TOWN OF SOUTH BETHANY

Canal Water Quality Presentation

Thursday, May 22, 2008

at the
Council Work Shop
Meeting

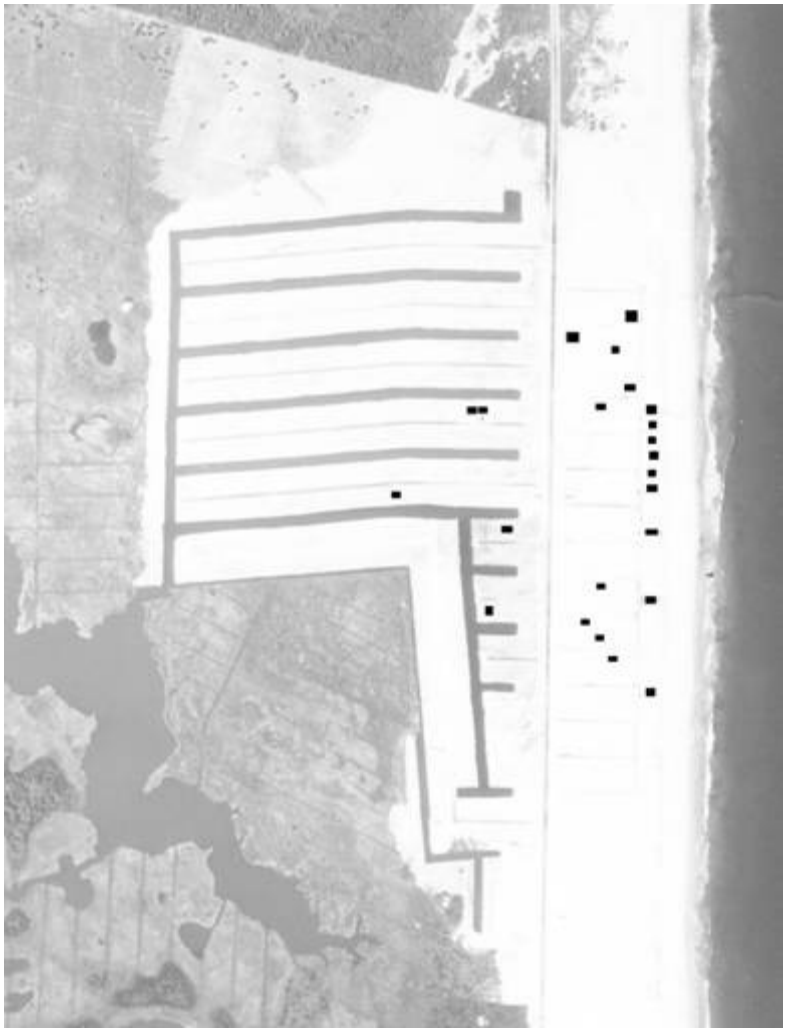
Agenda – **Canal Water Quality Presentation**

1. Introduction and Welcome	Jay Headman
2. Purpose of Meeting	Jay Headman
3. History of Monitoring Studies – Status of Canals	George Junkin
4. South Bethany Actions to Improve Water Quality	Jay Headman
5. Oyster Gardening	Jay Headman
6. Water Quality Monitoring	Al Rae
7. Stormwater Runoff Options	George Junkin
8. Tidal Pump Project	George Junkin
9. Anchorage Canal Drainage Area Assessment Project	Chris Bason

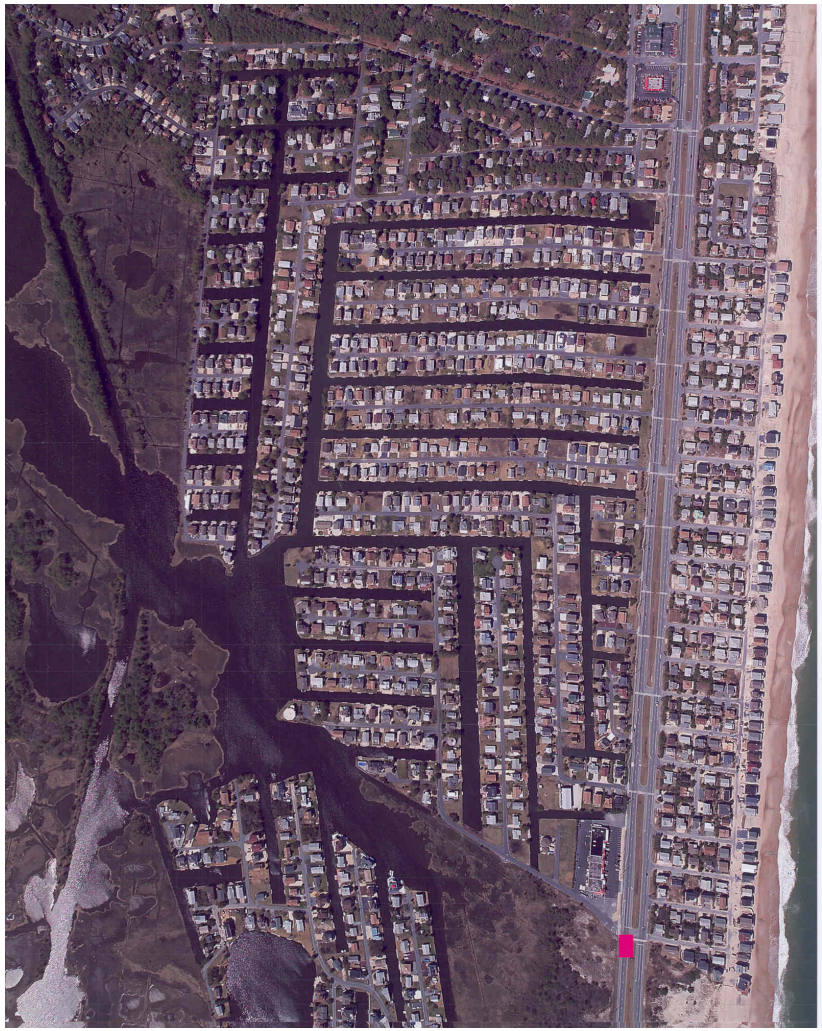
Town of South Bethany Water Quality Committee's Purpose For This Presentation

- Provide the status of the work of the Canal Water Quality Committee
- Provide the status of the work of the Tidal Pump Committee
- Provide overview of and an update on the Anchorage Canal Drainage Area Assessment Project

History of Monitoring Studies



In July 1954 South Bethany Canals Were Fishable and Swimmable



Development Has Reduced The Water Quality In South Bethany Canals

Summary of Studies, Monitoring And Efforts to Improve Canal Water Quality

Date	Location	Report, Study, Conference, or Measurements
1990-06-27	25 places	H2O & Air Temp., PH, DO, Sal., Bacteria
1990-08-10	6 places	Bacteria
1995		Stormwater Charrette Focused on Land West of Rt. 1
1997		Maxted paper on Dead - End Canals
13 Rain events in ’98, ‘99	**Anchorage**	**Precip., Runoff Volume, N, P, COD, Bacteria**
6 Months in ’01, ‘02	5 Canals	DO Increase Caused by Aeration 24 hour fish sampling
2003-05-17		Dead-End-Canal Conference
2004-04	**Anchorage**	**DelDOT Installs Sediment Forebay**
2004-04 to 2005-04	**Anchorage**	**Precip., Runoff Volume, Sedimentation Efficiency**
2006-05 to Present	Layton Russell & Anchorage	H20 & Air Temp, DO, Sal., Secchi Disk Just now starting to track Bacteria

1996 Lagoon Water Quality/Rainfall Study

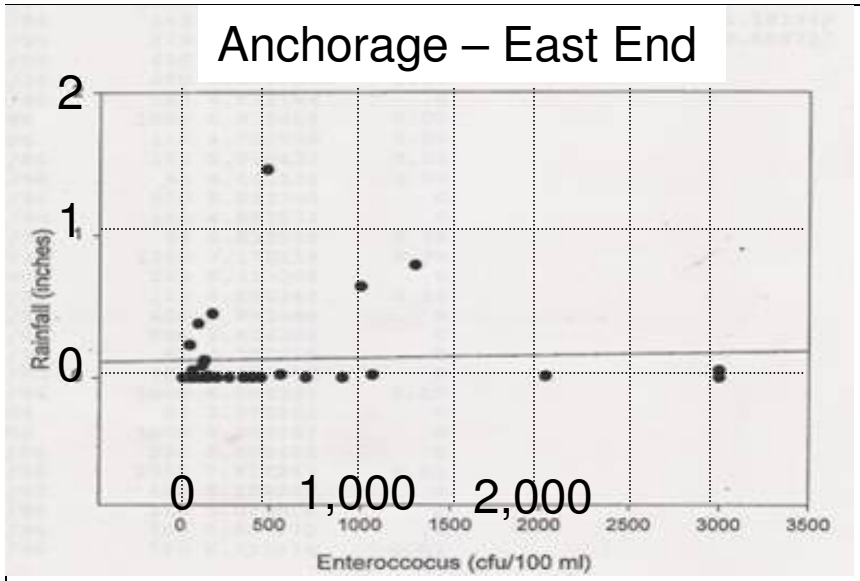
by Jack Pingree, Division of Water Resources, DNREC

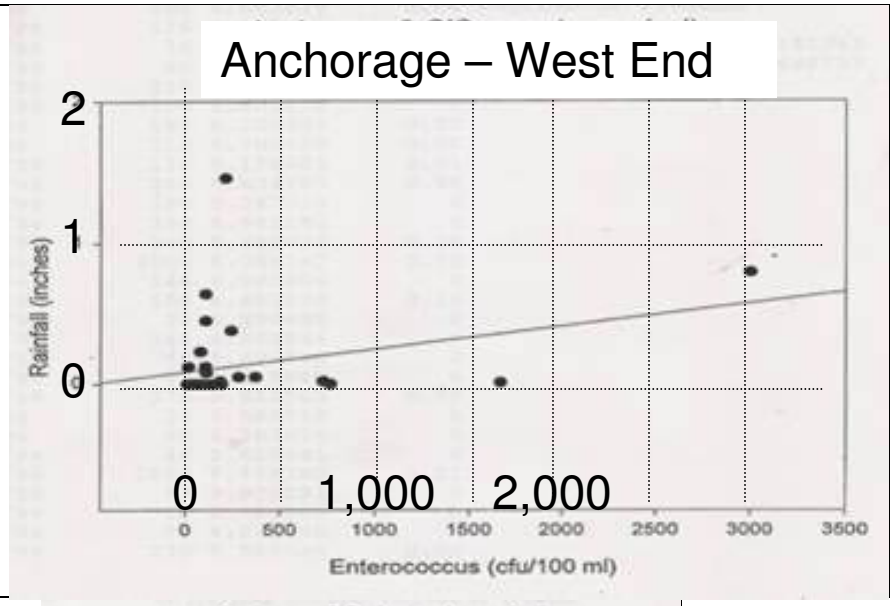
- Water Quality (Enterococcus Level) was measured 34 times between April 22, 1996 and August 28, 1996 at 4 sites. Swimming standard at the time was 156 cfu/100ml

