

IN THE COURT OF COMMON PLEAS  
FRANKLIN COUNTY, OHIO

STATE OF OHIO, *ex rel.*,  
JIM PETRO  
ATTORNEY GENERAL OF OHIO,

Plaintiff,

CITY OF COLUMBUS,

Defendant.

Case No. 04 CVH 05 5336

Judge Reece

TERMINATION NO. 7  
9-17-04

FILED  
COMMON PLEAS COURT  
FRANKLIN CO. OHIO  
2004 SEP 17 AM 10:18  
CLERK OF COURTS

**CONSENT ORDER**

The Plaintiff, State of Ohio, by its Attorney General (hereinafter "Plaintiff" or "State of Ohio") and Defendant, City of Columbus (hereinafter "Defendant" or "Columbus"), hereby consent to the entry of this Consent Order in order to resolve the allegations in this matter and pursuant to Chapter 6111 of the Ohio Revised Code.

**NOW THEREFORE**, without trial or admission of any issue of law or of fact, and upon the consent of the parties hereto, it is hereby **ORDERED, ADJUDGED** and **DECREED** as follows:

**I. JURISDICTION AND VENUE**

1. The Court has jurisdiction over the parties and the subject matter of this case pursuant to R.C. Chapter 6111. The complaint states a claim upon which relief can be granted against the Defendant and venue is proper in this Court.

**II. PARTIES**

2. The provisions of this Consent Order shall apply and be binding upon the Plaintiff and Defendant, Defendant's agents, officers, employees, assigns, successors in interest and any person acting in concert or privity with the Defendant or the Defendant's officers, agents,

employees, successors, or assigns. Columbus shall provide a copy of this Consent Order to each general contractor and each consultant or engineer that it employs to perform any of the activities or work itemized herein. Columbus shall require each general contractor to provide a copy of this Consent Order to each of its subcontractors for such work.

**III. SATISFACTION OF LAWSUIT AND RESERVATION OF RIGHTS**

3. Plaintiff alleges that Defendant has operated its combined sewer system in such a manner as to result in violations of the requirements of the National Pollution Discharge Elimination System (hereinafter "NPDES") Permits issued to it by the Director of Ohio EPA and in violation of the water pollution laws of the State of Ohio. The State's allegations of various violations of Columbus' NPDES permits include: the failure to timely complete a Long Term Control Plan; the failure to fully implement the minimum control measures required by the NPDES permits; and the failure to properly operate and manage the combined sewer system. Columbus denies the allegations of the complaint. Compliance with the terms of this Consent Order shall constitute full satisfaction of any civil liability by Defendant for all claims of violations alleged in the complaint, as well as the claims for injunctive relief and civil penalties in the complaint.

4. Nothing in this Consent Order shall be construed to limit the authority of the State of Ohio to seek relief against other appropriate persons for claims or conditions alleged in the complaint. Nothing in this Consent Order shall be construed to limit the authority of the State of Ohio to seek relief against Columbus or other appropriate persons for claims or conditions not alleged in the complaint, including violations which occur after the filing of the complaint. Similarly, nothing in this Consent Order shall be construed to limit the authority of the State of

Ohio to undertake any action against any person, including Columbus, to eliminate or mitigate conditions, which may present a threat to the public health, welfare or the environment.

#### IV. DEFINITIONS

5. Definitions:

“Combined Sewer System” or “CSS” shall mean the portions of Defendant’s Sewer System designed to convey both municipal sewage (including sewage, industrial waste and other waste) and stormwater runoff through a single pipe to Defendants’ interceptor sewers, Wastewater Treatment Plants or a Combined Sewer Overflow Outfall, or any area that is tributary to a sewer regulator. Defendant’s CSS is set forth in the map attached hereto as Attachment A. Attachment A is incorporated into this Order as if fully restated herein.

“Combined Sewer Overflow” or “CSO” shall mean any discharge from: (i) any overflow and/or outfall identified as a combined sewer overflow or CSO in Defendant’s Current NPDES Permits, as defined below, (ii) any other overflow and/or outfall listed in Attachment B, or (iii) from any other combined sewer structure within the CSS. Attachment B is incorporated into this Order as if fully restated herein.

“Combined Sewer Overflow Outfall” or “CSO Outfall” shall mean the outfall from which CSOs discharge to waters of the state.

“CSO Policy” shall mean the U.S. Environmental Protection Agency’s “Combined Sewer Overflow Policy” which was published in the Federal Register on April 19, 1994 (59 Fed. Reg. 18688 et seq).

“NPDES Permits” means NPDES Permit 4PF00000\*JD (Jackson Pike WWTP) and Permit 4PF00001\*KD (Columbus Southerly WWTP), and any such NPDES permits that succeed those permits and are in effect at a particular time in question.

“Nine Minimum Controls” shall mean the Nine Minimum Controls set forth in the CSO Policy at 59 Fed. Reg. 18691.

Jackson Pike “outfall 003” is the mechanical bypass at Jackson Pike WWTP, installed pursuant to PTI No. 90-666.

“Sewer System” shall mean the wastewater collection and transmission system owned or operated by Defendant designed to collect and convey municipal sewage (sewage, industrial waste and other waste) to Defendant’s Wastewater Treatment Plants or overflow structures and/or outfall locations. Sewer System includes but is not limited to the CSS.

“SSO consent order” shall mean the Consent Order entered in State of Ohio ex rel Betty D. Montgomery v. City of Columbus, Franklin County Common Pleas Court Case No. 02CVH-05-5768 on August 1, 2002.

“Wastewater Treatment Plant(s) or “WWTP(s)” shall refer to Defendant’s Jackson Pike and Southerly Wastewater Treatment Plants.

“Water Quality Standards” or “WQS” shall mean the water quality standards adopted by Ohio, that are in effect at any particular point in time. These water quality standards may appear in OAC Chapter 3745-1 or elsewhere in the Ohio Administrative Code. Water Quality Standards shall also include any applicable water quality standards promulgated by US EPA for waters of the state pursuant to 33 U.S.C. 1313(c)(4).

#### **V. SPECIFIC INJUNCTIVE RELIEF**

6. Columbus is hereby permanently enjoined and immediately ordered to comply with the requirements of R.C. Chapter 6111 and the rules adopted thereunder, and the terms and conditions of its NPDES Permits, including NPDES Permits No. 4PF00000\*JD and 4PF00001\*KD, and any renewals or modifications thereof.

7. Columbus shall properly operate and maintain its Combined Sewer System and any associated equipment and structures. By April 1, 2005 Columbus shall submit to Ohio EPA, for review and approval, an update of its November 1996 “Combined Sewer Systems Operations and Maintenance Plan” (CSSOMP). The plan shall outline the procedures used to ensure that the collection system is adequately maintained, and the steps taken to ensure that the frequency, duration and volume of flow, and that the pollutant loads discharge from the permittee's combined sewer overflows are minimized in accordance with the Nine Minimum Controls. The CSSOMP shall, *inter alia*, include routine inspection schedules for the following critical components of the CSS: the Whittier Street Storm Tanks, Alum Creek Storm Tank, Dodge Park Combined Pump Station, and the nineteen Regulators listed in Attachment B. In developing the CSSOP, the City may utilize EPA’s *Combined Sewer Overflows – Guidance for Nine Minimum Controls* (EPA 832-B-95-003) (May 1995). Upon approval of the updated CSSOMP, Columbus shall thereafter operate and maintain the CSS in accordance with the approved updated CSSOMP. In the event that Ohio EPA later approves further changes to the approved updated CSSOMP, Columbus shall thereafter operate and maintain the CSS in accordance with such changes.

8. No later than October 15, 2004, Columbus shall develop and submit to Ohio EPA, for review and approval, a public notification program that informs the public of the location of any CSO overflow and/or CSO Outfall, the possible health and environmental impacts associated with CSO overflows/ CSO Outfalls, and advises the public against contact or recreation when elevated bacteria levels may endanger public health. This public notification program shall, *inter alia*, include development and maintenance in a form that is accessible to the public via the internet of: (i) a map of the CSO overflows/ CSO outfalls; (ii) a data base showing the date and

volume of each overflow or discharge from a CSO overflow/CSO outfall; and (iii) the Characterization Report required by paragraph 11, or the executive summary from the Characterization Report together with a summary of the sampling data generated for the Characterization Report. This information shall be periodically updated consistent with the terms of the public notification program as approved. Upon approval of the public notification program by Ohio EPA, Columbus shall thereafter implement and comply with the program as approved.

9. By July 1, 2004 Columbus shall submit to Ohio EPA for review and approval, a plan for insuring that there is ample public participation throughout all stages of development of Columbus' Long Term Control Plan. The plan shall, at a minimum, include a description of the measures that Columbus will undertake: (i) to make information Columbus develops in the course of the planning process available to the public for review; (ii) to solicit public opinion on Columbus' development of the Long Term Control Plan. The plan shall also include a schedule for holding public hearings at meaningful times during the planning process in order to provide the public with information developed in the planning process and to solicit information from the public regarding the components of the Long Term Control Plan. The plan shall describe how Columbus will take public opinion and information provided by the public into account as Columbus develops its Long Term Control Plan. Upon approval by Ohio EPA, Columbus shall implement the plan as approved.

10. By July 1, 2005 Columbus shall submit to Ohio EPA, for review and approval, a Long Term Control Plan (LTCP). The goal of the LTCP is to: bring all wet weather CSOs and CSO outfall discharge points into compliance with the technology-based and water-quality based requirements of the Clean Water Act and Ohio Revised Code 6111; to minimize water quality, aquatic biota and human health impacts from CSOs and CSO outfalls; and to minimize the

discharge of pollutants. The LTCP shall comply with the CSO Policy and shall be developed in compliance with the CSO Policy. In developing the LTCP, Columbus may utilize EPA's *Combined Sewer Overflows – Guidance for Long Term Control Plan* (EPA 832—95-002) (September 1995). The development of the LTCP by Columbus shall include but not be limited to the following:

- A. Characterization of the combined sewer system and its impact on the receiving stream, including development and use of both a collection system hydraulic model and a receiving stream water quality model; monitoring to support model(s) development and use; and a water quality study;
- B. public participation;
- C. consideration of sensitive areas;
- D. development and evaluation of alternatives;
- E. any proposed revisions to the approved updated CSSOMP;
- F. maximization of treatment at WWTPs;
- G. an implementation schedule;
- H. post-construction compliance monitoring.

11. Characterization: Defendant shall adequately characterize, through monitoring, modeling and other means as appropriate, for a range of storm events, the response of its sewer system to wet weather events, including the number, location and frequency of CSOs and CSO Outfalls, volume concentration and mass of pollutants discharged and the impacts of the CSOs and CSO Outfalls on the receiving waters and their designated uses. To achieve this

characterization, the City shall develop and utilize a hydraulic model for its Sewer System, which will include CSOs, CSO Outfalls, and the actual and potential hydraulic capacities of its WWTPs. Defendant shall also develop and utilize a water quality model that will adequately characterize the response of the receiving waters to CSO overflow, CSO outfall discharges and discharges from the WWTPs under various scenarios. Columbus shall submit this characterization in a Characterization Report together with the LTCP. The Characterization Report shall include a summary of the monitoring data and modeling that Columbus currently has or develops in the characterization process. It shall also summarize the methodology and findings of the characterization, including the baseline data on the number, volume and duration of CSO overflows and/or CSO Outfall discharges and their impact on the receiving streams as well as the projected impact of the selected controls.

- A. Columbus shall implement a monitoring program that provides adequate data to characterize and model the sewer system and overflows and their impact on the receiving waters; supports development and implementation of the minimum control measures; supports development and implementation of a long-term control plan; and allows the effectiveness of control measures to be evaluated. The monitoring shall include the collection of dissolved oxygen data from sites on the Scioto River, the Olentangy River, Big Walnut and Alum Creek under differing flow and weather scenarios using datasondes. Columbus shall analyze the temporal duration and areal extent of bacteria WQS exceedances in the Big Walnut, Alum Creek, Olentangy, and Scioto River, including but not limited to downstream of the Columbus Southerly WWTP, and the contribution made by CSOs and CSO outfalls, based both on baseline conditions and projected



conditions after implementation of CSO/CSO outfall controls for a typical year. The monitoring shall include further data collection sufficient to support calibration and verification of the hydraulic model and water quality model and a wet weather evaluation of the water quality model.

- B. Columbus shall perform the receiving water modeling consistent with Defendant's "Long-Term Control Plan Update Receiving Water Modeling Methodology Memorandum", attached hereto as Attachment C. Due to the necessary interaction between the LTCP and the studies being conducted pursuant to the SSO Consent Order, the parties agree that the City may utilize, as necessary, the Third Approximation approach outlined in Attachment C.

12. Development and Evaluation of Alternatives:

- A. Columbus shall develop LTCP alternatives that include, but are not limited to: elimination of all existing CSO overflows/ CSO Outfalls by complete separation of all combined sewers; separation of specific portions of the CSS, construction of additional separate sanitary express sewers to convey additional flows to the WWTPs for treatment; various sizes of storage basins or tunnels for the Combined Sewer System; construction of additional facilities (such as high rate treatment or ballasted flocculation facilities) for providing primary treatment or advanced primary treatment to CSOs and CSO Outfalls; construction of additional facilities for providing disinfection and dechlorination of CSOs and CSO Outfalls; construction of facilities for removing floatables from CSOs and CSO Outfalls; relocation of CSOs and CSO Outfalls; and construction and/or implementation of

combinations of these alternatives. Columbus shall develop and evaluate alternatives that provide for construction of Best Available Technology Economically Achievable (BAT) and Best Conventional Pollutant Control Technology (BCT) at all existing CSO overflows or CSO Outfall discharge points, including but not limited to a high rate treatment plant for the flows from the Whittier Street storm tanks currently discharged to the Scioto River, and other storage or treatment options.

- B. Columbus' development and evaluation of alternatives in the LTCP shall include an assessment of the costs, effectiveness (in terms of pollutant loading reductions, regardless of water quality impacts) and water quality benefits of a wide range of alternatives for eliminating, reducing and treating any and all of Defendants CSO overflows or CSO Outfalls. The evaluation of each alternative in the LTCP shall include: costs; benefits such as reduction in overflow events, volume, and load as compared to baseline conditions; impact on user rates; affordability; and construction and implementation schedules. In developing this analysis, the U.S. EPA's "Combined Sewer Overflows- Final Guidance for Financial Capability Assessment and Schedule Development", February 1997 (EPA-832-B-97-004) and "Guidance Coordinating CSO Long-Term Planning with Water Quality Standards Reviews"(EPA-833-R-01-002, July 31, 2001) shall be used as tools.
- C. Columbus shall also develop and evaluate alternatives in the LTCP consistent with the CSO Policy and the following:

1). Columbus shall give highest priority to controlling overflows to sensitive areas. Sensitive areas include: State resource waters, Superior high quality waters, Outstanding state waters or Outstanding national resource waters (OAC 3745-1-05, 1-09), Bathing Waters (OAC 3745-1-07(B)(4)), waters with primary contact recreation and all surface waters within 500 yards of an existing public water supply intake. CSOs and CSO Outfalls to these waters shall be eliminated or relocated whenever physically possible and economically achievable, except where elimination or relocation would provide less environmental protection than additional treatment. If elimination or relocation is not physically possible or economically achievable, then treatment must be provided that will result in attainment of Water Quality Standards criteria and designated uses.

