

# CONTINUING EVALUATION OF HDPE PIPE FOR MARINE OUTFALLS

Prepared by:

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Phillips, Tim O'Leary & Baker McCullough



**King County**

Department of  
Natural Resources and Parks

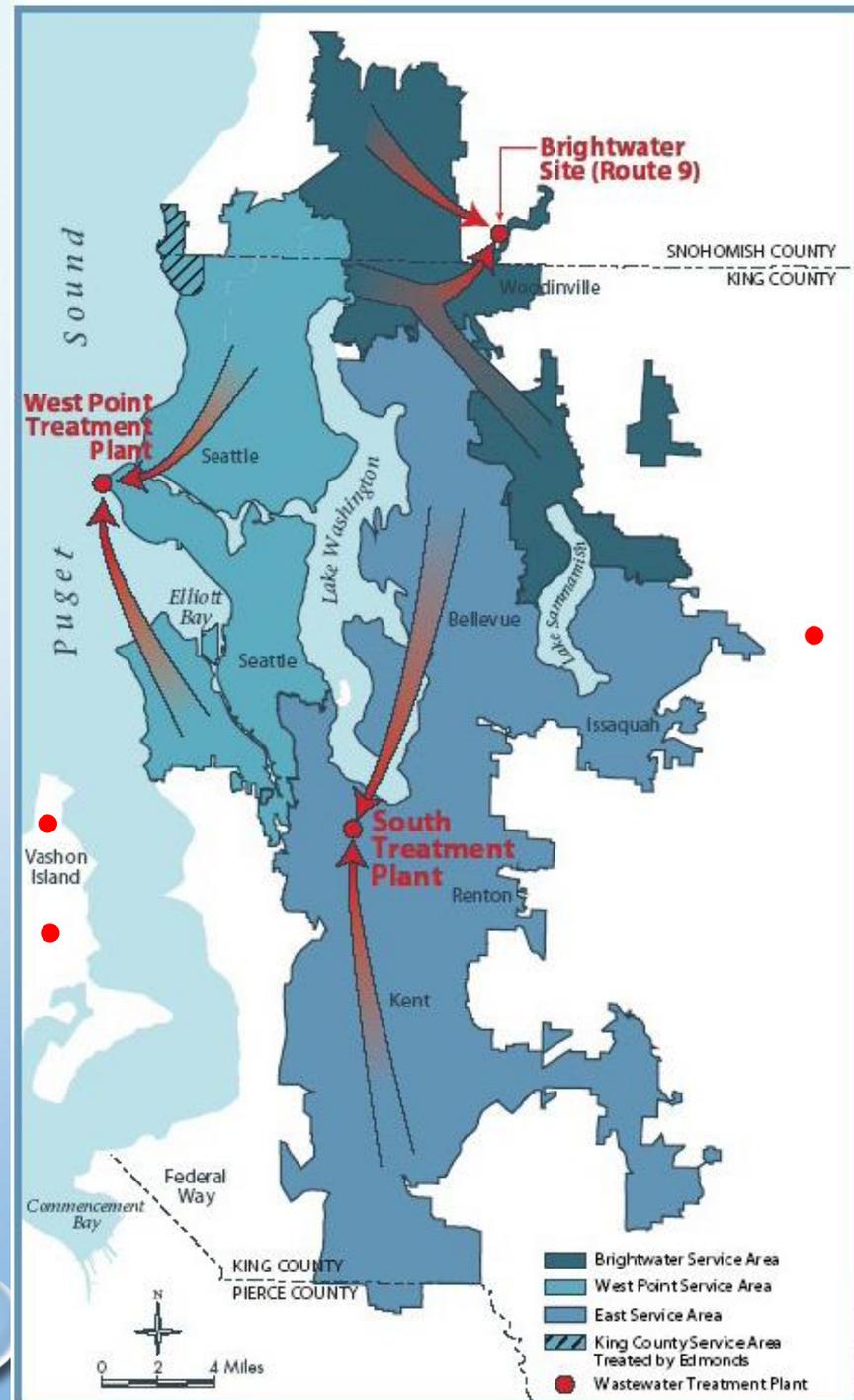
**Wastewater Treatment Division**

# PRESENTATION OUTLINE

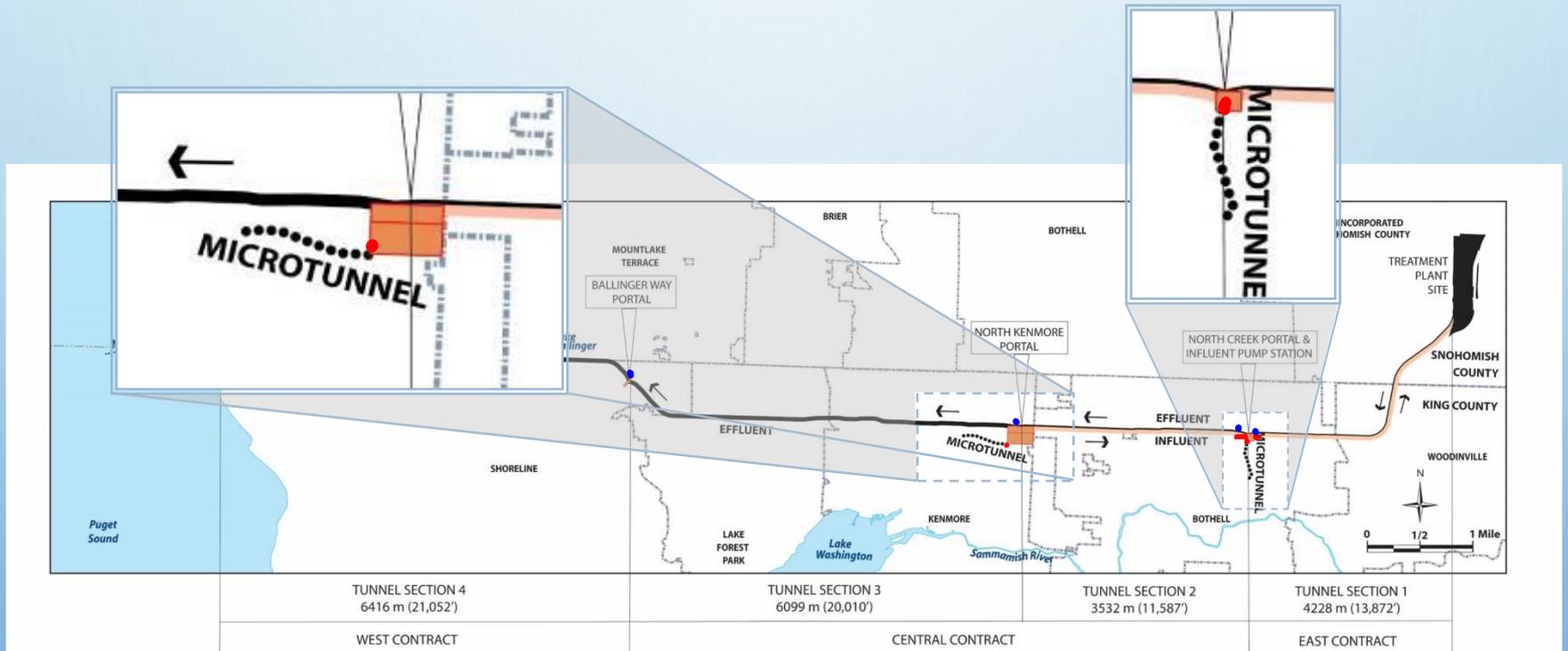
- Brightwater Outfall Description
- Outfall Inspections
- Material & Habitat Study
- Habitat Results
- Material Results
- Where do we go from here?

# KING COUNTY WASTEWATER TREATMENT DIVISION

- 5 WWTPs
  - West Point
  - South
  - Brightwater
  - Carnation
  - Vashon (2)
- 47 Pump stations
- 26 Regulators
- 38 Overflows
- 4 CSO treatment plants
- 391 Miles of sewers



# BRIGHTWATER TREATMENT & CONVEYANCE SYSTEM



How many utilities have marine outfalls?

River outfalls?

How many are using HDPE for the outfall pipe?



