TIDAL PUMP

TOWN OF SOUTH BETHANY

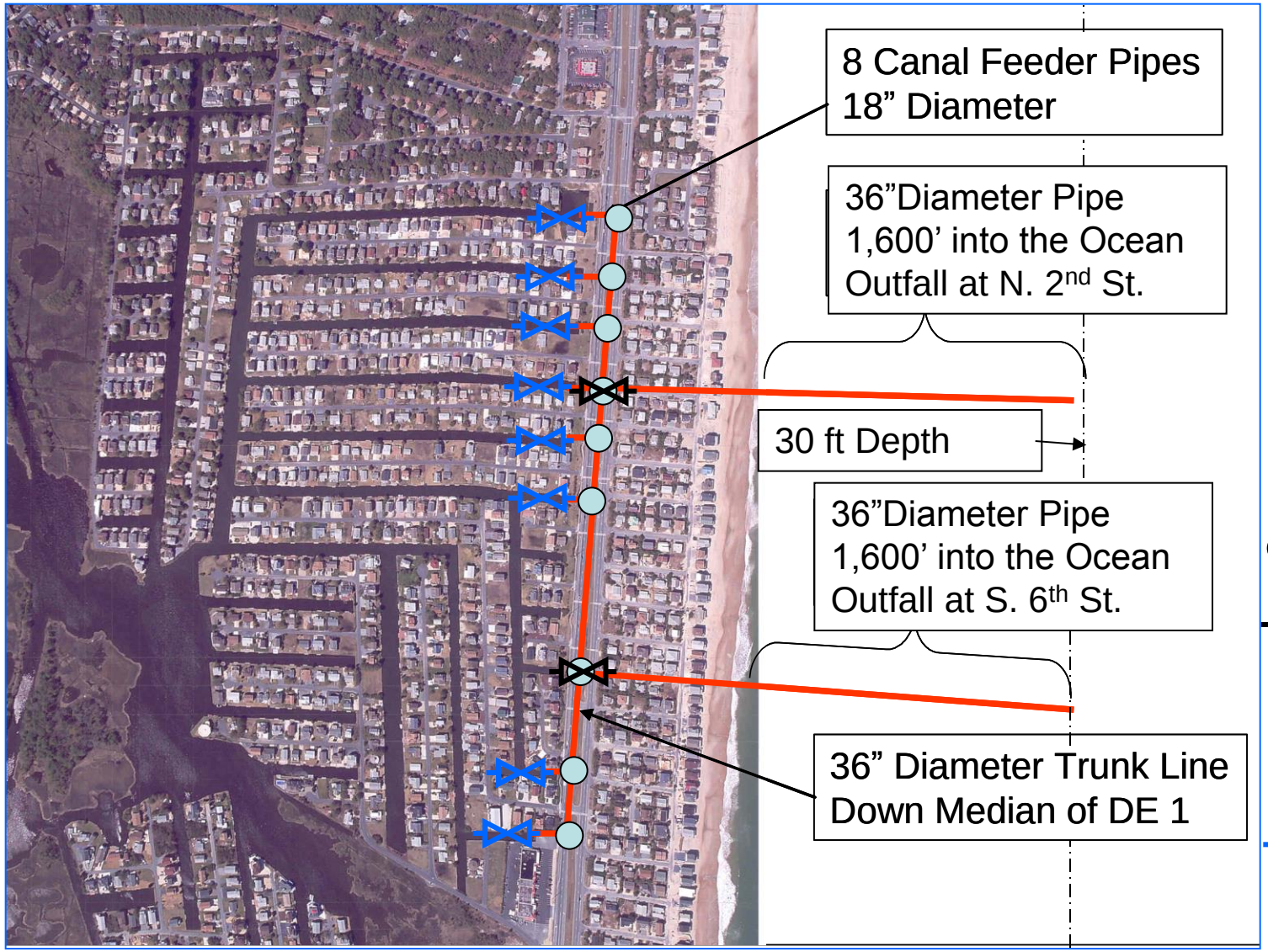
JPP MEETING

JULY 17, 2008

Project Purpose and Need

- The purpose is to improve the quality of water in the South Bethany Canals, Little Bay and the Little Assawoman Bay, to make the waters “fishable and swimable” by
  - improving the flushing and circulation
  - increasing the DO
  - decreasing the water temperature by bringing in colder ocean water will allow the water to hold more oxygen, thus increasing DO
  - Diluting the nutrients by adding ocean water
  - Stabilizing the salinity to minimize the yearly extreme fluctuations in salinity (< 5ppt to >30ppt). See the next sheets for measured data from the canals and Little Assawoman areas.
  - Reduce the impact of stormwater runoff from DE route 1 from the southern edge of South Bethany to the northern edge of Sea Colony.