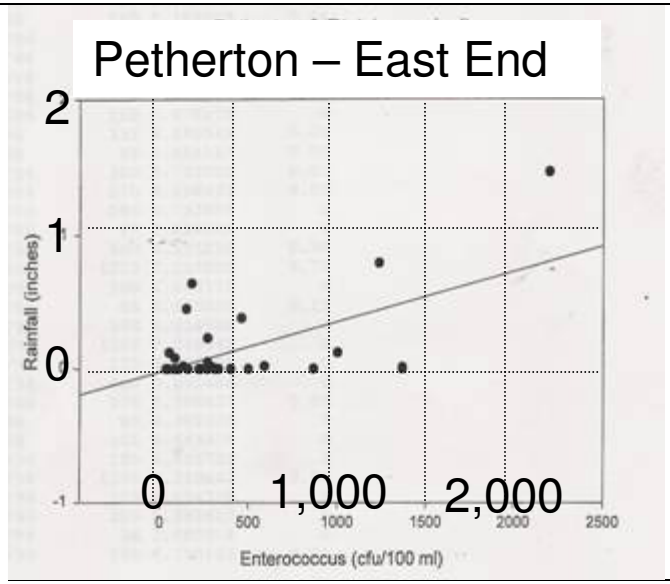
1. Anchorage & Rt. 1
   Exceeded standard 20 times
   Maximum measured 3,000 cfu/100ml
2. Anchorage & O'Connor home
   Exceeded standard 11 times
   Maximum measured 3,000 cfu/100ml
3. Petherton & Rt. 1
   Exceeded standard 20 times
   Maximum measured 2,200 cfu/100ml
4. Anchorage & Petherton
   Exceeded standard 7 times
   Maximum measured 2,166 cfu/100ml

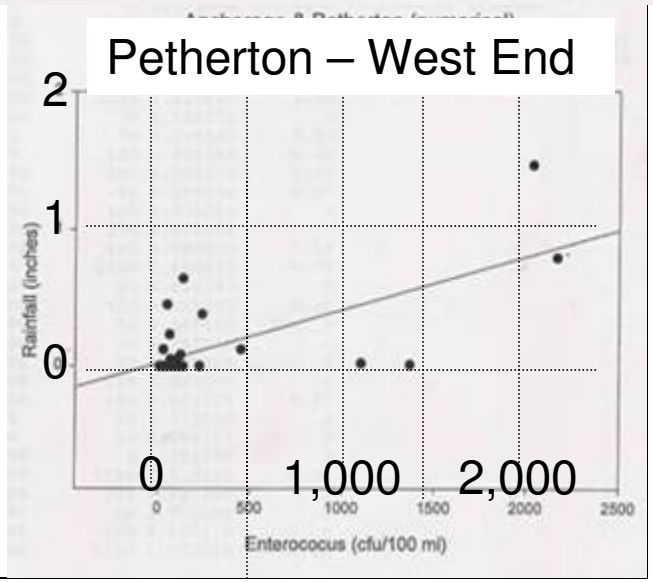
1996 Lagoon Water Quality/Rainfall Study

Plots of Rainfall Vs Water Quality









The January 2001 Report Characterized Storm Water Discharge Into The Anchorage Canal

- The study report documents that for each rainfall of about ½ inch during 1998 and 1999
  - About 360,000 gallons of stormwater were dumped into the Anchorage Canal.
  - During each event this stormwater contained
    - 6 pounds of Nitrogen
    - ½ pound of Phosphorous
    - 90 pounds of Chemical Oxygen Demand (COD) material
    - 10,000 to 100,000 colony forming units of fecal coliforms per 100ml of stormwater
- Previous Studies in the 1990s Documented oil slicks, heavy algae growths, foul odors, diminished water clarity and deposition of large amounts of silt.

In Early 2004 DelDOT Installed the Current Sediment Control Forebay at the Easterly End of the Anchorage Canal

August 2005 DNREC Report Evaluates The Efficiency of The Stormwater Sediment Control Forebay At ~28%

Summary

The forebay captured a substantial amount of the storm water sediments that were destined for Anchorage Canal. Sediment capture efficiencies of forebays are typically from 50 to 90 % (USEPA, 1999), however these are based on designs for systems that have much longer residence times (24 hrs) and larger surface areas in relation to drainage area. Based on the small size of the forebay and minimal retention time the Anchorage Canal forebay performed as well as could be expected with an overall efficiency of 28 % based on volume.

The outflow design of the forebay needs modification as evidenced by the severe scour at the outfall. The outfall weir should either be widened to decrease outflow velocity and/or the canal bottom should be hardened to prevent erosion.

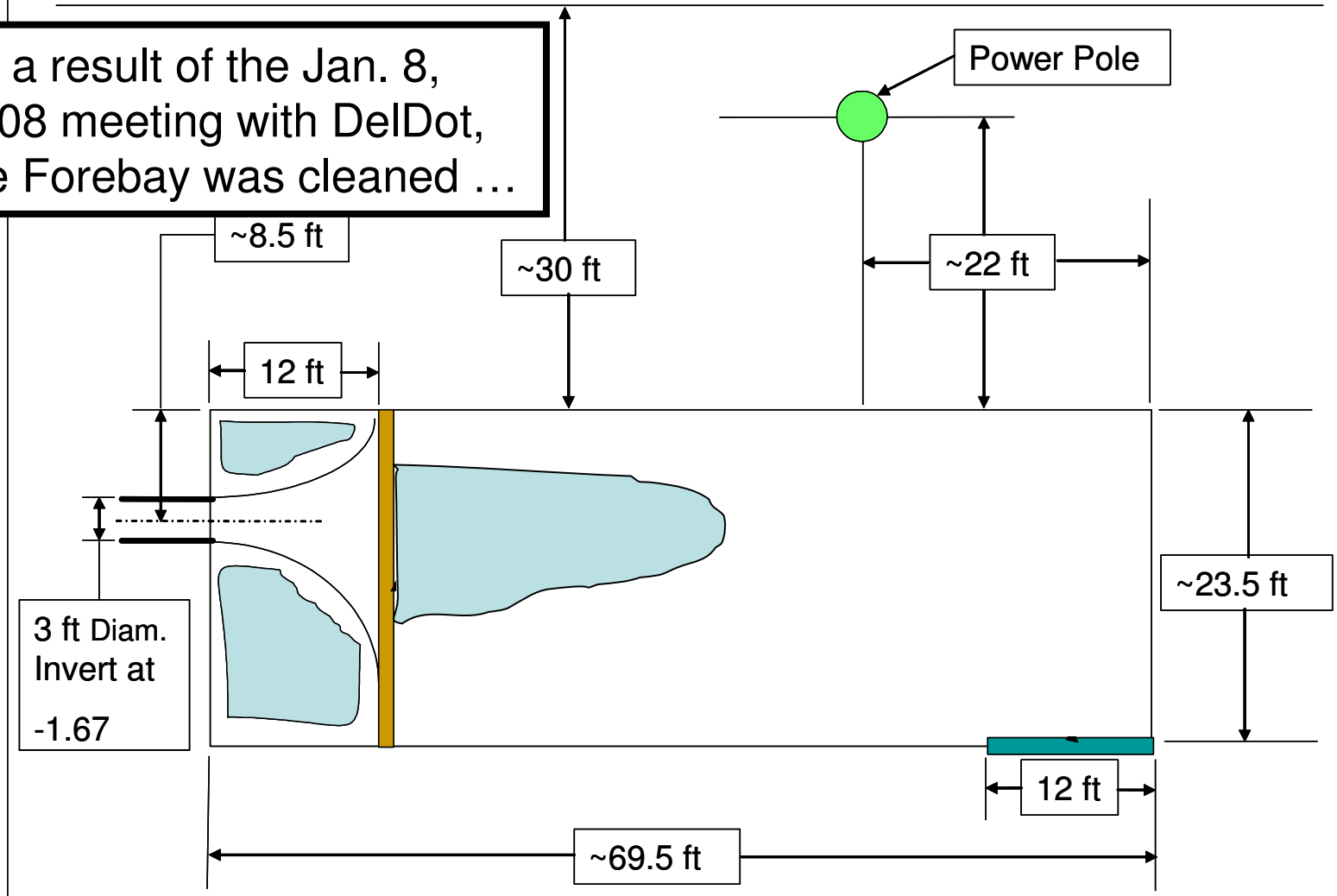
The evaluation year was completed without the occurrence of a major storm event. The largest storm monitored (7.59 cm, 3.0 in) was the equivalent of a 2-year return frequency 12-hour storm (Bonnin, et al., 2004). The ability of the forebay to trap the sediment in runoff from larger storm events can not accurately be estimated. Two factors will affect efficiency as storm water flow increases; at one point the overland flow will increase to a sufficient velocity to erode the sandy soil and transport it into the drainage system, substantially increasing the forebay loading rate. In addition, the higher velocity water flow through the forebay might re-suspend trapped sediments and flush them into the canal.

Existing Forebay At High and Low Tides

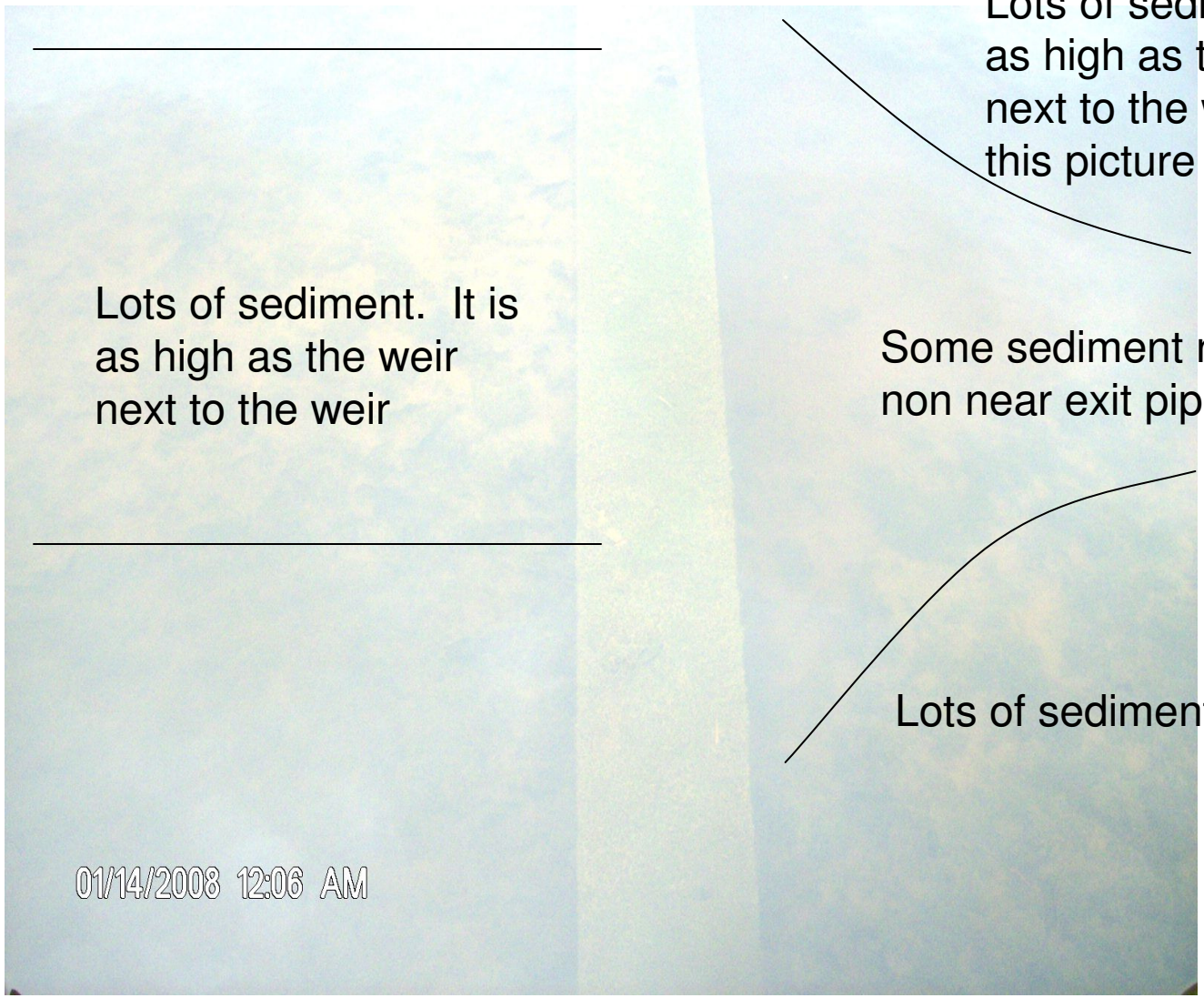
Our canal dredging has cleaned this out at the spillway

Our Inspection Shows Significant Sedimentation. (Pre-Weir), ~20” Deep in The Blue Area, ~7” Deep Around It, ~1” Deep Where The Water Exits The Pipe. (Post Weir), ~20 Deep In Blue Area Decreasing to Just A Few Inches.