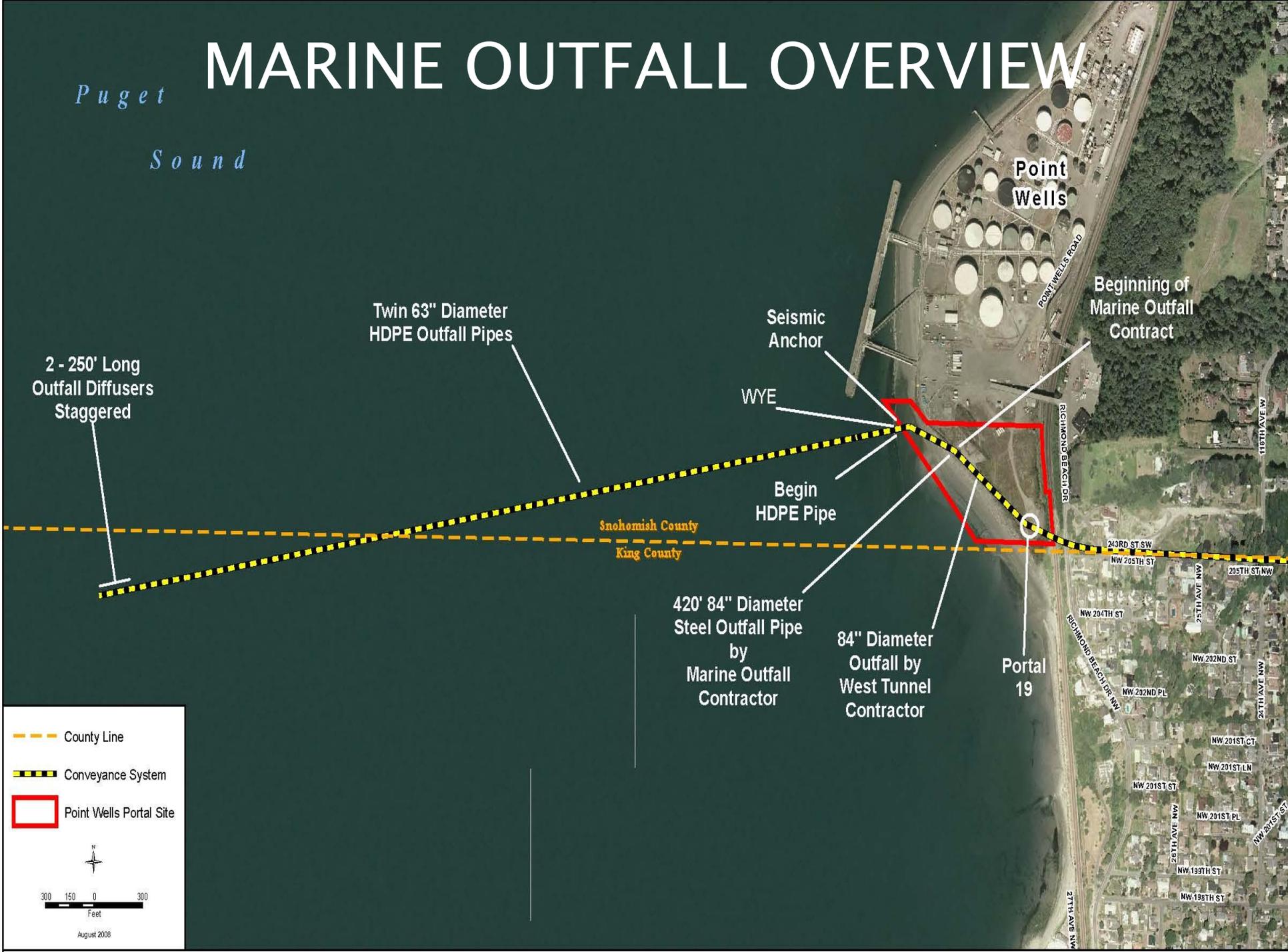
# BWMO CHARACTERISTICS

- 420 feet 84" polyurethane lined/coated steel pipe w/ICCP
- Sheet pile & concrete seismic anchor
- Wye transition
- 2 – 63-inch OD HDPE pipes 5,018 & 4,768 feet long (DR 21 & 26)
- 494 feet buried, remaining bottom laid pipe
- 250 foot long diffuser on each, staggered
- Flow range is 8 MGD low flow – 170 MGD peak

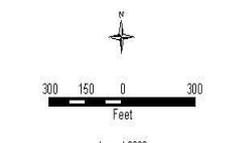
Puget

Sound

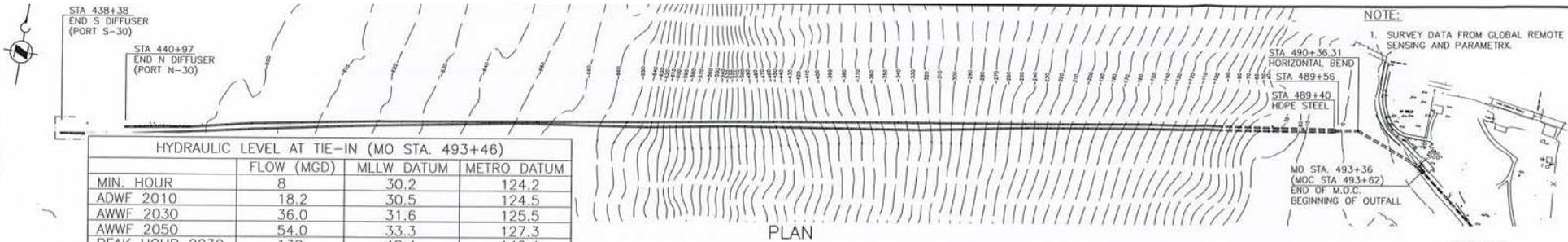
# MARINE OUTFALL OVERVIEW



- County Line
- Conveyance System
- Point Wells Portal Site

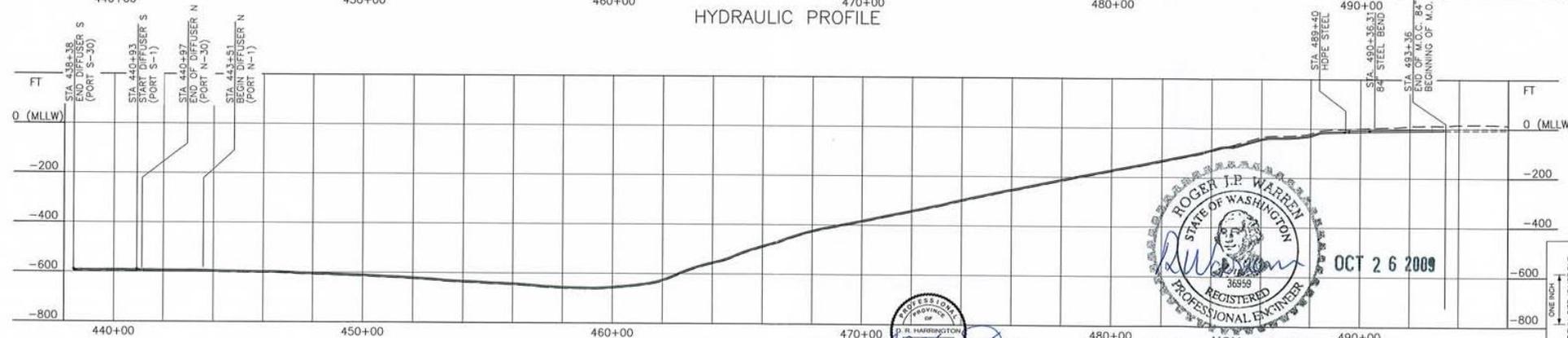
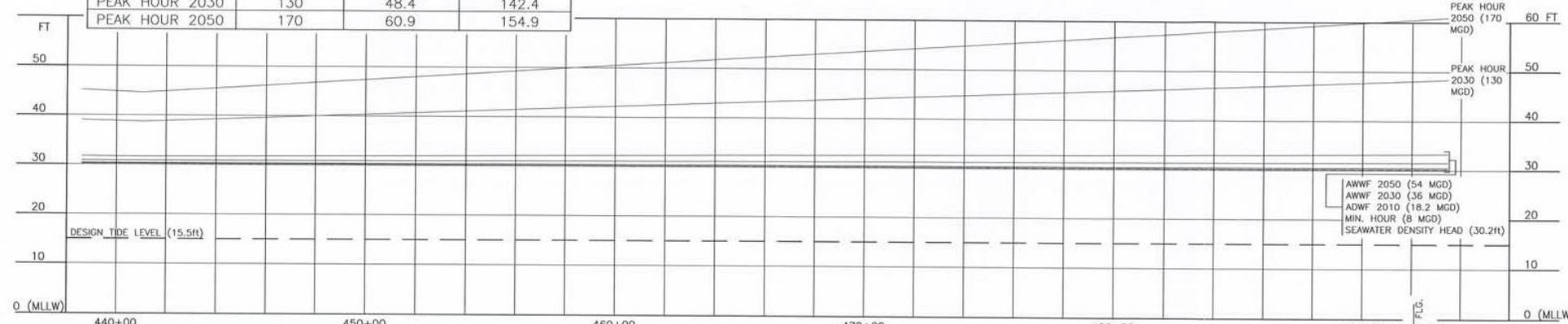


# MARINE OUTFALL PLAN/PROFILE



HYDRAULIC LEVEL AT TIE-IN (MO STA. 493+46)

	FLOW (MGD)	MLLW DATUM	METRO DATUM
MIN. HOUR	8	30.2	124.2
ADWF 2010	18.2	30.5	124.5
ADWF 2030	36.0	31.6	125.5
ADWF 2050	54.0	33.3	127.3
PEAK HOUR 2030	130	48.4	142.4
PEAK HOUR 2050	170	60.9	154.9