The Tidal Pump Provides Flushing & Circulation To The South Bethany Canals And To The Northern End Of The Little Assawoman Bay (Particularly Little Bay)



Benefits

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

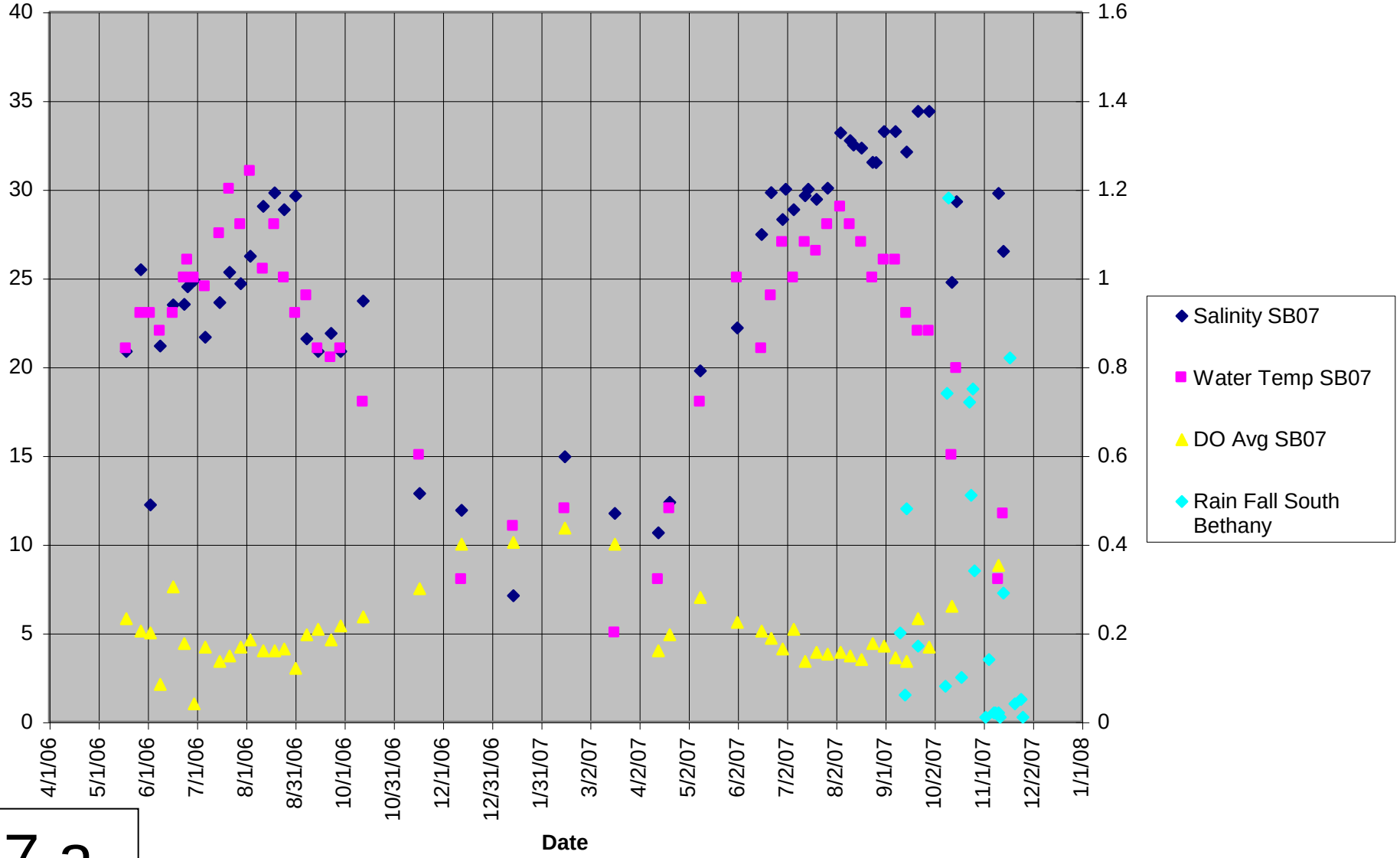
Legend

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

Tidal Pump - Introduction

- The tidal pump is a sub-surface piping system that exchanges water between the dead-end canals and the Atlantic Ocean
- Water exchange is accomplished via diametrically opposed tidal heights resulting in flow between the two bodies of water.
- The piping system consists of:
  - Two 36” diameter pipes extending 2400’ into the ocean
  - One 36” trunk line under Rt. #1 median strip connecting the ocean pipes to the canal pipes
  - Eight 18” diameter pipes connecting the trunk line to the canals
  - Nine manholes containing sediment traps
  - Shut-off valves in each ocean pipe and each canal pipe (used for maintenance and to control flow volume if needed)
- No additional outside energy is required to achieve water flow
- Water flow can be regulated via timers to achieve the desired flow
  - Two way flow (does not require a timer)
  - From ocean to canal (6 ~ 9 hrs per day) 95 – 190 mil gal/mo
  - From canal to ocean (9 ~15 hrs per day) 240 – 480 mil gal/mo
- Cost - $5 - $7 Million

Citizen Monitoring At SB07 Layton Canal South Bethany
Summer Has High Salinity & Temperature And Low DO
Winter Has Very Low Salinity & Temperature and High DO



7.a.