2). At a minimum, Columbus shall evaluate alternative control measures based on the number of CSO Events as well as percent Capture. Columbus shall evaluate the level of controls necessary to reduce the number of CSO Events in a typical year to one and four systemwide. Columbus shall evaluate the controls necessary to achieve 90 %, 95%, 99% and 100% Capture. Columbus shall include in its evaluation of percentage Capture, an explanation of the level of treatment being provided.

For purposes of this requirement, the following terms shall have the following definitions. "CSO Event" shall mean one or more overflows from the CSS as the result of a precipitation event that does not receive minimum treatment. "Capture" shall mean the elimination or capture for at least minimum treatment by volume of the combined sewage collected in the CSS during precipitation events on a system-wide annual average basis. "Minimum treatment" shall mean primary clarification, solids and floatables disposal and disinfection.

3). Columbus shall consider ways to reduce public sources of storm water flow into combined sewers. Steps to consider include diverting storm water away from the combined system (e.g, by constructing retention basins;) as well as methods to store and retain stormwater(e.g.; using catch basin flow restriction, stormwater retention basins).

- D. By August 2, 2004, Defendant shall submit to Ohio EPA a "Technologies and Initial Alternatives Report" ("TIA") for review and comment. The TIA shall be developed in accordance with the TIA Workplan, attached hereto as Attachment D. The TIA shall include a description/list of the various technology alternatives to be studied in the alternatives evaluation. If any comments by Ohio EPA

request the inclusion of additional technology alternatives to the evaluation of alternatives, the technology shall be added and fully developed and evaluated by Columbus in the LTCP.

13. Interim Alternatives. In addition to the final alternatives, Columbus shall in the development of the LTCP also investigate interim alternatives that would mitigate the impact of CSOs and/or CSO Outfalls. In determining whether any interim alternatives should be included in the recommended alternative set forth in the LTCP, Columbus shall consider the following factors: the length of time it will take to fully implement a permanent alternative; the relative cost of the interim alternative; the anticipated water quality benefits of the interim alternative and the relationship between the interim and final alternatives. In any case, Columbus shall achieve a substantial reduction, in terms of flows or pollutant loads or both, in the discharges from the Whittier Street Storm Tanks by no later than July 1, 2010.

14. Recommended Alternative: In addition to the evaluation of alternatives in the LTCP, Columbus shall specifically include in the LTCP its recommended permanent alternative, as well as any recommended interim alternatives. The recommended alternative shall comply with the CSO Policy and with the goals set forth in paragraph 10. The recommended alternative for the LTCP shall not increase the use of the bypass at Jackson Pike WWTP, outfall 002 and/or outfall 003, unless the City simultaneously submits a feasibility study that justifies the bypasses consistent with the provisions of 40 CFR 122.41(m).

15. Public Participation: The LTCP shall also include a section describing the public input sought by Columbus in the development of the LTCP. This section shall also include a plan and schedule for soliciting further public participation as needed on the LTCP.

16. Implementation Schedule: Columbus shall include an implementation schedule for the recommended alternative, as well as any interim alternatives, in the LTCP. The implementation schedule for each project shall include proposed milestones for: a) commencement of construction, b) completion of construction, and c) controls fully operational. The LTCP implementation schedule may be developed consistent with U.S. EPA's guidance "Combined Sewer Overflows- Final Guidance for Financial Capability Assessment and Schedule Development", February 1997 (EPA-832-B-97-004) and shall at a minimum provide for the implementation and completion of construction of the recommended alternatives that attain full operation as expeditiously as practicable. In any event the schedule shall be as expeditious as practicable and shall at a minimum provide for completion of implementation and construction of all projects under the LTCP no later than July 1, 2025.

17. Pursuant to the SSO Consent Order, Columbus is required to submit to Ohio EPA a System Evaluation Capacity Assurance Plan ("SECAP") on July 1, 2005. The parties recognize that the capital improvement projects required by the LTCP and the SECAP may have an impact on each other and that some projects may be common to both plans.

18. (a) Ohio EPA Determination of LTCP: If Ohio EPA concludes that the LTCP (including the proposed schedule and/or the recommended interim or final alternatives) is unacceptable, Ohio EPA shall so notify Columbus in writing. If such notice occurs, the parties agree to use good faith efforts to resolve their differences. Within thirty days of the conclusion of this informal negotiation period Ohio EPA will, in writing, either approve, approve with conditions, or disapprove the LTCP. (Each of these forms of approval, approval with conditions, or disapproval shall be known as "the Determination").

(b) Court Retains Jurisdiction to Adjudicate Determination: Columbus shall comply with Ohio EPA's Determination, unless Columbus, within thirty days, moves this Court for relief from the Determination and prevails on its motion. The parties agree that this Court has jurisdiction to consider such a motion for relief from Ohio EPA's Determination of the LTCP. The City shall in its motion set forth a specific proposal for relief. The City shall bear the burden of proving by a preponderance of the evidence that it is entitled to the relief sought and that the relief sought is consistent with this consent order and applicable state and federal law.

(c) Court's Jurisdiction is Limited: The parties agree that, pursuant to R.C. 3745.04, the Court does not have jurisdiction to entertain a petition related to the issuance, renewal, modification, denial or revocation of a permit, or the issuance of orders or other actions of the Director of Environmental Protection. The term "actions" of the Director of Environmental Protection shall be interpreted consistent with the definitions set forth in R.C. 3745.04.

(d) Stay of Implementation Schedule: Submission of a motion to this Court under this subparagraph 18 (b) shall not extend any deadline set forth in the Consent Order or in the schedule of implementation as approved by Ohio EPA. If the City files a motion pursuant to subparagraph 18 (b), the City may also file a motion for a stay of the implementation schedule. The parties agree that the Court may use the standard for issuing a temporary restraining order to determine whether the City is entitled to a stay. If the City obtains a stay of the implementation schedule and its motion for relief is ultimately denied, the City shall be liable for and pay any stipulated penalties that would have accrued if no stay had been issued.

(e) Implementation of the Approved LTCP: The LTCP as approved by Ohio EPA and/or this Court, including the implementation schedule, shall be incorporated into this consent order and become an enforceable part of the order. Columbus shall comply with the LTCP once

it is approved and perform all of the projects identified in the LTCP in accordance with the approved schedule.

19. The parties agree that, notwithstanding any language that might be subject to a different interpretation, the term “Water in Basement” or “WIB” as it is used in the SSO Consent Order is not limited to Columbus’ separate sanitary sewers, but rather expressly includes WIBs that occur in Columbus’ combined sewer system.

20. The City shall provide annual reports on the progress of the projects set forth in the LTCP implementation schedule. The annual reports shall be due on February 15 of the following year, beginning on February 15, 2006. Columbus may combine the LTCP annual report with the annual report required by the SSO Consent Order.

21. For at least three years after the date of the entry of this Consent Order, Defendant shall prepare and submit to Ohio EPA quarterly reports regarding the implementation of the CSSOP. The quarterly reports shall include but not be limited to an analysis whether Columbus followed the routine inspection schedules for the Whittier Street Storm Tanks, Alum Creek Storm Tanks, Dodge Park Pump Station, and the nineteen Regulators listed in Attachment B. The quarterly reports shall be due on April 30, July 31, October 31 and January 31 for the preceding quarter. Columbus shall continue to submit quarterly reports until such time as the stipulated penalties required by paragraph 29 are terminated.

22. Columbus shall fully respond to any comments received from Ohio EPA on the documents submitted pursuant to this Consent Order within 60 days of receiving the comments (or such longer period as agreed upon by the parties); including modification of the LTCP, the alternatives and any related plans as needed to respond to the comments.

## **VI. SUBMITTAL OF DOCUMENTS**

23. All documents required to be submitted to Ohio EPA pursuant to the Consent Order shall be submitted to the following address, or to such addresses as Ohio EPA hereafter may designate in writing:

Ohio EPA  
Central District Office  
Division of Surface Water  
3232 Alum Creek Drive  
Columbus, Ohio 43207

Attn: Enforcement Coordinator

All documents submitted to Columbus pursuant to the Consent Order shall be submitted to

Administrator  
Division of Sewerage and Drainage  
Department of Public Utilities  
910 Dublin Road  
Columbus, Ohio 43215

## **VII. DUTY TO COMPLY AND COMPLIANCE NOT DEPENDENT ON GRANTS OR LOANS**

24. Nothing in this Consent Order shall affect Columbus' obligation to comply with all applicable federal, state or local law, regulations, rule or ordinance. Columbus shall obtain any and all federal, state or local permits necessary to comply with this Consent Order. Performance with the terms of this Consent Decree by Defendant is not conditioned on the receipt of any federal or state grant, loan or funds. In addition, Defendant's performance is not excused by the failure to obtain any federal or State grant or loan funds, or by the processing of any application for the same.



## **VIII. CIVIL PENALTY & SUPPLEMENTAL ENVIRONMENTAL PROJECTS**

25. Within thirty (30) days of the effective date of this Consent Order, it is hereby ordered that Defendant shall pay to the State of Ohio a civil penalty of One Hundred Thousand Dollars (\$100,000.00). The penalty shall be paid by delivering a check for the appropriate amount, payable to the "Treasurer, State of Ohio," to Amy Laws, or her successor, at the Ohio Attorney General's Office, Environmental Enforcement Section, 30 East Broad Street, 25<sup>th</sup> Floor, Columbus, Ohio, 43215-3400.

26. In lieu of payment of an additional civil penalty and in furtherance of the mutual objectives of the State of Ohio and the City of Columbus in improving the environment and water quality in Central Ohio, the City of Columbus agrees to and is hereby ordered to expend funds in the amount of One Hundred and Fifty Thousand Dollars (\$150,000) on a Supplemental Environmental Project ("SEP") which is acceptable to both the City of Columbus and Ohio EPA. Pursuant to the SSO Consent Order, the City of Columbus is pursuing as a SEP the Fifth Avenue Dam Project. The purpose of the Fifth Avenue Dam Project is to provide funding for the study, modification and/or removal of the dam, and stream restoration in the area of the Fifth Avenue Dam in order to improve and enhance water quality and stream habitat in this area of the Olentangy River. Columbus agrees to spend a further \$150,000 on this project, in addition to the money committed to the project in the SSO Consent Order, under the same terms as set forth in the SSO Consent Order. In the event that the Fifth Avenue Dam Project is determined not viable for any reason, the City of Columbus shall within 45 days of such determination, submit an alternate Supplemental Environmental Project proposal to the Ohio EPA for its review and approval. The Fifth Avenue Dam Project SEP, or any Ohio EPA approved alternative, shall be completed within four (4) years of the entry of this Consent Order; unless an alternate schedule is

approved, in writing, by the Director. The approval of a SEP alternative and/or an alternate schedule shall be within the Director's sole, unreviewable discretion. Any monies not disbursed for the Fifth Avenue Dam Project SEP, or any Ohio EPA approved alternative SEP, shall be paid to the State by delivering to the Attorney General's Office, Environmental Enforcement Section, 30 East Broad Street, 25<sup>th</sup> Floor, Columbus, Ohio 43215-3400, to the attention of Amy Laws or her successor, a check payable to the order of the "Treasurer State of Ohio", in the amount of the unexpended money, within thirty (30) days of the end of the 4 year period or within 30 days of the end date in any alternate schedule approved by the Director.

27. Columbus is required, pursuant to the SSO Consent Order, to file quarterly reports with Ohio EPA, summarizing the money it has expended on the Fifth Ave. Dam Project or other approved SEP. The City shall include in those quarterly reports the amounts it expends pursuant to this order on this SEP or an alternate SEP.

#### **IX. STIPULATED PENALTIES**

28. For each day the City fails to meet a deadline or milestone established in or pursuant to Section V of this Consent Order or fails to meet a deadline or milestone established in the approved LTCP implementation schedule, the City shall be liable for and shall pay a penalty pursuant to the following schedule: up to thirty (30) days – Five Hundred Dollars (\$500.00) per day per deadline; from thirty-one (31) to sixty days (60) - Seven Hundred and Fifty Dollars (\$750.00) per day per deadline; for more than sixty (60) days– One Thousand Dollars (\$1,000.00) per day per deadline.

For each day that the City fails to conduct an inspection required by the approved CSSOMP of Whittier Street Storm Tanks, Alum Creek Storm Tank, Dodge Park Combined Pump Station, and the nineteen Regulators listed in Attachment B, the City shall be liable for and shall pay a penalty. The City shall pay stipulated penalties pursuant to this paragraph on a quarterly basis and according to the following schedule: If the City misses between one and five inspections in one quarter, the City shall pay a stipulated penalty of \$200.00 per missed inspection. If the City misses between five and ten inspections in one quarter, the City shall pay a stipulated penalty of \$400.00 per missed inspection. If the City misses more than ten inspections in one quarter, the City shall pay a stipulated penalty of \$600.00 per missed inspection. This paragraph will terminate upon the occurrence of three consecutive years during which no stipulated penalties were due pursuant to it.

30. During the term of this Consent Order, Defendant shall pay a stipulated penalty of two thousand dollars (\$2,000) for each dry weather CSO event. For purposes of this paragraph an "event" means each day (up to 24 hours) for each location that an overflow and or discharge occurred from a CSO. This paragraph will terminate upon the occurrence of three consecutive years during which no stipulated penalties were due pursuant to it.

For each calendar day on which there is a bypass from outfall 002 or outfall 003 at Jackson Pike WWTP, the City shall pay a stipulated penalty of \$2,000 per day for each outfall where a bypass occurs.

32. Stipulated penalties under paragraph 28 shall be paid within forty-five (45) days from the date of the failure to meet the applicable deadline or milestone, and, if necessary, monthly thereafter, and shall be accompanied by a written explanation of the deadline or milestone missed. Stipulated penalties under paragraph 29 shall be paid within forty-five (45)

days after the quarterly report required by paragraph 21 is due. Stipulated penalties under paragraph 30 shall be paid within forty-five (45) days from the date of the dry weather CSO event. Stipulated penalties under paragraph 31 shall be paid within forty-five (45) days from the date of the bypass. Any payment required to be made under this paragraph shall be made by delivering to Amy Laws, or her successor, at the address set forth in Section VIII, paragraph 25, a check for the appropriate amounts, made payable to "Treasurer, State of Ohio". The payment of stipulated penalties by Defendant and the acceptance of such stipulated penalties by Plaintiff for specific violations pursuant to Section IX shall not be construed to limit Plaintiff's authority to seek additional relief or to otherwise seek judicial enforcement of this Consent Order. Further, payment by Defendant shall not be considered an admission of liability on the part of Defendant.

**X. RETENTION OF JURISDICTION**

33. The Court will retain jurisdiction of this action for the purpose of administering or enforcing Columbus' compliance with this Consent Order.

**XI. COSTS**

34. Defendant is hereby immediately ordered to pay the court costs of this action.

**XII. ENTRY OF CONSENT ORDER AND FINAL JUDGMENT BY CLERK**

35. The parties agree and acknowledge that final approval by the Plaintiff and Defendant, and entry of this Consent Order is subject to the requirement of 40 C.F.R. §123.27 (d)(2)(iii), which provides for notice of the lodging of this Consent Order, opportunity for public

comment, and the consideration of any public comment. The Plaintiff and Defendant reserve the right to withdraw consent to this Consent Order based on comments received during the public comment period. Defendant shall pay the cost of publishing the public notice within thirty (30) days of receipt of a bill or notice from the Ohio EPA

36. Upon the signing of this Consent Order by the Court, the clerk is hereby directed to enter it upon the journal. Within three (3) days of entering the judgment upon the journal, the clerk is hereby directed to serve upon all parties notices of the judgment and its date of entry upon the journal in the manner prescribed by Rule 5(B) of the Ohio Rules of Civil Procedure and note the service in the appearance docket.

