\ ft - 3\ ft$$

$Z_{7\text{-}F}$ = 727.90 ft

Set the forcemain 4 ft below grade:

- CSO 5, Structure Rim elevation = 747.00 ft
  - Forcemain Elevation = 743 ft
- CSO 6, Structure Rim elevation = 748.90 ft
  - Forcemain Elevation = 744.90 ft
- CSO 7, Structure Rim elevation = 754.11 ft

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- Forcemain Elevation = 750.11 ft

Based on the above forcemain elevations above, the static head for each forcemain will be calculated using an elevation of 750.11 ft.

Calculate the static head for each of the pump stations.

- CSO 5, low water level = 728.40 ft

$$H_S = 750.11\ ft - 728.40\ ft$$

H_S = 21.71 ft

- CSO 6, low water level = 723.40 ft

$$H_S = 750.11\ ft - 723.40\ ft$$

H_S = 26.71 ft

- CSO 8, low water level = 730.90 ft

$$H_S = 750.11\ ft - 730.90\ ft$$

H_S = 19.21 ft

Calculate the friction head for each segment.

- Segment 1: CSO 7 to the Primary Treatment Facility
  - Total Length - 500 ft
  - Forcemain Diameter – 20 inches
  - Total Flow – 6,993 gpm

$$H_f = 0.2083\left(\frac{100}{110}\right)^{1.85}\frac{(6993)^{1.85}}{(20)^{4.8655}}\left(\frac{500}{100}\right)$$

H_f = 5 ft

- Segment 2: CSO 6 to CSO 7
  - Total Length - 775 ft
  - Forcemain Diameter – 16 inches
  - Total Flow – 5,076 gpm

$$H_f = 0.2083\left(\frac{100}{110}\right)^{1.85}\frac{(5076)^{1.85}}{(16)^{4.8655}}\left(\frac{775}{100}\right)$$

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H_f = 13 ft

- Segment 3: CSO 5 to CSO 6
  - Total Length - 300 ft
  - Forcemain Diameter – 8 inches
  - Total Flow – 1,451 gpm

$$H_f = 0.2083\left(\frac{100}{110}\right)^{1.85}\frac{(1451)^{1.85}}{(8)^{4.8655}}\left(\frac{300}{100}\right)$$

H_f = 15 ft

For the concept level design assume that minor losses (H_m) are 5 ft.

Calculate the total dynamic head (TDH) for each of the CSO structures

- CSO 5:

$$TDH_5 = H_S + H_f + H_m$$

$$H_f = Seg.1 + Seg.2 + Seg.3 = 5\ ft + 13\ ft + 15\ ft$$

H_f = 33 ft

$$TDH_5 = 22\ ft + 33\ ft + 5ft$$

TDH_5 = 63 ft

- CSO 6:

$$TDH_6 = H_S + H_f + H_m$$

$$H_f = Seg.1 + Seg.2 = 5\ ft + 13\ ft$$

H_f = 18 ft

$$TDH_6 = 27\ ft + 18\ ft + 5ft$$

TDH_6 = 50 ft

- CSO 7:

$$TDH_7 = H_S + H_f + H_m$$

$$H_f = Seg.1 = 5\ ft$$

H_f = 5 ft

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$$TDH_7 = 19\ ft + 5\ ft + 5ft$$

TDH_7 = 29 ft

Table 2 summarizes the design point for each of the pumps as calculated above

	Q (gpm)	TDH (ft)
Pump Station CSO 5	1451	63
Pump Station CSO 6	3625	50
Pump Station CSO 7	1917	29

Calculate the discharge piping size for each of the pump stations. Set flow velocity to approximately 6 fps.

- CSO 5 – Design flow = 1,451 gpm = 3.23 cfs

$$d = 2\sqrt{\frac{Q}{v\pi}} = 2\sqrt{\frac{3.23cfs}{6fps * \pi}}$$

d = 0.83 ft = 9.9 inches

Use a 10 inch pipe and fittings

- CSO 6 – Design flow = 3,625 gpm = 8.08

$$d = 2\sqrt{\frac{Q}{v\pi}} = 2\sqrt{\frac{8.08\ cfs}{6fps * \pi}}$$

d = 1.31 ft = 15.7 inches

Use 15 inch pipe and fittings

- CSO 7 – Design flow = 1,917 gpm = 4.27 cfs

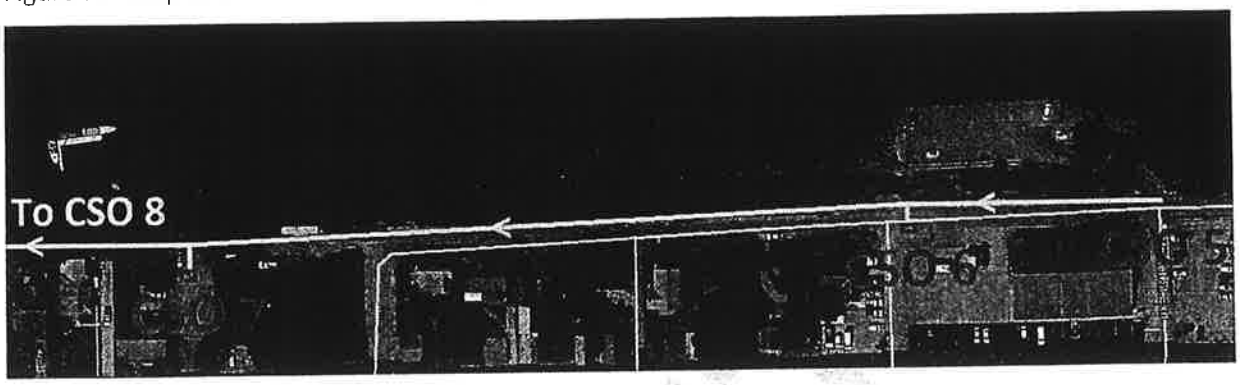
$$d = 2\sqrt{\frac{Q}{v\pi}} = 2\sqrt{\frac{4.27\ cfs}{6fps * \pi}}$$

d = 0.95 ft = 11.4 inches

Use 12 inch pipe and fittings

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Figure 7: Pump Station Forcemain Schematic



Estimate the materials and quantity for each of the CSO Pump Stations

CSO 5

Concrete:

- Internal Dimensions – 8 ft by 8 ft
- Height – 747 ft – 725.4 ft = 21.6 ft
- Calculate the volume of the foundation. Assume the foundation extends 1 ft beyond wall and is 2 ft thick.

$$V = 13ft * 13ft * 2ft$$

V = 338 ft^3

- Calculate the volume of the walls. Assume a wall thickness of 1.5 ft

$$V = [(11ft * 11ft) - (8ft * 8\,ft)] * 21.6ft$$

V = 1,231 ft^3

- Calculate the roof volume. Assume a 10 inch thick roof with a 4 ft by 4 ft hatch opening

$$V = [(11ft * 11ft) - (4ft * 4\,ft)] * \left({}^{10"}/_{12}\right)$$

V = 88 ft^3

Total Concrete Volume = 1,657 ft^3 = 61 yd^3

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Stone:

- Assume 2 ft of stone under and around the structure
- Calculate the volume under the structure:

$$V = 15ft * 15ft * 2ft$$

V= 450 ft^3

- Calculate the volume around the structure:

$$V = [(15ft * 15ft) - (11ft * 11\,ft)] * 21.6ft$$

V= 2246 ft^3

Total Stone Volume = 2,696 ft^3 = 100 yd^3

CSO 6

Concrete:

- Internal Dimensions – 12 ft by 12 ft
- Height – 748.9 ft – 720.4 ft = 28.5 ft
- Calculate the volume of the foundation. Assume the foundation extends 1 ft beyond wall and is 2 ft thick.

$$V = 17ft * 17ft * 2ft$$

V = 578 ft^3

- Calculate the volume of the walls. Assume a wall thickness of 1.5 ft

$$V = [(15ft * 15ft) - (12ft * 12\,ft)] * 28.5ft$$

V = 2,309 ft^3

- Calculate the roof volume. Assume a 10 inch thick roof with a 5 ft by 5 ft hatch opening

$$V = [(15ft * 15ft) - (5ft * 5ft)] * \left({}^{10"}/_{12}\right)$$

V = 167 ft^3

Total Concrete Volume = 3,054 ft^3 = 113 yd^3

Stone:

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- Assume 2 ft of stone under and around the structure
- Calculate the volume under the structure:

$$V = 19ft * 19ft * 2ft$$

V= 722 ft^3

- Calculate the volume around the structure:

$$V = [(19ft * 19ft) - (15ft * 15\,ft)] * 28.5ft$$

V= 3,876 ft^3

Total Stone Volume = 4,598 ft^3 = 170 yd^3

CSO 7

Concrete:

- Internal Dimensions – 8 ft by 8 ft
- Height – 754.1 ft – 727.9 ft = 26.2 ft
- Calculate the volume of the foundation. Assume the foundation extends 1 ft beyond wall and is 2 ft thick.

$$V = 13ft * 13ft * 2ft$$

V = 338 ft^3

- Calculate the volume of the walls. Assume a wall thickness of 1.5 ft

$$V = [(11ft * 11ft) - (8ft * 8\,ft)] * 26.2ft$$

V = 1,493 ft^3

- Calculate the roof volume. Assume a 10 inch thick roof with a 4 ft by 4 ft hatch opening

$$V = [(11ft * 11ft) - (4ft * 4\,ft)] * \left({}^{10"}/_{12}\right)$$

V = 88 ft^3

Total Concrete Volume = 1,919 ft^3 = 71 yd^3

Stone:

- Assume 2 ft of stone under and around the structure

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- Calculate the volume under the structure:

$$V = 15ft * 15ft * 2ft$$

$$V = 450\ ft^3$$

- Calculate the volume around the structure:

$$V = [(15ft * 15ft) - (11ft * 11\ ft)] * 26.2ft$$

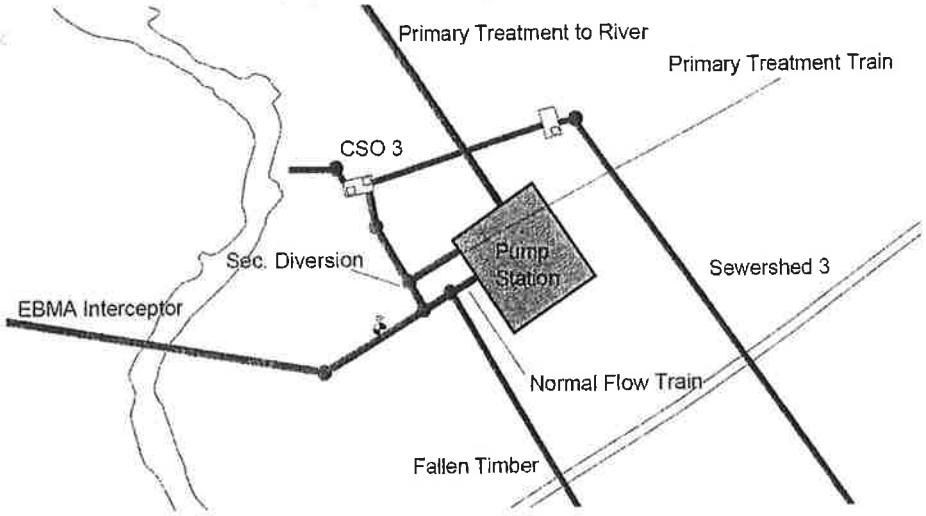
$$V = 2725\ ft^3$$

Total Stone Volume = 3,175 ft^3 = 118 yd^3

Primary Treatment, CSO 3

Due to space requirements a storm king will not be used for flow from CSO 3. Instead, flows from CSO 3 will receive primary treatment from a secondary headworks train in the pump station. Similar to CSO 8, a secondary diversion structure will be constructed for CSO 3. During dry weather, flow from CSO will be directed to a primary headworks train in the pump station rated for a flow of 1.3 mgd. During wet weather, flow will be directed to a secondary headworks train in the pump station which will provide primary treatment. Disinfection will be provided for in a structure adjacent to the pump station.

Figure 8 – Pump Station Layout, Alternative P1



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Headworks Train Design

Provide a concept level design of the Normal Flow Channel and Primary Treatment Channel

Design Flows:

- Normal Flow Channel = 2.402 mgd = 1,668 gpm = 3.71 cfs
- Primary Treatment Channel = 5.590 mgd = 3,882 gpm = 8.65 cfs

Design the Normal Flow Channel with the following equipment:

- 54" Long by 6" Wide Cutthroat Flume
- 7' Diameter Grit Chamber rated for 2.5 mgd
- 1' 3" Wide Mechanical Bar Screen

Figure 9 – Conceptual Headworks Layout – Normal Flow Train

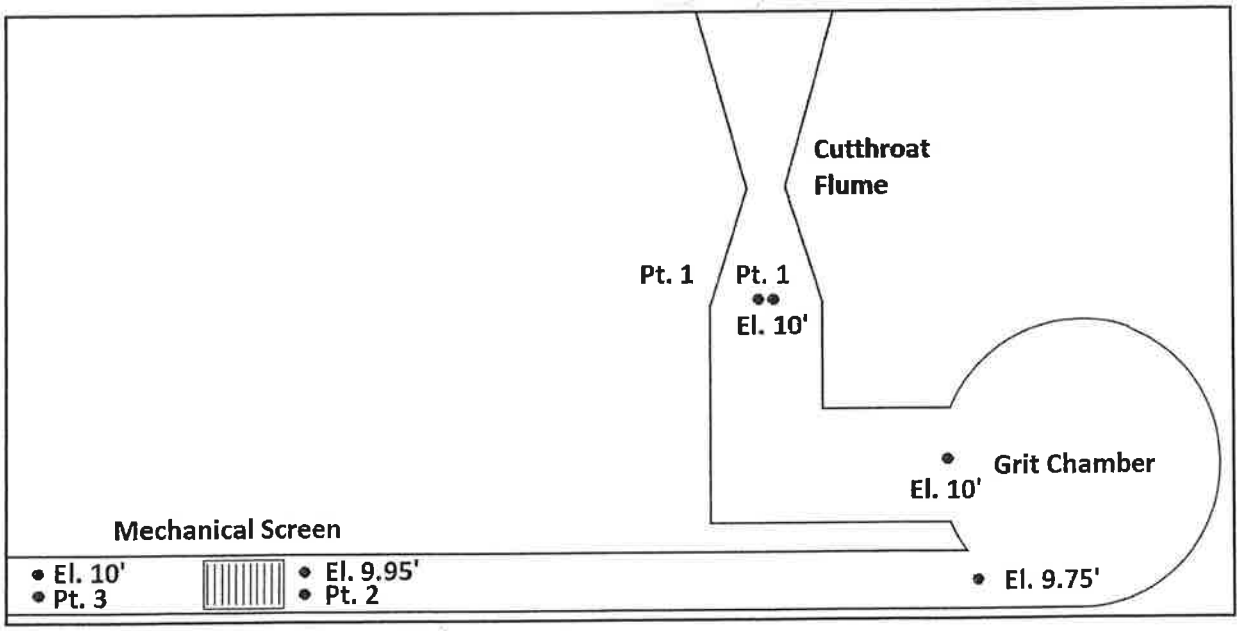


Figure 9 is a conceptual layout of the Normal Flow Channel. Not shown are slide gates and the manual bar screen channel. Determine the approximate water surface profile, ignore friction losses.

- Flow depth at Pt. 1 – Use equation for 54" X 6" cutthroat flume

$$y_1 = \left(\frac{Q}{1.96}\right)^{1/1.72} = \left(\frac{3.71\ cfs}{1.96}\right)^{1/1.72}$$

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y_1 = 1.45 ft

- Determine the total Head at Pt. 1

$$H_1 = y_1 + z_1 + \frac{v_1^2}{2g}$$

$$v_1 = {}^{Q}/_{A} = {}^{3.71cfs}/_{(1.45ft * 1.5ft)}$$

v = 1.71 fps

$$H_1 = 1.45ft + 10ft + \frac{(1.71fps)^2}{2g}$$

H_1 = 11.50 ft

- Flow depth at Pt. 2 – Assume that $H_1 = H_2$

$$H_1 = y_2 + z_2 + \frac{v_2^2}{2g}$$

- Guess y_2 = 1.49 ft

$$v_2 = {}^{Q}/_{A} = {}^{3.71cfs}/_{(1.49ft * 1.5ft)}$$

v_2 = 1.99 fps

$$H_2 = 1.49ft + 9.95ft + \frac{(1.99fps)^2}{2g}$$

H_2 = 11.50 ft = 11.50 ft – OK

y_2 = 1.49 ft

- Flow depth at Pt. 3 – Determine headloss through mechanical bar screen, assume 0.25 inch bar thickness, 0.25 inch clear space, 25% blockage.

$$h_l = \frac{Q^2}{2gK^2}\left[\left(\frac{1}{W_e(y_l + h_l)}\right)^2 - \left(\frac{1}{W(y_l + h_l)}\right)^2\right]$$

Q: Flow rate (cfs)

K: Frictional coefficient – 0.84

W_e: Effective width (ft)

W: Channel width (ft)

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Y_l: Downstream flow depth (ft)

h_l: Headloss

$$W_e = (W - S)\left(\frac{c}{b+c}\right)(1 - B)$$

S: Side fabrication thickness (ft) – Assume 0.25 ft

c: Clear opening between bars (in.)

b: Bar thickness (in.)