OCT 26 2009



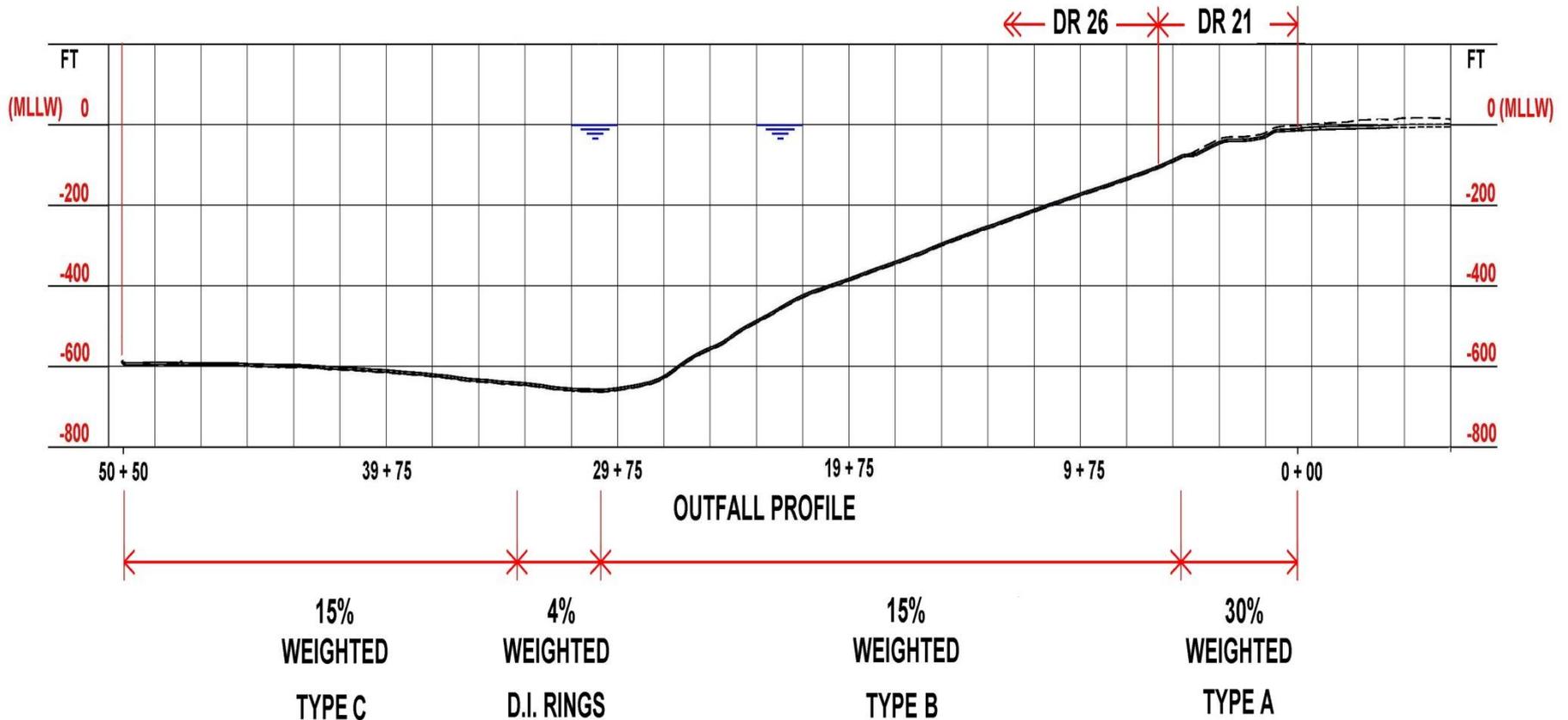
EXPIRES: NOV 04 2010

400 600 800 FEET

# BRIGHTWATER MARINE OUTFALL PROFILE

END OF DIFFUSERS

START OF TWIN  
63" DIA. PIPELINES









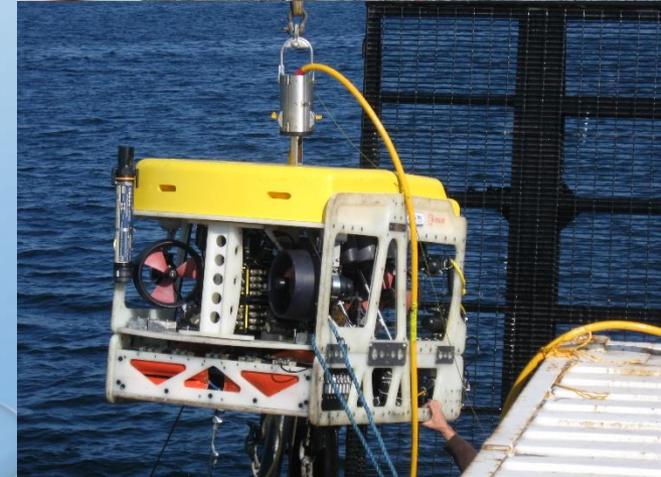
# OPERATION & INSPECTION OVERVIEW

- Outfall built in 2008
- Operational in 2012
- High degree of biological colonization noticed early
- 10 Year study created



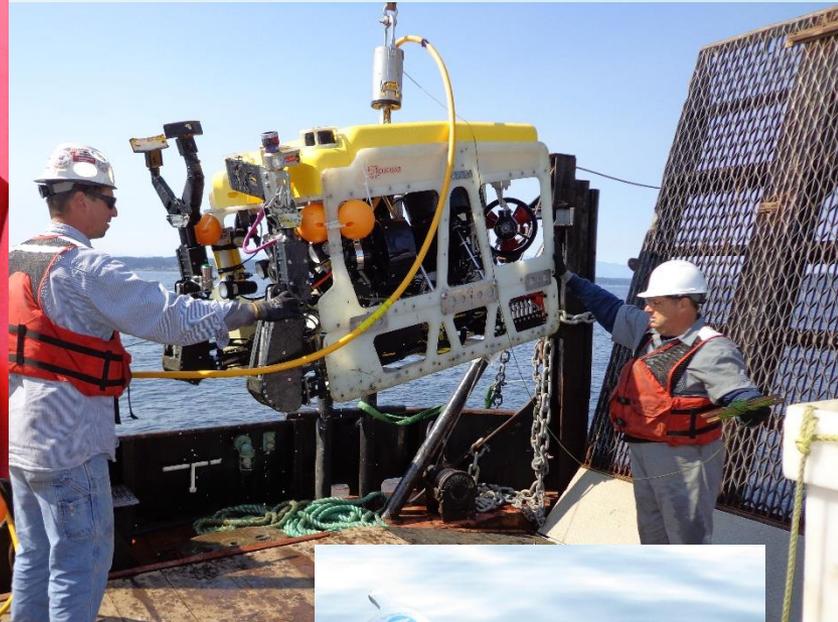
# BWMO MONITORING

- Annual visual inspection with Remote Operated Vehicle (ROV)
  - King County research vessels Liberty or Sound Guardian with small ROV
  - In year 2, 5 & 10 using work class ROV and salvage contractor barge
- 5 year diffuser elevation



# ANNUAL VISUAL INSPECTIONS

# TOOLS OF THE TRADE



# 100 FEET



# 300 FEET

03-NOV-10  
13:26:21

2010

D: 305.2F  
H: 105

King County

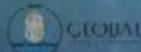
RACK-B  
2012 18/09/12

Time 17:38:13  
STATION 478+28.5  
E: 1254739.2  
N: 288059.1

222  
+88



TERRASOUND



-0209F

177 +10P -100.9m  
+0 +OR -22

2016

DEC 04 16  
12:55:19  
Brightwater

\$GPGGA,125509.74,4746.72744,N,12224.2393  
9,W,-1.00,0.0,0.0,M,,,\*0F6,N,12237.6150

# 600 FEET



# 100 FEET VIDEOS

2008

Depth 035.2M  
Tilt -16.6Deg  
Vector -44.1Deg  
Pitch -0.89713/2008  
Roll HDD 100% 0.15517/13



25-JUN-15

12:23:17

D:097.7F

H:344

2015



107 -30P 34.9m  
-1 -17R -37  
2016

+47.779200° N  
-122.400300° W  
GPS: 08:31:28

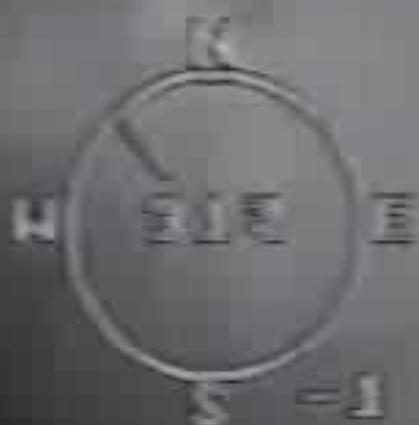
Bightwater  
09/28/2016  
08:31:38

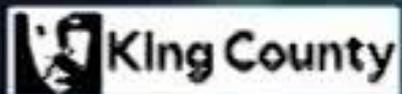


# 300 FEET VIDEOS

2008

Depth 097.7M  
Tilt -7.6Deg  
Vector -44.2Deg  
Pitch -0.89713/2008  
Roll HDD 100% 04:5:38:14





King County

RACK-B  
2012

18/09/12

Time 17:37:47  
STATION 478+60.6  
E: 1254770.9  
N: 288864.1



-0203F

TERRASOUND GLOBAL

075 +17P 67.8m  
-2 -8R -36 2015

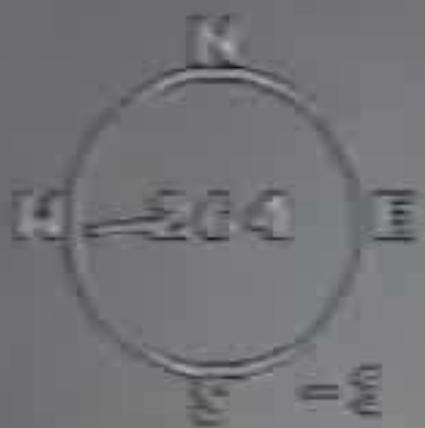
MAR 18 15  
09:09:28  
Brightwa\_

4, W, -1, 00, 0.0, 0.0, N, , , \*05, , \*120000.0000  
\$GPGGA, 090926.68, 4746.73886, N, 12224.1314

# 600 FEET VIDEO

2008

Depth 216.3M  
Tilt 18.0Deg  
Vector -44.1Deg  
Pitch -0.09713/2008  
Roll HDD 100% 0417:34:11



# POST DEPLOYMENT STUDY

- No previous long term information
- Three primary goals
  - Determine if marine life had an affect on the HDPE
  - What colonizes on the HDPE
  - Determine what effect the pipeline has on marine habitat – Pipe good? Pipe Bad?



