# SOURCE FLOW REDUCTION AND FLOW TARGET SUBCOMMITTEE INTERIM REPORT

## FEBRUARY 16, 2017
## Revised November 2017

## 1. Purpose of this Report

The purpose of this report is twofold:

- To provide a consensus-based summary document from a municipal perspective, which addresses Interim Investigative Flow Target Metric Thresholds as a resource to ALCOSAN's January 2017 response to the 308 letter received from United States Environmental Protection Agency (USEPA) in June 2015 as modified in October 2015.
- To provide a consensus-based framework for acceptance by the municipalities of a compliance process and Interim Investigative Flow Target Metric Thresholds for incorporation into potential regulatory implementation orders.

This *interim* report is the product of the Source Flow Reduction and Flow Target (SFRFT) Subcommittee of the Wet Weather Working Group (3WG), facilitated by 3 Rivers Wet Weather. This collaborative group has been developed through, and is an offshoot of, the cooperative efforts of the Allegheny County Sanitary Authority (ALCOSAN), Pittsburgh Water and Sewer Authority (PWSA) with the representatives of most of the 83 municipalities/sanitary authorities within the ALCOSAN service area. Additional stakeholders included the Allegheny Conference on Community Development, the Allegheny County Conservation District (ACCD), and Economic Development South.

The SFRFT has held 30+ meetings to discuss technical matters, policy issues, and implementation strategies surrounding potential development of a consensus-based, long term plan to accomplish source flow reduction in both separate and combined sewer systems, with the ultimate goal of supporting the ALCOSAN Interim Wet Weather Plan (IWWP) Implementation through cost-effective removal of Infiltration and inflow.

The IWWP is comprised of expansion of the ALCOSAN's Wastewater Treatment Plant, increased conveyance capacity and a limited regional tunnel system for equalization/storage. The IWWP is projected to reduce sewer overflows by approximately 65% relative to future (2046) flows at an estimated cost of $2 billion. It is anticipated that additional overflow reduction measures will be required to comply with wet weather overflow policy. This could be accomplished through source reduction and/or other projected future grey/green infrastructure including supplemental tunnels and/or conveyance capacity. Prudent sewage facility planning efforts in terms of future wet weather improvements must include source reduction efforts that are determined to be more cost-effective than an increased regional tunnel system that could be implemented through a future expanded scope of the IWWP.

As the subcommittee is committed to continue its work toward developing strategies for source flow reduction to further address the region's wet weather issues, the final report of the subcommittee, which will include this interim report and refined recommendations for future implementation, is under development.

As a preliminary matter, owing to the absence of full scale comprehensive flow monitoring-based definitive cost and effectiveness studies, it is stressed that this report suggests that an iterative adaptive management approach to source reduction be undertaken. The metrics included herein are not intended to be, nor should they be interpreted as a final “hard target” recommendation.

Further, the subcommittee acknowledged the need to reiterate that source flow reduction is not intended to supplant other operation and maintenance obligations associated with the municipal systems.

## 2. Background Information

### 2.1 The ALCOSAN System

ALCOSAN provides regional wastewater conveyance and treatment for the City of Pittsburgh and all or portions of 82 other municipalities. Wastewater from the service area flows to ALCOSAN’s 250 million gallon per day wastewater treatment plant that is located on the north side of the City of Pittsburgh. The ALCOSAN service area covers approximately 309 square miles. According to the 2010 census, 836,600 people live within the service area.

Roughly 17 percent of the geographic area and 41.6 percent of the population is served by combined sewer systems. Combined sewer systems are designed to carry both wastewater and stormwater in the same pipes. These systems were prevalent in older communities with collection systems built before 1940. Also incorporated into these combined systems were sewers built during the late 1800’s and early 1900’s that “culverted” many native streams during the rapid development of the Pittsburgh region in that time period.

About 52 percent of the geographic area and 56.9 percent of the population is served by separate sanitary sewer systems. Separate sanitary sewer systems are designed to carry only wastewater (sanitary flow or simply spent water usage) while stormwater is managed through a different set of pipes, culverts or ditches. Separate sanitary sewer systems were required for any new systems built after the 1940s.

The remaining 31 percent of the geographic area is either undeveloped or served by individual on-lot systems, accounting for 1.5 percent of the population.

ALCOSAN owns, operates, and maintains over 92 miles of interceptor sewers, force mains, and other sewer pipe categories that convey wastewater from 83 customer municipalities in the region to the ALCOSAN treatment plant. The ALCOSAN interceptor sewers range in size from 12 inches to 12 feet in diameter. Part of the interceptor system, buried up to 120 feet deep under the rivers, is sometimes referred to as the deep tunnel system. There are over 300 regulator structures along the ALCOSAN interceptor system that are owned and/or operated by ALCOSAN. These regulator structures direct all the dry weather flow to the ALCOSAN system and control the quantity of flow diverted to the ALCOSAN treatment plant during wet weather conditions. The system was designed to purposely release excess stormwater and wastewater from the collection system directly into the area’s rivers and streams when the flow exceeds the pipes’ capacity, usually during wet weather events. The regulators not only direct excess flows away from city streets and buildings, but also protect the treatment facility from flow surges that could overwhelm the plant and lead to diminished treatment effectiveness that may last for extended periods of time.

### 2.2 The 83 Municipalities

Into the ALCOSAN interceptors run over 4,000 miles of wastewater collection sewers that are owned, operated, and maintained by 83 customer municipalities, or their designated municipal authorities. In general, the sewage collection systems throughout the region transport wastewater by gravity, flowing from higher geographical points to lower valleys and ultimately to the lowest point along the rivers where the trunk sewers connect to the ALCOSAN interceptor system. In some parts of the system, a pump station is needed to transport the wastewater over a hilly area until gravity can take over again.

Because the sewage collection systems follow the topography of the land ultimately flowing to the lowest point along the rivers, the pipes transporting wastewater to the ALCOSAN treatment facility do not abruptly end at the boundaries of a community, but rather are interwoven throughout the 83 municipalities in the ALCOSAN region. In most cases, an upstream community's wastewater flows not only through its own collection system, but through a downstream community's sewer system on its way to the treatment plant.

Of the 83 customer municipalities tributary to the ALCOSAN system, 17 have combined sewer systems, 57 have separate sanitary sewer systems, and 9 have portions that are combined and portions that are separate (termed "hybrid" or "mixed" systems). The fact that there are both combined and separate sewer systems discharging to the ALCOSAN interceptors, and that each of the 83 municipalities within the region has its own governmental entity, further complicates the wet weather challenge (described below).

### 2.3 Infiltration /Inflow and the Wet Weather Challenge

Infiltration/inflow (I/I) is extraneous water entering the wastewater collection system through a variety of sources.

Infiltration is groundwater (often referred to as Groundwater Infiltration or GWI) that enters the system through either physical defects such as cracked pipes/manholes or deteriorated joints or purposeful connections such as foundation drains, and is extant in both combined sewer systems and separate sanitary sewer systems. Many sewer pipes are located in the surrounding groundwater table (even more so during seasonal, late winter or early spring), therefore leakage into the sewer is a broad problem that can be difficult and expensive to identify and remove. Often, groundwater that is denied access to a rehabilitated manhole or sewer pipe merely migrates, traveling through the ground (or in the pipe zone of rehabilitated pipe exteriors) until it finds another access point somewhere in the system. Further, portions of combined sewer systems may have been designed to allow infiltration in order to drain out certain areas, thereby creating more developable acreage.

Inflow is water (other than wastewater) which enters sewage collection systems through both point and non-point sources. Inflow is commonly accepted as being a direct response to precipitation being captured by the system. Inflow is often referred as Rainfall Dependent Infiltration/Inflow or RDII. Combined sewer systems, as described above, were designed to promote inflow of stormwater, and also, as noted above, can include flow from culverted streams incorporated into the system. In sanitary sewer systems, however, which are not designed to carry stormwater or stream flow, inflow sources are highly detrimental, and the connection of such sources from private property has historically been prohibited by ordinance or regulation. Examples of non-distributed sources of inflow to sanitary sewer systems include: downspouts from roofs, driveway drains, yard and area drains, sump pumps, manhole covers, cross connections from storm drains or catch basins, foundation drains connected to building drains and also above-ground defects such as deteriorated manhole sections near streams, broken or missing cleanout caps, streams, etc. Distributed sources to sanitary sewers systems result from groundwater movement from the surrounding soil into the sanitary sewer system. It is a function of water entering the soil column from the surface as well as ground water flow and other dispersed sources. Distributed source inflow when coupled with elevated groundwater tables (periods with high infiltration) exacerbates conditions associated with I/I. As such, inflow can be described as direct (e.g. roof leaders, driveway drains, streams etc.) or indirect (e.g. migration through the soil).

High levels of I/I reduce pipeline capacity in the collection system that would otherwise be available to transport sanitary flow. It is estimated that current volume of water in the sewer system associated with infiltration and culverted streams amounts to more than 60% of long term volume. Compounding this problem is that during nearly every rainfall or snow melt, considerably more excess water gets into municipal sewer systems via direct or indirect pathways, causing overflows and resulting in untreated sewage and storm water adversely affecting the water quality of our streams and rivers. Overflows from the combined sewer system are known as combined sewer overflows (CSOs) while those from a separate sanitary sewer system are known as separate sewer overflows (SSOs).

Under existing conditions with typical rainfall over a 12-month period, it is estimated the ALCOSAN system captures and treats approximately 70 billion gallons/year of wastewater flow. Of this, about 22.5 billion gallons is wastewater, 7.5 billion gallons is stormwater from inflow, and 40 billion gallons is infiltration (approximately 22 billion gallons from combined systems and 18 billion gallons from separate systems). Approximately 9 billion gallons overflow from the 350 ALCOSAN and municipal CSO outfalls scattered throughout the service area and approximately 0.7 billion gallons of wastewater is discharged from 98 SSO outfalls. These overflows not only violate the federal Clean Water Act, but they cause a multitude of health and environmental concerns.

### 2.4 ALCOSAN - 2008 Consent Decree

On January 23, 2008, ALCOSAN became a party to a Consent Decree (CD) issued by the Federal Court in Pittsburgh on behalf of the U.S. Environmental Protection Agency (EPA), the PA Department of Environmental Protection (DEP) and the Allegheny County Health Department (ACHD). CDs have been issued to municipalities across the nation to comply with the objectives set by the federal Clean Water Act and Combined Sewer Overflow Control Policy, as well as state laws and local regulations. Their purpose is to improve water quality in receiving streams and protect designated waterway uses that include drinking water, recreation, aquatic life, and others.

The CD was the result of seven years of negotiations and compromise. The primary requirements for meeting compliance are to eliminate SSOs, control CSOs, meet water quality standards and increase conveyance and treatment capacity. ALCOSAN's mandate was to:

- Develop a Wet Weather Plan that identifies wastewater infrastructure needs through 2046;
- Describe actions and facilities needed to meet the requirements of the CD; and
- Provide a schedule to complete and operate all improvements by 2026

**2.5 Municipal Orders - 2004 Administrative Consent Order (ACO)/Consent Order and Agreement (COA):**

Beginning in 1997, the EPA began investigating municipalities in the ALCOSAN service area for sewage overflow violations of the Clean Water Act, and initially cited more than 50 of the separate sewer system communities for the overflows. The EPA and the U.S. Department of Justice threatened litigation or administrative action against these municipalities and ALCOSAN that would total $275 million in penalties.

EPA and the Department of Justice took a step back at the time and held off with issuing the penalties. Instead, the municipalities within the ALCOSAN service area with sanitary sewer systems were placed under Administrative Consent Orders (ACOs) from the Allegheny County Health Department (ACHD). Those with combined systems were issued Consent Order and Agreements (COAs) from the Pennsylvania Department of Environmental Protection (PaDEP). In both cases, the municipalities were required to participate and cooperate with ALCOSAN in the development of the WWP, including:

- Establishing with ALCOSAN the quantity and rate of sewage flow from the Municipality to its point(s) of connection with the ALCOSAN Regional Conveyance System;
- Establish, with ALCOSAN, how the municipalities will manage their respective flows; and
- The development of a feasibility study with an alternatives analysis evaluating the Municipality's options to address any overflows within the municipality's collection system.
- If the municipality's control strategy included the conveyance of its wet weather flows to ALCOSAN's Regional Conveyance System, the feasibility study was to also address the conveyance capacities of the trunk sewers connecting the municipality to the ALCOSAN system. The municipal orders also required ALCOSAN customer municipalities to develop and provide information necessary to develop a regional WWP and municipal feasibility studies, including:
    - Completing physical surveys, visual inspections, and closed circuit television internal inspections of the sewer systems that are tributary to the ALCOSAN sewer system; and
    - Preparing and submitting an updated comprehensive sewer map of the sewer systems that are tributary to the ALCOSAN sewer system; and
    - Conducting a hydraulic capacity evaluation of its sewer system; and
    - For municipalities with combined sewer systems, determining and providing the frequency, volume, and duration of CSOs on an average annual basis.
- The municipal orders also required ALCOSAN customer municipalities to complete activities that would impact the quantity and rate of wastewater flow conveyed to the ALCOSAN sewer system, including:

- For municipalities with separate sewer systems, testing all structures to identify any illicit roof leader, yard drain, and driveway drain connections to its sewer system and requiring corrective actions to remove these illegal connections
- Removing streams and springs connected to the sewer lines; and
- Repairing significant structural defects and defects that cause a sewer blockage, basement flooding, or other public health nuisance

Upon completion of the stipulated tasks the 2004 ACOs/COAs expired in March 2015.