**IT IS SO ORDERED:**

## Judge Guy L. Reece II

\_\_\_\_\_  
Judge  
Franklin County Court of Common Pleas

\_\_\_\_\_  
Date

**APPROVED:**

**JIM PETRO  
ATTORNEY GENERAL**

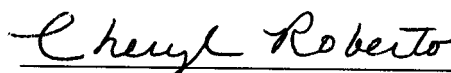
By:



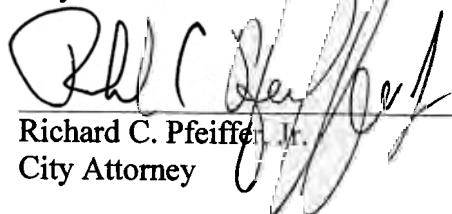
Margaret A. Malone (0021770)  
Teri J. Finfrock (0037903)  
Assistant Attorneys General  
Environmental Enforcement Section  
30 East Broad Street, 25<sup>th</sup> Floor  
Columbus, Ohio 43215-3400  
Tele. (614) 466-2766

Attorney for State of Ohio

By:

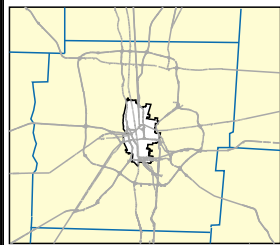
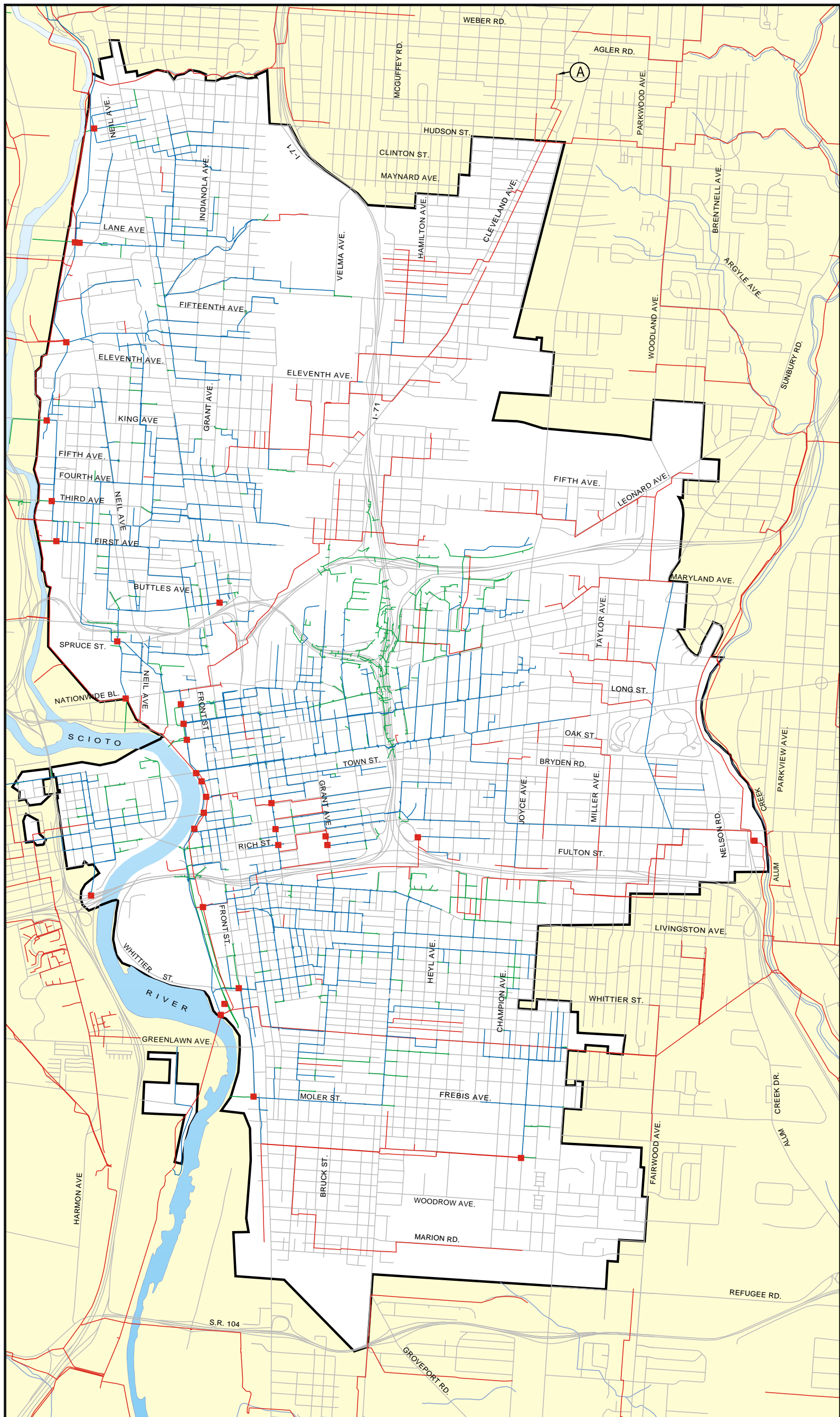


Cheryl Roberto  
Director  
Department of Public Utilities  
910 Dublin Road  
Columbus, Ohio 43215  
Tele: (614) 466-7447  
Authorized Representative  
City of Columbus



Richard C. Pfeiffer, Jr.  
City Attorney

9/17/04



**Key Map**



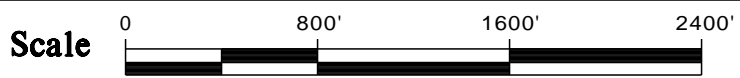
**North**

**Legend**

- Combined Sewer Area Boundary
- Sanitary Sewer Line
- Storm Sewer Line
- Combined Sewer Line
- Combined Sewer Overflow (CSO)

**Notes:**

- Exhibit illustrates sewers 18 inch and larger.
- Exhibit illustrates storm sewers tributary to combined sewer system.
- Sewer legend in this Exhibit reflects information from the City of Columbus sewer atlas.
- Sewer "A" is tributary to combined sewer system under extreme wet weather flow only.



City of Columbus, Ohio, Division of Sewerage and Drainage (DOSD)

July 2004

**Attachment A**

Combined Sewer Overflows

tributary to Jackson Pike WWTP

Combined Sewer Overflow				CSO Buffer		
Description	Latitude	Longitude	NPDES Number	Description	Latitude	Longitude
REG alley n/o Hudson St. On the Olentangy Rvr	40 00 51.1	83 00 54.1	4PF00000004	Olentangy River w/o regulator	40 00 50.88	83 00 57.6
REG s/o of Neil (Frambes), e/o Tuttle Park	40 00 18.49	83 00 59.1	4PF00000005	Olentangy River at 84 inch storm sewer w/o regulator	40 00 17.36	83 01 12.91
REG beneath 1791 Neil Ave., Biology Annex	39 59 48.73	83 01 05.34	4PF00000006	Olentangy River at 108 inch storm sewer s/o John Herrick Dr.	39 59 48.84	83 01 23.41
REG on King Ave., 300' w/o Perry St.	39 59 26.37	83 01 11.02	4PF00000007	Olentangy River below Fifth Ave. dam	39 59 18.99	83 01 25.54
REG 50' s/o intersection of Nationwide Blvd. (Dublin Ave.) & Cozzins St.	39 58 03.76	83 00 40.03	4PF00000008	Scioto River at 96 inch storm sewer at Cozzins	39 57 53.95	83 00 40.45
REG on Marconi Blvd., 100' n/o Chestnut St.	39 58 03.14	83 00 18.98	4PF00000010	Scioto River at 126 inch storm sewer r/o Federal bldg.	39 57 50.23	83 00 25.62
REG Spring & Marconi	39 57 59.85	83 00 22.13	4PF00000011	Scioto River at 126 inch storm sewer r/o Federal bldg.	39 57 50.23	83 00 25.62
REG Marconi & Long	39 57 55.09	83 00 20.16	4PF00000012	Scioto River at 126 inch storm sewer r/o Federal bldg.	39 57 50.23	83 00 25.62
Capital St. (extended), 200' w/o Front St.	39 57 40.04	83 00 11.81	4PF00000013	Scioto River at 48 inch sewer w/o overflow	39 57 40.07	83 00 12.09
State St. (extended), 150' w/o Front St.	39 57 35.93	83 00 10.32	4PF00000014	Scioto River at 24 inch sewer w/o overflow	39 57 35.89	83 00 10.58
REG Civic Center & Town	39 57 29.79	83 00 11.07	4PF00000015	Scioto River at w/o regulator	39 57 30.58	83 00 11.76
REG Rich St. & Civic Center	39 57 25.70	83 00 14.51	4PF00000016	Scioto River at w/o regulator	39 57 25.44	83 00 15.10
REG Grand & Civic Center	39 57 41.91	83 00 12.37	4PF00000017	Scioto River at w/o regulator	39 57 41.58	83 00 14.04
Whittier St. Storm Standby Tanks	39 56 31.19	83 00 03.86	4PF00000018	Scioto River at Greenlawn dam	39 56 30.04	83 00 03.25
Whittier St. Storm Standby Tank Bypass	39 56 31.19	83 00 03.86	4PF00000019	Scioto River at Greenlawn dam	39 56 30.04	83 00 03.25
REG Moier & Front	39 56 07.33	82 59 50.59	4PF00000020	Scioto River at 66 inch storm sewer w/o regulator	39 56 07.36	82 59 58.71
REG Perry & Third	39 59 01.66	83 01 08.43	4PF00000027	Olentangy River at 84 inch storm sewer w/o regulator	39 59 02.62	83 01 14.91
REG on Spruce St. between Harrison & Neil	39 58 21.54	83 00 43.79	4PF00000028	Scioto River at 96 inch storm sewer at Cozzins	39 57 53.95	83 00 40.45
REG Markison & Wilson	39 55 49.24	82 58 08.6	4PF00000029	Scioto River at 122 inch storm sewer n/o S.R. 104, 2500 feet w/o Barthman & High	39 55 29.5	83 00 16.2
REG s/o of Tuttle Park & Neil (Frambes)	40 00 18.89	83 01 00.66	4PF00000031	Olentangy River at 84 inch storm sewer w/o regulator	40 00 17.36	83 01 12.91
REG First Ave. & alley e/o Perry	39 58 50.47	83 01 07.05	4PF00000032	Olentangy River at 24 inch storm sewer w/o regulator	39 58 50.53	83 01 14.45
REG w/o Front St., on Whittier St.	39 56 38.65	82 59 57.66	4PF00000033	Scioto River at 84 and 96 inch storm sewers w/o Deshler & Front	39 56 27.42	82 59 56.81
MH Grant & Mound	39 57 21.3	82 59 22.2	4PF00000041	Scioto River at 136x87 inch storm sewer in Bicentennial Park	39 57 22.43	83 00 17.22
MH 722 E. Mound	39 57 24.1	82 58 47.6	4PF00000042	Scioto River at 84 and 96 inch storm sewers w/o Deshler & Front	39 56 27.42	82 59 56.81
MH Grant & Noble	39 57 23.7	82 59 22.6	4PF00000043	Scioto River at 136x87 inch storm sewer in Bicentennial Park	39 57 22.43	83 00 17.22
REG Liberty St., e/o Short St.	39 57 03.23	83 00 08.84	4PF00000044	Scioto River at 84 and 96 inch storm sewers w/o Deshler & Front	39 56 27.42	82 59 56.81
MH Cherry & 4th	39 57 26.4	82 59 42.3	4PF00000045	Scioto River at 136x87 inch storm sewer in Bicentennial Park	39 57 22.43	83 00 17.22
MH Noble & 4th	39 57 21.5	82 59 41.2	4PF00000046	Scioto River at 136x87 inch storm sewer in Bicentennial Park	39 57 22.43	83 00 17.22
MH 4th & Town	39 57 33.55	82 59 44.19	4PF00000047	Scioto River at 136x87 inch storm sewer in Bicentennial Park	39 57 22.43	83 00 17.22
Dodge Park Combined Pump Station (SA-13)	39 57 07.61	83 00 53.04	4PF00000048	Scioto River at 72 inch storm sewer via the Dodge Park Storm Pump Station ST-26	39 57 08.79	83 00 47.88
MH Kerr s/o Russell	39 58 33.6	83 00 03.4	4PF00000049	Scioto River at 126 inch storm sewer r/o Federal bldg.	39 57 50.23	83 00 25.62

City of Columbus

Combined Sewer Overflows

tributary to Southerly WWTP

Combined Sewer Overflow				CSO Buffer		
Description	Latitude	Longitude	NPDES Number	Description	Latitude	Longitude
Alum Creek Storm Tank, Main & Alum Creek Dr.	39 57 23.12	82 58 40.66	4PF00001006	Alum Creek at 144x90 inch sewer e/o tank	39 57 23.07	82 58 35.66



---

**City of Columbus**

**LONG-TERM CONTROL PLAN UPDATE  
RECEIVING WATER MODELING METHODOLOGY  
MEMORANDUM**

---

**CITY OF COLUMBUS OVERALL ENGINEERING COORDINATION  
CONTRACT  
COLUMBUS, OHIO**

April 11, 2003

**PROJECT NO. 0228-716**

MALCOLM PIRNIE, INC.  
1900 Polaris Parkway, Suite 200  
Columbus, Ohio 43240

## TABLE OF CONTENTS

<b>1.0</b>	<b>INTRODUCTION AND OVERVIEW OF ANALYSIS METHODS</b> .....	<b>1</b>
1.1	FIRST APPROXIMATION – END OF PIPE ANALYSIS.....	2
1.2	SECOND APPROXIMATION – DILUTION ANALYSIS.....	3
1.2.1	Spreadsheet Analysis.....	4
1.2.2	Monte Carlo Simulation.....	4
1.3	THIRD APPROXIMATION – DILUTION/DECAY ANALYSIS.....	4
1.3.1	Spreadsheet Steady-State Analysis (Pathogen).....	4
1.3.2	Worst Case Steady-State Analysis.....	5
1.3.3	Complex Dynamic Analysis.....	5
<b>2.0</b>	<b>DATA REQUIREMENTS</b> .....	<b>7</b>
2.1	HISTORICAL RAINFALL.....	8
2.2	HISTORICAL STREAM FLOW.....	8
2.3	INSTREAM WATER QUALITY (BACKGROUND CONDITIONS).....	8
2.3.1	Pathogens.....	9
2.3.2	Dissolved Oxygen, CBOD and Nutrients.....	9
2.4	CSO DISCHARGE WATER QUALITY.....	9
2.4.1	Pathogens.....	9
2.4.2	Dissolved Oxygen, CBOD, and Nutrients.....	10
2.5	HYDRODYNAMIC DATA.....	10
2.5.1	Flow Monitoring.....	10
2.5.2	Cross Sections.....	11
2.5.3	Time of Travel.....	11
<b>3.0</b>	<b>FIRST APPROXIMATION ANALYSIS</b> .....	<b>12</b>
3.1	CONTINUOUS SWMM SIMULATIONS.....	12
3.2	SUMMARIZING ESTIMATED END-OF-PIPE MEASURES FROM THE SWMM MODEL OUTPUT.....	13
3.2.1	Number of Activations.....	14
3.2.2	Hours of Overflow.....	15
3.2.3	Total Overflow Volume.....	15
3.2.4	Maximum Flow.....	15
3.2.5	CSO Flow Frequency.....	16
3.3	EXAMPLE CSO LTCP ALTERNATIVE ANALYSIS – USE OF CONTINUOUS SIMULATION RESULTS.....	16
<b>4.0</b>	<b>SECOND APPROXIMATION ANALYSIS</b> .....	<b>19</b>