As a result of the Jan. 8, 2008 meeting with DelDot, the Forebay was cleaned …



Picture of Significant Sediment In Post Weir Forebay – January 14, 2008



Councilman Jay Headman Leads a Water Quality Improvement Committee Whose Goal Is To Make The South Bethany Canals "Fishable & Swimmable"

- Town of South Bethany Water Quality Initiatives
  - Implementation of the Tidal Pump
  - Water Quality Monitoring Program
  - Oyster Gardening
  - Work with DelDot, the CIB, DNREC, The Town of South Bethany, homeowners and stakeholders to reduce the pollutants that enter the South Bethany Canals
    - Highest priority is stormwater run off from Route 1
    - Educate homeowners
      - to eliminate impervious surfaces
      - to eliminate piping of gray water and storm water into the canals
    - Develop ordinances relative to impervious surfaces and piping storm water and gray water into the canals
    - Support state and federal initiatives that limit nutrients from entering the Inland Bays
  - Dredging shallow areas and filling deep areas in the canal

Al Allenspach, a Member of The SBPOA, is Leading Over 30 SBPOA Oyster Gardeners

Al Rae, President of SBPOA, is Leading a Group to Monitor Water Quality in the South Bethany Canals

Testing Locations

Quantities to be monitored:

- For "Fishable" Waters
  - Dissolved Oxygen
  - Water Temperature
  - Salinity
  - Nitrogen and Phosphorus
  - Secchi Depth
- For "Swimmable" Waters
  - Bacteria
- Storm Water Influence
  - Collect accurate local rain data

Seven Volunteers Monitor The Seven

1	(SB01)	Gene Hendrix
2	(SB02)	Sandy Rawley
3	(SB07)	Lloyd Hughes
4	(SB04)	Dick Oliver
5	(SB10)	Norman Montigny
6	(SB09	Bryant Hopkins
7	(SB12)	Rob Youngs

Water Quality Monitoring Issues

1 Most of our sites are not shown on the University of Delaware site for the Citizens Monitoring Program

2 Combined Spring Quality Assurance and training Meeting for water quality volunteers scheduled here for June 6th

3 Generally slow response from University of Delaware on all questions. I am told they are overextended.

4 We have had more turnover of testers than I expected. 3 of original 7 have changed, SB10 twice.

Potential Alternatives Suggested From Previous Reports for Improving Storm Water Discharge Conditions Into the Anchorage Canal

- Alternatives suggested in the 2001 Characterization Report
  - Flow equalization basin coupled with a sand filter
  - Flow equalization basin coupled with a constructed wetland
  - Redirect stormwater to the Little Assawoman Canal
  - Redirect stormwater directly into the ocean
- Alternatives suggested in the 2005 Forebay Evaluation Report
  - Design the forebay to have longer residence times (24 hours)
  - Design the forebay to have more surface area
  - To reduce the canal scour increase the length of the spillway and/or harden the bottom of the canal.
- Concept Developed by Lloyd Hughes and Chris Bason
  - Capture all Route 1 stormwater runoff and pipe south through South Bethany to a constructed wetland in the State Park.

Where Do We Go From Here? What Are Our Options To Improve The Quality Of The Water That Enters The Anchorage Canal From Route 1?

- Do nothing. – Live with it the way it is.
- Put a band aid on it. – Fix the scouring, clean it out more often. **(DelDOT has committed to do these two)**
- Make a significant improvement along the lines of suggestions that have been made in previous reports.
  - Flow equalization basin coupled with a sand filter
    - Design the forebay to have longer residence times (24 hours)
    - Design the forebay to have more surface area
  - Flow equalization basin coupled with a constructed wetland
    - Capture all Route 1 stormwater runoff and pipe south through South Bethany to a constructed wetland in the State Park.
  - Redirect stormwater directly into the ocean

Details Of Three Significantly Different Suggestions For BMPs That Would Significantly Improve The Quality of The Water Discharged Into The Anchorage Canal

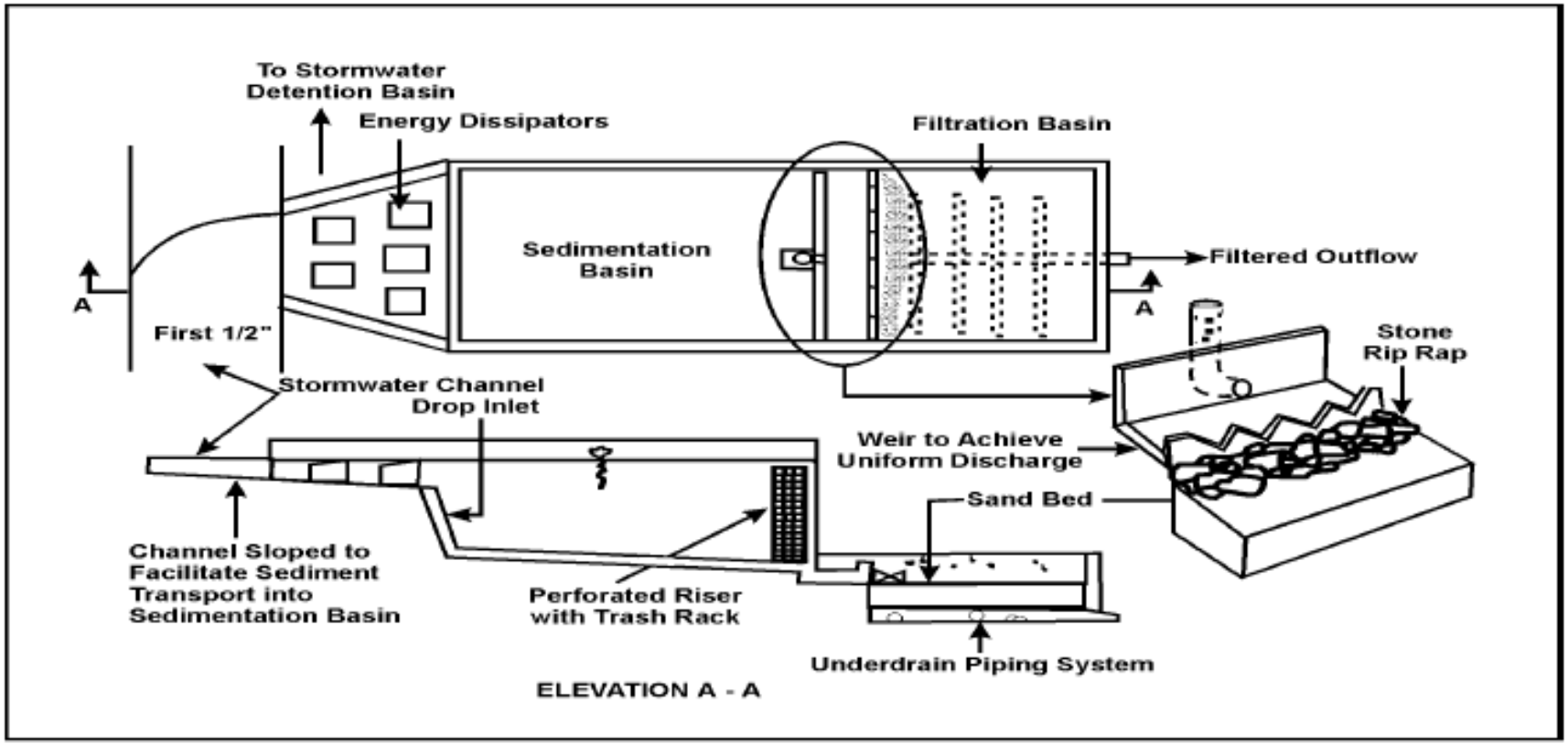
1. Sand Filter
2. Artificial wetland
3. Pipe to Ocean

We asked DelDOT in the Jan. 8, 2008 meeting to evaluate (pros, cons, cost effectiveness) these alternatives and to suggest others.

They have not yet gotten back to us with their evaluation of alternatives.

1. Sand Filter – There is Zero Head Room Available For A Typical BMP at Anchorage

An Austin Sand Filter Which Can Accommodate Stormwater Run Off From Over 50 Acres Requires Over 6' of head.

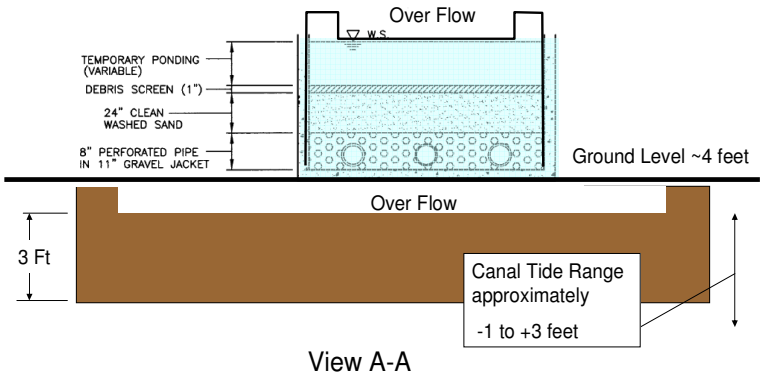


Source: Schueler, 1992.

FIGURE 1 TYPICAL AUSTIN SAND FILTER DESIGN

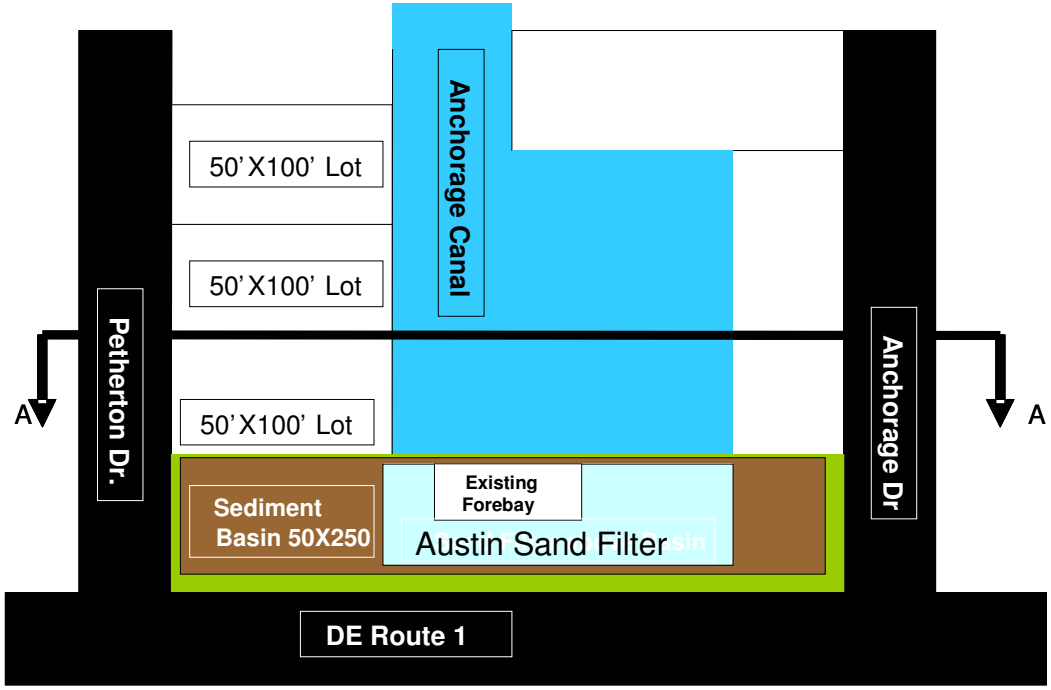
EPA 832-F-99-007, Sept.,1999, Stormwater Technology Fact Sheet – Sand Filters

An Innovative Approach Would Use A Low Flow Rate (200 GPM) Pump To Overcome The Zero Head Room Issue



In this innovative approach

- The sand filter is above the sediment basin
- A low volume pump empties the sediment basin into the sand filter over a 24 hour period



Note: The sedimentation filter, designed per EPA 832-F-99-007 is significantly larger than the existing forebay

What Would A Sand Filter Do For Us?