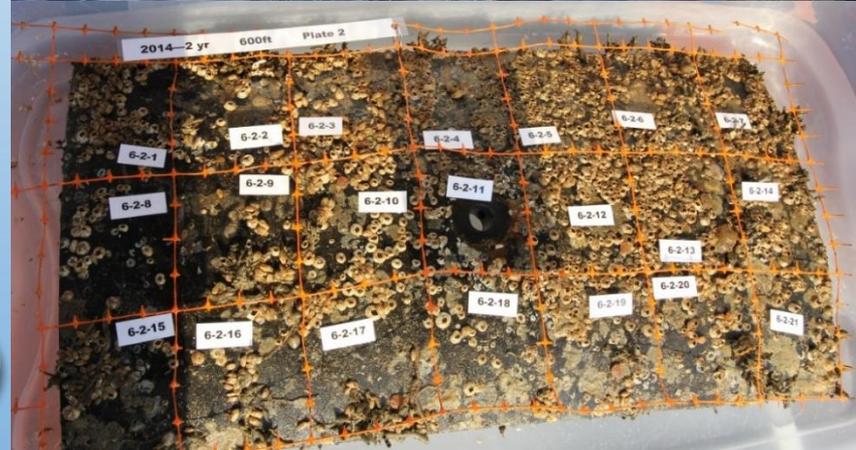
# STUDY DESIGN

- 2 ft x 1 ft sections of pipe deployed in 2012
  - -100, -300, -600 ft MLLW
  - Reference site (-600 ft)
- 10 “settlement plates” for each site
- 3 replicates to be collected at each depth year 2 & 5 and 4 in year 10



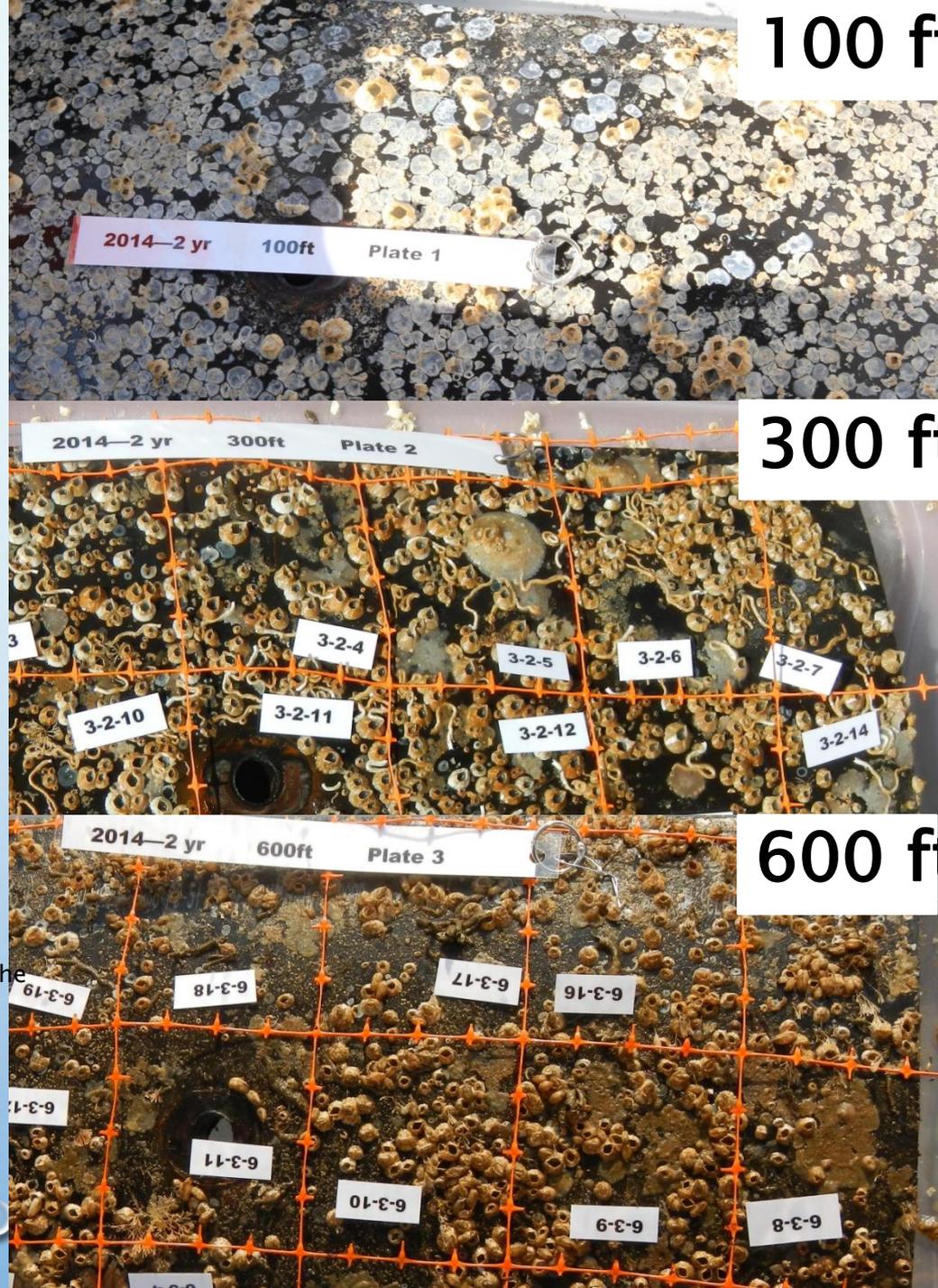
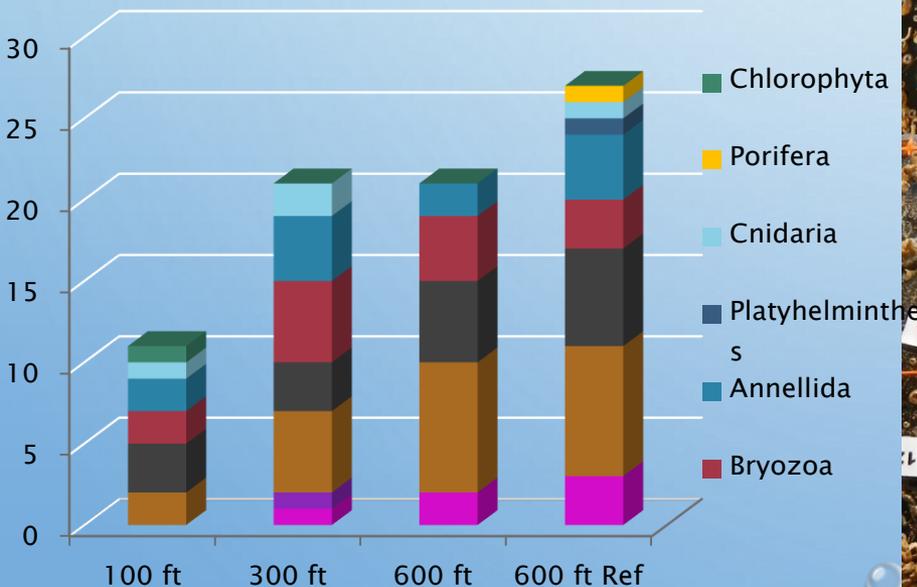
- ROV collection
- Samples assessed for % cover
- Flexible mesh grid aids in estimation – 21 cells
- Macroscopic biota identified in the field
- Photographs of each cell
  - Future identification
  - Better estimate of % cover

## SAMPLE RETRIEVAL



# PRELIMINARY RESULTS 2014

- Diversity increased past 100 ft





*Pododesmus macrochisma*



Serpulidae



*Delectopecten*



*Schizoporella* sp. & *Spiroborbis* sp.



*Tubulipora* sp.



*Trichotropsis cancellata*



*Chlamys hastata*



*Chelyosoma* sp.



*Urticina crassicornis*



*Crisia* sp.