### 2.6 ALCOSAN 2013 Wet Weather Plan (WWP) and Interim Municipal Phase I Consent Orders

The ALCOSAN WWP addresses the elimination of sanitary sewer overflows and the control of combined sewer overflows from ALCOSAN's Conveyance and Treatment System, including overflow structures located at the points of connection with the municipal collection sewer systems. The Plan does not directly address the elimination or control of overflows within the municipal collection systems. However it provides for the hydraulic capacity to accept additional wet weather flows from the municipalities which may be conveyed to the ALCOSAN Conveyance and Treatment System pursuant to municipal feasibility studies completed under the separate compliance orders described above. Because the Municipal Orders required submission of municipal feasibility studies six months after submission of this WWP, ALCOSAN worked closely with their customer municipalities throughout the development of the Plan to incorporate preliminary municipal planning information in the analysis of regional control strategies. ALCOSAN expects that municipal control strategies will continue to evolve and will likely warrant modifications to the elements of the regional plan.

From ALCOSAN's WWP, a control strategy designated the Selected Plan was identified. The Selected Plan proposes construction of an extensive network of regional conveyance tunnels along with the expansion of the treatment facilities in order to eliminate SSOs and reduce CSOs from 9 to 1 billion gallons annually. The total project cost of the Selected Plan is estimated at $3.6 billion. An affordability assessment of the Selected Plan concluded that it would be cost prohibitive to implement under the 2026 deadline.

As part of the WWP, ALCOSAN had developed three Year 2026 alternatives which were considered affordable as defined by CSO policy affordability provisions. One alternative plan focused primarily on SSO elimination along with a 75% capture of CSOs. A second alternative gave priority to improving water quality by diverting the largest overflows to the treatment plant and protecting areas of high recreation use and other sensitive areas. The third alternative, which eventually was chosen as the Recommended Plan, balanced the priorities of CSO and SSO control, water quality improvement, and continued economic development.

Subsequent to the WWP submission ALCOSAN has been negotiating a different plan. The Interim Wet Weather Plan (IWWP), would reduce annual overflows by approximately 65% relative to future (2046) flows through SSO and CSO control, with key elements including expansion of the treatment facilities and its pump station capacity, constructing a limited version of the regional tunnel system proposed in the Selected Plan, and constructing new enlarged conveyance sewers in the area.

Closing the gap to project CSO compliance requires an additional 25% reduction compared to future (2046) flows; this is where source flow reduction comes into play, with a range of potential outcomes from achieving 3 billion gallons of reduction required to project CSO policy compliance to significantly reducing the scope of future WWP improvements beyond IWWP Implementation to removing cost-effective I/I while maintaining or improving service at a localized / municipal level.

Therefore, responsive to ALCOSAN's IWWP and a request for a scheduled completion milestone date beyond 2026 (as established by the 2008 CD) necessitating CD negotiations with USEPA, DEP and ACHD, the regulatory agencies issued in January 2016 Interim Phase 1 municipal consent orders to all of the contributory communities/authorities. These consent orders, in general, require municipalities to:

- Conduct limited source reduction studies
- Develop source flow reduction projects
- Evaluate potential flow reductions through sewer lining and private lateral repairs (separate)
- Identify suitable areas for green infrastructure for source reduction (combined systems)
- Provide requested information to help with the setting of flow targets
- Provide a summary Source Flow Reduction Study to the regulatory agencies by December 2017.

### 2.7 3 Rivers Wet Weather

In 1998, ALCOSAN and ACHD, in a unique partnership, joined forces to create the 3 Rivers Wet Weather Demonstration Program (3RWW) to help the 83 ALCOSAN municipalities address the region's wet weather challenges and sewage overflow problem.

Since its inception, 3RWW has assisted communities in a variety of ways, including investing $10.5 million in 33 innovative sewer-related projects throughout Allegheny County. In the first five years, much of the funding was used to support technology demonstrations such as pipe bursting, trenchless technologies, stream removal and sewer separations that other communities could model.

Over the past decade, 3RWW has also focused its resources and support on multi-municipal projects, particularly those that include studies or activities that lead to sewer system consolidation. Through a regional and consensus-based approach to problems, 3RWW has saved millions of dollars for ratepayers of southwestern Pennsylvania, while providing invaluable tools to support long-term, viable solutions to the myriad of wet weather issues.

In 2014, 3RWW organized the Wet Weather Working Group (3WG). The 3WG was modeled after successful similar working groups (namely Flow Monitoring Working Group (FMWG), Feasibility Study Working Group (FSWG), and the Flow Monitoring Implementation Team (FMIT) developed to provide municipal assistance with the 2004 ACOs/COAs. The 3WG was formed with the following premises, goals and objectives:

<u>Premises for a Wet Weather Working Group</u>

- Many of the municipalities face significant costs associated with wet weather issues in the next 5 years and beyond, making this a concern to be addressed now.

- Regionalization will be a significant effort over the next few years.
- A Wet Weather Working Group discusses and helps resolve and coordinate municipal wet weather issues.
- To provide a platform to engage and provide a common voice to approach the Agencies on negotiation of the Feasibility Studies, Sewage-related Orders, Total Maximum Daily Loads (TMDL), Stormwater NPDES Permits and water quality issues.
- The major benefits of the Wet Weather Working Group is as a forum for municipalities to share information, and coordination of efforts to meet obligations in the most sustainable and cost-effective manner, while also maximizing the benefits to a community.
- Available municipal revenues will be limited and the financial obligations associated with wet weather issues, including stormwater quality and quantity, remain to be determined.
- Provide a communications link to the municipalities.

The general goals and objectives for the Wet Weather Working Group (3WG) are as follows:

- Involve major stakeholders (municipal managers and elected officials, municipal engineers, ALCOSAN, and the Agencies) in evaluating the best path forward for the municipalities.
- Provide understanding of what is likely required to meet the Municipal Separate Storm Sewer Systems (MS4) requirements, impaired streams, and Total Maximum Daily Loadings water-quality-based discharge limitations on sewage and stormwater.
- Provide a forum for discussion, education, and outreach of regionalization, flow controls, source flow reduction, green infrastructure, stormwater, and stream water quality.
- Develop methodologies for municipalities to estimate their potential cost obligations for stormwater regulations in addition to those for sewage already described in their Feasibility Studies.
- Provide a forum for municipalities that guides a stream water quality monitoring program and assures timely input from data collection to analysis and plan implementation.
- Provide a platform to engage and have a common voice to approach the Agencies on any proposed stream water quality monitoring programs.
- Maximize the use of previous stream water quality monitoring data collected in the region.
- Implement QA/QC and peer review approaches to assure that meaningful and coordinated stream water quality monitoring data is collected.
- Assure that stream water quality monitoring lab testing and data analyses are “quality assured/quality controlled” and will withstand critical evaluation.
- Achieve economies of scale that will arise from multi-municipal and watershed-based coordination and shared resources.
- Obtain data suitable for the evaluation of municipal affordability to address both sewage and stormwater water-quality-based discharge limitations.
- Address additional issues identified by municipalities, as needed.

On June 17, 2014, representatives from EPA and the Department of Justice attended and spoke at a municipal update hosted by 3RWW in Green Tree, PA. At this event, EPA presented expectations that ALCOSAN and the municipalities would implement sewer regionalization, conduct infrastructure improvements, set flow limits and develop flow reduction (I/I and GI) approaches within the confines of an “adaptive management” structure predicated on 6-year interim “check-in” periods. At subsequent meetings, the 3WG determined that a subcommittee should be organized to specifically address the issues of flow targets and source flow reduction.

## 3. Creation of the Source Flow Reduction and Flow Target (SFRFT) Subcommittee

The SFRFT subcommittee was developed as an offshoot of the 3WG when it was determined that a smaller group, consisting of mainly municipal engineers and other interested stakeholders, should be formed to focus specifically on the very technical issues of source flow reduction and flow targets. The subcommittee was established to discuss and develop a municipal consensus regarding source flow reduction strategies and potential flow targets. In anticipation of the inclusion of flow targets by the regulatory agencies in the municipal implementation (Phase 2) consent orders, it was deemed important for municipalities to have input on how the flow targets would be set and achieved. The first meeting of the group, which included representatives from 73 of the 83 ALCOSAN member communities, was held on June 4, 2015.

Other contributing factors leading to the Source Flow Reduction Flow Target Subcommittee discussion was a request for information by EPA from ALCOSAN in June 2015 (modified in October 2015) in accordance with Section 308 of the Clean Water Act as well as modified in October 2015.

### 3.1 SFRFT Subcommittee Mission Statement

The SFRFT subcommittee adopted the following mission statement at the outset; *Recognizing the regulatory requirement to achieve water quality standards, the Source Flow Reduction and Flow Target Subcommittee will develop goals and implementation strategies to reduce groundwater infiltration and stormwater inflow to optimize local and regional sewer service. The goals and strategies are intended to be technically achievable, economically affordable, reasonably quantified, and enforceable. The Subcommittee will work to develop regional, consensus-based recommendations for cooperative implementation of the goals and strategies by ALCOSAN Customer Municipalities and Authorities, ALCOSAN, DEP, ACHD, and others.*

### 3.2 Basic Challenges

As noted elsewhere, there are both combined and separate sewer systems in the ALCOSAN service area, and the fact that the two types of systems are very different in their nature and design dictates that the strategies implemented to facilitate source flow reduction can also differ between the systems. This further creates a challenge to develop flow targets which are viewed as fair, consistent, and equitable across the communities and systems. A specific flow target metric applied to a separate system may not make sense for a combined system, and vice versa, however they should be equitable in terms of the relative outcome of achieving source flow reduction.

Apart from reaching consensus within the region in the development of flow targets, the subcommittee also acknowledges the challenge of proposing flow targets (and their subsequent implementation) which will be accepted by the regulatory agencies as the region moves forward in its approach to mitigating wet weather issues. A brief overview of the SFRFT efforts is provided in the following section.

## 4. SFRFT Technical Discussion

### 4.1 Philosophical Approaches to Subcommittee Objectives

Early in the discussions the SFRFT identified five (5) overarching potential methodologies for achieving source flow reduction. These methodologies are discussed below:

**Methodology 1. "Close the Gap"** - ALCOSAN's Interim Wet Weather Plan (IWWP) is intended to reduce overflows through modification of or addition to ALCOSAN facilities. It is conceivable that the regulatory agencies might expect the municipalities to further reduce the overflow discharge to by achieving flow targets within their individual systems in order to project compliance consistent with the "Selected" alternative of the WWP. Therefore the "Close the Gap" approach is essentially a system-wide requirement for an additional 25% reduction compared to future (2046) overflows that would complement the IWWP. However considering the geographical nature of the IWWP, certain parts of the system such as portions of the Chartiers Creek and Turtle Creek basins would need to achieve complete compliance solely with flow targets since ALCOSAN's IWWP would not provide increased conveyance capacity to those portions of the system. General discussion concluded that "Close the Gap" is overly simplistic as a first step in establishing flow targets and would conceivably place an un-balanced financial source flow reduction burden on those municipalities upstream of the IWWP geographic limits. Discussion on this methodology suggested that an achievable, sustainable source reduction program which "Closes the Gap" may not be an appropriate first step but that it could offer some merit after evaluating the other methodologies and perhaps is better suited as a future distinct individual strategy within the confines of another methodology to better prioritize source flow reduction expenditures.