4.1	SUMMARIZING ESTIMATED END-OF-PIPE MEASURES FROM THE SWMM MODEL OUTPUT .....	19
4.2	STREAM FLOW PROBABILITY FOR THE DILUTION CALCULATION .....	20
4.3	SPREADSHEET ANALYSIS FOR COMBINED PROBABILITY OF CSO DISCHARGE AND STREAMFLOW .....	22
4.4	MONTE CARLO ANALYSIS TO COMBINE PROBABILITIES OF CSO DISCHARGE AND STREAMFLOW .....	22
4.5	EXAMPLE CSO LTCP ALTERNATIVE ANALYSIS – USE OF DILUTION RESULTS .....	23
<b>5.0</b>	<b>THIRD APPROXIMATION ANALYSIS .....</b>	<b>24</b>
5.1	USE OF ESTIMATED END-OF-PIPE MEASURES FROM THE SWMM MODEL OUTPUT .....	24
5.2	QUAL2E MODEL SIMULATION – WORST CASE STEADY STATE .....	24
5.2.1	QUAL2EU Uncertainty Analysis .....	26
5.3	WASP MODEL SIMULATION – COMPLEX DYNAMIC ANALYSIS.	26
5.3.1	Coupling WASP with SWMM Model .....	27
5.3.2	WASP Based on Existing QUAL2E Network .....	27
5.3.3	WASP Based on Extended Network for Dam Pools .....	27
5.3.4	Simulation of Conservative and Non-Conservative Pollutants	27
5.4	EXAMPLE CSO LTCP ANALYSIS – USE OF WASP MODEL OUTPUT .....	28
<b>6.0</b>	<b>PREVIOUS WORK .....</b>	<b>31</b>
6.1	BUFFALO SEWER AUTHORITY, NEW YORK .....	31
6.2	CITY OF FORT WAYNE, INDIANA.....	32
6.3	CITY OF AKRON, OHIO .....	33
<b>7.0</b>	<b>PATHOGEN MODELING.....</b>	<b>35</b>
7.1	FIRST APPROXIMATION SUFFICIENT FOR CURRENT PRIMARY CONTACT USE DESIGNATION STANDARDS.....	36
7.2	ADVANTAGES/DISADVANTAGES OF FIRST APPROXIMATION .	36
<b>8.0</b>	<b>CITY OF COLUMBUS RECOMMENDATION .....</b>	<b>38</b>
8.1	SELECTING CRITERIA OF INTEREST .....	38
8.2	RECOMMENDED MODELING APPROACH .....	38
8.2.1	Pathogens and Second Approximation .....	38
8.2.2	Detailed Dilution Decay Modeling.....	39

8.3	PRESENTATION OF RESULTS.....	39
8.3.1	Summary Statistics of Exceedances .....	39

## 1.0 INTRODUCTION AND OVERVIEW OF ANALYSIS METHODS

The US Environmental Protection Agency Combined Sewer Overflow Guidance documents (USEPA, CSO) present the demonstration approach and presumptive approach as two methodologies for complying with the water quality requirements of a Long Term Control Plan (LTCP). The purpose of this paper is to present possible modeling and analysis methods available to comply with the CSO policy. In particular, these methods support characterization of existing CSO impacts on receiving waters, and provide a mechanism for comparing abatement alternatives. As part of presenting the modeling and analysis methodologies, this paper will also present the results and implications of previous efforts conducted by Malcolm Pirnie.

This paper focuses primarily on the City of Columbus's proposed LTCP update. The City currently has CSO discharge points on Alum Creek, the Olentangy River, and the Scioto River. FIGURE 1 (located at the end of this document) shows the proposed study area along with the location of CSO discharge points. One significant issue with the study area is the fact that there are several dams within the study area and that the majority of CSO discharge locations are upstream of these low-head dams. The most significant CSO discharge is the Whittier Street Storm Stand-By Tanks, which is at the toe of Greenlawn Dam, the most downstream dam on the Scioto River. FIGURE 1 also shows the location of the dams relative to the CSO discharge points.

The City of Columbus currently has a comprehensive SWMM model for evaluating the hydraulic characteristics of the sewage collection system including the CSO areas of the City. The City also has a comprehensive QUAL2E water quality model for evaluating steady-state water quality conditions in the receiving waters within parts of the study area. The current QUAL2E model can evaluate water quality conditions from Greenlawn Dam on the Scioto River to just upstream of Circleville and from Livingston Avenue on Alum Creek to the mouth of Big Walnut Creek on the Scioto River.

There are a number of analyses that could be completed to support the demonstration or presumptive approach, i.e., project the attainment of water quality standards and use designations, or quantify the impacts of a LTCP alternative on a receiving water or reduce CSO discharges to 4 per year. There are three approximation methods with special relevance to the City's goals; these are briefly explained below and further explained in later sections.

A critical step in selecting appropriate receiving water modeling and analysis techniques for LTCP development is identifying the water quality parameters of primary interest. The screening and selection of analysis techniques presented in this paper is predicated on the assumption that pathogens are the controlling water quality parameter for the City's LTCP. This assumption is based on the simple reality that in order to preclude CSOs from violating current bacteriological standards, effective reduction of CSO discharge for small storms (12-Month or less) is often the only option. With reduction of CSOs to control pathogens, control of other water quality parameters in the CSO discharge is obviously also accomplished. In this situation, sophisticated water quality analysis of other parameters becomes unnecessary.

Disinfection is also a viable alternative for reducing pathogen levels in CSO discharge. Facility requirements for disinfection make it a less feasible alternative for some CSO discharge locations. Also, disinfection rather than reduction of CSO discharge does not preclude the need for water quality analysis for other parameters such as ammonia or dissolved oxygen. Effective disinfection of CSO discharge can reduce pathogen concentrations to less than the water quality standard of 2000 MPN/100ml.

## **1.1 FIRST APPROXIMATION – END OF PIPE ANALYSIS**

---

A first approximation would involve an end of pipe analysis using output from a continuous SWMM model simulation. The assumption with an end of pipe analysis is that any CSO discharge would cause bacteria concentrations greater than 2000 MPN/100ml at the end of the discharge pipe since CSO discharge

typically has bacteria concentrations near  $10^6$  to  $10^7$  MPN/100ml. This approach would not include analysis of the transport, fate, or decay of pathogens in the receiving stream.

Estimates of annual CSO measures are the basis for the first approximation analysis. These measures would be obtained from SWMM model simulations for each alternative, for example, total annual CSO volume, a count of CSO activations per year, hours of activation per year, maximum discharge rates and CSO discharge frequencies. Alternatives would be compared based on a comparison of the statistical analyses. Concentrations could also be applied to the CSO volume to estimate loadings of contaminants.

The first approximation is especially applicable for pathogens, given that with current bacteriological water quality standards an exceedance of the 2000 MPN/100ml is effectively triggered with any CSO occurrence. The first approximation is not as applicable for assessing attainment of water quality standards for other parameters, e.g. dissolved oxygen.

## **1.2 SECOND APPROXIMATION – DILUTION ANALYSIS**

---

The second approximation incorporates a concentration and dilution analysis and is built upon the first approximation. All of the analysis included in the first approximation would be completed and combined with concentrations and river flows thereby providing an estimate of the dilution of the CSO discharge and instream concentrations. The second approximation does explicitly account for CSO discharge concentrations, and also for background concentrations in the stream. It still does not include transport, fate or decay processes. The second approximation again assumes that bacteriological standards are the most critical and the most difficult criteria to meet. There are two ways to estimate concentrations and dilution when combining the background receiving water with the CSO discharge hydrographs from SWMM model output.

### **1.2.1 Spreadsheet Analysis**

Spreadsheet analysis is the simplest form of the second approximation approach. Using this approach would involve combining the probability of a stream discharge rate with the predicted CSO discharge rates (from the SWMM model). Event mean concentrations would be incorporated into the SWMM model discharge rates to predict concentrations.

### **1.2.2 Monte Carlo Simulation**

A Monte Carlo simulation is a more complex approach to the second approximation. The Monte Carlo simulation would incorporate uncertainties in the values of concentrations and flow rates. The results would be very similar to the spreadsheet analysis.

## **1.3 THIRD APPROXIMATION – DILUTION/DECAY ANALYSIS**

---

The third approximation is the most complex and comprehensive analysis that could be performed in support of the demonstration approach. A continuous SWMM simulation similar to the analysis mentioned above would be used to predict CSO discharge hydrographs as input for subsequent receiving water analysis. This approach would account for the transport, fate and decay of the parameters of interest. The choice of modeling tools depends on the specific questions that need to be answered and how detailed the simulation needs to be to obtain necessary information.

### **1.3.1 Spreadsheet Steady-State Analysis (Pathogen)**

Analysis via spreadsheet is possible but not recommended. It would be possible to build a spreadsheet model to estimate the transport and decay for pathogens but other models already exist for performing the similar types of analyses more efficiently.



### **1.3.2 Worst Case Steady-State Analysis**

The USEPA QUAL2EU model includes transport, fate, and decay for dissolved oxygen (DO), nitrogen, phosphorus, carbonaceous biochemical oxygen demand (CBOD) and fecal coliforms. QUAL2EU is a steady state model which would yield conservative estimates of the impacts that result from CSO discharges. Using the current QUAL2EU model would require accounting for all CSO loads as a single point source at the upstream end of the model, i.e., the transport and decay through the low-head dam pools would not be modeled. Extending the QUAL2EU further upstream into the dam pool areas is not considered cost-effective for a conservative pathogen analysis.

### **1.3.3 Complex Dynamic Analysis**

The most extensive dilution-decay analysis would be a full dynamic simulation using modeling tools such as the USEPA Water Quality Analysis Simulation Program (WASP). The WASP model includes all of the parameters that can be modeled by QUAL2EU; in addition it is a transient or dynamic model. The WASP model would be much more data intensive and would be able to provide more in-depth answers to how the river would be impacted by CSO discharges with the various alternatives, not just for a worst-case condition but for dynamic conditions during and after wet-weather events. The WASP model would still use the output of the SWMM model to characterize CSO inputs. Results would include the spatial extent and duration of water quality exceedances. Although WASP would be the most realistic model for CSO impacts on receiving water quality, the extra effort and cost associated with developing a WASP model is not expected to impact the outcome of the alternative analysis significantly with the assumption that pathogen control is the primary objective.

The complex dynamic analysis can be applicable in two situations:

- When a parameter other than pathogens is of primary interest, especially a parameter where in-stream fate and transport impacts attainment of water quality standards (e.g., DO).

- When a permittee is considering the option of requesting a change in water quality standards as part of their wet-weather control plan.

## 2.0 DATA REQUIREMENTS

Each of the relevant methods introduced in Section 1 above have certain data requirements. These data requirements are summarized below, with additional details on each of the data types provided in the subsequent subsections.

The first approximation requires:

- SWMM model, which has already been developed. A time-intensive data collection effort for the SWMM model is not anticipated. Data collection would likely be limited to compiling historical rainfall data to develop an average, or typical, precipitation year.

The second approximation requires:

- SWMM model.
- Compilation of streamflow records.
- Instream water quality.
- CSO discharge water quality

The third approximation requires:

- SWMM model.
- Compilation of streamflow records
- Instream water quality.
- CSO discharge water quality
- Worst-Case Steady State: QUAL2E model, which has already been developed. A time-intensive data collection effort for the QUAL2E model is not anticipated.
- Complex Dynamic: WASP model, which has not been developed. Additional water quality and hydrodynamic data would be required to develop the WASP model

It should be noted that the City of Columbus has already suggested doing a bacteria study for the CSO impacted streams, which would support the instream water quality and CSO discharge water quality data needs.

## **2.1 HISTORICAL RAINFALL**

---

Historical rainfall data analysis is necessary for the SWMM model. The historical rainfall data will be analyzed to develop an average, or typical, precipitation year. The analysis will include approximately 50 years of rainfall data. The average rainfall year will be the baseline for all of the SWMM model simulations, for both existing conditions and the alternative analysis.

## **2.2 HISTORICAL STREAM FLOW**

---

Historical stream flow data would be necessary for performing dilution models and dilution-decay models. Similar to rainfall, an average annual stream flow would have to be developed for the receiving water. Further analysis that compares streamflow to rainfall would better solidify the relationship or correlation between the two datasets. A significant correlation may not exist, but the goal would be to isolate an annual streamflow record that corresponds to the average rainfall year.

## **2.3 INSTREAM WATER QUALITY (BACKGROUND CONDITIONS)**

---

There are two main data types for instream water quality that are of particular interest for modeling the impacts of CSOs on receiving streams – pathogens and DO/CBOD/nutrients. For both of these data types, it is important to characterize concentration not only in the impacted waters but also the background concentrations. Furthermore, sampling of dry and wet weather conditions is also necessary. The background conditions may on their own exceed water quality standards with no CSO inputs. It is possible that many pollutants typically associated with CSO discharges could also be originating from other sources (wildlife, pets, fertilizer) during rain events.

The USEPA Combined Sewer Overflows Guidance For Monitoring and Modeling, January 1999 notes that CSOs can affect several receiving water quality parameters. It also states that the impact on one parameter is frequently much greater than other parameters; therefore, relieving the impact by the one parameter will likely relieve the other parameters. Pathogens are most likely the highest impact considering current water quality standards and relieving pathogen impacts through reduction of CSOs will most likely eliminate any DO, CBOD and nutrient impacts.

### **2.3.1 Pathogens**

As noted at the beginning of this section, the City of Columbus has suggested a bacteria study to identify background levels and sources of bacteria.

### **2.3.2 Dissolved Oxygen, CBOD and Nutrients**

DO, CBOD and nutrient data would be necessary for the transport, fate, and decay modeling using QUAL2EU or WASP. The data would be used to develop boundary conditions and calibration points for either model. The WASP model would require the most extensive data collection effort.

## **2.4 CSO DISCHARGE WATER QUALITY**

---

Sampling of CSO discharge is necessary to develop an understanding of “typical” CSO discharge quality. The typical CSO discharge quality would be applied to the SWMM CSO discharge results to estimate loadings, as part of the existing condition assessment and alternatives analysis.

### **2.4.1 Pathogens**

The collection of pathogen data for the CSO discharge points would be included in the previously noted bacteria study. Sampling of CSO discharges would need to begin during early activation and continue through the end of the event. A full data set for a CSO discharge would allow the determination of an event mean concentration.

## **2.4.2 Dissolved Oxygen, CBOD, and Nutrients**

Sampling procedures would be similar to the procedures for pathogens. Sampling would need to begin at activation and continue at regular intervals during the entire overflow event. Event mean concentrations would be determined from the sampling data and applied to existing conditions and alternatives analysis.

## **2.5 HYDRODYNAMIC DATA**

---

The requisite hydrodynamic data already exist for Alum Creek and Big Walnut Creek. In addition, the Ohio EPA developed hydraulic information for the Scioto River south of the Greenlawn Dam. The US Corp of Engineers has a well-developed HEC-RAS model for the Scioto River north of the Jackson Pike WWTP. All of the existing data will be useful for evaluating CSO impacts on the receiving waters with two possible exceptions.

The area of the Scioto River upstream of the Greenlawn Avenue Dam would require additional hydrodynamic data if a WASP model is developed for that area. Although there is an existing HEC-RAS model for the area upstream of the Greenlawn Avenue Dam, it was developed for significantly higher flow rates than what would be used for CSO impact modeling.