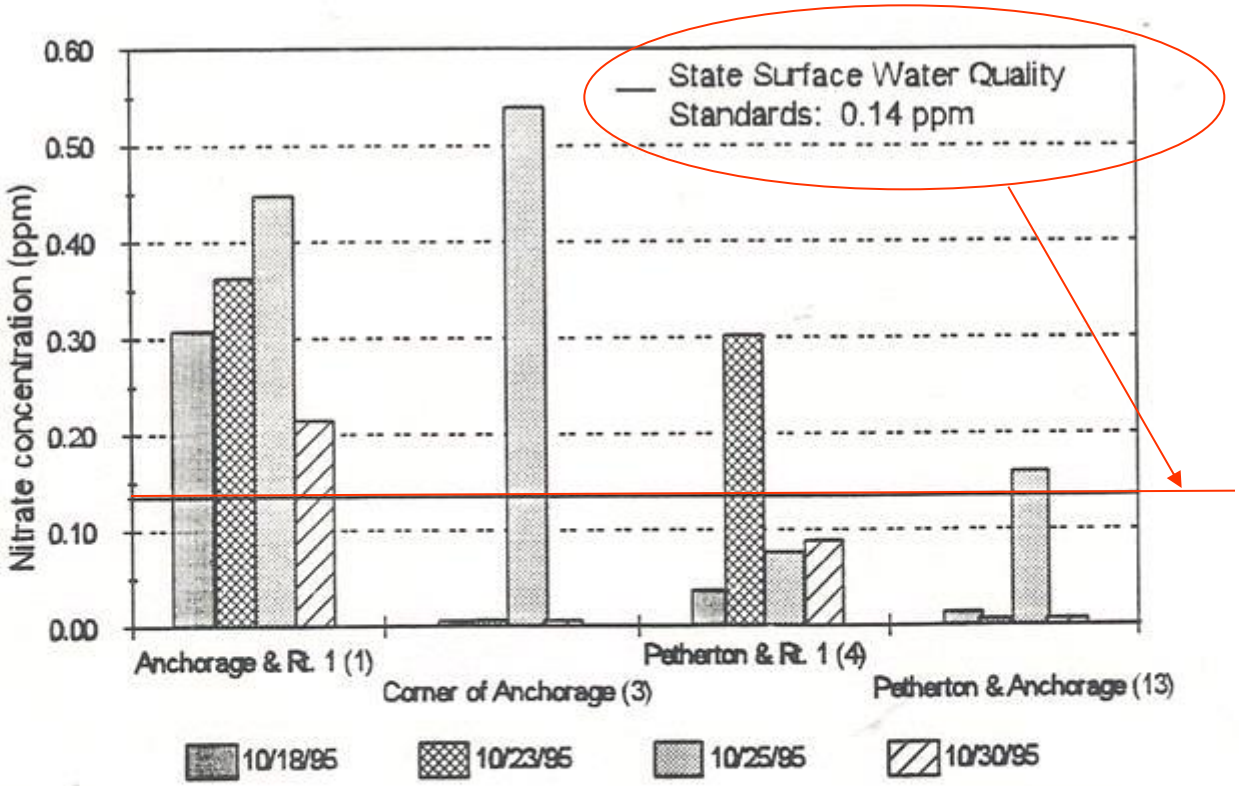
It Is Well Documented That There Is Not Adequate Flushing/Circulation In Dead-End Canals Thus Producing Poor Water Quality

- *The Ecological Condition of Dead-End Canals of the Delaware And Maryland Coastal Bays* by Maxted, Weisberg, Eskin and Kutz, June 1997.
- *South Bethany Canal Survey Report of Results 1995,* by Renee' J. Karrh, 17 January 1996.
- *1996 South Bethany Bacteria Lagoon Water Quality/Rainfall Study* by Jack Pingree.
- *Volume and Characteristics of Collected Storm Water Discharges into the Loop Section of the Anchorage Canal, South Bethany, Delaware* by Martin, Farrell and Balascio, January 2001.
- *The Evaluation of Aeration as a Method for Improving the Ecological Condition of Dead-End Canals* by Robert W. Scarborough, Ph.D., Report Year 1 November 2000, and Report Year 2 February 2002.
- *Hydrodynamic and Water Quality Modeling and Feasibility Analysis Of Indian River, Rehoboth Bay and Little Assawoman Bay* by ENTRIX, Inc., J. E. Edinger Associates, Inc. and Gahagan and Bryant Associates, Inc., August 28, 2001.

7.a.

South Bethany Canal Survey Report of Results 1995, by Renee' J. Karrh, 17 January 1996

Show High Nitrogen Levels



7.a.

Figure 8. Inorganic nitrogen (nitrate) concentrations for the canal sites sampled in October, 1995.

1996 Lagoon Water Quality/Rainfall Study by Jack Pingree, Division of Water Resources, DNREC Shows That The Canals Have Very, Very High Enterococcus Levels

- 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

7.a.