**Methodology 2. "Equal % Reduction"** – The genesis of this methodology was from Paragraph 30 of the June 2015 USEPA Request for Information. As the name implies, this methodology essentially pro-rates source flow reduction by a certain percentage (perhaps an arbitrary percentage of 10%, 20%, 30% or other) based on inch-miles, footage, acreage etc. on a POC by POC basis. This methodology would project full compliance with the 2008 CD when implemented with the Selected Alternative from the WWP. Discussion on this methodology concluded that it may not be cost effective to do across the board as an initial step and may over burden those municipalities that have completed a lot of source flow reduction work historically (double jeopardy). Discussion on this methodology concluded that an achievable, sustainable source reduction program which requires "Equal % Reduction" is not an appropriate first step but that it could offer some merit after evaluating the other methodologies and perhaps is better suited as a future distinct individual strategy within the confines of another methodology to better prioritize source flow reduction expenditures.

**Methodology 3. "Maximum Targets"** – This methodology is used in other larger metropolitan wet weather planning activities whereby a "target" can be independently established for either combined sewer systems, separate sanitary sewer systems, or hybrid (mixed) systems on a dry weather or wet weather basis. This methodology could also allow for establishing a near term target as well as provide for more stringent metrics or targets to be established in the future as part of adaptive management principles within the confines of IWWP implementation. This methodology would require only areas that have extraneous flows above an established threshold value to reduce flows or perhaps trigger a more refined source flow reduction study. Initial dialogue pertaining to this methodology suggested that perhaps a target with a sliding scale could be established to differentiate smaller and larger systems.

**Methodology 4. "Cost Competitive Flow Reduction"** – This methodology makes a connection between a source flow reduction metric and an opportunity to realize a cost benefit via "cost competitive source flow reduction alternative" versus a "convey all" type of wet weather control proposed as part of the Municipal Feasibility Studies. In this methodology, source flow reduction would be implemented in only those POCs/sheds where source flow reduction could replace planned grey infrastructure purely on a cost basis. Targets would be implemented only in sheds where it is cost competitive. Considering that this methodology would be of limited geographical area within the confines of the ALCOSAN system, initial discussion on this methodology repeated similar arguments to "Close the Gap" in that this methodology is IWWP geography driven and concluded that an achievable, sustainable source reduction program which requires "Cost Competitive Flow Reduction" could offer some merit after evaluating the other methodologies and perhaps is better suited as a future distinct individual strategy within the confines of another methodology as part of to better prioritize source flow reduction expenditures.

Supplemental discussion pertaining to "Cost Competitive Flow Reduction" methodology concluded that ALCOSAN's on-going efforts related to Regionalization (a separate initiative of the WWP, IWWP and CD) would significantly impact this methodology over time, potentially becoming a regional cost burden in lieu of a current local/municipal cost burden acknowledging that total regional costs are a consideration contemplated as described in the SFRFT Mission Statement.

**Methodology 5, "Municipal Source Reduction Studies Approach"** - This methodology relies on the ability of the Interim Municipal Phase I Consent Orders to serve as a guide to establishing flow targets. Given the due date/timing of the Source Reduction Studies (due in December 2017) in consideration of the USEPA 308 letter response related to final flow targets by January 2017 as well the fact that the submitted studies may be geographically limited within certain defined areas of the municipalities, this methodology was not seriously considered as a starting point but rather considered an additional body of data that could be potentially available to refine flow targets established using one of the other methodologies as part of adaptive management.

**<u>Selected Methodology</u>**

After considering the merits of all five methodologies, the SFRFT focused technical efforts related to a hybrid methodology which includes portions of each acknowledging that the five methodologies may come into play at a later date as part of adaptive management or may refine an established flow target(s) during implementation of the IWWP. Adaptive management in this context suggests using data accumulated, results realized, and lessons learned to inform future implementation steps and refine established flow targets over time. Underpinning all of this is the understanding that any selected metric must be cost-effective and affordable.

The selected methodology can be broadly described as a compliance/performance-based sliding scale interim investigative flow target metric threshold that would screen portions of the Municipal system for initial, cost-effective and affordable source flow reduction prioritization followed by more stringent flow targets adaptable to IWWP implementation.

The selected metrics are presented in Section 4.5 of this report.

### 4.2 Existing Data Available

For the purposes of developing metrics associated with source flow reduction, owing predominantly to the fact that it constituted a large simultaneous data base under a common hydrologic flow regime, flow data from the 2008 Regional Collection System Flow Monitoring Program (RCS-FMP) including Long-Term and Short-Term monitors was utilized. Non-synoptic data as well as ALCOSAN Shallow-Cut monitoring data was also used to assess the potential to use a long term (3 to 5 year) running average metric. Ultimately the long term basis was abandoned in favor of a 12-month metric.

**4.3 Potential Metrics**

SFRFT discussion focused on a series of *flow target* (an amount of flow to which flow reduction targets are geared) *metrics* (unit of measurement used to set a flow target). Metrics can be volumetric (e.g. gallons) or rate (volume over time, gallons per day (gpd) or million gallons per day (mgd)).

Metrics can be unitized in many ways. One example, gallons per inch mile per day (gpimd) is a methodology introduced by EPA in the mid – 1970's to account for the surface area of a larger pipe diameter pipe to a smaller pipe diameter with respect to I/I. This metric utilizes pipe circumference/surface area expressed by the pipe diameter in inches and the pipe length expressed in miles.

Rate-related metrics can vary from short-term averages, peak-flow based (mgd in hourly increments vs. mgd in 15-minute increments) or long-term averages (mgd in annual averages).

Metrics can also be represented as percentages, for example percent capture or "R" values calculating rainfall percentage "captured" as RDII.

Metrics can also be represented as peaking factors or ratios such as peak hour rate (mgd): annual average (mgd).

Metrics can vary from system type to system type, average "R" values for separate systems vs. gallons annual runoff per impervious acre for combined sewers.

**4.4 Source Flow Reduction Metrics – Other Parts of the US**

Given the range of available metrics that can be applied, other regional wet weather programs around the United States were considered. Figure 1 identifies flow reduction metrics for other Wet Weather Programs. As shown, published source flow reduction metrics vary from agency to agency as well as specific targeted flow components (e.g. RDII, GWI, RDII+GWI, runoff).

Based on discussion and deliberations of the SFRFT it was determined that an annualized volumetric gpimd metric is suggested for separate systems while combined systems would implement a capture/ % flow reduction metric.

**Figure 1**

## Flow Reduction Metrics for Other Wet Weather Programs

2/7/2017

| Targeted Component of Flow | Flow-Related Metric | Agency Using Metric | Metric Value |
|---|---|---|---|
| Rainfall Dependent Infiltration / Inflow (RDII) | Maximum Allowable Peak Hourly Flow Rate (GPAD) | MMSD | Maximum Allowable Peak Hourly Flow Rate varies inversely to the acreage of the metershed and ranges from 22,000 GPAD for small areas to 4,000 GPAD for areas greater than 5,000 acres. *See MMSD Rules §3.201 et seq.* |
| | Flow Rate Increase for Design Storm (GPD) | MWRA | Prioritize sub-basin inflow based on the flow increase for a 1-year, 6-hour (1.7 in) design storm. Per DEP guidelines additional investigations to be conducted on all sub-basins that account for not less than 80% of the total storm inflow. |
| | 10-year Peak Hourly Flow Rate (gpd/eru) | HRSD | Early agreements between HRSD and the municipalities required them to reduce their 10-year peak hourly flow rate to 775 gpd/eru (Peak Flow Threshold). Since that time a regional approach has employed targeted selection of I/I reduction and the original metric is no longer applicable. |
| | Peaking Factor | ReWa | Allowable peaking factors vary by subdistrict. Most are based on the Babbitt Equation which relates the peaking factor to population. Overall goal is to reduce peak flows at the WWTPs to no more than 2.5 times the ADDWF. |
| | Peaking Factor | MCES | I/I reduction goals are determined on a metershed basis and expressed as an allowable peak hourly flow (PHF). Allowable PHF = (10-year rolling average daily flow for metershed + adjustment for growth + allowance for water conservation and I/I mitigation) x MCES standard peaking factor. |
| | RDII Contribution to Peak Wet Weather Flow | OCSD | The primary purpose of the Cooperative Projects Program has been to improve local sewer systems in order to achieve a 20 percent reduction in the RDII contribution to the District's peak wet weather flows by the year 2020. |
| Groundwater Infiltration (GWI) | Average Volume (gpimd) | MWRA | Current conditions range from 500 to over 10,000 gpimd. DEP guidelines suggest investigations on all sub-basins with an infiltration rate above 4,000 gpimd. |
| Runoff | Annual CSO Volume Reduction (MG/yr) | NYDEP | 12.1 bgy (billion gallons per year) |
| | ditto | OCDWEP | 247,000,000 gallons/year |
| | ditto | NEORSD | 44 MG (Million Gallons) |
| | Greened Acres (GA)[1] | PWD | 9,600 acres of impervious cover converted to Greened Acres |
| | Average Annual Runoff Reduction (MG/yr) | LAN | 1,053 MG/yr |
| | Green Infrastructure Storage (MG) | KCWSD | 3.5 MG of Green Storage (Middle Blue River Basin Only) |
| | Average Annual CSO Volume (MG/avg yr) | DCWASA | 118.7 mg/avg yr (million gallons per average year) controlled with GI at CSOs 027, 028, 029 & 049 |
| | Impervious Surface Area Controlled by Green Infrastructure (acres) | BSA | 1,315 acres managed by GI |

[1]Acres of impervious cover that have at least the first inch of runoff managed by stormwater infrastructure

Agency Acronym Definitions

BSA - Buffalo Sewer Authority (Buffalo, NY)
DCWASA - DC Water and Sewer Authority (Washington, DC)
HRSD - Hampton Roads Sanitation District (Southeast Virginia)
KCWSD - Kansas City Water Services Department (Kansas City, MO)
LAN - City of Lancaster, PA
MCES - Metropolitan Council Environmental Services (St. Paul, MN)
MMSD - Milwaukee Metropolitan Sewer District (Milwaukee, WI)
MWRA - Massachusetts Water Resource Authority (metropolitan Boston)
NEORSD - Northeast Ohio Regional Sewer District (Cleveland, OH)
NYDEP - New York City Department of Environmental Protection (New York, NY)
OCDWEP - Onondaga County Department of Water Environment Protection (Syracuse, NY)
OCSD - Orange County Sanitation District (Southern CA)
PWD - Philadelphia Water Department (Philadelphia, PA)
ReWa - Renewable Water Resources (Greenville, SC)

### 4.5 Municipal Interim Investigative Source Reduction and Flow Target Approach

After research into other urban wet weather plans, consideration of historic regulatory positions, analysis of the limited local data available, and intense debate and deliberation, the subcommittee has determined that there is insufficient full-scale project data, associated capital and operating cost data, and engineering cost-effectiveness analyses to provide adequate guidance to inform and refine adoption of firm, universally-applied metrics that are achievable, cost-effective, and affordable. Consequently, as an interim step, it is proposed, in concert with USEPA's adaptive management framework, to adopt individual short-term metrics for both sanitary sewer and combined sewer systems. As an initial step, if a specific sewershed exceeds the accepted interim metric, work toward achieving the metrics "engineering" would be undertaken in the targeted subsystems over an initial period of 4 to 6 years with the intent of developing a database to support the future implementation of more definitive, potentially more stringent, flow target-type metrics.

The "engineering" will take the form of:

- In Separate System:
    - Flow monitoring, flow isolation studies, and cost-effectiveness analyses utilizing the Cost Effectiveness Program (CEP) tool to identify candidate source reduction target areas,
    - Hydraulic and hydrologic modeling to assess SSO compliance,
    - Affordability analysis; to determine financial capability to undertake construction
- In Combined Systems:
    - Flow monitoring, hydraulic and hydrologic modeling and cost-effectiveness analysis
    - Affordability analysis; to determine financial capability to undertake construction

The cost-effectiveness analysis will include capital cost/flow removal offsets for local internal municipal improvements (e.g. trunk upsizing or equalization basins), ALCOSAN-deferred capital projects (i.e. Selected Plan grey backbone projects like Chartiers Creek parallel interceptor), operating cost savings (e.g. power, labor, chemicals), and/or wet weather surcharges.

### 4.6 Municipal Interim Investigative Flow Target Metric Thresholds – Sanitary Sewer Systems

For municipal separate sanitary sewer systems the following Interim Investigative Flow Target Metric Threshold comprised of two components is proposed:

1) a cost-effectiveness, inch-mile based unitized annual volumetric flow rate, and
2) a municipal SSO control threshold.