*Chlamys rubida*



*Hiatella*



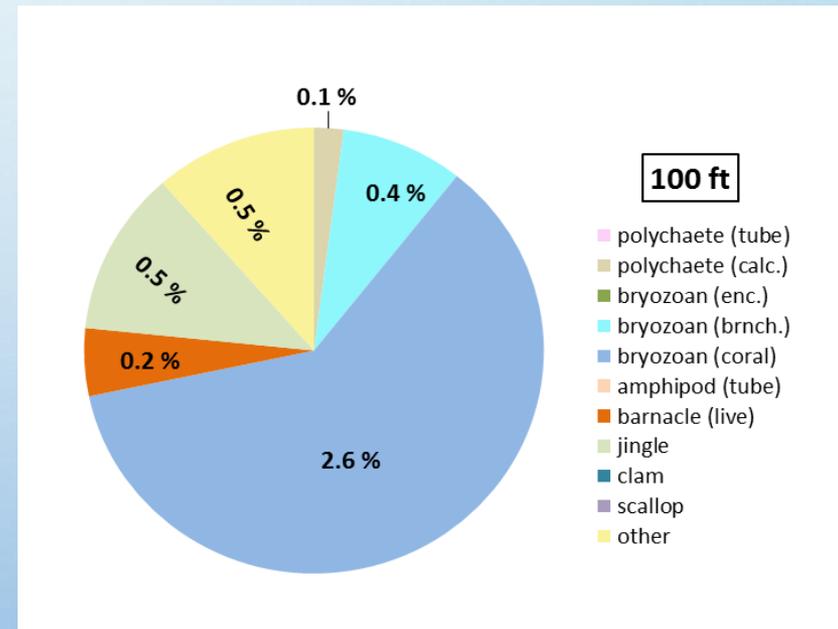
*Harmothoe* sp.



*Strongylocentrotus* sp.

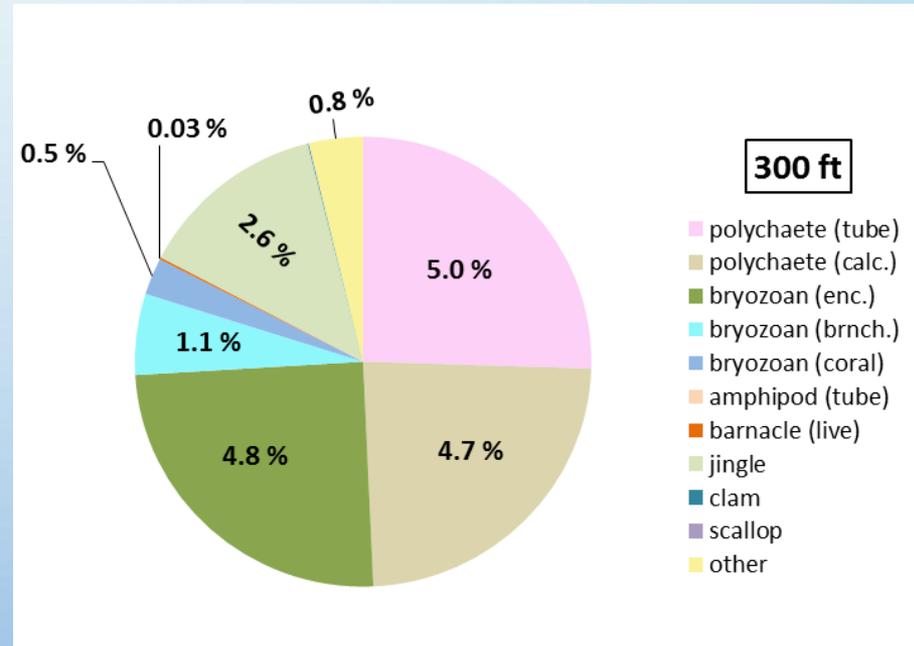
# 2014 SAMPLE 100 FEET

- Least Diverse
- High % of barnacle scars (52.1% coverage)
- Avg. total % cover was 56.3%
- Avg. % cover for live organisms was 4.2%
- Barnacle settlement was substantial however, predation likely limited the presence
- It is expected that recruitment of new



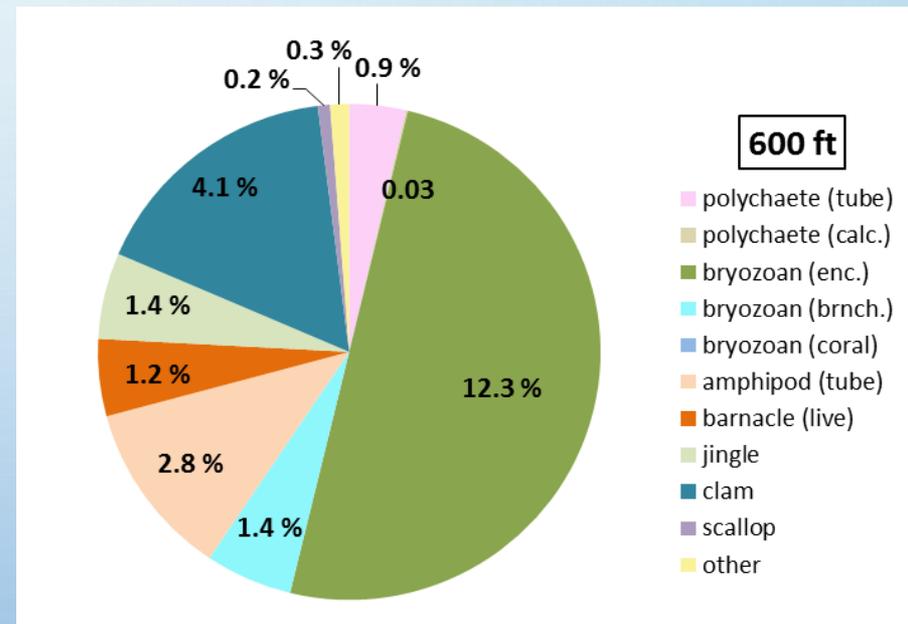
# 2014 SAMPLE 300 FEET

- Tube worms were the most abundant
- Live barnacles 0.03%
- Total percent cover 47.9%
- Due to the presence of dead barnacles
- 19.6% cover of live organisms



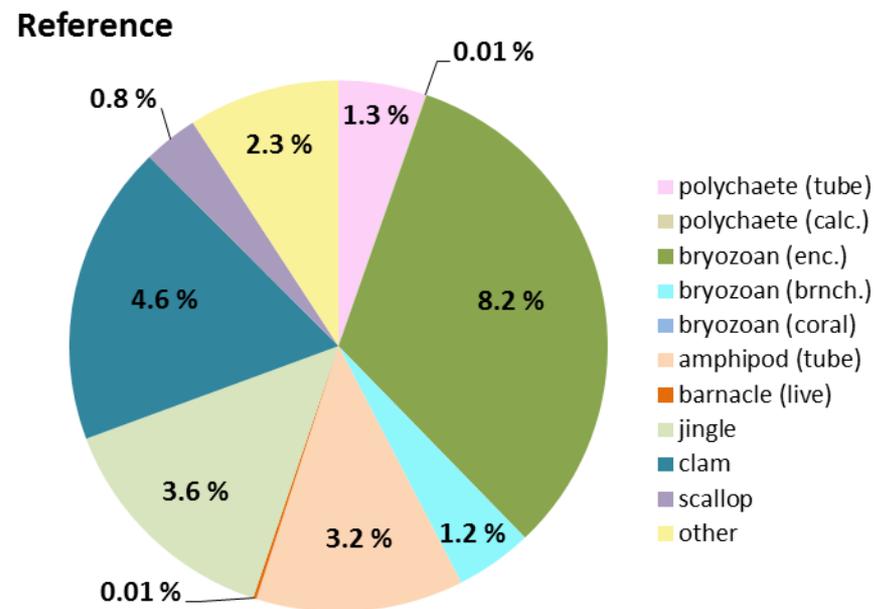
# 2014 SAMPLE 600 FEET

- The coral bryozoan was seen at lower depths but not at 600ft
- The scallops were recently settled (small), not seen at other depths
- Few motile organisms
- Total percent cover at this depth averaged 60%