B: Degree of blinding (fraction)

$$W_e = (1.25\ ft - 0.25\ ft)\left(\frac{0.25\ in.}{0.25\ in. + 0.25\ in.}\right)(1 - 0.25)$$

W_e = 0.375 ft

- Guess h_l = 0.49 ft

$$h_l = \frac{(3.71\ cfs)^2}{2g(0.84^2)}\left[\left(\frac{1}{0.375ft(1.49ft + 0.49ft)}\right)^2 - \left(\frac{1}{1.25ft(1.49ft + 0.49ft)}\right)^2\right]$$

h_l = 0.49 ft = 0.49 ft - OK

$y_3 = y_2 + hl$ = 1.49 ft + 0.49 ft

y_3 = 1.98 ft

Design the Primary Treatment Channel with the following equipment:

- 54" Long by 12" Wide Cutthroat Flume
- 10' Diameter Grit Chamber rated for 7 mgd
- 2' Wide Mechanical Bar Screen
- Flow depth at Pt. 1 – Use equation for 54" X 12" cutthroat flume

$$y_1 = \left(\frac{Q}{1.96}\right)^{1/1.72} = \left(\frac{8.65\ cfs}{1.96}\right)^{1/1.72}$$

y_1 = 2.37 ft

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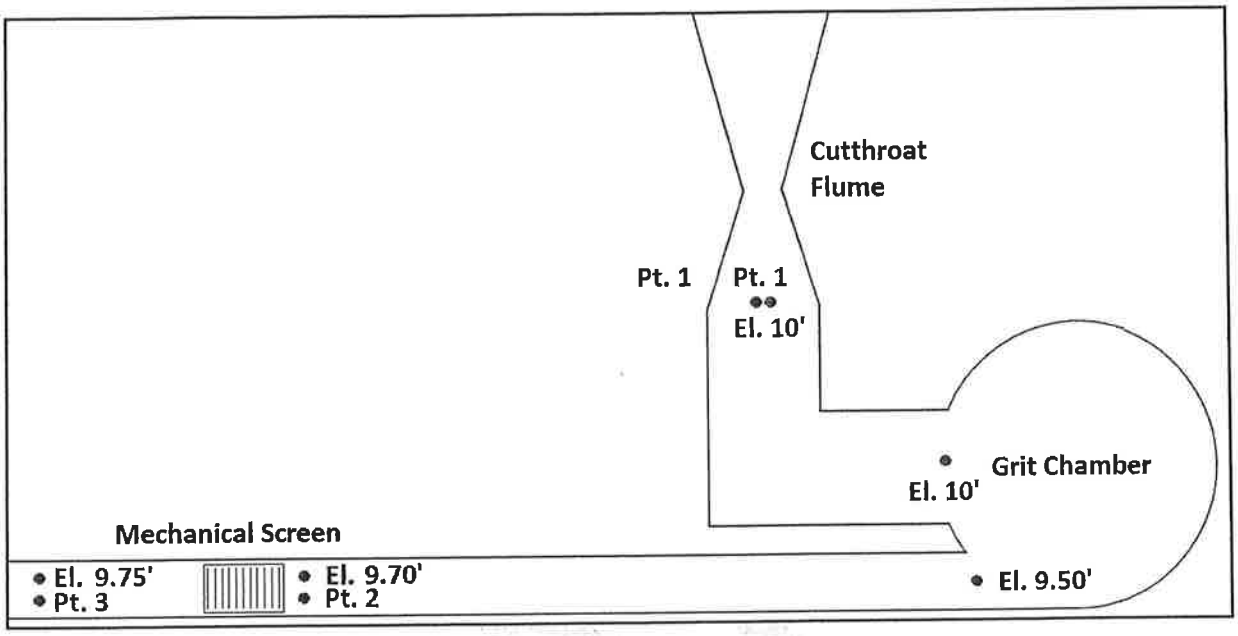
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Figure 10 – Conceptual Headworks Layout – Primary Treatment Train



- Determine the total Head at Pt. 1

$$H_1 = y_1 + z_1 + \frac{v_1^2}{2g}$$

$$v_1 = {}^{Q}/_{A} = {}^{8.65\ cfs}/_{(2\ ft * 2.37 ft)}$$

v = 1.82 fps

$$H_1 = 2.37ft + 10ft + \frac{(1.82fps)^2}{2g}$$

H_1 = 12.42 ft

- Flow depth at Pt. 2 – Assume that $H_1 = H_2$

$$H_1 = y_2 + z_2 + \frac{v_2^2}{2g}$$

- Guess y_2 = 2.68 ft

$$v_2 = {}^{Q}/_{A} = {}^{8.65\ cfs}/_{(2.68\ ft * 2\ ft)}$$

v_2 = 1.61 fps

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$$H_2 = 8.65ft + 9.70ft + \frac{(1.61fps)^2}{2g}$$

H_2 = 12.42 ft = 12.42 ft – OK

y_2 = 2.68 ft

- Flow depth at Pt. 3 – Determine headloss through mechanical bar screen, assume 0.25 inch bar thickness, 0.25 inch clear space, 25% blockage.

$$h_l = \frac{Q^2}{2gK^2}\left[\left(\frac{1}{W_e(y_l + h_l)}\right)^2 - \left(\frac{1}{W(y_l + h_l)}\right)^2\right]$$

$$W_e = (W - S)\left(\frac{c}{b + c}\right)(1 - B)$$

$$W_e = (2\ ft - 0.25\ ft)\left(\frac{0.25\ in.}{0.25\ in. + 0.25\ in.}\right)(1 - 0.25)$$

W_e = 0.656 ft

- Guess h_l = 0.37 ft

$$h_l = \frac{(8.65\ cfs)^2}{2g(0.84^2)}\left[\left(\frac{1}{0.656ft(2.68ft + 0.37ft)}\right)^2 - \left(\frac{1}{2.00ft(2.68ft + 0.37ft)}\right)^2\right]$$

h_l = 0.37 ft = 0.37 ft - OK

$y_3 = y_2 + hl$ = 2.68 ft + 0.37 ft

y_3 = 3.05 ft

Pump Station Wet Well

The pump station will be fitted with two dry weather pumps on VFDs operating in a primary back up system and two wet weather pumps also operating in a primary backup configuration. The depth of the wet well is determined based on the following assumptions:

- The dry weather pump off level is 5 feet above the floor
- The dry weather pumps required 2.5 feet of operating level
- The wet weather pumps required 2.5 feet of operating level
- 1 foot off freeboard is provided

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- The top of the wet well is positioned at the headworks channel floor elevation so that during normal operation, the wet well level does not impact the water surface profile of the headworks.

CSO 3 Secondary Diversion Structure

The following are the design flows for CSO 3 for alternatives involving primary treatment:

- Allocated Capacity – 0.240 mgd
- Additional Capacity – 1.102 mgd
- Primary Treatment Capacity – 5.590 mgd

Therefore, the total flow entering the secondary diversion structure is 6.932 mgd = 4,813 gpm = 10.73 cfs.

Use a 21 inch conduit at a slope of 0.005 ft/ft between the existing CSO structure and the secondary diversion structure. Check the capacity:

$$Q = \frac{1.49}{n} R^{2/3} \sqrt{S} (A)$$

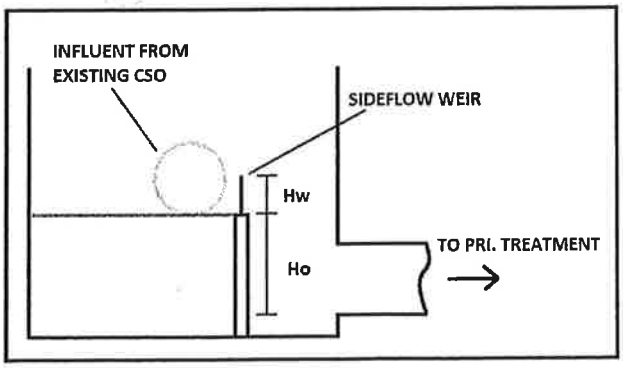
$$Q = \frac{1.49}{0.011} (0.4375ft)^{2/3} \sqrt{0.005} (2.41ft)$$

Q = 13.28 cfs > 10.73 cfs – OK

Design the secondary diversion structure similar to the structure designed for CSO in previous sections.

Figure 11 shows a profile view of the secondary diversion structure for CSO 3

Figure 11 – CSO 3 Secondary Diversion Structure



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Set H_O to 4 ft based on the calculated water surface profile in the Primary Treatment Train. This will ensure that the backwater effect of the headworks will not impact the weir in the Secondary Diversion Structure.

Determine the influent elevation of the Secondary Diversion Structure ($Z_{SD\text{-}3\text{-}IN}$)

CSO 3 Influent Elevation ($Z_{3\text{-}IN}$) = 723.82 ft

The length of the conduit from CSO 3 to the Secondary Diversion Structure is approximately 30 ft at a slope of 0.005 ft/ft.

$$Z_{SD-3-IN} = Z_{3-IN} - (S * L) = 723.82\ ft - (0.005 * 30\ ft)$$

$Z_{SD\text{-}3\text{-}IN}$ = 723.67 ft

Based on the elevation of the influent to the Secondary Diversion Structure, the effluent elevation ($Z_{SD\text{-}3\text{-}OUT}$) is:

$Z_{SD\text{-}3\text{-}OUT}$ = 719.67 ft

Set the weir height in the Secondary Diversion structure so that the allocated and required additional capacity is directed to the Normal Flow headworks train

The total flow rate (Q_T) that is must be directed to the Normal Flow channel from CSO 3 is **1.342 mgd = 2.08 cfs**, set the weir elevation 5% higher than the calculated normal flow depth at Q_T.

Both the influent and effluent pipe are a 21 inch pipe at a slope of 0.005 ft/ft and have a capacity of 13.28 cfs as calculated above.

Determine ratio of design flow to full flow:

$$Q/_{Q_{full}} = {}^{2.08\ cfs}/_{13.28\ cfs} = 0.16$$

Use the below graph to determine the ratio of design flow depth to full flow depth (y/D):

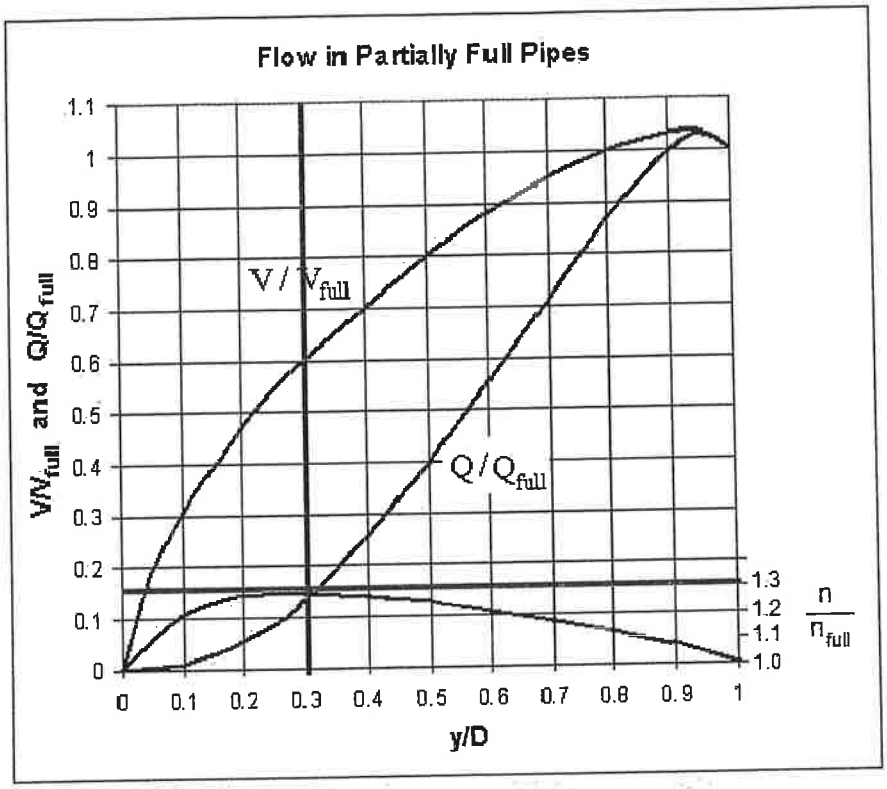
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y/D ≈ 0.30

Calculate the normal depth (y)

$$y = (^{y}/_{D})D = 0.30 * 21\ in.$$

y = 6.3 in. = 0.525 ft

Calculate H_W:

$$H_W = y * 1.05 = 0.525\ ft * 1.05$$

Set H_W = 6 – 5/8"

Set the Pump Station influent elevation ($Z_{PS\text{-}IN}$)

$Z_{PS\text{-}IN}$ = 719.50 ft

Pump Station Cost Estimate

Reference Figures 12 and 13 for a plan and profile view of the pump station. Note that the figures are general, not to scale and for concept level design only.

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Figure 12: Pump Station Layout, NTS

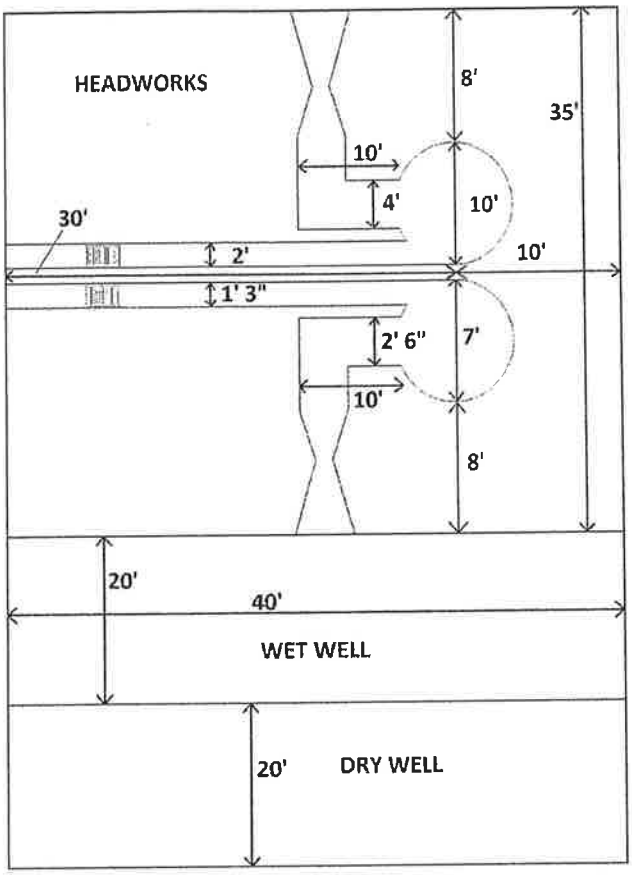
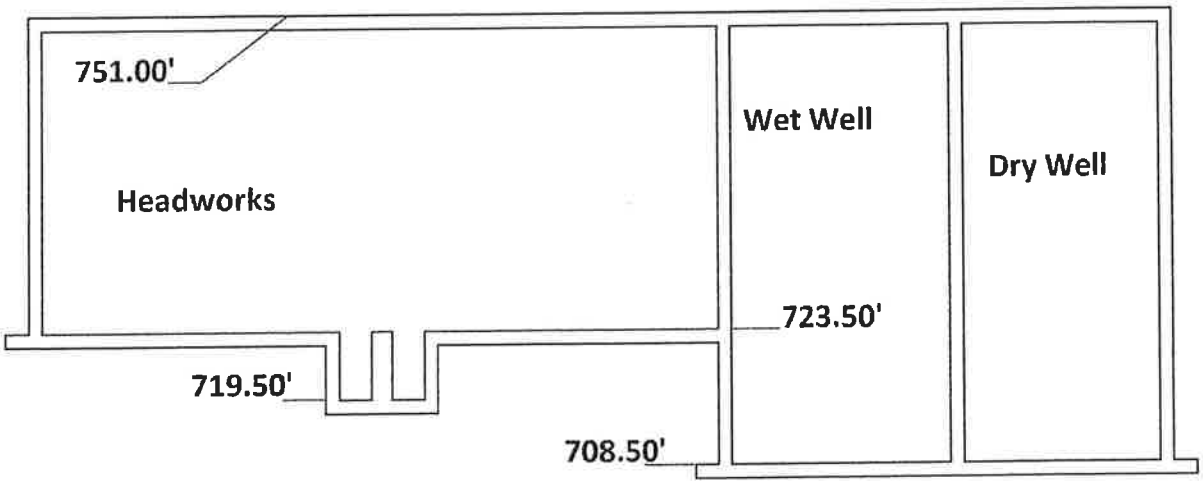


Figure 13: Pump Station Profile, NTS



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Reinforced Concrete Volume

Assume foundation is 2 ft thick and walls are 1.5 ft thick.

Headworks Floor:

$$V = 35ft * 40ft * 2ft = 2{,}800\ ft^3$$

Channel Walls (excluding grit chambers):

- Assume channel height of 4.5 ft. Assume total wall length of 140 ft

$$V = 4.5ft * 140ft * 1.5ft = 945ft^3$$

Channel Walls (grit chamber): Reference Figure 14 below

- 7 mgd grit chamber:

$$V = \left[\left(\pi\left({}^{10ft}/_{2}\right)^2\right) - \left(\pi\left({}^{7ft}/_{2}\right)^2\right)\right] * 3.67ft + \left[\left(\pi\left({}^{6ft}/_{2}\right)^2\right) - \left(\pi\left({}^{3ft}/_{2}\right)^2\right)\right] * 5ft$$

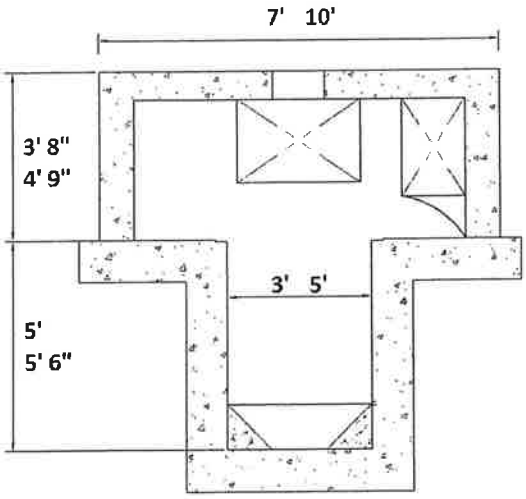
V = 253 ft^3

- 10 mgd chamber:

$$V = \left[\left(\pi\left({}^{13ft}/_{2}\right)^2\right) - \left(\pi\left({}^{10ft}/_{2}\right)^2\right)\right] * 4.75ft + \left[\left(\pi\left({}^{8ft}/_{2}\right)^2\right) - \left(\pi\left({}^{5ft}/_{2}\right)^2\right)\right] * 5.5ft$$

- V = 426 ft^3

- Figure 13: Grit Chamber Profile View, NTS



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Alternative P1-A, P1-B

Drawing No.

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Wet Well/Dry Well Floor:

$$V = 40\ ft * 40\ ft * 2\ ft = 3{,}200\ ft^3$$

Headworks Wall: Total Length

$$V = [2(35\ ft) + 2(40\ ft)](1.5\ ft)(27.5\ ft) = 6{,}187.5\ ft^3$$

Wet Well/Dry Well Wall:

$$V = [(3(40\ ft) * 1.5\ ft * 42.5\ ft)] + [40\ ft * 1.5\ ft * 15\ ft] = 8{,}550\ ft^3$$

Final Grade Floor, Assume 10 Inches thick:

$$V = (75\ ft)(40\ ft)\left(^{10\ in}/_{12}\right) = 2{,}500\ ft^3$$

Total Reinforced Concrete Volume = 24,862 ft³ = 921 yd³

Excavation Volume

Existing Grade is approximately 742 ft. The geotechnical report indicates that the top 20 feet of material is waste.

Outside dimensions of pump station is 78 ft by 43 ft, excavate a minimum area of 118 ft by 83 ft.

Excavate 5 feet below bottom of wet well floor, elevation 703.50 ft.

Sheet Pile two sides (along the railroad tracks, 83 ft and along Fallen Timber creek, 118 ft)

Cut back the remaining two sides at a 1:1 slope

Total Excavation depth:

$$742\ ft - 703.5\ ft = 38.5 ft$$

Excavation (Not including cutback)

$$V = 118\ ft * 83\ ft * 38.5\ ft = 377{,}069\ ft^3$$

Cut Back Volume:

$$V = \left[\left(^1/_2\right)(38.5\ ft)(38.5\ ft)(156\ ft)\right] + \left[\left(^1/_2\right)(38.5\ ft)(38.5\ ft)(121\ ft)\right] = 205{,}291 ft^3$$

Total Excavation Volume = 582,360 ft³ = 21,568 yd³

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Sheet Piling Surface Area

Assume sheet piling extends 10 feet below excavation depth.

$$SA = (118\ ft + 83\ ft) * 48.5\ ft = 9{,}750\ ft^3$$

Stone Volume

Assume that stone is used to backfill the excavation volume excluding the cutback area and the pump station volume (129,129 ft^3)

Total Stone Backfill Volume = 247,940 ft^3 = 9,183 yd^3

Assume the excess material disposal volume is equal to the stone volume.