TABLE 2 TYPICAL POLLUTANT REMOVAL EFFICIENCY

Pollutant	Percent Removal
Fecal Coliform	76
Biochemical Oxygen Demand (BOD)	70
Total Suspended Solids (TSS)	70
Total Organic Carbon (TOC)	48
Total Nitrogen (TN)	21
Total Kjeldahl Nitrogen (TKN)	46
Nitrate as Nitrogen (NO_3-N)	0
Total Phosphorus (TP)	33
Iron (Fe)	45
Lead (Pb)	45
Zinc (Zn)	45

Source: Galli, 1990

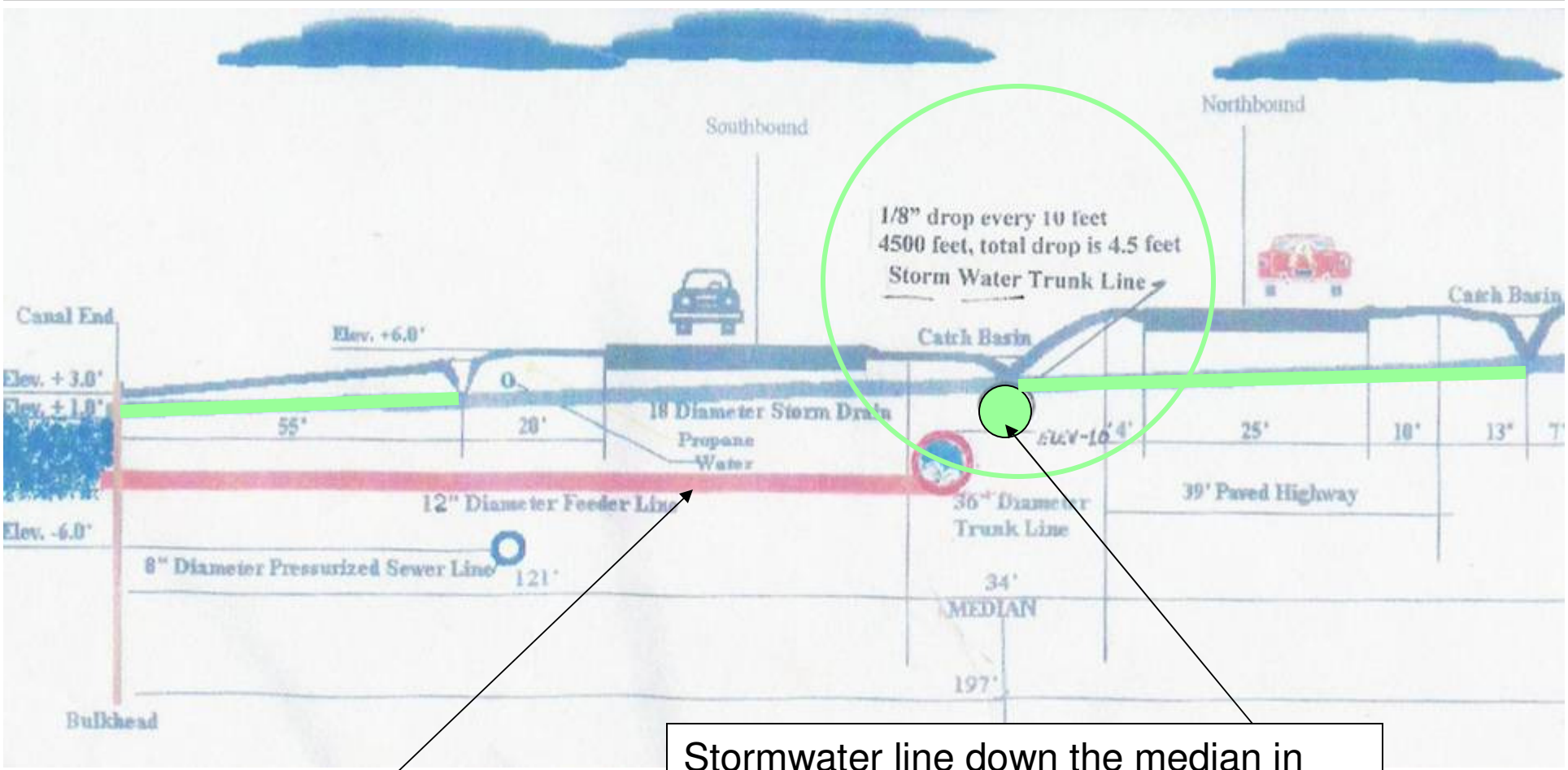
EPA 832-F-99-007, Sept.,1999, Stormwater Technology Fact Sheet – Sand Filters

Table 1. Sand Filter Data

Pollutant	Austin sand filter	Delaware sand filter
Fecal Coliform	76 %	not measured
Total Suspended Solids (TSS)	70 %	80-83%
Biochemical Oxygen Demand (BOD)	70 %	77.5%
Total Organic Carbon (TOC)	48 %	65.9%
Total Kjeldahl Nitrogen (TKN)	46 %	70.6%
Iron (Fe)	45%	not measured
Lead (Pb)	45 %	not measured
Zinc (Zn)	45 %	81.6%
Total Phosphorous (TP)	33 %	72.3%
Total Nitrogen	21 %	47.2%
Nitrate as Nitrogen (NO_3--N)	0 %	62.7%

SAND FILTER FOR TREATING STORM WATER RUNOFF

2. Capture Route 1 Stormwater and Pipe South – in the Route 1 Median, To a Constructed Wetland in the State Park



Proposed Tidal Pump Lines in Red

Stormwater line down the median in DE Route 1

A pump and an equalization basin would probably be required

An Artificial Wetland at Georgetown Industrial Park is One of the CIB Action Plan Demonstration Projects

United States Environmental Protection Agency

Office of Water (4504F)

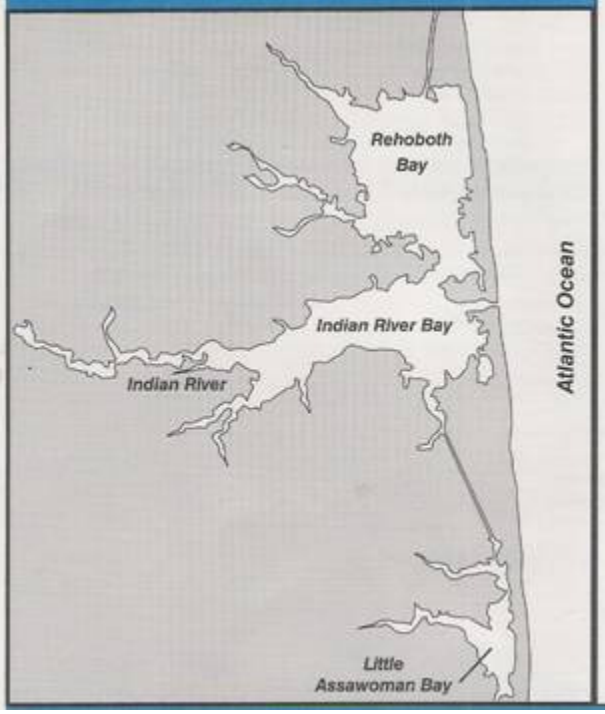
EPA 842-F-95-001C September 1995

EPA

Georgetown Stormwater Management Project

Demonstrating Practical Tools For Watershed Management Through The National Estuary Program

Delaware Inland Bays, Delaware



Characteristics:

- The Delaware Inland Bays consist of Rehoboth, Little Assawoman, and Indian River Bays.
- The Bays and their tributaries stretch across about 32 square miles and drain a 182 square mile watershed.
- About 120,000 people live in the Bay watershed.
- Approximately 75 square miles of the watershed are used as farmland, 3 square miles are urban, and the rest is mainly open space and forest.

The Problem: The overloading of nutrients in the Bay from point and nonpoint sources has resulted in decreased water quality and loss of habitat.

- Submerged aquatic vegetation beds once thrived in the Bays; however, excessive nutrient levels have suppressed their growth.
- Soft clam, oyster, and bay scallop fisheries are essentially extinct.
- Nonpoint sources, especially stormwater runoff, are the primary source of nutrient loading in the Bays.

The Project: The Georgetown Stormwater Management Demonstration Project was designed to construct an artificial freshwater wetland for stormwater control and habitat creation in an urban area, the Georgetown Industrial Park.

3. Pipe to the Ocean – Rehoboth Beach Has 5 Stormwater Outfalls into the Ocean

Pipes are 30” to 36” HDPE, supported and held down with timber piles every 6’

The outfalls run from the boardwalk out to an invert at the mean low water based on the restored beach. The following pictures are at Maryland Ave. were the outfall is exposed due to erosion of the restored beach.

Outfalls are located at Grenoble Pl., Maryland Ave., Rehoboth Ave., Delaware Ave., and Laurel St.