The Ohio EPA developed the hydraulic coefficients downstream of the Greenlawn Avenue Dam in the early 1980's and Malcolm Pirnie revised some of the coefficients between Greenlawn Dam and the JPWWTP in 2001. Given the age of the hydraulic coefficients on the Scioto River, there may be a need to update them as well for a CSO impact analysis. This would only need to be completed if there is a significant lack of confidence in the dilution/decay model results when run with wet weather flow rates.

### **2.5.1 Flow Monitoring**

Flow monitoring at key locations along the Scioto River and Olentangy River would be required for transport, fate, and decay modeling. The flow

monitoring would involve continuously recording level meters. Rating curves would have to be developed for each flow monitoring point.

### **2.5.2 Cross Sections**

Cross section data would be necessary for the areas upstream of the Greenlawn Dam to develop hydrodynamic data for transport, fate, and decay modeling.

### **2.5.3 Time of Travel**

Time of travel data is extremely useful for developing hydrodynamic models. If it is determined that dilution decay modeling must be completed in the areas upstream of the Greenlawn Dam, then two separate time of travel studies would be necessary. One study would need to be completed at a lower flow rate and another at a higher flow rate. If time of travel work is completed for this reach of the river, it would be advisable to extend the study south into Pickaway County. Extending the study south would allow a more complete evaluation of the existing hydraulic data for the Scioto River and could increase confidence in current and future models.

## **3.0 FIRST APPROXIMATION ANALYSIS**

The first approximation method analyzes the results of SWMM model output and uses the model predictions of end-of-pipe CSO activity to compare CSO abatement alternatives. The assumption for this analysis is that any CSO discharge will cause an exceedance of 2000 MPN/100ml for pathogens regardless of background concentrations. Also assuming the minimum sampling frequency of five per month, two discharges in a 30-day period could be an exceedance of the primary contact water quality standard. Data requirements for this analysis include historical rainfall data only. The current SWMM model used by the City will be the primary tool for the analysis.

### **3.1 CONTINUOUS SWMM SIMULATIONS**

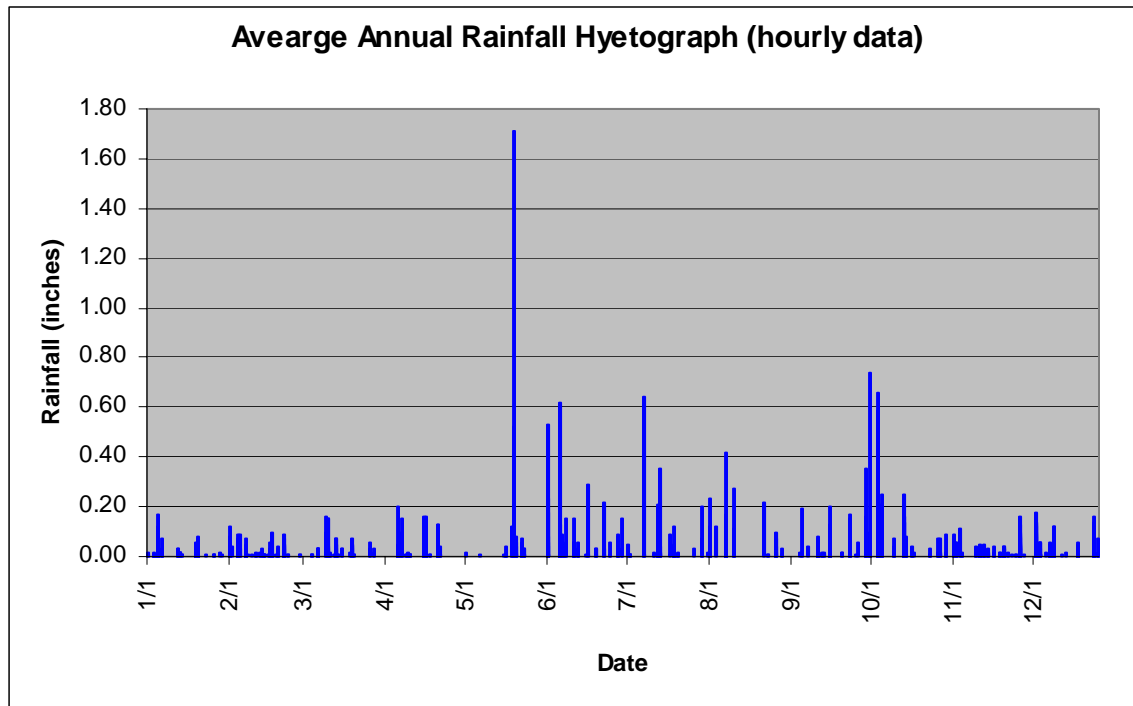
---

The SWMM model will be used to simulate the sewer collection system for the entire recreational season in which the bacteria use designation is applied. The recreational season is May 1<sup>st</sup> to November 1<sup>st</sup> (6 months). It is possible to extend the simulation to a full 12-month period, but this would require some analysis of snowfall.

A representative annual rainfall pattern, or typical precipitation year, would need to be developed as an input for the SWMM model. All of the rainfall data available from a local or nearby National Weather Service station, typically more than a 40 year record, will be analyzed. This analysis establishes average annual measures and average monthly measures (e.g., total depth, number of events, etc.) for the entire period of record. Using these definitions of average characteristics, each year is reviewed to identify the real historical year that is the closest to an average year. Once the closest real historical year is identified, the distribution of rainfall events within that year and within individual months is compared to the long-term average. Where necessary, individual events are added, deleted, or traded to represent the long-term average distribution of events. The final result is a synthetic, average annual rainfall record, developed



entirely from real historical data. This average annual rainfall has already been developed by Columbus and will be the baseline for all SWMM continuous simulations. The figure below is an example of an average annual rainfall record developed for the Buffalo Sewer Authority SWMM model.

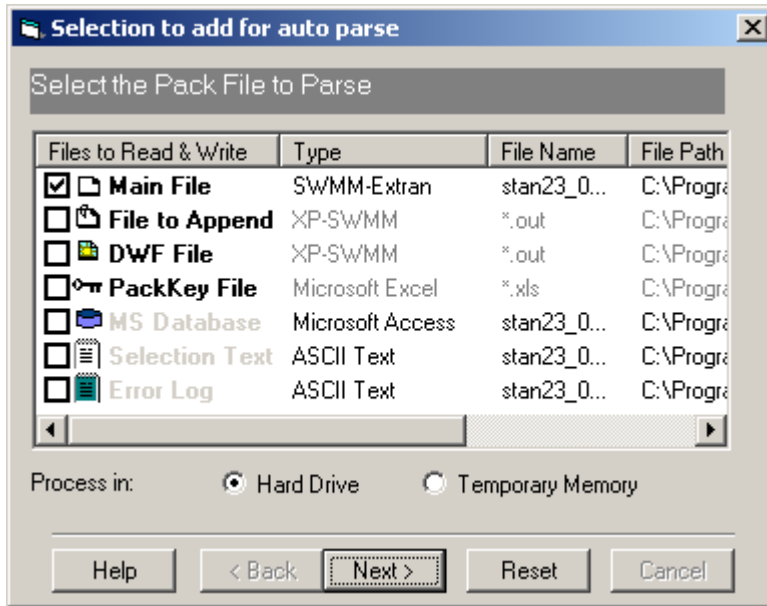


### 3.2 SUMMARIZING ESTIMATED END-OF-PIPE MEASURES FROM THE SWMM MODEL OUTPUT

---

The output of each SWMM model simulation will be processed and statistically summarized. The statistics for the end-of-pipe measures for each alternative will be entered into a matrix for comparison.

The SWMM model output file will be processed using result-processing tools developed by Malcolm Pirnie. These software programs extract the information from SWMM output files and place them in readily usable Microsoft Excel tables. The tools can then be used to begin summarizing the relevant end-of-pipe results of each model simulation. The image below is an example of one of the Malcolm Pirnie developed programs.



A number of relevant end-of-pipe results from SWMM model analyses are listed in the following sections. The full performance of any single alternative must be compared to other alternatives by an aggregate of these results. No single summary such as number of activations would be an accurate assessment by itself. For instance, there could be many activations per year but the maximum flow rate, duration and volume may be low in comparison to other alternatives. The system-wide summaries of all results will provide the best snapshot of alternative performance.

### 3.2.1 Number of Activations

The LTCP guidance documents consider the number of activations a valid measure of CSO performance for the demonstration and presumption approaches. In fact, the presumptive approach is largely based on this metric. A summary of the number of activations for each CSO can be developed from each SWMM model simulation. The activation summary is developed on a CSO by CSO basis; these results can then also be combined into a system-wide basis. Different alternatives can be compared to determine if the number of activations increases or decreases. As introduced previously, given the current

bacteriological water quality standard, estimates of the number of CSO activations in a 30-day period can serve as a surrogate for estimating the number of water quality standard exceedances for bacteria assuming that disinfection or treatment of CSO discharge is not employed.

### **3.2.2 Hours of Overflow**

The duration or time extent from activation to zero flow of each CSO discharge event is another valid measure of the performance of alternatives. The total time of duration or sum of all events for each CSO can be computed. A further evaluation would compute the frequency or cumulative frequency of different durations for each CSO and/or the system. This frequency analysis would answer questions such as what percent of the events exceeded a 1-hour or 3-hour duration.

### **3.2.3 Total Overflow Volume**

The volume of CSO discharge for each event is another important measure of combined sewer system performance. Each rain event that causes an overflow will produce a certain volume of discharge. The total volume of CSO discharge for each alternative will be summarized for each CSO and on a system-wide basis. Furthermore, the frequency or cumulative frequency of event volume per CSO or for the system will permit a more in-depth understanding of system behavior. Since volume can be directly converted to a load if concentrations are applied, it is considered one of the most important measures of combined sewer performance and receiving water impacts.

### **3.2.4 Maximum Flow**

The maximum flow rate from any CSO will vary depending on the event and the level of control. A frequency analysis of maximum flow rates for each CSO will help assess the performance of the various alternatives.

### 3.2.5 CSO Flow Frequency

A CSO flow frequency analysis would be similar to the maximum flow analysis but it would also include a time variable. The frequency of various flow rates could be plotted for each CSO. For instance, a CSO could discharge at 1-cfs for a total of 10 hours per year, 1.5-cfs for 5 hours per year and 2-cfs for 0.5 hours per year. The value of the y-axis would be hours and the x-axis would be flow rate.

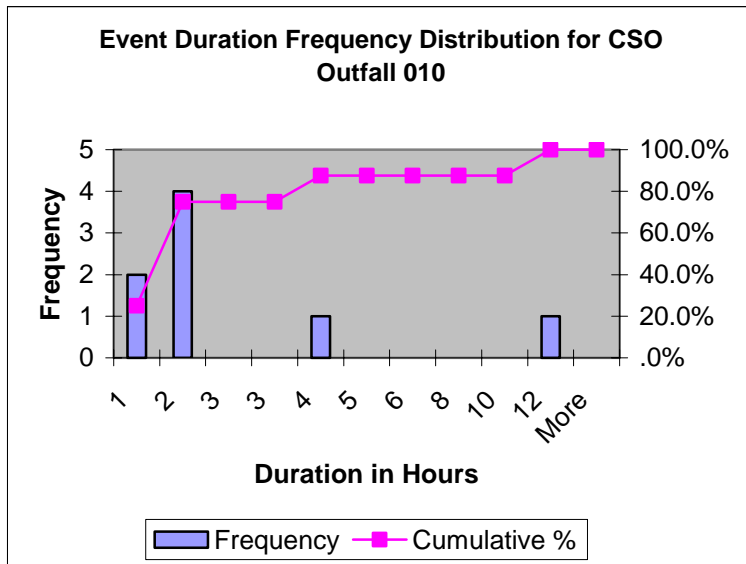
### 3.3 EXAMPLE CSO LTCP ALTERNATIVE ANALYSIS – USE OF CONTINUOUS SIMULATION RESULTS

---

The following table is a partial list of CSO discharge points from a 3-month continuous SWMM simulation presented for example purposes. The data is from a Malcolm Pirnie project (2002) for the Buffalo Sewer Authority in Buffalo, NY. The table shows the total duration of overflow (in hours) that the model predicted for each CSO. The table also shows the number of activations or overflow events. Events were defined using a 6-hour inter-event duration, i.e., an event was considered a new event if the preceding 6 hours had zero flow.

CSO Outfall	Model Node	Model Link	Duration of Overflow (hr)	Number of Overflows
001a	WWTPOF	WETWELLOF	22	9
003	5494	5500	103	8
004	10208	10213	4	1
004	10210	10221	4	1
005	5868	5873	2	1
006	5708	5710	468	10
008	5904	5906	139	16
010	5551	5553	26	8
011	6728	6729	31	5
012	6362	6363	31	10
013	10034	10047	11	1
014	9009	L9201	10	1
015	15669	15670	8	1
016	14964	14968	159	19
016	BR0.00	SPP39w	5	2
017	14580	14584	385	14
021	15439	L15434	6	1
022	14690	L14678	34	3
025	15467	15468	9	1

CSO Outfall ID	Model Outfall Node ID	March - May Total Overflow Volume (cu. ft.)
001	WWTPGRIT	764,500,000
001a	WWTPOF	0
002	TBD	TBD
003	5494	993,500
004	10208 & 10210	2,741,000
005	5868	114,200
006	5708	109,800,000
008	5904	642,800
010	5551	898,800
011	6728	2,015,000
012	6362	2,220,000
013	10034	1,961,000
014	9009	1,666,000
015	15669	1,477,000
016	14964 & BR0.00	429,100
017	14580	13,170,000
021	15439	79,630
022	14690	824,600
025	15467	362,700

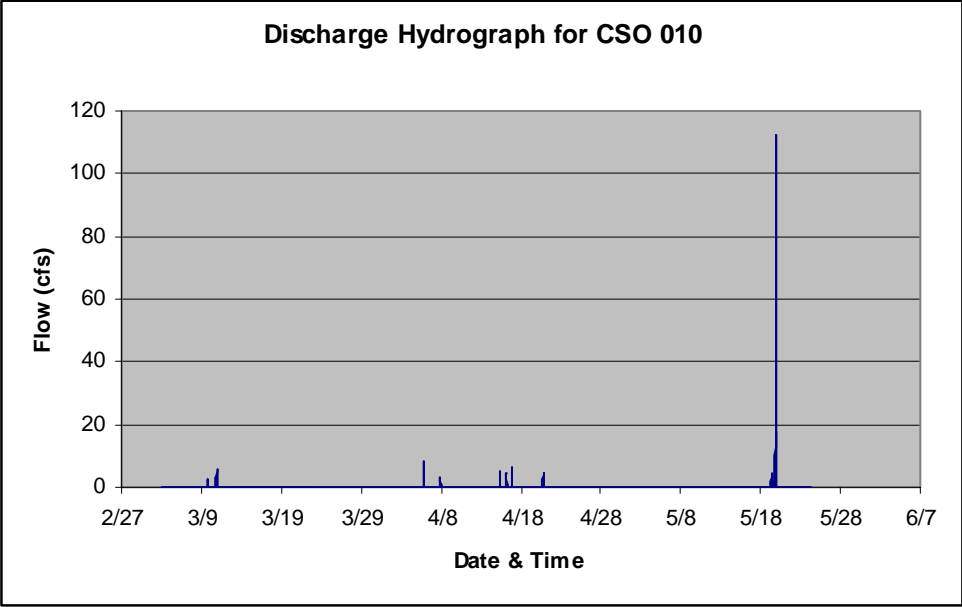


An examination of the flow duration per event for CSO Outfall 010 is shown in the figure above and right. The cumulative distribution shows that 75-percent of all events were 2 hours in duration or less.