Assume a site grading volume of 8,000 yd^3

Primary Treatment Disinfection

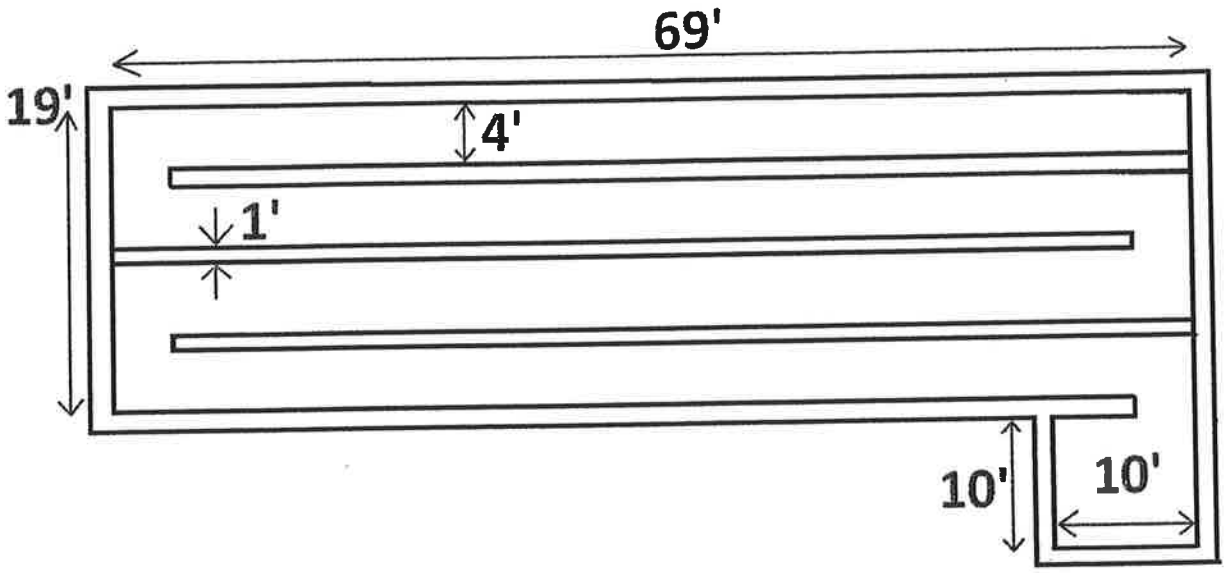
According to the Disinfection/Treatment of Combined Sewer Overflows, Syracuse, New York (EPA-600/2-79-134) "Bench-scale test indicate that target levels of bacteria and viruses could be accomplished within two minutes in simulated CSO with a Cl_2 dosage of 25 mg/l." Large scale testing described in the same document indicate that a contact time of 1 minute and a dosage of 8 mg/l will satisfy most regulatory requirements. The system would have to have adequate capacity so that adjustments could be made to accommodate site conditions. Design the system for a contact time of 10 minutes at peak flow and dosage of 25 mg/l

$$V = Q * T = 3{,}882\ gpm * 10\ min. = 38{,}820\ gallons = 5{,}200\ ft^3$$

Design a tank as follows:

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Figure 14: Contact Chamber, Profile View, NTS



Based on the elevation of the primary treatment headworks effluent (719.50 ft) flow from the contact tank will have to be pumped out. The 10' by 10' chamber at the end of the contact tank will hold two submersible pumps.

Determine the volume of concrete in the contact tank, assume exterior walls have a thickness of 1.5 feet. Set influent elevation 5 feet below headworks effluent so that backwater effect does not impact headworks water profile. The contact chamber will be placed 20' downstream of the pump station. Assume an influent elevation ($Z_{CC\text{-}IN}$) is 714 feet. Set top of structure to elevation 751 feet. Total height is 37 feet.

Calculate foundation volume: Assume 2 ft thickness

$$V = 22\ ft * 72\ ft * 2\ ft = 3{,}168\ ft^3$$

Calculate exterior wall volume:

$$V = [(22\ ft * 72\ ft) - (19\ ft * 69\ ft)] * 37\ ft = 10{,}101\ ft^3$$

Calculate internal wall volume: Assume 6 ft height, total length of 195 ft

$$V = 195\ ft * 1\ ft * 6\ ft = 1{,}170\ ft^3$$

Total contact tank concrete volume = 14,439 ft^3 = 535 yd^3

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Assume pump wet well is 6 feet deep, total height of the structure is 43 feet

Calculate foundation volume: Assume 2 ft thickness

$$V = 13\ ft * 13\ ft * 2\ ft = 338\ ft^3$$

Calculate exterior wall volume:

$$V = [(13\ ft * 13\ ft) - (10\ ft * 10\ ft)] * 43\ ft = 2{,}967\ ft^3$$

Total wet well concrete volume = 3,355 ft^3 = 124 yd^3

Sheet Pile: Based on the location next to the stream and an adjacent property not owned by the Authority, sheet pile on all sides the entire depth. Sheet pile and area, 40 ft by 80 ft to accommodate the wet well. Sheet pile to elevation of 700 ft, 40 feet deep.

$$SA = [2(40) + 2(80\ ft)] * 40\ ft = 9{,}600\ ft^2$$

Calculate the excavation volume

Disinfection Tank: Excavate to an elevation of 710 feet, assume existing grade at 740 feet

Excavate an area 28 ft by 78 ft.

$$V = 40\ ft * 80\ ft * 30\ ft = 96{,}000\ ft^3$$

Wet Well: Excavate an additional 13 ft by 13 ft by 6 ft for the wet well

$$V = 13\ ft * 13\ ft * 6\ ft = 1{,}014\ ft^3$$

Total Excavation Volume = 97,014 ft^3 = 3,593 yd^3

Assume stone backfill the entire excavation minus the contract tank volume.

Approximate Stone Volume = 49,494 ft^3 = 1,833 yd^3

Design pump and forcemain

Set velocity to 6 fps. Design flow is 5.59 mgd = 8.65 cfs

$$= 2\sqrt{\frac{Q}{v\pi}} = 2\sqrt{\frac{8.65\ cfs}{6fps * \pi}}$$

d = 1.35 ft = 16.2 inches

Use 16 inch pipe and fittings

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Pump invert is approximately 710 feet and discharges into CSO 3 at an elevation of 724 feet.

Static head is 14 feet. Calculate friction head:

- Total Length - 50 ft
- Forcemain Diameter – 16 inches
- Total Flow – 3,882 gpm

$$H_f = 0.2083\left(\frac{100}{110}\right)^{1.85}\frac{(3{,}882\ gpm)^{1.85}}{(16\ in)^{4.8655}}\left(\frac{50}{100}\right)$$

$H_f = 0.5$ ft

Provide a pump with a design point of 3,882 gpm at 15 ft TDH

Provide chemical feed pumps capable of providing 25 mg/l dosage for both chlorination and dechlorination. This will provide a conservative design and allow for flexibility when calibrating the dosage to suite site conditions

Determine dosage rate in lb/min

Design Flow Rate = 5.59 mgd = 14,693 L/min

Design Concentration = 25 mg/l

$$Dosage = 25\ {}^{mg}/_{L} * 14{,}693\ {}^{L}/_{min} = 367{,}352\ {}^{mg}/_{L} = 0.367\ {}^{kg}/_{min}$$

Assume a 12% strength solution of sodium hypochlorite solution

$$12\ \% = 120{,}000\ {}^{mg}/_{L} = 120\ {}^{kg}/_{m^3}$$

Sodium Hypochlorite feed rate:

$$Q = \frac{0.367\ {}^{kg}/_{min}}{120\ {}^{kg}/_{m^3}} = 0.003\ {}^{m^3}/_{min} = 0.808\ gpm = 48\ gal/hr$$

Assume a 44% strength sodium bisulfite solution

$$44\ \% = 440{,}000\ {}^{mg}/_{L} = 440\ {}^{kg}/_{m^3}$$

Sodium Bisulfite feed rate:

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$$Q = \frac{0.367\ {}^{kg}/_{min}}{440\ {}^{kg}/_{m^3}} = 0.0008\ {}^{m^3}/_{min} = 0.220\ gpm = 13\ gal/hr$$

Flow Equalization Tank (Alternative P1-A Only)

Design the Flow EQ tank at the WWTP to accommodate excess flows from CSO 3.

Flow will enter into the pump station flows exceeds the dry weather capacity (≈900 gpm) wet weather pumps will turn on directing flow to the Flow EQ tanks. The following are the Flow EQ tank design parameters for Alternative P-1:

- Peak Flow Rate Q_P = 1.10 mgd = 761 gpm = 1.70 cfs
- Storage Volume = 1.14 million gallons

The largest diameter tank that can fit onto the site is 80 feet.

Use a 78-foot diameter, 33-foot-tall flow equalization tank

The tank floor will sit at an approximate elevation of 748 feet.

Operating Narrative: During periods of wet weather, flows in excess of the dry weather pumping capacity (900 gpm) will be pumped using wet weather pumps to the Flow EQ tanks at the WWTP. After the event is over, flow will be pumped from the Flow EQ tanks into the normal process tanks.

Assume the pump intake is an elevation of 712 feet.

Determine the Static Head when tank is full:

$$H_s = (748\ ft + 32\ ft) - 712\ ft = 68\ ft$$

Set the forcemain velocity to 5 fps

$$d = 2\sqrt{\frac{Q}{v\pi}} = 2\sqrt{\frac{1.70\ cfs}{5fps * \pi}}$$

d = 8 inches

Determine the friction head:

$$H_f = 0.2083\left(\frac{100}{110}\right)^{1.85}\frac{(761\ gpm)^{1.85}}{(8\ in.)^{4.8655}}\left(\frac{850\ ft}{100}\right) = 13\ ft$$

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Add 5% extra to account for minor headlosses:

$$H = 1.05(68\ ft + 13\ ft) = 85\ ft$$

The Wet Weather pump design point is 761 gpm @ 85 ft TDH

Aeration must be provided so that the stored volume does not go septic. Domestic Wastewater Facilities Manual requires 1.25 cfm/1,000 gallons

$$Q_{air} = \frac{1{,}140{,}000\ gallons}{1000} * 1.25 \frac{cfm}{1000\ gallons} = 1{,}425\ cfm$$

Determine the blower motor size:

- Tank depth when full of 32 feet. Assume a diffuser submergence of 30 feet
- Assume an additional 5 feet of headloss through pipes, fittings and diffusers.
- The peak operating pressure is then 15 psi add 1 psi as a safety factor

$$P_w \frac{QP_1}{66.4 e_m e_B}\left[\left(\frac{P_2}{P_1}\right)^{0.283} - 1\right]$$

Blower Horsepower (hp)

Q = Air flow rate in (CFM)

P_1 = Inlet Pressure (psia)

P_2 = Outlet Pressure (psia)

e_m = Blower Motor Efficiency (Assume 70%)

e_B = Blower Efficiency (Assume 90%)

$$P_w = \frac{(1{,}425\ CFM)(14.7\ psia)}{66.4(0.7)(0.9)}\left[\left(\frac{30.7\ psia}{14.7\ psia}\right)^{0.283} - 1\right] = 116\ hp$$

Provide two 150 hp blowers in a primary backup configuration

House the blowers in a 25 ft by 20 ft building

Collection System Upgrades

Concept Level Design Calculations

Collection System Upgrades Alternative Analysis for Alternatives P2-A, P2-B, and B1

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Primary Alterative 3 involves conveying all primary treatment flows to the proposed EBMA pump station to receive primary treatment in a dedicated headworks train. Excess flows from CSO 3 will be pumped to the WWTP to a flow equalization tank. Table 1 list the design flows for this alternative.

Table 1

Alternative P2-A			
	Peak Flow Rate (mgd)	Peak Flow Rate (gpm)	Volume (gallons)
Primary Treatment at EBMA PS	20.830	14465	-
Collection/Conveyance Upgrades CSO 5	2.090	1451	-
Collection/Conveyance Upgrades CSO 6	5.220	3625	-
Collection/Conveyance Upgrades CSO 7	2.760	1917	-
Collection/Conveyance Upgrades CSO 8	5.170	3590	-
Flow Equalization	1.100	764	1,136,000
EBMA Pump Station Capacity	1.296	900	-
WWTP Capacity*	2.500	1736	-
* Assumes a Wylie Capacity of 1.2 mgd			

Determine if it is more economical for flows from CSO 8, 7, 6, and 5 to be pumped or flow by gravity to the EBMA pump station.

Gravity Flow Alternative

Table 2 below list the approximately minimum existing pipe slope between the each of the CSO structures and the total cumulative flow required to convey.

Table 2

	Minimum Segment Slope	Maximum Flow (mgd)	Conduit Size (in.)	Manning's "n"	Capacity (mgd)
CSO 8 to CSO 7	0.0008	5.17	27	0.012	6.149
CSO 7 to CSO 6	0.0011	7.93	30	0.012	9.550
CSO 6 to CSO 5	0.0017	13.15	36	0.012	19.306
CSO 5 to Pump Station	0.0012	15.24	36	0.012	16.220

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To ensure that the interceptor operates properly during normal conditions, the wet weather flows will be routed through a parallel interceptor. Table 3 list the depths, lengths, conduit size, and if the conduit will be installed by open cut or horizontal drilling.

Table 3

Manhole	Depth (ft)	Conduit Size (in)	Length (ft)	Installation Method
MH L	19.50	27	78	OC
MH K	5.71	27	195	OC
MH O	20.36	27	255	HD
MH I	20.98	27	210	HD
MH H	21.75	30	275	HD
MH G	22.45	30	317	HD
MH F	21.32	36	269	HD
MH E	19.39	36	290	HD
MH D	19.84	36	350	HD
MH C	25.33	36	191	HD
MH B	23.77	36	160	HD
OC - Open Cun; HD- Horizontal Drilling				

Pump Station Alternative

CSO 5, 6, 7, and 8 Pump Station Design

Design pump stations for CSOs 5, 6, 7, and 8 similar to the pump station design at CSO 8 above. Table 1 lists the design flows for each of the pump stations:

Table 1: Design Flows

	Q (mgd)	Q (gpm)	Q (cfs)
Pump Station CSO 5	2.090	1451	3.23
Pump Station CSO 6	5.220	3625	8.08
Pump Station CSO 7	2.760	1917	4.27
Pump Station CSO 8	5.170	3590	8.00

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Each of the pump stations will pump into the same forcemain. Calculate the size of the wetwell for each of the pump stations. As previously stated, the wet well should be sized so that the pump does not cycle more than 10 times per hour:

- CSO 5:

$$V = 1.5Q_P = 1.5 * 1451\ gpm$$

V = 2177 gallons = 291 ft^3

- CSO 6:

$$V = 1.5Q_P = 1.5 * 3625\ gpm$$

V = 5438 gallons = 727 ft^3

- CSO 7:

$$V = 1.5Q_P = 1.5 * 1917\ gpm$$

V = 2875 gallons = 384 ft^3

- CSO 8:

$$V = 1.5Q_P = 1.5 * 3590\ gpm$$

V = 5382 gallons = 720 ft^3

Determine the elevation of each of the pump station floors. Set the floor elevation based on the following assumptions;

- Set the low water level 3 feet above the floor
- Set the high water level 1 foot below the outfall so that when the influent flow rate exceeds the pump capacity, flow will be directed to the river.

Determine the operating height based on the previously calculated above.

- CSO 5, assume internal dimensions of 8 ft by 8 ft:

$$h = \frac{V}{A} = \frac{291\ ft^3}{(8\ ft * 8\ ft)}$$

h = 4.5 ft

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- CSO 6, assume internal dimensions of 12 ft by 12 ft:

$$h = \frac{V}{A} = \frac{727\ ft^3}{(12\ ft * 12\ ft)}$$

h = 5.0 ft

- CSO 7, assume internal dimensions of 8 ft by 8 ft:

$$h = \frac{V}{A} = \frac{384\ ft^3}{(8\ ft * 8\ ft)}$$

h = 6.0 ft

- CSO 8, assume internal dimensions of 8 ft by 8 ft:

$$h = \frac{V}{A} = \frac{720\ ft^3}{(12\ ft * 12\ ft)}$$

h = 5.0 ft

Based on calculated operated height, determine the elevation of the pump station floor:

- CSO 5, effluent elevation = 733.95 ft

$$Z_{5-F} = 733.95\ ft - 1\ ft - 4.5\ ft - 3\ ft$$

$Z_{5\text{-}F}$ = 725.4 ft

- CSO 6, effluent elevation = 729.42 ft

$$Z_{6-F} = 729.42\ ft - 1\ ft - 5.0\ ft - 3\ ft$$

$Z_{6\text{-}F}$ = 720.40 ft

- CSO 7, effluent elevation = 737.86 ft

$$Z_{7-F} = 737.86\ ft - 1\ ft - 6.0\ ft - 3\ ft$$

$Z_{7\text{-}F}$ = 727.90 ft

- CSO 8, effluent elevation = 731.05 ft

$$Z_{7-F} = 731.05\ ft - 1\ ft - 5.0\ ft - 3\ ft$$

$Z_{8\text{-}F}$ = 722.05 ft

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The forcemain would follow the same path as the existing interceptor. Table 4 list the rim elevation of each of manholes along the interceptor. Set the forcemain 4 ft below grade:

Table 4

Manhole	Rim Elevation	CSO Discharge
MH L	751	CSO 8
MH K	737	
MH O	751.5	
MH I	751.5	
MH H	752.07	CSO 7
MH G	752.31	
MH F-1	750.36	
MH F	750.63	CSO 6
MH E	748.25	
MH D	748.25	CSO 5
MH C	**753.31**	
MH B	751.5	

Based on the above existing manhole rim elevations and assuming that the forcemain is installed 4 feet deep, the static head for each forcemain will be calculated using an elevation of 753.31 ft. Calculate the static head for each of the pump stations.

- CSO 5, low water level = 728.40 ft

$$H_S = 753.31\ ft - 728.40\ ft$$

H_S = 24.91 ft

- CSO 6, low water level = 723.40 ft

$$H_S = 753.31\ ft - 723.40\ ft$$

H_S = 29.91 ft

- CSO 7, low water level = 730.90 ft

$$H_S = 753.31\ ft - 730.90\ ft$$

H_S = 22.41 ft

- CSO 8, low water level = 725.00 ft

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$$H_S = 753.31\ ft - 725.05\ ft$$

H_S = 28.26 ft

Calculate the friction head for each segment.