24- Hour Fish Sampling At Indian River Acres – During Aeration Study

	April		May		June		July		August		September	
Catch	Control	Aerated	Control	Aerated	Control	Aerated	Control	Aerated	Control	Aerated	Control	Aerated
Blue Crab	3	7	11	8	6	17	45	26	29	19	13	29
Drum	0	0	0	0	0	0	0	0	6	2	2	14
Eel	39	23	23	16	14	3	0	4	10	5	8	1
Flounder	0	0	1	0	1	1	4	0	1	5	0	9
Grass Shrimp	37	121	5	1	9	3	28	10	3	2	11	26
Horseshoe Crab	0	1	1	0	0	0	0	0	0	0	0	0
Jack Cravelle	0	0	0	0	0	0	1	3	0	0	0	0
Killifish-Banded	2	1	0	1	1	5	16	1	2	0	0	0
Killifish-Striped	2	0	6	7	11	1	37	10	12	6	0	0
Menhaden	0	0	0	17	24	86	256	21	69	74	454	67
Mullet	0	0	11	23	162	22	23	80	5	6	0	3
Mummichog	22	1	2350	10450	834	4700	1260	1170	722	895	3	41
Sheepshead Minnow	1	10	2	12	1	116	0	5	2	0	1	0
Shrimp	0	0	0	0	0	0	0	0	0	0	8	32
Silver Perch	0	0	0	0	0	0	0	1	0	0	143	141
Silverside (Atlantic)	72	143	20	19	83	79	256	178	107	130	86	175
Spot	0	0	0	11	253	402	197	97	122	90	33	8
Spotfin Killifish	0	0	1	0	0	0	0	0	0	0	0	0
Spotted Hake	1	0	0	0	0	0	0	0	0	0	0	0
Stonefish	0	0	0	0	0	0	0	0	0	0	0	0
Weakfish	0	0	0	0	1	0	0	0	3	13	1	2
White Perch	0	0	0	0	0	0	1	0	0	1	3	0
	179	307	2431	10565	1400	5435	2124	1606	1093	1248	766	548
	9	8	11	11	13	12	12	13	14	13	13	13

7.a.

24-hour Fish Sampling At South Bethany – During Aeration Study – Essentially No Fish At South Bethany Compared To Indian River

	April		May		June		July		August		September	
Catch	Control	Aerated	Control	Aerated	Control	Aerated	Control	Aerated	Control	Aerated	Control	Aerated
Anchovy	2	8	0	0	0	1	0	0	0	0	0	0
Blue Crab	0	2	0	12	5	31	3	29	0	26	8	13
Bluefish	0	0	0	0	0	0	0	1	0	0	0	0
Eel	7	4	24	1	3	2	14	0	1	0	6	1
Flounder	0	0	0	0	0	3	0	1	0	5	2	0
Grass Shrimp	0	0	0	0	0	0	0	2	0	1	0	0
Horseshoe Crab	0	1	0	0	0	2	0	0	0	0	0	0
Menhaden	0	1	42	5	59	0	27	29	0	8	21	16
Mummichog	0	16	3	35	3	0	0	0	0	0	0	0
Sheepshead Minnow	0	1	0	0	0	0	0	0	0	0	0	0
Silver Perch	0	0	0	0	0	0	0	0	0	0	0	20
Silverside (Atlantic)	0	100	5	121	9	39	0	1	0	0	0	0
Spot	0	0	0	6	1	32	9	30	0	48	2	1
Stickleback	3	3	0	0	0	0	0	0	0	0	0	0
Sunfish	0	22	0	0	0	0	0	0	0	0	0	0
Weakfish	0	0	0	1	0	0	0	0	0	0	0	0
White Perch	17	72	2	2	0	1	0	2	20	0	2	0
Total Catch	29	230	76	183	80	111	53	95	21	88	41	51
[illegible]	4	11	5	8	6	8	4	8	2	5	6	5

7.a.

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.

7.a.

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

Now we are ~15 miles from the OC Inlet and ~10 miles from the Indian River Inlet Instead of ~1 mile from the old Inlet Creek Inlet.

7.a.

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.

7.a.

7.b. Alternatives Considered - The Tidal Pump ($5 to $7 million) Appears to be a Reasonable Selection compared to the Alternatives Considered

- Alternative recommended from *The Ecological Condition of Dead-End Canals of the Delaware And Maryland Coastal Bays* by Maxted, Weisberg, Eskin and Kutz, June 1997, page 326, is "The most meaningful restoration would return them to their original condition, although this is impractical in most cases." We agree that this is a financially impractical alternative.
- Aeration was evaluated in *The Evaluation of Aeration as a Method for Improving the Ecological Condition of Dead-End Canals* by Robert W. Scarborough, Ph.D., Report Year 1 November 2000, and Report Year 2 February 2002. Aeration does improve DO by eliminating stratification over a 600 to 1,000 foot length of canal. It does not increase overall DO concentrations. 25 to 40 aerators would be required to cover the 5 miles of SB canals and they would not increase the overall DO concentrations. This wil be a hazard to boaters. This will not help to minimize the salinity extremes.
- An inlet or high volume pump connecting Little Assawoman Bay to the Ocean was investigated in *Hydrodynamic and Water Quality Modeling and Feasibility Analysis Of Indian River, Rehoboth Bay and Little Assawoman Bay* by ENTRIX, Inc., J. E. Edinger Associates, Inc. and Gahagan and Bryant Associates, Inc., August 28, 2001. Cost were estimated to be $40 to $80 million.
- Continue with the town's efforts to encourage homeowners to install rain gardens & rain barrels and to disconnect showers & roof down spouts from flowing into the canals. Continue efforts to get stakeholders to treat storm water runoff before it enters the canals. These efforts will help to reduce nutrient & bacteria loading and should definitely be continued. However this will not cause an increase in flushing & circulation and will not minimize the salinity extremes.