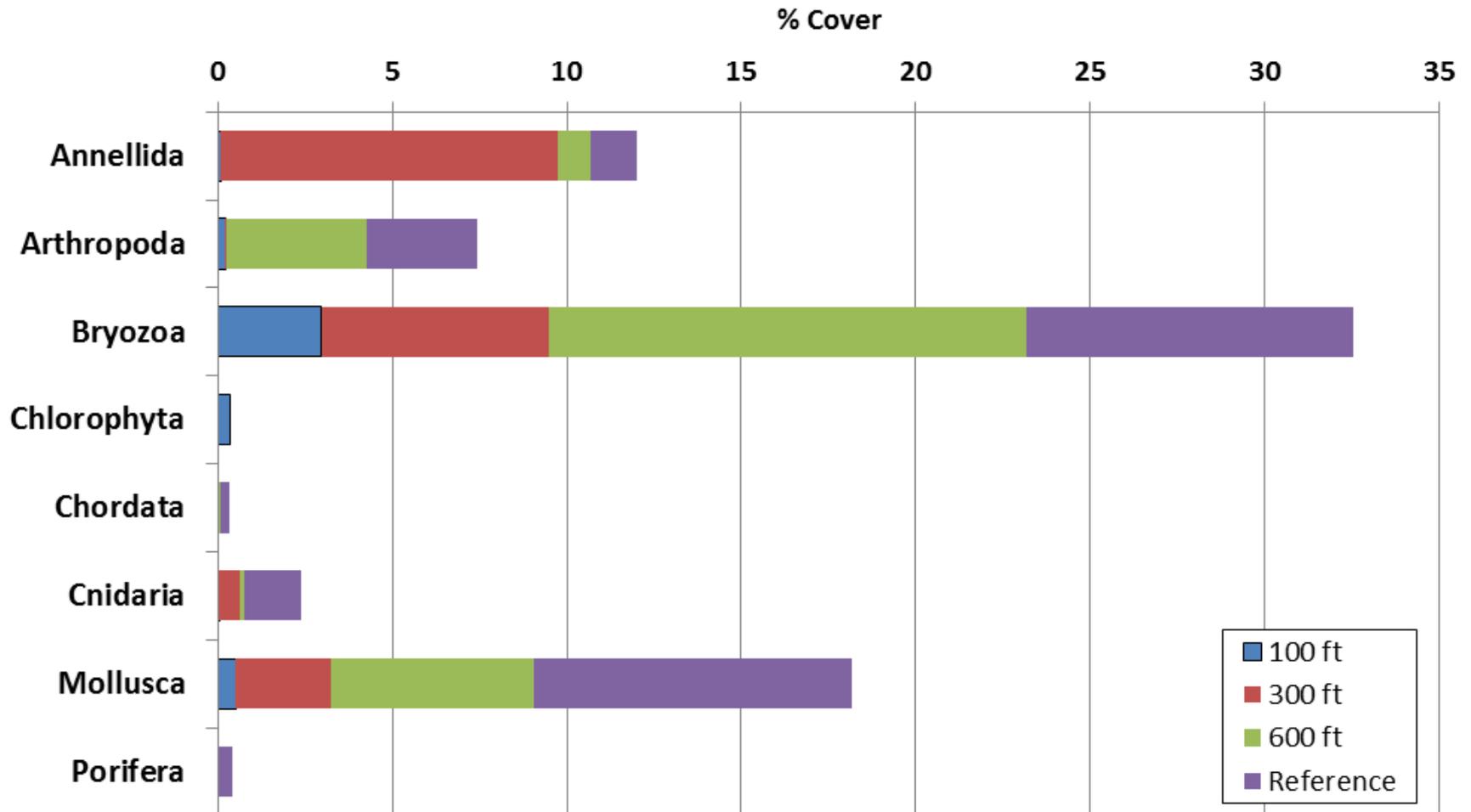


# 2014 SAMPLE 600 FEET REFERENCE

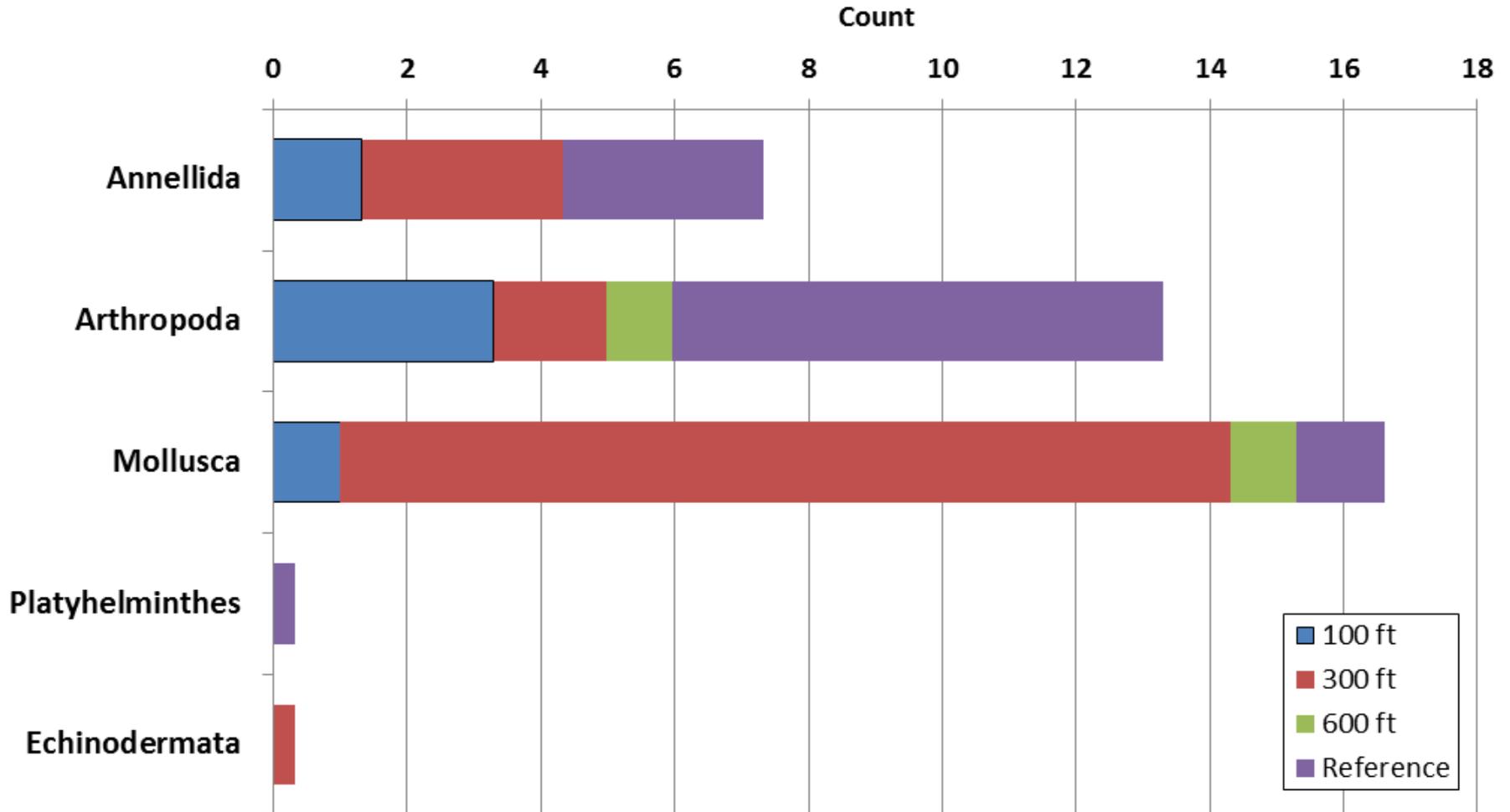
- The most motile organisms
- Total percent cover at this site averaged 67.8%, the highest of all four sites
- Percent cover of live organisms is 25.2%



# AVERAGE PERCENT COVER OF NON-MOTILE ORGANISMS BY PHYLUM FOR ALL SITES



# AVERAGE PERCENT COVER OF MOTILE ORGANISMS BY PHYLUM FOR ALL SITES



		100 ft				300 ft				600 ft				Reference: 600 ft			
Non-motile (% cover)	Phylum	Rep 1	Rep 2	Rep 3	100 ft	Rep 1	Rep 2	Rep 3	300 ft	Rep 1	Rep 2	Rep 3	600 ft	Rep 1	Rep 2	Rep 3	Reference
calcareous tubeworm	Annelida	0	0.08	0.19	<b>0.09</b>	5.34	5.58	3.08	<b>4.66</b>	0.03	0	0.06	<b>0.03</b>	0.04	0	0	<b>0.01</b>
polychaete: tube	Annelida	--	--	--	--	7.47	0.19	7.32	<b>4.99</b>	1.50	0.31	0.86	<b>0.89</b>	2.12	1.86	0	<b>1.33</b>
amphipod	Arthropoda	--	--	--	--	--	--	--	--	4.81	2.56	1.05	<b>2.81</b>	2.12	5.74	1.60	<b>3.15</b>
live barnacle	Arthropoda	0.49	0	0.15	<b>0.21</b>	0	0.10	0.00	<b>0.03</b>	0.09	3.61	0	<b>1.23</b>	0.02	0	0	<b>0.01</b>
branched bryozoan	Bryozoa	0	0.31	0.79	<b>0.37</b>	1.47	0.64	1.32	<b>1.14</b>	1.09	0.63	2.42	<b>1.38</b>	2.15	1.02	0.35	<b>1.17</b>
coral bryozoan	Bryozoa	1.56	3.01	3.27	<b>2.61</b>	0.53	0.59	0.44	<b>0.52</b>	--	--	--	--	--	--	--	--
encrusting bryozoan	Bryozoa	--	--	--	--	1.23	6.95	6.37	<b>4.85</b>	11.28	13.77	11.82	<b>12.29</b>	15.87	3.37	5.40	<b>8.21</b>
<i>Ulva</i>	Chlorophyta	0	1.13	0	<b>0.38</b>	--	--	--	--	--	--	--	--	--	--	--	--
tunicate	Chordata	--	--	--	--	0.12	0	0	<b>0.04</b>	0.11	0.00	0	<b>0.04</b>	0.33	0.02	0.38	<b>0.24</b>
anemone	Cnidaria	0	0	0.14	<b>0.05</b>	1.82	0	0	<b>0.61</b>	--	--	--	--	4.24	0	0	<b>1.41</b>
hydroid	Cnidaria	--	--	--	--	--	--	--	--	0	0	0.29	<b>0.10</b>	0.00	0.00	0.62	<b>0.21</b>
bivalve: clam	Mollusca	--	--	--	--	0	0.03	0.01	<b>0.01</b>	3.39	4.95	3.75	<b>4.03</b>	2.15	9.56	2.14	<b>4.62</b>
jingle	Mollusca	0.22	1.14	0.17	<b>0.51</b>	1.75	2.17	3.95	<b>2.63</b>	1.51	0.65	1.99	<b>1.38</b>	5.91	1.22	3.63	<b>3.59</b>
limpet	Mollusca	--	--	--	--	0.02	0	0.00	<b>0.01</b>	0	0	0.02	<b>0.01</b>	--	--	--	--
scallop	Mollusca	--	--	--	--	--	--	--	--	0.22	0.34	0.02	<b>0.19</b>	1.48	1.01	0	<b>0.83</b>
slipper	Mollusca	0.03	0	0	<b>0.01</b>	0.12	0	0.11	<b>0.08</b>	0.36	0	0.12	<b>0.16</b>	0.03	0.15	0.05	<b>0.08</b>
mussel	Mollusca	--	--	--	--	--	--	--	--	0	0.09	0	<b>0.03</b>	--	--	--	--
calcareous sponge	Porifera	--	--	--	--	--	--	--	--	--	--	--	--	0.09	0.09	0.62	<b>0.26</b>
demosponge	Porifera	--	--	--	--	0.07	0	0	<b>0.02</b>	--	--	--	--	0	0	0.36	<b>0.12</b>
<b>Motile (count)</b>																	
polychaete: errant	Annelida	0	2	1	<b>1</b>	4	3	2	<b>3</b>	--	--	--	--	4	5	0	<b>3.00</b>
amphipod/shrimp	Arthropoda	--	--	--	--	1	1	0	<b>0.67</b>	--	--	--	--	0	2	0	<b>0.67</b>
Cancridae crab	Arthropoda	3	3	2	<b>2.67</b>	1	2	0	<b>1</b>	--	--	--	--	--	--	--	--
Majoidae crab	Arthropoda	--	--	--	--	--	--	--	--	1	1	1	<b>1</b>	0	1	1	<b>0.67</b>
sea urchin	Echinodermata	--	--	--	--	1	0	0	<b>0.33</b>	--	--	--	--	--	--	--	--
snail gastropod	Mollusca	--	--	--	--	--	--	--	--	0	1	0	<b>0.33</b>	0	1	0	<b>0.33</b>
<i>Trichotropsis</i> gastropod	Mollusca	--	--	--	--	18	4	18	<b>13.33</b>	0	1	1	<b>0.67</b>	0	1	2	<b>1.00</b>
ribbon worm	Nemertea	--	--	--	--	--	--	--	--	--	--	--	--	0	2	0	<b>0.67</b>
flatworm	Platyhelminthes	--	--	--	--	--	--	--	--	--	--	--	--	0	0	1	<b>0.33</b>
<b>Miscellaneous</b>																	
unidentified		--	--	--	--	0	0.07	0.02	<b>0.03</b>	0.06	0.04	0	<b>0.03</b>	0.34	0.01	1.85	<b>0.73</b>
Total % cover		59.25	53.23	56.39	<b>56.29</b>	48.16	51.67	43.78	<b>47.87</b>	55.26	64.07	60.91	<b>60.08</b>	60.64	74.33	68.36	<b>67.78</b>