- Segment 1: CSO 5 to Manhole A' (Discharges to proposed gravity line adjacent to Boat Club)
  - Total Length - 700 ft
  - Forcemain Diameter – 24 inches
  - Total Flow – 10,583 gpm

$$H_f = 0.2083\left(\frac{100}{110}\right)^{1.85}\frac{(10{,}583)^{1.85}}{(24)^{4.8655}}\left(\frac{700}{100}\right)$$

H_f = 7 ft

- Segment 2: CSO 6 to CSO 5
  - Total Length – 560 ft
  - Forcemain Diameter – 24 inches
  - Total Flow – 9,132 gpm

$$H_f = 0.2083\left(\frac{100}{110}\right)^{1.85}\frac{(9{,}132)^{1.85}}{(24)^{4.8655}}\left(\frac{560}{100}\right)$$

H_f = 4 ft

- Segment 3: CSO 7 to CSO 6
  - Total Length - 590 ft
  - Forcemain Diameter – 18 inches
  - Total Flow – 5,507 gpm

$$H_f = 0.2083\left(\frac{100}{110}\right)^{1.85}\frac{(5{,}507)^{1.85}}{(18)^{4.8655}}\left(\frac{590}{100}\right)$$

H_f = 7 ft

- Segment 4: CSO 8 to CSO 7
  - Total Length - 740 ft

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- Forcemain Diameter – 16 inches
- Total Flow – 3,590 gpm

$$H_f = 0.2083\left(\frac{100}{110}\right)^{1.85}\frac{(3{,}590)^{1.85}}{(16)^{4.8655}}\left(\frac{740}{100}\right)$$

$H_f = 7$ ft

For the concept level design assume that minor losses (H_m) are 5 ft.

Calculate the total dynamic head (TDH) for each of the CSO structures

- CSO 8:

$$TDH_8 = H_S + H_f + H_m$$

$$H_f = Seg.1 + Seg.2 + Seg.3 + Seg.4 = 7\ ft + 4\ ft + 7\ ft + 7\ ft$$

$H_f = 24$ ft

$$TDH_8 = 28\ ft + 24\ ft + 5ft$$

$TDH_8 = 57$ ft

- CSO 7:

$$TDH_7 = H_S + H_f + H_m$$

$$H_f = Seg.1 + Seg.2 + Seg.3 = 7\ ft + 4\ ft + 7\ ft$$

$H_f = 17$ ft

$$TDH_7 = 22\ ft + 17\ ft + 5ft$$

$TDH_7 = 44$ ft

- CSO 6:

$$TDH_6 = H_S + H_f + H_m$$

$$H_f = Seg.1 + Seg.2 = 7\ ft + 4\ ft$$

$H_f = 11$ ft

$$TDH_6 = 30\ ft + 11\ ft + 5ft$$

$TDH_6 = 46$ ft

- CSO 5:

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$$TDH_5 = H_S + H_f + H_m$$

$$H_f = Seg.1 = 7\,f$$

H_f = 7 ft

$$TDH_5 = 25\,ft + 7\,ft + 5ft$$

TDH_6 = 37 ft

Table 2 summarizes the design point for each of the pumps as calculated above

	Q (gpm)	TDH (ft)
Pump Station CSO 5	1451	37
Pump Station CSO 6	3625	46
Pump Station CSO 7	1917	44
Pump Station CSO 8	3590	57

Calculate the discharge piping size for each of the pump stations. Set flow velocity to approximately 6 fps.

- CSO 5 – Design flow = 1,451 gpm = 3.23 cfs

$$d = 2\sqrt{\frac{Q}{v\pi}} = 2\sqrt{\frac{3.23cfs}{6fps * \pi}}$$

d = 0.83 ft = 9.9 inches

Use a 10 inch pipe and fittings

- CSO 6 – Design flow = 3,625 gpm = 8.08 cfs

$$d = 2\sqrt{\frac{Q}{v\pi}} = 2\sqrt{\frac{8.08\ cfs}{6fps * \pi}}$$

d = 1.31 ft = 15.7 inches

Use 16 inch pipe and fittings

- CSO 7 – Design flow = 1,917 gpm = 4.27 cfs

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$$d = 2\sqrt{\frac{Q}{v\pi}} = 2\sqrt{\frac{4.27\ cfs}{6fps * \pi}}$$

d = 0.95 ft = 11.4 inches

Use 12 inch pipe and fittings

- CSO 8 – Design flow = 3,590 gpm = 8.0 cfs

$$d = 2\sqrt{\frac{Q}{v\pi}} = 2\sqrt{\frac{8.0\ cfs}{6fps * \pi}}$$

d = 1.3 ft = 15.6 inches

Use 16 inch pipe and fittings

Estimate the materials and quantity for each of the CSO Pump Stations

CSO 5

Concrete:

- Internal Dimensions – 8 ft by 8 ft
- Height – 747 ft – 725.4 ft = 21.6 ft
- Calculate the volume of the foundation. Assume the foundation extends 1 ft beyond wall and is 2 ft thick.

$$V = 13ft * 13ft * 2ft$$

V = 338 ft^3

- Calculate the volume of the walls. Assume a wall thickness of 1.5 ft

$$V = [(11ft * 11ft) - (8ft * 8\ ft)] * 21.6ft$$

V = 1,231 ft^3

- Calculate the roof volume. Assume a 10 inch thick roof with a 4 ft by 4 ft hatch opening

$$V = [(11ft * 11ft) - (4ft * 4\ ft)] * \left({}^{10"}/_{12}\right)$$

V = 88 ft^3

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Total Concrete Volume = 1,657 ft^3 = 61 yd^3

Stone:

- Assume 2 ft of stone under and 2.5 ft around the outside of the structure
- Calculate the volume under the structure:

$$V = 18ft * 18ft * 2ft$$

V= 648 ft^3

- Calculate the volume around the structure:

$$V = [(18ft * 18ft) - (11ft * 11\ ft)] * 21.6ft$$

V= 4,385 ft^3

Total Stone Volume = 5,033 ft^3 = 186 yd^3

Excavation:

- Total Depth (assumes 2 ft thick foundation and stone) = 25.6 ft
- Excavation Area = 18 ft by 18 ft
- Calculate volume of excavation:

$$V = 25.6\ ft * 18ft * 18ft$$

$$\boldsymbol{V = 8,294\ ft^3 = 307\ yd^3}$$

- Sheet pile area, assume 10 feet below bottom of excavation:

$$SA = 4(18ft) * 35.6ft$$

SA = 2,563 ft^2

CSO 6

Concrete:

- Internal Dimensions – 12 ft by 12 ft
- Height – 748.9 ft – 720.4 ft = 28.5 ft
- Calculate the volume of the foundation. Assume the foundation extends 1 ft beyond wall and is 2 ft thick.

$$V = 17ft * 17ft * 2ft$$

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$V = 578\ ft^3$

- Calculate the volume of the walls. Assume a wall thickness of 1.5 ft

$$V = [(15ft * 15ft) - (12ft * 12\ ft)] * 28.5ft$$

$V = 2{,}309\ ft^3$

- Calculate the roof volume. Assume a 10 inch thick roof with a 5 ft by 5 ft hatch opening

$$V = [(15ft * 15ft) - (5ft * 5ft)] * \left({}^{10"}/_{12}\right)$$

$V = 167\ ft^3$

Total Concrete Volume = 3,054 ft^3 = 113 yd^3

Stone:

- Assume 2 ft of stone under and 2.5 ft around the outside of the structure
- Calculate the volume under the structure:

$$V = 20ft * 20ft * 2ft$$

$V = 800\ ft^3$

- Calculate the volume around the structure:

$$V = [(20ft * 20ft) - (15ft * 15\ ft)] * 28.5ft$$

$V = 4{,}987\ ft^3$

Total Stone Volume = 5,787ft^3 = 214 yd^3

Excavation:

- Total Depth (assumes 2 ft thick foundation and stone) = 32.5 ft
- Excavation Area = 20 ft by 20 ft
- Calculate volume of excavation:

$$V = 32.5\ ft * 20\ ft * 20\ ft$$

$$\boldsymbol{V = 13{,}00\ ft^3 = 481\ yd^3}$$

- Sheet pile area, assume 10 feet below bottom of excavation:

$$SA = 4(20ft) * 42.5\ ft$$

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SA =3,400 ft²

CSO 7

Concrete:

- Internal Dimensions – 8 ft by 8 ft
- Height – 754.1 ft – 727.9 ft = 26.2 ft
- Calculate the volume of the foundation. Assume the foundation extends 1 ft beyond wall and is 2 ft thick.

$$V = 13ft * 13ft * 2ft$$

V = 338 ft³

- Calculate the volume of the walls. Assume a wall thickness of 1.5 ft

$$V = [(11ft * 11ft) - (8ft * 8\,ft)] * 26.2ft$$

V = 1,493 ft³

- Calculate the roof volume. Assume a 10 inch thick roof with a 4 ft by 4 ft hatch opening

$$V = [(11ft * 11ft) - (4ft * 4\,ft)] * \left({}^{10"}/_{12}\right)$$

V = 88 ft³

Total Concrete Volume = 1,919 ft³ = 71 yd³

Stone:

- Assume 2 ft of stone under and 2.5 ft around the outside of the structure
- Calculate the volume under the structure:

$$V = 18ft * 18ft * 2ft$$

V= 648 ft³

- Calculate the volume around the structure:

$$V = [(18ft * 18ft) - (11ft * 11\,ft)] * 26.2ft$$

V= 5,319 ft³

Total Stone Volume = 5,967 ft³ = 221 yd³

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Excavation:

- Total Depth (assumes 2 ft thick foundation and stone) = 30.2 ft
- Excavation Area = 15 ft by 15 ft
- Calculate volume of excavation:

$$V = 30.2\ ft * 15ft * 15ft$$

$$\boldsymbol{V = 6,795\ ft^3 = 252\ yd^3}$$

- Sheet pile area, assume 10 feet below bottom of excavation:

$$SA = 4(15ft) * 30.2\ ft$$

SA =1,812 ft²

CSO 8

Concrete:

- Internal Dimensions – 12 ft by 12 ft
- Height – 748.45 ft – 722.05 ft = 26.4 ft
- Calculate the volume of the foundation. Assume the foundation extends 1 ft beyond wall and is 2 ft thick.

$$V = 17ft * 17ft * 2ft$$

V = 578 ft³

- Calculate the volume of the walls. Assume a wall thickness of 1.5 ft

$$V = [(15ft * 15ft) - (12ft * 12\ ft)] * 26.4ft$$

V = 2,138 ft³

- Calculate the roof volume. Assume a 10 inch thick roof with a 5 ft by 5 ft hatch opening

$$V = [(15ft * 15ft) - (5ft * 5\ ft)] * \left({}^{10"}/_{12}\right)$$

V = 167 ft³

Total Concrete Volume = 2,883 ft³ = 107 yd³

Stone:

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- Assume 2 ft of stone under and 2.5 ft around the outside of the structure
- Calculate the volume under the structure:

$$V = 20\ ft * 20ft * 2ft$$

V= 800 ft^3

- Calculate the volume around the structure:

$$V = [(20ft * 20ft) - (15ft * 15\ ft)] * 26.5ft$$

V= 4,638 ft^3

Total Stone Volume = 5,438 ft^3 = 201 yd^3

Excavation:

- Total Depth (assumes 2 ft thick foundation and stone) = 30.4 ft
- Excavation Area = 19 ft by 19 ft
- Calculate volume of excavation:

$$V = 30.4\ ft * 20ft * 20ft$$

$$\boldsymbol{V = 12,160\ ft^3 = 450\ yd^3}$$

- Sheet pile area, assume 10 feet below bottom of excavation:

$$SA = 4(20ft) * 40.4\ ft$$

SA =3,232 ft^2

Estimate Generator size:

- Determine pump horsepower for each pump station (assume 50% efficiency)
  - CSO 8:

$$P_{hp-8} = \frac{Q * H}{3960 * n} = \frac{3{,}590\ gpm * 57\ ft}{3960 * 0.5} = 103\ Hp$$

  - CSO 7:

$$P_{hp-7} = \frac{Q * H}{3960 * n} = \frac{1{,}917\ gpm * 44\ ft}{3960 * 0.5} = 43\ Hp$$

  - CSO 6:

$$P_{hp-6} = \frac{Q * H}{3960 * n} = \frac{3{,}625\ gpm * 46\ ft}{3960 * 0.5} = 84\ Hp$$

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- CSO 5:

$$P_{hp-5} = \frac{Q * H}{3960 * n} = \frac{1{,}451\ gpm * 37\ ft}{3960 * 0.5} = 27\ Hp$$

- Total power is 180 hp = 134 kW, use a 150 kW generator.

Gravity/Pump Station Alternative

The following alternative involves the construction of a pump station at CSO 8 to handle flows from CSO 8 and 7 and a pump station at CSO 5 to handle flows from CSO 6 and 5. Excess flows from CSO 7 would gravity flow to CSO 8 to be pumped and excess flows from CSO 6 would gravity flow to CSO 5 to be pumped.

Gravity Flow Design

CSO 7 to CSO 8: (design flow of 2.76 mgd)

- Use an orifice plate on the effluent of the line leaving CSO 7 so that when the water surface elevation in the exiting diversion structure is equal to the overflow invert elevation the flow through the orifice is equation to the design flow.
  - Overflow invert, CSO 7 ≈ 737 ft
- Use a 12-inch orifice with a centerline 2 feet below the overflow invert. Orifice flow rate at design conditions:

$$Q = CA\sqrt{2gh} = (0.61)(0.78ft^2)\sqrt{2\left(32.2\ {}^{ft}/_{sec^2}\right)(2\ ft)}$$

$$Q = 5.4\ cfs = 3.51\ mgd > 2.76 - OK$$

- Set the outflow invert elevation to the CSO 8 pump station to **734.5 ft.**
- Add the following manholes: (listed in order from CSO 7 to CSO 8)

Manhole	Rim Elevation	Invert Elevation	Depth (ft.)	Conduit Size (in)	Length (ft)
MH 7-A	751.5	734.5	17	18	20
MH 7-B	751.5	730.63	21	18	255
MH 7-C	738.00	730.24	8	18	195

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CSO Pump Station	751.00	730.00	21	18	100

- Approximate total length – 570 ft
- Based on elevations above, the pump station floor elevation of 722.05 can be kept. CSO 7 would connect to the pump station with a drop connection.

CSO 6 to CSO 5: (design flow of 5.22 mgd)

- Use an orifice plate on the effluent of the line leaving CSO 6 so that when the water surface elevation in the exiting diversion structure is equal to the overflow invert elevation the flow through the orifice is equation to the design flow.
  - Overflow invert, CSO 7 ≈ 729 ft
- Use a 16-inch orifice with a centerline 2 feet below the overflow invert. Orifice flow rate at design conditions:

$$Q = CA\sqrt{2gh} = (0.61)(1.40ft^2)\sqrt{2\left(32.2\ {}^{ft}/_{sec^2}\right)(2\ ft)}$$

$$Q = 9.67\ \text{cfs} = 6.25\ \text{mgd}\ 5.22 - \text{OK}$$

- Set the outflow invert elevation to the CSO 5 pump station to **726.30 ft.**
- CSO 5 is located approximately 270 feet downstream of CSO 6. Use a 21 inch conduit at a slope of 0.2%. The flow from CSO 6 will enter the CSO 5 pump station at an elevation approx. **725.70 ft.**

Pump Station Design

Table XX: Design Flows

	Q (mgd)	Q (gpm)	Q (cfs)
Pump Station CSO 8	7.93	5,507	12.3
Pump Station CSO 5	7.31	5,076	11.3

Determine the wet well size so that the pump does not cycle more than 10 times per hour:

- CSO 8:

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$$V = 1.5Q_P = 1.5 * 5{,}507\ gpm$$

V = 8,260 gallons = 1,104 ft^3

- CSO 5:

$$V = 1.5Q_P = 1.5 * 5{,}076\ gpm$$

V = 7,614 gallons = 1,018 ft^3

Determine the elevation of the pump station floor. Set the elevation based on the following assumptions;

- Set the low water level 3 feet above the floor
- Set the high water level 0.5 foot below the overflow outlet so that when the influent flow rate exceeds the pump capacity flow will be directed to the river
- Set the lowest influent pipe 1 foot above the overflow outlet

Determine the operating heights, assume 12 ft by 12 ft internal dimensions

- CSO 8:

$$h = \frac{V}{A} = \frac{1{,}104\ ft^3}{(12\ ft * 12\ ft)}$$

h = 7.7 ft

- CSO 5:

$$h = \frac{V}{A} = \frac{1{,}018\ ft^3}{(12\ ft * 12\ ft)}$$

h = 7.0 ft

Determine floor elevation based on above:

- CSO 8, lowest influent elevation is 729.80,

$$Z_8 = 729.80 - 1\ ft - 0.5\ ft - 7.7\ ft - 3ft$$

Z_8 = 717.60 ft

- CSO 8, lowest influent elevation is 725.70

$$Z_8 = 725.70 - 1\ ft - 0.5\ ft - 7\ ft - 3ft$$

Z_8 = 714.20 ft

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Based on the existing manhole rim elevations (as shown in Table 4) and assuming that the forcemain is installed 4 feet deep, the static head for each forcemain will be calculated using an elevation of 753.31 ft.

Calculate the static head for each of the pump stations.

- CSO 8, low water level = 720.60 ft

$$H_S = 753.31\ ft - 720.60\ ft$$

H_S = 32.71 ft

- CSO 5, low water level = 717.20 ft

$$H_S = 753.31\ ft - 717.20\ ft$$

H_S = 36.11 ft

Calculate the friction head for each segment.

- Segment 1: CSO 5 to Manhole A' (Discharges to proposed gravity line adjacent to Boat Club)
  - Total Length - 700 ft
  - Forcemain Diameter – 24 inches
  - Total Flow – 10,583 gpm

$$H_f = 0.2083\left(\frac{100}{110}\right)^{1.85}\frac{(10{,}583)^{1.85}}{(24)^{4.8655}}\left(\frac{700}{100}\right)$$

H_f = 7 ft

- Segment 2: CSO 8 to CSO 5
  - Total Length – 1,890ft
  - Forcemain Diameter –21 inches
  - Total Flow – 5,507 gpm

$$H_f = 0.2083\left(\frac{100}{110}\right)^{1.85}\frac{(5{,}507)^{1.85}}{(21)^{4.8655}}\left(\frac{1{,}890}{100}\right)$$

H_f = 10 ft

For the concept level design assume that minor losses (H_m) are 5 ft.

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Calculate the total dynamic head (TDH) for each of the CSO structures

- CSO 8:

$$TDH_8 = H_S + H_f + H_m$$

$$H_f = Seg.1 + Seg.2 = 7\ ft + 10\ ft$$

H_f = 17 ft

$$TDH_8 = 33\ ft + 17\ ft + 5ft$$

TDH_8 = 55 ft

- CSO 5:

$$TDH_7 = H_S + H_f + H_m$$

$$H_f = Seg.1 = 7\ ft$$

H_f = 7 ft

$$TDH_7 = 36\ ft + 7\ ft + 5ft$$

TDH_7 = 48 ft

Table 2 summarizes the design point for each of the pumps as calculated above

	Q (gpm)	TDH (ft)
Pump Station CSO 8	5,507	55
Pump Station CSO 5	5,076	48

Calculate the discharge piping size for each of the pump stations. Set flow velocity to approximately 6 fps.