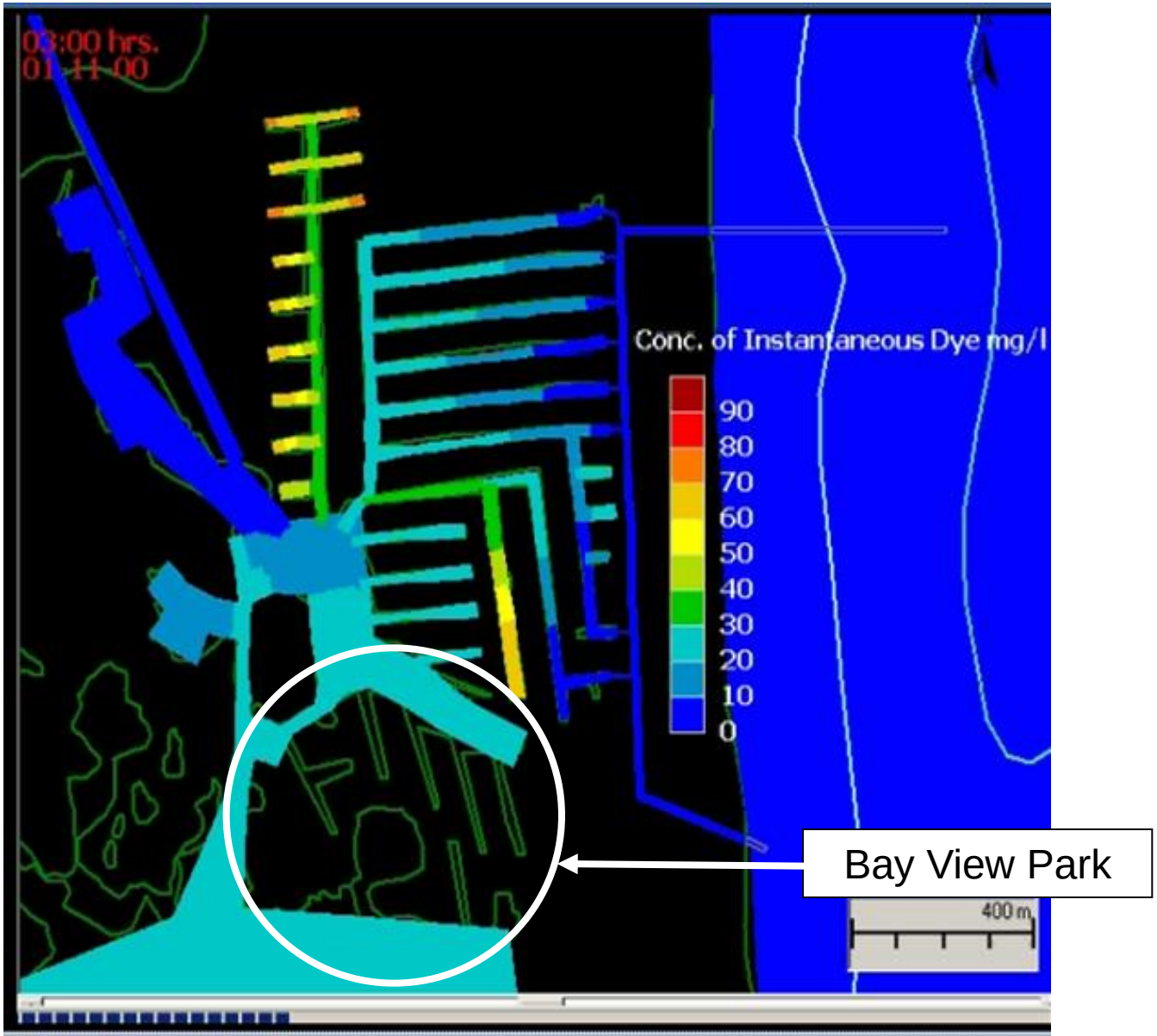
7.b.

7.c. Acreage of Wetland Impacts – Performance of the Tidal Pump

- The shores of Little Bay, Little Assawoman Canal, Jefferson Creek, The South end of Assawoman Canal and Miller Creek would be positively impacted by better flushing and circulation