Our application would require a high volume pump or an equalization basin couple with a low volume pump

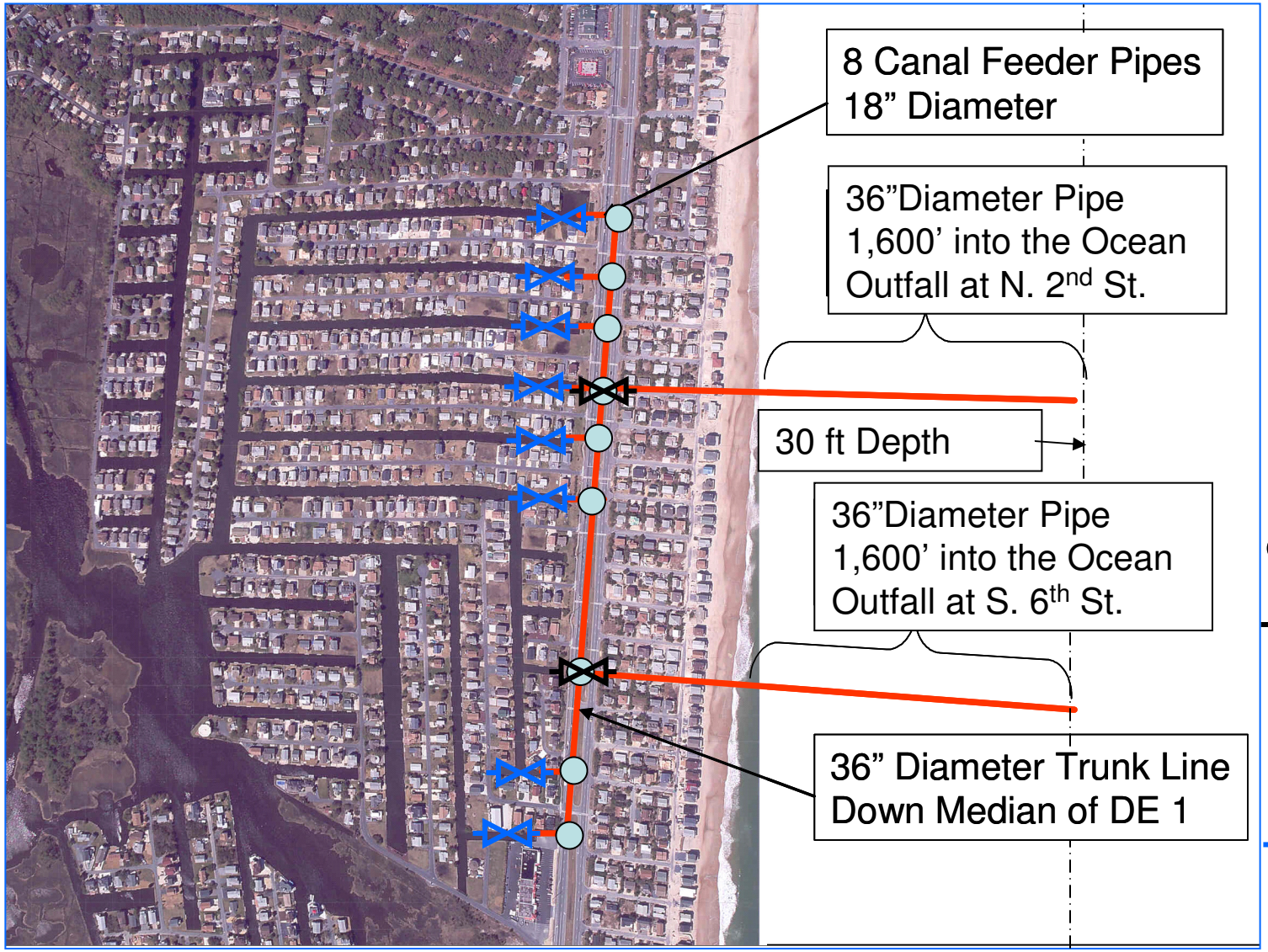
- Summary
  - The current forebay is not designed for the volume of water that is discharged into it.
  - The current forebay is not designed to effectively remove
    - Fecal Coliform
    - Nitrogen
    - Phosphorus

- Where Do We Go From Here?
- How Do We Decide Which Is The “Best” BMP For The Anchorage Canal?

Inlets that once provided exchanges between the Little Assawoman Bay and the Atlantic Ocean have closed, resulting in poor flushing and poor circulation to the Little Assawoman Bay

- Current location of Indian River Inlet, Cut open in 1929, Stabilized with jetties in 1937. Jetties cause north shore to migrate west.
- Indian River Bay
- Assawoman Canal
- South Bethany
- Jefferson Creek
- **Closed Inlet Creek Inlet**
- Little Bay
- Little Assawoman Bay
- **Closed Assawoman Inlet**
- Fenwick Island, State Line
- **Closed Mattapany Inlet**
- Assawoman Bay
- Ocean City Inlet, formed and stabilized with jetties in 1933. Jetties cause south shore to migrate west.

The Tidal Pump Has All The Benefits Of An Inlet Without The Disadvantages



Benefits

- Provides Flushing & Circulation
- No Impact to the Shore Line
- No Bridge Required

Legend

- 9 Man Holes
- 2 Electrically Powered Gate Valves (36") in Median
- 8 Manual Gate Vales (18") at Canals

It Is Well Documented That An Increase In The Exchange Between The Inland Bays And The Ocean Would Be Beneficial to The Inland Bays

- *The Problem of Keeping Indian River Inlet Open* by R.P. Powell, Lieutenant-Colonel, Corps of Engineers, January 8, 1931. "There efforts should be confined to maintaining an inlet for increasing the salinity of the Bays and the restoration of marine life rather than one suitable for navigation."
- *Dynamic Systems at the Land-Sea Interface* by David E. Krantz
- *Salinity Control as a Mitigation Strategy for Habitat Improvement of Impacted Estuaries* by Bruce J. French and Dale Kerper
- *Delaware/Maryland Dead-end Canal Conference Proceedings: Challenges and Solutions, May 17, 2003 at Rusty Rudder*, Dewey Beach
- Letter from Senator George H. Bunting, Jr. included in above proceedings. "Some type of controlled flushing, I believe, will do more to cleanse the little Assawoman Bay and these lagoons than all the other important measures we are addressing today."
- Letter from Kent S. Price, Ph.D., Associate Professor Emeritus, College of Marine Studies, University of Delaware, 1,13,2006. "I …find it a very creative solution to a long standing dead end canal water quality problem that may be otherwise insoluble."
- City of Destin, FL has a large, 50,000 gpm, 250 hp, electric pump that pumps Gulf of Mexico water into Sandpiper Cove.

History of Tidal Pump Design & Analysis

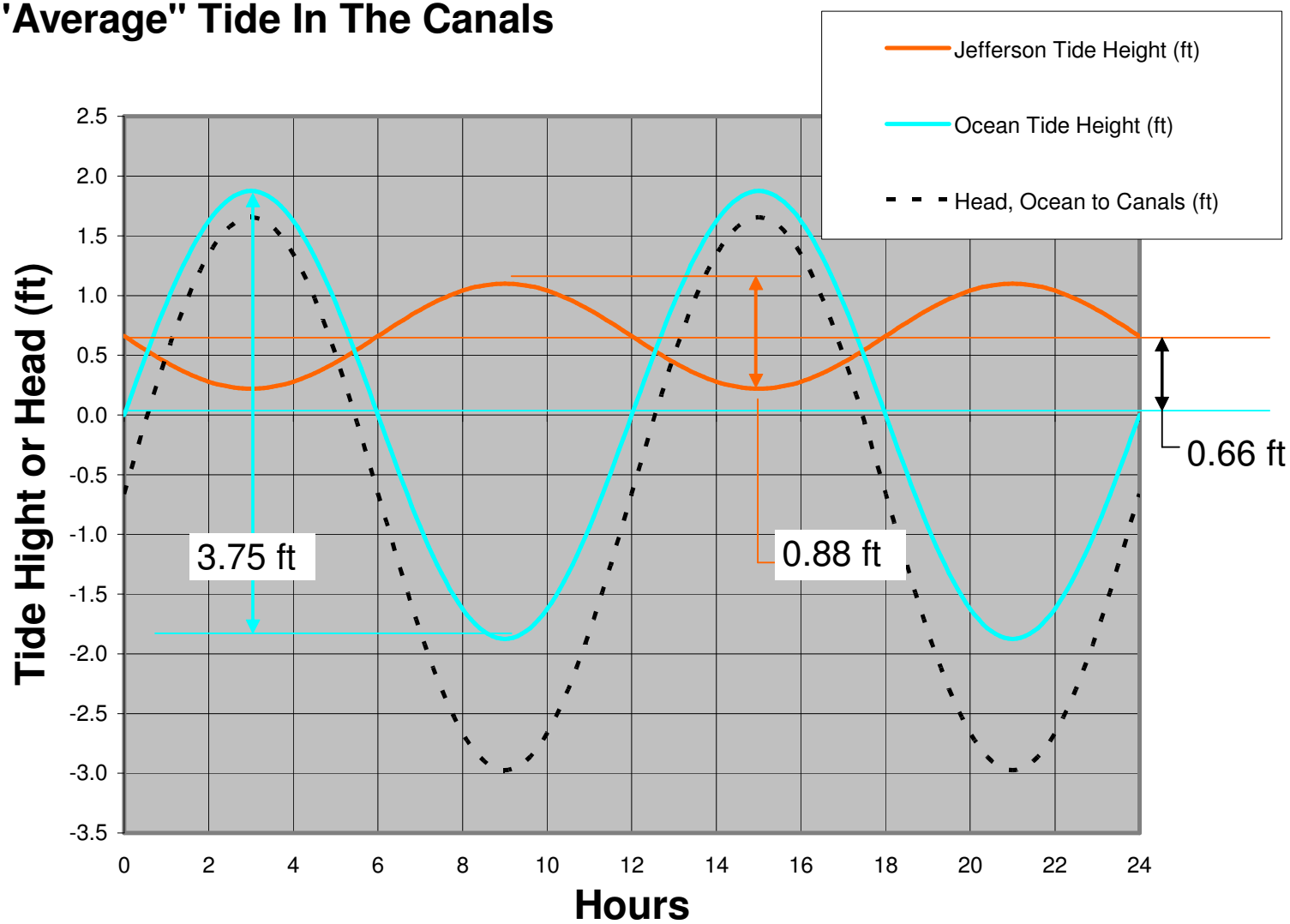
- In 2002 Lloyd Hughes, a former Town of South Bethany Councilman, began researching the development of a system to flush and circulate the waters in the canals.
- In 2005 the Town of South Bethany issued a contract to Entrix, Inc and J.E. Edinger Associates for $17,000 to conduct a residence time analysis of Lloyd's proposed Tidal Pump design.
  - This analysis shows that residence times would be reduced from greater than 120 days to about 3 days.
- In 2006 the Town of South Bethany issued a contract to Oceaneering International, Inc. and KCI Technologies, Inc. for $50,000 to determine the feasibility, practicality and cost of the Tidal Pump design.
  - Their results verified that the Tidal Pump was practical and feasible.
  - They recommended that the pipes be High Density Polyethylene (HDPE) for corrosion and life considerations and that the Installation method into the ocean be Horizontal Directional Drill (HDD)
  - They recommended that the south outfall be the same as the north outfall.
  - They estimated the cost to be $250,000 for design, $5.2M to $ 6.7M for construction and $18,000/year for maintenance.

Recent History – Meetings With DNREC and Feedback From DNREC

- Issues raised at November 20, 2007 meeting with DNREC Staff
  - Existence of field data for ocean tides
  - Impact of ocean water causing a bulge or dead flow in Assawoman Canal
  - Impact on salinity on inland bays
  - Impact of polluted canal/bay water on the ocean
- DNREC review of Tidal Pump resulting from December 13, 2007 presentation to John Hughes
  - Environmental benefits and/or concerns of building the Tidal Pump System as proposed
  - Will the Tidal Pump System work as designed?
  - Permitting issues
  - Operation and maintenance issues
- Meeting with Hassan Mirsajadi on “Will the Tidal Pump Work?”