- CSO 8 – Design flow = 5,507 gpm = 12.3 cfs

$$d = 2\sqrt{\frac{Q}{v\pi}} = 2\sqrt{\frac{12.3cfs}{6fps * \pi}}$$

d = 1.6 ft = 19 inches

Use a 21 inch pipe and fittings

- CSO 5 – Design flow = 5,076 gpm = 11.3 cfs

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$$d = 2\sqrt{\frac{Q}{v\pi}} = 2\sqrt{\frac{11.3\ cfs}{6fps * \pi}}$$

d = 1.5 ft = 18 inches

Use 21 inch pipe and fittings

Estimate the materials and quantity for each of the CSO Pump Stations

CSO 8

Concrete:

- Internal Dimensions – 12 ft by 12 ft
- Height – 748.45 ft – 717.6 ft = 30.9 ft
- Calculate the volume of the foundation. Assume the foundation extends 1 ft beyond wall and is 2 ft thick.

$$V = 17ft * 17ft * 2ft$$

V = 578 ft^3

- Calculate the volume of the walls. Assume a wall thickness of 1.5 ft

$$V = [(15ft * 15ft) - (12ft * 12ft)] * 30.9ft$$

V = 2,503 ft^3

- Calculate the roof volume. Assume a 10 inch thick roof with a 5 ft by 5 ft hatch opening

$$V = [(15ft * 15ft) - (5ft * 5ft)] * \left({}^{10"}/_{12}\right)$$

V = 167 ft^3

Total Concrete Volume = 3,275 ft^3 = 121 yd^3

Stone:

- Assume 2 ft of stone under and around the structure
- Calculate the volume under the structure:

$$V = 20ft * 20ft * 2ft$$

V= 800 ft^3

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- Calculate the volume around the structure:

$$V = [(20ft * 20ft) - (15ft * 15\ ft)] * 30.9ft$$

V= 5,408 ft^3

Total Stone Volume = 6,208 ft^3 = 230yd^3

Excavation:

- Total Depth (assumes 2 ft thick foundation and stone) = 34.9 ft
- Excavation Area = 20 ft by 20 ft
- Calculate volume of excavation:

$$V = 34.9\ ft * 20ft * 20ft$$

$$\boldsymbol{V = 13,960\ ft^3 = 517\ yd^3}$$

- Sheet pile area, assume 10 feet below bottom of excavation:

$$SA = 4(20ft) * 44.9ft$$

SA = 3,592 ft^2

CSO 5

Concrete:

- Internal Dimensions – 12 ft by 12 ft
- Height – 747.00 ft – 714.20 ft = 32.8 ft
- Calculate the volume of the foundation. Assume the foundation extends 1 ft beyond wall and is 2 ft thick.

$$V = 17ft * 17ft * 2ft$$

V = 578 ft^3

- Calculate the volume of the walls. Assume a wall thickness of 1.5 ft

$$V = [(15ft * 15ft) - (12ft * 12\ ft)] * 32.8ft$$

V = 2,657 ft^3

- Calculate the roof volume. Assume a 10 inch thick roof with a 5 ft by 5 ft hatch opening

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$$V = [(15ft * 15ft) - (5ft * 5ft)] * \left({}^{10"}/_{12}\right)$$

V = 167 ft^3

Total Concrete Volume = 3,402 ft^3 = 126 yd^3

Stone:

- Assume 2 ft of stone under and around the structure
- Calculate the volume under the structure:

$$V = 20\ ft * 20\ ft * 2ft$$

V= 800 ft^3

- Calculate the volume around the structure:

$$V = [(20ft * 20ft) - (15ft * 15\ ft)] * 32.8ft$$

V= 5,642 ft^3

Total Stone Volume = 6,442ft^3 = 239 yd^3

Excavation:

- Total Depth (assumes 2 ft thick foundation and stone) = 36.8 ft
- Excavation Area = 20 ft by 20 ft
- Calculate volume of excavation:

$$V = 36.8\ ft * 20ft * 20ft$$

$$\boldsymbol{V = 14,720\ ft^3 = 545\ yd^3}$$

- Sheet pile area, assume 10 feet below bottom of excavation:

$$SA = 4(20ft) * 46.8\ ft$$

SA =3,744 ft^2

Estimate Generator size:

- Determine pump horsepower for each pump station (assume 50% efficiency)
  - CSO 8:

$$P_{hp-8} = \frac{Q * H}{3960 * n} = \frac{5{,}507\ gpm * 55\ ft}{3960 * 0.5} = 164\ Hp$$

  - CSO 5:

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$$P_{hp-7} = \frac{Q * H}{3960 * n} = \frac{5{,}076\ gpm * 48\ ft}{3960 * 0.5} = 123\ Hp$$

- Total power is 287 hp = 212 kW, use a 250 kW generator.

Alternatives P2-A, P2-B

Concept Level Design Calculations

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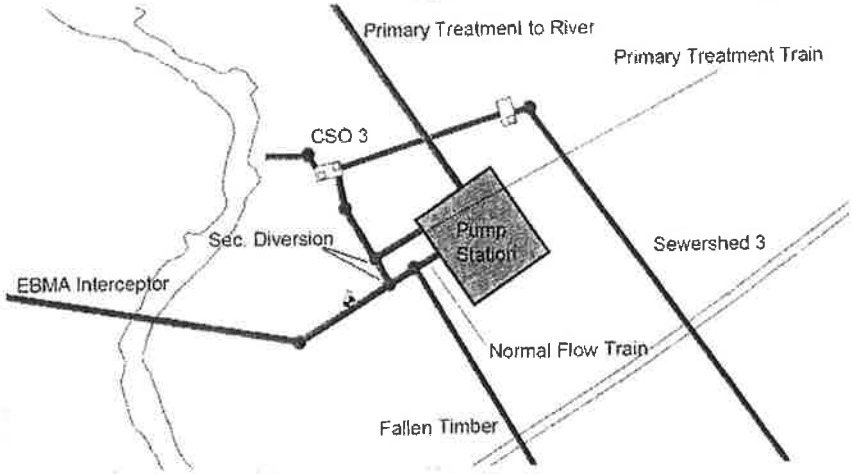
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Primary Treatment, CSO 3

Due to space requirements a storm king will not be used at the EBMA pump station location. Instead, flows from CSO 8, 7, 6, 5, and 3 will receive primary treatment from a secondary headworks train in the pump station. During dry weather, flow from CSO 8, 7, 6, 5, and 3 will be directed to a Normal Flow headworks train in the pump station rated for a flow of 20.83 mgd (14,465 gpm). During wet weather, flow will be directed to a secondary headworks train in the pump station which will provide primary treatment. Disinfection will be provided for in a structure adjacent to the pump station.

Figure 1 – Pump Station Layout, Alternative P2



Headworks Train Design

Provide a concept level design of the Normal Flow Channel and Primary Treatment Channel

Design Flows:

- Normal Flow Channel = 2.402 mgd = 1,668 gpm = 3.71 cfs
- Primary Treatment Channel = 20.830 mgd = 14,465 gpm = 32.23 cfs

Design the Normal Flow Channel with the following equipment:

- 54" Long by 6" Wide Cutthroat Flume
- 7' Diameter Grit Chamber rated for 2.5 mgd
- 1' 3" Wide Mechanical Bar Screen

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Figure 2 – Conceptual Headworks Layout – Normal Flow Train

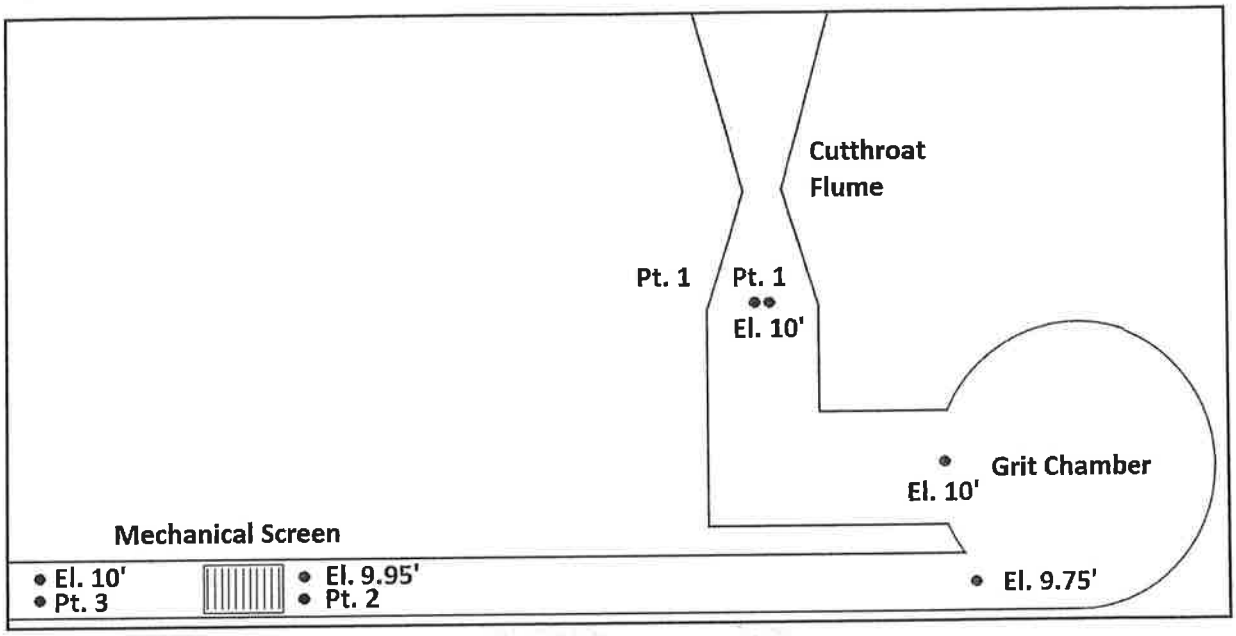


Figure 2 is a conceptual layout of the Normal Flow Channel. Not shown are slide gates and the manual bar screen channel. Determine the approximate water surface profile, ignore friction losses.

- Flow depth at Pt. 1 – Use equation for 54" X 6" cutthroat flume

$$y_1 = \left(\frac{Q}{1.96}\right)^{1/1.72} = \left(\frac{3.71\ cfs}{1.96}\right)^{1/1.72}$$

y_1 = 1.45 ft

  - Determine the total Head at Pt. 1

$$H_1 = y_1 + z_1 + \frac{v_1^2}{2g}$$

$$v_1 = {}^{Q}/_{A} = {}^{3.71cfs}/_{(1.45ft * 1.5ft)}$$

v = 1.71 fps

$$H_1 = 1.45ft + 10ft + \frac{(1.71fps)^2}{2g}$$

H_1 = 11.50 ft

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- Flow depth at Pt. 2 – Assume that $H_1 = H_2$

$$H_1 = y_2 + z_2 + \frac{v_2^2}{2g}$$

  - Guess y_2 = 1.49 ft

$$v_2 = {}^{Q}/_{A} = {}^{3.71cfs}/_{(1.49ft * 1.5ft)}$$

v_2 = 1.67 fps

$$H_2 = 1.49ft + 9.95ft + \frac{(1.67\ fps)^2}{2g}$$

H_2 = 11.50 ft = 11.50 ft – OK

y_2 = 1.49 ft

- Flow depth at Pt. 3 – Determine headloss through mechanical bar screen, assume 0.25 inch bar thickness, 0.25 inch clear space, 25% blockage.

$$h_l = \frac{Q^2}{2gK^2}\left[\left(\frac{1}{W_e(y_l + h_l)}\right)^2 - \left(\frac{1}{W(y_l + h_l)}\right)^2\right]$$

Q: Flow rate (cfs)

K: Frictional coefficient – 0.84

W_e: Effective width (ft)

W: Channel width (ft)

Y_l: Downstream flow depth (ft)

h_l: Headloss

$$W_e = (W - S)\left(\frac{c}{b + c}\right)(1 - B)$$

S: Side fabrication thickness (ft) – Assume 0.25 ft

c: Clear opening between bars (in.)

b: Bar thickness (in.)

B: Degree of blinding (fraction)

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$$W_e = (1.25\ ft - 0.25\ ft)\left(\frac{0.25\ in.}{0.25\ in. + 0.25\ in.}\right)(1 - 0.25)$$

$W_e = 0.375$ ft

- Guess $h_l = 0.49$ ft

$$h_l = \frac{(3.71\ cfs)^2}{2g(0.84^2)}\left[\left(\frac{1}{0.375ft(1.49ft + 0.49ft)}\right)^2 - \left(\frac{1}{1.25ft(1.49ft + 0.49ft)}\right)^2\right]$$

$h_l = 0.49$ ft = 0.49 ft - OK

$y_3 = y_2 + hl = 1.49$ ft + 0.49 ft

$y_3 = 1.98$ ft

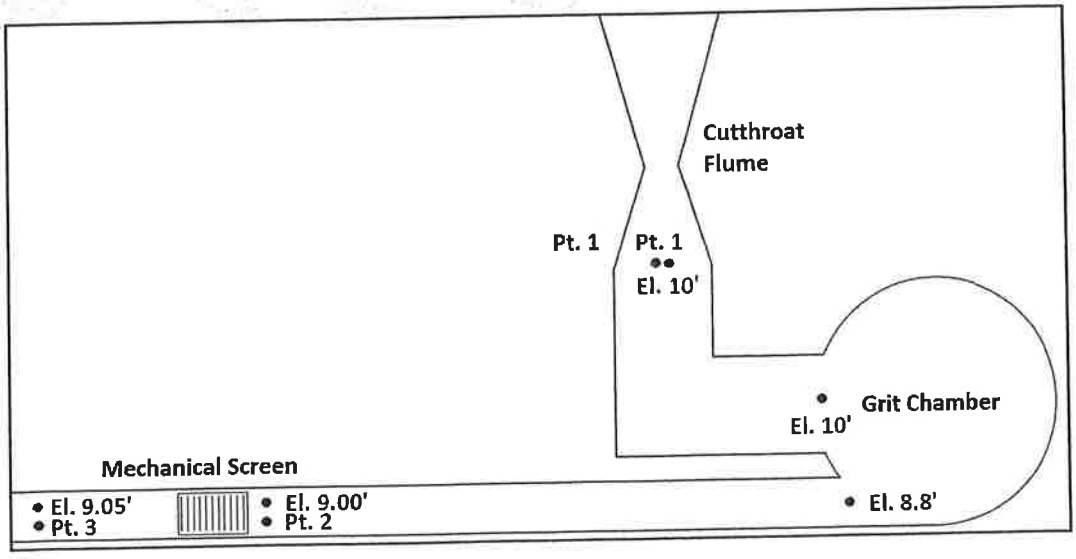
Design the Primary Treatment Channel with the following equipment:

- 108" Long by 24" Wide Cutthroat Flume
- 16' Diameter Grit Chamber rated for 20 mgd
- 4' Wide Mechanical Bar Screen
- Flow depth at Pt. 1 – Use equation for 108" X 24" cutthroat flume

$$y_1 = \left(\frac{Q}{7.11}\right)^{1/1.56} = \left(\frac{32.26\ cfs}{7.11}\right)^{1/1.56}$$

$y_1 = 2.63$ ft

Figure 3 – Conceptual Headworks Layout – Primary Treatment Train



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- Determine the total Head at Pt. 1

$$H_1 = y_1 + z_1 + \frac{v_1^2}{2g}$$

$$v_1 = {}^{Q}/_{A} = {}^{32.23\ cfs}/_{(4\ ft * 2.63 ft)}$$

v = 3.06 fps

$$H_1 = 2.63ft + 10ft + \frac{(3.06\ fps)^2}{2g}$$

H_1 = 12.78 ft

- Flow depth at Pt. 2 – Assume that $H_1 = H_2$

$$H_1 = y_2 + z_2 + \frac{v_2^2}{2g}$$

- Guess y_2 = 3.71 ft

$$v_2 = {}^{Q}/_{A} = {}^{32.23\ cfs}/_{(3.71\ ft * 4\ ft)}$$

v_2 = 2.17 fps

$$H_2 = 3.71ft + 9.00ft + \frac{(2.17 fps)^2}{2g}$$

H_2 = 12.78 = 12.78 ft – OK

y_2 = 3.71 ft

- Flow depth at Pt. 3 – Determine headloss through mechanical bar screen, assume 0.25 inch bar thickness, 0.25 inch clear space, 25% blockage.

$$h_l = \frac{Q^2}{2gK^2}\left[\left(\frac{1}{W_e(y_l + h_l)}\right)^2 - \left(\frac{1}{W(y_l + h_l)}\right)^2\right]$$

$$W_e = (W - S)\left(\frac{c}{b + c}\right)(1 - B)$$

$$W_e = (4\ ft - 0.25\ ft)\left(\frac{0.25\ in.}{0.25\ in. + 0.25\ in.}\right)(1 - 0.25)$$

W_e = 1.41 ft

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- Guess h_l = 0.56 ft

$$h_l = \frac{(32.23\ cfs)^2}{2g(0.84^2)}\left[\left(\frac{1}{1.41ft(3.71ft + 0.56ft)}\right)^2 - \left(\frac{1}{4.00ft(3.71ft + 0.56ft)}\right)^2\right]$$

h_l = 0.56 ft = 0.56 ft - OK

$y_3 = y_2 + hl = 3.71\ ft + 0.56\ ft$

y_3 = 4.27 ft

Pump Station Wet Well

The pump station will be fitted with two dry weather pumps on VFDs operating in a primary back up system and two wet weather pumps also operating in a primary backup configuration. The depth of the wet well is determined based on the following assumptions:

- The dry weather pump off level is 5 feet above the floor
- The dry weather pumps required 2.5 feet of operating level
- The wet weather pumps required 2.5 feet of operating level
- 1 foot of freeboard is provided
- The top of the wet well is positioned at the headworks channel floor elevation so that during normal operation, the wet well level does not impact the water surface profile of the headworks.

Pump Station Cost Estimate

Reference Figures 4 and 5 for a plan and profile view of the pump station. Note that the figures are general, not to scale and for concept level design only.