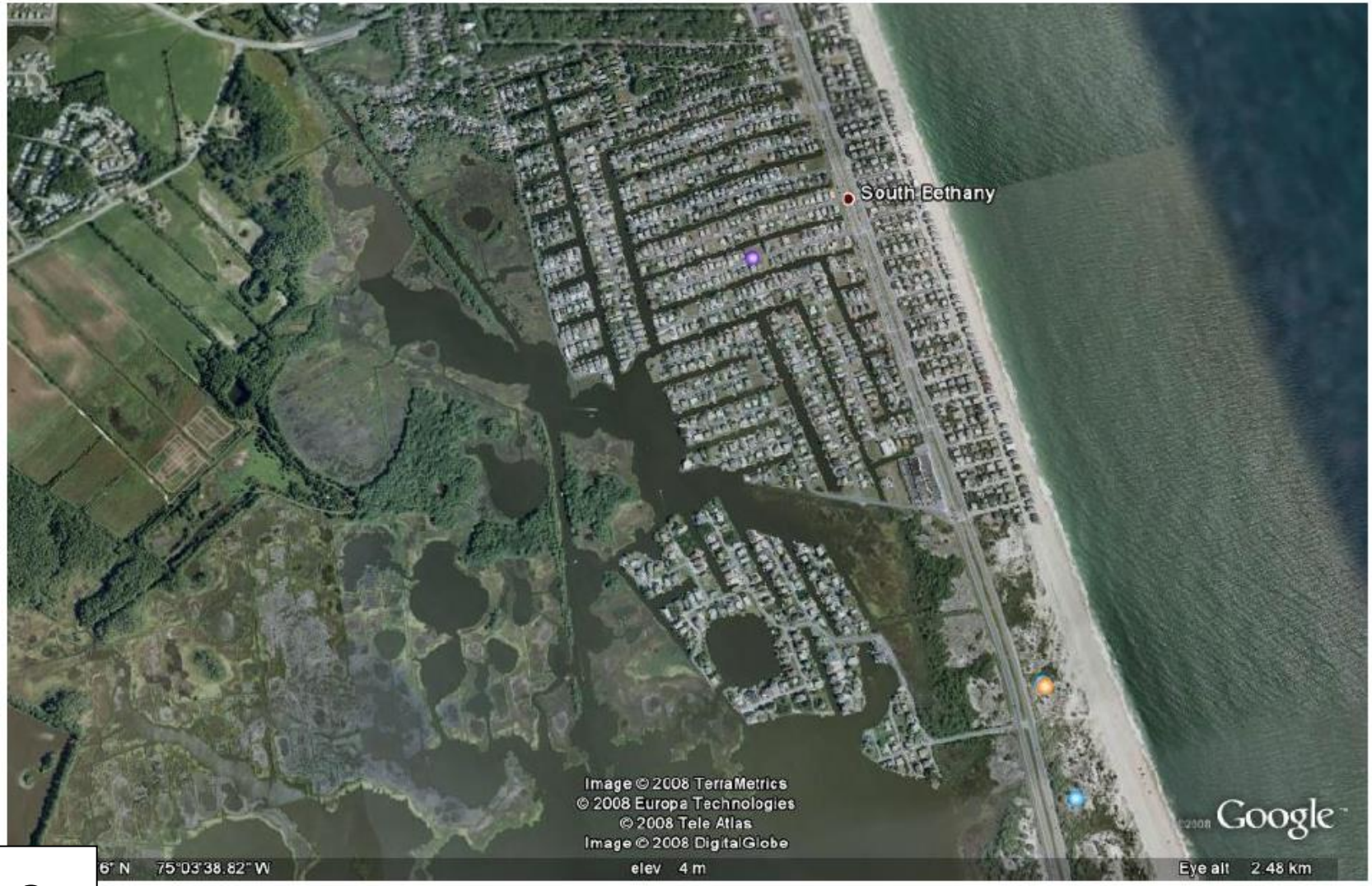
- Entrix Analysis (September 2005) shows that the quality of water in the South Bethany Canals have significant impact on the northern end of Little Bay and the waters around Bay View. If the canals are cleaned up this will have a positive impact on the northern end of the Little Assawoman Bay.
- Performance Analysis (Summer 2008) of the Tidal Pump based on actual tide data shows that the volume of water moved from the ocean into the South Bethany Canals would cause an exchange of water volume in less than two weeks and an exchange of water volume in the Little bay in less than two months.
- The performance analysis shows that there would be a positive, but negligible impact on the Little Assawoman Bay.

Entrix Analysis (September 2005) Shows That The Water Quality In Our Canals Affect The Water Around Bay View Park And The Northern End Of Little Bay.



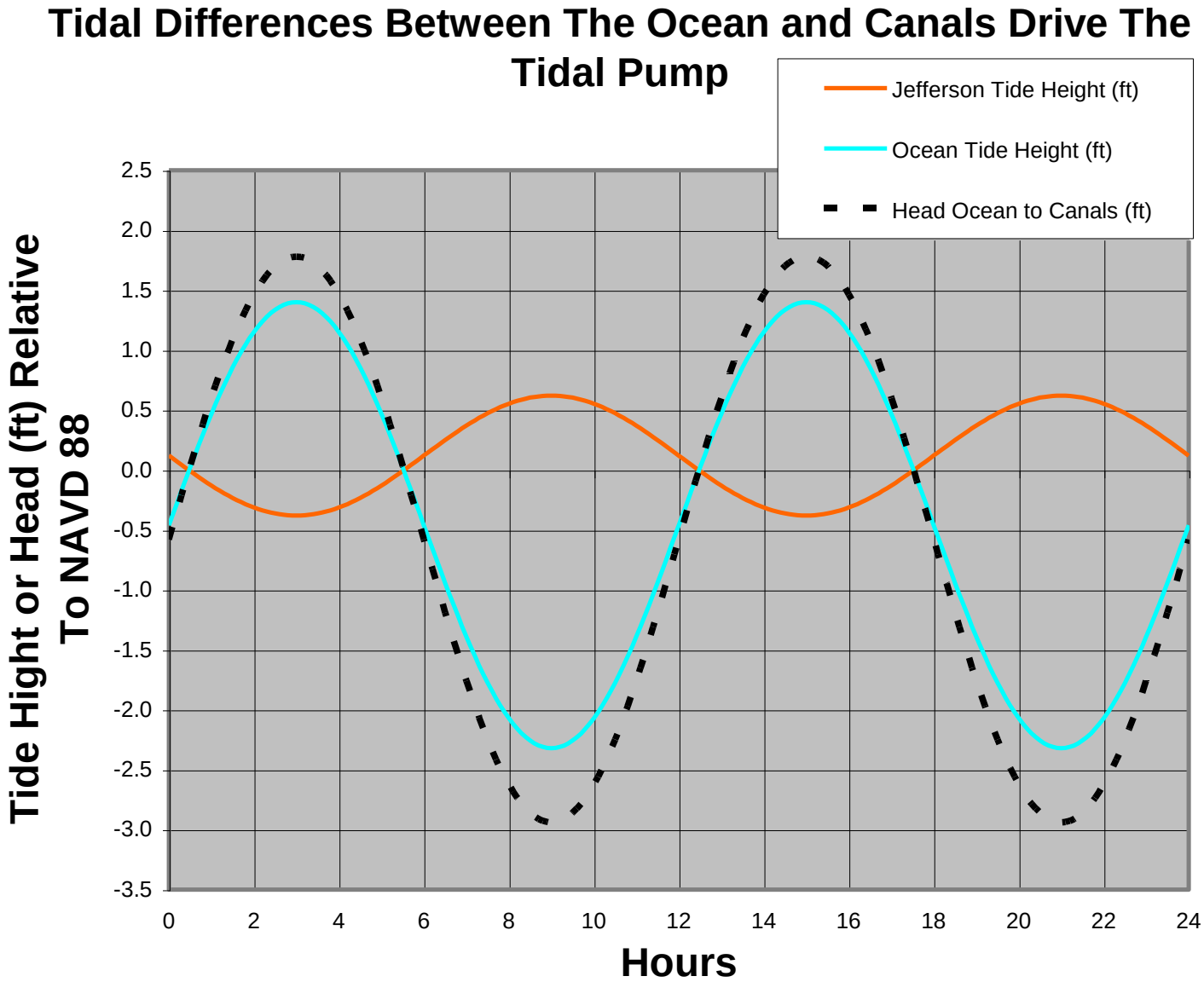
7.c.