The table above and left is from the same model run and shows the total discharge volume for each of the CSO discharge points (a partial list). For example, the total volume discharged by CSO 010, as predicted by the model, was 898,800 cubic feet. A frequency distribution for event volume frequency (very similar to the event duration frequency distribution) could also be developed from the model output.

Other analyses such as establishing the maximum flow rate frequency distribution are similar in concept to the event duration frequency analysis.

The final figure presented below is the predicted annual hydrograph for CSO 010. This hydrograph can serve as the input to a subsequent water quality analysis under the second or third approximation methods.



## **4.0 SECOND APPROXIMATION ANALYSIS**

The second approximation method will directly build upon the first approximation by adding concentrations and stream flow to account for dilution effects and to identify potential instream concentrations. This step is a natural extension of the first approximation approach, although the answers will typically be similar with respect to estimates of bacteriological water quality exceedances. Adding dilution via background streamflow will reduce the duration of exceedances at the beginning and tail end of each event because exceedances will be based on a comparison of predicted instream concentrations to water quality standards, rather than on CSO activations. The advantage of this analysis would be the ability to predict instream concentrations of contaminants at the discharge points (under the simplifying assumption of complete mixing) including background concentrations.

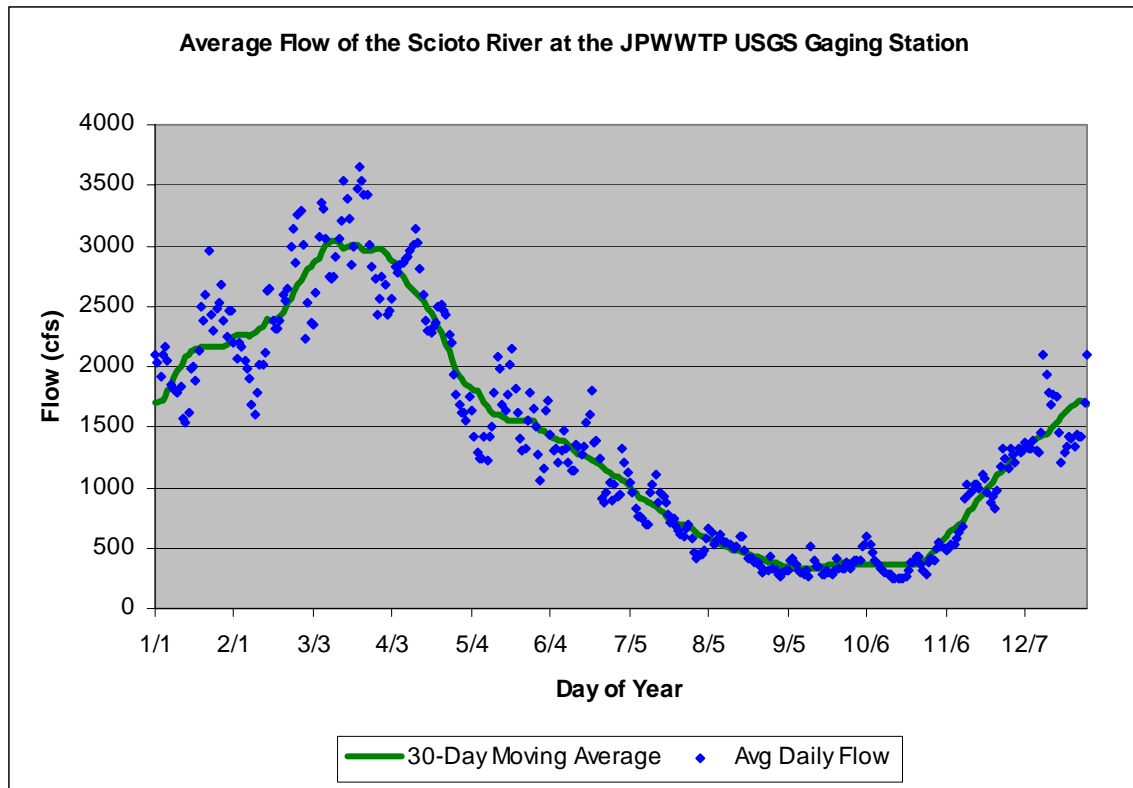
### **4.1 SUMMARIZING ESTIMATED END-OF-PIPE MEASURES FROM THE SWMM MODEL OUTPUT**

---

The end-of-pipe analysis described in SECTION 3.0 will still be applicable for the second approximation analysis. The significant additional step that would be necessary for this analysis but unnecessary for the previous analysis is the application of concentration to the CSO discharge. This requires a definition of “typical” CSO discharge quality, as noted in SECTION 2.0. If CSO discharge concentrations were not accounted for in the calculation, the only information that could be determined from the dilution analysis is the percentage of river flow that is CSO.

## 4.2 STREAM FLOW PROBABILITY FOR THE DILUTION CALCULATION

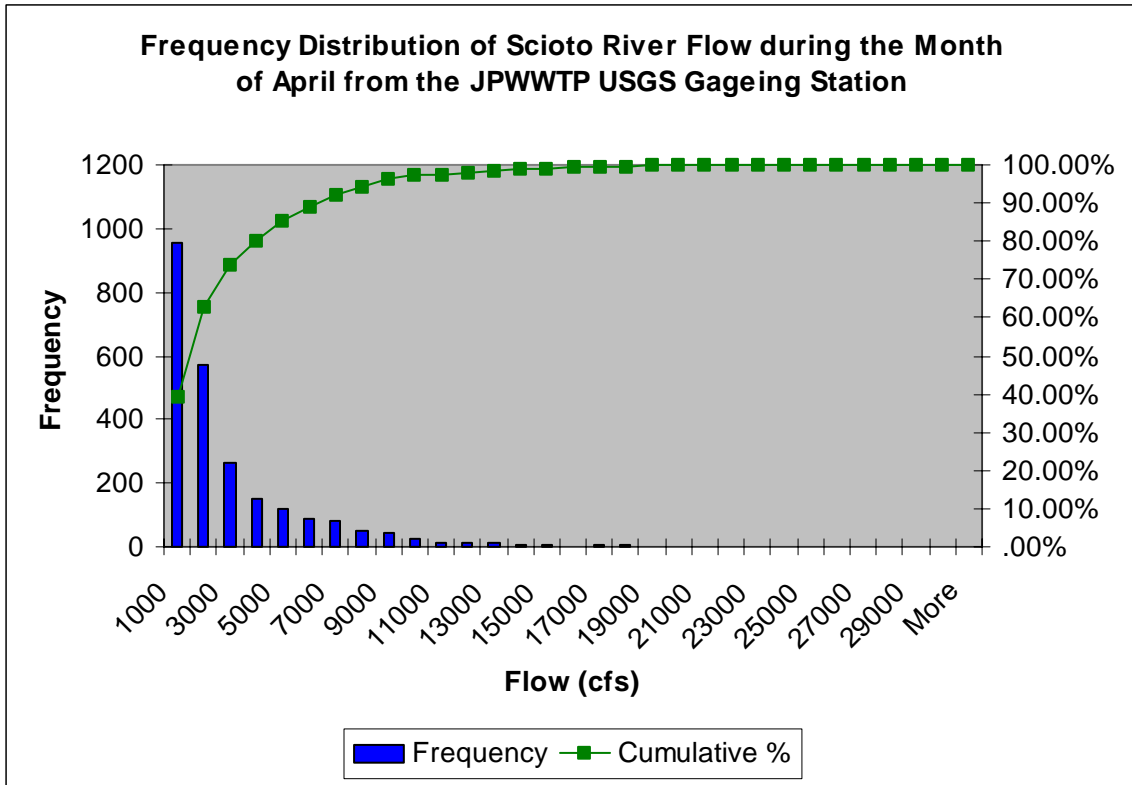
The base streamflow for any CSO event can vary depending on the season and preceding rain events. Because background flow varies, applying a single background flow is not an entirely accurate method of estimating dilution. As a simplifying assumption, the average monthly flow would be a reasonable estimate. The figure below represents the average monthly streamflow for the entire period of record at the JPWWTP USGS Gaging Station.



Using the average plus some standard deviation from the average to predict instream concentrations would be slightly more robust than just applying the appropriate monthly average value. To extend beyond use of an average streamflow (or band around the average), one would need to examine the frequency distribution of the monthly streamflow and apply the probability of stream flow rates to the dilution calculations. The figure below is a histogram of the flow rate for the month of April. The end result of the analysis would be a



probability distribution of a particular concentration occurring in the stream for a given CSO event.



There is also some correlation between rainfall and stream flow. The correlation of historical rainfall and streamflow datasets would need to be analyzed and incorporated into the analysis. Incorporating the correlation would better account for the probability of a concentration occurring in the stream for a given CSO event. For example, during a very wet spring with significant volumes of rainfall, the stream flow rate would most probably be higher than average. The opposite would most probably be true during a dry or low rainfall volume spring.

#### **4.3 SPREADSHEET ANALYSIS FOR COMBINED PROBABILITY OF CSO DISCHARGE AND STREAMFLOW**

---

A spreadsheet analysis can be performed to provide a single value for the probability of exceedance of a single instream concentration, for example 2000 most probable number per 100ml (MPN/100ml) bacteria. To obtain the single value, the probability of background streamflow and concentration would be combined with the probability of CSO flow rate and concentration.

The process of combining probabilities would be completed along the length of the stream for each CSO encountered. For each new CSO encountered, the background streamflow will have increasingly higher concentrations of bacteria if the upstream CSO was also discharging. The analysis would not include decay; therefore, travel time would be irrelevant. The other possible approach is to sum all CSO discharges system wide and apply the system wide flow and concentration probability (i.e. load) to the stream background flow and concentration. The system wide approach would best be applied at the downstream end of the CSO areas.

#### **4.4 MONTE CARLO ANALYSIS TO COMBINE PROBABILITIES OF CSO DISCHARGE AND STREAMFLOW**

---

A Monte Carlo analysis would be a more advanced approach as compared to the dilution only model. A Monte Carlo analysis would use the probability distributions of stream flow rates, instream concentrations, CSO flow rates, and CSO concentrations as inputs to the dilution equation. The equation would be solved 1000 or more times with each solution using a randomly selected value from each probability distribution.

The Monte Carlo results would be presented as frequency or cumulative frequency distributions of the resulting modeled set of instream concentrations.

Determination of the percent of time that the instream concentration will exceed any value can be easily extracted from the distribution.

#### **4.5 EXAMPLE CSO LTCP ALTERNATIVE ANALYSIS – USE OF DILUTION RESULTS**

---

The results from the second approximation would be very similar to the statistical summaries from the first approximation. For example, a histogram of the duration of concentrations could be created that would be similar to the histograms presented in SECTION 3. The difference would be that the histograms and distributions would reflect predicted concentrations in the receiving stream, as opposed to end-of-pipe CSO measures.

## **5.0 THIRD APPROXIMATION ANALYSIS**

The third approximation method incorporates dilution, transport, fate, and decay modeling using either a steady state or dynamic model. The dilution-transport-fate-decay modeling is the only analysis that is capable of predicting the complex interactions between multiple CSO contaminants such as ammonia and CBOD impacts on dissolved oxygen. Again, it is important to recognize that the impacts of bacteria will most likely dominate the analysis since it will be the most difficult water quality criterion to meet. Identifying an alternative that meets bacteria water quality standards through CSO reduction is expected to also meet other water quality standards such as ammonia and instream DO levels.

### **5.1 USE OF ESTIMATED END-OF-PIPE MEASURES FROM THE SWMM MODEL OUTPUT**

---

The specific use of the SWMM model output in this third approximation analysis depends on the choice of steady state or dynamic modeling. If steady state modeling in QUAL2E is chosen, then the end-of-pipe summary statistics determined in SECTION 3.2 above will be used as inputs for the QUAL2E model. If dynamic modeling is used, then the full hydrograph output of the continuous SWMM simulation will be used as the input to the dynamic WASP model. In either case, an event mean concentration of the modeled parameters would have to be combined with the SWMM model output to develop the appropriate load inputs.

### **5.2 QUAL2E MODEL SIMULATION – WORST CASE STEADY STATE**

---

QUAL2EU is a USEPA developed receiving water model capable of predicting the steady-state transport, fate, and decay of DO, CBOD, nitrogen, phosphorus, suspended algae, and fecal coliforms as well as three user defined constituents. The City already has a well-developed QUAL2E model for the Scioto River downstream of Greenlawn Dam and for Alum Creek and Big Walnut Creek downstream of Livingston Avenue. The QUAL2E analysis can be used to

examine the instream DO response and pathogen decay under steady-state flow conditions. It is important to realize that the pathogen capability of QUAL2E is a simple first order decay process and it is only affected by temperature. Pathogens have no effect on, nor are they affected by, any other process in the QUAL2E model.

For this application, the existing QUAL2E model would be run at low wet-weather flow rates determined from historical streamflow data. The lower flow rates are considered conservative and would reduce reaeration and travel time, causing reduced pathogen transport and greater dissolved oxygen sags to occur in the stream. The inputs at CSO discharge points are entered as boundary conditions.

On the Scioto and Olentangy Rivers, all of the CSO discharge points would be entered at the headwater of the existing model, which is Greenlawn Dam. Greenlawn Dam is also the location of the most significant CSO on the Scioto River, the Whittier Street Storm Tanks. Any CSO discharge points downstream of the Greenlawn Dam would be input at the appropriate location.

There is only one CSO discharge point on the Alum Creek. The Alum Creek Storm Tanks are approximately 3100-feet upstream of the current upper boundary of the QUAL2E model of Alum and Big Walnut Creeks. The Alum Creek Storm Tank would be input as part of the headwater condition of the model.

The QUAL2E model is a conservative method of examining the stream response for CSO LTCP development because all of the loadings will be entered as constant, and at their maximum level, rather than time-varying. The USEPA LTCP Modeling Guidance recognizes QUAL2E as a model valid for analyzing receiving water impacts. Furthermore, the guidance documents note that QUAL2E is conservative in this application and will provide worst-case predictions. In other words, the instream concentrations would not be expected to exceed the results predicted by the model. Different alternatives would be

compared based on the results of the QUAL2E model. The longitudinal extent of the impacts from CSO contaminants could also be identified from the QUAL2E model, although the predicted longitudinal extent may be non-conservative given the use of lower streamflow rates.

The current QUAL2E model will require validation with wet weather data. The validation work is currently proposed to be completed.

### **5.2.1 QUAL2EU Uncertainty Analysis**

The Monte Carlo analysis option of QUAL2EU could be invoked for a more robust analysis of the receiving water quality impacts. The Monte Carlo analysis would be very similar to the spreadsheet version of Monte Carlo analysis in SECTION 4.4 except QUAL2EU has a built-in Monte Carlo tool. The characteristics of all of the modeled constituents would have to be examined to identify the best probability distribution and also the coefficient of variance (standard deviation/mean). The Monte Carlo analysis results could be presented in a frequency distribution or cumulative frequency distribution.

### **5.3 WASP MODEL SIMULATION – COMPLEX DYNAMIC ANALYSIS**

---

WASP is another USEPA-developed model that can be used to model the transport, fate, and decay of the same parameters as QUAL2E, along with many more parameters. WASP is a dynamic model that can simulate time-varying streamflow rates along with time varying loading sources such as CSOs, rather than applying them as worst-case, steady-state sources. The WASP model would be a more realistic representation of the river and CSO system under wet-weather conditions.