- Municipal Unitized Annual Volumetric Interim Investigative Flow Target Metric Threshold
    - It is proposed to utilize a 12-month average (or otherwise reasonable period allowing for seasonal variability definition and similitude adjustment to base 2008 RCS-FMP datum) cumulative annual GWI/RDII inclusive volumetric flow rate unitized based on inch miles of mainline sewer as presented on Figure 2.
    - If the average unitized volumetric rate (as measured at separate sewer POCs to ALCOSAN, or at a municipal boundary, or to a combined sewer system) is above the established threshold, the municipalities will perform a study to determine source reduction efforts that

are cost-effective and affordable in an effort to achieve a flow volume below the threshold. If found to be both cost-effective and affordable, the projects will be implemented. Pre- and Post- monitoring will be performed to assess source reduction effectiveness.

- Municipal SSO's
  - For a given 12-month period no more than one (1) SSO occurrence for any non-snow melt storm event of a duration and total precipitation less than 1.18 inches per hour or 2.33 inches in 24 hours[1]
  - If in a given 12-month period there is more than one (1) SSO for any non-snow melt storm events less than 1.18 inches per hour or 2.33 inches in 24 hours the municipalities will develop and implement a comprehensive flow monitoring program and develop a calibrated H&H model sufficient to derive and implement a solution to achieve compliance with this metric.

Proposed implementation of the Interim Investigative Separate System Flow Target Metric Threshold is shown in the flowchart, Figure 3.

[1] ALCOSAN Wet Weather Plan Section 4 Table 4-1 2 Year Return SCS Type II Design Storm precipitation and (NOAA Atlas14, Volume 2, Version { Lat. 40.4407 Long -80.0027})

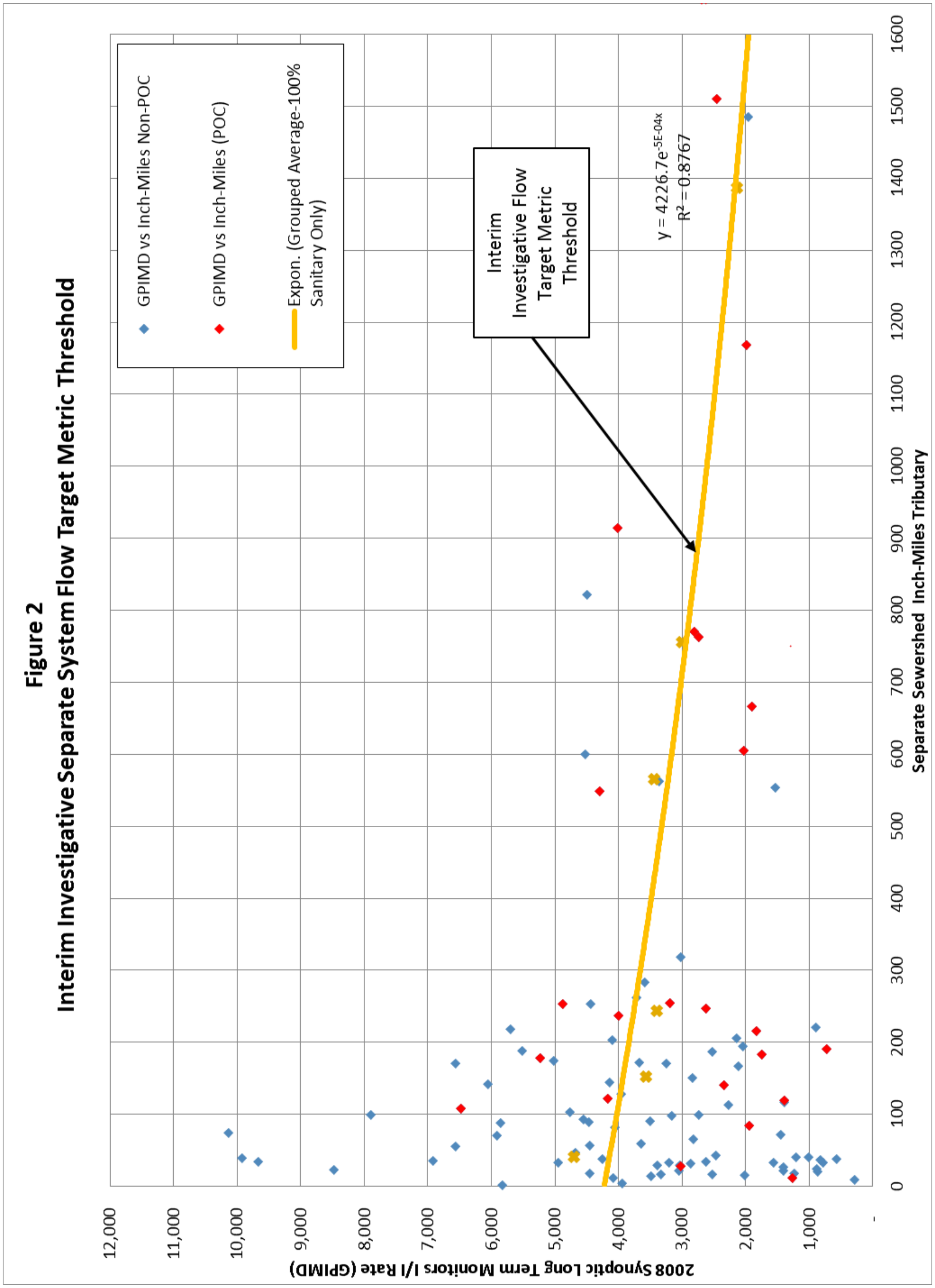


Figure 2
Interim Investigative Separate System Flow Target Metric Threshold
GPIMD vs Inch-Miles Non-POC
GPIMD vs Inch-Miles (POC)
Expon. (Grouped Average-100% Sanitary Only)
Interim Investigative Flow Target Metric Threshold
y = 4226.7e^-5E-04x
R² = 0.8767
2008 Synoptic Long Term Monitors I/I Rate (GPIMD)
Separate Sewershed Inch-Miles Tributary
12,000
11,000
10,000
9,000
8,000
7,000
6,000
5,000
4,000
3,000
2,000
1,000
-
0
100
200
300
400
500
600
700
800
900
1000
1100
1200
1300
1400
1500
1600


**Figure 2**

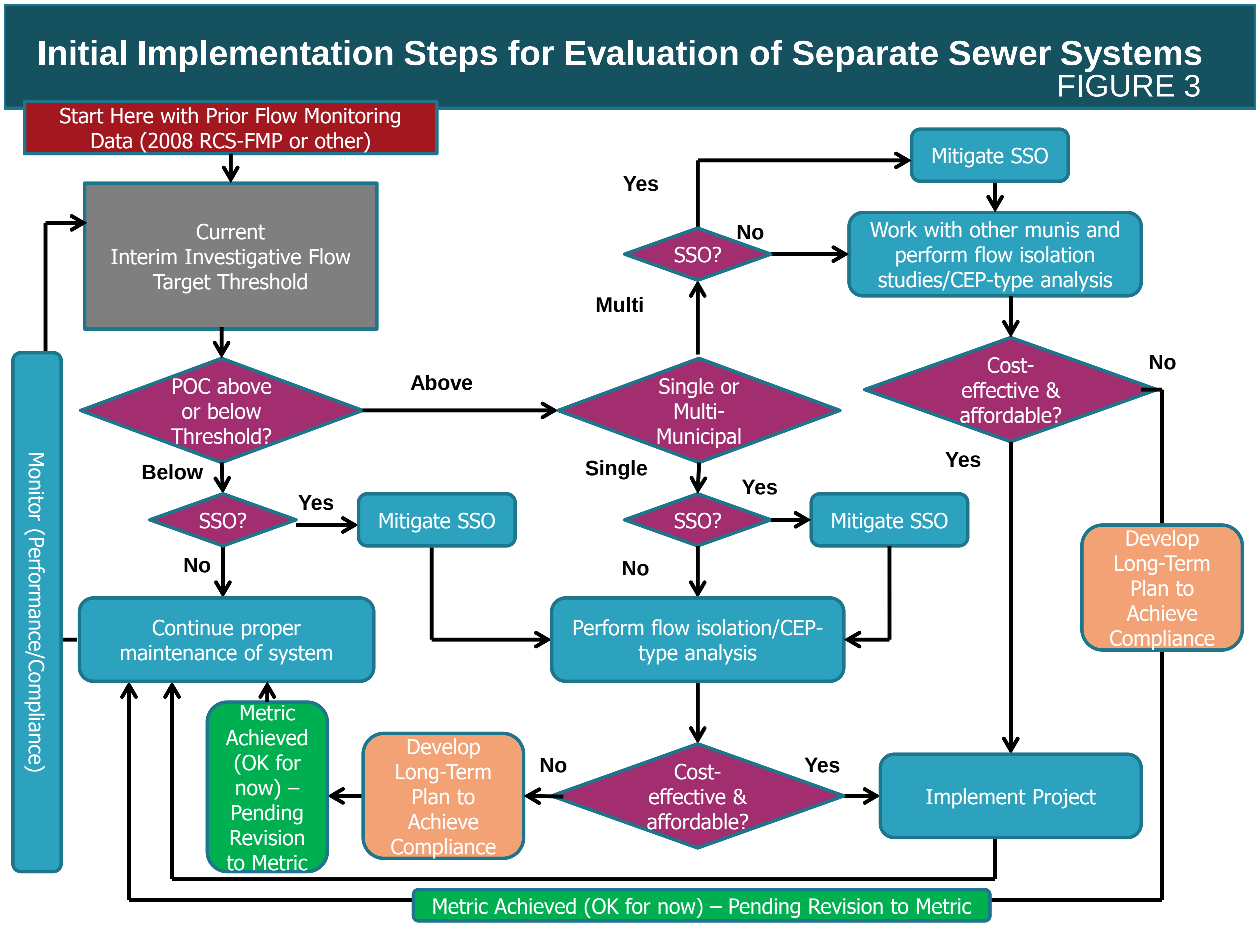



**Figure 3**

**Multi-Municipal Systems**

Multi-municipal systems are very common in the ALCOSAN service area. A schematic example of how to apply the separate sanitary sewer metric on a multi-municipal system is illustrated below.

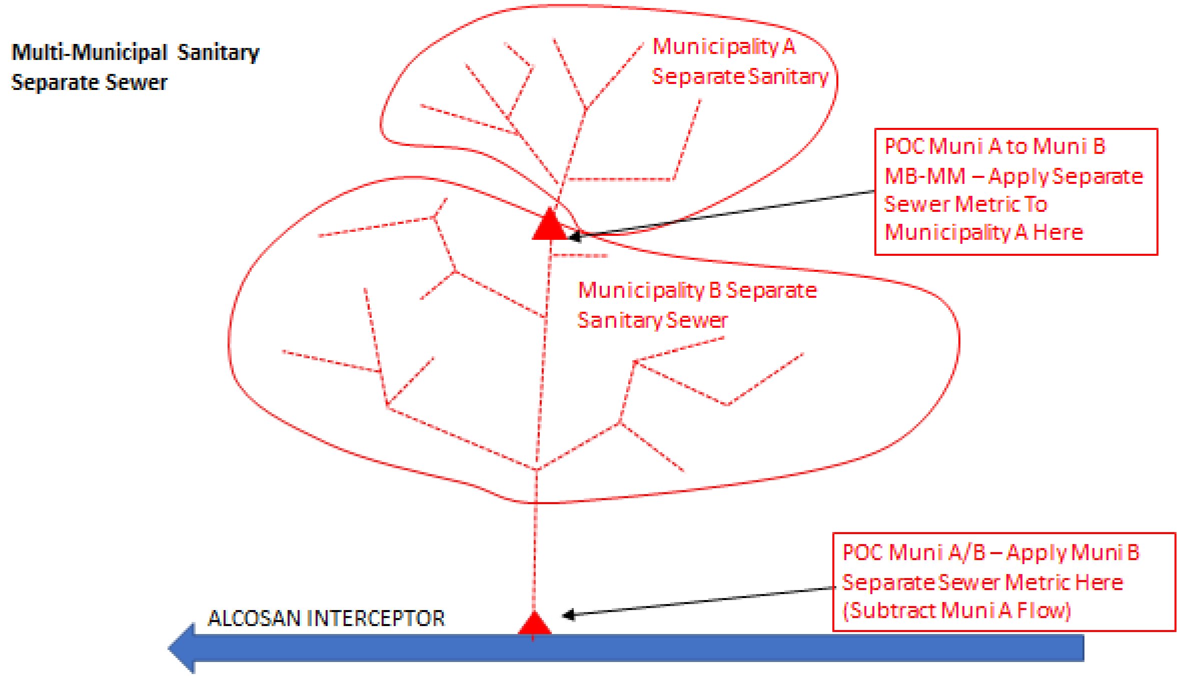



**Figure 4**

### 4.7 Municipal Interim Investigative Flow Target Metric Thresholds – Combined Sewer Systems

As defined by the Source Flow Reduction and Flow Target Subcommittee, a combined sewer metric is a basis for determining whether a combined sewer system needs to implement green stormwater infrastructure (GSI) or other source reduction projects (including sewer separation) to manage and reduce wet weather volume and ultimately reduce combined sewer overflow (CSO) volume, frequency, and duration to meet water quality standards or to provide water quality improvements.