These Are The Inland Waters That Will Be Significantly Affected And Improved By The Tidal Pump.



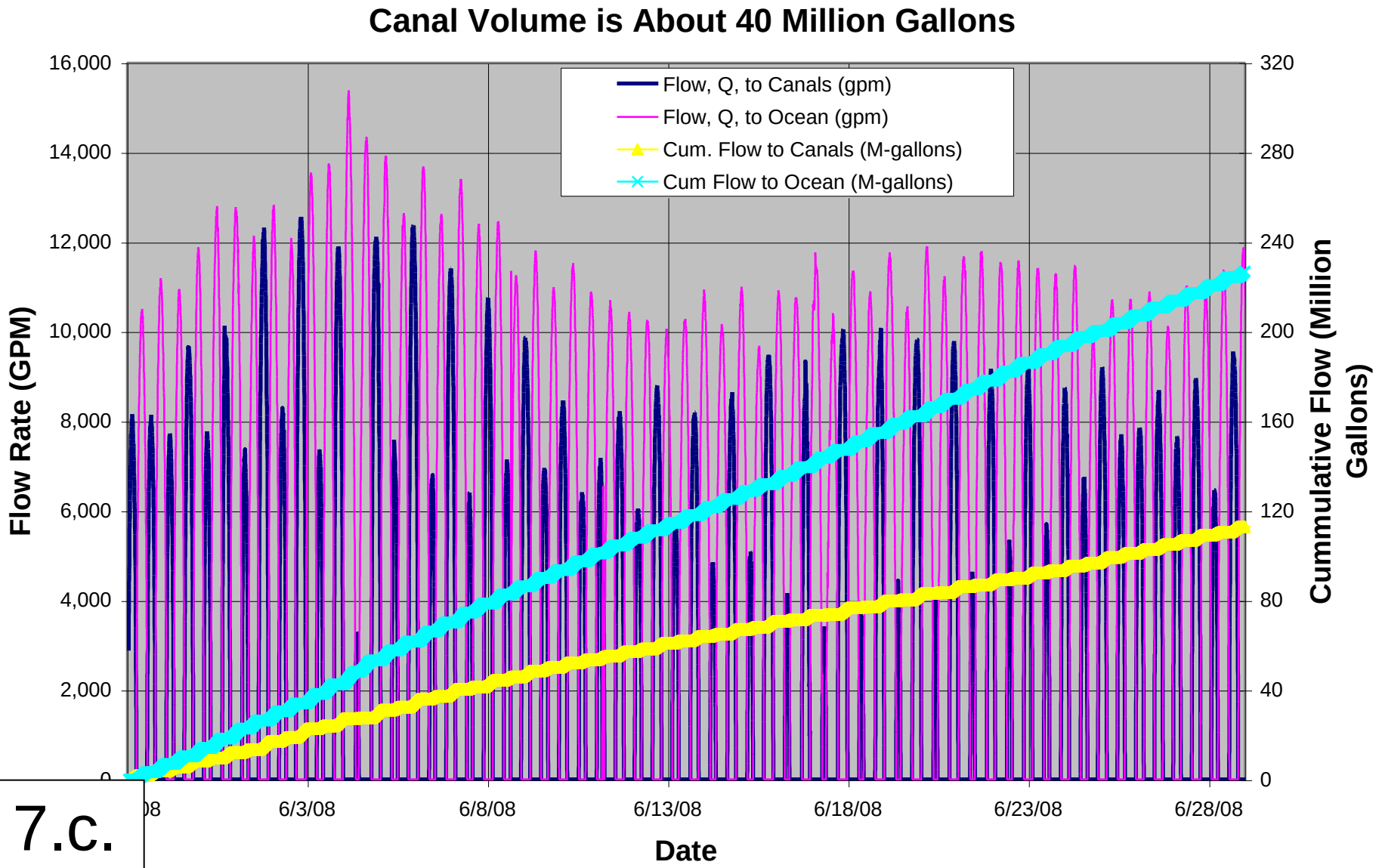
7.c.