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Figure 4 – Pump Station Layout, NTS

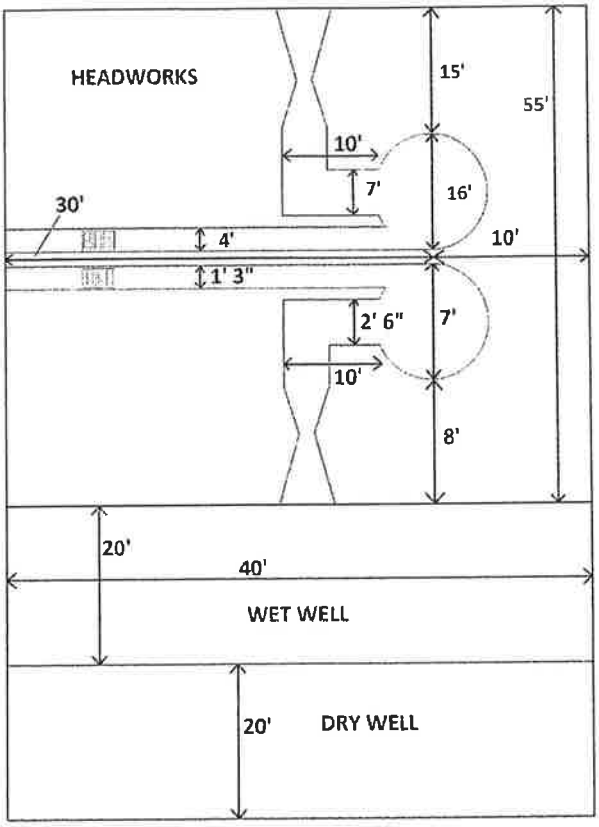
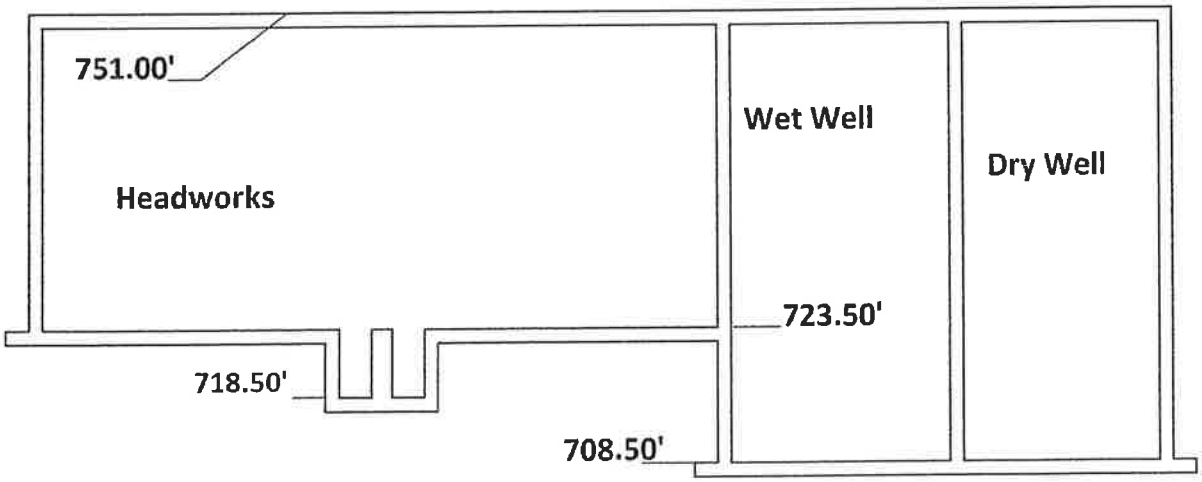


Figure 5 – Pump Station Profile View, NTS



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Reinforced Concrete Volume

Assume foundation is 2 ft thick and walls are 1.5 ft thick.

Headworks Floor:

$$V = 55ft * 40ft * 2ft = 4{,}400\ ft^3$$

Channel Walls (excluding grit chambers):

- Assume channel height of 5.5 ft. Assume total wall length of 140 ft

$$V = 5.5ft * 140ft * 1.5ft = 1{,}196\ ft^3$$

Channel Walls (grit chamber): Reference Figure 6 below

- 7 mgd grit chamber:

$$V = \left[\left(\pi\left({}^{10ft}/_{2}\right)^2\right) - \left(\pi\left({}^{7ft}/_{2}\right)^2\right)\right] * 3.67ft + \left[\left(\pi\left({}^{6ft}/_{2}\right)^2\right) - \left(\pi\left({}^{3ft}/_{2}\right)^2\right)\right] * 5ft$$

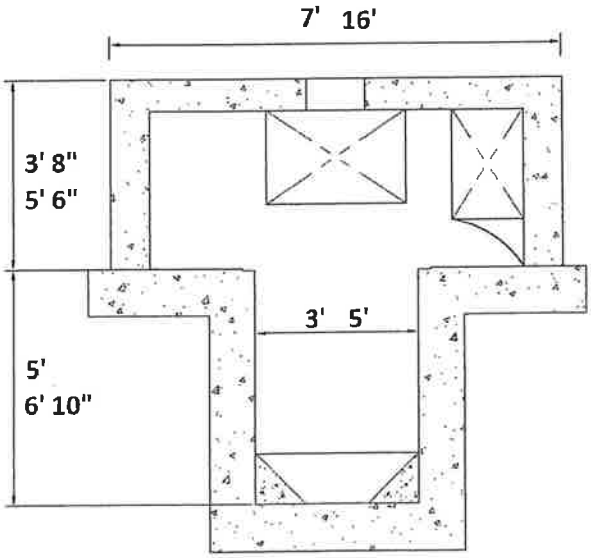
V = 253 ft^3

- 20 mgd chamber:

$$V = \left[\left(\pi\left({}^{19ft}/_{2}\right)^2\right) - \left(\pi\left({}^{16ft}/_{2}\right)^2\right)\right] * 5.50ft + \left[\left(\pi\left({}^{8ft}/_{2}\right)^2\right) - \left(\pi\left({}^{5ft}/_{2}\right)^2\right)\right] * 6.8ft$$

V = 662 ft^3

Figure 6 – Grit Chamber Profile View, NTS



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Wet Well/Dry Well Floor:

$$V = 40\ ft * 40\ ft * 2\ ft = 3{,}200\ ft^3$$

Headworks Wall: Total Length

$$V = [2(35\ ft) + 2(40\ ft)](1.5\ ft)(27.5\ ft) = 6{,}187.5\ ft^3$$

Wet Well/Dry Well Wall:

$$V = [(3(40\ ft) * 1.5\ ft * 42.5\ ft)] + [40\ ft * 1.5\ ft * 15\ ft] = 8{,}550\ ft^3$$

Final Grade Floor, Assume 10 Inches thick:

$$V = (75\ ft)(40\ ft)(^{10\ in}/_{12}) = 2{,}500\ ft^3$$

Total Reinforced Concrete Volume = 36,950 ft³ = 998 yd³

Excavation Volume

Existing Grade is approximately 742 ft. The geotechnical report indicates that the top 20 feet of material is waste.

Outside dimensions of pump station is 98 ft by 43 ft, excavate a minimum area of 138 ft by 83 ft.

Excavate 5 feet below bottom of wet well floor, elevation 703.50 ft.

Sheet Pile two sides (along the railroad tracks, 83 ft and along Fallen Timber creek, 138 ft)

Cut back the remaining two sides at a 1:1 slope

Total Excavation depth:

$$742\ ft - 703.5\ ft = 38.5ft$$

Excavation (Not including cutback)

$$V = 138\ ft * 83\ ft * 38.5\ ft = 440{,}979\ ft^3$$

Cut Back Volume:

$$V = [(^1/_2)(38.5\ ft)(38.5\ ft)(176\ ft)] + [(^1/_2)(38.5\ ft)(38.5\ ft)(121\ ft)] = 220{,}114ft^3$$

Total Excavation Volume = 661,093 ft³ = 24,485 yd³

Sheet Piling Surface Area

Assume sheet piling extends 10 feet below excavation depth.

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$$SA = (138\ ft + 83\ ft) * 48.5\ ft = 10{,}719\ ft^3$$

Stone Volume

Assume that stone is used to backfill the excavation volume excluding the cutback area and the pump station volume (162,239 ft^3)

Total Stone Backfill Volume = 278,740 ft^3 = 10,324 yd^3

Assume the excess material disposal volume is equal to the stone volume.

Assume a site grading volume of 8,000 yd^3

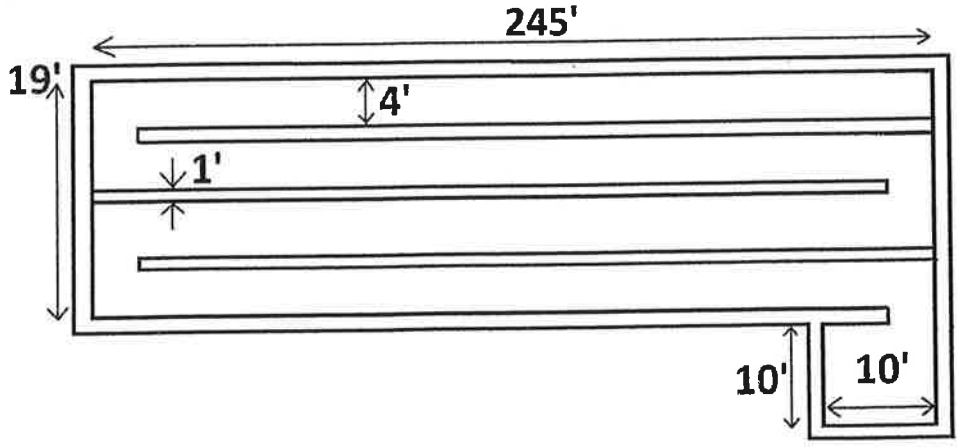
Primary Treatment Disinfection

According to the Disinfection/Treatment of Combined Sewer Overflows, Syracuse, New York (EPA-600/2-79-134) "Bench-scale test indicate that target levels of bacteria and viruses could be accomplished within two minutes in simulated CSO with a Cl_2 dosage of 25 mg/l." Large scale testing described in the same document indicates that a contact time of 1 minute and a dosage of 8 mg/l will satisfy most regulatory requirements. The system would have to have adequate capacity so that adjustments could be made to accommodate site conditions. Design the system for a contact time of 10 minutes at peak flow and dosage of 25 mg/l

$$V = Q * T = 14{,}465\ gpm * 10\ min. = 144{,}650\ gallons = 19{,}340\ ft^3$$

Design a tank as follows:

Figure 7 – Disinfection Chamber, NTS



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Based on the elevation of the primary treatment headworks effluent (719.50 ft) flow from the contact tank will have to be pumped out. The 10' by 10' chamber at the end of the contact tank will hold two submersible pumps.

Determine the volume of concrete in the contact tank, assume exterior walls have a thickness of 1.5 feet. Set influent elevation 5 feet below headworks effluent so that backwater effect does not impact headworks water profile. The contact chamber will be placed 20' downstream of the pump station. Assume an influent elevation ($Z_{CC\text{-}IN}$) is 714 feet. Set top of structure to elevation 751 feet. Total height is 37 feet.

Calculate foundation volume: Assume 2 ft thickness

$$V = 22\ ft * 248\ ft * 2\ ft = 10{,}912\ ft^3$$

Calculate exterior wall volume:

$$V = [(22\ ft * 248\ ft) - (19\ ft * 245 ft\ )] * 37\ ft = 23{,}310\ ft^3$$

Calculate internal wall volume: Assume 6 ft height, total length of 720 ft

$$V = 720\ ft * 1\ ft * 6\ ft = 4{,}320\ ft^3$$

Total contact tank concrete volume = 38,542 ft^3 =1,427 yd^3

Assume pump wet well is 6 feet deep, total height of the structure is 43 feet

Calculate foundation volume: Assume 2 ft thickness

$$V = 13\ ft * 13\ ft * 2\ ft = 338\ ft^3$$

Calculate exterior wall volume:

$$V = [(13\ ft * 13\ ft) - (10\ ft * 10\ ft\ )] * 43\ ft = 2{,}967\ ft^3$$

Total wet well concrete volume = 3,355 ft^3 = 124 yd^3

Sheet Pile: Based on the location next to the stream and an adjacent property not owned by the Authority, sheet pile on all sides the entire depth. Sheet pile and area, 40 ft by 265 ft to accommodate the wet well. Sheet pile to elevation of 700 ft, 40 feet deep.

$$SA = [2(40) + 2(265\ ft)] * 40\ ft = 24{,}400\ ft^2$$

Calculate the excavation volume

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Disinfection Tank: Excavate to an elevation of 710 feet, assume existing grade at 740 feet

Excavate an area 40 ft by 265 ft.

$$V = 40\ ft * 265\ ft * 30\ ft = 318{,}000\ ft^3$$

Wet Well: Excavate an additional 13 ft by 13 ft by 6 ft for the wet well

$$V = 13\ ft * 13\ ft * 6\ ft = 1{,}014\ ft^3$$

Total Excavation Volume = 319014 ft³ = 11,815 yd³

Assume stone backfill the entire excavation minus the contract tank volume.

Approximate Stone Volume = 155,334 ft³ = 5,753 yd³

Design pump and forcemain

Set velocity to 6 fps. Design flow is 5.59 mgd = 8.65 cfs

$$= 2\sqrt{\frac{Q}{v\pi}} = 2\sqrt{\frac{8.65\ cfs}{6fps * \pi}}$$

d = 1.35 ft = 16.2 inches

Use 16 inch pipe and fittings

Pump invert is approximately 710 feet and discharges into CSO 3 at an elevation of 724 feet.

Static head is 14 feet. Calculate friction head:

- Total Length - 50 ft
- Forcemain Diameter – 24 inches
- Total Flow – 14,465 gpm

$$H_f = 0.2083\left(\frac{100}{110}\right)^{1.85}\frac{(14{,}465\ gpm)^{1.85}}{(24\ in)^{4.8655}}\left(\frac{50}{100}\right)$$

H_f = 1 ft

Provide a pump with a design point of 14,465 gpm at 16 ft TDH

Provide chemical feed pumps capable of providing 25 mg/l dosage for both chlorination and dechlorination. This will provide a conservative design and allow for flexibility when calibrating the dosage to satisfy site conditions

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Determine dosage rate in lb/min

Design Flow Rate = 20.83 mgd = 54,677 L/min

Design Concentration = 25 mg/l

$$Dosage = 25\ {}^{mg}/_{L} * 54{,}677\ {}^{L}/_{min} = 1{,}366{,}952\ {}^{mg}/_{L} = 1.367\ {}^{kg}/_{min}$$

Assume a 12% strength solution of sodium hypochlorite solution

$$12\ \% = 120{,}000\ {}^{mg}/_{L} = 120\ {}^{kg}/_{m^3}$$

Sodium Hypochlorite feed rate:

$$Q = \frac{1.367\ {}^{kg}/_{min}}{120\ {}^{kg}/_{m^3}} = 0.011\ {}^{m^3}/_{min} = 3.0\ gpm = 180\ gal/hr$$

Assume a 44% strength sodium bisulfite solution

$$44\ \% = 440{,}000\ {}^{mg}/_{L} = 440\ {}^{kg}/_{m^3}$$

Sodium Bisulfite feed rate:

$$Q = \frac{1.367\ {}^{kg}/_{min}}{440\ {}^{kg}/_{m^3}} = 0.003\ {}^{m^3}/_{min} = 0.818\ gpm = 49\ gal/hr$$

Flow Equalization Tank (Alternative P2-A Only)

Design the Flow EQ tank at the WWTP to accommodate excess flows from CSO 3.

Flow will enter into the pump station flows exceed the dry weather capacity (≈900 gpm) wet weather pumps will turn on directing flow to the Flow EQ tanks. The following are the Flow EQ tank design parameters for Alternative P-1:

- Peak Flow Rate Q_P = 1.10 mgd = 761 gpm = 1.70 cfs
- Storage Volume = 1.14 million gallons

The largest diameter tank that can fit onto the site is 80 feet.

Use a 78-foot diameter, 33-foot-tall flow equalization tank

The tank floor will sit at an approximate elevation of 748 feet.

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Operating Narrative: During periods of wet weather, flows in excess of the dry weather pumping capacity (900 gpm) will be pumped using wet weather pumps to the Flow EQ tanks at the WWTP. After the event is over, flow will be pumped from the Flow EQ tanks into the normal process tanks.

Assume the pump intake is an elevation of 712 feet.

Determine the Static Head when tank is full:

$$H_s = (748\ ft + 32\ ft) - 712\ ft = 68\ ft$$

Set the forcemain velocity to 5 fps

$$d = 2\sqrt{\frac{Q}{v\pi}} = 2\sqrt{\frac{1.70\ cfs}{5fps * \pi}}$$

d = 8 inches

Determine the friction head:

$$H_f = 0.2083\left(\frac{100}{110}\right)^{1.85}\frac{(761\ gpm)^{1.85}}{(8\ in.)^{4.8655}}\left(\frac{850\ ft}{100}\right) = 13\ ft$$

Add 5% extra to account for minor headlosses:

$$H = 1.05(68\ ft + 13\ ft) = 85\ ft$$

The Wet Weather pump design point is 761 gpm @ 85 ft TDH

Aeration must be provided so that the stored volume does not go septic. Domestic Wastewater Facilities Manual requires 1.25 cfm/1,000 gallons

$$Q_{air} = \frac{1{,}140{,}000\ gallons}{1000} * 1.25\frac{cfm}{1000\ gallons} = 1{,}425\ cfm$$

Determine the blower motor size:

- Tank depth when full of 32 feet. Assume a diffuser submergence of 30 feet
- Assume an additional 5 feet of headloss through pipes, fittings and diffusers.
- The peak operating pressure is then 15 psi add 1 psi as a safety factor

$$P_w\frac{QP_1}{66.4e_me_B}\left[\left(\frac{P_2}{P_1}\right)^{0.283} - 1\right]$$

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Blower Horsepower (hp)

Q = Air flow rate in (CFM)

P_1 = Inlet Pressure (psia)

P_2 = Outlet Pressure (psia)

e_m = Blower Motor Efficiency (Assume 70%)

e_B = Blower Efficiency (Assume 90%)

$$P_w = \frac{(1{,}425\ CFM)(14.7\ psia)}{66.4(0.7)(0.9)}\left[\left(\frac{30.7\ psia}{14.7\ psia}\right)^{0.283} - 1\right] = 116\ hp$$

Provide two 150 hp blowers in a primary backup configuration

House the blowers in a 25 ft by 20 ft building

Alternatives B1

Concept Level Design Calculations

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The following are the design flows for Alternative B1

Alternative B1			
	Peak Flow Rate (mgd)	Peak Flow Rate (gpm)	Volume (gallons)
Collection/Conveyance Upgrades CSO 5	2.090	1451	-
Collection/Conveyance Upgrades CSO 6	5.220	3625	-
Collection/Conveyance Upgrades CSO 7	2.760	1917	-
Collection/Conveyance Upgrades CSO 8	5.170	3590	-
EBMA Pump Station Capacity	23.230	16132	-
WWTP Capacity*	10.000	6944	
Flow EQ Tank	14.430	9710	660,000
* Assumes a Wylie Capacity of 1.2 mgd			

Pump Station Design

Design the pump station so that normal dry weather flow will receive screening and grit removal and that wet weather flows would be directed to a separate train that provides screening through a manual bar screen and is discharged to a common wet well through a separate cutthroat flume.