The CSO Metric described below is based on the idea of attempting to "close the gap of the overflow volume to required levels," incrementally over a period of time.

**A. Combined Sewer System (CSS) Metric**

The basic CSO metric includes the following:

1. Evaluate runs of an agreed-upon, standardized model to determine levels of wet weather capture based on a typical year at the ALCOSAN outfalls designated as combined in ALCOSAN's CD as well as municipal CSO outfalls.
2. Areas with less than 85% wet weather flow capture will be highlighted as candidates to implement an investigation into the feasibility of source flow management and reduction efforts.
3. The candidates for flow reduction will perform evaluations to determine the cost-effectiveness of managing and reducing wet weather flows and/or CSO volume by 10% (analysis will also be

done for 15% and 20% for evaluation purposes). The analysis would identify potential areas that may benefit from more stringent requirements for stormwater management in redevelopment projects, stream removal, or other potential projects that could be performed to convert or control impervious tributary areas.

4. The evaluation should include various phases of ALCOSAN's wet weather plan, up to and including the expansion of the WWTP and the tunnel construction. If the outfall does not meet the 85% capture for any of these scenarios, the evaluation will go forward.
5. Full life-cycle analysis to include cost as well as non-cost aspects (traffic disruption, etc.) of the projects should also be evaluated in the cost-effectiveness analysis. The affordability of the project will need to be investigated, based on EPA affordability guidelines.
6. If found to be cost-effective and affordable, the projects will be implemented.
7. Pre- and post- monitoring information will need to be collected to confirm performance.

Proposed implementation of the Interim Investigative Combined System Flow Target Metric Threshold is shown in the flowchart, Figure 5.

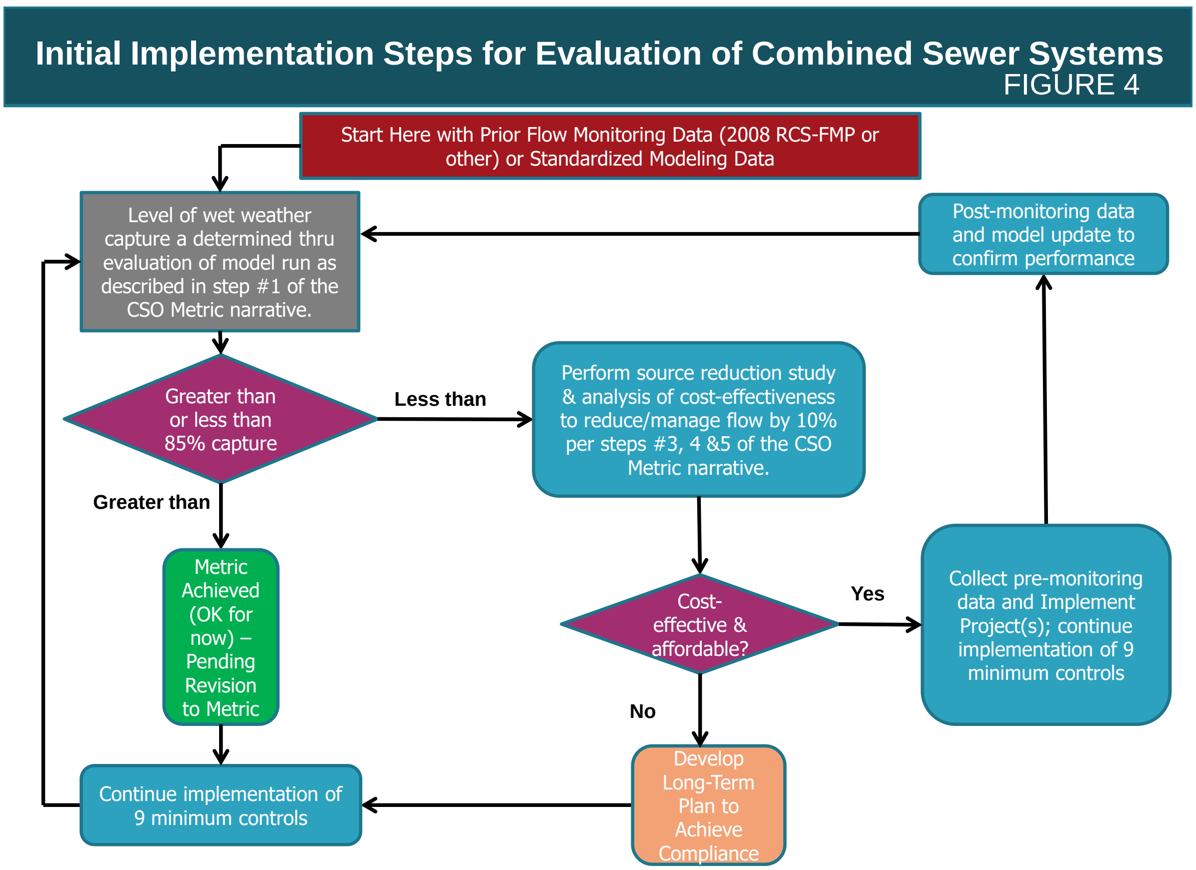



**Figure 5**

B. **Hybrid System Metric**

There are two basic types of hybrid systems, both classified as combined from ALCOSAN's point of view. Regardless of the type of hybrid system, the separate sanitary sewer portion will follow the separate sewer metric and the combined sewer system will follow the CSS Metric outlined above and illustrated below in Figures 6 and 7.

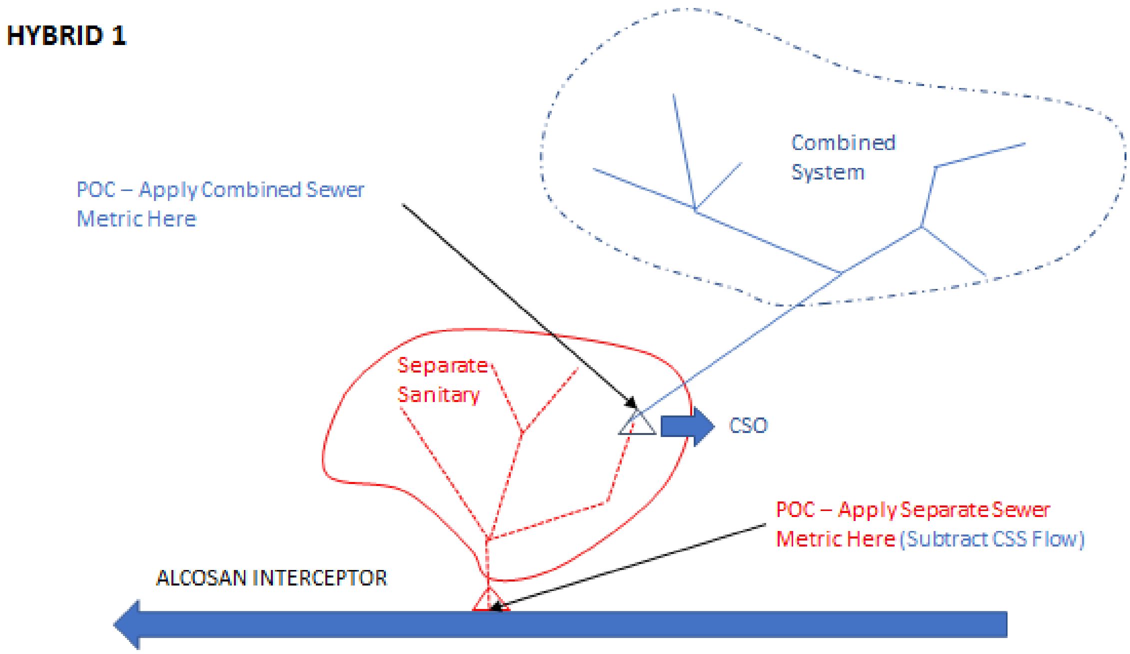



**Figure 6**

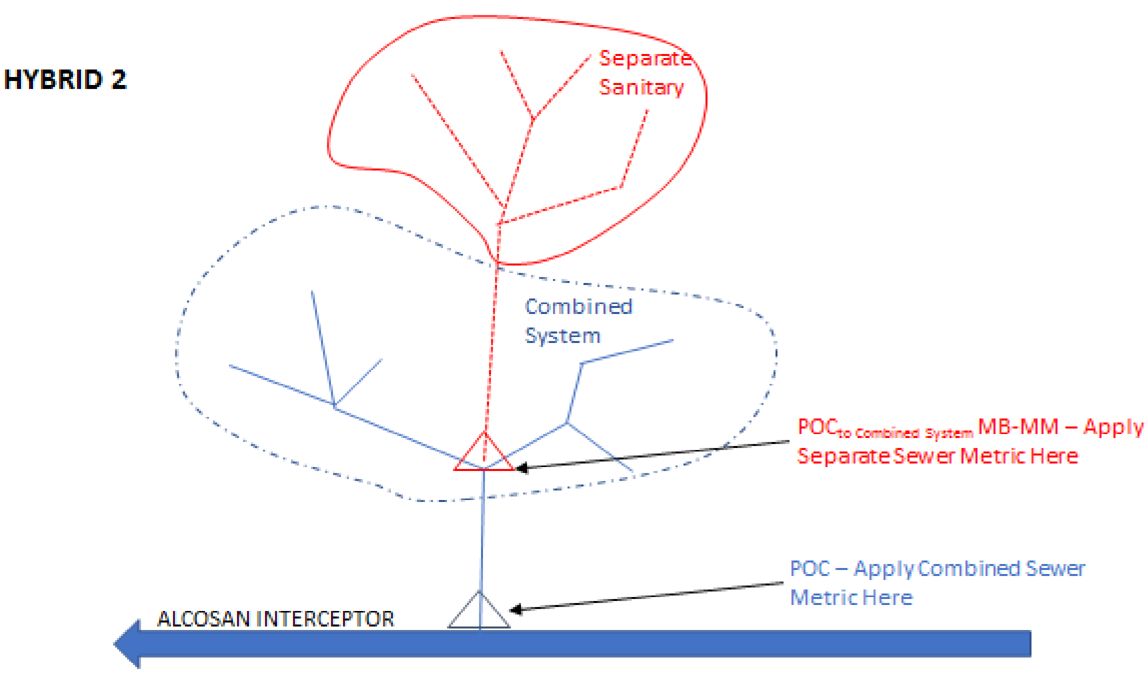



**Figure 7**

### 4.8 Other Considerations Necessary to Refine Interim Investigative Flow Target Metric Thresholds

A fundamental consideration of selection and implementation of any source reduction or flow target program is determination of economic appropriateness of the program. Cost of implementation and the effectiveness of flow reduction are integral elements of flow reduction planning efforts. As part of the Feasibility Study Working Group (FSWG) 3 Rivers developed a series of Technical Documents that address cost-effectiveness and affordability including *Document 013 Guidelines for Performance of Source Flow Reduction Cost-Effectiveness Analysis* applicable to separate sanitary sewer systems. This document included a computational tool (CEP) to perform the sub-unit level evaluation of excess flow removal vs. convey and treat cost-effectiveness analysis attendant to source reduction deliberations.

Cost-Effective

Embedded in the classic "cost-effectiveness" process for identifying removable I/I sources is the concept of "excessive Infiltration/Inflow". "Excessive Infiltration/Inflow" as defined in the Federal Register (40 CFR 35.2005 (b)(16)) is:

> *"The quantities of infiltration/inflow which can be economically eliminated from a sewer system as determined in a cost-effectiveness analysis that compares the costs for correcting the infiltration/inflow conditions to the total costs for transportation and treatment of the infiltration/inflow."*

The CEP tool 3 Rivers developed yields a knee-of the-curve graphic illustration of the "present worth-cost based cost-effectiveness" findings for individual sub-units within a sewer shed. The graphic below presents a sample of a typical finding for a point of connection subsystem. As presented, CEP evaluates five alternate source reduction "options", each with associated option-specific capital implementation cost and reduction effectiveness. In this example the "No Action" value, 0 subunits rehabilitated, of collect/convey/store/ treat is about $24M. To produce the curve, the findings of the cost-effectiveness analysis for each subunit are sorted based on unit cost of removal, lowest cost to highest cost of removal. The net savings are deducted from the No Action point of beginning value to yield the data points comprising the curve. As can be observed, each option demonstrates a different inflection point where the individual subunit value of removal becomes greater that the value of convey-treat. Although all subunits where the cumulative value is less than $24M are considered "cost-effective". However, simply being determined to be being "cost-effective" does not imply that a target metric can be achieved or that the option is affordable. This finding was documented in the pilot study performed by 3 Rivers in 2015 which is summarized in a subsequent section of this report.