The information on the physical configuration of the river reaches in the current QUAL2E models could be used to develop the WASP models for those reaches. Extending the WASP model upstream of the Greenlawn Dam would be significantly more difficult and costly due to the required data collection effort.

### **5.3.1 Coupling WASP with SWMM Model**

The SWMM model output hydrographs would be used as a time-varying input for the WASP model. Event mean concentrations would be applied to the hydrograph thereby developing the appropriate loads for the modeled parameters. The location of the CSO inputs incorporated in the model will depend on the extent of the modeled network.

### **5.3.2 WASP Based on Existing QUAL2E Network**

The representation of river reach characteristics and hydrodynamics in the current QUAL2E model can be converted for use in WASP. The WASP model would require calibration and validation to existing wet-weather flow and water quality data and quite possibly some new wet-weather data.

### **5.3.3 WASP Based on Extended Network for Dam Pools**

WASP (or more generally a dynamic model) is the only recommended dilution, transport, fate, and decay model for the area upstream of Greenlawn dam. The extensive pools created by the dams result in slow moving water and applying constant CSO sources would be overly conservative. Using time-varying CSO loading in the dam pools would be more appropriate. Extending the model network upstream of Greenlawn Dam would allow the CSO inputs to be located at their actual discharge points into the pools.

Extending the network upstream of Greenlawn Dam will require a significant data collection effort to define the hydraulics in the dam pools. The data collection effort was noted previously in SECTION 2.0. In particular, data would need to include continuous flow monitoring at multiple sites, stage-discharge curve development and time of travel studies.

### **5.3.4 Simulation of Conservative and Non-Conservative Pollutants**

WASP can readily model DO, CBOD, ammonia, nitrogen, phosphorus and bacteria. Furthermore, WASP has the capability to model sediment processes,

although sediment modeling adds a significant level of complexity to the model and data collection effort. Bacteria are still the most likely contaminant to focus on given the difficulty in meeting bacteriological water quality standards under wet weather conditions.

The WASP model for either network will be run continuously for the same time period as the SWMM model. The results of the WASP model are time-varying instream concentrations for the modeled parameters. These results can be presented as a cumulative frequency distribution of parameter concentrations, and these distributions can be used to compare abatement alternatives. The longitudinal extent of the water quality impacts resulting from CSO discharges can also be reasonably predicted via the WASP model.

#### **5.4 EXAMPLE CSO LTCP ANALYSIS – USE OF WASP MODEL OUTPUT**

---

The following table presents an example of how continuous WASP model output can be used to assess the impact of CSOs in terms of water quality standards exceedances. These results are from a continuous 6-month simulation using a calibrated WASP model of the Cuyahoga River. Several points can be identified from the table.

- The table shows that the majority of the modeled river reaches violated the Fecal Coliform Geometric Mean requirement of 1000 coliform per 100ml for 2 months out of the 6-month recreational period (see SECTION 7 for details on the water quality standard for fecal coliforms).
- The 10-percent rule of the fecal coliform water quality standard, i.e. no more than 10-percent of the samples in a 30-day period can exceed 2000 coliform per 10ml, was exceeded every month by 35 of the 38 discharge points. The remaining 3 discharge points exceeded the standard 5 months out of the 6-month simulation.
- The table shows that there were no exceedances of the DO standard in the stream during the six-month period. This particular result is in some ways unique to the project situation being used in this example.



The 10-percent rule observation highlights the concept that virtually any CSO discharge will result in an exceedance of the bacteriological water quality standard. The dynamic modeling used on the example project was necessary for other parameters; however, it is very relevant to observe that in terms of bacteria, the same conclusion regarding water quality exceedances could have been achieved using the first approximation analysis. The first approximation would have taken significantly less time and dollars to complete.

**TABLE 12-11**  
**Summary of Water Quality Violations**  
**Cuyahoga River**

(Based on Predictions From the Water Quality Model for the Six-Month Recreational Period (May-October))

	<b>Number of Months when the Fecal Coliform Geometric Mean is greater than 1000 col. per 100 ml</b>	<b>Number of Months that the Fecal Coliform samples exceed 2000 col. per 100 ml more than 10% of the time</b>	<b>Number of Months in Violation of the Primary Contact Bacteriological Standard</b>	<b>Number of Days in Violation of the DO Standard</b>
CR(46-38)	0	6	6	0
CRL(45-85)	0	6	6	0
CR(45-08)	0	6	6	0
CRL(44-86)	0	6	6	0
Dam	0	6	6	0
CR(44-3)	0	6	6	0
CR(43-4)	0	6	6	0
CR(43-3)	0	6	6	0
CR(43-2)	0	6	6	0
CR(43-1)	0	6	6	0
CR(42-5)	0	6	6	0
CRL(42-4)	0	6	6	0
CR(41-4)	2	6	6	0
CR(41-3)	2	6	6	0
CRL(41-2)	2	6	6	0
CR(40-4)	2	6	6	0
CR(40-3)	2	6	6	0
CR(40-2)	2	6	6	0
CR(40-1)	2	6	6	0
CR(39-4)	2	6	6	0
CR(39-3)	2	6	6	0
CR(39-2)	2	6	6	0
CR(39-1)	2	6	6	0
CR(38-4)	2	6	6	0
CR(38-3)	2	6	6	0
CR(38-2)	2	6	6	0
CR(38-1)	2	6	6	0
CR(37-5)	2	6	6	0
CR(37-4)	2	6	6	0
CRL(37-45)	2	6	6	0
CR(37-30)	2	6	6	0
CR(37-10)	2	6	6	0
CR(36-30)	2	5	5	0
CR(35-60)	2	5	5	0
CR(34-38)	2	5	5	0
CRL(42-2)	2	6	6	0
CRL(44-2)	0	6	6	0
CRL(45-42)	0	6	6	0

## 6.0 PREVIOUS WORK

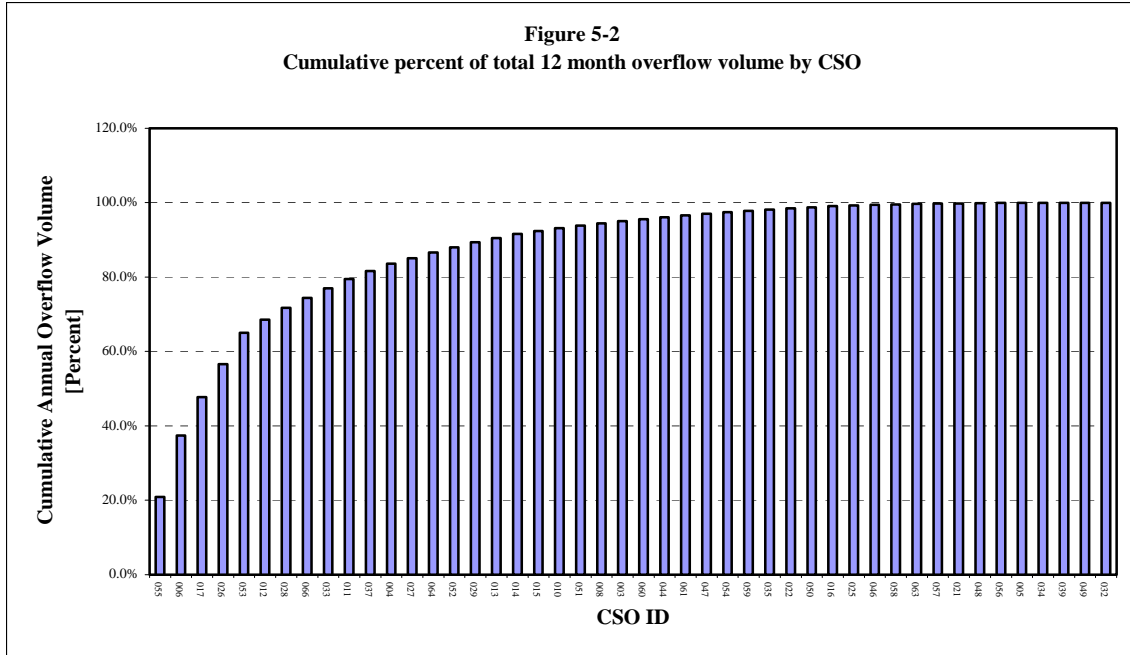
### 6.1 BUFFALO SEWER AUTHORITY, NEW YORK

---

Malcolm Pirnie is the Coordinating Consultant for the Buffalo Sewer Authority's development of a CSO LTCP. As the Coordinating Consultant, Malcolm Pirnie is leading a team of four consultants on the project, and is responsible for model development, characterization of existing conditions, and preparing data collection and alternative screening protocols for use by the other three consultants working in their respective drainage areas (Districts).

BSA's 68 CSOs discharge into the Buffalo River, Black Rock Canal, and Niagara River, along with several major urban streams that run through the City of Buffalo. Early in the project, it was recognized that attainment of water quality standards would be an imperfect measure for comparing CSO abatement alternatives, given the significant background concentrations in BSA's receiving waters. Therefore, sophisticated water quality modeling was not incorporated in the project; rather, predicted end-of-pipe CSO measures were used to prioritize CSOs under existing conditions, and provide a measure of benefit for abatement alternatives. Sophisticated water quality modeling may still be pursued in local sensitive areas, but only where its usefulness is demonstrable; its use as a system-wide analysis tool was not warranted.

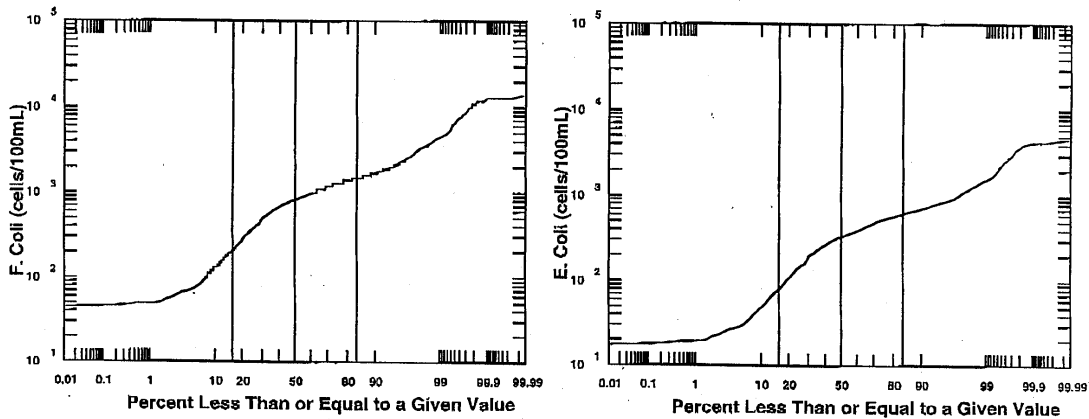
An example of the use of predicted end-of-pipe measures from continuous XP-SWMM model simulations for the BSA project is shown below. This figure shows predicted annual overflow volume by CSO, and can be used to quickly identify the significant contributors in terms of annual CSO volume. From this figure, it is clear that approximately 80 percent of the annual system-wide CSO volume comes from the top ten CSOs.



## 6.2 CITY OF FORT WAYNE, INDIANA

The City of Fort Wayne, Indiana, submitted their draft CSO LTCP to the Indiana Department of Environmental Management and USEPA in July of 2001. The draft LTCP has been reviewed by USEPA, and the City is currently engaged in comment response and negotiation.

A team of consultants led by Malcolm Pirnie developed the LTCP for the City, including dynamic collection system and receiving water modeling tools. The receiving water modeling tools were used to characterize CSO impacts under existing conditions to a high level of detail, resulting in concentration frequency distributions such as those shown below.



Example Pathogen Frequency Distribution in a Fort Wayne Receiving Water Reach

Predicted end-of-pipe measures were used as the primary method to characterize the benefit of improvement alternatives, with reductions in CSO activations used as a surrogate for reduction in number of bacteriological water quality exceedances.

### 6.3 CITY OF AKRON, OHIO

---

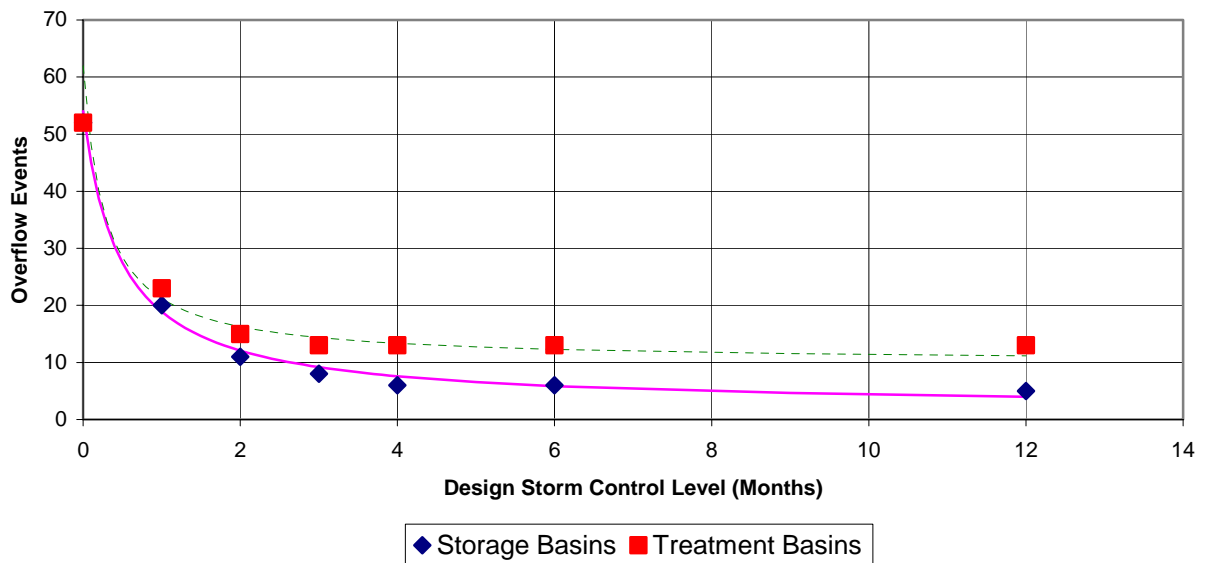
The City of Akron submitted their draft CSO LTCP to Ohio EPA in early 2000. They are currently in the final stages of negotiating the final LTCP with Ohio EPA and USEPA.

Malcolm Pirnie was the modeling consultant on the City's LTCP development team. Using XP-SWMM for the collection system, and WASP for the receiving streams, a number of continuous annual simulations were performed. Conclusions from the modeling of existing conditions were as follows:

- Dissolved oxygen depression does occur during wet-weather events, but exceedances of DO water quality standards are rare.
- Exceedance of bacteriological water quality standards occurs regularly during wet weather, due to both upstream concentrations and CSO discharges.

Given these conclusions, widespread use of the water quality modeling tools to assess the benefit of alternatives in terms of attainment of water quality standards was not warranted, since attainment would not be sensitive to CSO control levels to background concentrations. Rather, reduction in end-of-pipe measures was used as the primary measure of benefit for assessment of abatement alternatives. This approach allowed the team to identify a “knee-of-the-curve” control point for each CSO, where the incremental increase in benefit (as measured by reduction in end-of-pipe activity) starts decreasing with increase in control level. An example of this level of control relationship is shown below.

**Regulator K06285**  
**Comparison of Annual Number of Overflow Events**



## 7.0 PATHOGEN MODELING

Throughout this paper, pathogens have been identified as the single most difficult water quality parameter of concern with the City's CSO discharges. The basis of this concern includes the current water quality standards for pathogens, the average concentration of pathogens in CSO discharge, and previous LTCP development experience.