The Tidal Pump Uses Energy From The Tides – No Mechanical Pump Is Required

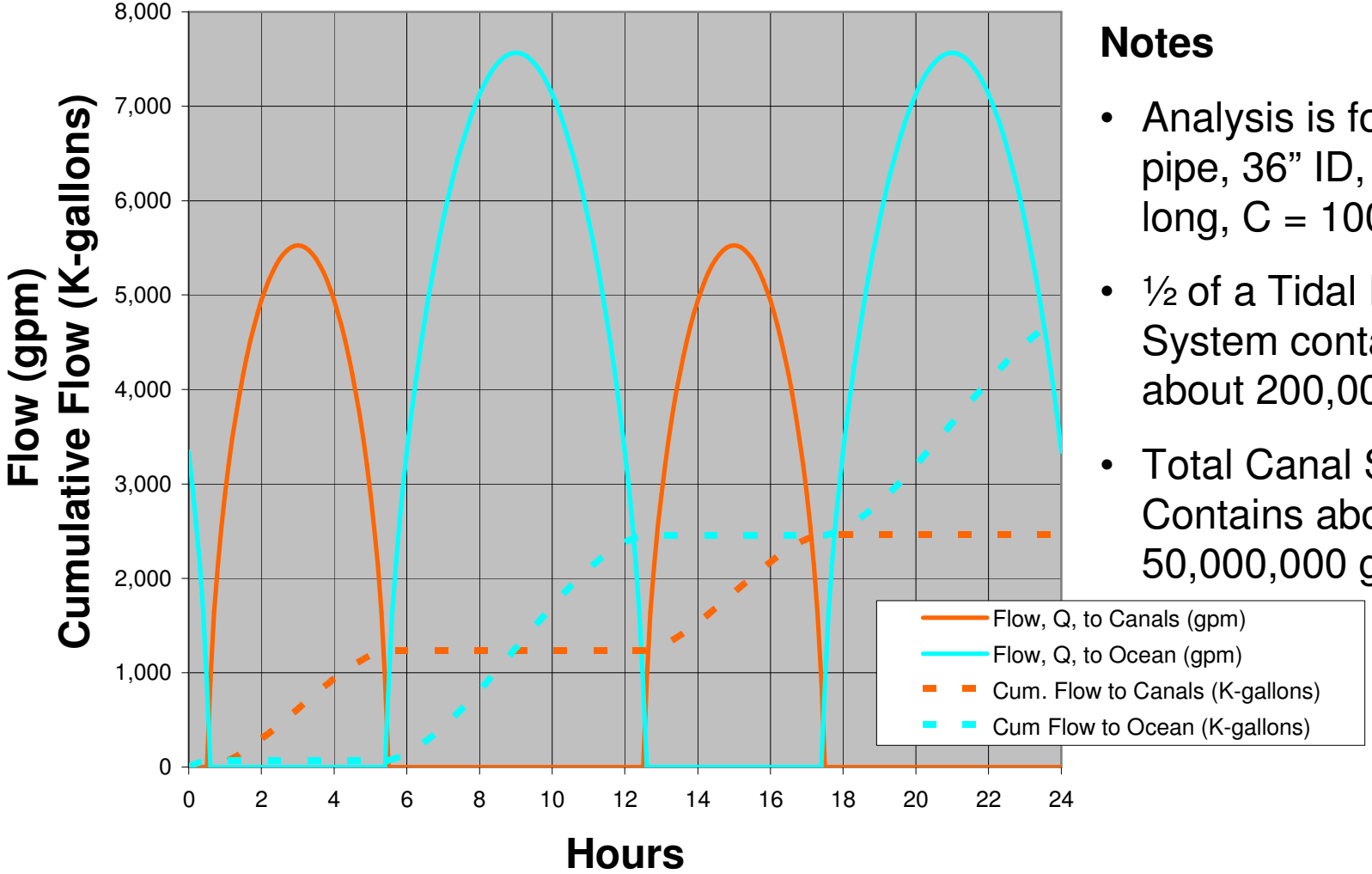
Analysis Is For "Average" Tide off of South Bethany And The "Average" Tide In The Canals



The above values came from John Tally, Director and State Geologist of the Delaware Geological Survey

The Tide Difference Between The Canals And The Ocean Drives Thousands of Gallons Per Minute Through The Tidal Pump

Flow to the Ocean and Flow to the Canals

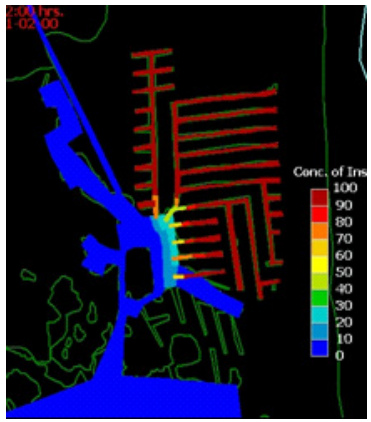


Notes

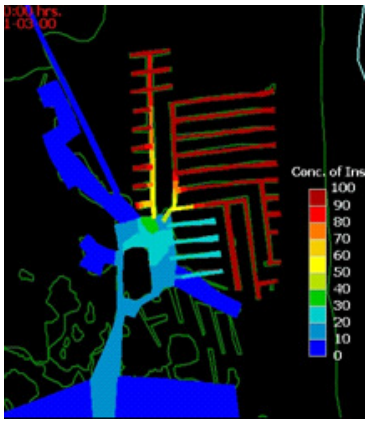
- Analysis is for one pipe, 36” ID, 2,400 ft long, C = 100
- ½ of a Tidal Pump System contains about 200,000 gal.
- Total Canal System Contains about 50,000,000 gal.

Entrix Analysis Verifies That Residence Times Within The Canal System Will Be Reduced By An Order Of Magnitude (1 of 3)

No Tidal Pump – Entrix Analysis



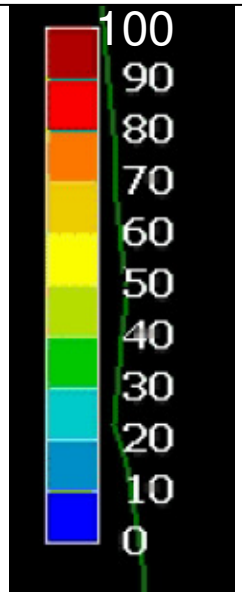
Time, Start

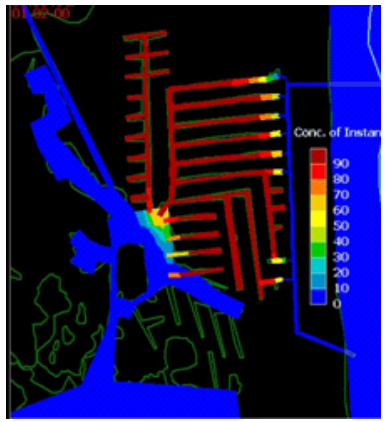


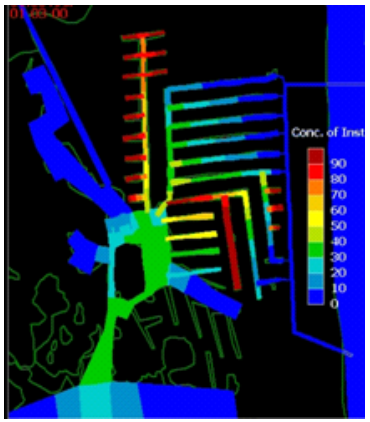
Time, 1 Day

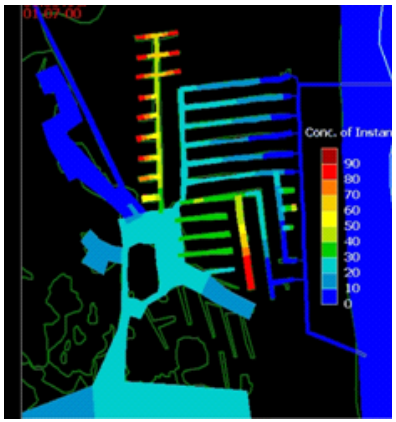
Time, 5 Days

Concentration of Instantaneous Dye (mg/L)









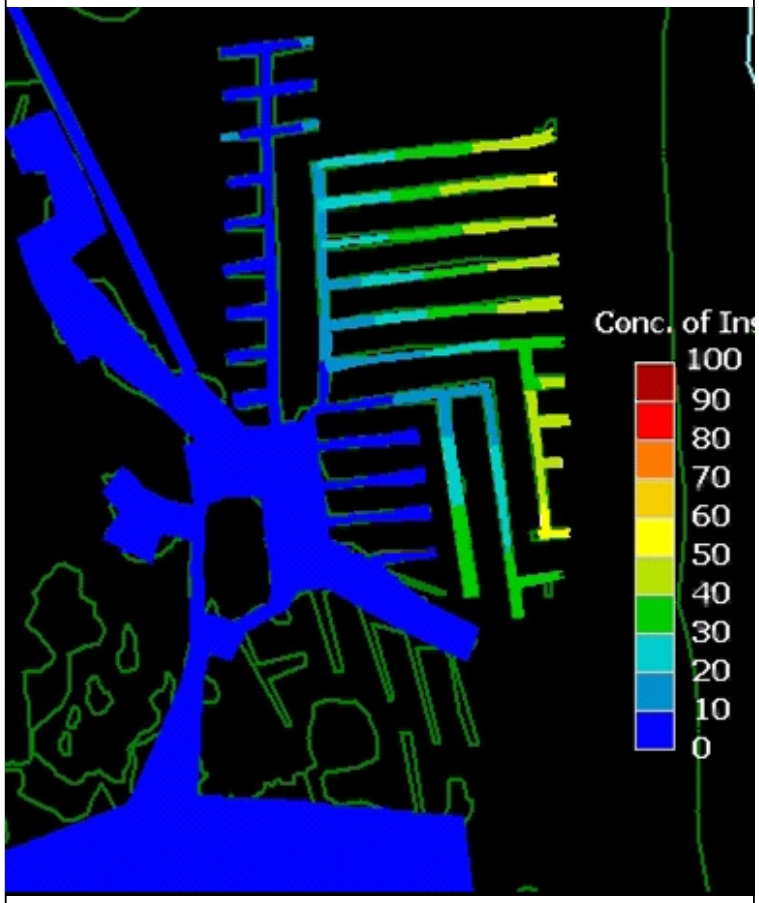
With The Tidal Pump

- Entrix used measured tide data from the Lewis Breakwater tide gage and the Jefferson Creek tide gage beginning with 01/01/2000.

Entrix Analysis Verifies That Residence Times Within The Canal System Will Be Reduced By An Order Of Magnitude (2 of 3)

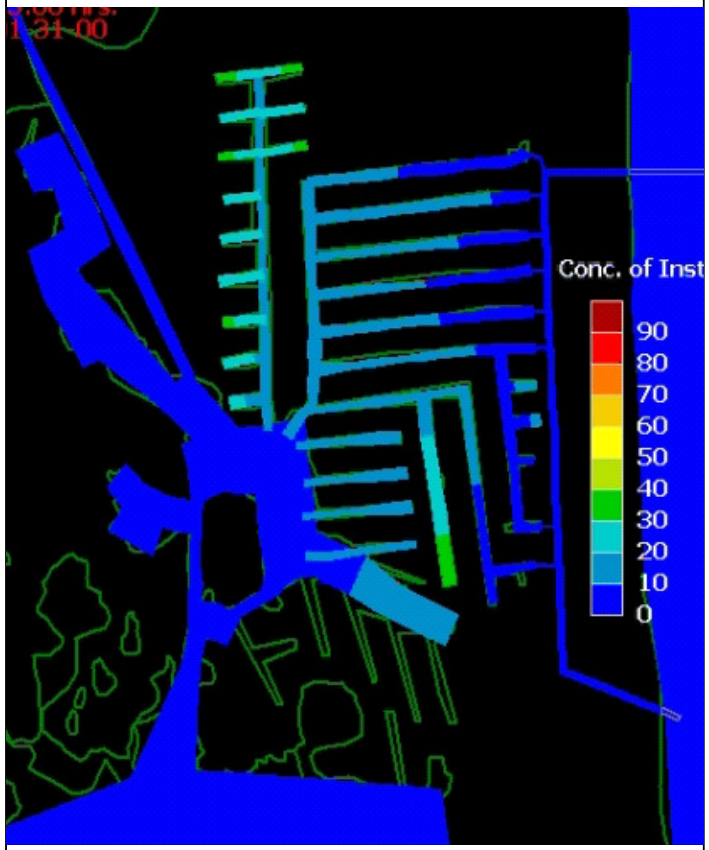
No Tidal Pump

3 Months

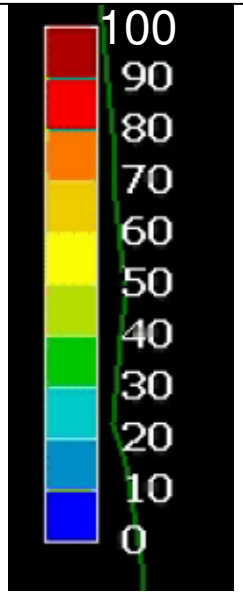


With The Tidal Pump

1 Months



Concentration of Instantaneous Dye (mg/L)