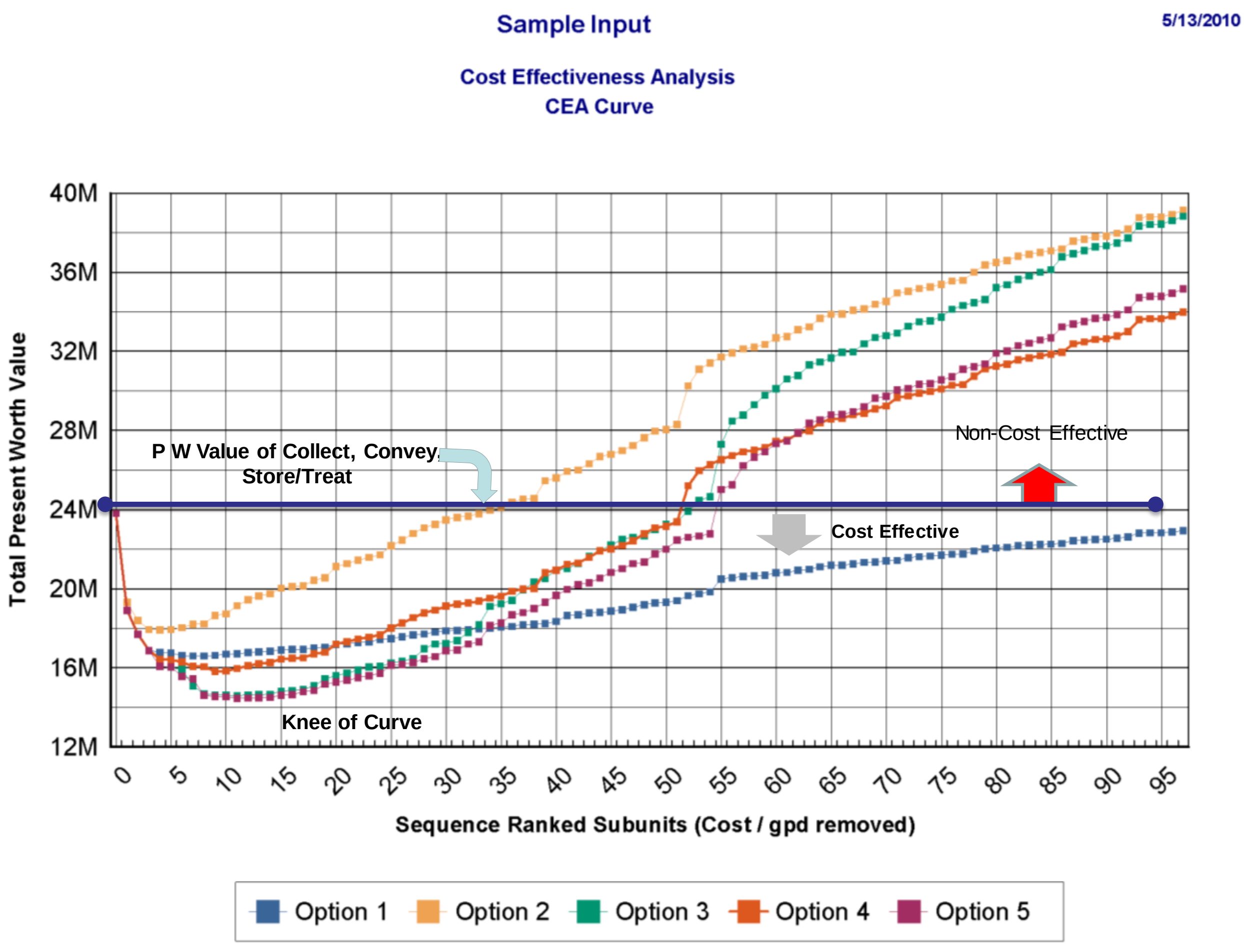



**Figure 8**

Affordable

A finding of "cost-effective" does not automatically connote affordable which the American College Dictionary defines as: "… to be able to meet the expense of…". At this time there is no regulatory agency accepted standard metric defining affordability as applied to separate sanitary sewer systems; however, in developing the idea of Integrated Planning Framework (IPF), USEPA has made allowances for municipalities to prioritize their expenditures based on affordability while still meeting the intended regulatory standards. It is important to note that the separate system source control programs combined with the regional costs of ALCOSAN's improvements, as well as the recently-imposed MS4 PRP/TMDL program implementation costs have created a substantial financial burden on individual residential households and other ratepayers. Whether the cost burden to the ratepayer is imposed by ALCOSAN or the local municipality does not matter because it must come "from the same pocket." Consequently, so as not to bankrupt local municipalities, some sort of affordability metric is used to facilitate IPF or Adaptive Management approaches.

To select a methodology to evaluate affordability the SFR/FT subcommittee looked to the ALCOSAN WWP which utilized the federal affordability metric (US EPA LTCP-EZ template) for combined sewer systems to assess county-wide affordability of the WWP. The US EPA LTCP-EZ template uses a prescribed computational process to derive both individual residential and community factors to determine financial capability expressed as a financial "burden." Following this methodology the burden to a community is characterized as either low, medium, or high burden. The computational methodology derives a "Residential Indicator" based on; current and projected wastewater system costs, annual cost per household, and Median Household Income (MHI) and a community "Financial Capability Indicator Benchmark" based on a given community's bond rating, net debt, unemployment rate, MHI, property tax and collection rate. These two indicators are applied to the EPA-proscribed matrix, Figure 9 (Table CAF-4), to characterize the burden.

**Table CAF-4. Financial capability**

| Permittee capability (socioeconomic, debt, and financial indicators) | Residential(CPH as %MHI) | | |
|---|---|---|---|
| | **Low** | **Mid-Range** | **High** |
| Weak | Medium Burden | High Burden | High Burden |
| Mid-Range | Low Burden | Medium Burden | High Burden |
| Strong | Low Burden | Low Burden | Medium Burden |

**Figure 9**

Given that this method was developed by USEPA for assessing affordability of LTCP's, and the fact that the source reduction plans under consideration are an integral part of ALCOSAN's WWP, it is recommended that the "Financial Capability Assessment and Schedule Development" guideline issued by US EPA for Combined systems, which includes the EPA LTCP-EZ template, also be adopted as the affordability approach for separate sanitary sewer systems. The impact of affordability on establishing Flow Targets is further addresses in the discussion below on the 2015 3 Rivers Wet Weather Pilot Study findings.

Incentives

A parallel concept to cost-effectiveness or affordability is the idea of incentivizing owners of sewer systems to undertake source reduction. Incentives can take the form of economic subsidy, economic offset, or economic penalties.

The recently implemented ALCOSAN Green Revitalization of Our Waterways (GROW) grant program is an economic subsidy form of incentivization. This program augments municipal capital funding for source reduction projects that document measurable flow/overflow reduction at the ALCOSAN POC. Early insights, based on the number of GROW Letters of Interest (LOIs) and application submittals for the first round of funding suggest an enhanced interest in municipal source flow reduction.

The concept of economic offset incentive is based on the thinking that source reduction at the local level, that is flow removed from the collection system, reduces the need to undertake improvements to the conveyance system resulting in capital or operating cost savings. An example that has been cited is the potential that substantial source flow reduction in the Chartiers Creek basin municipal collection systems could potentially eliminate the need to construct the ALCOSAN parallel interceptor conveyance pipeline.

Economic incentives can also take the form of a surcharge for excessive I/I.

The economic off-set and surcharge approaches are discussed more fully in the section on the 3 Rivers 2015 Flow Isolation Study Pilot Program (Appendix A).

**Source Flow Reduction and Flow Target Case Studies (2015 3RWW Pilot Shed Programs)**

In 2015 3 Rivers undertook a pilot program to demonstrate three differing flow isolation based techniques for assessing source flow reduction, to re-establish the value and utility of flow isolation methods, and assess the impact of recent advances in data storage, computing technology, and instrumentation. The key field work elements evaluated in the 3 Rivers Pilot Study included: Key manhole sub-basin flow monitoring, Sub-unit scale flow isolation studies via minimum-nighttime flow weirings, Sub-system scale Flow Isolation studies via dye dilution techniques, and Sub-unit/sub-system scale RDI/I flow studies via "micro-monitoring."

<u>2015 Pilot Study Flow Target Conclusions</u>

IT IS NOTED HERE THAT THE FOLLOWING ANALYSES ARE BASED ON A VERY LIMITED DATA SET. ONLY FOUR (4) OF SOME 200+ BASINS HAVE SUFFICIENT DATA AVAILABLE TO COMPLETE THE FLOW TARGET /AFFORDABILITY EVALUATION. AS SUCH THESE FINDINGS ARE CONSIDERED INFORMATIVE AND ILLUSTRATIVE OF THE PROBABLE IMPACT OF IMPOSITION OF STRINGENT FLOW TARGETS.

Appendix A to this document presents an overview and summary findings of the 2015 3 Rivers Wet Weather Pilot Study. The full study, which included detailed knee-of-the-curve cost-effectiveness analyses of five (5) source reduction approaches for each of four basins, is available on the 3 Rivers Wet Weather website. The conclusions of the 2015 Pilot Study demonstrate that GWI and RDI/I flow can be isolated to small (1,500 to 3,000 lf.) sub-units and that varying, community-specific amounts of source reduction can be cost effective.

As discussed in Appendix A to this document, the source reduction cost-effectiveness analysis considered multiple levels of "GWI -RDI/I allowance" including a "0 gpimd" allowance which reflects true "pay-to-play" (i.e. a conveyance/treatment charge is applied to 100% of the flow conveyed to ALCOSAN). Partial pay-to-play analyses were also performed by incorporating incremental GWI -RDI/I allowances of 600 gpimd, 2,500 gpimd, and 5,000 gpimd. This analysis was supplemented to include 1,500 gpimd as part of the SFR/FT subcommittee discussions. The "cost-effectiveness" analysis defines the Present Worth Value cutoff, or inflection, point for the given "allowance" that is the point at which it becomes cheaper to pay a surcharge than pay to remove flow assuming some base amount of GWI-RDI/I is "allowed" to remain. Under the current Z Agreements with ALCOSAN there is effectively an unlimited GWI-RDI/I allowance.

Alternatively, to assess the probable capital cost of implementation of hard flow targets the capital cost vs flow remaining columns of the CEP spreadsheet output were scanned to determine where a target was achieved and the associated capital costs of achieving the stipulated target (Figure 10). As shown, the capital cost increases as the flow target level decreases. There is no cost to achieve the 5,000 gpimd threshold for any of the four basins included. However, using C-48 as an example (N.B. C-48 was the only 2015 Pilot Study basin above the gold line standard, see Figure 11 below), to achieve the "Gold Line Standard" would cost $620,550 while a flow target of 2,500 gpimd would have an associated capital cost of $6,631,287. Further, a flow target of 1,500 gpimd would cost $22,496,771 and a flow target of 600 gpimd cannot be achieved by any of the source reduction methods considered.

| | Lowest Cost Option | | | |
|---|---|---|---|---|
| **POC / Target** | **A-60** | **C-48** | **S-15** | **T-29** |
| 5000 gpimd | $0 | $0 | $0 | $0 |
| Investigative Flow Target Threshold (A-60=4,095 / C-48=3,688 / S-15=3,786 / T-29=4,234) | $0 | $620,550 | $0 | $0 |
| 2500 gpimd | $0 | $6,631,867 | $2,202,393 | $255,878 |
| 1500 gpimd | $618,941 | $22,496,771 | $10,218,465 | $676,144 |
| 600 gpimd | $6,875,028 | | | |

Basin Above Gold Line Standard

Achieves noted threshold target without additional rehabilitation based on 2008 Flow data

Noted threshold flow target cannot be met based on CEP default removal effectiveness estimates and 2008 Flow data

**Figure 10**

2015 Pilot Study Affordability Conclusions

To illustrate the impact on affordability of various flow targets, the capital costs associated with each of the flow targets presented in Figure 10 above for the four pilot study basins were evaluated on a current community-specific, rate-district basis using the US EPA LTCP-EZ template described herein. All line item inputs utilized in this analysis were updated to current year (2017) values. Figure 11 below presents the 2015 Pilot Study basins data points on the gold line standard with high/low RDI/I color bands graphic.