Headworks Train Design

Provide a concept level design of the Normal Flow Channel and Primary Treatment Channel

Design Flows:

- Normal Flow Channel = 2.402 mgd = 1,668 gpm = 3.71 cfs
- Wet Weather Bypass Channel = 20.830 mgd = 14,465 gpm = 32.23 cfs

Design the Normal Flow Channel with the following equipment:

- 54" Long by 6" Wide Cutthroat Flume
- 7' Diameter Grit Chamber rated for 2.5 mgd
- 1' 3" Wide Mechanical Bar Screen

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Figure 1 – Conceptual Headworks Layout – Normal Flow Train

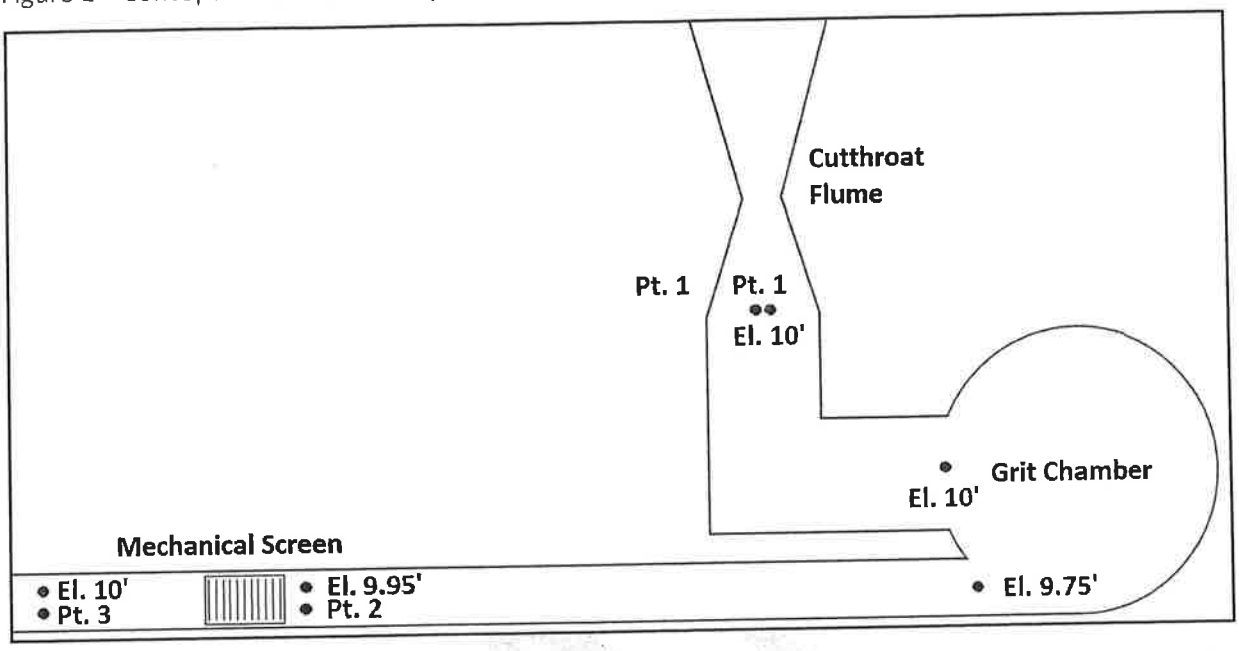


Figure 2 is a conceptual layout of the Normal Flow Channel. Not shown are slide gates and the manual bar screen channel. Determine the approximate water surface profile, ignore friction losses.

- Flow depth at Pt. 1 – Use equation for 54" X 6" cutthroat flume

$$y_1 = \left(\frac{Q}{1.96}\right)^{1/1.72} = \left(\frac{3.71\ cfs}{1.96}\right)^{1/1.72}$$

y_1 = 1.45 ft

  - Determine the total Head at Pt. 1

$$H_1 = y_1 + z_1 + \frac{v_1^2}{2g}$$

$$v_1 = {}^{Q}/_{A} = {}^{3.71cfs}/_{(1.45ft * 1.5ft)}$$

v = 1.71 fps

$$H_1 = 1.45ft + 10ft + \frac{(1.71fps)^2}{2g}$$

H_1 = 11.50 ft

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- Flow depth at Pt. 2 – Assume that $H_1 = H_2$

$$H_1 = y_2 + z_2 + \frac{v_2^2}{2g}$$

  - Guess y_2 = 1.49 ft

$$v_2 = {}^{Q}/_{A} = {}^{3.71cfs}/_{(1.49ft * 1.5ft)}$$

v_2 = 1.67 fps

$$H_2 = 1.49ft + 9.95ft + \frac{(1.67\ fps)^2}{2g}$$

H_2 = 11.50 ft = 11.50 ft – OK

y_2 = 1.49 ft

- Flow depth at Pt. 3 – Determine headloss through mechanical bar screen, assume 0.25 inch bar thickness, 0.25 inch clear space, 25% blockage.

$$h_l = \frac{Q^2}{2gK^2}\left[\left(\frac{1}{W_e(y_l + h_l)}\right)^2 - \left(\frac{1}{W(y_l + h_l)}\right)^2\right]$$

Q: Flow rate (cfs)

K: Frictional coefficient – 0.84

W_e: Effective width (ft)

W: Channel width (ft)

Y_l: Downstream flow depth (ft)

h_l: Headloss

$$W_e = (W - S)\left(\frac{c}{b + c}\right)(1 - B)$$

S: Side fabrication thickness (ft) – Assume 0.25 ft

c: Clear opening between bars (in.)

b: Bar thickness (in.)

B: Degree of blinding (fraction)

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$$W_e = (1.25\ ft - 0.25\ ft)\left(\frac{0.25\ in.}{0.25\ in. + 0.25\ in.}\right)(1 - 0.25)$$

$W_e = 0.375$ ft

- Guess $h_l = 0.49$ ft

$$h_l = \frac{(3.71\ cfs)^2}{2g(0.84^2)}\left[\left(\frac{1}{0.375ft(1.49ft + 0.49ft)}\right)^2 - \left(\frac{1}{1.25ft(1.49ft + 0.49ft)}\right)^2\right]$$

$h_l = 0.49$ ft = 0.49 ft - OK

$y_3 = y_2 + hl = 1.49$ ft + 0.49 ft

$y_3 = 1.98$ ft

Design the bypass channel with the following:

- 108" Long by 24" Wide Cutthroat Flume
- 4'-6" Wide Manual Bar Screen
- Use equation for 108" X 24" cutthroat flume to determine the flow depth

$$y_1 = \left(\frac{Q}{7.11}\right)^{1/1.56} = \left(\frac{32.26\ cfs}{7.11}\right)^{1/1.56}$$

$y_1 = 2.63$ ft

- Flow depth at Pt. 3 – Determine headloss through manual bar screen, assume 0.375 inch bar thickness, 0.25 inch clear space, 25% blockage.

$$h_l = \frac{Q^2}{2gK^2}\left[\left(\frac{1}{W_e(y_l + h_l)}\right)^2 - \left(\frac{1}{W(y_l + h_l)}\right)^2\right]$$

$$W_e = (W - S)\left(\frac{c}{b + c}\right)(1 - B)$$

$$W_e = (4\ ft - 0.25\ ft)\left(\frac{0.25\ in.}{0.375\ in. + 0.25\ in.}\right)(1 - 0.25)$$

$W_e = 1.275$ ft

- Guess $h_l = 0.99$ ft

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$$h_l = \frac{(32.23\ cfs)^2}{2g(0.84^2)}\left[\left(\frac{1}{1.275ft(2.63ft+0.99ft)}\right)^2 - \left(\frac{1}{4.5ft(2.63ft+0.99ft)}\right)^2\right]$$

h_l = 0.99 ft = 0.99 ft - OK

$y_3 = y_2 + hl$ = 2.63 ft + 0.99 ft

y_3 = 3.62 ft

Pump Station Wet Well

The pump station will be fitted with two dry weather pumps on VFDs operating in a primary back up system and two wet weather pumps also operating in a primary backup configuration. The depth of the wet well is determined based on the following assumptions:

- The dry weather pump off level is 5 feet above the floor
- The dry weather pumps required 2.5 feet of operating level
- The wet weather pumps required 2.5 feet of operating level
- 1 foot of freeboard is provided
- The top of the wet well is positioned at the headworks channel floor elevation so that during normal operation, the wet well level does not impact the water surface profile of the headworks.

Pump Station Cost Estimate

Reference Figures 2 and 3 for a plan and profile view of the pump station. Note that the figures are general, not to scale and for concept level design only.

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Figure 2 – Pump Station Layout, NTS

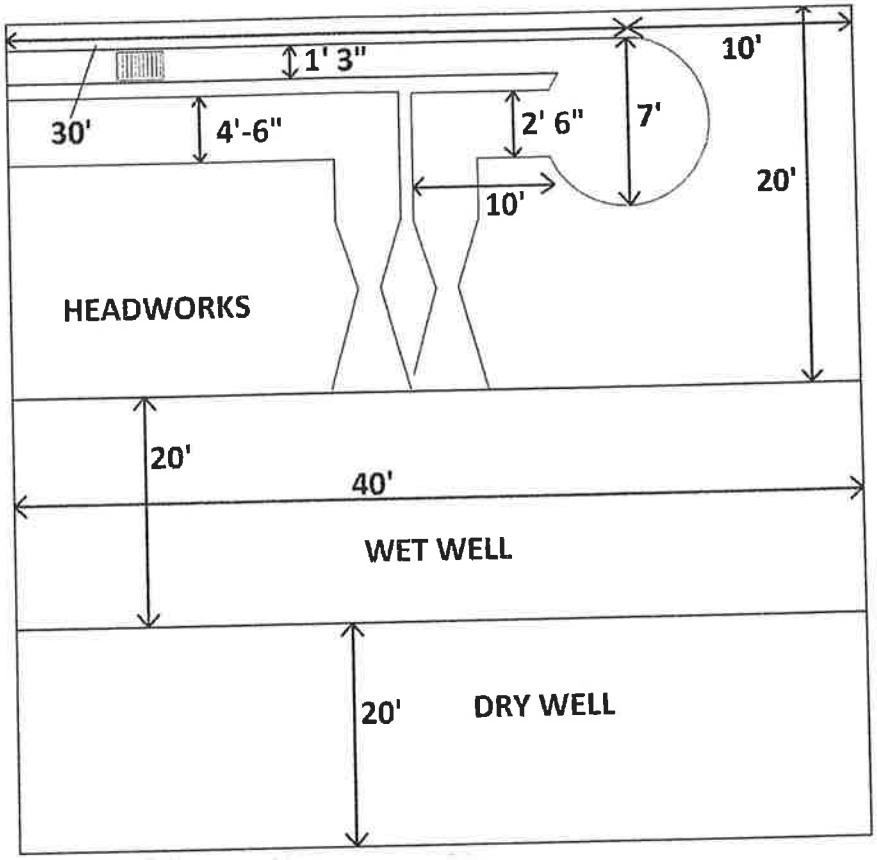
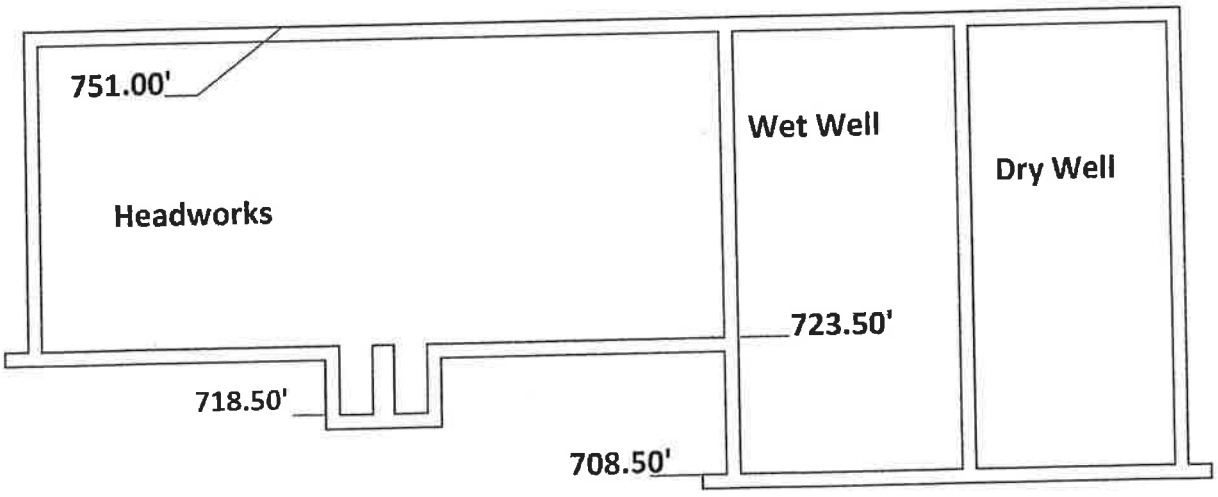


Figure 3 – Pump Station Profile View, NTS



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Reinforced Concrete Volume

Assume foundation is 2 ft thick and walls are 1.5 ft thick.

Headworks Floor:

$$V = 20ft * 40ft * 2ft = 1{,}600\ ft^3$$

Channel Walls (excluding grit chambers):

- Assume channel height of 5.5 ft. Assume total wall length of 150 ft

$$V = 5.5ft * 150ft * 1.5ft = 1{,}238\ ft^3$$

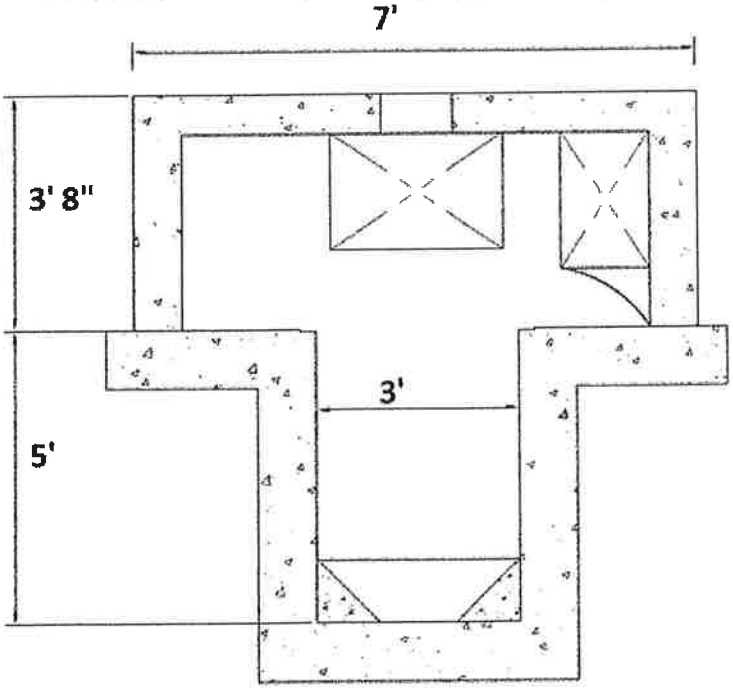
Channel Walls (grit chamber): Reference Figure 4 below

- 7 mgd grit chamber:

$$V = \left[\left(\pi\left({}^{10ft}/_{2}\right)^2\right) - \left(\pi\left({}^{7ft}/_{2}\right)^2\right)\right] * 3.67ft + \left[\left(\pi\left({}^{6ft}/_{2}\right)^2\right) - \left(\pi\left({}^{3ft}/_{2}\right)^2\right)\right] * 5ft$$

V 253 ft^3

Figure 4 – Grit Chamber Profile View, NTS



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Wet Well/Dry Well Floor:

$$V = 40\ ft * 40\ ft * 2\ ft = 3{,}200\ ft^3$$

Headworks Wall: Total Length

$$V = [2(35\ ft) + 2(40\ ft)](1.5\ ft)(27.5\ ft) = 6{,}188\ ft^3$$

Wet Well/Dry Well Wall:

$$V = [(3(40\ ft) * 1.5\ ft * 42.5\ ft)] + [40\ ft * 1.5\ ft * 15\ ft] = 8{,}550\ ft^3$$

Final Grade Floor, Assume 10 Inches thick:

$$V = (60\ ft)(40\ ft)\left(^{10\ in}/_{12}\right) = 1{,}992\ ft^3$$

Total Reinforced Concrete Volume = 23,021 ft³ = 852 yd³

Excavation Volume

Existing Grade is approximately 742 ft. The geotechnical report indicates that the top 20 feet of material is waste.

Outside dimensions of pump station is 63 ft by 43 ft, excavate a minimum area of 103 ft by 83 ft.

Excavate 5 feet below bottom of wet well floor, elevation 703.50 ft.

Sheet Pile two sides (along the railroad tracks, 83 ft and along Fallen Timber creek, 103 ft)

Cut back the remaining two sides at a 1:1 slope

Total Excavation depth:

$$742\ ft - 703.5\ ft = 38.5 ft$$

Excavation (Not including cutback)

$$V = 103\ ft * 83\ ft * 38.5\ ft = 329{,}137\ ft^3$$

Cut Back Volume:

$$V = \left[\left(^1/_2\right)(38.5\ ft)(38.5\ ft)(141\ ft)\right] + \left[\left(^1/_2\right)(38.5\ ft)(38.5\ ft)(121\ ft)\right] = 194{,}174\ ft^3$$

Total Excavation Volume = 523,284 ft³ = 19,380 yd³

Sheet Piling Surface Area

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Assume sheet piling extends 10 feet below excavation depth.

$$SA = (103\ ft + 83\ ft) * 48.5\ ft = 9{,}021\ ft^3$$

Stone Volume

Assume that stone is used to backfill the excavation volume excluding the cutback area and the pump station volume (104,297 ft^3)

Total Stone Backfill Volume = 84,917 ft^3 = 3,145 yd^3

Assume the excess material disposal volume is equal to the stone volume.

Assume a site grading volume of 8,000 yd^3

Pump Station Pump Design

For dry weather pumps, use 3 pumps in a lead-lag-standby configuration each with a design flow of 4.4 mgd (when both pumps are in operation, the total output will be 8.8 mgd, which, in addition to 1.2 mgd from the Wylie pump station would be the capacity of the WWTP).

For the wet weather pumps, also use 3 in a lead-lag-standby configuration each with a design point of 7.22 mgd.

Dry Weather Pumps

For the dry weather pumps, the static head is estimated as follows:

- Discharge Elevation = 758 ft
- Intake Elevation ≈ 713 ft

$$H_s = 758\ ft - 713\ ft$$

$$H_s = 45\ ft$$

Determine the dry weather pump friction head

- Total Length - 675 ft
- Forcemain Diameter – 16 inches
- Total Flow – 6,111 gpm

$$H_f = 0.2083\left(\frac{100}{110}\right)^{1.85}\frac{(6{,}111)^{1.85}}{(16)^{4.8655}}\left(\frac{675}{100}\right)$$

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H_f = 16 ft

Add 5% of the static and friction head for minor losses, the design point for the dry weather pumps are:

3,055 gpm @ 64 ft TDH

Wet Weather Pumps

Static head is estimated as follows:

- Discharge Elevation = 785 ft (assumes a flow equalization tank with a 64 ft diameter, 28 feet tall)
- Intake Elevation ≈ 715 ft

$$H_s = 785\ ft - 715\ ft$$

$$H_s = 70\ ft$$

Determine the dry weather pump friction head

- Total Length - 850 ft
- Forcemain Diameter – 24 inches
- Total Flow – 10,021 gpm

$$H_f = 0.2083\left(\frac{100}{110}\right)^{1.85}\frac{(10{,}021)^{1.85}}{(24)^{4.8655}}\left(\frac{850}{100}\right)$$

H_f = 7 ft

Add 5% of the static and friction head for minor losses, the design point for the dry weather pumps are:

5,015 gpm @ 81 ft TDH

Flow Equalization Tank

Design the Flow EQ tank at the WWTP

Use a 64-foot diameter, 28-foot-tall flow equalization tank

The tank floor will sit at an approximate elevation of 752 feet.