# STRUCTURAL ANALYSIS OF 2014 SAMPLES

- Uponor, the pipe supplier, provided the samples
- Inspection team fabricated stands and racks
- Uponor agreed to do testing and provide data in exchange for



**BUSINESS NUMBER (BN) - IMPORT EXPORT ACCOUNT REGISTRATION FORM FOR BROKERS AND AGENTS**  
 The entire form must be completed for clients who do not have a Canadian Federal Business Number (Payroll, G.S.T., Corporate Tax, etc.). Part 2 can be left blank when a BN has been entered in Part 1.  
 If your client is incorporated and does not already have a BN, please include a copy of the Certificate of Incorporation with this application.

**Part 1 - Client Identification**

Fax to the Winnipeg Tax Centre at 1-800-959-8302. Allow 24 hours

If your client has a BN, please enter it here: \_\_\_\_\_

Legal status (check one):  Individual proprietor  Partnership  Corporation  
 Other - describe **County government entity**

Legal name: (As it appears on a Birth Certificate or a Certificate of Incorporation):  
**King County, Washington**

Business name or division name (When different from legal name): \_\_\_\_\_

Business address: (street, city, province/state, county, postal/zip code)  
**201 S. Jackson ST  
 KSC-NR-0568  
 Seattle, WA 98104**

Mailing address: (If different from business address)  
 c/o \_\_\_\_\_

Language preference:  English  French

Contact who can be reached at this business:  
 First name: **Jeffrey** Last Name: **Lundt**  
 Telephone: **(206) 477-5582** Fax: **(206) 484-1710**

**Part 2 - Owner Information (name of proprietor, partner or executive officer of the corporation)**

First name: **Dow** Last name: **Constantine**  
 Canadian Social Insurance Number: **Not applicable** Title: **King County Executive**  
 Telephone: **not available** Fax: **not available**

**Part 3 - Import/Export Account Information**

Check one of the following:  Import Account  Export Account  Import-export account  MCIT  
 Type of goods exported: **HDPE Samples** Estimated annual value of goods exported: **SCAN: \$42 USD**

**Part 4 - Broker/Agent Information**

Broker agent first name: **NOEMI** Broker agent last name: **CRTZ**  
 Brokerage: **FEDEx TRADE NETWORKS TRANSPORT & BROKERAGE**  
 Telephone: 1 800 388 9479 X 296 Fax: (905) 362 2383

Departmental use - Importer/Exporter # \_\_\_\_\_ RM \_\_\_\_\_

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**UNIFORM STRAIGHT BILL OF LADING ORIGINAL - NOT NEGOTIABLE**

**FedEx**

Shipper: \_\_\_\_\_ Receiver: \_\_\_\_\_  
 Description of goods: \_\_\_\_\_  
 Quantity: \_\_\_\_\_  
 Weight: \_\_\_\_\_  
 Volume: \_\_\_\_\_  
 Dimensions: \_\_\_\_\_  
 Special handling instructions: \_\_\_\_\_  
 Incoterms: \_\_\_\_\_  
 Date of issue: \_\_\_\_\_  
 Place of issue: \_\_\_\_\_  
 Place of destination: \_\_\_\_\_  
 Date of arrival: \_\_\_\_\_  
 Place of arrival: \_\_\_\_\_  
 Signature of shipper: \_\_\_\_\_  
 Signature of receiver: \_\_\_\_\_

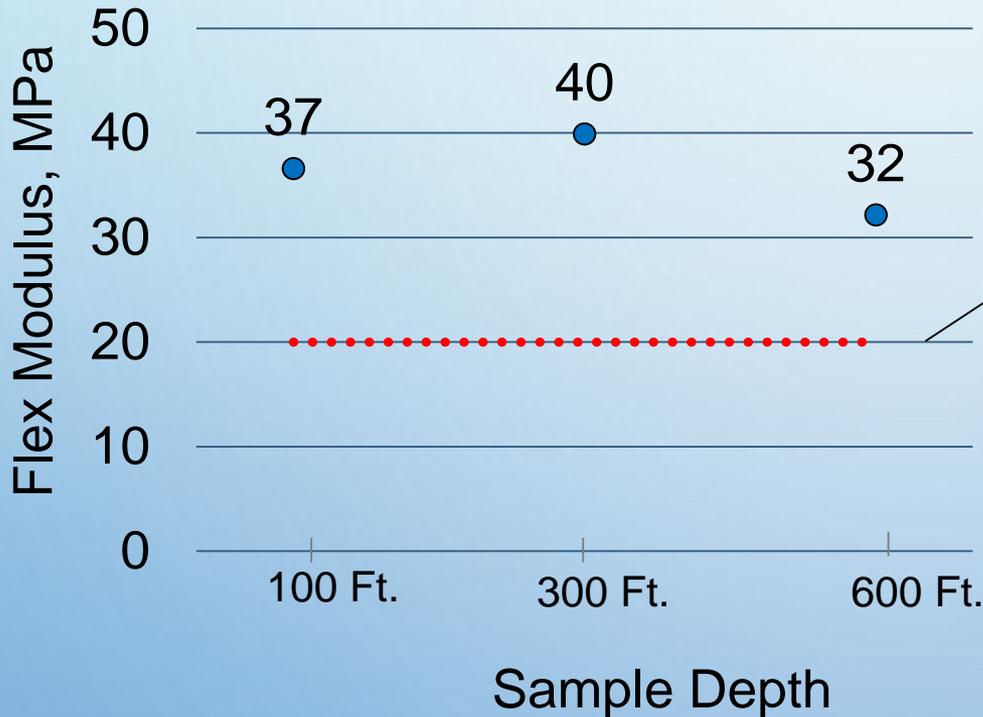
DATE	TIME	BY	DESCRIPTION	QUANTITY	WEIGHT	VOLUME	INCOTERMS	DATE OF ISSUE	PLACE OF ISSUE	PLACE OF DESTINATION	DATE OF ARRIVAL	PLACE OF ARRIVAL
1	CRT 12		pipe samples (to be returned to original manufacturer)	2	10							