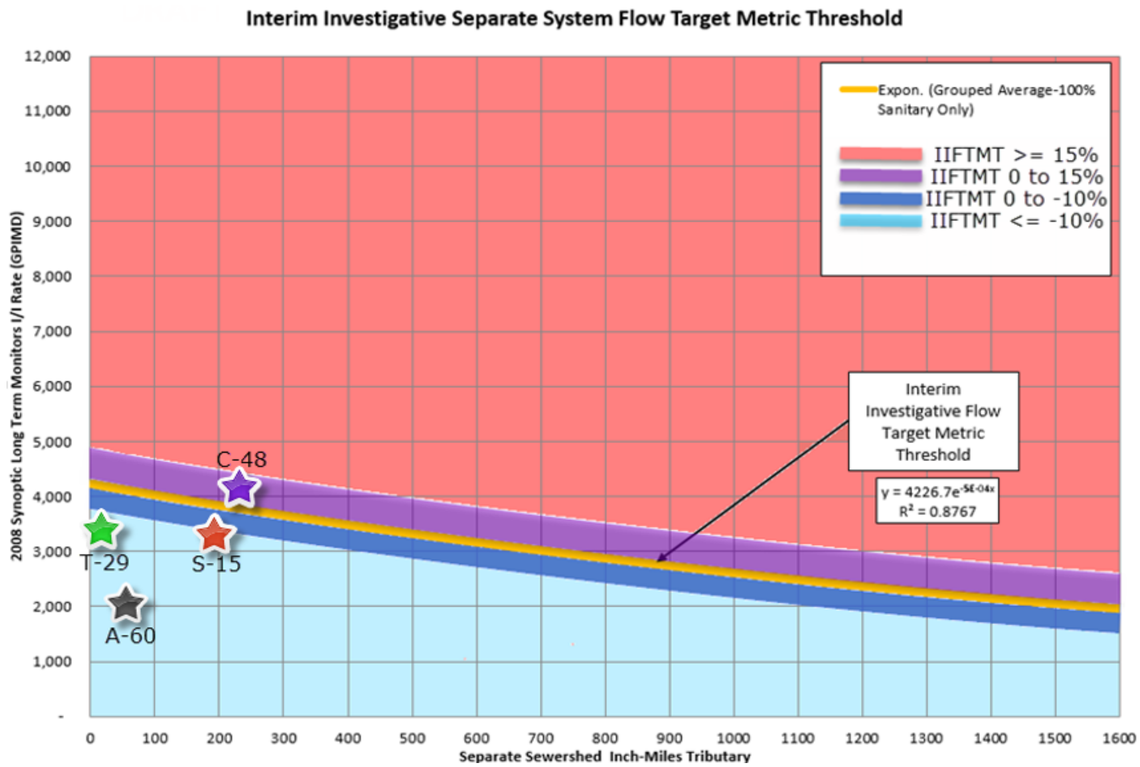



**Figure 11**

Figure 12 below presents a histogram of the affordability findings. As indicated affordability was considered for four scenarios:

1. Current costs,
2. Current costs plus implementation of the ALCOSAN WWP
3. Current costs plus implementation of the ALCOSAN WWP, plus implementation of a 2,500 gpimd flow target, and
4. Current costs plus implementation of the ALCOSAN WWP, plus implementation of a 1,500 gpimd flow target.

Looking first at A-60 (Reserve) and T-29 (Turtle Creek), both of which are below the suggested gold line standard, implementation of the ALCOSAN Wet Weather Plan increases their community-specific burden to a level at or above high burden. Imposition of a Flow Target below 2,500 gpimd pushes both well into high burden range.

S-15 (McNeilly Run), also currently below the suggested gold line standard, moves from low-medium burden to mid-range medium burden with implementation of the ALCOSAN Wet Weather Plan and upper mid-range medium burden with imposition of a 2,500 gpimd flow target and into high burden with imposition of a 1,500 gpimd flow target.

C-48, which is currently above the suggested gold line standard, moves from low-medium burden currently to mid-range medium burden with implementation of the ALCOSAN Wet Weather Plan, to very nearly high burden with imposition of a 2,500 gpimd flow target and well into high burden with imposition of a 1,500 gpimd flow target.

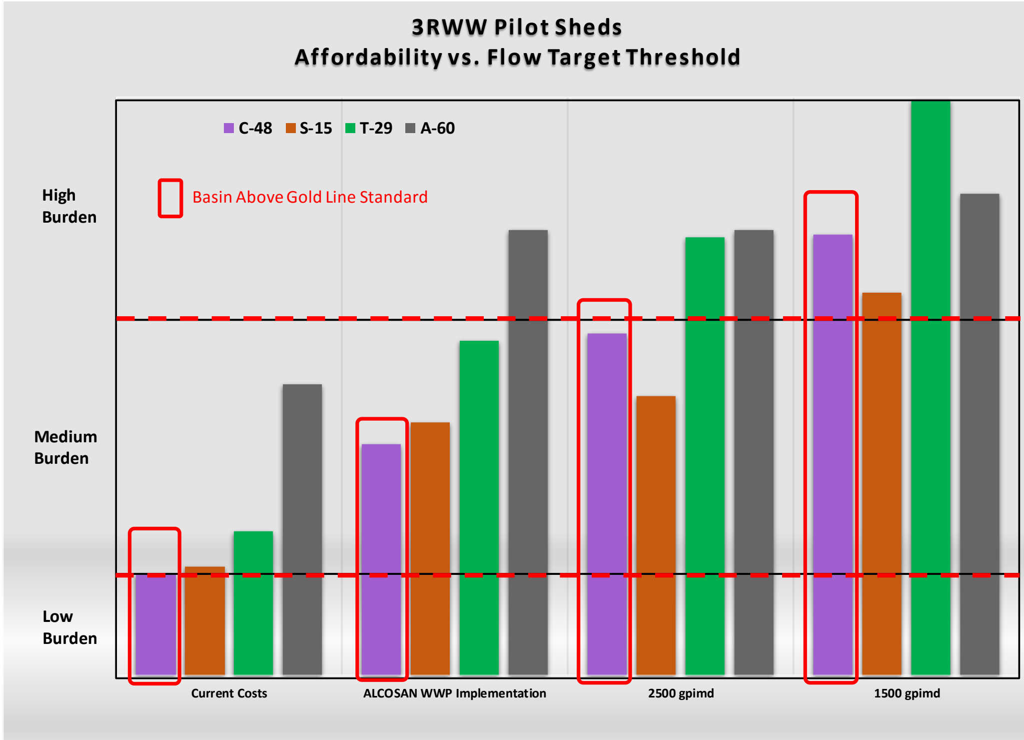



**Figure 12**

### 4.9 Overview Implementation Schedule

Figure 13 outlines high level tasks during the first six-year adaptive management check-in period. It should be noted that the schedule presented below pertains to source flow reduction is not intended to depict other operation and maintenance obligations associated with the municipal systems.

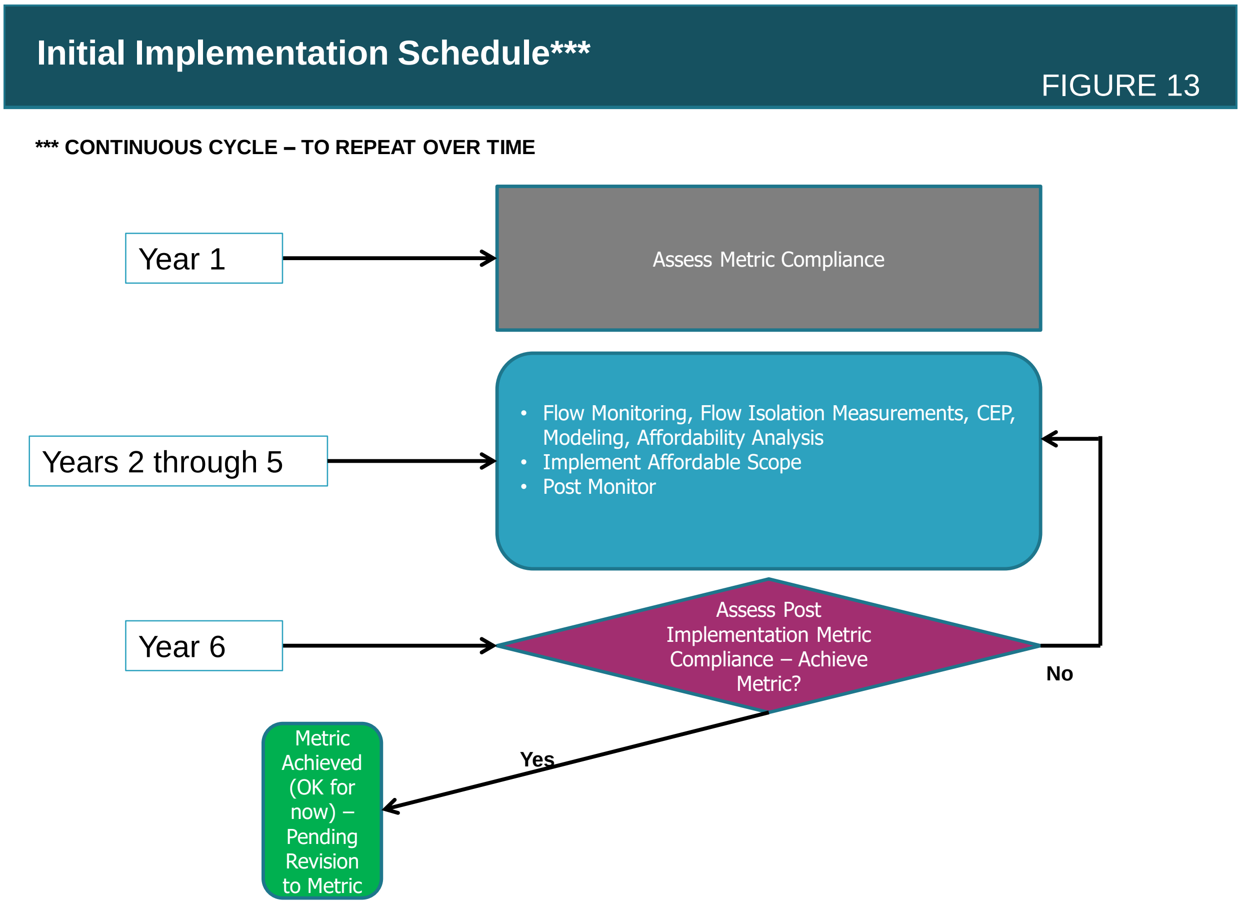



**Figure 13**

### 4.10 Other Considerations

In addition to discrete tasks presented, several technical, institutional, administrative concepts remain be vetted by the SFRFT including but not limited to:

1. Establish 2008 RCS-FMP Datum as Baseline – One technical topic in which the SFRFT Subcommittee will need to discuss and then develop/refine is a standardized methodology that would translate the 2008 flow regimes to precipitation and/or groundwater conditions to other flow regimes. This methodology would promote a hydraulically uniform evaluation of the separate sanitary sewer systems source flow reduction metrics identified herein for monitoring programs (performed on a smaller scale) by projecting to the largest scale monitoring program available (2008 RCS-FMP).
2. Debate and/or discussion pertaining to enforcement of flow targets from a monitoring vs. metering vs. model (or some permutation/combination) perspective.
3. Develop criteria for POCs and municipal boundaries that are too small to reasonably monitor

4. Private vs. Public Source RDII – Ability of municipalities and/or ALCOSAN to effectively manage "private source" RDII reduction
5. Identification of intermunicipal or multi-municipal management agencies to implement and/or manage source flow reduction efforts.
6. Schedule Refinement
7. Incentives/surcharges

## 5 Closing

This interim report accomplishes its two objectives/purposes noted below.

- To provide a consensus-based summary document from a municipal perspective, which addresses Interim Investigative Flow Target Metric Thresholds as a resource to ALCOSAN's January 2017 response to the 308 letter received from United States Environmental Protection Agency (USEPA) in June 2015 as modified in October 2015.
- To provide a consensus-based framework for acceptance by the municipalities of a compliance process and Interim Investigative Flow Target Metric Thresholds for incorporation into potential regulatory implementation orders.

However, Section 4.10 (Other Considerations) identifies a preliminary listing of remaining source flow reduction/flow target topics that will need vetted by the SFRFT to achieve implementation strategies *"intended to be technically achievable, economically affordable, reasonably quantified, and enforceable"* (SFRFT Subcommittee Mission Statement).