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Operating Narrative: During periods of wet weather, flows in excess of the dry weather pumping capacity (6,110 gpm) will be pumped using wet weather pumps to the Flow EQ tanks at the WWTP. After the event is over, flow will drain back to the pump station through the forcemain to be pumped into the normal process tanks.

Assume the pump intake is an elevation of 712 feet.

Aeration must be provided so that the stored volume does not go septic. Domestic Wastewater Facilities Manual requires 1.25 cfm/1,000 gallons

$$Q_{air} = \frac{660{,}000\ gallons}{1000} * 1.25 \frac{cfm}{1000\ gallons} = 825\ cfm$$

Determine the blower motor size:

- Tank depth when full of 27 feet. Assume a diffuser submergence of 25 feet
- Assume an additional 5 feet of headloss through pipes, fittings and diffusers.
- The peak operating pressure is then 13 psi add 1 psi as a safety factor

$$P_w \frac{QP_1}{66.4 e_m e_B}\left[\left(\frac{P_2}{P_1}\right)^{0.283} - 1\right]$$

Blower Horsepower (hp)

Q = Air flow rate in (CFM)

P_1 = Inlet Pressure (psia)

P_2 = Outlet Pressure (psia)

e_m = Blower Motor Efficiency (Assume 70%)

e_B = Blower Efficiency (Assume 90%)

$$P_w = \frac{(825\ CFM)(14.7\ psia)}{66.4(0.7)(0.9)}\left[\left(\frac{28.7\ psia}{14.7\ psia}\right)^{0.283} - 1\right] = 60\ hp$$

Provide two 75 hp blowers in a primary backup configuration

House the blowers in a 25 ft by 20 ft building

Appendix K

Cost Per Household

Worksheet 1
Alternative P1-A

		Line Number
Current WWTP Cost		
Annual Operations and Maintenance Expenses (Excluding Depreciation)	$ 642,000	100
Annual Debt Service (Principal and Interest)	$ 1,172,000	101
Subtotal	$ 1,814,000	102
Projected WWTP and CSO Cost (Current Dollars)		
Estimated Annual Operations and Maintenance Expenses (Excluding Depreciation)	$ 54,000	103
Annual Debt service (Principal and Interest)	$ 1,172,000	104
Subtotal	$ 1,226,000	105
Total Current and Projected WWTP and CSO Control Cost	$ 3,040,000	106
Residential Share of Total WWT and CSO Control Cost	$ 3,040,000	107
Total number of Households in Service Area	2,204	108
Cost Per Household	$ 1,379	109

Support Data

Consumer Price index (Five Year Average)	XXX
Total Wastewater Flow (Five Year Average)	1
Nonresidential Wastewater Flow (Five Year Average)	0

Cost Per Household

Worksheet 1
Alternative P1-B

		Line Number
Current WWTP Cost		
Annual Operations and Maintenance Expenses (Excluding Depreciation)	$ 642,000	100
Annual Debt Service (Principal and Interest)	$ 413,000	101
Subtotal	$ 1,055,000	102
Projected WWTP and CSO Cost (Current Dollars)		
Estimated Annual Operations and Maintenance Expenses (Excluding Depreciation)	$ 55,000	103
Annual Debt service (Principal and Interest)	$ 1,330,200	104
Subtotal	$ 1,385,200	105
Total Current and Projected WWTP and CSO Control Cost	$ 2,440,200	106
Residential Share of Total WWT and CSO Control Cost	$ 2,440,200	107
Total number of Households in Service Area	2,204	108
Cost Per Household	$ 1,107	109

Support Data

Consumer Price index (Five Year Average)	XXX
Total Wastewater Flow (Five Year Average)	1
Nonresidential Wastewater Flow (Five Year Average)	0

Cost Per Household

Worksheet 1

Alternative P2-A

		Line Number
Current WWTP Cost		
Annual Operations and Maintenance Expenses (Excluding Depreciation)	$ 642,000	100
Annual Debt Service (Principal and Interest)	$ 413,000	101
Subtotal	$ 1,055,000	102
Projected WWTP and CSO Cost (Current Dollars)		
Estimated Annual Operations and Maintenance Expenses (Excluding Depreciation)	$ 54,000	103
Annual Debt service (Principal and Interest)	$ 1,252,800	104
Subtotal	$ 1,306,800	105
Total Current and Projected WWTP and CSO Control Cost	$ 2,361,800	106
Residential Share of Total WWT and CSO Control Cost	$ 2,361,800	107
Total number of Households in Service Area	2,204	108
Cost Per Household	$ 1,072	109

Support Data

Consumer Price index (Five Year Average)	XXX
Total Wastewater Flow (Five Year Average)	1
Nonresidential Wastewater Flow (Five Year Average)	0

Cost Per Household

Worksheet 1
Alternative P2-B

		Line Number
Current WWTP Cost		
Annual Operations and Maintenance Expenses (Excluding Depreciation)	$ 642,000	100
Annual Debt Service (Principal and Interest)	$ 413,000	101
Subtotal	$ 1,055,000	102
Projected WWTP and CSO Cost (Current Dollars)		
Estimated Annual Operations and Maintenance Expenses (Excluding Depreciation)	$ 52,000	103
Annual Debt service (Principal and Interest)	$ 1,413,700	104
Subtotal	$ 1,465,700	105
Total Current and Projected WWTP and CSO Control Cost	$ 2,520,700	106
Residential Share of Total WWT and CSO Control Cost	$ 2,520,700	107
Total number of Households in Service Area	2,204	108
Cost Per Household	$ 1,144	109

Support Data

Consumer Price index (Five Year Average)	XXX
Total Wastewater Flow (Five Year Average)	1
Nonresidential Wastewater Flow (Five Year Average)	0

Cost Per Household

Worksheet 1
Alternative B1

		Line Number
Current WWTP Cost		
Annual Operations and Maintenance Expenses (Excluding Depreciation)	$ 642,000	100
Annual Debt Service (Principal and Interest)	$ 413,000	101
Subtotal	$ 1,055,000	102
Projected WWTP and CSO Cost (Current Dollars)		
Estimated Annual Operations and Maintenance Expenses (Excluding Depreciation)	$ 47,000	103
Annual Debt service (Principal and Interest)	$ 1,167,500	104
Subtotal	$ 1,214,500	105
Total Current and Projected WWTP and CSO Control Cost	$ 2,269,500	106
Residential Share of Total WWT and CSO Control Cost	$ 2,269,500	107
Total number of Households in Service Area	2,204	108
Cost Per Household	1030	109

Support Data

Consumer Price index (Five Year Average)	XXX
Total Wastewater Flow (Five Year Average)	1
Nonresidential Wastewater Flow (Five Year Average)	0

Residential Indicator

Worksheet 2
Alternative P1-A

		Line Number
Median Household Income (MHI)		
Census Year MHI	$ 49,620.00	201
MHI Adjustment Factor [1]	1.00	202
Adjusted MHI	$ 49,621.00	203
Annual WWT and CSO Control Cost Per Household (Line 109)	$ 1,379	204
Residential Indicator		
Annual Wastewater and CSO Control Cost per Household as a Percent of Adjusted MHI	2.8%	

Support Data

Consumer Price index (Five Year Average) [1]	XXX
Census Year	XXX
Current Year	XXX

(1) Data for the median household income was obtained from the Southwest Pennsylvania Commission and is reported fro August 2016

Residential Indicator

Worksheet 2
Alternative P1-B

		Line Number
Median Household Income (MHI)		
Census Year MHI	$ 49,620.00	201
MHI Adjustment Factor [1]	1.00	202
Adjusted MHI	$ 49,621.00	203
Annual WWT and CSO Control Cost Per Household (Line 109)	$ 1,107	204
Residential Indicator		
Annual Wastewater and CSO Control Cost per Household as a Percent of Adjusted MHI	2.2%	

Support Data

Consumer Price index (Five Year Average) [1]	XXX
Census Year	XXX
Current Year	XXX

(1) Data for the median household income was obtained from the Southwest Pennsylvania Commission and is reported fro August 2016

Residential Indicator

Worksheet 2
Alternative P2-A

		Line Number
Median Household Income (MHI)		
Census Year MHI	$ 49,620.00	201
MHI Adjustment Factor [1]	1.00	202
Adjusted MHI	$ 49,621.00	203
Annual WWT and CSO Control Cost Per Household (Line 109)	$ 1,072	204
Residential Indicator		
Annual Wastewater and CSO Control Cost per Household as a Percent of Adjusted MHI	2.2%	

Support Data

Consumer Price index (Five Year Average) [1]	XXX
Census Year	XXX
Current Year	XXX

(1) Data for the median household income was obtained from the Southwest Pennsylvania Commission and is reported fro August 2016

Residential Indicator

Worksheet 2
Alternative P2-B

		Line Number
Median Household Income (MHI)		
Census Year MHI	$ 49,620.00	201
MHI Adjustment Factor [1]	1.00	202
Adjusted MHI	$ 49,621.00	203
Annual WWT and CSO Control Cost Per Household (Line 109)	$ 1,144	204
Residential Indicator		
Annual Wastewater and CSO Control Cost per Household as a Percent of Adjusted MHI	2.3%	

Support Data

Consumer Price index (Five Year Average) [1]	XXX
Census Year	XXX
Current Year	XXX

(1) Data for the median household income was obtained from the Southwest Pennsylvania Commission and is reported fro August 2016

Residential Indicator

Worksheet 2
Alternative B1

		Line Number
Median Household Income (MHI)		
Census Year MHI	$ 49,620.00	201
MHI Adjustment Factor [1]	1.00	202
Adjusted MHI	$ 49,621.00	203
Annual WWT and CSO Control Cost Per Household (Line 109)	$ 1,030	204
Residential Indicator		
Annual Wastewater and CSO Control Cost per Household as a Percent of Adjusted MHI	2.1%	

Support Data

Consumer Price index (Five Year Average) [1]	XXX
Census Year	XXX
Current Year	XXX

(1) Data for the median household income was obtained from the Southwest Pennsylvania Commission and is reported fro August 2016

Bond Rating

Worksheet 3

		Line Number
Most Recent General Obligation Bond Rating		
Date		
Rating Agency		
Rating		301
Most Recent Revenue (Water/Sewer or Sewer) Bond		
Date	1/30/2015	
Rating Agency	S&P	
Bond Insurance (Yes/No)		
Rating	BBB+	302
Summary Bond Rating	BBB+	303
Score	Mid-Range	

Overall Net Debt as a Percent of Full Market Property Value

Worksheet 4

		Line Number
Direct Net Debt (G.O Bonds Excluding Double-Barreled Bonds)		401
Debt of Overlapping Entities (Proportionate Share of Multijurisdictional Debt)	$ 11,001,189	402
Overall Net Debt	$ 11,001,189	403
Market Value of Property	$ 246,381,361	404
Overall Net Debt as a Percent of Full Market Property Value	4.5%	405
Score	Mid-Range	

Benchmarks:
Weak: Above 5%
Mid-Range: 2-5%
Strong: Below 2%

Unemployment Rate

Worksheet 5

		Line Number
Unemployment Rate - Permittee	10.8%	501
Source	SPC	
Unemployment Rate - County	7.6%	
Source	SPC	502
Benchmark		
Average National Unemployment Rate	9.2%	503
Source	SPC	
Score	Weak	

Benchmarks:
Weak: More Than 1% Above National
Mid-Range: ± 1% National
Strong: More Than 1% Below National

Median Household Income

Worksheet 6

		Line Number
Median Household Income (Line 203)	49,621	601
Source	SPC	
Benchmark		
Census Year National MHI	$ 53,046	602
MHHI Adjustment Factor (Line 202)	1.00	603
Adjusted National MHI	$ 53,046	604
Source	SPC	
Score	Mid-Range	

Benchmarks:
Weak: More Than 25% Below National
Mid-Range: ± 25% National
Strong: More Than 25% Above National

Property Tax Revenues as a Percent of Full Market Property Value

Worksheet 7

		Line Number
Full Market Value of Real Property (Line 404)	$ 246,381,361	701
Property Tax Revenues	$ 1,637,258.62	702
Property Tax Revenues as a Percent of Full Market Property Value	1%	703
Score	Strong	

Benchmarks:
Weak: Above 4%
Mid-Range: 2-4%
Strong: Below 2%

Property Tax Revenue Collection Rate

Worksheet 8

		Line Number
Property Tax Revenue Collection (702)	$ 246,381,361	801
Property Taxes Levied	$ 523,699,391	802
Property Tax Revenue Rate	47%	803
Score	Weak	

Benchmarks:
Weak: Below 94%
Mid-Range: 94-98%
Strong: Above 98%

Summary of Permittee Financial Capability Indicators

Worksheet 9

	Column A: Actual Value	Column B: Score	Line Number
Bond Rating (Line 303)	BBB+	2	901
Overall Net Debt as a Percent of Full Market Property Value (Line 405)	4.5%	2	902
Unemployment Rate (Line 501)	10.8%	1	903
Median Household Income (Line 601)	$ 49,621	2	904
Property Tax Revenues as a Percent of Full Market Property Value (Line 703)	0.7%	3	905
Property Tax Revenue Collection Rate (Line 803)	47%	2	906
Permittee Indicator Score		2.0	907

Financial Capability Matrix Score

Worksheet 10

		Line Number
Residential Indicator Score (Line 205)		1001
Alternatvie P1-A	2.78% High	
Alternatvie P1-B	2.23% High	
Alternatvie P2-A	2.16% High	
Alternatvie P2-B	2.30% High	
Alternatvie B1	2.08% High	
Permittee Financial Capability Indicator Score (Line 907)	2.0	1002
Financial Capability Matrix Category		1003
Alternatvie P1-A	High Burden	
Alternatvie P1-B	High Burden	
Alternatvie P2-A	High Burden	
Alternatvie P2-B	High Burden	
Alternatvie B1	**High Burden**	

Premittee Financial Capability Indication Score	**Residential Indicator**		
	Low (Below 1.0%)	Mid-Range (Between 1.0 and 2.0%)	High (Above 2.0%)
Weak (Below 1.5)	Medium Burden	High Burden	High Burden
Mid-Range (Between 1.5 and 2.5)	Low Burden	Medium Burden	High Burden
Strong (Above 2.5)	Low Burden	Low Burden	Medium Burden

Public Comment

The LTCP was advertised for a 30 day public comment period starting May 10, 2017 with two information meetings held May 11, and June 8, 2017. A public hearing was held on June 9, 2017.

No public comments were received during this period.

AFFP
Long Term Control Plan

Affidavit of Publication

STATE OF PENNSYLVANIA } SS
COUNTY OF
WESTMORELAND }

Jeffrey T. Oliver, being duly sworn, says:

That he is General Manager of the Mon Valley Independent, a daily newspaper of general circulation, printed and published in Monessen, Westmoreland County, Pennsylvania; that the publication, a copy of which is attached hereto, was published in the said newspaper on the following dates:

April 28, 2017

That said newspaper was regularly issued and circulated on those dates.

SIGNED:

General Manager

Subscribed to and sworn to me this 28th day of April 2017.

Joseph A Dalfonso, Notary Public, Westmoreland County, Pennsylvania

My commission expires: January 01, 2018

Magisterial District Judge
Westmoreland County, PA
My Commission Expires
1st Monday in January 2018

00001778 00009020 412-384-3144

Andrea Zober
Elizabeth Boro Municipal Authority
1 Locust St
ELIZABETH, PA 15037

PUBLIC NOTICE

Long Term Control Plan for
Elizabeth Borough
Municipal Authority

By this notice, all public and interested agencies are hereby notified that the Elizabeth Borough Municipal Authority's Long Term Control Plan for combined sewage facilities will be available for public inspection starting May 8, 2017 at the wastewater treatment plant located at

1 Locust Street
Elizabeth, PA 15037

The sewage treatment plant is a secure facility. Interested parties must call to schedule an appointment to review the document. Appointments can be scheduled by calling 412 384 3686, Monday thru Friday between the hours of 9:00 AM to 2:00 PM

The Long Term Control Plan requires the construction of two new pump stations within Elizabeth Borough's collection system, the construction of a new pump station to replace the existing Mill street pump station, and the construction of a new wastewater treatment facility on the existing wastewater treatment plant property

Member of the public are encouraged to attend one of two informational meeting on May 11, 2017 and June 8, 2017 at 4:30 PM. The Authority will hold a public hearing to address questions and comments from the public on June 9, 2017 at 4:00 PM. All meetings will be held at the wastewater treatment plant located at:

#1 Locust Street
Elizabeth, PA 15037

A 30-day comment period has been established to allow the general public or other interested agencies to review the plan and offer comments. Comments should be submitted in writing to the following address on or before June 9, 2017.

Michael Elisco, E.I.T
420 William Pitt Way
Pittsburgh, PA 15238

Comments received will be addressed in the final submission to PA DEP.
4/28

CERTIFICATION

I hereby certify that the following people were in attendance at the Friday, June 9, 2017 Public Hearing for discussion of the Elizabeth Borough Municipal Authority's Long Term Control Plan scheduled and convened at 4:00 pm, local time at 1 Locust Street, Elizabeth, PA 15037.

Michael J. Zrenchak Operations Manager
Kenneth L. Hillman Senate Engineering
Annabel L Zober Admin Assist.
David G. House Holder Chairman.

Amy R. Schrempf, Solicitor

By: _____

Amy R. Schrempf, Solicitor
PA I.D. No. 87619
1103 East Carson Street
Pittsburgh, PA 15203

No public participation by 4:10pm
ARS

RESOLUTION NO. 03-17

A RESOLUTION OF ELIZABETH BOROUGH MUNICIPAL AUTHORITY, ALLEGHENY COUNTY, COMMONWEALTH OF PENNSYLVANIA, STATINGS ITS INTENTION TO ADOPT THE LONG TERM CONTROL PLAN AS PREPARED BY SENATE ENGINEERING

WHEREAS, Elizabeth Borough Municipal Authority desires to adopt the Long Term Control Plan as prepared by Senate Engineering, presented as a draft on January 19, 2017;

WHEREAS, said plan was advertised, two public meetings were held and the period for public comments has ended;

WHEREAS, no public objections or comments were brought forth or raised;

WHEREAS, EBMA desires to formally adopt the Long Term Control Plan as prepared by Senate Engineering;

AND NOW THEREFORE, the Authority hereby resolves and officially adopts the Long Term Control Plan as presented in its draft form by Senate Engineering on January 19, 2017, as incorporated herein by reference.

RESOLVED this 8th day of June, 2017.

TALLY OF VOTES: 6 Yeas 0 Nays

Attest: David G. Rosenholtz