# STRUCTURAL ANALYSIS 2014 SAMPLES

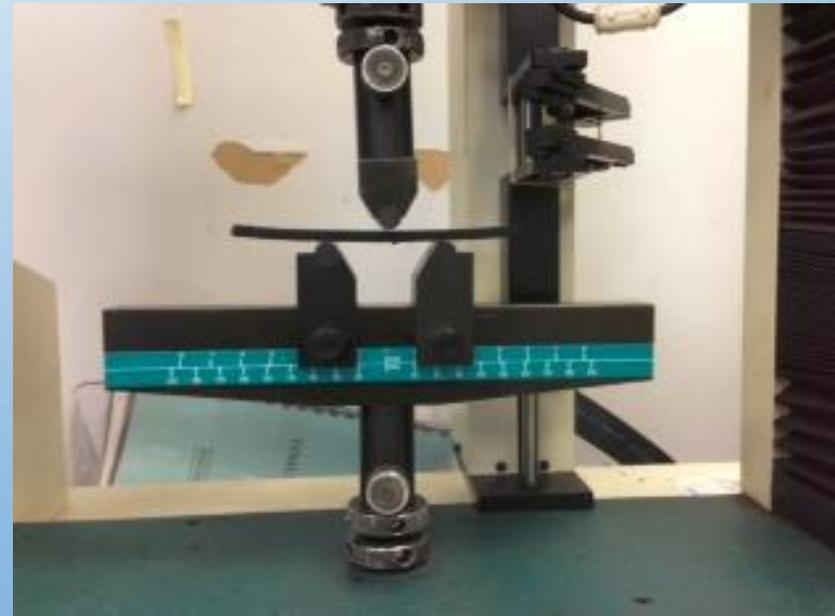
- Uponsor's QA material testing lab in Saskatoon, Saskatchewan.
- Samples tested for:
  - Tensile strength,
  - Flex modulus @ 5% strain,
  - Flex modulus @ 2% strain



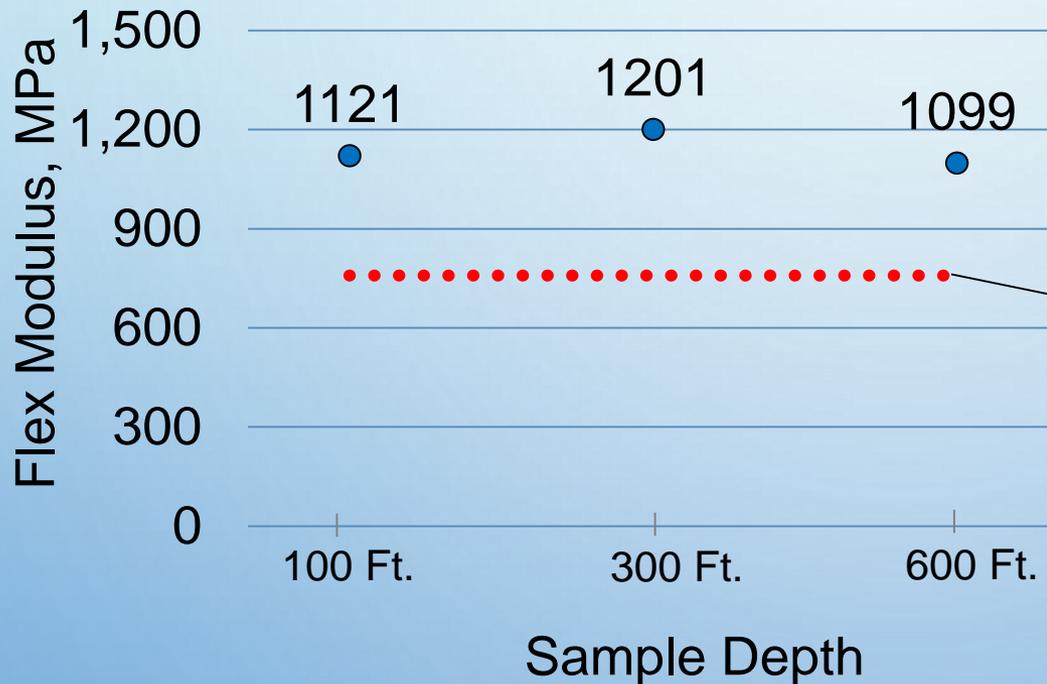
# FLEX MODULUS @ 5% STRAIN - 2 YEAR



Reference minimum flex modulus-5% value for Uponor's solid-walled HDPE (20 MPa)



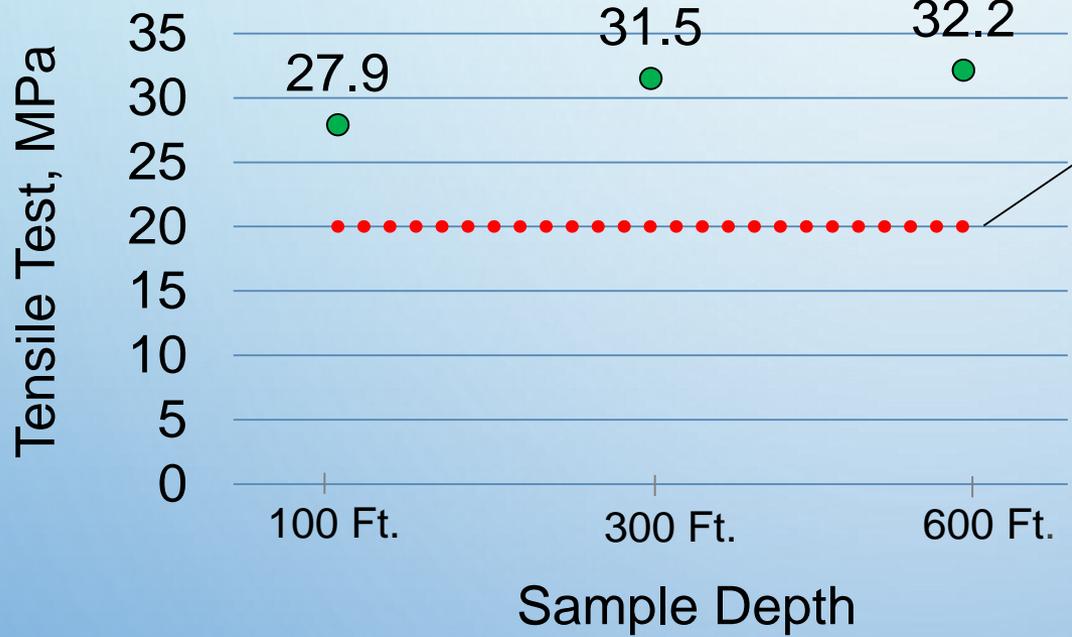
# FLEX MODULUS (SECANT) @ 2% STRAIN - 2 YEAR DATA



Reference minimum flex modulus-2% value for Uponor's solid-walled HDPE (758 MPa)



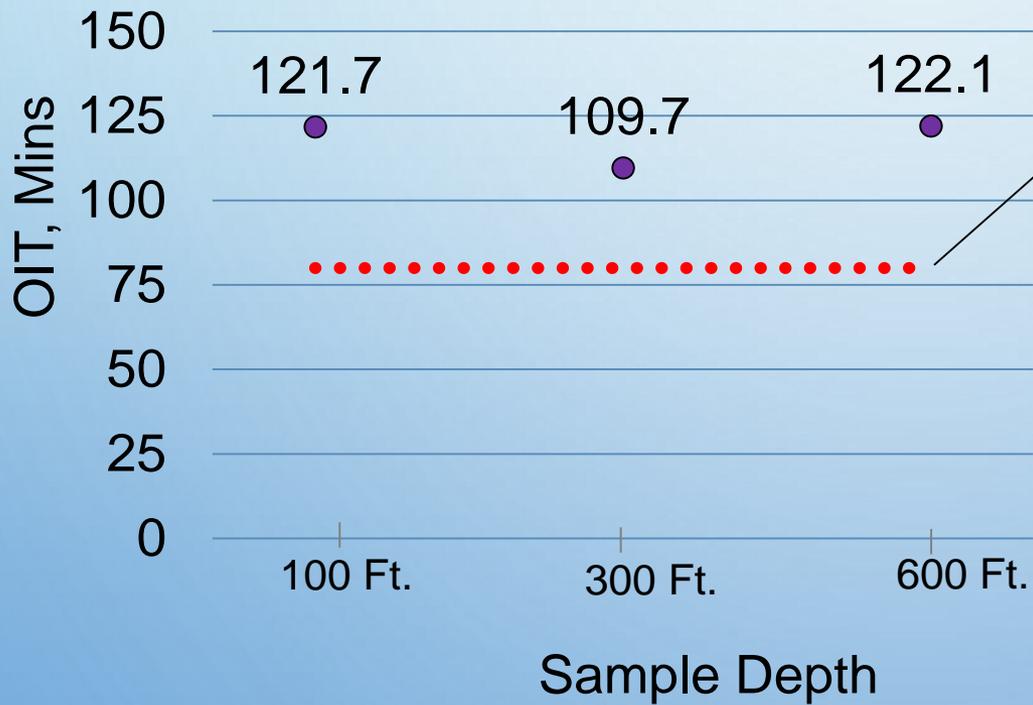
# TENSILE TEST



Reference minimum tensile strength value for Uponor's solid-walled HDPE (20 MPa)



# OXIDATIVE INDUCTION TIME



Reference minimum tensile strength value for Uponor's solid-walled HDPE (80 mins)



# CONCLUSION

- It does not appear that the effluent has had a substantial impact on the biological colonization and composition of the plates.
- The outfall pipe made a habit for marine life
- HDPE pipe was found to be above baseline strength
- Numbering & marking on weights & ports is quickly hidden by marine growth
- 10 year's data should provide good info for habitat evaluation

# COMMENTS & QUESTIONS



For more information please contact:

Jeff Lundt

[jeff.lundt@kingcounty.gov](mailto:jeff.lundt@kingcounty.gov)

206/477-5582