## APPENDIX A – SOURCE REDUCTION AND FLOW TARGET CASE STUDIES

**(2015 3RWW Pilot Shed Programs)**

In 2015 3 Rivers undertook a pilot program to demonstrate three differing flow isolation based techniques for assessing Source Flow reduction, to re-establish the value and utility of flow isolation methods, and assess the impact of recent advances in data storage, computing technology, and instrumentation. The key field work elements evaluated in the 3 Rivers Pilot Study included: Key manhole sub-basin flow monitoring, Sub-unit scale Flow Isolation studies via minimum-nighttime flow weirings, Sub-system scale Flow Isolation studies via Dye dilution techniques, and Sub-unit/sub-system scale RDI/I flow studies via "Micro-monitoring"

Following completion of the field work, engineering analyses were completed on the field data collected for four of the basins: T-29, S-15, C-48 and A-60. The engineering analysis included:

- Field flow monitoring/weiring data QA/QC including mass balance, and continuity checks.
- Preparation of quantitative flow isolation diagrams/graphics (i.e. Bubble Diagrams)
- Cost-Effectiveness Process (CEP) economic analysis
- Evaluation of Flow Targets

The cost analyses discussed in the following paragraphs address the potential for incentivization based on a surcharge for excess flow scenario(s) as well as the cost to achieve potential Flow Target metrics.

Sub-Basin Overview:

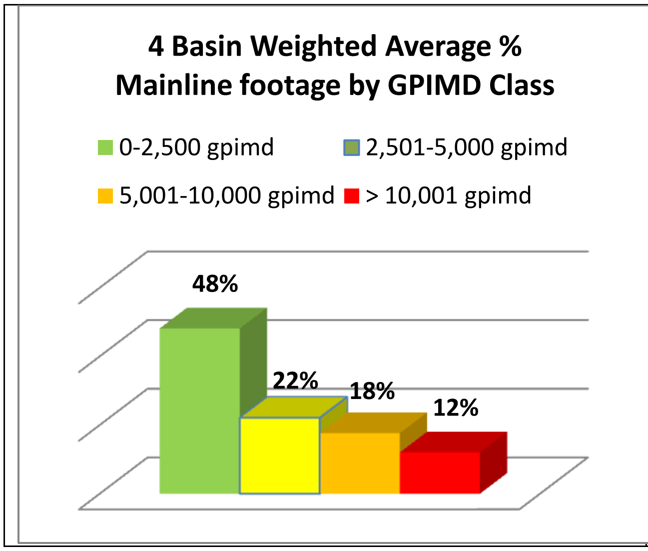
<u>A-60;</u> The portion of A-60 that was studied is a small part of the overall A-60 POC sewershed. The studied area is situated in the upper-most reaches of the basin above the combined sewered areas and comprised some 263 acres, 44,300 l.f. of mainline with 644 service connections. This area can be characterized as moderate sewered density at 15 service connections 1,000 l.f. of pipe with a total estimated annual GWI/RDI/I of about 52 MG per year. About 6.6% of the subunits were found to exhibit unit infiltration rates exceeding 10,000 gpimd and an added 3.5% were in the range of 5,001 to 10,000 gpimd.

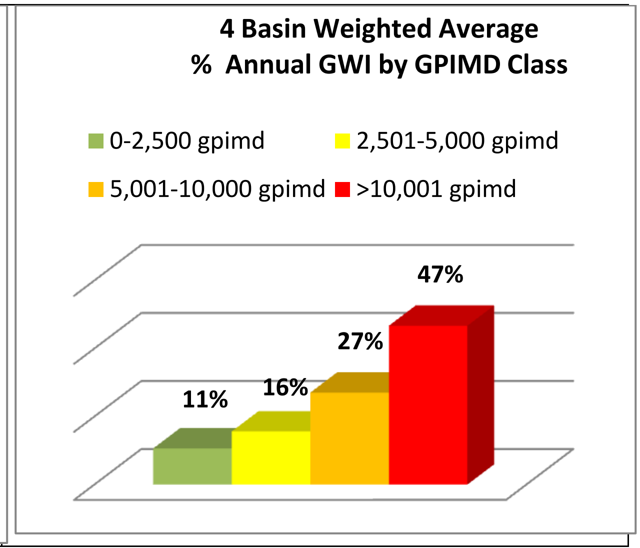
<u>C-48</u> ; C-48, the Hope Hollow watershed, is a large sized sub-basin comprising 837 acres, containing some 153,160 l.f. of mainline with 2,389 service connections. It can be characterized as moderate sewered density at 15.6 service connections 1,000 l.f. of pipe with a total estimated annual GWI/RDI/I of 614 MG per year. About 17.3% of the subunits exhibited unit infiltration rates exceeding 10,000 gpimd and an added 24.5% were in the range of 5,001 to 10,000 gpimd.

<u>S-15;</u> S-15, McNeilly Run, is a moderate sized sub-basin comprising some 539 acres, 117,943 l.f. of mainline with 2,959 service connections. It can be characterized as higher sewered density at 25 service connections 1,000 l.f. of pipe with a total estimated annual GWI/RDII of 249 MG per year. About 7.8% of the subunits exhibited unit infiltration rates exceeding 10,000 gpimd and an added 14.2% were in the range of 5,001 to 10,000 gpimd.

<u>T-29 ;</u> Like A-60, T-29, located in Turtle Creek, is a very small sub-basin comprising some 22 acres, 6,465 l.f. of mainline with 131 service connections. It can be characterized as moderate sewered density at 20 service connections 1,000 l.f. of pipe with a total estimated annual GWI/RDI/I of 12 MG per year. About 2.3% of the subunits exhibited unit infiltration rates exceeding 10,000 gpimd and an added 14.8% were in the range of 5,001 to 10,000 gpimd.

Consolidated flow isolation distribution histograms (below) for the four basins summarize the GWI flow distribution as established by the field weiring data. This data definitively establishes that the GWI flow is “quantifiable and isolatable” to small “geographic” portions of the overall sanitary sewer systems. The data also affirmed that very small wet areas are the source of very large percentages of the total annual GWI flow. This is illustrated in the histograms that show that 12% of the total pipe footage across all basins produces 47% of the total GWI. Likewise, 30% of the total pipe footage across all basins produces 74% of the total GWI.




2015 Flow Isolation (FI) Pilot Study CEP Cost-Effectiveness Analysis:

The source reduction Cost-Effectiveness analysis performed as part of the 2015 Flow Isolation Pilot Study considered multiple levels of “GWI -RDI/I allowance”; including a “0 gpimd” allowance which reflects true “Pay to Play” (i.e. a conveyance/treatment charge is applied to 100% of the flow conveyed to ALCOSAN). Partial Pay-to-Play analyses were also performed by incorporating incremental GWI -RDI/I allowances of 600 gpimd, 2,500 gpimd, and 5,000 gpimd. Each of these analyses identify the “cost-effectiveness” cutoff point for the given “allowance”, that is the point at which it becomes cheaper to pay a surcharge than pay to remove flow. The analysis included estimated capital costs as well as estimated annual surcharge fees, based on current ALCOSAN overage charges, for GWI/RDI/I flow above the stipulated allowance that is not removed. Summary findings are presented in the table below:

| Basin | | | **Pay To Play Findings** | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | 0 gpimd GWI-RDI/I Allowance | | | 5,000 gpimd GWI-RDI/I Allowance | | |
| | Size (Ac) | Mainline footage | Footage of Pipe to be rehabilitated | Capital Cost $ | Annual Surcharge $ | Footage of Pipe to be rehabilitated | Capital Cost $ | Annual Surcharge $ |
| A-60 | 263 | 44,300 | 3,700 | $954,000 | $199,900 | 650 | $242,000 | $258,963 |
| C-48 | 837 | 153,160 | 57,800 | $12,345,000 | $1,251,812 | 19,834 | $5,467,000 | $2,222,200 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| S-15 | 539 | 117,943 | 13,875 | $3,465,000 | $911,368 | 5,900 | $1,694,000 | $1,114,839 |
| T-29 | 22 | 6,465 | 1,230 | $364,000 | $37,429 | 146 | $30,800 | $61,474 |

2015 FI Pilot Study Flow Target Findings:

In addition to the Cost-Effectiveness analysis a follow up analysis of the potential to achieve various flow targets based on annualized volumetric Unit Infiltration rate thresholds identified above, (i.e. 600 gpimd, 2500 gpimd, and 5000 gpimd) was also performed with the findings as presented on the table below.

A-60; In the A-60 sub-basin, flow targets of 5,000 gpimd and 2,500 gpimd as measured at the bottom of the sub-basin were met based on the 2008 flow monitoring data. To achieve a 600 gpimd target would require full-parallel replacement of some 38,800 l.f. of pipeline at a cost of $10,600,000.

C-48; In the C-48 sub-basin, to achieve a 5,000 gpimd target, as measured at the bottom of the sub-basin based on the 2008 flow monitoring data, would require full parallel replacement of some 25,200 l.f. of pipeline at a cost of $3,630,000. To achieve a 2,500 gpimd target would require replacement of some 106,700 l.f. of pipeline at a cost of $25,396,000. The 600 gpimd flow target cannot be met in C-48 based on source reduction estimates utilized in the CEP© analysis.

S-15; In the S-15 sub-basin, a flow target of 5,000 gpimd as measured at the bottom of the sub-basin was met based on the 2008 flow monitoring data. To achieve a 2,500 gpimd target would require full parallel replacement of some 9,280 l.f. of pipeline at a cost of $2,879,000. The 600 gpimd flow target cannot be met in S-15 based on source reduction estimates utilized in the CEP© analysis.

T-29; In the T-29 sub-basin, a flow target of 5,000 gpimd as measured at the bottom of the sub-basin was met based on the 2008 flow monitoring data. To achieve a 2,500 gpimd target would require full parallel replacement of some 980 l.f. of pipeline at a cost of $295,000. The 600 gpimd flow target cannot be met in T-29 based on source reduction estimates utilized in the CEP© analysis.

**3RWW 2015 Regional Flow Isolation Measurement Program**

**CEP estimated Construction Costs required to**

**GPIMD "Target" Findings Based on 2008 Synoptic Flow Monitoring**

**October 5, 2016**

| **Target:** | **5000 gpimd** | | | |
|---|---|---|---|---|
| **POC / Option** | **A-60** | **C-48** | **S-15** | **T-29** |
| Option 1 Trenchless | $0 | $0 | $0 | $0 |
| Option 2 In Trench | $0 | $0 | $0 | $0 |
| Option 3 Full Parallel | $0 | $0 | $0 | $0 |
| Option 4 Partial Parallel | $0 | $0 | $0 | $0 |
| Option 5 Phased Partial Parallel | $0 | $0 | $0 | $0 |
| | | | | |
| **Target:** | **Investigative Flow Target Threshold ( GPIMD= 4262.8 e^(-0.0006In-Miles)** | | | |
| **POC / Option** | **A-60** | **C-48** | **S-15** | **T-29** |
| Option 1 Trenchless | $0 | $620,550 | $0 | $0 |
| Option 2 In Trench | $0 | $945,486 | $0 | $0 |
| Option 3 Full Parallel | $0 | $620,550 | $0 | $0 |
| Option 4 Partial Parallel | $0 | $620,550 | $0 | $0 |
| Option 5 Phased Partial Parallel | $0 | $620,550 | $0 | $0 |
| | | | | |
| **Target:** | **2500 gpimd** | | | |
| **POC / Option** | **A-60** | **C-48** | **S-15** | **T-29** |
| Option 1 Trenchless | $0 | | | |
| Option 2 In Trench | $0 | $9,794,045 | $6,605,416 | $412,287 |
| Option 3 Full Parallel | $0 | $6,631,867 | $2,202,393 | $294,430 |
| Option 4 Partial Parallel | $0 | $8,420,988 | $2,872,694 | $255,878 |
| Option 5 Phased Partial Parallel | $0 | $7,297,453 | $2,526,310 | $266,710 |
| | | | | |
| **Target:** | **600 gpimd** | | | |
| **POC / Option** | **A-60** | **C-48** | **S-15** | **T-29** |
| Option 1 Trenchless | | | | |
| Option 2 In Trench | | | | |
| Option 3 Full Parallel | $6,875,028 | | | |
| Option 4 Partial Parallel | | | | |
| Option 5 Phased Partial Parallel | | | | |

Achieves noted threshold target without additional rehabilitation based on 2008 Flow data

Noted threshold flow target cannot be met based on CEP default removal effectiveness estimates and 2008 Flow data

2015 FI Pilot Study CEP and Flow Target Conclusions:

The conclusions of the 2015 FI Pilot Study suggest that GWI and RDI/I flow can be isolated to small (1,500 to 3,000 lf.) sub-units and that some degree of source reduction can be achieved. However, the very limited scope of the analytic work, essentially two moderate sized basins, is not sufficient to draw any conclusions regarding development of long term “hard” flow targets.