The current water quality standard for pathogens is as follows:

*Primary contact pathogen standard for Ohio requires that one of the two following bacteriological standards are met:*

**Fecal coliform** - *geometric mean fecal coliform content (either MPN or MF), based on not less than five samples within a thirty-day period, shall not exceed 1,000 per 100 ml and fecal coliform content (either MPN or MF) shall not exceed 2,000 per 100 ml in more than ten per cent of the samples taken during any thirty-day period.*

**E. coli** - *geometric mean E. coli content (either MPN or MF), based on not less than five samples within a thirty-day period, shall not exceed 126 per 100 ml and E. coli content (either MPN or MF) shall not exceed 298 per 100 ml in more than ten per cent of the samples taken during any thirty-day period.*

Typical total coliform concentrations for CSOs are reported as  $10^5$  to  $10^7$  MPN/100ml. With these discharge concentrations, the volume of dilution water alone would have to be at least 3 orders of magnitude greater than the CSO volume. For instance, if the CSO discharge rate were 10 cfs and bacteria concentrations were  $10^7$  MPN/100ml, then the stream would have to be flowing at 50,000 cfs and have zero background coliform concentrations. This would meet the 2,000 MPN/100ml limit. To put 50,000 cfs into perspective, a 500-year flood on the Olentangy River is 28,700 cfs. The 10-year and 50-year floods at

the USGS gaging station located at JPWWTP on the Scioto River are 37,000 cfs and 60,400 cfs respectively. According to 10-State Standards, a wastewater treatment plant can cease operations past 25-year flood events.

In addition, the current bacteriological standard does not explicitly allow for dilution to be accounted for in assessing attainment. Because there is no guidance on when or where samples are to be taken, the standard creates the possibility that a sample could be taken at a location where the effect of dilution or mixing has not been achieved. Because of this, the standard might be interpreted to effectively require that the concentration limits be met at all times, at all locations, in the receiving stream.

## **7.1 FIRST APPROXIMATION SUFFICIENT FOR CURRENT PRIMARY CONTACT USE DESIGNATION STANDARDS**

---

For the reasons stated above, the first approximation analysis (summary analysis of end-of-pipe estimates from continuous SWMM model simulation) is considered a valid measure of existing conditions and abatement alternative performance. Any CSO discharge will most likely cause an exceedance of the current primary contact standard for bacteria, so the “measure” of exceedance for the purposes of the analysis is a predicted CSO activation.

## **7.2 ADVANTAGES/DISADVANTAGES OF FIRST APPROXIMATION**

---

The first approximation analysis for evaluating the LTCP alternatives has the following advantages:

- Rapid Analysis of Pathogen Impacts
- Significant Cost Savings
- Does Not Require an Extensive Data Collection Effort
- Readily Available Tools
- Does Not Require Instream Background Concentrations
- Attainment of Pathogen Criteria Through CSO Reduction will most likely result in Attainment of other Water Quality Criteria

The disadvantages of the first approximation analysis are as follows:



- Does Not Identify Instream Concentrations of Pathogens
- Omits Dilution, Transport, Fate, and Decay (Duration and Longitudinal Extent of Exceedance is Not Determined)
- Does Not Allow for Analysis of Parameters With Significant Instream Fate and Transport Characteristics (e.g., CBOD/DO).
- Does Not Support Discussion of Modifying Water Quality Standards.

## **8.0 CITY OF COLUMBUS RECOMMENDATION**

There are many ways to approach the evaluation of CSO impacts on receiving waters as part of a CSO LTCP development process. Obviously, conducting the full suite of evaluations is typically not feasible due to cost and schedule considerations. More importantly, complex analyses will most likely not result in significant differences in the outcome of the CSO LTCP recommended alternative, given that the controlling factor is typically the requirement to attain current water quality standards for pathogens

### **8.1 SELECTING CRITERIA OF INTEREST**

---

The first major step to determining an acceptable modeling and analysis approach is to determine the criteria of interest. The single most difficult water quality standard to attain is that for pathogens; therefore, it is the recommended focus for the City's LTCP analysis. Ammonia toxicity and dissolved oxygen depletion are also parameters of concern with CSO contaminants, but it is anticipated that they will not be an issue if the water quality standards for bacteria are attained through CSO reduction. If technology such as disinfection is used at any CSO discharge point, it may be necessary to consider other parameters.

### **8.2 RECOMMENDED MODELING APPROACH**

---

#### **8.2.1 Pathogens and Second Approximation**

The recommended primary modeling approach for the CSO LTCP is to use the second approximation analysis as outlined in SECTION 4.0. The second approximation approach can be applied to the CSO discharge points on the Olentangy River, the Scioto River, and the Alum Creek. This includes the analysis of the dam pools, which have significantly different hydraulics than the areas on the Alum Creek and the Scioto River downstream of Greenlawn Dam. Additional types of modeling in the dam pools would require significant data collection efforts to define the hydraulics of the pools, with potentially no

additional benefit to analyzing and comparing alternatives in terms of attainment of bacteriological water quality standards.

## **8.2.2 Detailed Dilution Decay Modeling**

If analysis of the CSO impacts for parameters such as DO and ammonia is required, an analysis can be effectively conducted using the existing QUAL2E models. Analysis of DO, ammonia and CBOD would be necessary if there is still a significant discharge volume at any CSO location but the discharge is disinfected. SECTION 5 covers the QUAL2E modeling in more detail. The USEPA LTCP Guidance documents support QUAL2E and note that it can be used in this manner, with the understanding that the results will represent worst-case conditions.

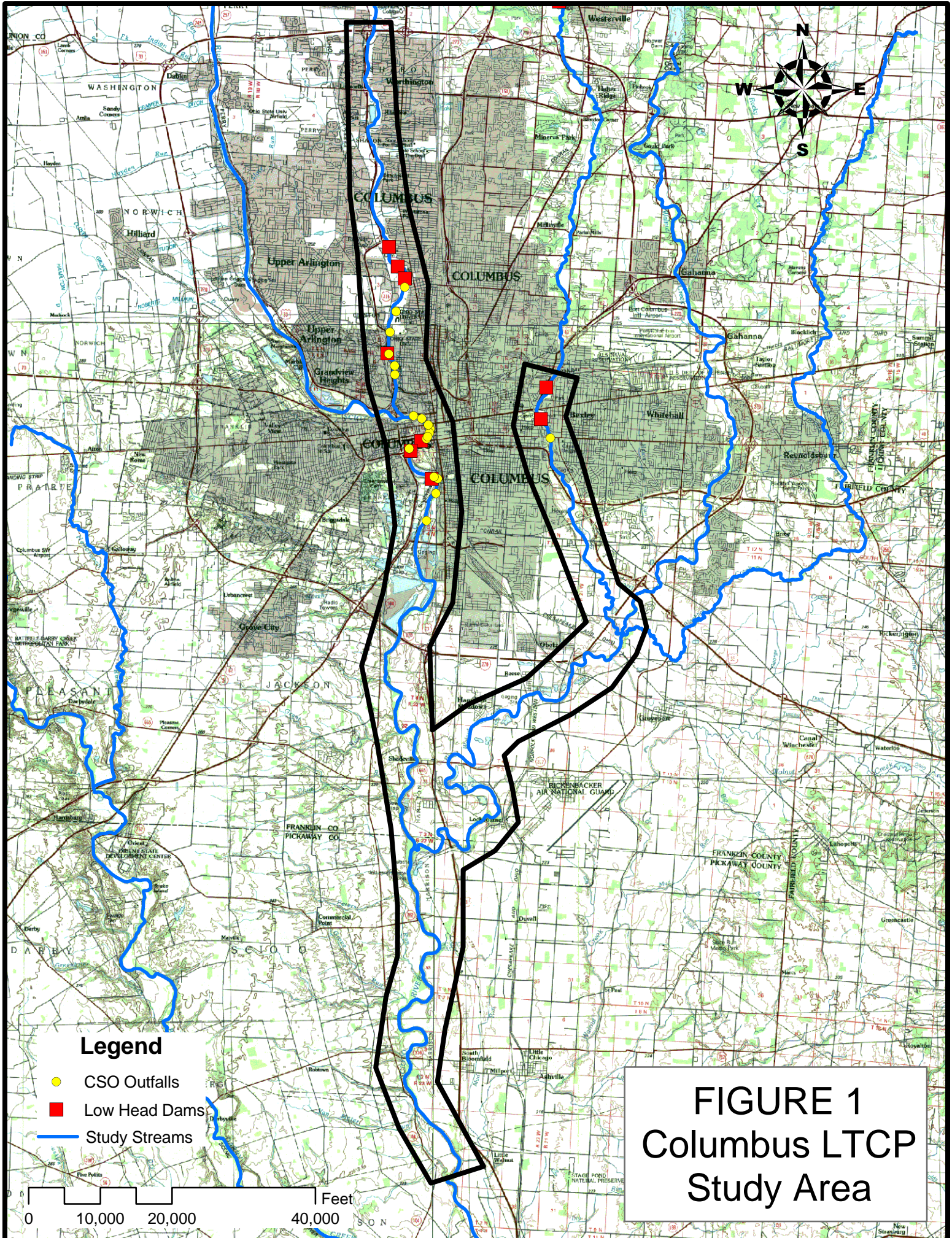
## **8.3 PRESENTATION OF RESULTS**

---

### **8.3.1 Summary Statistics of Exceedances**

The results of the second approximation analysis would primarily be summary statistics of in stream concentrations based on the SWMM model output and historical streamflow. The output can be processed into frequency distributions that would allow the likelihood of exceedance of bacteriological water quality standards to be determined. The LTCP alternatives would be compared based on the statistical evaluation.





- Legend**
- CSO Outfalls
  - Low Head Dams
  - Study Streams

**FIGURE 1**  
**Columbus LTCP**  
**Study Area**

0 10,000 20,000 40,000 Feet



# **ATTACHMENT D**

**April 12, 2004**

## **CITY OF COLUMBUS LTCP**

### **SCOPE OF WORK FOR THE**

### **TECHNOLOGY AND INITIAL ALTERNATIVES REPORT**

#### **1.1 Introduction**

The City of Columbus intends to prepare a Technology and Initial Alternatives (“TIA”) Report by August 1, 2004. The TIA will identify and provide a brief, initial discussion of the technologies and alternatives the City is considering for its LTCP. The purpose of this document is to describe how the City will prepare the TIA.

#### **1.2 General Considerations for the TIA**

In the TIA, the City will structure conceptual CSO control alternatives. At this stage, the CSO control alternatives are structured at the “big-picture” level, considering the initial decision factors and potential characteristics of alternatives outlined below. Individual alternatives for CSOs will be identified to better develop the “big-picture” alternatives.

##### **1.2.1 Projects Common To All Alternatives**

Any infrastructure improvement projects already planned by the City that impact the wet-weather performance of the collection system and WWTPs will be identified and incorporated in all alternatives. These are projects that have been selected independently of CSO control objectives, but have a cross-benefit in terms of wet-weather control.

##### **1.2.2 Outfall-Specific Solutions**

Certain CSOs are inherently conducive to outfall-specific solutions for achieving CSO control goals, due to their location or the magnitude of their CSO discharge. An example is the Alum Creek Storm Tanks, discharging to Alum Creek, which is remote from any other CSO outfall. CSOs with the potential for outfall-specific solutions will be identified under this task, along with general technology candidates to achieve local CSO control (e.g., storage, treatment, etc.)

### 1.2.3 Localized Consolidation Of Outfalls

As opposed to CSOs that are candidates for outfall-specific solutions, groups of CSOs may stand out as candidates for local consolidation for CSO control purposes. Under this task, groups of CSOs with potential for consolidation will be identified, along with general candidate technologies.

### 1.2.4 Regional Consolidation

Regional consolidation of CSOs may be a candidate component of an overall alternative, in combination with additional system capacity and wet-weather equalization at the treatment plants. This possibility will be investigated.

### 1.2.5 Utilization Of POTW Capacity

As part of recognizing the importance of the WWTPs as downstream controls on the collection system, the City will use WWTP upgrade programs to maximize utilization of the WWTP capacity as part of the City's CSO control program.

## 1.3 Goals Of Initial Alternatives Development

In the TIA, the City will develop specific CSO control alternatives to meet the CSO control goals. In developing these specific CSO control alternatives, several factors, or goals, will be considered:

- The alternatives will coordinate with potential SSO control alternatives identified by the CMOM/SECAP team as well as recommended upgrades in the WWTP Facilities Upgrade Program. This coordination between the three programs is essential to the City's wet-weather control program.
- The alternatives will include scaleable components, e.g., storage and/or treatment technologies. This will allow the alternatives to be assessed for varying levels of control – for example, control to a 3-month return period event, allowing approximately 4 untreated overflows per year, or control to a 12-month return period event, allowing no overflows in a typical precipitation year. The TIA will use a one-year level of control for the comparison and initial evaluation.

The City will work with Ohio EPA during this process. It is the City's intention to meet with Ohio EPA on a regular basis as it develops its alternatives analysis.

## 1.4 Identification Of Control Alternatives

The City will, in coordination with its CMOM/SECAP program, work through a screening process to identify up to ten system-wide alternatives to achieve the identified CSO control goals. Each of the alternatives will be made up of combinations of control measures. The control measures will in general emerge from one of the following four categories:

- Source controls – can include technological controls, e.g., sewer separation, or policy/regulatory controls, e.g. pollution prevention programs.
- Collection system controls – can include technological controls, e.g., adjustment of weir heights, or operational controls, e.g., wet-weather operating strategies for pump stations.
- Storage technologies – include a wide range of technological controls, from local, end-of-pipe storage facilities to centralized storage tunnels.
- Treatment technologies – include a wide range of technological controls, from local, end-of-pipe treatment facilities to centralized high rate treatment at the WWTP.

The initial selection of the components that in total make up an integrated CSO control alternatives is based on the CSO control goals identified above. Many combinations of components are possible, and within each component there are potentially many specific technologies available. Judgment and common sense are necessary to consolidate the many possibilities into a tractable group of 10 integrated CSO control alternatives.

During this phase, the components of each alternative are developed only to the level necessary to define the alternative. For example, end-of-pipe treatment at a particular CSO may be identified as a component of an alternative, but the specific treatment technology, along with the final recommended size of the facility (a function of the level of control), will be determined during the evaluation of the integrated alternatives.

## **1.5 Preliminary Sizing Considerations**

In identifying the up to 10 candidate integrated CSO control alternatives, the City will investigate preliminary sizing consideration using existing flow monitoring and rainfall data collected from January 1, 2000 to January 1, 2004. The final sizing analysis for the LTCP will utilize the City's PC-SWMM model. Preliminary sizes will be developed for a one-year level of control for all CSOs; however, selection of a final level of service will not occur until the LTCP is complete

## **1.6 Preliminary Siting Issues**

In developing the ten integrated CSO control alternatives, preliminary siting issues must be included. Using the information on facility sizes required to obtain a desired CSO control goal, control technologies can be assessed relative to available sites for facilities. This level of screening is the beginning of an iterative process on selecting technologies and sites. As stated in the CSO Guidance:

*“As with other aspects of the alternative development process, identifying and evaluating potential sites calls for iterative screening. The objective of preliminary site development is to identify potential locations for the*

*range of facilities identified based on the sizing procedures. Common sense and engineering judgment are used at the preliminary siting level to identify possible locations for facilities.”*

## **1.7 Conclusion**

Based on the methodologies described above, the City will prepare a TIA by August 1, 2004. The TIA will provide a “big picture” list of the available alternatives that will be evaluated in more detail as the LTCP is developed.