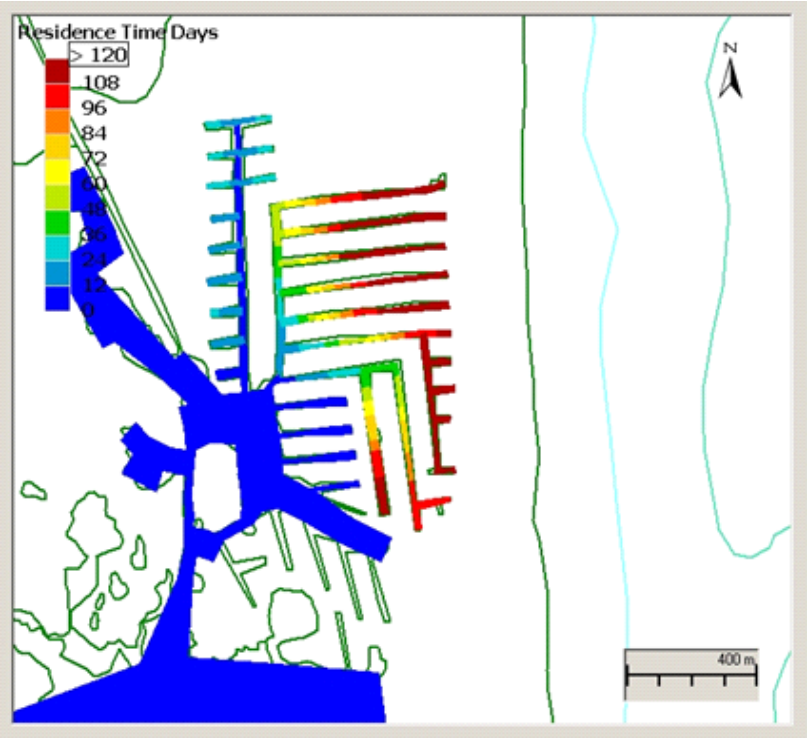


When we watch the video you will see how the flow will help the Little Assawoman Bay

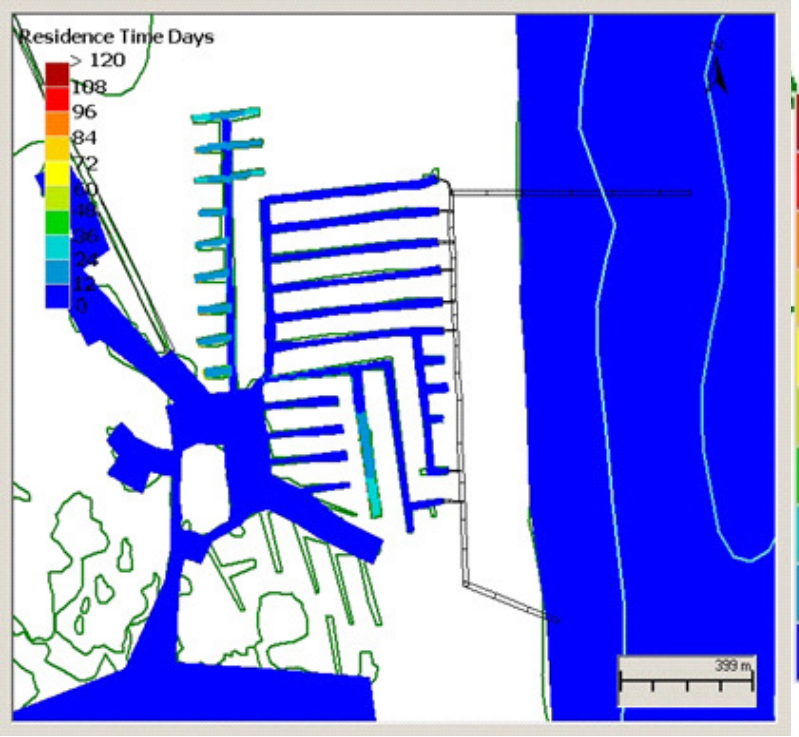
Entrix Analysis Verifies That Residence Times Within The Canal System Will Be Reduced By An Order Of Magnitude (3 of 3)