The Tide Difference Between The Ocean And Jefferson Creek Is The Head That Drives The Tidal Pump



7.c.

In June 2008 The Maximum Flow From The Canals To The Ocean Would Have Been ~15,000 gpm for C=75 (Very, Very Rough Pipe Surface)



7.c.

Rough Calculations Show That The Tidal Pump Produces Significant Flushing In The South Bethany Canals, With Lesser Flushing Of Little Bay and Negligible Flushing Of The Little Assawoman

	Volume in million gallons	Time to exchange water volume using only water from the ocean to canals
Volume of water moved by TP during one month from canals to the ocean	220	
Volume of water moved by TP during one month from ocean to the canals	**100**	
Volume of water in the South Bethany Canals	40	0.4 months
Volume of water in Little Assawoman Bay, from Little Assawoman Bay Feasibility Study	1,100	11 months
Guess at volume of water in Little Bay by “eye balling” areas of Little Bay Compared to Little Assawoman at about 20%	200	2.0 months

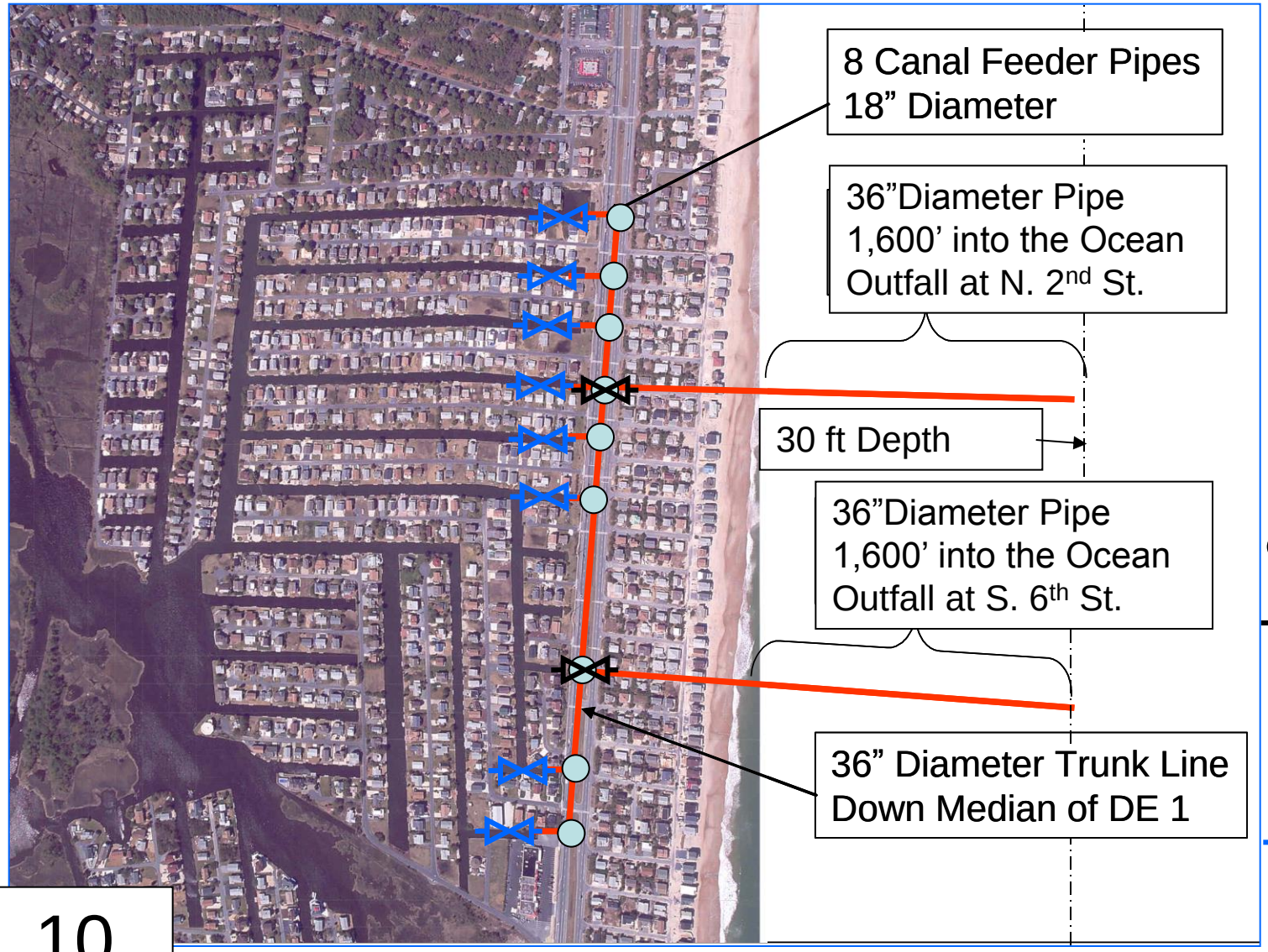
7.c.

10. History of Tidal Pump – Design & Analysis Plan Views and Cross Sections

- 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.

10.

Based On Results From Entrix And Oceaneering/KCI Studies, Lines To Ocean Moved Toward The Center and Lines To Canals Increased To 18", Thus Reducing Losses



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Legend

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