Residence Time Comparison

>120 Days Compared to ~3 Days

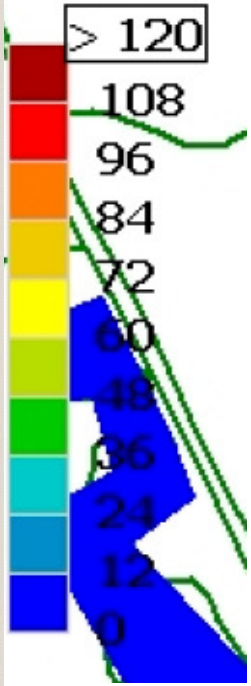


No Tidal Pump



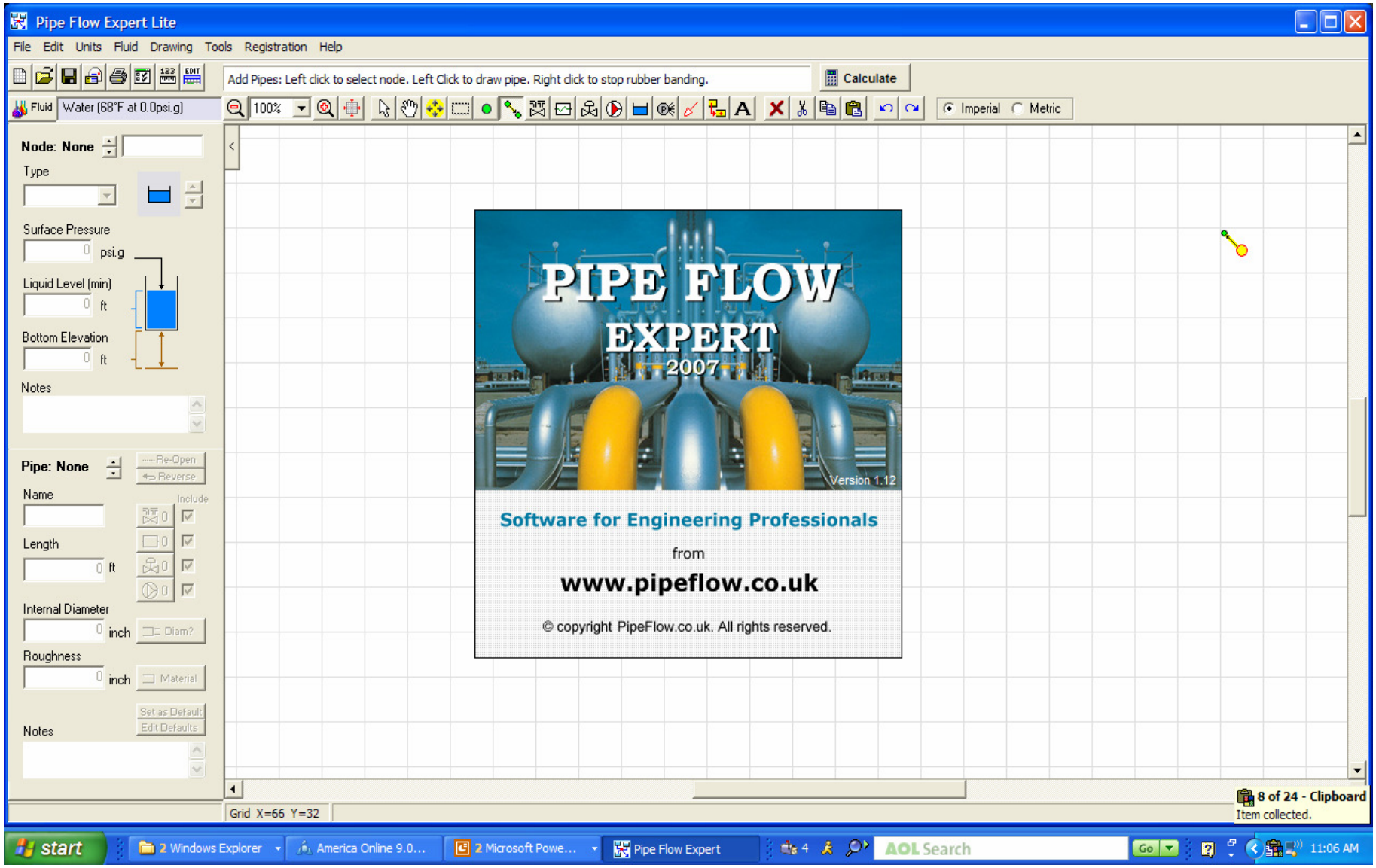
With Tidal Pump

Residence Times in Days

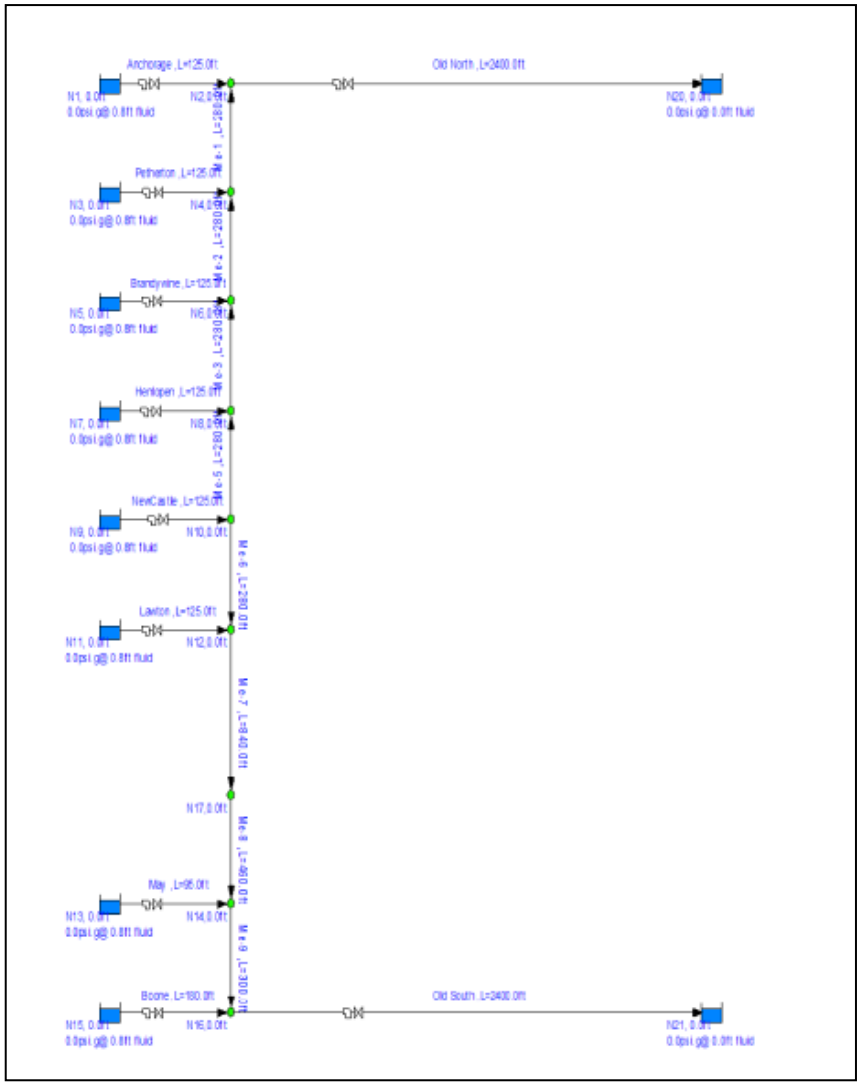


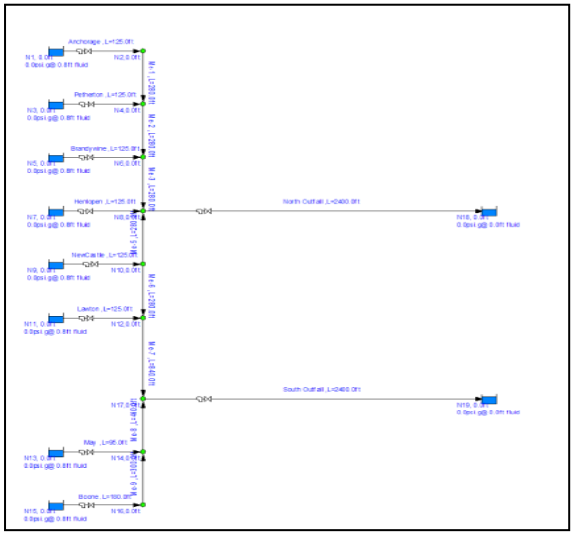
Residence time is defined as the time it takes to reduce a concentration by 36.79%

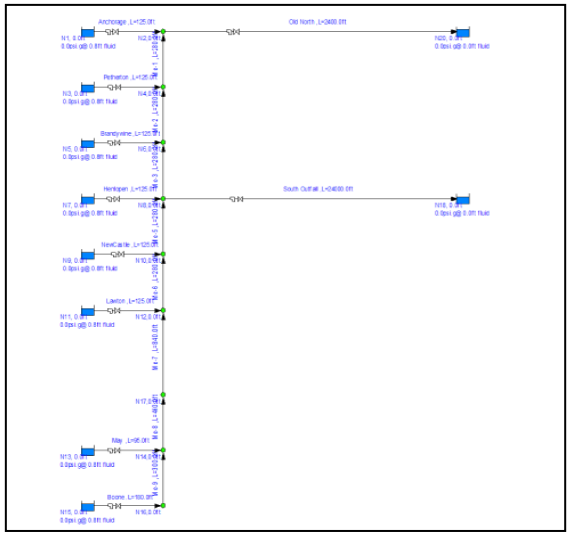
South Bethany Purchased Pipe Flow Expert To Analyze Different Tidal Pump Options



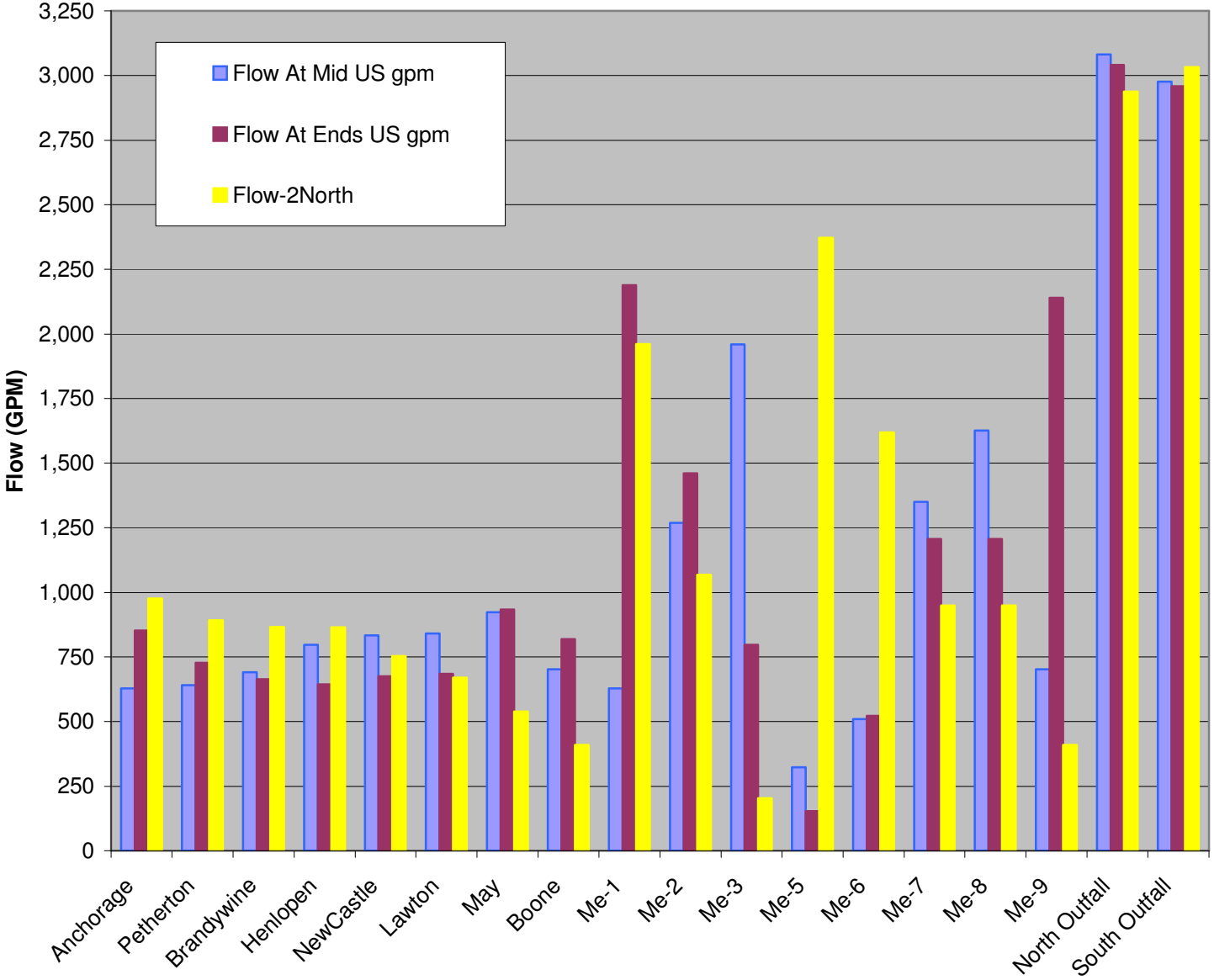
Various Arrangements Were Analyzed Using Our New Pipe Flow Expert Software.







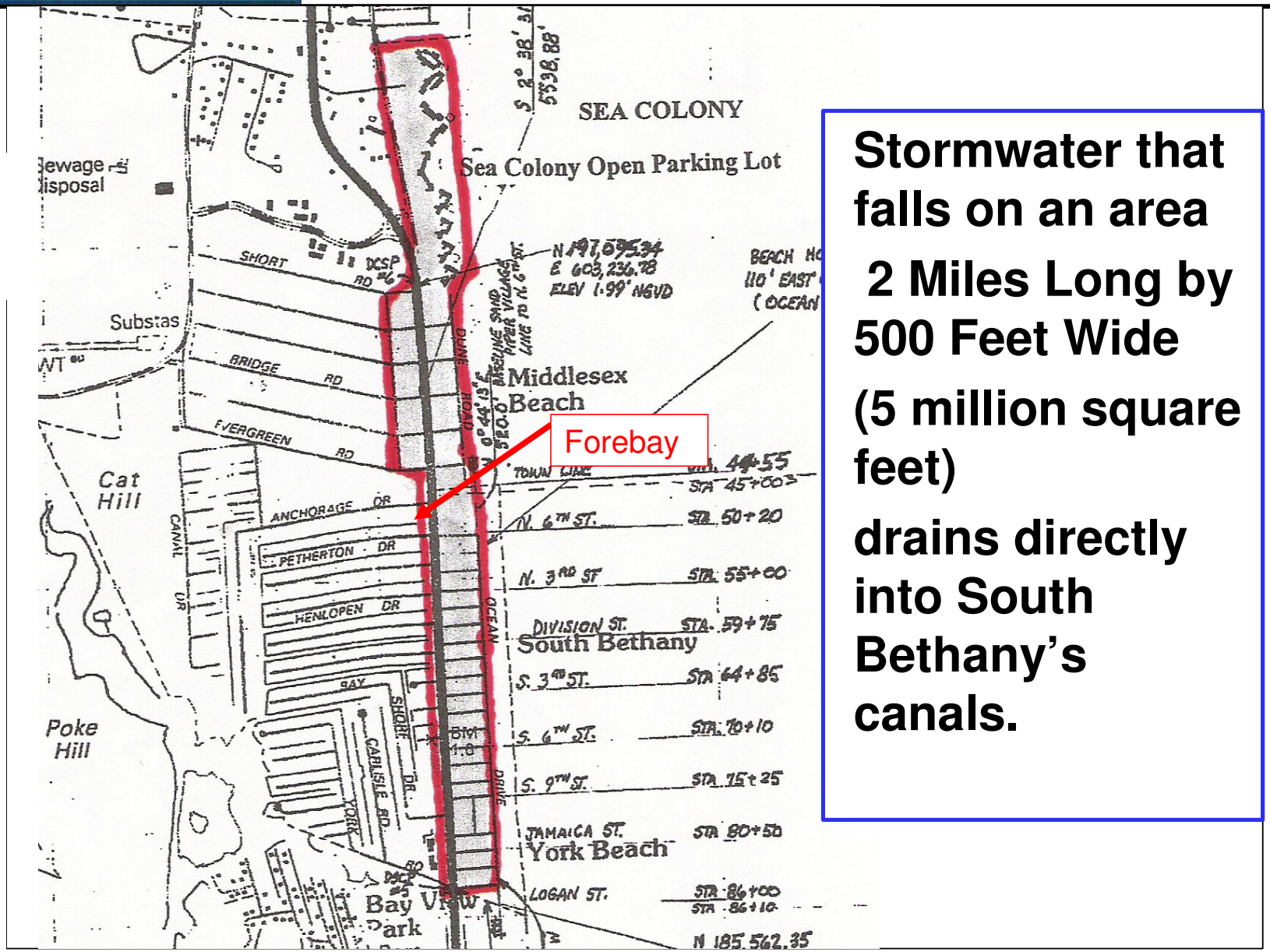
For 18” Canal, 36” Outfall And 36” Trunk Pipes; With 0.8’ Of Head And Roughness Of 1.0” The Flow Through Each Outfall Is About 3,000 GPM As Previously Predicted



Summary

- The Tidal Pump is the only initiative that will make a significant impact to the quality of water in the dead end canals and the Little Assawoman Bay. (Dead-End Canal Conference May 2003)
- Dilution is not the best solution, but for certain situations it can assist in dealing with a persistent problem that cannot be solved or moderated by other means.
- The Tidal Pump should not be used to allow more impacts. All initiatives of the water quality committee must be worked.
- The Tidal Pump should not be substitute for other restoration efforts. Again all initiatives of the water quality committee must be worked.

Anchorage Canal Drainage Area Assessment Project – ½ The Water Entering Our Canals Comes From The Area North Of Anchorage Canal



Stormwater that falls on an area

2 Miles Long by 500 Feet Wide

(5 million square feet)

drains directly into South Bethany's canals.